NOTES ON
NEW YORK CITY AND VICINITY

COMPILED FOR

NEW ENGLAND WATER WORKS ASSOCIATION

Convention of 1905

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NOTES ON

NEW YORK CITY AND VICINITY

DESCRIBING ENGINEERING WORKS
AND PLACES OF GENERAL INTEREST

COMPILED FOR THE ANNUAL CONVENTION

OF THE

NEW ENGLAND WATER WORKS ASSOCIATION

TO BE HELD IN NEW YORK CITY

SEPTEMBER 13 TO 16, 1905

NEW YORK
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To the members and guests of the New England Water Works Association this booklet is offered on the occasion of the annual convention in New York City, September 13 to 16, 1905, with the compliments of the Local Committee on Arrangements. It has been compiled and edited by the sub-committee on publication as a summer evening pastime. No one claims that it is unabridged; something is left to the inquisitiveness of the reader. Furthermore, as the committee receives a commission on all guide books sold in New York, particular care has been exercised to avoid interfering with that business. Free use has been made of any sources of information that suited the whims of the committee, and no detailed obligations will be acknowledged. Everybody who wishes may claim credit for contributions. No mistakes have been made; if you disagree with anything on the following pages, just change it.

Most respectfully,

Sub-Committee on Publications,

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New York, August 10, 1905.

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HIGH BRIDGE.

Matters of Interest to Visitors to New York.

The subjects of greatest interest to most visitors to New York depend chiefly upon the commercial and financial greatness of the city. New York has little to offer to the historian except personal associations of distinguished men. Excepting for its superb site, it cannot be regarded as a beautiful city. It is the home of several important universities and other centers of instruction, but the claim of intellectual superiority is not the one most prominently advanced. It is as a center of commerce and finance that New York stands alone in America. In these respects it is also becoming the chief city of the world.

Many of the causes and evidences of the vast trade and money interests which center in New York are apparent to the most casual tourist. It is to aid in bringing some of these objects to the attention of water-works men and engineers that the following notes are prepared. The same information is obtainable from other quarters, but it is believed that this brief account may lead the visitor to economize some of his time and prove not unhelpful to an intelligent opinion of the Metropolis. For fuller information concerning the sights of the city the visitor is referred to various guide books, among the best and most recent of which are the "Standard Guide," published by Foster & Reynolds, 25 cents; "Appleton's Directory of Greater New York," 25 cents; the "World" and "Eagle" almanacs.

HISTORY.

The authentic history of New York begins with the exploration of the Hudson River by Henry Hudson in 1609. The first permanent settlement was made in 1624 by the West India Company. At this time Manhattan Island was bought from the Indians for about $25.00 by Peter Minuit, who founded the settlement which was called New Amsterdam and has since become the city of New York. The town was seized by the English, in time of peace, in 1664, was retaken by the Dutch in 1673 and passed into English possession again by treaty in 1674.

In 1765 delegates of nine of the thirteen colonies met in New York to protest against the Stamp Act and assert the doctrine of no taxation without representation. The first bloodshed of the Revolution took place in New York in 1770, in a scuffle with British soldiers about a liberty pole erected by the Americans to commemorate the repeal of the Stamp Act. This was six weeks before the Boston Massacre. At that time New York had a population of about 20,000, and was exceeded in size by Boston and Philadelphia. The city extended as far up town as the present location of the City Hall. The liberty pole just referred to was in this vicinity.

New York was the scene of some desperate contests during the Revolutionary War. Washington occupied the place in 1776. In the neighborhood of 116th Street, on high ground now occupied by Columbia University, may be seen a tablet marking a place which was heroically defended by the Americans in the Battle of Harlem Heights, September 16, 1776. After the battles of Harlem Heights and Long Island, the American army retired from the vicinity of New York, and the town was occupied by the British as headquarters for seven years. The British evacuated it in 1783, the last boatload of soldiers leaving the Battery on November 25. From 1785 to 1790, New York was the seat of the new Federal Government. Until 1797 it was the capital of the State.

At the commencement of the 17th century the population of New York was 60,000; at the commencement of the 20th century it was 3,437,202. In 1807 the first steamboat was put upon the Hudson; the Erie Canal connecting New York with Buffalo, on Lake Erie, was opened in 1825; Croton water was introduced in 1842; the elevated railroad was opened in 1878; gas lighting dates from 1825; illumination by electricity about 1881. In the war of 1812, commerce in New York suffered greatly. The city contributed 116,000 men to the Civil War.

TOPOGRAPHY AND DIVISIONS OF THE CITY.

Topographically, New York may be divided into two parts: Manhattan Island and the districts which are adjacent to it. The chief interest to tourists naturally centers about Manhattan, which is the oldest, most thickly populated and most important section of the city.

Manhattan Island is a long, narrow neck of land extending almost in a north-and-south direction between the Hudson River and a broad, deep, tidal channel, connecting Long Island Sound with New York Harbor, called the East River. The island's greatest length is 13 miles, and its average width less than 2 miles. The northern part is hilly, with limestone and gneiss formations; the southern is low, with deep alluvial deposits. Manhattan Island has a long water front, nearly all of which is available for ships of the deepest draft. The water front of the greater city is about 450 miles.

North of Manhattan Island is that section of New York City known as the borough of the Bronx. It is mainly a district of suburban homes and parks with several thickly-settled neighborhoods along its southeastern border. The area of the Bronx is about 40 square miles. The region is made up chiefly of parallel hills and valleys, the greatest elevations being about 200 ft. New York University is situated in the Bronx with its celebrated Hall of Fame overlooking the Harlem River at Morris Heights, easily reached by the New York Central Railway. The Bronx and its various parks, of which the Zoölogical and Botanical Gardens are of the greatest interest to strangers, can be reached by the Second or Third Avenue elevated railway system, by the Rapid Transit Subway or by various trolley lines.

To the east of Manhattan Island lies the borough, and former separate city, of Brooklyn. Brooklyn is popularly known as the "City of

Churches," although just before it was consolidated with New York City, Brooklyn was the fourth largest manufacturing center in the United States. Some of its factories are the largest in the vicinity of New York. Extensive sections of Brooklyn are devoted to unpretentious but comfortable residences. Prospect Park and the Mt. Prospect Water Laboratory are situated in Brooklyn. The population of Brooklyn in 1900 was 1,166,582. Most of the land is well elevated above the sea. The Brooklyn and Williamsburg Bridges and various ferries across the East River connect this borough with Manhattan.

East of Brooklyn lies the borough of Queens, the largest geographical division of New York City; its total area is 124 square miles. For the most part the land lies at a comparatively slight elevation above tide water. The borough of Queens extends from the Atlantic Ocean to Long Island Sound. Excepting the large settlements near Long Island City and Jamaica, Queens is a region of farms, suburban homes and one-day summer resorts. The most interesting of these resorts, Coney Island and Rockaway Beach, can be most conveniently reached by boat from the Battery, by trolley across the Brooklyn Bridge, or by the Long Island Railroad from Thirty-Fourth Street, East River, Manhattan.

South of New York is the borough of Richmond, generally known as Staten Island; its area is 57 square miles. There is probably no other region of that extent on the Atlantic Coast so diversified in scenery and in botanical interest. The hills of Staten Island reach the greatest elevation of any land on the Atlantic Coast south of Maine, 412 ft. A magnificent panoramic view of outer New York Harbor, the Atlantic, Brooklyn, Coney Island and Manhattan can be had in fine weather from the Howard Boulevard, which can be reached by trolley from St. George, the terminal of the Staten Island ferry, which leaves the Battery every half hour. The population of Staten Island resides for the most part in several old villages and in extensive country places scattered over the hills. Midland Beach and South Beach are one-day summer resorts reached by trolley from St. George.

THE HARBOR.

The southern extremity of Manhattan Island, called the Battery, forms the inland limit of the upper New York Bay, a land-locked harbor 8 miles long and 4 to 5 miles wide. The State of New Jersey lies to the west; Long Island to the east. It is 18 miles from the Battery to the ocean. The lower bay, or outer New York Harbor, is connected with the upper bay by a slender channel called the Narrows, and is protected from the sea by a bar, 18 miles long, which extends from Sandy Hook on the New Jersey shore to that part of Long Island known as Coney Island. There are 32 ft. of water over the bar at high water. Sandy Hook and the Narrows are elaborately fortified. Good views of the upper and lower bays can be had from the Coney Island boats, leaving Pier 1, North River, and West Twenty-Second Street, hourly, or from the swift steamboats of the Sandy Hook line from Pier 6, North River. Between the upper and lower bays is Staten Island, with an area three times that of Manhattan

Island, but a population only about one twenty-seventh of that of its smaller neighbor.

There are several islands in the upper bay which are of interest to tourists. Liberty Island is interesting for the colossal statue of Liberty Enlightening the World, which it contains. This work is by Bartholdi, and was presented by the French people to commemorate the 100th anniversary of the Declaration of Independence. The statue is of copper, 151 ft. high, resting on a granite pedestal 155 ft. high, the total height above low-water mark being 306 ft. It was unveiled in 1886. Liberty Island may be reached by steamboats which run at hourly intervals from the Battery; fare 25 cents for round trip. An excellent bird's-eye view of the upper harbor and shipping may be had from the various points on the statue, to which admission can be obtained. The drinking water used on the island is carried there by boat.

Ellis Island, to the north of Liberty Island, is a government station for immigrants. All the immigrants which reach New York from foreign ports are landed here and cared for in large buildings until they can be forwarded to their proper destinations, or called for by relatives. The drinking water used here is piped from New Jersey. The total number of alien immigrants from foreign countries who arrived at the port of New York in 1903 was 718,423. Of this number over 200,000 came from Italy; 170,000 from Austria-Hungary, and 104,000 from the Russian Empire and Finland.

Governor's Island lies at the mouth of the East River, near the Battery. It is a government army station, the headquarters of the Department of the Atlantic. The principal point of interest is the picturesque Castle William, a small, round brick fort which is situated on the western shore. The drinking water for Governor's Island is brought from the Long Island shore by pipe line.

Blackwell's Island, which lies in the East River between Fiftieth and Eighty-Fifth Streets, Manhattan, is owned by the city, and used, in common with other islands in the vicinity, for public institutions of various kinds. Blackwell's Island contains a charity hospital, penitentiary, almshouse, workhouse and lunatic asylum. It can be reached by ferry from the foot of East Twenty-Sixth Street, near Bellevue Hospital, one of the largest hospitals in the world. A permit from the Commissioner of Charities and Corrections is required.

Ward's and Randall's Islands, at the junction of the Harlem and East Rivers, are occupied by city institutions, and can be reached by the ferry at the foot of East Twenty-Sixth Street. Permission to visit these islands is required from the Commissioner of Charities and Corrections.

In the lower bay are Hoffman and Swinburne Islands, occupied by the Commissioner of Quarantine of the State of New York. The quarantine of the harbor is carried on by this commission under circumstances which give security against the introduction of infectious diseases from other ports and impose the least possible inconvenience upon commerce. Instead of detaining ships 40 days, as the name quarantine implies, many vessels are not delayed a moment. The necessary formalities and examinations are often carried on by the quarantine officers while the ship is still under way. The quarantine office, with its disinfecting apparatus, laboratories and other extensive equipment, may be visited at its principal headquarters at Stapleton, Staten Island. Dr. A. H. Doty is quarantine officer.

The transportation of passengers and merchandise across the bay and rivers in the New York district is a large business. The total number of vessels which entered and cleared the harbor in 1903 was 7,532, with a total tonnage of 17,900,168 tons. In the same year the number of vessels belonging to the port of New York was 4,138, with a tonnage of 1,400,000 tons. A large amount of the freight traffic carried by water at New York is handled by the railroads which have terminals at this point, the total weight of freight, exclusive of coal, carried by these roads exceeding 5,000,000 lbs. per day. There were transported on ferry boats in the New York district in 1903, 204,000,000 passengers, of which 8,811,000 traveled directly across the center of the upper New York Bay. Most of the remainder crossed the Hudson and East Rivers. Many of these passengers were "commuters," who traveled back and forth daily between their homes and business. In the same year the number of pleasure seekers carried on excursion steamers was 2,300,000.

STATISTICS.

By consolidation with Brooklyn, Staten Island and some other neighbors, New York greatly increased its area and population in 1896. The chief increase in population came from the absorption of the city of Brooklyn; the principal additions to the city's area came from the rural districts of Queens and Staten Island. The total area of the city is 209,218 acres, or 226.9 square miles. The population, according to the census of 1900, was 3,437,202. Of the total population, 1,850,093 lived in Manhattan, and 1,166,582 in Brooklyn. In addition tens of thousands come every day from New Jersey and more distant regions. In 1904, there were 77,083 deaths, making a total death rate of 20.32 per 1,000.

New York has 6,962 acres of parks and open spaces, and nearly half as many acres of cemeteries. There are 2,852 miles of streets, 1,636 miles of sewers, and nearly 1,000 miles of street railways, including the elevated and subway systems. The net public debt in 1904 was $333,914,133; the assessed value of real estate, $5,015,463,779; the total value of personal property, $625,078,878; the tax rate per $1,000 of assessed value, between $15.10 and $15.90, differing slightly in the different boroughs; the estimated population, 3,892,455; the death rate, 16.63. The police cost more than any other department, except public schools, which cost $21,997,017. The number of policemen was 8,282, and the cost of maintaining this force was $12,409,466. The cost of cleaning the streets was $5,692,912.

BROADWAY.

Broadway, the most important business thoroughfare in New York, extends, with numerous curves, from the Battery, at the southern extremity of Manhattan Island, to the northern limits of the city, its general direction being a little east of north. Most of the avenues run in a more northeasterly direction, so that several of them intersect it. Broadway is said to be the largest street in the world, and is a part of the old Post Road to Albany, the State Capital, 144 miles up the Hudson River. For 4 miles from its beginning Broadway is crowded on either side with tall office buildings, many of which are built on the steel skeleton principle. By this method of construction buildings are erected which do not depend upon the strength of their walls for support; in fact, it is common for the walls, like curtains, to be added after much of the frame has been finished. Some of these buildings exceed 30,000 tons in weight; occasionally their foundations go down 100 ft. to bed rock. In some of these buildings there are local and express elevators which move at the rate of 500 ft. per minute, and carry 25,000 persons per day. The cost of some of these buildings, with land, is several million dollars. Space for office purposes on the upper floors of the tall office buildings rents for from $2.00 to $4.00 per square foot per year. In at least one of these buildings, the Broad Exchange, there are over 3,000 people who receive mail. The first steel skeleton building to be constructed anywhere is the structure at No. 50 Broadway, built in 1888-89. Among the most important of the office buildings on lower Broadway are the Washington, Bowling Green, Standard Oil, No. 42, Manhattan Life, Equitable, Empire, Trinity, Western Union and St. Paul. Aldrich Court, at No. 43, occupies the site of the first habitation of white man on Manhattan Island.

Trinity Church, at the head of Wall Street, was built in 1839-46, on the site of a church erected in 1696. The Trinity Corporation owns real estate of different kinds which is said to produce a yearly income of over $500,000. St. Paul's Church, a little further up Broadway, was erected in 1756, and is the oldest church in New York; it was designed by Sir Christopher Wren, the architect of some of the finest churches in London. Across the way from St. Paul's, on the corner of Vesey Street, is the Astor House, one of the best known hotels in the city, built in 1836. On Park Row, in the same vicinity, is the Park Row office building, the tallest structure in the city—390 ft. high. The cost of the building and ground was $4,000,000. The general postoffice, at the junction of Park Row and Broadway, is a large stone building with a mansard roof. About 3,000 persons are said to be employed here. In 1900 the receipts of this postoffice amounted to $3,998,378.60. There were twenty-seven collections each day. In New York City there are about 10,000,000 pieces of mail matter handled every twenty-four hours. Transportation of mail is facilitated by the use of pneumatic tubes extending to various parts of the city. There are a large number of branch postoffices.

The City Hall, in the center of City Hall Park, near the intersection of Broadway and Chambers Street, was built in 1803-12. Among the interesting things shown to visitors is the chair used by Washington at his inauguration and in which he wrote his first message to Congress. North of the City Hall are the Court House and other buildings used as city offices. On the east is the entrance to the Brooklyn Bridge.

One block east of Broadway, at Franklin Street, is the City Prison, commonly called "the Tombs." Here persons charged with the most heinous crimes are confined pending trial or transportation to the State Penitentiary at Sing Sing. The Tombs received its name from its gloomy, damp and unwholesome appearance. Before it was remodeled it was probably the best specimen of Egyptian architecture outside of Egypt. Connecting the Tombs with the Criminal Court Building across the street is an overhead passage called the "Bridge of Sighs."

From City Hall Park to Astor Place, or Eighth Street, Broadway is given up almost exclusively to wholesale drygoods establishments. A block or so east of Broadway and Eighth Street is Cooper Union, a public institution which offers night courses in arts and sciences for persons who must be otherwise employed during the day time. Cooper Union has the largest assembly hall in the city used for public meetings. Near by, on Lafayette Place, is the Astor Library, founded in 1848 by John Jacob Astor; it contains 450,000 volumes and 200,000 pamphlets. In 1895, the Astor, Tilden and Lenox libraries were combined and are now known collectively, with other smaller libraries which have since been amalgamated with them, as the New York Public Library. This combined library has two reference branches and twenty-nine circulation branches. Its total number of books in 1904 exceeded 1,000,000. There was circulated for home use in the same year over 3,500,000 volumes.

From Eighth Street to Thirty-Fourth Street, Broadway is the most important thoroughfare, and the eastern limit of the shopping district. Many of the largest retail department stores are located within this area. The other important streets in the shopping district are Fourteenth Street, Sixth Avenue, Eighteenth, Twenty-Second and Twenty-Third Streets, and Fifth Avenue from Twenty-Second to Thirty-Fourth Streets.

Grace Church (Protestant Episcopal) at Broadway and Eleventh Street, erected in 1845, is one of the most beautiful specimens of Gothic architecture in the city. Its interior has been decorated with great care and is rich in stained glass, carvings and mosaics. A large earthenware jar in front of the building was brought from Rome, where it was found 40 ft. below the surface of the ground. The church is always open.

Union Square Park is at Broadway, Fourteenth and Seventeenth Streets. At the southeast corner stands an excellent equestrian statue of Washington, by J. Q. A. Ward, and a smaller statue of Lafayette, by Bartholdi; a statue of Lincoln is nearby. Two blocks east, on Fourteenth Street, is Tammany Hall, the home of the Tammany Society, founded in 1789 for benevolent purposes.

Broadway intersects Fifth Avenue at Twenty-Third and Twenty-Fourth Streets, opposite Madison Square Park. Here stands the towering, wedge-shaped Fuller office building, popularly styled "flatiron." The extensive structure of Madison Square Garden, 425 ft. long and 200 ft. wide, surmounted by the statue of Mercury, by St. Gaudens, is at the northeast corner of Madison Square. Dr. Parkhurst's church, on Madison Avenue, now overtopped by the building of the Metropolitan Life Insurance Company, is at the southeast corner of Madison Square. Across Madison Avenue, in the Park, is a statue of S. S. Cox, who was overcome and met his death from exposure at this point in the blizzard of March 12,

1888. One of the finest statues in the city, that of Farragut, by St. Gaudens, is at the northwest corner of the park. A statue of Seward, and an obelisk to Worth, are near by. The Fifth Avenue Hotel, long a landmark of the city, is at the southwest corner of Madison Square. From Twenty-Third Street to Forty-Fourth Street, Broadway, is largely given over to hotels, restaurants, theaters and shops.

In the vicinity of Thirty-Fifth Street and Broadway are several new and large department stores, and the building of the "New York Herald." Through large windows in the Herald Building the latest types of newspaper presses may be seen turning out editions of the "Herald" and "Evening Telegram." At Fifth Avenue, Thirty-Third and Thirty-Fourth Streets, one block east, is the fashionable Waldorf-Astoria Hotel.

The neighborhood of Forty-Second Street and Broadway is at night one of the most brilliantly lighted districts in the world. It is a center of theaters, hotels and restaurants. At this point the new Times Building covers a triangular block, similar to that occupied by the Flatiron Building. The Hotel Astor, one of the newest and largest hotels in the city, is at Broadway and Forty-Fourth Street. From Forty-Fourth to Fifty-Ninth is the center of the automobile and horse and carriage business. Above Fifty-Ninth Street, Broadway, formerly called the Boulevard, is chiefly occupied by small temporary buildings and large apartment houses.

WALL STREET.

Wall Street is quite as much the name of a district as of a thoroughfare. In its broader sense it includes that part of the city which is chiefly given up to the establishments of bankers and brokers and the offices where the management of large industrial enterprises is carried on. By far the largest part of these headquarters are located in suites of rooms in tall buildings, although some of the most important have separate quarters. Wall Street received its name from the fact that it marks the northern limit of a wall which was built for defensive purposes around the city when it was under the Dutch rule. It is a short street, and as someone has said, has a graveyard at one end and a river at the other.

Among the chief points of interest is the United States Sub-Treasury on the corner of Nassau Street with its handsome bronze statue of Washington, by the sculptor, Ward. On this site the first Congress met after adopting the constitution, and here also George Washington was inaugurated as the first President of the United States. Immense sums of money are stored in the basement of this building, the whole structure being cleverly designed to serve as a fortress in case of attack. The receipts of the Sub-Treasury are said to reach nearly $1,500,000,000 annually, and the payments about the same sum. The vaults are not open to the inspection of visitors.

Close to the Sub-Treasury is the unimposing United States Assay office. Here vast quantities of gold are melted and handled, preparatory to shipment to Europe and elsewhere. Visitors are admitted between 10 A. M. and 3 P. M.

The Gillender office building is on the corner of Nassau and Wall

Streets. Across the street, in an old-fashioned white marble structure, is the office of J. P. Morgan, probably the most influential magnate of this district. The New York Custom House, with large granite columns in front, is further east on Wall Street. It will soon be removed to make room for a tall office building, a new and larger custom house being in course of construction at the foot of Broadway.

On Broad Street, a few doors from the corner of Nassau Street, is the new York Stock Exchange, with an elaborately executed facade. The foundations for this building are particularly deep, and were built after the surrounding structures had been completed. As most of the excavation was through sand, the engineering difficulties were peculiarly great. On the floor of the New York Stock Exchange, brokers buy and sell a greater value of stocks than are exchanged in any other financial market. The membership is limited to about 1,000. A seat, as membership is called, has sold for $80,000. Admission to the gallery overlooking the floor, where sometimes scenes of great excitement can be witnessed, can be had by card from a member. On the street in front of the exchange there may be witnessed between 10 and 3 during week days an animated crowd of young men, known as the "curb." Here stocks, sometimes not listed on the regular exchanges, are bought and sold with a close imitation of the incidents which occur in the other exchanges in the neighborhood. Opposite the New York Stock Exchange, on Broad Street, is a twenty-story office building known as the Broad Exchange. Its reputed cost was over $7,000,000. It is the largest office building in the city, or in the world. A walk through Exchange Place is like a trip through a canyon.

The New York Clearing House, where most of the banks of the city adjust the balances which exist in their accounts against other banks, is in Cedar Street, near Broadway. The building is a handsome one, but visitors are not admitted to its interior.

The Chamber of Commerce Building, a new and richly decorated structure, is in Liberty Street, west of Broadway. The chamber itself is an ancient, influential body of merchants who are pledged to foster and protect the commercial interests of the port. An enumeration of the various important buildings in this vicinity would be a long list.

FIFTH AVENUE.

Fifth Avenue affords perhaps the most imposing show of affluence of all streets in the world. It has long been regarded as the most fashionable street in New York, and although the pretentions of its lower portion are gradually yielding to the encroachments of business, the major portion of this famous thoroughfare is still devoted to handsome residences and fashionable clubs, churches and hotels. From its beginning, at the handsome arch commemorating Washington's inauguration as first President, to the Harlem River, Fifth Avenue is 6 miles long. The arch is of white marble, is 70 ft. high, and was built by popular subscription. From Twelfth to Twenty-Third Streets, tall office buildings have replaced many of the old residences. Some of the largest publishing houses are situated here. The Calumet Club is on the northeast corner of Twenty-Ninth Street.

