MR. WILLIAM FOULKE JOHNES. Member of the Society.-The gentleman who spoke first said that he objected to classified specifications, or, rather, to classified material in specifications. Now, I think that a certain amount of classification is desirable. Take it in the case which he cited, where rock cropped up in five places in his tunnel where rock was not expected. If he were getting paid a price for rock he would get better pay for it. It would be fair to the contractor. Then take another case where the contractor is running through ground that had been filled. If he simply is giving bids so much per foot-I am speaking of sewer work especiallyand the soundings they make show boulders, he estimates they are ordinary boulders, but when he comes to excavate he finds rock measuring a yard and a yard and a half in size. Those rocks have got to be blasted. That is an additional expense which I think it is only fair the contractor should be paid for. If your specification read, "all material to be excavated except rock or rock in rock filling which measures a yard or over," I think it would be a fair specification to the contractor, at least fairer than making him bid a uniform price for all materials, because either he is going to estimate a larger amount of rock, to put himself safe, or else underestimate, and he is then getting into a hole.

Another thing in regard to the specifications which are styled "club" specifications. I think every engineer will admit they are bad and ought not to be in specifications, but while the majority of contractors are honorable men, who are trying to do good work, yet we all know there are a certain number of men who are not; men who go into this thing bidding low and expecting to skin. Now, for such a man "club" specifications are necessary. Engineers will not use a "club" specification where it is not necessary. Almost all of those "club" specifications come under the clause: at the discretion of the engineer. I admit they are bad, but I claim they are necessary.

MR. MYRON H. LEWIS, Member of the Society.—I do not agree entirely with the previous speaker's remarks about the separate classification of earth and rock in specifications. In a case that came to my notice a year ago a contract was let for about a mile of country road. Very slight cuts and fills, rarely exceeding 2 ft., alternated along the entire length. The original surface of the road was earth with rock persistently outcropping, or else rock with a thin layer of overlying earth, making it extremely difficult, almost impossible, to determine with reasonable accuracy the quantity of either. Unquestionably a single item for "material excavated" would have been best in this case, but the contract was let under a separate classification, the prices being about 30 cents for earth and about \$1.50 for rock. It is difficult to see how the contractor arrived at these prices, for similar work in the vicinity done by other contractors cost from \$3 to \$4 per yard.

I do not believe we can lay down any hard or fast rule in this matter, as so much depends on the character of the work. Where any difficulty is likely to be experienced in classifying the material, a single item in the specifications would avoid much confusion.

I have on many occasions seen small and apparently unimportant items in specifications give more trouble than the large ones. I wish to mention one or two instances.

A contract for a road was let; cuts and fills both heavy; material classed as "earth" and "rock" to be paid for in excavation. In the estimate the amount of borrow was reduced by calculating the rock to go in the fills; but there was a great deal of rock needed to pave the slopes and the contractor did as we would do: he used the rock from the excavation for paving purposes. This necessitated an increased corresponding amount of earth borrow. The question was, should this additional borrow be paid for? As the specification did not clearly order the excavated rock to be placed in the fills, payment will no doubt have to be made for the extra excavation.

The same contractor was building a number of bridge piers. The specifications called for "Dimension Stone," "Pier," "Rubble" masonry, etc. The dimension stone (\$35 per cu. yd.) was cut from the pick of the quarry, was coursed and of uniform color. The pier masonry (\$12 per cu. yd.) could not be obtained uniform in color. The engineer protested, the specifications were hunted over, but not one word could be found as to the color of this particular class of work. The color may have been intentionally omitted, but it would have been better to have specified that a uniform color would not be required.

On this same work the depths of the joints were not clearly specified in several cases and gave further room for argument. These are merely slight illustrations of the problems constantly coming up before the engineer engaged on construction, many of which could be avoided by clearer and more complete specifications.

I wish to say that on this work both the engineer and contractor were able and reasonable, and the work proceeded rapidly with but little friction.

Why should not efforts towards harmony always be made by engineer and contractor? Why should so much dissension and so much trouble be necessary? Both are working towards the same goal, both are trying to rear the same edifice; why should not both forces act in the same and not in opposite directions, and thus accomplish the highest good? The contractor should recognize that the reputation, the very future, of the engineer depends upon the work; the engineer should recognize that the contractor is entitled to a reasonable profit to pay for his work and investment, and if each follows the golden rule of dealing with the other as he would wish to be dealt with faults in the specifications could be readily adjusted.