A little to the east on Twenty-Ninth Street is the "Little Church Around the Corner," made famous by the willingness of its pastor to perform burial services over the bodies of actors, for whom this office is said to be refused by the ministers of the more fashionable churches on Fifth Avenue.

The Knickerbocker Club, one of the most aristocratic in the city, stands at the corner of Thirty-Second Street. The Hotel Waldorf-Astoria, which is said to have cost $12,000,000, occupies the block between Thirty-Third and Thirty-Fourth Streets. The Lotos Club, known for the entertainment of distinguished foreigners, stands at Forty-Sixth Street. The Union League Club, the leading Republican club of New York, is at the corner of Thirty-Ninth Street. Between Fortieth and Forty-Second Streets rises the large new building of the Public Library on the site of a Croton water reservoir which occupied this ground for many years. The Grand Central Station and Manhattan and Belmont Hotels are a block or two east on Forty-Second Street. The Temple Emanu El, the principal synagogue of New York, is at Forty-Third Street. The blocks west of Fifth Avenue on Forty-Third and Forty-Fourth Streets contain some of the largest and best known clubs of the city, including the New York Yacht Club, the Century and Racquet Club and the New York Academy of Medicine. Sherry's and Delmonico's restaurants are on opposite corners of Forty-Fourth Street. On the corner of Forty-Eighth Street is a Dutch Reformed Church, which is generally recognized as one of the most graceful and artistic churches in the city. St. Patrick's Cathedral, at Fiftieth Street, is said to be the most important ecclesiastical edifice in the new world. It is 400 ft. in length, 125 ft. wide and 112 ft. high. It can hold 5,000 people.

On the northeast corner of Fifty-First Street is the Union Club, one of the wealthiest and most exclusive in the city. Two large brown stone houses on the west side of Fifth Avenue, between Fifty-First and Fifty-Second Streets, were built by W. H. Vanderbilt. The home of William K. Vanderbilt, one of the most beautiful in New York, is on the northwest corner of Fifty-Second Street. At Fifty-Third Street is the University Club. At Fifty-Fifth Street St. Thomas' Church is on one corner and Hotel St. Regis on another.* The home of the late C. P. Huntington is on the southeast corner of Fifty-Seventh Street, and the home of Mrs. Cornelius Vanderbilt is on the northwest corner.

At Fifty-Ninth Street, Fifth Avenue meets Central Park in a large open space called the Plaza. Here are the Hotel Netherlands, Savoy and Plaza. The last named building is about to be demolished in order to make room for one still larger. At the entrance of Central Park at Sixtieth Street is a new and pretentious equestrian statue of General W. T. Sherman. At the corner of Sixtieth Street is the Metropolitan, sometimes called the "Millionaires" Club. Eldbridge T. Gerry's house is one door above on the same block. The Progress Club is at Sixty-Third Street, the Havemeyer house is at Sixty-Sixth Street, and the Brokaw house is at Seventy-Ninth Street. Senator W. A. Clark's

* This church was destroyed by fire August 10.

house is on the corner of Seventy-Seventh Street. The east entrance to Central Park menagerie is in Sixty-Sixth Street. The Lenox Library, now merged into the New York Public Library, is at Seventieth and Seventy-First Streets. Besides its large collection of reference works, there are many objects of special interest here, including probably the first book printed with movable types, the first book printed in English, the first book printed in the United States, and many other rare books. An art gallery is connected with the library. The Metropolitan Museum of Art is at Eighty-Second Street and Fifth Avenue. Andrew Carnegie's house is at Ninetieth Street.

MUSEUMS, MONUMENTS AND PARKS.

New York is peculiarly fortunate in its museums. There are but three museums of general interest to tourists, and these are among the most extensive and complete of their kind to be found anywhere. The American Museum of Natural History occupies a portion of the large block bounded by Seventy-Seventh and Eighty-First Streets, Columbus Avenue and Central Park West. It is the plan to occupy the whole of this space eventually, but at the present time only a fraction of the contemplated building has been completed; but the portion now standing covers a very large area of ground. The main entrance is on Seventy-Seventh Street. The value of the collections exceeds $5,000,000. The arrangements of the exhibits and their completeness, particularly those of the woods and stones of North America, insects, gems, mounted birds and large animals, are particularly fine. The stuffed skin of Jumbo and other celebrated show animals are exhibited. The Museum is open from 9 A. M. to 5:30 P. M. on week days, and after 1 P. M. on Sundays.

The Metropolitan Museum of Art at Eighty-Second Street and Fifth Avenue is the principal ornament of the city. The value of its exhibits cannot be estimated, for many of its objects are not replaceable. Of particular interest are the Phœnician and Greek art antiquities (the largest and most complete collection of this kind in the world), the historical collection of glass, musical instruments and the collection of ancient and modern pictures, including examples of Rembrandt, Van Dyck, Frans Hals, Velasquez, Reubens, Meissonier, Detaille, Rosa Bonheur and Corot. The Museum is free from 10 A. M. to 6 P. M. except on Mondays and Fridays, when a fee of 25 cents is charged. The Sunday hours are from 1 to 5 P. M.

The museum of the Historical Society of New York is at the corner of Second Avenue and East Eleventh Street. The building contains a large number of valuable volumes, pamphlets and manuscripts relating to American history and American genealogies, and busts and portraits of distinguished men. The art gallery contains probably the second largest collection of sculpture and paintings by old and modern masters in America. It is open from 9 A. M. to 6 P. M. throughout the year, except in August.

The most imposing monument in New York is the tomb of General

BIRD'S-EYE VIEW OF CENTRAL PARK, FROM FIFTY-NINTH STREET AND FIFTH AVENUE.

Grant, at Riverside Drive, on the banks of the Hudson, at 125th Street. This is a massive structure of light Maine granite, with a conical dome and severe facade; it is inscribed with the well-known quotation, "Let us have peace." The tomb was built in 1892-97 from a fund to which 90,000 persons contributed. At Riverside Drive and Eighty-Ninth Street is a graceful white marble monument, with handsome approaches, commemorating the soldiers and sailors of New York who took part in the War of the Rebellion. It was built by the city. Nearby is a statue of Lafayette, given by the school children of the city.

Central Park is the most frequented and popular of the large breathing spaces in New York. It occupies 840 acres of ground. It is four times as long as broad and lies between Fifty-Ninth Street and 110th Street and Fifth Avenue and Eighth Avenue. It was designed in 1858 by Olmstead and Vaux. There are twenty entrances; about 10 miles of driveways extend, with occasional intersections, along both sides of the park. The drive on the east side is the more fashionable and more frequented. There are four principal ponds or lakes, on some of which boating is allowed in summer and skating in winter. The possibilities for landscape effects throughout the park are developed to a high point. There are two taverns or restaurants in the park, one known as McGown's Pass Tavern and the other the Casino. Both are near the east drive. Altogether there are about 30 miles of foot paths. The principal points of interest are the Mall, Terrace, Bethesda Fountain, Cleopatra's Needle, Ramble, Seventy-Second Street Lake, Menagerie, American Museum of Natural History, Metropolitan Museum of Art, and reservoirs.

A system of reservoirs for distributing Croton water covers an area of 143 acres, and lies in the center of the park. They can be reached from the East Eighty-Second Street or West Eighty-First Street entrances. A view of the reservoirs may be had from the Belvedere, a stone building situated on top of a natural eminence near the center of the park. The park may conveniently be seen from park carriages, in which seats can be had at the Fifty-Ninth Street and Fifth Avenue entrance, or at Fifty-Ninth Street and Eighth Avenue, for a tour of the park for 25 cents.

Riverside Park, with its beautiful drive and handsome residences, skirts the Hudson River for over 3 miles, from Seventy-Second Street to 130th Street, and is being extended. The residence of Charles M. Schwab is at Seventy-Second Street, and that of Bishop Potter is at Eighty-Ninth Street. At the northern end of the drive is the excellent Claremont restaurant, just north of Grant's Tomb. A fine view of the Palisades from the west can be had from this point. Near the upper part of Riverside Drive is Columbia University, recognizable from the low, flat dome of its library building. Near Grant's Tomb and Columbia University is the Cathedral of St. John the Divine (Protestant Episcopal) at Amsterdam Avenue and 110th Street. It is estimated that this structure will cost $6,000,000, and take fifty years to build. It will be 520 ft. long, 172 ft. wide, and its tower 445 ft. high. The beautiful crypt, hewn out of the solid rock, is open to visitors on Tuesdays, Thursdays and Saturdays from 4 to 6 P. M. St. Luke's hospital is close at hand. Park stages can be taken from Seventy-Second Street and Riverside Drive to Grant's Tomb and vicinity.

A viaduct across the narrow Manhattan valley at 130th Street permits carriages to cross from Riverside Drive to Washington Heights. At 158th Street the drive along the Hudson enters Ft. Washington Park and becomes the Boulevard Lafayette. At the northern termination of this boulevard is Dyckeman Street, which connects with the Speedway, a long, broad avenue at the edge of the Harlem River, especially built to afford a speeding place for fast trotting and pacing horses. Automobiles, trucks and bicycles are not permitted upon this thoroughfare. The time to see the speeding of horses at its best is about 11 o'clock on Sunday mornings. A tour of Riverside Drive, Boulevard Lafayette, the Speedway and Central Park is a long afternoon's carriage drive.

A number of large parks have been laid out in the less settled sections, but are not yet fully developed. Among these are Van Cortlandt and Bronx Parks, near the northern limits of the city, and Pelham Bay Park, on the shores of Long Island Sound. In the neighborhood of Van Cortlandt Park are the new botanical gardens with an extensive herbarium and museum. The New York Zoölogical Gardens are near by. Here an attempt has been made on a large scale to imitate the conditions of nature in the surroundings of the wild animals which are exhibited.

THE WATER FRONT.

The chief points of interest on the Manhattan water front, beginning at the Battery and proceeding up the Hudson River, are the following: Battery Park, a small but popular open space which gives an excellent view of the upper harbor and shipping, and contains the Aquarium, in the circular Castle Garden, one of the defenses of the city built in the war of 1812. At this time the land on which the Aquarium now stands was an island, 200 ft. from shore. The Aquarium is free to visitors between 10 and 4 daily. At the Battery stands the statue of John Ericsson, the famous Swedish engineer, the designer of the "Monitor" of Civil War fame. Ericsson is said to have been the first to apply the screw propeller to steam navigation, in 1836-41. From Pier A, North River, northwards, are numerous piers and bulkheads for the extensive terminal and highly developed facilities for receiving and shipping the freight brought or dispatched by the railroads terminating at New York harbor. Conveniences are also provided here for millions of passengers who travel by ferries, steamships and steamboats across the neighboring waters. In this vicinity are located the piers of some of the largest trans-Atlantic steamship lines, including the White Star and Cunard Companies. The Hudson River Tunnel, begun twenty-five years ago from Hoboken, reaches the Manhattan shore at Morton Street, near the Hoboken ferry.

The city's largest meat, produce and shell-fish market, West Washington Market, is situated near Twelfth Street. From Fourteenth to Twenty-Second Streets are the landing places of large ice and lumber companies. The water front thus far may conveniently be seen from the decks of the Coney Island boats. From Twenty-Ninth to Thirty-Eighth Streets is an immense freight yard of the New York Central & Hudson River Railroad. From Forty-Third to Seventy-Second Streets are extensive slaughter houses, stock yards, gas houses, freight yards and grain elevators. From Seventy-Second to 129th Streets the river is bordered by Riverside Park. At and near 130th Street are ferries to New Jersey, a recreation pier and various commercial enterprises. Above this point, as far as 158th Street, the shore line is undeveloped. From 158th Street to 219th Street is Fort Washington Park. The land at Fort Washington is 240 ft. above the water. The Boulevard Lafayette, running high along the side of a steep slope, affords a magnificent view of the Palisades across the Hudson. From this point to the south end of Staten Island the air line length of New York City is about 35 miles. The Harlem River cuts Manhattan Island from the main land a little above Fort Washington.

Starting again at the Battery and passing up the East River, the chief points of interest on the Manhattan shore begin with a cluster of seven ferries and many small government bureau headquarters which lie close to Battery Park. A little farther up the river are canal boat wharves and piers, where many of the largest sailing vessels from South America and Eastern ports find wharfage. At Fulton Street is the principal fish market of the city. Further on are a number of large pontoon and sectional dry docks. At the foot of East Sixteenth Street are reception hospitals for contagious diseases, and the laboratories and disinfecting stations of the Board of Health. At Twenty-Sixth to Twenty-Eighth Streets are the buildings of Bellevue Hospital, the largest hospital in the city. Ferries for Blackwell's, Hart's, Randall's and Ward's Islands leave this point. At East Seventy-First Street a tunnel from Long Island under the East River brings illuminating gas to Manhattan Island. Jefferson Park is at 112th Street. The Harlem River enters the East River at 127th Street.

The points of interest along the Long Island and Brooklyn shore include some of the largest commercial enterprises in New York. Half of the sugar consumed in the United States is refined in Brooklyn. One refinery alone, the largest in the world, treats 2,000 tons of raw sugar per day, producing 12,000,000 lbs. of the refined product. This refinery occupies the water front from South First Street to South Fifth Street, as well as several blocks on Kent Avenue. This is opposite East Twenty-Third Street, Manhattan. Further south, along the Brooklyn water front is the Brooklyn Navy Yard. A good view of the East River shores and shipping can be had from the ferries of the Long Island Railroad, which ply between Pier 13, East River, near the foot of Wall Street, and Long Island City; fare, 10 cents.

Near Governor's Island, on the Brooklyn shore, is the extensive property of the Brooklyn Wharf and Warehouse Company, whose capital is $30,000,000. The facilities for handling freight here are among the most extensive in the harbor. The ships of fifty regular lines dock at the wharves of this company. New York is one of the most extensive grain handling ports in the world, and stores four-fifths of the grain brought to this harbor in Brooklyn. The capacity of the grain elevators exceeds 20,000,000 bushels. The largest are Dows, at Columbia and Pacific Streets.

It is estimated that the total transfer capacity of the stationary and floating grain elevators in New York harbor exceeds 160,000 bushels per hour. The Atlantic Basin, acknowledged to be the largest grain depot in the world, with a frontage of bulkheads and piers of over 3 miles, lies south of Governor's Island. This point can be reached via the Hamilton Ferry from the Battery. The Erie Basin lies still further south; it contains about 100 acres on the bay, and is protected by a bulkhead a mile long. Here are numerous piers and elevators, two of the latter being employed for handling nitrate of soda, potash and similar substances. The Erie Basin dry docks are the largest in New York. Most of the iron ships which require docking at New York are cared for here. Dock No. 2 has a length of 610 ft., and a width of 124 ft. at top and 60 ft. at bottom. Beyond this point are numerous shipping and boat building establishments, yacht club anchorages, and finally, a succession of summer pleasure resorts.

An excellent view of the New York water front may be had from the "Seeing New York Yacht," which leaves the foot of West Twenty-Third Street twice daily, and makes the circuit of Manhattan Island. Inquire of American Sight-Seeing Coach & Boat Company, Twenty-Third Street and Broadway.

The circuit of the Staten Island water front exceeds 50 miles in length. Most of this coast is not yet utilized; it is low and marshy, with shallow water along the shores. Beginning at St. George, the point nearest Manhattan Island, and following the shore to the west, there are several large manufacturing establishments. The largest mill in the white lead trust is here, Jewetts; and the Dean Linseed Oil Mills, the most important in the linseed oil trust, are near by. At Mariner's Harbor is the largest flouring mill in the eastern States, which belongs to the Jones-Hecker-Jewell syndicate. The portable railroad manufacturing establishment of the C. W. Hunt Company, and several ship building yards and other industries are near by. The principal ferry for Staten Island leaves the Battery for St. George every half hour; fare, 5 cents.

Water Works of Greater New York.

RESERVOIRS, DAMS AND AQUEDUCTS

OF THE

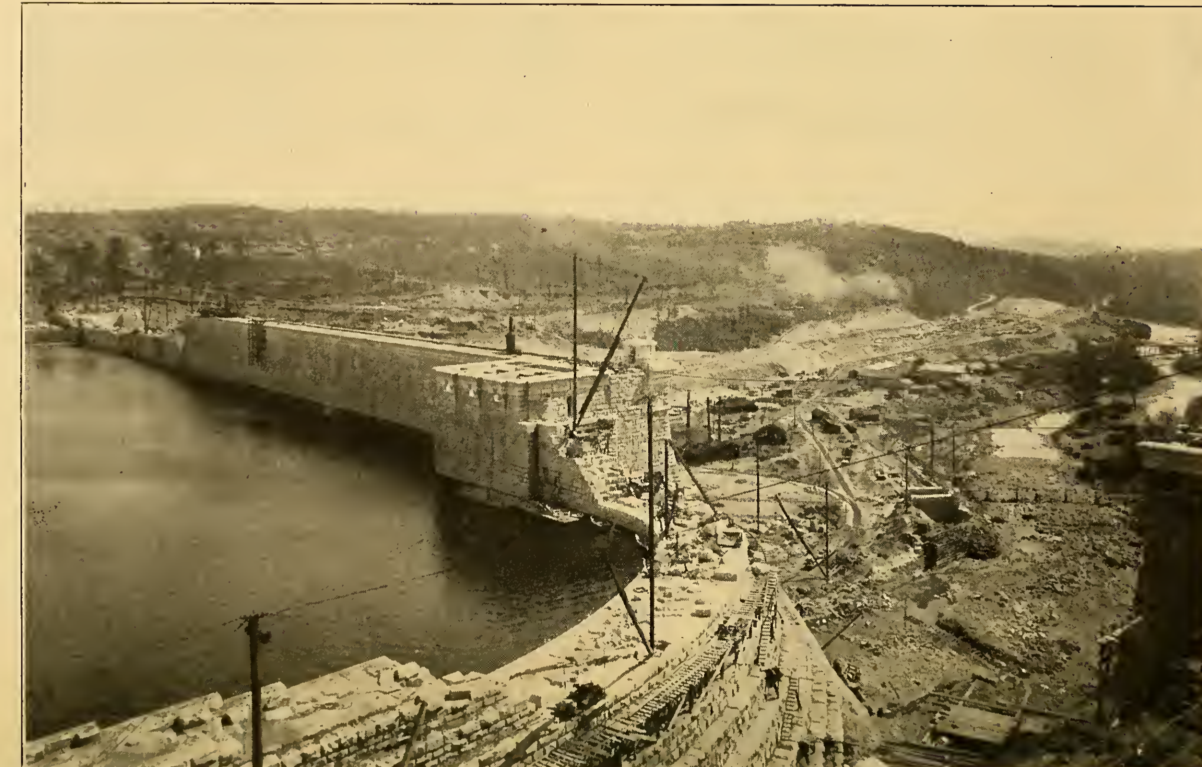
CROTON WATER SYSTEM.

(With Map Showing Locations.)

The New Croton dam is on the Croton River, about 6 miles from its mouth and 35 miles from New York. Above this lowest dam are ten large dams, besides several secondary dams or dykes, one large dam in course of construction and another which is to be advertised for construction early in the fall, thus making thirteen principal dams on the river and its tributaries. Designs for a great dam across the Croton at Quaker Bridge, or the Cornell site, were studied as early as 1882. Cornell site, about 1¼ miles above Quaker Bridge, was finally chosen, and construction begun in September, 1892; it is expected that the dam and all the appurtenances of the reservoir will be completed by the end of this year. The accompanying tables give the principal figures of interest for the Croton dams and reservoirs, and the map shows their locations, together with some other features of the Croton watershed. A cross-section of the New Croton dam is also shown.

New Croton dam is the highest and largest masonry dam in the world, containing approximately 850,000 cu. yds. of masonry. Only about one-half the height of the main part of the dam appears above the ground, and, roughly, two-thirds of the mass of this portion are below the earth's surface. Approximately 1,750,000 cu. yds. of earth and 425,000 cu. yds. of rock excavation were required. The reservoir is nearly 20 miles long, and its total contents when full are about 38,000,000,000 gals., of which ordinarily 20,000,000 gals. are available. Over 32 miles of new highways and 21 steel bridges have been built in connection with this reservoir. Four of these bridges are noteworthy for their size. Hunter's Brook bridge has two spans of 217 ft. and one of 310 ft. At the Old Croton dam there is a 124½-ft. plate girder span, and a 396-ft. truss. Pines bridge is a cantilever with two 160-ft. shore spans, and a main span of 384 ft. A county highway traverses the top of the dam and is carried over the waste channel on a 200-ft. steel arch. Nearly 75 miles of stone walls enclose the land required for this reservoir. When the new reservoir is full, the Old Croton dam, about 3 miles above the new dam, will be submerged to a depth of 34 ft.

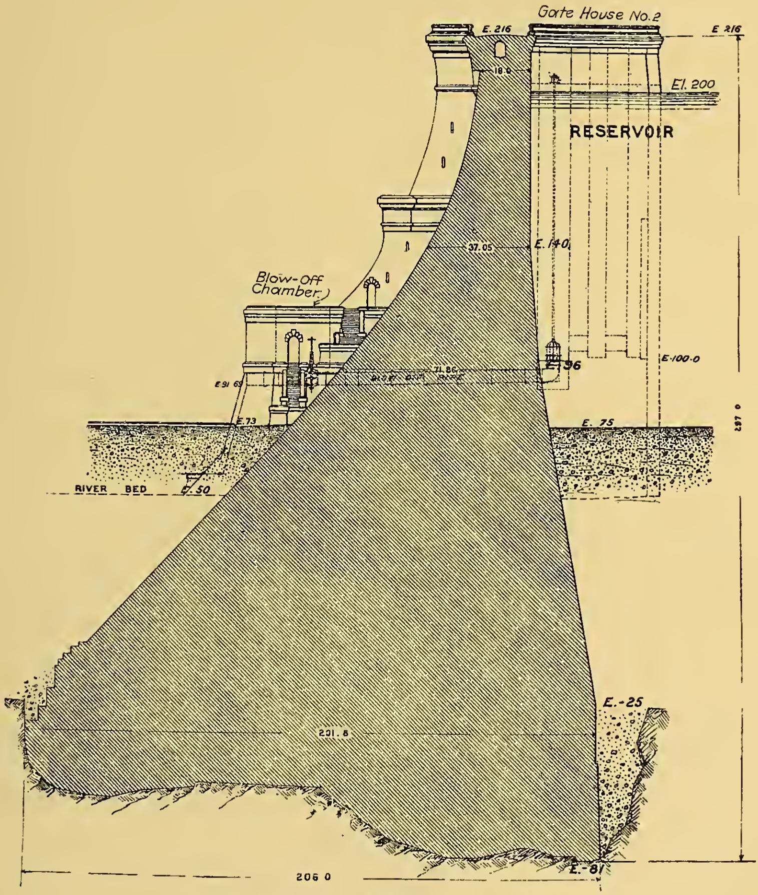
A short distance upstream from its middle the New Croton reservoir is very narrow, and above this place the water is shallow over large areas, even when the reservoir is full. Consequently the Muscoot dam has been built here to hold the water at full reservoir level ordinarily. In emergency this upper basin can be drawn down through a gate house in the



NEW CROTON DAM, LOOKING DOWN STREAM.

dam. The overfall of the dam is 950 ft. long, and all the natural flow of the river and the water drawn from the reservoirs above will pass over it.

A large gate house, finished about 1890, at a cost of nearly $750,000, situated just below the Old Croton dam, controls the flow of water into the Old and New Croton aqueducts, through which it flows to the city.



MAXIMUM SECTION

NEW CROTON DAM.

The old gate house controlling the old aqueduct is submerged by the new reservoir, and consequently has been partially dismantled. The old aqueduct has a capacity of about 80,000,000 gals. daily, was completed in 1842, and is approximately 34 miles long, 2 miles of earth and 2 miles of rock tunnels and 30 miles in trench or on embankment. Its interior dimensions are 7½ ft. wide by 8 ft. high, area of cross-section about 53 sq. ft., and its

OLD CROTON DAM AND NEW HIGHWAY BRIDGE.

slope 13¼ ins. per mile. For most of its length it has an 8-in. brick arch, a 4-in. brick invert on concrete and rubble side walls, lined with one course of brick. Its total cost, including land, was $12,000,000. Between the old and new dams, the old aqueduct, being in the new reservoir, has been strengthened and the parts on embankments replaced by loops following the contour of the hillside on natural ground.

New Croton aqueduct, nearly 31 miles long, is almost wholly in deep rock tunnel, only a little over 1 mile being in trench or on embankment, and terminates at the 135th Street gate house, near the northerly end of the main part of Manhattan Island. Old Croton aqueduct has also been connected into this gate house, and from this place water is conveyed to Central Park distributing reservoirs and various points of connection with the pipe system through eight 48-in. cast-iron mains. For about three-quarters of its length the new aqueduct has a horseshoe cross-section 13.6 ft. wide and 13.53 ft. high, maximum inside dimensions, with an area of 154 sq. ft., and a slope of 0.7 ft. per mile. The lining is brick, with brick or rubble backing, mostly. Gould's swamp siphon is circular, 14.25 ft. in diameter, 1,135 ft. long. For 36,080 ft., from a point north of Jerome Park reservoir to 135th Street, the aqueduct is under pressure, and circular, being 12.25 ft. diameter, excepting the 1,300 ft. under the Harlem River, 10.5 ft. diameter. The maximum capacity of the equeduct when clean is about 300,000,000 gals. daily. Forty-two shafts were sunk for driving the tunnels. The new aqueduct was first put into service July 15, 1890, and was transferred to the Department of Public Works (now Department of Water Supply, Gas and Electricity) June 24, 1891. Its total cost, exclusive of land and engineering, was approximately $20,000,000. In its construction 2,260,000 cu. yds. of earth and rock were excavated, and 904,000 cu. yds. of masonry built.

RESERVOIRS ON CROTON WATERSHED.

Name of Reservoir or Controlled Pond.	Year First Filled and Available.	Elevation of Spill-way Crest, Croton Datum.	Available Capacity at this Elevation, m.g.	Area Water Surface at this Elevation, sq. m.	Area of Tributary Watershed sq. m.	Available Depth for Drawing Water, ft.
White Pond	1899	......	200	0.18	0.90	7.4
Boyd's Corners	1873	593.	2,727	0.44	21.43	40.
Barrett's Pond	1870	779.	170	0.11	0.50	8.
Lake Gleneida	1870	505.	165	0.28	0.80	5.
West Branch or Carmel	1895	503.	10,070	1.56	19.51	40.
Middle Branch	1878	372.	4,005	0.67	20.51	48.
East Branch: Bog Brook	1891	415.	4,145	0.64	76.90	45.
East Branch: Sodom	1891	415.	4,883	0.90		60.
Titicus	1893	325.	7,167	1.10	22.80	65.
Lake Kirk	1870	583.	565	0.16	2.00	19.
Lake Mahopac	1870	660.	575	0.88	2.50	3.
Amawalk or Muscoot	1897	400	7,678	0.94	18.32	50.
Lake Gilead	1870	497.	380	0.19	0.60	12.
Old Croton	1842	166.2	700	0.76	159.3	
New Croton	1905	200.	20,000	5.33	180.9	46.
Total	....	......	72,730	......	360.4	......

CARMEL DAM, SPILLWAY.

PRINCIPAL DAMS ON CROTON WATERSHED.

Name.	Kind.	Total Length, Feet.	Length of Main Dam, Feet.	Length of Spillway, Feet.	Length of Earth Portion, Feet.	Max Ht. above Foundation, Ft.	Elev. of Top of Main Dam, Croton Datum.	Elevation of Crest of Spillway.	Slopes of Earth Portion of Dam.	Thickness at Top, Min., Feet.	Maximum Thickness at Bottom, Feet.
Boyd's Corners...	Masonry with earth backing	670	670	135.	....	78	596	593.	2½: 1	8.6	57.
Carmel..........	Earth with masonry spillway.	1810	1550	260.	550	86	515	503.	2: 1 upstr. 2.5: 1 down	15.	245.
Middle Branch...	Earth, rubble core.	515	515	100.	515	94	380	370.	....	50.	660.
Sodom..........	Masonry and earth.	....	500	500.	....	96	425	415.	....	12.	55.
Bog Brook, No. 1..	Earth, rubble core.	1314	1314	None	1314	74	425	.....	2: 1 upstr. 2½: down	25.	240.
Titicus..........	Earth and masonry.	1519	336	200.	983	135	334	325.	2.4: 1 upstr. 2.5: 1 down	18.	83.
Amawalk........	Earth, rubble core.	1270	....	50.	....	82	410	400.	5: 1 upstr. 3: 1 down	50.	680.
Old Croton.......	Earth and masonry on crib, with earth backing.	460	293	251.4	167	55	....	166.2	....	10.	64.
New Croton......	Masonry.	2168	1168	1000.	....	297	216	200.	....	18.	206.
Muscoot.........	Masonry.	1130	....	950.	....	55	210	200.	....	4.	38.5
Carmel Auxiliary..	Earth, rubble core.	725	725	......	725	67	515	.....	2: 1 upstr. 2.36:1 down	24.	260.

COSTS OF SOME CROTON RESERVOIRS.

DOUBLE RESERVOIR ON THE EAST BRANCH.

(Sodom and Bog Brook.)

Construction	$890,696
Engineering	161,550
Land	685,420
Legal expenses	243,992
Total	$1,981,658

Cost per million gallons stored, $219.

CARMEL OR WEST BRANCH RESERVOIR.

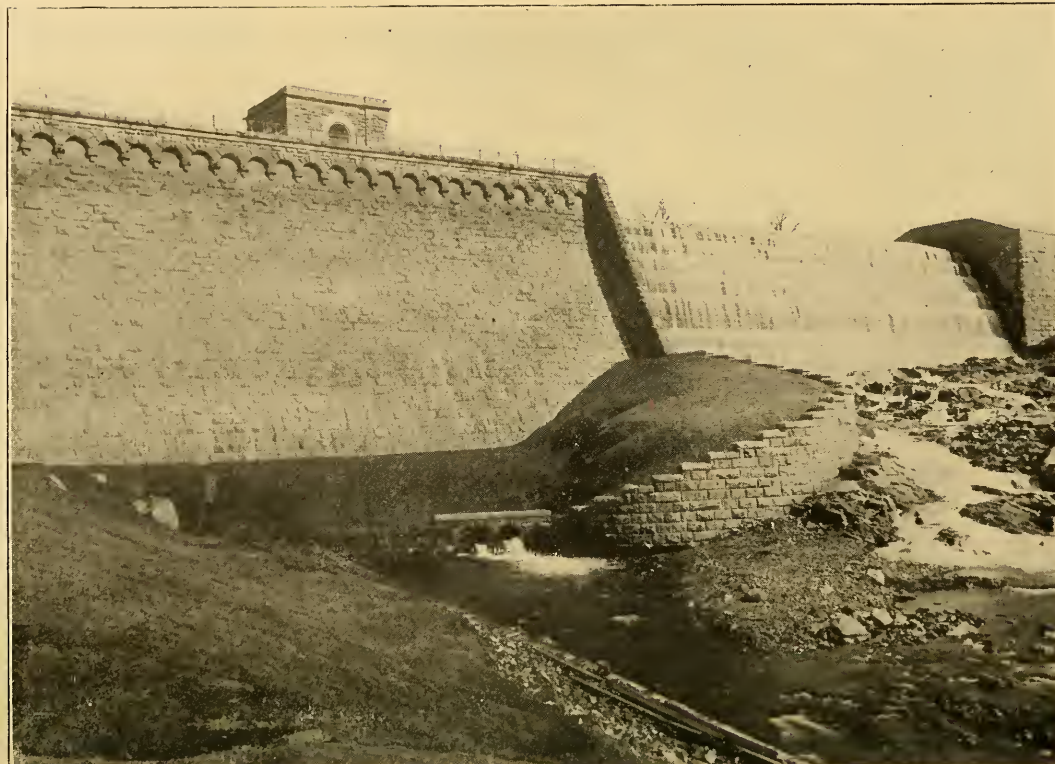
Construction	$818,637
Engineering	155,669
Land	511,963
Legal expenses	180,604
Total	$1,666,873

Cost per million gallons stored, $166.

TITICUS RESERVOIR.

Construction	$1,078,073
Engineering	103,292
Land	512,284
Legal expenses	116,304
Total	$1,809,953

Cost per million gallons stored, $253.



TITICUS DAM.

NEW CROTON RESERVOIR.

Construction	$9,200,000
Engineering and legal expenses, assumed	1,500,000
Land	4,500,000
Total	$15,200,000

Cost per million total gallons stored, $507.

The figures for the Carmel and Ticticus reservoirs do not include preliminary surveys nor borings, and those for the New Croton reservoir are partially estimated, since the work is not quite completed. The New Croton dam will have cost, when completed, for construction alone, about $7,500,000.

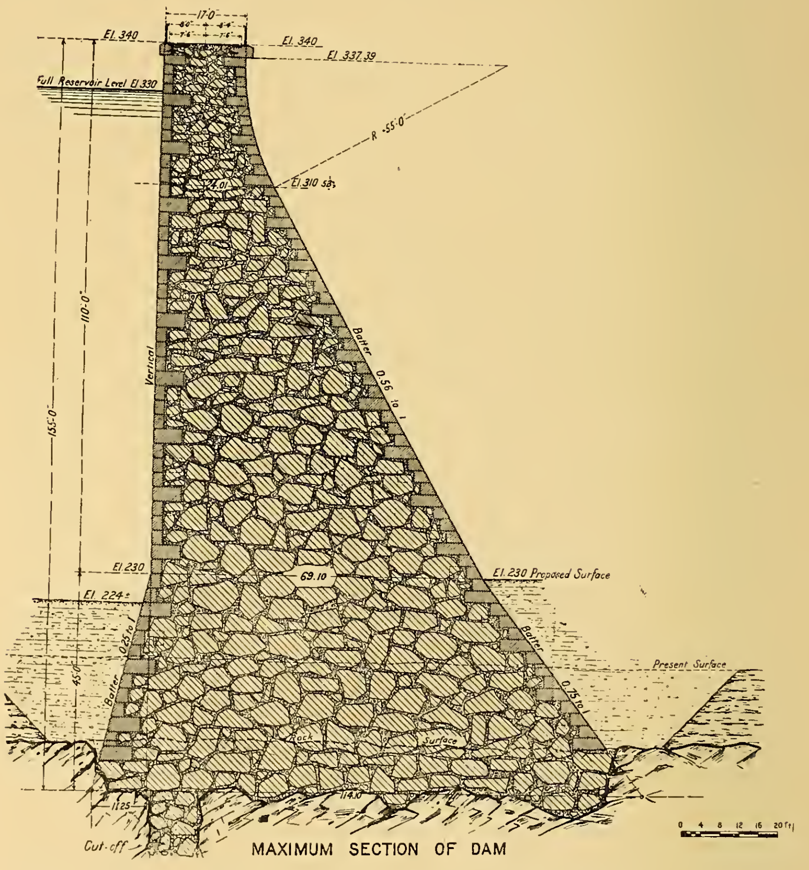
CROSS RIVER AND CROTON FALLS RESERVOIRS.

(The Further Development of the Croton Watershed.)

Dilatoriness in building additional water works for the Metropolis has brought on the necessity of getting more water, if practicable, from the present sources, especially the Croton, in the shortest possible time. During the past twelve months, Mr. J. Waldo Smith, chief engineer of the Aqueduct Commissioners, has had made careful studies of the development of the Croton watershed and surveys of available reservoir sites. Computations indicated that, under the emergency conditions existing, a further storage capacity of 20,000,000,000 to 30,000,000,000 gals. might advisably be provided, especially if the reservoirs could be constructed very quickly, so as to be useful during the six or seven years which must intervene before the Catskill supply can be made even partially available. The storage per square mile on the east side of the watershed is much less than on the other parts. On the Cross River, one of the eastern tributaries, a good reservoir site had long been known, but the dam had never been built. Another site for a high dam, about a mile above Croton Falls Village, promises fairly well and is being examined. It is on the West Branch just below its confluence with the Middle Branch; but the surplus water is in the East Branch, and so a small diverting dam and a channel or conduit about one mile long will be necessary. If built here, the Croton Falls reservoir will have a capacity of about 14,000,000,000 gals., and a masonry dam nearly 175 ft. high and 1,100 ft. long.

June 21, 1905, the contract for the Cross River reservoir was signed, and it is to be completed in 26 calendar months. MacArthur Brothers Company and Winston & Company are the contractors. Work is now actively in progress and can be reached by trains from the Grand Central Station to Katonah, on the Harlem Branch of the New York Central Railroad. The reservoir will have a capacity of 9,000,000,000 gals., a length of 3¼ miles, and a maximum depth of 130 ft. Cyclopean masonry is being used in the dam, and it will be faced with concrete blocks. It will be 865 ft. long, with a maximum height above foundation of 160 ft., a thickness at top of 17 ft., and a maximum thickness at bottom of 114 ft. It will contain about 135,000 cu. yds. of masonry. A waste weir 240 ft. long will extend along the rocky hillside from a bastion at the northeasterly end of the dam. An accompanying cut shows a section of the dam. The total cost of construction for the reservoir will be about $1,250,000.

During the past 18 years the flow of the Croton River has been 30 per



CROSS RIVER DAM, CROTON WATER WORKS.

cent. greater, on the average, than for the preceding 18 years, 1869 to 1886, and 11½ per cent. greater than the average for 37 years. In 1901, 1902 and 1903 the flow was excessively high. These facts have masked the necessity for further works to meet the consumption in a series of dry years, which may occur at any time.

The following table shows the distribution of storage on the Croton watershed after the completion of the Cross River and Croton Falls reservoirs:

DISTRIBUTION OF STORAGE ON CROTON WATERSHED.

Portion of Watershed.	Storage Per Square Mile, Million Gallons.
West Branch	343
Middle Branch	203
Amawalk	420
Titicus	314
East Branch	117
New Croton, alone	212
Cross River	276
Croton Falls, combining East, Middle and West branches	250
Total watershed above New Croton dam	244

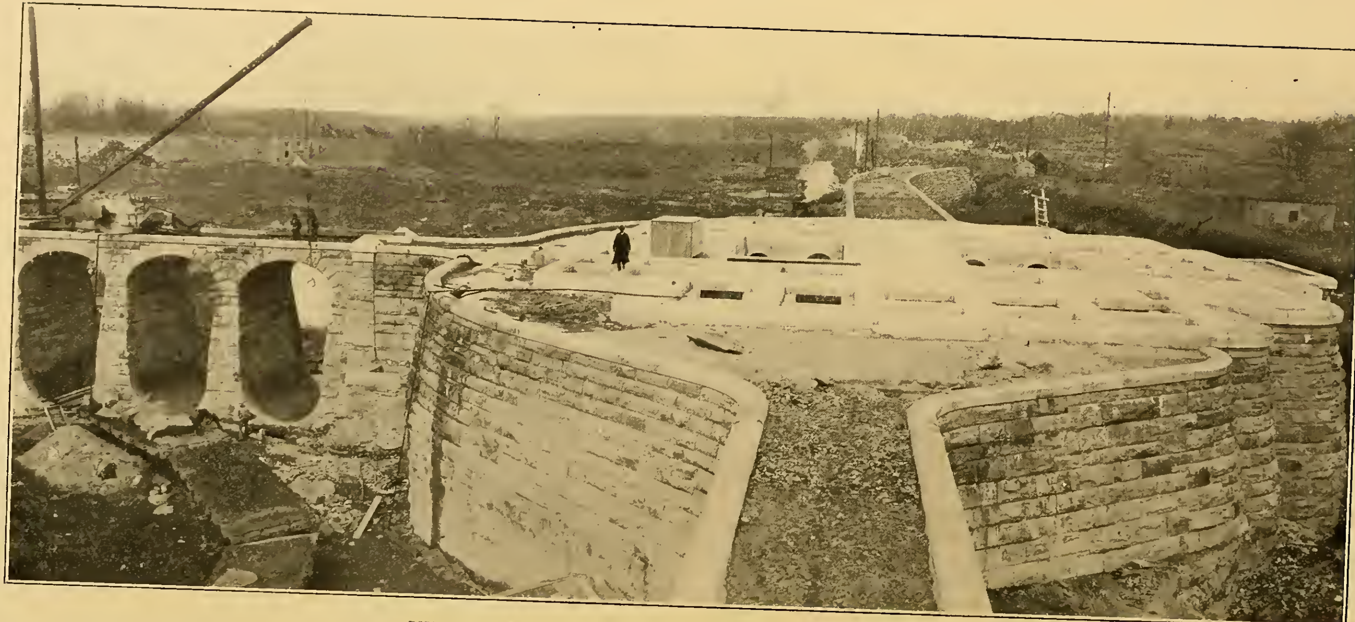
The building of additional reservoirs in the Croton watershed, beyond those now planned, would serve no useful purpose.

The chief engineers of the New Croton works have been successively Benjamin S. Church, Alphonse Fteley, William R. Hill, J. Waldo Smith and Walter H. Sears, the latter having been made acting chief engineer to succeed Mr. Smith, August 1, 1905, when Mr. Smith became chief engineer of the new Board of Water Supply.

HIGH BRIDGE, WATER TOWER, HARLEM TUNNEL AND SHAFT 25.

Between 172d and 182d Streets, at the Harlem River, is an interesting group of structures, most conspicuous among them Washington Bridge and High Bridge, spanning the railroads, the river and the Speedway. Access is had by railroad from the Grand Central Station or by combinations of elevated, subway and surface cars. Washington Bridge is described on another page. High Bridge is a noble masonry structure 1,450 ft. long, of 15 arches, eight of 80 ft. span, and seven of 50 ft., with its top about 120 ft. above the river. Ten of the piers are on pile foundations. It was finished in November, 1848, but its top was built higher in 1863. Its upper part contains pipes laid to carry the water of the Old Croton aqueduct. Its total cost was about $1,000,000.

Near the westerly end of High Bridge, is a small high-service reservoir, and beside it a picturesque stone water tower, visible from considerable distances in many directions. North of the bridge is a long, low, red brick structure; this is the 179th Street pumping station of the Department of Water Supply. The new aqueduct also crosses the Harlem at this place, but in a tunnel about 300 ft. below mean tide, between two shafts designated as Nos. 24 and 25. An ornamental granite building has been built as a head house over Shaft 25, on the Manhattan side, in which a pneumatic deep well pumping plant has been installed for removing water from the shafts and tunnel whenever necessary for inspection or repair. No. 25 is a double shaft, the northerly well being the aqueduct, and the southerly the pump well, both 12.25 ft. diameter. A bronze gate 1.67 x 2.5



JEROME PARK RESERVOIR, GATE HOUSE No. 5.

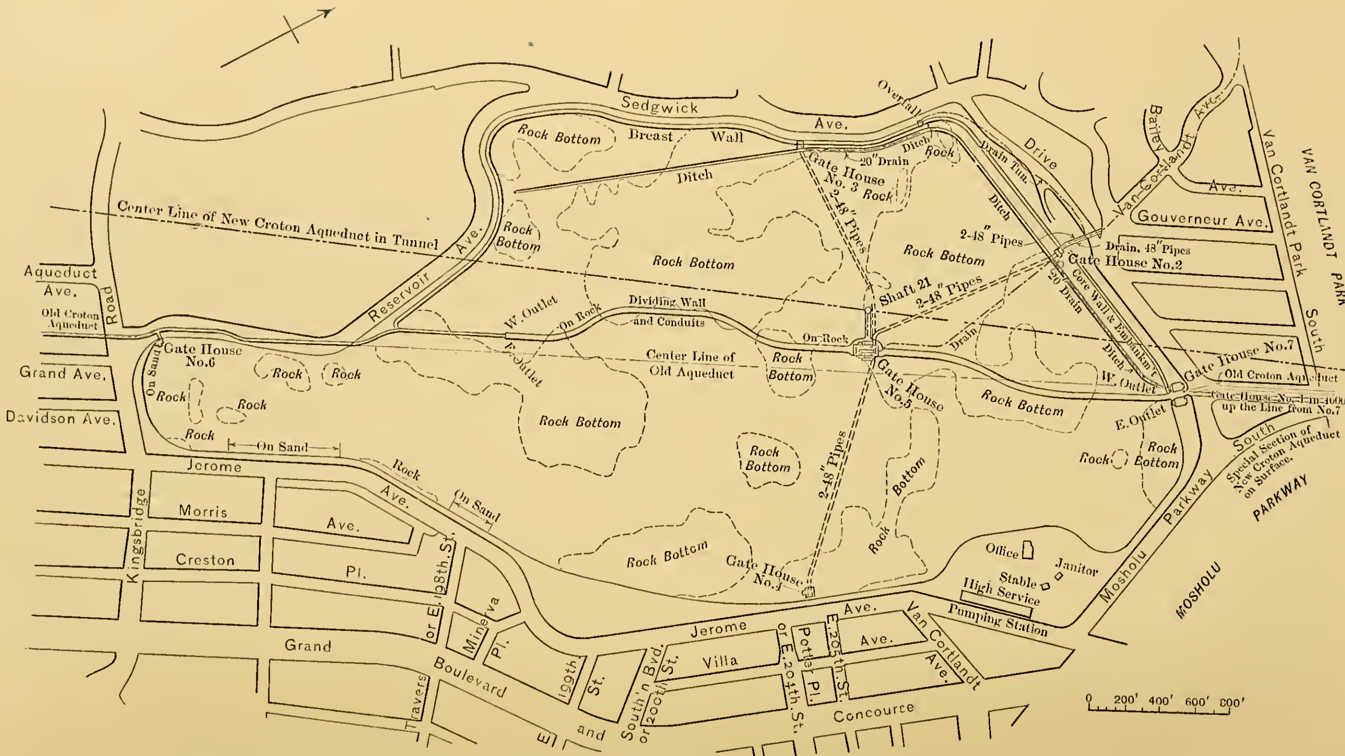
ft., 417 ft. below the top of the shaft, connects the two wells. The pump shaft is lined with iron, and extends 21.75 ft. below the tunnel. Originally an engine-driven bucket hoist with two 1,390-gal. buckets was installed, but this required too much time. In 1903-04 the Pneumatic Engineering Company, under contract, put in a pump on the Harris system, comprising a twin-connected 27 x 48-in. Comstock compressor, driven by a 24 x 48-in. horizontal Corliss engine, an air switch, an auxiliary compressor, four large steel tanks at the bottom of the shaft, and the necessary air and water pipes. The tanks are worked in pairs, being alternately filled with water and emptied by the action of compressed air, which, by the switch, is directed cyclicly into one tank and then another. The apparatus is required to raise 2,500,000 gals. 337 ft. in 12 hours. It cost nearly $50,000. Steam is supplied from the 179th Street pumping station.

The hydraulic gradient of the aqueduct (elevation 131) is between the top of the roof and the cornice of the tower of the head house, and so each well contains near its top a masonry diaphragm 9 ft. thick, pierced by a manhole closed by double, bolted covers. Shaft 26, a short distance west of Shaft 25, rises above the hydraulic gradient; consequently two 48-in. overflow pipes were laid from it to the river, passing through a gate chamber at the side of the Speedway, through which also passes a 48-in. blow-off pipe from Shaft 25. There is also a blow-off chamber at Shaft 24, on the Bronx side, near Washington Bridge, and there are several other blow-off chambers distributed along the aqueduct. Near the east end of High Bridge is an office building, occupied by the Department of Water Supply.

JEROME PARK RESERVOIR.

When, a generation ago, the city's consumption of Croton water had grown to be equivalent to the capacity of the Old Croton aqueduct, it was found that the distributing reservoirs within the city were not large enough to permit shutting off the aqueduct, even for the few days needed for cleaning and inspection. A serious break would have been most disastrous. Consequently when the new works were planned it was decided to include in the system a very large distributing reservoir to be built at Jerome Park, a driving park in the Bronx, near the Yonkers line. After much delay, construction was begun in 1895, but has progressed so slowly that the reservoir is still far from completion, and again the city's consumption has overtaken the aqueduct capacity. Consequently, the New Croton aqueduct has not been emptied for thorough cleaning and inspection since it was finally put into service. Energetic efforts for the current two years will probably compass the completion by November of the western basin of the two, into which the reservoir is divided. It has been recommended by the late chief and the consulting engineers that the completion of the easterly basin be delayed until the question of filtration of the Croton water be decided, and that then its design be modified to make at least a part of it a covered reservoir for filtered water.

Jerome Park reservoir will be one of the largest artificial distributing reservoirs in the world. Its capacity will be nearly 2,000,000,000 gals., its water surface area 241 acres, its water depth 25.5 ft., its extreme length



PLAN OF JEROME PARK RESERVOIR.

5,800 ft., its greatest width 2,650 ft. The east basin has an area of 147 acres, and a capacity of 1,175,000,000 gals.; the west basin an area of 94 acres, and a capacity of 771,000,000 gals. By far the greater part of the reservoir is in excavation, requiring the removal of over 4,000,000 cu. yds. of earth and about 3,000,000 cu. yds. of rock, the maximum cut being 65 ft., and the average about 18.5 ft. The perimeter will have 5,000 ft. of breast wall, and 9,900 ft. of embankment with rubble core and concrete slope paving, the total distance around being 2.8 miles. The division wall is 4,200 ft. long, and contains the rebuilt portion of the Old Croton aqueduct, crossing the reservoir, and the conduits for the circulation of the water.

A large variety of construction work is now going on. The reservoir can be reached in about an hour from the Grand Central Station, by taking Sixth or Ninth Avenue elevated to 155th Street and transferring to Jerome Avenue trolley cars overhead, on Central Bridge. The latter cars pass close along the easterly side of the reservoir.

At the northeast corner of the reservoir is a granite building on a high knoll, built for the use of the engineers during construction, and the keeper subsequently. Just below, beside Jerome Avenue, is a large high-service pumping station recently completed by the Department of Water Supply. Van Cortlandt Park, one of the largest in the city, with its golf links and polo grounds, lies just north of the reservoir. The total cost, if finished as now planned, will be approximately $7,500,000 exclusive of land, which cost nearly $3,500,000. An accompanying general plan shows the arrangement of the reservoir and its seven gate houses.

Connection with the New Croton aqueduct, which passes beneath the reservoir bottom at a depth of approximately 100 ft., is accomplished by a cut-and-cover aqueduct, starting from a point where the New Croton aqueduct is near the surface of the ground, about 5,600 ft. north of the reservoir. Aqueduct North, as it is called, is of horseshoe section 11.40 ft. wide by 13.53 ft. high inside, extends from gate house No. 1 at the New Croton aqueduct, through gate house No. 7 at the northern extremity of the reservoir, to gate house No. 5, the great central controlling gate house. In gate house No. 7, provision has been made for connections with future low-service aqueducts, if they should ever be built. Gate house No. 6, at the southern extremity, is a connection with the old aqueduct, which also passes through gate houses Nos. 7 and 5. From gate houses 2, 3 and 4, pipe lines extend to connections with the distribution pipe system, and these gate houses are in turn connected by pipes with gate house No. 5. A small overflow chamber has been built on the northwest side of the reservoir and connected with a large sewer. Superstructures for the gate chambers are now being designed by Trowbridge & Livingston, architects, of New York. Shaft 21 of the New Croton aqueduct is 227 ft. west of gate house No. 5, in the reservoir. A circular stone structure has been built over it, up to the same height as the gate house sub-structures, and an 11 ft. circular conduit laid beneath the reservoir bottom to connect the shaft with the gate house. Over this conduit an arched causeway has been erected.

135TH STREET GATE HOUSE, CROTON AQUEDUCT.

Both basins of the reservoir are to be paved with concrete 6 ins. thick on the bottom, and 12 and 18 ins. thick on the embankment slopes. Of all kinds of masonry about 535,000 cu. yds. will have been used, if the reservoir is completed as now designed.

CENTRAL PARK RESERVOIRS.

The reservoirs in Central Park receive water from both the new and the old aqueducts, and are used merely as distributing reservoirs to equalize the variation in consumption and to have a small supply in reserve, at the present rate of consumption about enough for four days' supply.

There are two reservoirs, the "old" and the "new." The "old reservoir" covers an area of 31 acres and is divided into two parts, but they are commonly connected and used together. This reservoir was built about 65 years ago, at the same time as the Old Croton aqueduct, and water was let into it for the first time on June 27, 1842, a great day for the people of New York. It has a capacity of 200,000,000 gals. The "new reservoir" was built for use with the New Croton aqueduct and was first put into service in 1890. It covers an area of 96 acres and has a capacity of 1,000,000,000 gals. It is at an elevation of about 115 ft. From these two reservoirs pipes lead to all parts of the city that are of suitable elevation to be supplied by gravity. The higher portions of the city are supplied by the pumping stations at 179th Street, High Bridge, Ninety-Eighth Street and Jerome Park.

FILTRATION OF THE CROTON WATER.

Croton water long had a good reputation. Filtration, however, has been so successful in many places that the standard for water supplies has been raised. Increasing population on the Croton watershed, especially summer residents, occasional excessive turbidity and color, with frequent unpleasant tastes and odors, render filtration not only most desirable, but, for the protection of the city's health, urgently necessary. Competent engineers and sanitary experts have repeatedly recommended the filtration of the Croton water, and in a recent report the Commissioner of Health has very emphatically declared the necessity for the purification of the water. By which of the organizations now engaged upon the city's water works the filter plant is to be built, when the work is to be undertaken, and what system of filtration is to be employed are questions not yet settled. If a slow sand filter plant be built, it will be larger than any other yet constructed. One or two sites for such a plant are available along the New Croton aqueduct. The total cost has been estimated roughly at $10,000,000. Filtration would require changes in some of the distributing reservoirs, including the covering of a portion of the Jerome Park reservoir, as intimated on another page.

WATER DISTRIBUTION IN NEW YORK, AND BOROUGH SUPPLIES.

DISTRIBUTION PIPE SYSTEM IN MANHATTAN.

Both the old and the new aqueducts deliver their water to the gate house at 135th Street, near Amsterdam Avenue. From this point the water of the old aqueduct flows southward into the city by one 48-in., two 36-in. and one 60-in. pipe, while the water from the new aqueduct flows through eight 48-in. pipes, laid down Convent Avenue. Six of these pipes lead to the distributing reservoirs in Central Park, while the others lead directly into the distribution system supplying the portions of the city north of Central Park.

From the south end of the new Central Park reservoir six 48-in. pipes lead out into the distribution system, and two 30-in. pipes lead from the old reservoir. Several of these pipes run through Fifth Avenue to the lower portions of the city. The others spread out and run down various avenues. They are all cross-connected, as a general thing, by 20-in. pipes at several streets, such as Seventy-Eighth, Fifty-Seventh, Thirty-Eighth, Twenty-Ninth, Twenty-First, Tenth, Houston and Chambers Streets. Between these mains the smaller pipes are run, but on account of the length of time that many of these pipes have been laid, and the increase in demand for water, often rendering it necessary to reinforce certain streets with additional mains, no definite system can be said to exist.

HIGH-PRESSURE FIRE SYSTEMS OF NEW YORK CITY.

The high-pressure fire system now being built by the Department of Water Supply of New York City consists of an entire new system of mains, hydrants, etc., over the area to be protected, which extends from Chambers Street on the south to Twenty-Third Street on the north, and from the Bowery to the North River. The water for this system is to be taken from the pipes of the existing Croton supply, but a connection is also to be laid to the rivers, so that salt water can be used in case it should become necessary; but it is not intended to make use of the river water except in case of some unavoidable emergency.

There are to be two pumping stations, one on the East River, at the foot of Oliver Street, and one on the North River, at Gansevoort Street. Each station is to be equipped with five multi-stage centrifugal pumps, each direct-connected to an 800-brake horse-power induction motor, and space for three additional similar units has been provided. Each pump will be capable of delivering 3,000 gals. per minute against a head of 300 lbs., giving a total capacity for each station of 15,000 gals. per minute, or a capacity for the two stations combined of 43,000,000 gals. per day. The pumps will be designed so that they may be regulated to deliver the above quantity of water at any pressure desired between 100 and 300 lbs. The electrical equipment in these stations is designed to use alternating current, without transformation, at 6,300 to 6,600 volts and 25 cycles, and direct current at 120 to 240 volts, the former for driving the main pumps, the latter for the auxiliary apparatus and the lighting of the stations.

The general design of the distribution system consists of two 24-in. pipes, around the outside edges of the area to be protected, connected directly with each pumping station. These mains are cross-connected by 20-in. and 16-in. mains dividing the district into smaller areas. These smaller areas are supplied by 12-in. pipes, the smallest mains to be used. The hydrant connections are all 8 in. It will be possible to concentrate on any one block sixty fire streams of 500 gals. per minute each, or the full capacity of both stations, with a length of hose not exceeding 400 or 500 ft. The contract for the construction of this system is now being advertised, and it will be entirely built within the next year.

A similar system is being put in for Brooklyn, extending along the river front and over the most important business streets. This system has three pumping stations containing the same equipment as the New York stations. There is also a small high-pressure fire service plant at Coney Island, which has been nearly completed, and will give a pressure of 200 lbs. over the most hazardous portions of that famous resort.

This work is all under the charge of I. M. de Varona, chief engineer of the Department of Water Supply, Gas and Electricity.

USE OF WATER METERS IN NEW YORK CITY.

The use of meters in New York City would seem to be surprisingly small, compared with the usage of neighboring cities. There are, approximately, 50,000 meters in use in Manhattan and the Bronx, and 6,675 in the borough of Brooklyn. Considerable extension of the use of meters in Manhattan and the Bronx has been recommended, but the necessary appropriation has not yet been made. Investigations made in 1903, by N. S. Hill, Jr., former chief engineer of the Department of Water Supply, showed a very uneven distribution of revenue per thousand gallons actually supplied in various typical sections of the city. The actual revenue, metered and unmetered, in some districts covered by this investigation, showed the unmetered revenue to be as small as 1 cent per thousand gallons actually supplied. The fixed meter rate amounts to 13 1-3 cents per 1,000 gals. on all water used, whether in large or small amounts. These investigations also gave evidence of a great loss in the metered revenue, through illegal use of by-passes around meters. It is most unfortunate that the city of New York does not have control of its service pipes, as it is now almost impossible to prevent this unlawful practice.

In one section of Manhattan, wholly devoted to business, and presumably fully metered, it was found that out of a total supply of about 9,000,000 gals. daily, the total metered registration accounted for little more than half this amount. A very large amount of water is used by shipping in New York City. Many of the piers and docks are provided with meters. The large use of water by steam tugboats, on the North and East Rivers, is mainly unmetered, but reports are obtained by the meter department of the tugs taking water at each dock, by a force of inspectors attached to this department. The inspectors note the name of each tug, and the hour of taking water, and allowance is made according as the tug has high or low-pressure engines. In the borough of Brooklyn careful records are kept of the use of meters. On January 1, 1905, there were, in Brooklyn, 124,388 taps. The number of meters in use on the same date was 6,675.

WATER SUPPLY OF THE BOROUGH OF BROOKLYN.

From the incorporation of the city of Brooklyn, in 1834, up to 1855, the question of a public water supply was discussed at various times, but no definite action was taken until 1855, when the Nassau Water Company was incorporated. In the following year, a contract was made with this company to construct the works, the city to subscribe to $1,300,000 of the stock. The total cost of the works was to be $4,200,000. There was to be a closed

MT. PROSPECT LABORATORY AND TOWER, BROOKLYN.

conduit from the Ridgewood pumping station to a stream south of the village of Jamaica, known as Baisley's Stream, and from this point an open canal easterly to Hempstead Pond, south of the town of Hempstead. The original works were supposed to be capable of supplying about 20,000,000 gals. daily, and the water was to be pumped at the Ridgewood station into Ridgewood reservoir, located on the hills northeast of Brooklyn. There was to be a high-service pumping station within the city limits pumping into a reservoir at the corner of what is now Flatbush Avenue and Eastern Parkway. The distribution system was to consist of about 120 miles of mains, with 800 hydrants. The city acquired entire control of the construction in 1857, and in the latter part of 1858 the supply was first let into the distribution system.

The open canal from Baisley's Stream to Hempstead Pond was abandoned, and a brick conduit was built for the full length. This conduit is of horseshoe-shape, and at the lower end has a width of 10 ft., and a height of 8.67 ft.; the dimensions gradually reduce until at the upper end the width is 8.17 ft., and the height 6.33 ft. Within about ten years after completion, the original works could not meet the demands of the consumers, and in 1870 the large storage reservoir on Hempstead Stream was authorized. This reservoir was entirely completed in 1877, although the greater part of the work had been completed and the reservoir put into use several years earlier. This storage reservoir holds a little over 800,000,000 gals., and is practically the only storage reservoir connected with the Brooklyn supply. The supply has always been barely sufficient to meet the demands, and additions have been made from time to time by the construction of driven-well stations and pumping stations drawing a supply from ponds below the conduit line.

The extension of the works east of the terminal of the old conduit was commenced in 1889, and was practically completed in 1891, the water from the new water shed being carried by gravity through a brick conduit to the Millburn station, and pumped at that station through cast-iron pipes to the Ridgewood station. The conduit east of Millburn is brick, practically the same shape as the old conduit, the lower section having a width of 9.33 ft., and a height of 6.92 ft., while the most easterly section has a width of 7.33 ft., and a height of 5.92 ft. In 1894 the supply was again inadequate to meet the demands, and new driven-well stations were contracted for on the new watershed. Since that time various pumping stations have been established, until at the present time there are eighteen stations supplying water to the city, not including the Mt. Prospect, Ridgewood and Millburn stations, which simply force the supply to higher levels.

This supply is derived entirely from the sandy soil on the south side of Long Island, there being three driven-well stations within the city limits owned by the city, and one large private station with several smaller private stations, furnishing restricted areas. The largest station is owned by the Flatbush Water Works Company, and supplies the Twenty-Ninth Ward, this company having an exclusive franchise for this ward. Outside of the city limits there are eleven stations deriving their supply wholly from driven wells, and three stations deriving their supply from driven wells and surface sources. One station derives its supply wholly from surface sources.

On account of the permeable character of the south side of Long Island, the conditions are ideal for an underground supply, and water is obtained both from the water table lying a short distance below the surface, and also from a deep water table lying below a clay bed, which is usually about 100 ft. below the surface, and of varying thickness, this bed, however, not being continuous over the island.

There are on the old watershed seven shallow ponds, formed by throwing dams across the stream valleys, which originally supplied the water directly by gravity into the brick conduit, and on the new watershed there are four similar ponds. Two of the gravity ponds on the old watershed are now filtered, and the supply pumped into the conduit. The average daily supply furnished during 1904 from the watershed outside of the city limits amounted to 104,300,000 gals. per day, while the supply derived from the three pumping stations within the city amounted to 8,800,000 gals. per day, making a total average supply of 113,100,000 gals. The estimated population is 1,290,800, making a per capita consumption of 87.6 gals.

The Millburn pumping station is equipped with engines having a nominal capacity of 75,000,000 gals. daily, while the nominal capacity of the engines at the Ridgewood station is about 140,000,000 gals. daily.

The main distribution reservoir, the Ridgewood reservoir, is divided into three basins, the total nominal capacity being about 300,000,000 gals. Mt. Prospect high-service reservoir has a nominal capacity of about 20,-000,000 gals. In 1891 the Mt. Prospect tower was built adjoining the reservoir to feed the higher sections of the borough. The elevation of the Ridgewood reservoir at normal water line is 170 ft. above mean high tide, and the elevation of the high-water line of the Mt. Prospect reservoir is 198 ft., while the overflow of the Mt. Prospect tower has an elevation of 278 ft. The Mt. Prospect reservoir service uses about 3,000,000 gals. daily, and the tower service uses about 4,500,000 gals. daily. A portion of the water for the Mt. Prospect reservoir has been, since early in 1905, pumped from the Ridgewood station, the supply for the Mt. Prospect station being taken from the distribution mains.

On January 1, 1905, there was a total length of mains in use of all sizes of 739 miles, together with 7,341 gate valves, and 8,444 hydrants. The original distribution system consisted mainly of 6 and 8-in. mains, and these were laid uncoated. The clogging by rust tubercules has been such that it is now necessary to replace all the original distribution mains smaller than 12 ins. in diameter.

WATER SUPPLY OF BOROUGH OF RICHMOND, CITY OF NEW YORK.

(Staten Island.)

The borough of Richmond has about 75,000 population and covers an area of about 57 square miles. A considerable portion of this area is without a public water supply, the inhabitants of many of the villages still having their own wells. There are three private water companies which supply the more densely settled portions of the island, and one pumping station operated by the city. The entire supply of water is taken from driven wells, which are mostly 4 ins. in diameter, and vary from 50 to 100 ft. deep.

The Staten Island Water Supply Company supplies the northwestern portions, including the villages of Tompkinsville, New Brighton, West New Brighton and Richmond. It has four pumping stations, three of which take water from wells, the fourth merely raising the pressure to supply the highest portion of the area. The water is pumped directly into the mains, which are connected with a reservoir.

The Crystal Water Supply Company supplies the southeastern portions of the island, including the villages of Stapleton, Clifton, Fort Wadsworth and Concord. It has three pumping stations, at all of which water is taken from wells. In addition to the low-service pumps, one of these stations also has high-pressure pumps to supply the higher portions of the island. The water is pumped into a standpipe for the high service, and into a reservoir for the low service.

The South Shore Water Company supplies water from two driven wells to the village of New Dorp. Its mains are directly connected with a standpipe. At the extreme southwestern portion of the island, the city operates a small pumping station, which supplies the village of Tottenville and the immediate neighborhood.

The city of New York is about to begin the construction of a complete new distribution sytem to cover the entire island. Water will be bought from a private company in New Jersey, and submerged mains will be laid across the Kill von Kull. It is the intention to have three distinct zones of elevation, the lower zone being supplied directly from the mains of the New Jersey company, the middle and high zones to be supplied by pumping. The island is in places over 400 ft. above the level of the sea. The sum of $1,500,000 has been recently appropriated for this work.

WATER SUPPLY OF BOROUGH OF QUEENS.

The borough of Queens consists of five wards, all of which are supplied with water from driven wells. The First Ward, Long Island City, has two pumping stations owned and operated by the city. The local supply of water is not sufficient for the demand, and the city is obliged to buy part of its supply, at a fixed price per million gallons, from the Citizen's Water Company, which also supplies all water used in the Second Ward, dealing directly with the consumers. This company operates five pumping stations, all discharging into a common system of mains, on which a standpipe is located. It also controls several other large tracts of water-bearing land. This Second Ward was originally the town of Newtown.

The Third Ward, comprising the former towns of Flushing, College Point, Whitestone, Bayside, Douglaston and Little Neck, is supplied by three driven-well pumping stations, owned and operated by the city. These stations pump directly into the mains, which are also connected to a standpipe. The Fourth Ward, or the former town of Jamaica, is supplied by the Jamaica Water Supply Company, a private company, which deals directly with the consumers. The Fifth Ward, a part of the old town of Hempstead, is also supplied by a private company—the Queens County Water Company. Both this and the Jamaica Company obtain their supply from driven wells.

MT. PROSPECT LABORATORY, BROOKLYN.

Mt. Prospect Laboratory is the main testing station of the Department of Water Supply, Gas and Electricity of New York City. It is situated near Mt. Prospect reservoir and water tower, Flatbush Avenue and Eastern Parkway, Brooklyn, and is within a short walk of Mt. Prospect engine house. From the Manhattan terminal of the Brooklyn Bridge, the Flatbush Avenue car reaches the laboratory in about twenty-five minutes.

The observatory on the top of the laboratory affords a fine view of Prospect Park and Plaza, and from the top of the water tower on a clear day may be had a comprehensive view of the entire borough of Brooklyn, as well as large portions of the boroughs of Manhattan and Queens.

The laboratory was established in 1897, by Mr. I. M. de Varona, chief engineer of the Department of Water Supply, Gas and Electricity, and it is beyond question the finest and most completely equipped water works laboratory in the country. The upper floor is divided into five rooms; a room devoted to the chemistry of water; a room for examinations for bacteria and microscopic organisms; a general chemical laboratory with a dark room and weighing room; a special chemical laboratory for the testing of lubricating oil, asphalt and coal, and an office for reports and records. On the lower floor is a physical room, devoted largely to cement tests, sand and gravel analyses for filtration purposes, and the sampling of metals for pipes, hydrant fittings, etc. There are also two rooms for gas analysis, a photometer room and a room for meter tests.

A branch laboratory is situated at Mt. Kisco, N. Y., on the Croton watershed and another branch laboratory for filter examinations is installed at Jamaica, L. I., on the Brooklyn watershed. The laboratory force is under the direction of Mr. D. D. Jackson, chemist in charge, and consists of three chemists, one bacteriologist, one stenographer, two office boys, one junior clerk, five laboratory assistants and seven laborers.

About ten thousand samples of water are collected and analyzed annually, and a considerable amount of work is done on supplies and general constructional materials. Regular weekly reports are made to the chief engineer on the condition of the water in the various boroughs, and on the efficiency of the filter plants. During the year, between 400 and 500 special reports are also made, in connection with the quality of materials used in the department, the temporary use or by-passing of the numerous sources of water supply and recommendations relating to the general sanitary patrol of the eighty-two distinct sources of water supply for Greater New York.

ADDITIONAL WATER SUPPLY FOR NEW YORK.

It has been estimated that the population of Greater New York will be 7,000,000 by 1930. To supply such a community with 100 gals. per capita per day would require 700,000,000 gals., and to meet an average demand for 150 gals. would require 1,050,000,000 gals. per day. Sources of supply now in use have an estimated combined safe capacity, in a series of dry years, of approximately 400,000,000 gals. daily, which is about the present conumption. Some of these are of such inferior quality that their use should be discontinued. Studies under municipal authorization and others, within recent years, have all shown the great urgency for securing water from new sources. Most notable among these investigations were those by Mr. John R. Freeman, the Merchants' Association and the Commission on Additional Water Supply (William H. Burr, Rudolph Hering and John R. Freeman) whose now famous reports were issued respectively in 1900 and 1904. Two or three relatively nearby sources of considerable promise have been ruled out on account of inter-State legal complications that would attend their development. Restrictive legislation in New York has also forbidden the city to use certain available sources wholly within the State. In June, 1905, two important Acts were passed by the Legislature, No. 723 creating a State commission, and No. 724 authorizing the Mayor of New York to appoint a Board of Water Supply. The State commission of five men is to have general supervision of municipal supplies. The members of the State commission are: President, Henry H. Persons, East Aurora; Ernst J. Lederle, New York City; John A. Sleicher, New York City; Milo M. Acker, Hornellsville, and Charles Davis, Saugerties.

On June 9, Mayor McClellan appointed, from lists of three names each presented by the Chamber of Commerce, the Board of Fire Underwriters and the New York Manufacturers' Association, J. Edward Simmons, president of the Fourth National Bank; Charles N. Chadwick, a manufacturer, and Charles A. Shaw, president of the Hanover Fire Insurance Company, to constitute the Board of Water Supply of the City of New York. Mr. Simmons has been chosen chairman. Offices have been established at No. 299 Broadway. On July 31, Mr. J. Waldo Smith was appointed chief engineer. John R. Freeman, of Providence; Frederic P. Stearns, of Boston, and William H. Burr, of New York, have been appointed consulting engineers. Engineering and executive staffs are being organized, and general plans for the work are being studied, which plans are subject to approval by the Board of Estimate and Apportionment of the city, and by the State Commission on Water Supply.

As the result of previous investigations and restrictive legislation, the source of supply to be immediately developed will probably be Esopus Creek, in Ulster County, on the west side of the Hudson and about 90 miles north of the city. The works, as recommended by the Burr-Hering-Freeman commission, will include a reservoir of about 66,000,000,000 gals. capacity, with a masonry dam 1,280 ft. long, of 175 ft. maximum height above the stream bed, an earth dam 10,700 ft. long, several smaller reservoirs and a 500,000,000-gal. aqueduct, in tunnel and trench about 90 miles long, involving a crossing of the Hudson River. A rough estimate of the total cost of the works is $100,000,000. Future extensions can be made in the watersheds of the Rondout, Schoharie and Catskill creeks, which are contiguous to the Esopus Creek. The waters of the upper Hudson may also be made available in the more distant future. Further development of the ground waters of Nassau County, Long Island, may add 25,000,000 to 50,000,000 gals. daily to the supply of the borough of Brooklyn, but Brooklyn will need also a share of the new supply from the North. For the borough of Richmond (Staten Island) a commission consisting of William H. Burr, J. Waldo Smith, Allen Hazen, Nelson P. Lewis and I. M. de Varona was appointed by the Mayor, early in the summer, to recommend proper procedure for improving the supply of that borough.

SUBWAY: ENTRANCE TO FULTON STREET STATION.

Rapid Transit in New York.

ELEVATED RAILROAD AND RAPID TRANSIT SUBWAY.

Students of transportation have found conditions in New York City peculiar in several respects. Owing to the great concentration of business in certain sections of Manhattan Island, and the distribution of resident sections at considerable distances, it has been necessary to develop to a high point the efficiency of lines of communication. The principal direction of travel on Manhattan Island is north and south. In the early morning hours there is a rush of passengers upon every longitudinal railroad on the island toward the south; in the late afternoon this tide of travel is reversed. During the periods of greatest travel, the cars of all transportation companies are overcrowded, so that it is not uncommon for an intending passenger to fail to find even standing room. More than a thousand million passengers yearly travel on the transportation lines in New York. The street railway services may be divided into three classes: surface roads, elevated roads and subways. The surface roads have been combined under one general management. The motive power is largely electricity, carried in underground conduits or third rails; horses are employed, however, to a large extent, principally upon the east side of Manhattan. Of the electric cars on the surface, there are three chief types, but they are generally interchangeable upon all the routes in Manhattan.

The elevated railroads of Manhattan and the Bronx are also united under one management, which is the same as that for the Rapid Transit Subway. The elevated roads run in a north and south direction upon Third, Sixth, Ninth and Second Avenues. In Brooklyn there are five lines of elevated railroads under the control of the Brooklyn Heights Railroad Company. The fares upon all the elevated and surface roads is 5 cents. The number of passengers carried on the elevated roads of the Manhattan system has been as large as 1,000,000 on a single day. It is estimated that about 40 per cent. of all fares given to the railroad companies in New York are paid to the elevated system. Local stations are placed at intervals of less than a half a mile, and express trains run on a third track on the Ninth and Third Avenue branches.

In order to increase the transportation facilities in a north-and-south direction, a subway has been built on Manhattan Island and in the Bronx. The work was constructed by the city, and has been leased to an operating company for a long term of years. As at present constructed, the subway begins at the Battery, follows a nearly direct line to the Grand Central Station at Forty-Second Street, thence passes west to Broadway, under which it runs to Ninety-Sixth Street; at this point a branch passes northeast under Central Park to Lenox Avenue, and under the Harlem River

SUBWAY: EIGHTEENTH STREET STATION INTERIOR.

to the borough of the Bronx. From Ninety-Sixth Street a second branch follows a northerly direction to the Harlem River, near its intersection with the Hudson. The system was opened October 27, 1904. The plan of train services in the subway is similar to that of the elevated railroads; local and express trains are run at frequent intervals. The motive power is electricity.

The subway is rectangular in section, from 25 to 50 ft. wide, and 13 ft. high. It was built for the most part as an open excavation through the streets of the city. A bed of concrete was laid upon the floor, while pillars of special design were constructed on either side and along the center, and beams were laid across the top. The side and top were then built up with waterproof masonry, and the whole was covered over and repaved. There are several sections of tunneling under Central Park, Washington Heights and the Harlem River.

The total length of the subway is 21 miles; its cost was $35,000,000; the material excavated measured over 3,000,000 cu. yds., of which about 1,300,000 was rock. In this construction there were used about 65,000 tons of steel, 8,000 tons of cast iron, and 550,000 cu. yds. of concrete. The construction of the subway presented a large number of peculiarly difficult financial and engineering problems. The contract for the whole work was taken by John B. McDonald. William Barclay Parsons was chief engineer until early in the present year, when he was succeeded by George S. Rice.

EAST RIVER TUNNEL OF THE NEW YORK RAPID TRANSIT RAILROAD COMMISSION.

The twin tunnels now building are the first to be constructed of the five tunnels which are proposed to connect the Manhattan and Brooklyn subway systems.

The tunnels are part of the line which connects Battery Park, in Manhattan, with the Long Island Railroad in Brooklyn and, in connection with the Atlantic Avenue improvement of that road, form a rapid transit system which extends almost to Jamaica, L. I.

The length of the river tunnel section is 6,550 ft. of double tunnels. Each tunnel is a cylindrical cast-iron shell, beton lined, with a clear inside diameter of of 15½ ft. The tunnels, on a 3.1 per cent. grade, reach a maximum depth (from base of rail) of about 94 ft. below mean high water, and have a roof covering of river bottom varying from 8 to 30 ft.

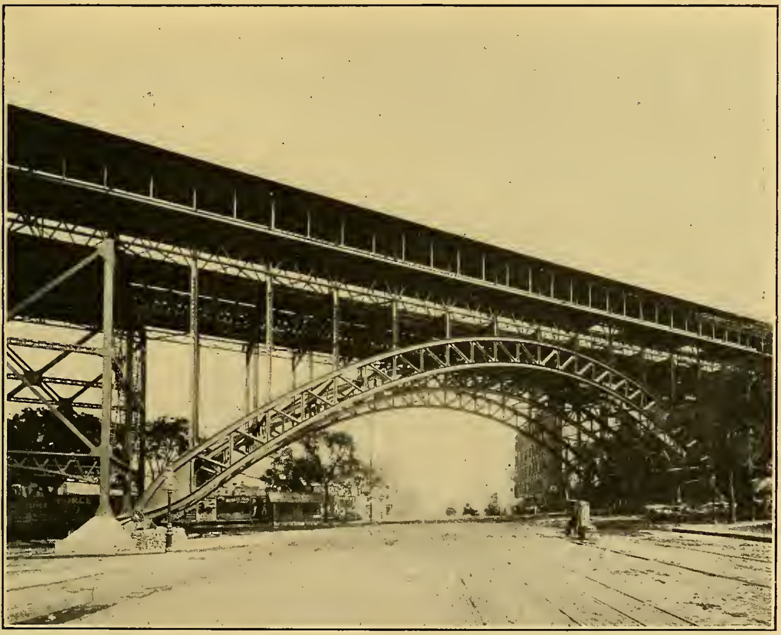
On the New York side the headings have advanced 1,700 ft. through bed rock, which is more or less treacherous; in some places the rock has fallen below the roof grade, leaving a covering of 15 ft. of clay and sand. These tunnels have reached a point 1,400 ft. beyond the bulkhead, or shore line, on the New York side, and 600 ft. on the Brooklyn side. The total distance between both bulkhead lines is 4,250 ft., thus leaving 2,250 ft. to be excavated.

The New York heading advanced through a rock excavation, made in the usual manner by drilling, blasting and timbering, conditions being complicated, of course, by the use of compressed air; the pressure at the present time is about 27 lbs. per square inch.

SUBWAY: ENTRANCE TO 116TH STREET STATION.

On the Brooklyn side two shafts were sunk to a depth of about 65 ft. near the point where the base of rail intersected the elevation of mean high water. On the up-grade, for a distance of 600 ft. from these shafts, independent tubes were driven by shields without the use of compressed air, as they were above the level of ground water. On the down-grade from these shafts below the elevation of mean high water, double tubes have been driven by shields 2,000 ft., in all a total for Brooklyn of 2,600 ft. (for New York 1,700 ft.), a total of 4,300 ft., which leaves 2,250 ft. yet to be built.

The greatest obstacles encountered in Brooklyn were buildings in the



SUBWAY: MANHATTAN VALLEY ARCH AND STATION.
(Span, 168.5 feet.)

narrow street and the small cover in the slip (9 ft.). The latter difficulty was surmounted by sinking a canvas covering on the bottom of the slip, and dumping on it scow loads of earth, until a sufficient depth of cover was obtained to resist the required air pressure.

The cast-iron lining is of the usual design, and is erected in lengths of 22 inches. Each length consists of a ring of eight segments, each 6½ ft. long, and a key 1 ft. long. The flanges are 1½ ins. thick with a depth of 7 inches, are stiffened by knee braces on sides and ends, and are each bored for nine bolts 1 in. in diameter. Each segment has a "lug" for convenience in handling, and is tapped with a 1¼-in. hole for grouting after erection. The weight of the rings in rock is 7,300 lbs., and in earth 8,300 lbs.; about 4,300 rings have been erected to date.

There were four cylindrical steel shields in Brooklyn. Each is 16 ft. 11¼ ins. in diameter, and 9½ ft. long, exclusive of a projecting hood 3½ ft. long. Five feet from the forward end there is a transverse vertical bulkhead (shown on photograph), made of steel and properly stiffened by verticals members which form seven openings and afford communication between the tunnel and the "heading" for material to be excavated.

The shield is advanced by fourteen hydraulic jacks with 8-in. pistons and 30-in. stroke. These are operated by a pump on a platform, which,

SUBWAY: SHIELD IN EAST RIVER TUNNEL.

on removable rollers attached to the completed shell, follows the shield. All of which will be clearly seen in the photograph.

The pressure is varied with the resistance, but in the usual gravelly material varies from 4,000 to 6,000 lbs. per square inch, and at the latter figure the total pressure advancing the shield is about four and a quarter million pounds.

In addition to the pump mentioned the platform carries, at a fixed distance behind the shield, an erector arm, for putting the lining segments in place. This consists of a hydraulic piston, which is capable of revolution in a plane normal to the grade by means of a gear wheel. The segments are placed in the plane of the erector arm and a piston is advanced to engage the lug on each segment. The movement of the piston is then reversed, until the segment clears the ground (as shown), the gear wheel then revolves it until the desired position for the segment is reached, the piston is again advanced until the segment is in place and bolted.

The lining is erected in the rear or tail of the shield, which on the next advance leaves an annular space of 1⅛ ins. outside of the newly erected cast-iron ring. This space is filled by grout (1 to 1 Portland cement) forced through the opening before mentioned by a pump which is carried on a second platform.

Mr. George S. Rice is chief engineer of the Rapid Transit Commission, and Mr. Robert Ridgeway is the division engineer in charge of this work.

HARLEM RIVER TUNNEL OF THE NEW YORK RAPID TRANSIT RAILROAD.

The Rapid Transit Railroad Tunnel under the Harlem River extends from a point near 144th Street, on the Manhattan side, to 149th Street on the Bronx side. The approaches, also in tunnel, have grades of 3 per cent., merging under the river into a vertical curve 450 ft. long, having a radius of 7,517 ft. At the middle of the river the base of rail is about 44.5 ft. below mean high water, the top of the finished structure about 21 ft. below mean low water. The approach tunnels are of heavy concrete arch construction, the arch itself reinforced by transverse steel rods spaced 1.5 ft. These tunnels are entirely encased in a sheath of brick, laid in an asphalt mixture.

A twin-tube construction extends from a point 89.5 ft. south of the Manhattan pierhead line to 151.5 ft. beyond the Bronx pierhead line, a total distance of 641 ft., the pierhead lines being 400 ft. apart. These cast-iron tubes have an inside diameter of 15 ft. They are 12.5 ft. apart, center to center, overlapping or merging into each other; that is, each tube is flattened at the line of contact. This flattened portion, or diaphragm, common to both tubes, has a tier of holes through the ribs and flanges on each side to accommodate the electrical conduits. The individual segments comprising the tubes have a length of 6 ft., and seven segments are required for each tube to complete a 6-ft. length. There are two sections in the diaphragm, making sixteen units in a complete 6-ft. length. The separate segments and sections have flanges on all four sides, thus allowing each unit to be bolted to adjacent units. The flanges and intermediate ribs are reinforced by lateral webs. The outer shell has a thickness of 1 in., the flanges a thickness of 1⅛ in., and a total width of 6 ins. A concrete envelope encloses the tubes. It has a thickness of 1 ft. under the tubes, 1.5 ft. on each side of the tubes, and 2.5 ft. above the tubes. On the inside of the tubes the pockets formed by the flanges and ribs are filled with concrete, making a smooth interior surface. The weight of cast iron in the 641 ft. of twin-tube construction is about 2,200 tons; the quantity of concrete is approximately 4,500 cu. yds.

A strip of the required width was dredged to within 8 or 10 ft. of sub-grade. Working platforms about 5 ft. above high water were built on piles north and south of the dredged strip. Along this strip transverse pile bents were driven 8 ft. apart, four piles to a bent. These piles were cut off and capped at about elevation of top of the tube construction. A timber crib composed of transverse trusses, spaced 8 ft., and of longitudinal timbers connecting the trusses, was floated in and sunk so that the top longitudinal members rested upon the caps of the pile bents, the trusses falling midway between the bents. This cribwork formed the chief guide for driving sheet piling. Each member of this piling was composed of three 12 x 12-in. sticks bolted together, and provided with tongue and groove to engage adjacent members. The piles were in lengths of about 65 ft., and were driven 10 ft. or more below sub-grade by 5,000-lb. hammers, working on specially designed ways. The sheet piling was cut off at about level of caps of pile bents mentioned above. The roof needed to complete the submerged working chamber or caisson was composed of three layers of 12 x 12-in. timbers, with courses of tongued and grooved planking between. This roof, built in convenient lengths, was sunk so as to rest upon the pile bents and the top of the sheet piling. Within the chamber thus formed, after pumping out and turning on compressed air, the tubes were assembled and the concrete envelope placed.

The above method was used for the Manhattan half of the channel. A modification was made for the work on the Bronx side. The sheet piling and pile bents were cut off about the elevation of the center of the tubes. The upper half of the tubes was assembled in about 90-ft. lengths on pontoons and the enclosing concrete placed. This completed upper half was launched and sunk until it rested upon the pile bents, and on brackets cast on the outside segments, upon the top of the sheet piling. The top of the structure itself thus formed the roof of a caisson in which the lower portions of the tubes were assembled and the concrete envelope completed. The air pressure used varied from about 10 to 15 lbs.

Important Railroad Improvements.

PENNSYLVANIA RAILROAD TUNNELS TO NEW YORK CITY.

Although ferryboats will continue to carry thousands of persons daily across the North and East Rivers, the Pennsylvania Railroad will, in a few years, have other means of conveying passengers to Manhattan Island. A system of tunnels and approaches with a great station between Seventh and Ninth Avenues, Thirty-First and Thirty-Third Streets is in progress of construction. Diverging from the main line at a point east of Newark tracks will be laid across the Hackensack Meadows, crossing highways and other railroads overhead, to North Bergen, where the tunnels start under the Bergen Hills. The tunnels pass under the North or Hudson River at considerable depth, pierce Manhattan Island, continue under the East River and come to the surface near Thompson Avenue, Long Island City, on Long Island. Beyond the easterly portals of the tunnels will be a very large storage and cleaning yard for cars and engines.

From the Jersey end to the station in Manhattan there are to be two tubes, one for trains in each direction, and from Seventh Avenue to Long Island City there are to be four tubes, two for Pennsylvania Railroad trains and two for the trains of the Long Island Railroad. A single tube is provided for each track so as to secure better ventilation, avoid the possibility of one train's interfering with another and reduce chances for accident. The total length of the tunnels is 6½ miles, and they will contain about 20 miles of single track. They will be used solely for passenger service. All trains will be moved through the tunnels by electric locomotives.

The terminal station for receiving and discharging passengers in New York will occupy an area 520 x 2,000 ft. under ground, but the structure above, which will comprise the station building, a postoffice and an express building, will be somewhat smaller. At this station the tracks are 40 to 60 ft. below the streets, depending upon the elevation of the latter. The total cost of construction for these works has been estimated at $60,000,000. Contracts for the major part have been let on the basis of completion by the end of 1908.

NEW YORK CENTRAL RAILROAD TERMINAL IMPROVEMENTS AND ELECTRIFICATION.

Improvements now being made by the New York Central Railroad consist of a change in motive power from steam to electricity, the construction of two main power houses and eight sub-stations, and lowering the tracks of the Grand Central yard and terminal from Fifty-Sixth Street south to Forty-Second Street, so as to permit the restoration of the cross streets from Forty-Fifth to Fifty-Sixth Streets, inclusive, which heretofore have been cut in two. The necessity for the change to electricity arose from the serious inconvenience due to the use of steam locomotives in the four-track Park Avenue tunnel, which extends from Fifty-Sixth Street to Ninety-Sixth Street, 2 miles. As the depression of the yard and terminus, with the consequent roofing in of the tracks by streets and viaducts, was not feasible with steam locomotives, an additional reason was presented for the change. The handling of from 500 to 700 trains a day in the Grand Central yard, with its maze of tracks and switches, presents a problem, the solution of which has never before been attempted with electricity as a motive power.

Extensive changes are also planned for the Grand Central Station, including a connection with the Rapid Transit Subway. It is also planned to four-track both the Hudson and the Harlem divisions within the electrical zone, which extends 34 miles to Ossining, on the former, and 24 miles to White Plains, on the latter. The change will involve the electrification of nearly 300 miles of single track, carrying very important passenger and mail traffic.

The whole question of this change of power is in the hands of the Electric Traction Commission. After deciding upon the limits of the electrically-operated service, the next step was the selection of the character of current to be used. The commission, for several reasons, unanimously adopted direct current, among which were that direct current would facilitate future interchange of equipment with other rapid transit lines in New York City and vicinity already similarly equipped, and that alternating-current apparatus had not been developed to the point where it was considered practicable for such an important installation.

Two central power stations are to be erected, one at Port Morris and one in the vicinity of Yonkers, each with an ultimate capacity of 30,000 kilowatts, and so connected that either is able, in case of accident, to carry the entire load of a train service much greater than the present schedule. After an exhaustive examination of the relative merits of reciprocating engine-driven alternators and turbo-generators, the commission has recommended the use of the latter, and the contract has been executed for eight 7,500-H. P. turbo-generators, with an ultimate installation of twelve. The turbines are the Curtis four-stage vertical type, running at 500 revolutions. The generators are 25-cycle, three-phase, alternating current, wound for 11,000 volts. These turbo-generators, while rated at 7,500 H. P., can readily develop over 10,000 H. P. The condensing apparatus is guaranteed to maintain a vacuum of 28 ins., with cooling water at 70° F.

The boiler houses will be of the one-floor type, and will contain, eventually, forty-eight 625-H. P. water-tube boilers with interval superheaters. The boilers are designed for a normal working pressure of 185 lbs., and the steam will be heated to 200° F. over and above the temperature due to the steam pressure.

The system of electrical distribution will be 11,000-volt, three-phase, alternating current, generated direct and fed to eight sub-stations, where the primary current will be transformed into 600-volt direct current and fed into the working conductors. These conductors will consist of the usual third rail, except at crossings, and in complicated yard work, where an overhead rail will be installed.

The commission consists of Wm. J. Wilgus, John F. Deems, B. J. Arnold, Frank J. Sprague and Geo. Gibbs. Edwin B. Katte is the electrical engineer for the company.

TUNNELS UNDER THE NORTH RIVER.

The New York & Jersey Railroad and the Hudson & Manhattan Railroad constitute the Interstate Rapid Transit System of New York and Jersey City of the Hudson companies, popularly known as the "McAdoo tunnels." The system comprises in Jersey City a belt-line railway extending from the Lackawanna Railroad, at Hoboken, as a northerly terminus, to the Jersey Central Railroad, at Communipaw, as a southerly terminus, with intermediate stations at the Erie Railroad, the Pennsylvania Railroad, and in Jersey City. From this Jersey City belt-line there extended across the Hudson River a double line of tubes, from the Pennsylvania Railroad to Cortlandt Street, Manhattan, and thence to a terminal station down-town, fronting on Church Street and north and south from Fulton to Cortlandt Streets. For the uptown connection two tube tunnels have been already completed across the Hudson River from Hoboken to the foot of Morton Street, New York City. These two tubes are being extended under Christopher Street, Sixth Avenue and Ninth Street to two termini; one at Thirty-Third Street and Sixth Avenue and the other at Ninth Street and Fourth Avenue, adjacent to Astor Place station on the Subway.

Work on the two tubes recently completed was commenced in 1869, and the present owners are the successors of the Hudson River Tunnel Company. For the most part the work of these companies consists of iron lined tunnels, without branch connections. There are now under construction some 12 miles of double-track railroad. It is intended to provide on the New Jersey end for a physical connection with the Public Service Corporation's lines, so that the company may deliver its passengers from its new high-speed suburban lines directly into New York, either up town or down town.

All these tunnels are designed for an equipment of steel cars equal in size to those used in the New York Rapid Transit Subway, with third-rail electrical operation on the multiple-unit system, using a maximum train length of eight cars. Work is being actively carried on from the working plants at the foot of Morton Street, New York, and from foot of Fifteenth Street; also from foot of York Street, Jersey City. It is being executed, without tearing up the surface, by shield tunneling methods.

Under the Hudson remarkable records have been obtained, the company having driven in one week (seven days) as much as 346 ft. of finished tunnel in one heading, with a maximum single day's work of 62 ft. This section of the work has been executed by means of a special shield capable of being forced through the clay underlying the Hudson River, removing only a very small portion of the clay in the construction of the work. Work under New York, however, is being carried on in a coarse sand and gravel, and has been driven under buildings and streets without any indication on the surface that the work was in progress, with no apparent settlement.

One of the novel features of the iron tube tunnel is the construction of the curves on a radius of 150 ft. with a shield and completely lined with an iron lining, by pushing the shield around on the radius of the curve with almost absolute accuracy. The construction of a tube tunnel on such a short radius with a shield has never previously been accomplished. The Hudson companies is directed by Mr. Walter G. Oakman, president, and the railroad companies are represented by Mr. W. G. McAdoo, who is the president of those companies. The work of construction is in charge and under the direction of Jacobs & Davies, as engineers. Tunnels are being driven under this river for the Pennsylvania Railroad, also, as described on another page.

A Few Prominent Bridges in New York.

WASHINGTON BRIDGE.

Washington Bridge, across the Harlem River, is built on the line of 181st Street prolonged, and extends from Amsterdam Avenue, in the borough of Manhattan, to Aqueduct Avenue, in the borough of the Bronx, a distance of 2,375 ft. It consists of two steel arches, each of 510-ft. span between the end bearing pins. Each of these arches is composed of six two-hinged steel ribs, 13.5 ft. high. These arches are flanked on the west side by three semi-circular stone arches of 60-ft. span, and on the east side by three similar arches of 60-ft. span, and one 55-ft. parabolic arch. Beyond the arches the bridge is continued on embankments between retaining walls. This bridge carries a roadway 50 ft. wide, and two sidewalks each 15 ft. in width. It has a height in the clear of the river span of 133.5 ft. Work was begun in July, 1886, and was finished in February, 1889, at a cost, exclusive of land, of $2,851,685.

It can be reached by Sixth or Ninth Avenue elevated cars, transferring to an Amsterdam Avenue trolley at 125th Street, or by train from the Grand Central Station to High Bridge station. It is well worth the trip, as High Bridge and the New York Water Department Pumping Station can also be seen at the same time.

BRIDGES OVER THE EAST RIVER.

There are, at present, two bridges in operation across the East River—the Brooklyn and the Williamsburg Bridge. Two others are in process of construction—the Manhattan Bridge and the Blackwell's Island Bridge.

The first bridge ever built across the East River was the Brooklyn Bridge, and for twenty years it was the only one available. Work was begun January 3, 1870, and the first wire of the cables was run across May 29, 1877, but it was not till 1883 that the bridge was opened for use. It was designed by John A. Roebling, who was succeeded by Washington A. Roebling; and C. C. Martin as chief engineer. It is a suspension bridge with a main span of 1,595.5 ft., and a land span of 930 ft. at each end. The clear height in the center above mean high water is 135 ft. Four cables, each containing 5,296 parallel (not twisted) galvanized, steel, oil-coated wires, closely wrapped to a solid cylinder 15¾ ins. in diameter, are used to carry the roadways and tracks, and six stiffening trusses are provided. The total length of wire in the four cables, exclusive of the wrapping wire, is 14,361 miles. The extreme width of the bridge is 85 ft., and it carries a footway 15½ ft. in width, two tracks for the cars of the elevated railways and the railway system of the bridge itself, and two 18-ft. roadways, each of which is considerably obstructed by a trolley track. The arrangement of

WASHINGTON BRIDGE AND SHAFT No. 25.

roadways differs materially from that which was contemplated when the general designs for the bridge were prepared, and numerous projects for increasing the strength of the structure, and consequently its capacity, have been suggested.

The special engineering feature of the bridge is the use of masonry towers. These towers were built on pneumatic caissons, which at the time were the largest of their kind ever sunk. One tower is 140 x 59 ft. at the water line, and the other is 140 x 56 ft. Each is 272 ft. high above the water. The Brooklyn tower contains 38,214 cu. yds. of masonry, and the New York tower 46,945 cu. yds. The bridge extends, with its approaches, from Park Row, Manhattan, to Sands Street, Brooklyn, a total distance of 6,016 ft., and if the extreme points of the terminal structure at the ends are included in the measurement, the length is 7,580 ft.

The second bridge built across the East River was the Williamsburg Bridge. This is also a suspension bridge, and connects the foot of the main street of the old city of Williamsburg with Delancey Street, Manhattan. This bridge has a main span of 1,600 ft., and a land span at each end of 596.5 ft. The land spans are not suspended from the cables, like those of the Brooklyn Bridge, but are independent truss structures. The clear height of this bridge in the center, above mean high water, is 140.4 ft.

The towers, rising about 332 ft. above the high-water level, are steel structures weighing about 3,048 tons each. Instead of one large caisson and a single base for each tower, as were used for the Brooklyn Bridge, two caissons and two masonry piers were employed for each tower of the Williamsburg Bridge, and one of these caissons had to be sunk to a depth of 107.5 ft., 30 ft. deeper than at the older bridge.

The towers carry four cables, 18⅝ ins. in diameter, each containing 7,696 wires. Two stiffening trusses, 40 ft. deep, form one of the most noticeable features of the structure, and when viewed from a distance, distinguish it more than anything else from the Brooklyn Bridge. The topographical conditions at each end of the bridge rendered it advisable to keep all the heavy traffic on one level, and for this reason the bridge has a width of 118 ft. A light overhead deck carries the footwalks and bicycle path, while the main floor has two tracks for elevated railway cars, four tracks for trolley cars, and two 20-ft. roadways; the length of these last, from the terminal at one approach to that of the other, is 7,264 ft. The bridge has about three times the capacity of the Brooklyn Bridge.

The bridge was designed by L. L. Buck, and built under his supervision, O. F. Nichols being his principal assistant engineer during all the important stages of the work. It was begun in October, 1896, and was opened for traffic on December 19, 1903. Its cost, exclusive of property, was $10,858,000.

The third bridge across the East River is the Blackwell's Island Bridge. It differs from the others in being a cantilever structure, a type of construction rendered possible by the natural advantage for tower foundations of Blackwell's Island, over which it passes, and from which it derives its name. The sub-structure for this bridge has been completed and the superstructure is now under way. Beginning on the Manhattan

WILLIAMSBURG SUSPENSION BRIDGE ACROSS EAST RIVER.

side of the river, there is first an anchor span of 469.5 ft., then a channel span of 1,182 ft., a span of 630 ft. over the island, a second channel span of 984 ft., and finally an anchor span of 459 ft. at Long Island City. The towers rise a little over 300 ft. above the water level. The total width of the bridge will be 86 ft., and the width between center of trusses 60 ft. There will be an upper deck, with two tracks for elevated trains and room for two more similar tracks when needed, and a lower deck carrying four trolley car tracks, a 36-ft. central roadway, and two 12-ft. sidewalks. The structure is particularly noteworthy, apart from its magnitude, by the unique connections at the centers of the channel spans, where no suspended spans are used, and for the fact that 6,000 of the 45,000 tons of steel in the superstructure will be nickel steel. There will be a maximum clear height under the bridge, above mean high water, of 135 ft. This bridge was designed by Gustave Lindenthal, while he was Commissioner of Bridges of New York City.

The fourth bridge across the East River is the Manhattan Bridge, and is located between the Brooklyn and the Williamsburg Bridges, and like them is a suspension bridge. The tower foundations are completed, and the plans for the superstructure have but recently been made public. The Brooklyn tower rests on rock, but the Manhattan tower is founded on sand at a depth, below mean high water, of 94 ft. The main span will be 1,470 ft. in length, with a land span on each end of 725 ft. The Manhattan approach will be 1,164 ft., and the Brooklyn 1,689 ft. There will be a clear head room above mean high water of 135 ft. The steel towers will rise to a height of 322 ft. above high water, and will carry four cables each, 21 ins. in diameter, the largest ever built. They will hang vertically and will not be cradled like those of the Brooklyn Bridge. There will be an upper deck with four tracks for elevated trains, and a lower deck 120 ft. wide, with four trolley car tracks, two 10.5-ft. sidewalks, and a 35-ft. roadway. The two stiffening trusses will be 24 ft. deep and form a much less conspicuous feature of the bridge than those of the Williamsburg Bridge. This bridge was designed by O. F. Nichols, chief engineer, and R. S. Buck, consulting engineer, of the Department of Bridges.

Lighting, Power and Sanitation.

GAS WORKS IN NEW YORK CITY.

There are five gas companies which manufacture and supply gas to New York City, the Consolidated Gas Company, the New York Mutual Gas Light Company, the Standard Gas Light Company, the Central Union Gas Light Company and the New Amsterdam Gas Company. The Consolidated Gas Company, organized November 11, 1884, is a consolidation of six different companies. It is at present operating five works in New York City, as well as having holder stations at four other locations. Gas is manufactured and purified at these different points by various processes. The combined holder capacity of this company is about 25,000,000 cu. ft. This company has at present under construction an immense plant at Astoria, L. I., the plans being to remove all the works from New York City, leaving only holder stations, and to pump the gas from Astoria to these stations. For the present, the unit now under construction being for coal gas, they will pump from Astoria to Ravenswood and mix with the water gas, and feed from the New Amsterdam Gas Company at this point, the mixed gas being pumped through a tunnel, described on another page, previously constructed, to Manhattan. They have, however, received a franchise for a new tunnel, extending from their works in Astoria to East 111th Street, New York, and will soon begin its construction. Mr. William H. Bradley is the chief engineer of the Consolidated Gas Company, and Mr. Howard Bruce is its general manager.

The New York Mutual Gas Light Company, incorporated in 1866, has works located at Twelfth Street and the East River, which manufacture water gas by the Lowe process. There is a holder capacity at this plant of 10,274,000 cu. ft. The Standard Gas Light Company, incorporated in 1886, has works located at 114th Street and the Harlem River. Gas is here manufactured by the Lowe process, and stored in two holders, one at 132d Street, near Broadway, and one at Nineteenth Street and Avenue A. The Central Union Gas Light Company has works located at 138th Street and the East River. It manufactures both coal and water gas, having installed both horizontal and inclined benches for the manufacture of the former.

The New Amsterdam Gas Company has its main works located in Long Island City. It also has holder stations at East Fortieth Street and West Fifty-Eighth Street, New York, to which gas is pumped, from the generating station to Manhattan, through two 36-in. mains. These mains are laid in a tunnel, about 10 ft. in diameter, extending from Webster Avenue, Long Island City, under Blackwell's Island and the two channels of the East River, to Seventy-First Street, New York. This tunnel was the first tunnel ever built under the East River. Portions of this tunnel, through the mud on the New York side, were driven by means of a shield, while the portion through rock was built without any protection. The roof of this tunnel is about 106 ft. below the surface of low water in the river.

ELECTRIC LIGHTING IN NEW YORK CITY.

The development of the electric lighting industry in New York is so closely allied with the development of the uses of electricity itself that a history of the Edison system in New York might well be called a history of electric lighting. The New York Edison Company, successor to the Edison Electric Illuminating Company, furnishes practically all the lighting in Manhattan and the Bronx, and is using on Manhattan Island the Edison three-wire low-tension system of distribution. In the Bronx an alternating-current system is used, due to the longer distances and scattered load. The Edison three-wire low-tension system, which was first installed in this city, starting from small beginnings, has grown to such a point that it now represents a connected installation of over 3,000,000 16-c. p. equipments. The distribution system itself is practically the same as when first installed, consisting of a network of mains on both sides of the street, all inter-connected, from which the customers' services are taken.

Low-tension feeders supply the mains at many feeding points throughout the city, the feeders being taken from the various sub-stations and older steam generating stations. The sub-stations, many of which were formerly low-tension generating stations, are supplied with high-tension alternating current from the Waterside station of the company, transforming the alternating current to low-tension direct current by means of step-down transformers and rotaries. Each sub-station has a distributing switchboard with three sets of busses maintained at slightly different voltages, thus allowing for the varying length of feeders and maintaining a constant potential in the mains. There are more than twenty of these sub-stations in the city, and it is interesting to note that each of these sub-stations contains one or more storage batteries to safeguard the customer in case of breakdown or other difficulties.

At the present time all the high-tension current is generated at the Waterside station, located on First Avenue between Thirty-Eighth and Thirty-Ninth Streets, which has a normal capacity of 58,000 kilowatts. The generating apparatus consists of eleven 6,000-H. P. engines of the three-cylinder compound vertical type, directly connected to 4,000-kilowatt rotary-field generators, and four 5,000-kilowatt Curtis steam turbines. The boiler equipment consists of fifty-six 650-H. P. Aultman & Taylor inclined water-tube boilers. About half the boilers are provided with stokers. The products of combustion are taken care of by means of four steel stacks 19 ft. in diameter and 200 ft. high.

The new Waterside station, under construction, will have a normal capacity of over 75,000 kilowatts, and will be ready for service in the summer of 1906. At the present time four 7,500-kilowatt units are in process of construction, two of the Westinghouse-Parsons type and two of the

Curtis type. The new Waterside station will contain ninety-six 650-H. P. Babcock & Wilcox boilers, which will be equipped with superheaters and forced-draught apparatus. The products of combustion from these boilers will be taken care of by means of four steel stacks 22 ft. in diameter and 300 ft. high.

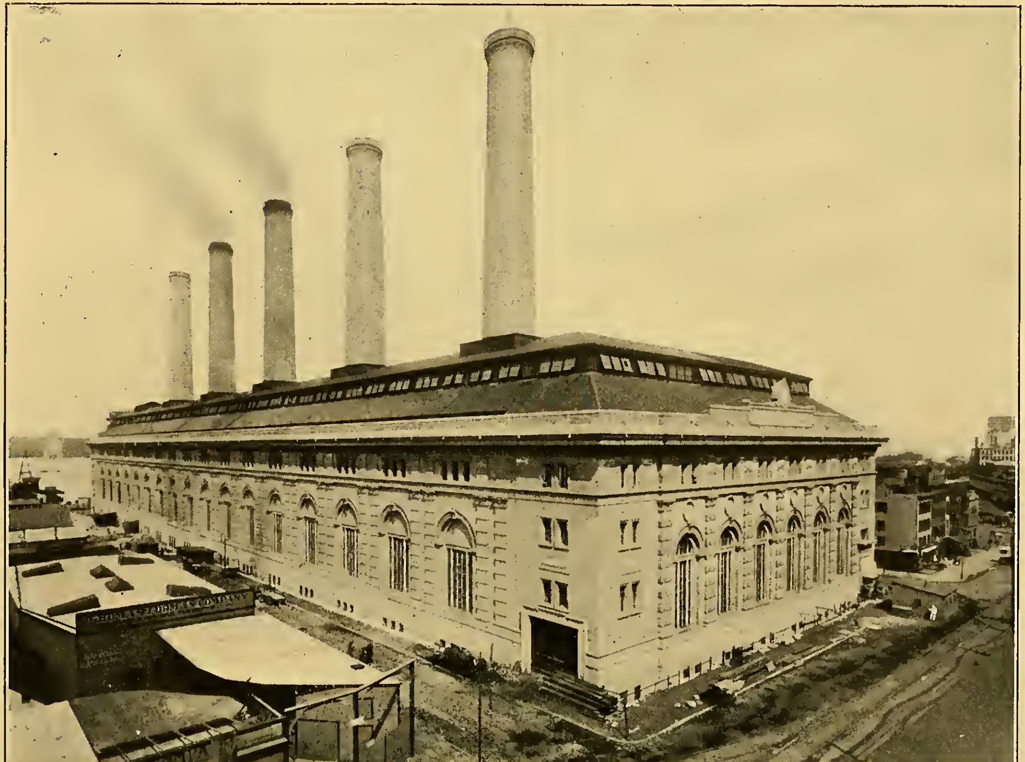
In the borough of Brooklyn a mixed system is in use, the three-wire Edison system for the urban district, and a number of alternating systems for the suburban territory. Most of the current is generated at the Bay Ridge station of the Edison Electric Illuminating Company of Brooklyn, but there are a number of smaller generating stations and sub-stations. In the boroughs of Queens and Richmond there are a number of alternating systems covering small districts.

PROPOSED MUNICIPAL LIGHTING PLANT FOR NEW YORK CITY.

The technical commission on electric lighting for the City of New York, consisting of Dr. Cary T. Hutchinson, Nelson P. Lewis and Prof. George F. Sever, has recently submitted to the Board of Estimate and Apportionment a report giving the cost of construction and operation of a city electric plant to supply all the city lighting by electricity for streets, parks and public buildings. The report deals in great detail with the problem, and claims that with the proposed equipment each arc lamp for which the city is now paying $146 per year can be operated at an annual cost of $64.07, and that at 5.5 cents per kilowatt-hour the city can obtain incandescent service which now costs 10 cents per kilowatt-hour. The estimated cost of the complete plant for Manhattan and the Bronx is $7,567,000.

The city owns a plot of ground bounded by Avenue A, Ninetieth and Ninety-First Streets and the East River, and it is proposed that the central station be located on this plot. The power house will comprise a boiler room, a turbine room, with switchboard galleries and two wings for office purposes. Each wing is to be approximately 50 x 53 ft. The boiler room is to be 88 x 260 ft., the turbine room 103 x 260 ft. The building is to be constructed of reinforced concrete and masonry.

The specifications call for two 5,000-kw, three 3,000-kw and one 1,000-kw turbo-generator units, together with one turbine or engine-driven exciter of at least 200-kw capacity. The exciter will be wound for 125 volts direct current, while the other generators are to be wound for three-phase, 60-cycle current at 11,000 volts. The boilers will be inclined water-tube boilers, designed for a working steam pressure of 200 lbs., and are to be fitted with mechanical stokers for burning either hard or soft coal. The equipment is to include twenty-four boilers, each of approximately 6,000 sq. ft. of heating surface (about 600 H. P. each). The superheaters will raise the temperature of the steam 150 deg. F. above the temperature at 200 lbs. pressure. A storage capacity for coal is to be provided sufficient to run the plant for six months. The power will be delivered to nine sub-stations in Manhattan and five in the Bronx, by means of cables run underground in ducts at 11,000 volts; it will be transformed to the required voltage. No provision whatever is made in the estimates for a



SUBWAY POWER HOUSE, FIFTY-EIGHTH STREET AND ELEVENTH AVENUE.

storage battery plant as a safeguard against breakdown or accident in the generating plant.

LARGE POWER HOUSES IN NEW YORK.

Visitors to New York, interested in the generation of electricity for power and lighting purposes, will find much to interest in the many large power houses now in operation or under construction. In no other locality in the world can one find so many examples of good design and modern construction. The following list includes all power houses larger than 20,000 kilowatts at normal rating:

Name and Company.	Boiler H. P.	Generator K. W.	Remarks.
New Waterside—The N. Y. Edison Co.	62,400	75,000	Construction
Subway—Interborough R. T. Co.	43,000	60,000	
Williamsburg—Brooklyn H'ts R. R. Co.	46,800	60,000	Construction
Waterside—The N. Y. Edison Co.	36,400	58,500	
Kingsbridge—Metropolitan St. Ry. Co.	32,000	42,000	
Manhattan—Interborough R. T. Co.	33,280	40,000	
96th Street—Metropolitan St. Ry. Co.	20,000	38,500	
Long Island City—Penn. Ry. Co.	....	33,000	Construction
Port Morris—New York Central	30,000	30,000	Construction
Yonkers—New York Central	30,000	30,000	Construction
Central—Brooklyn Heights R. R. Co.	20,800	21,600	

Of this list all but two generate power for the transportation systems of the city, the Waterside stations being used for lighting and general power purposes. Those marked "Construction" are not yet completed.

The latest type of railway generating station equipped with the modern steam turbo-generators may be seen at the Williamsburg, Port Morris or Long Island City stations, the differences in design of the stations being caused by the type of turbine used and the cost of real estate. Of the older stations the Subway and Manhattan are equipped with engines of the horizontal-vertical type, while the Kingsbridge, 96th Street and Central stations have ordinary vertical cross-compound engines. While the stations differ largely in generating apparatus, one type of boiler, the inclined water-tube, is common to all. The generating units vary in size from 2,700 kilowatts in the older stations to 7,500 kilowatts in the newer installations, the latter units having an overload capacity for three hours of 12,000 kilowatts, or over 16,000 H. P. Each one of these units will require a pump capable of supplying 30,000,000 gals. of water every twenty-four hours for condensing the 650,000 gals. of water used by the unit as steam.

In general design the station layouts are similar, consisting of an engine room, a switchboard, either at one side or end, and condensing apparatus in the basement. Alongside the engine room is the boiler room, having either one, two or three floors for boilers, with the feed pumps, tanks and ash machinery in the basement, and a coal pocket with the necessary coal-handling machinery above the boilers, the coal pocket in some instances having a capacity of 20,000 tons. The stations are located on the water front, using salt water for condensing purposes and handling coal and ashes by boat. About half of the stations are equipped with automatic stokers. All the stations are generating alternating current at high voltage, using either 6,600 or 11,000 volts, transmitting underground at this voltage to sub-stations, where step-down transformers and rotaries are used to tranform the electricity to the usual low-tension direct current used in traction and lighting service.

DEPARTMENT OF HEALTH.

The Department of Health of New York is generally recognized as one of the most efficient bureaus of its kind to be found in any large city. At its head is the Commissioner of Health. The Board of Health consists of the Commissioner of Health, the Commissioner of Police, and the Quarantine Officer of the State. There is an advisory board of physicians, composed of some of the most eminent medical practitioners in the city. The authority of the health department extends over every borough. The work of the department is divided into two branches, one of which is under a sanitary superintendent. In this division is a sanitary squad, composed of men detailed from the police department. A large corps of sanitary inspectors is employed and divided into mercantile inspectors, food inspectors, meat inspectors, fruit inspectors, fish inspectors, lodging house inspectors and offensive-trade inspectors. The duties of these various officers is to see that the various sections of the sanitary code of the city are enforced. The vital statistics of the city are collected and preserved under the authority of the Department of Health, which also issues certificates to minors, permitting them to accept employment under certain regulated conditions.

A great deal of attention has been given by the Department of Health to improving the quality of milk brought into the city, with the result that the condition of this important aricle of food has been considerably improved. Recently the milk inspectors have gone out into the country, from which the milk has been obtained, in order to exercise sanitary supervision over the conditions under which the milk is handled at its source.

There is a bureau called the Division of Contagious Diseases, composed of a medical corps, including diagnosticians, district medical inspectors, vaccinators, summer corps, oculists, medical inspectors of schools, school nurses, disinfectors and veterinarians. Each officer has his special duty. The diagnosticians are employed to diagnose causes of suspected contagious diseases; the medical inspectors direct quarantine and see that it is properly observed; the vaccinators move about among school chillren, lodging-house occupants, sweat-shop workers and others, and sometimes perform vaccination compulsorily in order to prevent the spread of smallpox; the oculists examine the eyes of children for contagious diseases; when these forms of illness exist, the children are barred from school. There are over half a million children in the public schools in New York, and their health is the subject of the special attention of the oculists and medical inspectors. When the children become ill they are visited in their homes by nurses.

There is a division of chemistry and a bacteriological laboratory. In these two bureaus milk, water, food and drugs are systematically analyzed, and the efficiency of disinfectants tested. Vaccine and antitoxins are prepared in a division of the laboratory. The bacteriological laboratory, working in conjunction with the division of contagious diseases, makes analyses of sputum and other pathological specimens to discover evidence of disease. There is a clinic for pulmonary diseases under the direction of the Department of Health. Here people are examined for evidence of consumption and other disorders of the respiratory apparatus. For the care of persons suffering from virulent contagious diseases, and for those who cannot be properly isolated, or receive proper treatment in their own homes, several contagious disease hospitals have been established in the city under the direction of the Department of Health. One of these hospitals is in Brooklyn, and one on North Brother's Island, at the entrance of the Long Island Sound, one at the foot of East Sixteenth Street, and one for contagious diseases of the eye, known as the Trachoma Hospital, at 118th Street and Pleasant Avenue.

STREET CLEANING DEPARTMENT.

The department of the city whose duty it is to keep the thoroughfares clean, is probably the largest force of its kind under one management in the world. The factories at Barren Island, where the house garbage of the city is converted into grease and fertilizer, and dead animals disposed of, is the largest plant of its kind in existence. There are several divisions of the Street Cleaning Department; the responsible head of them all at the present time is Commissioner J. McG. Woodbury, a physician. His salary is $7,500 per year. The jurisdiction of the head of the department of street cleaning extends over Manhattan, Brooklyn and the Bronx; the work of street cleaning and garbage disposal in the boroughs of Queens and Richmond are under the direction of the Commissioners of Public Works of those boroughs.

In Manhattan, Brooklyn and the Bronx, the streets are swept chiefly by hand, from one to four times a day. There are about 2,500 sweepers; they each have about 3.64 linear miles of street per day to clean. Sweeping machines are used in the suburbs. Some of the streets, about 75 miles in all, are washed with a hose, or by what is called a "flushing machine." Flushing is very popular among the residents in the crowded tenement district, where street cleaning is especially difficult, owing to the fact that the thoroughfares receive much filth of all kinds. Flushing is said to carry much solid matter into the sewers, which later has to be removed by hand, but the expense thus caused seems to be disproportionate to the advantages gained. The sweepers wear white duck uniforms and white helmets.

The garbage and ashes from dwelling houses are collected into large two-wheeled metal carts. There are about 1,500 of these carts and drivers. Each horse travels about 20 miles a day. The drivers wear brown uniforms. The refuse is put outside of the doors of the houses, kitchen garbage in one receptacle and ashes in another. Rounds are generally made daily by the collectors, each of whom has about one mile of houses to cover. Light rubbish, such as paper and boxes, is collected by large, two-wheeled wooden trucks, when a card bearing the letters "P. & R." is displayed in a window. A large amount of the garbage and ashes are collected by private scavengers who are paid by the individual house-holders. Most of the hotels dispose of their swill to persons who feed it to hogs; some burn it. Many of the large manufacturing and mercantile houses remove their refuse at their own expense. The total cost of clearing and disposing of the wastes, therefore, is not known. The appropriation for the Department of Street Cleaning for 1904 was $5,447,712.20; of this there was appropriated for sweeping and carting, $3,992,937.30, and for final disposition, $939,333.50.

The different kinds of refuse collected by the Department of Street Cleaning are disposed of in various ways. The kitchen garbage is hauled to wharves at the water front and there dumped into scows, which, when full, are towed to Barren Island, near Coney Island and Rockaway and Manhattan beaches. At Barren Island the garbage is conveyed mechanically from the scows to large cylinders or kettles, in which it is cooked by steam. The cooked garbage is then pressed in hydraulic presses, the liquid cooled, and the grease removed, and the solid residue used as a base for fertilizers. It is said that some of the grease is converted into delicate toilet soap. The tin cans which are found in the garbage are separated at the factory and converted into window weights. The transfer of garbage from the city and its utilization is paid for by the city by contract with a private corporation.

The ashes, collected separately, are used for filling in low land; they have sometimes been dumped at sea, to the frequent annoyance of bathers and other persons on the beaches. Some of the light rubbish is sorted, and the inflammable parts burned at a refuse furnace, built by the department at Forty-Seventh Street and the Hudson River. This plant was experimental, but has demonstrated the feasibility of consuming the class of worthless material which it has had to handle. About 100 loads of rubbish are burned here every day; each load weighs about 1,000 lbs., and measures 7½ cu. yds. By test it has been found that 1 lb. of refuse can be made to evaporate 1½ lbs. of water, and that 232.7 H. P. can be produced per hour. The grates of the furnace are of cast iron; the furnace is of red brick, lined with fire brick; natural draught is used. The stack is 114 ft. high.

At Riker's Island, in Long Island Sound, 63½ acres of low-lying land have been reclaimed by filling with ashes. The ashes are hauled from the city water front to Riker's Island by boat, and transferred upon flat cars, which carry it near to the point of deposit; orange peel buckets unload the ashes from the flat cars on to a conveyor, which carries it finally to the point of disposal. Brooklyn has a system for removing ashes on special trolley cars, each carrying large steel buckets, the ashes being dumped to fill low ground.

Snow, also, is removed from the streets under the direction of the Department of Street Cleaning. Contracts are let for most of the work.

When a certain depth of snow has fallen, usually about 2½ ins., the contractors are notified to begin work for its removal. Simple methods are used in this work. The snow is collected into piles; it is then shoveled into carts; these haul it to the river front and dump it into the water. Payment is made to the contractors according to the number of cubic yards removed, the quantities being computed from the known areas of the street cleaned and the estimated depth of snow. The most crowded thoroughfares are cleaned first. Sometimes several snowfalls occur before any of the principal streets are clean. No attempt is made to clear all of the streets of snow. Snow melting machines of various types have been experimented with, but have not been adopted.

BROOKLYN SEWERAGE IMPROVEMENTS.

Brooklyn, like Greater New York, of which it became a part in 1896, was made up of a number of communities which had been annexed to the original city from time to time. It has some of the largest sewers in the world, considerable lengths having diameters from 10 to 15 ft. In the older portion of the borough, some sewers have become inadequate, necessitating the construction in recent years of large relief sewers. The total area of the borough is 77.6 square miles, of which 26.1 lie south of the ridge of high land known as the backbone of Long Island. Large areas of this southerly and southeasterly portion are being rapidly developed by the laying out of miles of streets, and the erection of hundreds of houses from year to year. But this growth, instead of being from the shores inward, as is usual, has spread over the divide. These districts could not be drained into the sewers of the older city. Sewers built along the natural lines of drainage to the southerly shores would have been very long, and excessively costly, would have traversed wide areas not requiring sewers for many years, would have needed a long time for construction, delaying the relief to the developed districts, and would have discharged the sewage towards Coney Island, Gravesend Bay and other resorts. A number of purification works would have been demanded, and experience has shown such plants to be unsatisfactory and expensive.

Consequently a scheme was adopted dividing the region into nine districts, six of which have areas of 2 to 8 square miles. The prominent features of the scheme are the following of the natural drainage lines as nearly as possible in each district, the driving of two tunnels westward through the ridge to carry the sewage and storm water of two large districts, and the house sewage of two small districts into the Narrows, the separating of the house sewage from the storm water of other large districts at trap basins so as to send the sewage to a large existing purification station, the utilizing of practically all the pre-existing lateral sewers that had been parts of the old town systems, and the reaching of the built-up sections of the territory quickly. The estimated total cost of the system is about $14,000,000, including 98 miles of brick sewer from 30 to 180 ins. in diameter, 576 miles of 12 to 24-in. pipe sewers, four pumping stations and modifications of the East New York purification works. A large part of the undertaking has already been accomplished, involving some very deep trench work, and some unusually difficult tunnel construction, for which ingenious methods were devised. Mr. Henry R. Asserson is the chief engineer of the Brooklyn sewer department, and these works have been designed and constructed under his direction.

New Water Works in the Vicinity of New York.

YONKERS WATER WORKS.

Yonkers obtains it water from Grassy Sprain and Sprain Brook impounding reservoirs and from the Sawmill River. Beside the river there are fourteen 6-in. wells and a pumping station on the left bank, and a slow sand filter plant directly opposite. The reservoirs have no unusual engineering features, and with the wells are sufficient for needs, except in dry seasons. The filters, completed in June, 1904, and having a capacity of 3,000,000 gals. per day, are intended to supply deficiencies. There are two one-half-acre open beds and a 200,000-gal. filtered water reservoir, wholly in excavation, at such an elevation that the raw water can flow on to the beds by gravity. A 20-in. main under the river connects the filtered water reservoir with the pumping station.

Each filter is 182 x 124 ft. and 8 ft. deep inside, with 1 ft. of gravel, 3 ft. of sand and 3½ ft. of water. On the bottom of each bed are a 24-in. vitrified pipe main drain and 10-in. split tile laterals 18 ft. apart, laid with ¾-in. open joints. The filtered water reservoir is of the usual groined arch construction. Both it and the filters are of Portland cement concrete. The sand court, between the filters and the river, has an area of 900 sq. yds. and is paved with granolithic blocks. At the center of the court is a four-hopper sand washer of the ejector type. The concrete inlet chamber, at the northeasterly corner of the northerly filter, is only 6 x 8 ft. inside, and has no superstructure. The gate house, at the intersection of the front and division walls of the filters, contains duplicate chambers for the control of each filter separately, with two brass plate orifices and float gauges for indicating the rate of filtration and loss of head, besides the necessary valves. Filter sand was obtained by washing somewhat unpromising local sand by means of an ingenious device.

There are also two water towers of brick with stone trimmings, connected with the works. Accompanying views show their design. The top of the Lake Avenue tower is 400 ft. above the sea level and from its observatory a very fine view is had of the Hudson River, from New York Bay at the south, to Tappan Zee on the north, and from the Palisades on the west bank of the Hudson, to Long Island Sound on the east. The balcony of the Elm Street tower is 435 ft. above the sea level, and one of the finest views in this part of the country is obtained from its observatory. This view takes in Long Island Sound, the East River, the Hudson River, and all the surrounding cities, towns and villages within a radius of 20 miles.

ELM STREET WATER TOWER, YONKERS.

The dam at the Grassy Sprain reservoir, which is the main supply for the city, was increased in height during the last two years 12 ft., so that now when the reservoir is full, instead of 400,000,000 gals. storage, there are 900,000,000 gals. By this addition to the main reservoir, with the filter plant added during 1904, the city is well taken care of for the present.

Mr. Edward L. Peene is the superintendent of the works. Mr. Allen Hazen designed the filter plant, and Tucker & Vinton, Incorporated, of New York, built it. The total cost, including engineering, was about $54,000. To reach the filters or wells from New York, take Sixth or Ninth Avenue elevated to 155th Street terminus, and New York & Northern Railroad train to Nepperhan station, then walk north one quarter of a mile. To visit the towers—Lake Avenue, take Park Avenue cars from N. Y. C. & H. R. R. station; Elm Street tower, Mt. Vernon cars from same station.

WATER FILTERS AT POUGHKEEPSIE.

A covered slow sand filter has recently been built for the Hudson River State Hospital. Its capacity is 1,000,000 gals. per day, and it is situated between the railroad and the Hudson River, from which the raw water is drawn. There are two 1-6-acre beds and a 200,000-gal. filtered water reservoir. A small pumping station near by contains two pumps for supplying raw water to the filters, and two for raising filtered water to the hospital. The sand court, 46 ft. square, is on top of the groined roof arches with one diagonal in the center line of the division wall between the two filters. The ventilators which would have come within the square were omitted, but four holes into each filter, guarded by trap doors, allow clean sand to fall on to either bed whenever desired.

The sand washer consists of two reinforced concrete tanks supported on two walls 7 ft. high, standing on the sand court. One tank is divided into receiving and washing, and the other into trap and outlet chambers. The two tanks are close together, and a lip on the first overhangs the wall of the second. One 3-in. pipe from each filter rises beside the end of the first tank, to which the discharge hose of the sand ejector can be attached. In the washing chamber are a 2½-in. cast-iron header and six ¾-in. brass pipes 4 ft. long, perforated with forty-four 1-16-in. holes each. The portable sand ejector is a 16 x 32½-in. steel box 13 ins. deep, containing a pair of ejector nozzles and a pair of pipes for supplying water to aid in the feeding of the sand. The box has a hopper top. The regulator house can be entered from the filter roof, and through it access is had to either filter; there are no sand runs. Aside from these novel features the filter plant conforms to the well-known modern American design. The plant was designed by Messrs. Hazen & Whipple, and built by the T. A. Gillespie Company, of New York, at a total cost of about $40,000.

At Poughkeepsie there is also the oldest sand-filter plant in this country, designed by J. P. Kirkwood, and built in 1872. It was enlarged in 1896 by Supt. G. E. Fowler. It was built as an open plant, but has recently been covered.

LAKE AVENUE WATER TOWER, YONKERS.

THE EAST JERSEY WATER COMPANY.

The plant of this company is located on the Passaic River, at Little Falls, N. J. It comprises a pumping station having a daily capacity of 50,000,000 gals. and purification works having a daily nominal capacity of 40,000,000 gals. In the pumping station there are four Riedler pumps, three of which have a capacity of 10,000,000 gals. daily each, against a head of 300 ft., and one of 20,000,000 gals. daily capacity against a head of 115 ft. The plant is arranged so that the pumps can be driven by either steam or water-power, there being usually sufficient water in the river to operate the plant for the greater part of each year.

The water from the high-pressure pumps is delivered through a 51-in. steel main to a reservoir of 150,000,000 gals. capacity, located in Great

LITTLE FALLS PUMPING STATION.

Notch, on Garret Mountain, at an elevation of 425 ft. above tide. From this reservoir the primary distribution is made through 51-in. and 42-in. steel mains to the following municipalities: Montclair, Kearney, Harrison, Bayonne, West Orange, Bloomfield, Glen Ridge and Nutley; the village of Little Falls is also supplied directly from the force main. The water delivered by the low-pressure pump goes to supply the cities of Paterson and Passaic, through a 42-in. steel main, the low service in Paterson being on the distributing reservoirs, and the high service on direct pumping, while all of Passaic is on direct pumping through 24-in. and 20-in. cast iron extensions from the 42-in. steel conduit. In Passaic the low service system is controlled by pressure regulators. The population supplied by the high-service system is about 110,000, while that on the low service is about

LITTLE FALLS FILTERS, LOOKING UP STREAM TOWARD PUMP HOUSE.

170,000. The average per capita consumption is approximately 90 gals. per day. All water sold to the various municipalities and corporations is measured, except in a few cases, by Venturi meters, there being eight of these in service.

The East Jersey Water Company and other water companies are controlled by the New Jersey General Security Company, which company also controls the distribution systems of Paterson, Passaic and Montclair, each of which is owned by an independent company and furnished with water by the East Jersey Water Company. Of the distribution systems controlled by the New Jersey General Security Company all services in Montclair are metered, while in Paterson about 30 per cent. and in Passaic about 50 per cent. of all connections are metered. The total length of distributing mains in these three cities is about 200 miles.

The Jersey City Water Supply Company, also controlled by the New Jersey General Security Company, supplies Jersey City from an impounding reservoir on the watershed of the Rockaway River, at Boonton, N. J. This reservoir, the aqueduct line to Jersey City, of which 75 per cent. is steel pipe 72 ins. in diameter, and 25 per cent. is cut-and-cover concrete conduit and brick tunnel of the horseshoe type, and the main dam at Boonton, are described on another page.

LITTLE FALLS FILTERS.

At Little Falls, N. J., is the filtration plant of the East Jersey Water Company, one of the most widely known filter installations in this country. It is a mechanical plant, and noteworthy for its large capacity, as well as for several innovations in construction. The works have a nominal capacity of 40,000,000 gals. per day, and are designed for the purification of the water supplied to Paterson, Passaic, Montclair and the interurban districts. Construction was begun in the summer of 1901, and the filters were first used September 4, 1902, although not wholly completed for some time afterwards. The sub-structure and practically the whole superstructure, except the roofs, is of concrete, reinforced where necessary, with Ransome twisted steel rods.

Raw water is taken from the head race of the pump house through a 66-in. steel pipe, discharging into a concrete standpipe in the coagulating basin. In this standpipe the water receives the coagulant, and, after mixing by the natural agitation, is let into the basin. From the surface of the basin, at the opposite end, the water passes to the filters, of which there are thirty-two, rectangular, 15 x 24 ft., on top of the filtered-water reservoir, into which the water from the filters passes through Weston controllers. A 66-in. steel suction main leads back to the pumping station. Over the coagulating basin is a house 46 x 132 ft., with walls 13 ft. high, containing an office, machinery room, chemical store room, laboratories, etc. The filters are arranged in rows of eight, on either side of two pipe galleries. Two wings from the main house cover the pipe galleries, and one-third the length of each filter on either side. Sulphate of alumina is the chemical used, and during freshets, when the alkalinity of the water is very low, soda ash is also employed.

Each filter has a surface area of 360 sq. ft., and, including the concrete deck, which covers two-thirds of its length, was built as a monolith. The inlet to each filter opens into a trough, extending along three sides, and the longitudinal center line, which serves to distribute the entering water and collect the dirty water during washing. The bed is a 30-in. layer of screened quartz sand on a 5-in. layer of fine gravel, and a 2-in. layer of crushed quartz. A cast-iron header on the center line of the bottom of the tank with 1¾-in. cast-iron laterals, 6 3-32 ins. apart, fitted with Continental strainer heads, form the strainer system. In washing, compressed air and water are used alternately. The plant has given excellent results in service. It was designed by the engineers of the East Jersey Water Company and the New York Continental Jewell Filtration Company, and built by the latter company and the T. A. Gillespie Company. J. Waldo Smith was the chief engineer, George W. Fuller, consulting expert, and William B. Fuller, resident engineer for the water company, and Charles L. Parmelee was chief engineer for the filter company.

NEW WATER SUPPLY WORKS FOR JERSEY CITY.

(Boonton Dam and Conduit.)

Jersey City, with a population of about 215,000, and a water consumption approximating 32,000,000 gals. per day, was formerly supplied by the East Jersey Water Company. Last year works were completed for an independent supply. They comprise an impounding reservoir of a capacity of 7,600,000,000 gals., the Boonton masonry dam, the Parsippany earth dike, and a conduit 23 miles long, partly concrete and partly steel pipes, conveying the water by gravity to the city. The reservoir is 2 miles long, ½ mile wide and has an area of 900 acres; its maximum depth is 100 ft. at the dam, and the average 25 ft. The soil being generally thin and poor was not stripped, although deposits of organic matter near buildings and in other places were removed and wooded areas were cleared and grubbed. The area of the watershed above the dam is 122 sq. miles.

Boonton dam has a total length of 3,115 ft., of which 2,150 ft. are Masonry, with a maximum height of 140 ft. Only the Tansa and Bhatgur dams, in India, exceed this dam in length. It contains about 260,000 cu. yds. of masonry, and at each end terminates with an earth embankment having a concrete core wall. The masonry is cyclopean—large blocks of stone laid in very wet concrete. This class of masonry has since been used in the extension of the New Croton dam, and is being used in the Cross River dam, but previously the only large dam known to have been built of such masonry is the Vyrnwy dam of Liverpool's water system. All sizes and shapes of stones were used, up to about 7 tons; they were generally allowed to drop 2 or 3 ft. into the concrete bed. The dam is 17 ft. thick at top and 75 ft. at the bottom of the maximum section. Near the north end is a masonry waste weir 300 ft. long, with its crest 5 ft. below the top of the dam.

Upstream and downstream gate-chambers, connected by four 48-in. steel pipes, control the flow of the water into the conduit, which begins at the downstream chamber. The conduit has a capacity of 70,000,000 gals.

per day. Of its length 3.5 miles are reinforced concrete, 2 miles masonry-lined tunnels, and 17.5 miles 72-in. steel pipe. The pipe line crosses the Hackensack and Passaic rivers and the Great Piece and Hackensack meadows, which are frequently inundated. Across the former meadow the pipe is 3 ft. under ground, and across the latter on an embankment above extreme tide level, in order to prevent its floating, if empty when submerged. At Jersey City the pipe terminates in connections to two distributing reservoirs.

The concrete conduit and the tunnels are of horseshoe section, 8.5 x 8.5 ft. inside, the tunnels being lined with brick and the conduit reinforced with Ransome twisted rods. Rapidity of construction was a feature of the conduit work, 18,500 lin. ft. having been built between July 25 and November 14, 1903. On one section a gang of thirty-eight men averaged 40 ft. for sixty-five working days.

Mr. J. Waldo Smith was consulting engineer, Mr. Edlow W. Harrison chief engineer and Mr. William B. Fuller resident engineer for these works. Boonton dam can be reached via the Delaware, Lackawanna & Western Railroad to Boonton, Christopher and Barclay Street Ferries from New York. The works were built and are owned by the Jersey City Water Supply Company.

HACKENSACK FILTERS.

The Hackensack Water Company supplies water from the Hackensack River to Hoboken and thirty-three smaller cities and towns, with a total population of 225,000. Water is taken from the river at New Milford and pumped about 22 miles to a reservoir at Weehawken, where there is also a large water tower, nearly opposite 42d Street, New York, visible from many points in the city. The main pumping station contains an 18,000,000 and a 12,000,000-gal. Allis vertical triple-expansion engine and a Worthington high-duty pump of 10,000,000-gal. capacity. On account of increasing contamination of the river a large mechanical filter plant has been built, and is now nearing completion, very near the pumping station. A reservoir of 860,000,000-gal. capacity has also been constructed at Hillsdale, the dam being about 4 miles from the filters, to supplement the river flow in dry seasons. An interesting feature of this reservoir is the use of steel sheet piling as the cut-off below the ground surface under the earth dam, with a concrete core wall above. The present daily consumption is approximately 18,000,000 gals.

Local conditions make it necessary to pump the raw water to the new 12,000,000-gal. settling basin on a knoll near the pumping station. Embankments for the basin were made of the fine sand taken from the excavation. The inner slopes are lined with puddle, protected with concrete paving below, and dry stone paving above, a berm at mid-height; the bottom is paved with concrete. To pump the raw water two Allis-Chalmers 24,000,000-gal. submerged centrifugal pumps, driven by horizontal tandem-compound engines, direct-connected to the vertical pump shafts, have been installed in the station.

The filters, eight in number, of nominally 24,000,000-gal. daily capacity, the 1,200,000-gal. filtered-water reservoir, the pipe and operating galleries, laboratories and chemical apparatus are contained in a concrete and brick structure, 118 x 148 ft. in plan, part of it four stories high. Arranged four on each side of the pipe gallery and over the filtered-water reservoir, the filter tanks are reinforced concrete monoliths, each 46.67 x 25.83 x 9.5 ft., with walls 9 ins. thick and floors 6 ins. thick. Each is divided longitudinally by a reinforced concrete trough, 30 ins. wide overall, the inlet for settled water and the outlet for wash water, which contains the main air pipe supplying compressed air for agitating the sand during washing. From each side of the trough's top there extend to the walls six concrete lateral gutters for collecting dirty wash water. The collector and strainer system is a novel combination of hollow concrete blocks and perforated brass plates laid on the bottom of the filter, so formed that when assembled their upper surface is a checker-work of hopper-shaped square depressions separated by sharp ridges intersecting at right angles, the purpose being to prevent undue disturbance of the gravel while the filter is being washed. Compressed air is distributed through 1-in. brass tubes perforated along their bottoms, extending from each side of the bottom of the concrete trough to the filter walls, spaced 8¾ ins. center to center and laid close to the tops of the strainers. Above the strainers and air pipes are 10 ins. of graded gravel, 2.5 ft. of sand and 4 ft. of water. The rate controllers, of the float and balanced valve type, are unusually large. The various devices for regulating each filter are mounted on an operating table, and the eight tables are symmetrically arranged in the operating gallery over the pipe gallery.

Wash water is stored in a reinforced concrete tank near the filters, 10.5 ft. deep, 43 ft. diameter, set on concrete columns so that its water surface is 31 ft. above the filter sand. Beneath this tank are eight steel tanks for storing compressed air, each 6 ft. diameter and 22.5 ft. high. These tanks are filled by pumps in the filter house. Venturi meters have been provided for measuring the water filtered and the chemical solutions. Hering & Fuller are the consulting engineers for the plant; it was designed and built under their direction by William B. Fuller and John H. Gregory, with E. G. Manahan as resident engineer. To reach this plant take Erie Railroad, Chambers or 23d Street Ferry, to New Milford station.

CEDAR GROVE RESERVOIR, NEWARK WATER WORKS.

September, 1900, the East Jersey Water Company turned over to the water department of Newark a system of works which the company had built and had been operating for eight years, comprising three reservoirs on the watershed of the Pequannock, 21 miles northwest, and two rivetted steel conduits 48 and 42 ins. in diameter, connected with two distributing reservoirs within the city. To provide a large supply much nearer than the storage reservoirs, the Board of Street and Water Commissioneers, in 1901, decided to build a reservoir at Cedar Grove, about a mile from the conduits and 7 miles from the city, to be connected with the conduits and the distribution system.

Cedar Grove reservoir is 5,000 ft. long, 1,100 ft. wide, has a maximum depth of 50 ft., an average depth of 30 ft. and a capacity of 700,000,000 gals., equivalent to 30 days' consumption. Three dams were necessary, on north, south and west sides, respectively, 650, 825 and 2,700 ft. long on top. They are earth embankments with core walls of 1:2:5 concrete 4 ft. wide on top, battered ½ in. per ft. on each side. All the dams have 2:1 slopes both sides. The smaller ones are 12, and the largest 18 ft. wide on top. Owing to disintegrated rock in the foundation, which had to be excavated, the west core wall has a maximum height of 102 ft. For the portion of the wall below the ground surface, tracks were laid on stringers supported by logs across the trench, and the concrete deposited from cars through canvas chutes. When the wall had been built nearly to ground level, the track was elevated to a trestle bolted to the top of the lower part of the wall, by means of bolts previously embedded in the concrete. The trestle bents were 20 ft. high of 6 x 6-in. timbers, braced with 1-in. boards, the posts having the same batter as the wall. Bents were 8 ft. apart and served also as the posts of the forms. The trestle was raised three times as the wall was built up.

Such portions of the reservoir as required it were cleared and grubbed. In general the bottom of the basin was stripped to a depth of 6 in., and 12 in. were removed from the sites of the dams. The outlet, from the easterly side, is through a tunnel 3,000 ft. long in sandstone and trap rock, from the easterly end of which a 60-in. steel pipe leads to the city. The gate chambers are near the northerly end of the reservoir, the inlet chamber being on the east side, and the outlet chamber on the west. The connecting pipe from the conduits from the watershed enters from the north, and a concrete conduit extends from the inlet chamber to a low standpipe at the extreme south end of the reservoir. There is a by-pass connection from the pipe at the north to the outlet chamber, and a concrete outlet conduit extends from the chamber across the basin to the tunnel. Good provision is thus made for circulation and for cutting out the reservoir whenever necessary. The concrete conduits are reinforced with expanded metal, and made of heavy section to prevent floating as well as to resist external pressures when empty. The outlet conduit is designed to resist bursting pressure, so that it can be used when the reservoir is empty to convey water from the by-pass pipe to the tunnel. The outlet is a double conduit and has been tested to 34 lbs. pressure. All the conduits are horseshoe shaped 5 ft. in diameter.

Mr. M. R. Sherrerd, as engineer and superintendent of the department, was the chief engineer of the work. The nearest railroad station to Cedar Grove reservoir is Great Notch, on the Erie Railroad, Greenwood Lake branch, Chambers and Twenty-Third Street ferries from New York.

NEW WATER WORKS FOR EAST ORANGE, N. J.

East Orange, about 12 miles from New York, is a residential suburb. It has a population of about 25,000, and uses approximately 2,500,000 gals. of water daily. Municipal works have recently been completed, comprising twenty 6 and 8-in. driven wells in the valley of Canoe Creek, about 6 miles from the town, a pumping station near the wells, force and supply mains and a novel reinforced concrete reservoir. The wells get water from a large pocket of coarse gravel about 20 ft. thick, lying 75 to 110 ft. below the surface and covered by a thick stratum of impervious hardpan. To control the whole area in which wells could be driven to interfere with the city's wells 640 acres of land, covering the whole gravel pocket, have been bought. A catchment area of more than 17 sq. miles feeds the water-bearing stratum. Static pressure on the wells is sufficient to cause the

STANDPIPE, EAST ORANGE, N. J.

water to rise 16 to 20 ft. above the surface. A flow of 500,000 to 750,000 gals. in twenty-four hours has been obtained from each well, and their combined capacity is about 7,500,000 gals. daily. At the upper end of each drive pipe is a brick manhole 5 ft. in diameter. Provision has been made to lower the wells 26 ft. by siphon action. Twenty additional wells, independent of the first twenty, are being driven on the opposite side of the pumping station, as a duplicate supply for the needs of the more distant future.

The pumping station is a one-story brick building, with a 45-ft. sq. boiler room, a 69 x 53-ft. pump room and a 25 x 80-ft. coal pocket. The suction well has two 30-ft. square compartments and a maximum depth of water of 15 ft., and being below flood level in the creek its floor, walls and roof are of concrete, sufficiently heavy to prevent flotation. There are three 125-H. P. Babcock & Wilcox water-tube boilers, and two 4,000,000-gal. Snow horizontal cross-compound engines. The reservoir is covered, 139 x 240 x 21.25 ft inside, divided by a partition wall in the middle. Its capacity is 5,000,000 gals. Special pains were taken to make the structure monolithic. If denuded of concrete the reinforcing steel would resemble a huge bird cage. Exterior walls are 12 ins. and the partition wall 14 ins. thick, all reinforced by triangular buttresses 12 ins. thick, spaced 10 ft. on centers. The roof, 5 ins. thick, is supported by columns 12 ins. square, in line with the buttresses. The floor is 8 ins. thick, excepting under the buttresses it is 12 ins. The inner sides of the walls and floor were water-proofed by placing next to the face of the forms 1 in. of mortar, composed of 1 part Portland cement, 2 parts sand, mixed with a solution of light soft-soap 1¼ lbs., 15 gals. water and 3 lbs. powdered alum to each bag of cement. The walls were subjected to their maximum load two weeks after the forms were removed and before the roof was on by filling the earth against them. Before the earth covering was placed on the roof, four horses attached to a 3-ton wagon were driven over it. No noticeable effect was produced by these tests.

An accompanying illustration shows the reinforced concrete surge standpipe, 10 ft. diameter inside, and 40 ft. high, built at the summit of the 24-in. cast-iron main from the pumping station to the reservoir. From this place the water flows by gravity, much the greater part of the distance, to the reservoir.

Mr. C. C. Vermeule, of New York, was the engineer for the works. The wells and pumping station are 2½ miles from Milburn station on the Delaware, Lackawanna & Western Railroad, on the Parsonage Hill road. The reservoir can be reached by D., L. & W. R. R. trains to South Orange; it is on South Orange Avenue, about one mile from the station.

Miscellaneous.

THE FLAT-IRON BUILDING.

The Fuller Building, commonly known as the Flat Iron Building, is one of the sights of upper Broadway. It is situated on a triangular plot of ground at Twenty-Third Street, and has a length of about 175 ft., a width of about 75 ft. at one end, running to a point at the other, and rises to a height of nearly 250 ft. above the curb. It has twenty floors above the street level, and a basement and sub-basement, and is equipped with every conceivable convenience. It has six rapid-running Otis hydraulic elevators, and its own steam and electric lighting plant, and furnishes heat and light to tenants free of charge. It was erected by the George A. Fuller Company. Through the courtesy of Mr. Arthur J. Herschmann, mechanical engineer for the United States Realty & Construction Company, the members of the New England Water Works Association are invited to visit this building and obtain a view from the roof, which overlooks the surrounding portions of the city.

SOME LARGE ENGINEERING WORKS IN NEW YORK AND VICINITY, PROJECTED AND IN PROGRESS.

The following incomplete tabular statement can scarce fail of being impressive, suggesting, as it does, the enormous demands for capital and labor, as well as professional services, in the further development of the Metropolis. Some of the figures given have been published with more or less authority, but others are scarcely more than the roughest approximations:

Pennsylvania Railroad tunnels, terminals and connections....	$60,000,000
New York Central Railroad terminal improvements.........	25,000,000
Extension of the New York rapid transit system............	100,000,000
Subways in New York City, proposed by the Metropolitan Street Railway Company, and others......................	40,000,000
Additional tunnels under the Hudson River................	10,000,000
Erie Railroad improvements..............................	20,000,000
New York State barge canal..............................	101,000,000
Passaic Valley sewerage system..........................	7,000,000
Aqueduct Commissioners' work..........................	5,000,000
Additional water supply for New York City...............	100,000,000
Filtration of the Croton water supply......................	10,000,000
Total of the above...	$478,000,000

This list does not include large works which will be carried out by the regular city departments, the national government, the railroads, the street railways and other large corporations; nor does it take account of the very extensive building operations constantly going on. In addition, there will probably be other large undertakings projected within the next few years. The total may easily exceed half a billion dollars.

WEST POINT.

West Point, N. Y., the location of the United States Military Academy, is situated on the west bank of the Hudson River about 50 miles from New York. The Military Academy, the most famous school of military instruction in the world, is the place at which the Government provides preliminary training for commissioned officers for the army. It was founded in 1794, as a school for engineers and artillerists. Its existence was threatened several times in the early period of its history, and it was not until 1817, when Major Sylvanus Thayer, an engineer officer, was made superintendent, that the school was placed upon a firm and enduring basis. An act of Congress makes possible the appointment of one cadet from each Congressional District, one from the District of Columbia, one from Porto Rico, two from each State at large and forty from the United States at large. The maximum number of cadets permissible is, therefore, a little over 500.

During the four-year course the cadets are given little time for recreation except during the months of July and August. At other seasons they spend almost their entire time in study or at drills. At the end of the second year the second class is given two months furlough, at which time they are allowed to leave the academy. After the graduating exercises, which occur during the latter part of June, the first and third classes and the entering fourth class go into camp for July and August. Studies are dropped during this period. While the first and third classes have few duties other than military drills, usually occurring in the morning, the fourth-class men pass through a strenuous period of training.

The increase in the size of the standing army shortly after the Spanish-American War resulted in a demand for more officers and the gradual increase in the number of cadets beyond the capacity of the academy to provide for them. An act of Congress recently provided for an ultimate expenditure of over $5,000,000 for the enlargement of the Academy. As a result of an architectural competition a firm of Boston architects, Messrs. Cram, Goodhue & Ferguson, were engaged by the War Department to prepare plans for enlarging the Academy, Mr. Frederick Law Olmstead being retained for the landscape work. Final plans, prepared under the direction of the Superintendent of the Military Academy, Brig.-Gen. A. L. Mills, were approved by the Secretary of War, Hon. Elihu Root, and the work is now under way. Congress also appropriated money for the construction of a new water supply, and the work is being carried out under the direction of Major M. M. Patrick, Corps of Engineers. The watershed available embraces a considerable area, and a gravity supply will be had through a pipe line several miles in length.

It was at West Point that a massive chain was stretched across the Hudson River to prevent the British ships in New York from intercepting the overland supplies of the American army, which were being transported

LOOKING UP THE HUDSON FROM WEST POINT ACADEMY GROUNDS.

from New England to the starving troops in the Middle States, and were crossing the river at Newburgh, a few miles above West Point. A portion of this chain can be seen near the soldiers' monument, and is of great interest to visitors. The ruins of the old forts, Putnam and Clinton, and the old brick arches of the cells of the former, are of interest to engineers, as showing the condition of the masonry after so many years of use and exposure. Buildings of special interest are: Grand Hall, containing the kitchens for the corps of cadets; Memorial Hall, containing the dancing hall, portraits of distinguished graduates and memorial tablets of graduates that have fallen in battle, battle flags, etc., and the museum in the Academy Building, also the Library Building.

West Point may be reached by either the New York Central Railroad or the West Shore Railroad, express trains taking about one hour and a half from New York. The steamers of the Albany Day Line afford the pleasantest means of access, and give three hours at the Point, which is time enough to visit the buildings and see the cadets in camp on the plain. Parties desiring can remain to see the dress parade before supper, every day except Saturday, and return by train in the evening. Hotel accommodations may be obtained at the West Point Hotel.

A Few Manufacturing Plants of Interest to Water Works Men.

PLANT OF HENRY R. WORTHINGTON, AT HARRISON, N. J.

The new plant of Henry R. Worthington is situated in Harrison, N. J., 9½ miles from New York, and can be reached by the Delaware, Lackawanna & Western Railroad, ferries at Barclay and Christopher Streets, and also by the Pennsylvania Railroad, ferries from Cortlandt, Desbrosses and Twenty-Third Streets. Direct trains on the Delaware, Lackawanna & Western Railroad convey passengers within easy walking distance of the plant, and the Turnpike cars, to be found at the Pennsylvania Terminal in Jersey City, pass the door of the pump works.

The plant occupies 34½ acres of ground, and is thoroughly modern in every particular. Here will be found the latest designs of reciprocating engines direct connected to electric generators, surface condensers, boiler-feed pumps, air and circulating pumps, air compressors, mill supply pumps and Underwriter fire pumps, together with cooling towers and the most modern of boiler equipments, making the power house one of extreme interest to engineers. The Worthington Company has practically done away with belt transmission, and nearly all the tools in this immense plant are directly connected to motors.

The moulding machine foundry is one of unusual interest, owing to its uniqueness, it being the first foundry of its kind ever constructed. It is, in fact, a gigantic moulding machine in itself. In this room the pouring of iron proceeds continually, and the emptying of flasks takes place practically immediately after pouring, only sufficient time elapsing to allow the iron to "set." All the buildings in this plant are built in the most approved manner, to come well within the most stringent requirements of the Underwriters. Visitors will be most cordially welcome, and will find that attendants will be furnished them to conduct them about the works.

PLANT OF THE A. P. SMITH MANUFACTURING COMPANY AT NEWARK, N. J.

The A. P. Smith Manufacturing Company, of Newark, N. J., was incorporated in March, 1896, under the laws of the State of New Jersey, for the manufacture of patent tapping machines, fire hydrants and other water works specialties. The factory is situated at the eastern end of the city, directly on the Passaic River and adjacent to the Central Railroad of New Jersey, and about one mile from the Pennsylvania Railroad. Since beginning manufacturing, the company has extended largely and is now manufacturing some of the best water works specialties on the market. These comprise: The Smith patent tapping machine, for making large connections to any sized main without reducing the pressure, at present in use in nearly every large city in the United States, and in many of those in foreign countries; the Corporation tapping machine, used for inserting corporation cocks under pressure, and one of the lightest and most durable machines of its kind; the O'Brien patent lead furnace, in use in many cities, and considered by many water works superintendents to be one of the most economical tools for melting lead while laying pipe; the Sherrerd-French patent valve-inserting machine; the French pipe cutter, for all sizes of pipes; the O'Neil patent calking machine, used with steam or compresed air, suitable for pipe of 24 to 48 ins. diameter inclusive, used in Stockholm, Sweden; by two of the largest gas companies in London, and as occasion requires, in Newark and Pittsburg; the O'Brien fire hydrant, in use in many cities of the United States; and the high-pressure fire hydrant now used by the Government at Washington, the city of Philadelphia, and adopted by Greater New York. The specialties include all kinds of brass work, and the patent connections for use with the Smith tapping machine, also special high-pressure valves for any pressure.

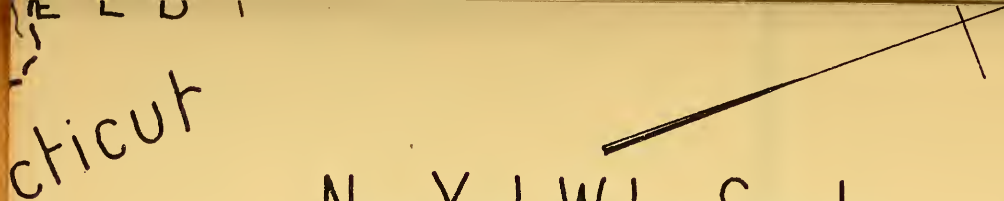
The factory can be reached from New York by the Pennsylvania Railroad, to Market Street station, Newark, thence east on the Plank Road car to Brill Street, at the foot of which the factory is located. Or by the Central Railroad, from Liberty Street station, to East Ferry Street station, thence east on Ferry Street to Brill Street. Or by Plank Road car from Cortlandt Street, New York, which passes by Brill Street.

NEPTUNE METER COMPANY'S PLANT.

The Neptune Meter Company's factory is situated in Long Island City, about five minute's trolley ride from the ferry, which runs from the foot of Thirty-Fourth Street, New York. The company is now engaged in extensive additions to its works, being made under contract with Westinghouse, Church, Kerr & Company, of New York. This factory is one of the most complete of its kind in the world, and is running now night and day. Members and guests of the association will be welcome.

NATIONAL METER COMPANY'S WORKS.

The National Meter Company is preparing a useful book for the members of the Association, and in it will tell the story of its extensive works, better than it could be told by the committee.



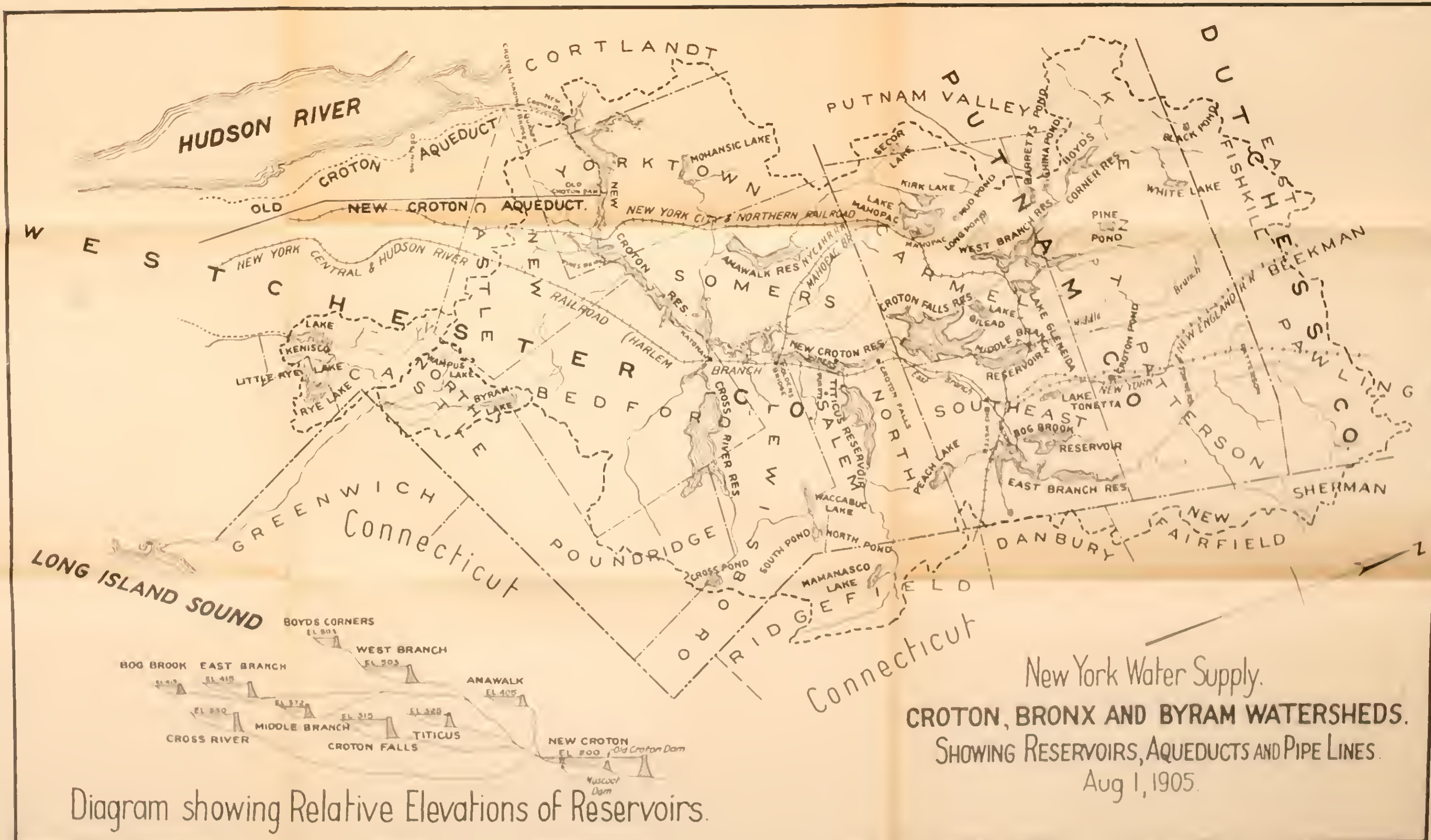
New York Water Supply.

CROTON, BRONX AND BYRAM WATERSHEDS.

SHOWING RESERVOIRS, AQUEDUCTS AND PIPE LINES.

Aug. 1, 1905.

ROBERT A. WELCKE PHOTO-LITH. 178 WILLIAM ST. N.Y.



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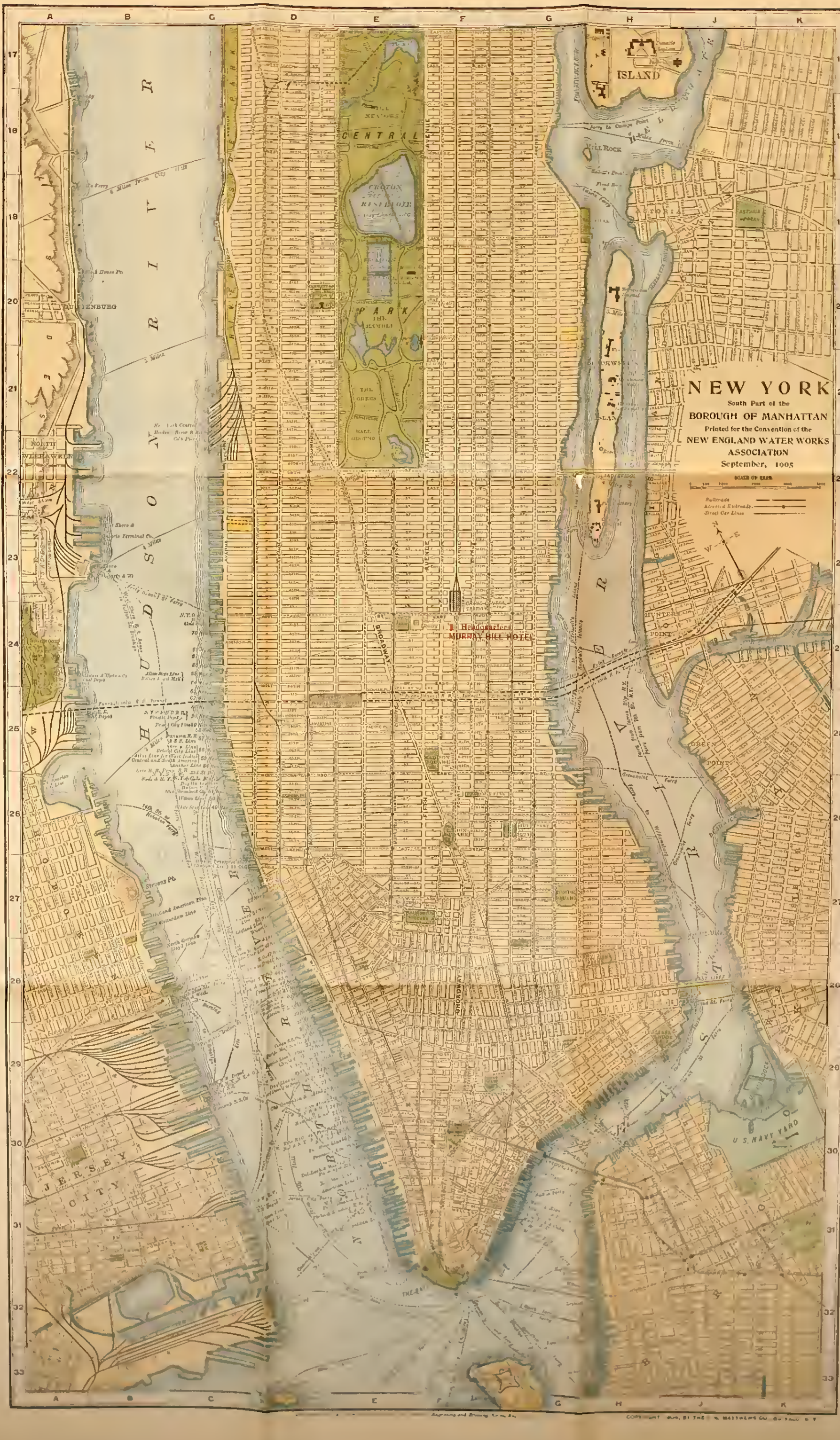
NEW YORK
South Part of the
BOROUGH OF MANHATTAN
Printed for the Convention of the
NEW ENGLAND WATER WORKS
ASSOCIATION
September, 1905
Railroads
Street Car Lines
CENTRAL PARK
CROTON RESERVOIR
HUDSON RIVER
EAST RIVER
BROADWAY
FIFTH AVENUE
Headquarters
MURRAY HILL HOTEL
ISLAND
MILL ROCK
NORTH WEEHAWKEN
JERSEY CITY
GREEN POINT
HUNTERS POINT
U.S. NAVY YARD
Stevens Pt.
Pennsylvania R.R. Tunnel

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NOTE—To find the location of a name on the map, look up the name in the index and notice the reference letter and figure. Draw lines across the map between corresponding letters and figures, and the name will be found near the intersection of such lines.

The reference letters and figures are exactly half a mile apart.

The reference figures on the Northern Half run from 1 to 17, and on the Southern Half they are continued from 17 to 33, and the reference letters are made to correspond on each half.

If you do not find what you are looking for here, consult Northern Half.

STREETS IN NEW YORK.

MANHATTAN BOROUGH.

SOUTHERN HALF.

STEAMSHIP LINES.

PLACES OF AMUSEMENT.

PROMINENT LIBRARIES.

PROMINENT COLLEGES AND SCHOOLS.

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THE CITY OF

NEW YORK.

SOUTH PART OF THE BOROUGH OF MANHATTAN

—AND—

STREET INDEX.

Covering Territory from North End of Central Park South to the Battery.

ALSO AN INDEX TO

DEPOTS, FERRIES, STEAMSHIP LINES, HOTELS, PLACES OF AMUSEMENT, PROMINENT INSTITUTIONS AND BUILDINGS, LIBRARIES, CHURCHES, COLLEGES, CLUBS, ETC.

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