MR. GARDNER L. VAN DUSEN, Member of the Society.-The question has been raised here of the discretionary powers of the engineer in charge, and I would like to speak of a point in regard to them which came under my knowledge in regard to the celebrated \$9 000 000 appropriation for the canal work. We had a very rigid specification. The estimates there were something like, as I recall them, 30 cents for earth and, I think, \$1.50 for rock. At one place there we had rock, which in this locality was shale. When it was uncovered and they had drilled down and blasted it, it would come up in great horizontal blocks that could be easily barred up for quite an extent, and then by a derrick lifted on to the bank very easily. At another place, less than 10 yards from it, all that was necessary to do in regard to that rock was to uncover it, and the next day, when they were ready to begin the excavation, the men could dig it up with their shovels. In a very short time the atmosphere would reduce it to such a consistency that it could be removed as easily as dirt in that locality. At the same time, in that same neighborhood, almost a stone's throw from this same rock, there was a layer of clay, and I have seen them at work on that. In some places they attempted to blast it. They put down a blast and when it was exploded it would merely blow out into a little pit 2 or 3 ft. across, and would not affect the surrounding earth at all, and an attempt to pick it out with a pick and shovel was extremely laborious, because they could only shave it off in small, thin cuttings, the width of the pick blade. According to the strict specifications, they were getting 30 cents a cubic yard for that excavation. On the other hand, for shale rock, which was reduced to the consistency of cream almost, they were getting \$1.50. It happened that our Resident Engineer was a man of very liberal mind and he used his discretion in the matter very liberally, and he proportioned this matter of the price in such a way as to give a little more nearer justice to the contractor and allow him in his estimates a certain percentage of that clay earth as rock so as to bring it up to something like justice to him. Otherwise he would have lost a great deal on that particular section. It occurred in this case that his rock excavation was really cheaper than the earth, and that if the engineer had not used his discretion in the matter, the contractor would have lost a great deal of money on that one small section.

MR. HENRY I. LURYE, Member of the Society.—There was one thing the speaker of the evening mentioned which struck me as very true and to which we ought to give careful consideration. He stated that plans and specifications should give every detail to enable the contractor to give an honest and sensible bid.

We give the contractor all the information regarding grades, lines and other measurements, but very few plans, and especially city plans, give any information regarding geological formation, and, if

they do, the information is very meagre and entirely insufficient to enable the contractor to bid honestly and sensibly.

The simple reason for the lack of this geological information is that very few city engineering offices are equipped with the necessary tools and instruments for obtaining geological knowledge. The majority of such offices have none, and the few that make a pretense to having them are at the best very poorly equipped.

I know of a contract, and I was on the construction myself and know whereof I speak, a three-quarter-of-a-million-dollar sewer contract, where not a single test boring was made and the sewer bid for, let and built. Of course, the general geological character of the vicinity was known, but no positive detail knowledge was ever obtained till the sewer was built.

Under such conditions the contractor cannot make an honest and fair bid. He must take chances and his bid must of necessity be larger to cover these chances.

Why all and every city construction office is not fully equipped with instruments and tools for obtaining geological information I cannot understand. It seems to me that from the contractors' and construction engineers' point of view a test boring set is of as much importance as a transit or a level, and that the due amount of time and labor be given by city construction engineers to geological information as to lines and grades.

Perhaps this geological information can be better obtained by special people more accustomed to the work, and under such conditions a separate contract for test borings, etc., would have to be entered into by the city before submitting any piece of important construction to contractors for bids. This would necessarily delay the work. The test borings are therefore cut out entirely and the contractor is forced to bid high to cover all chances.

The only remedy for this state of affairs is to fully equip each and every city construction office with complete test boring sets and other instruments and tools necessary for obtaining full geological information. These should be fully made use of and all plans and specifications should embody knowledge so obtained. Then and then only will contractors be able to make honest and fair bids.

MR. JOHN T. FETHERSTON, Member of the Society.—I would like to say, for the information of the gentleman who has just spoken, that Richmond Borough has such apparatus and undoubtedly there are boring machines used in other boroughs of the city for showing the geological strata.

MR. W. F. JOHNES.—I would like to say that in the Borough of The Bronx we do all such work. We make test borings for all such work.

MR. M. H. LEWIS.—There is another thing I wish to say while we are discussing the relations between the engineer and con-

tractor. The contractor can make the work of the engineer pleasant or annoying, according to the care taken in protecting the lines and grades given, and this is a matter of no small importance where the work is extensive and the field corps small. It is not the most pleasant thing to find the work of one day undone the next, only to be repeated with the same results, and those who have experienced these troubles appreciate what it is to have a painstaking and reasonable contractor to deal with. Certainly better relations between them would induce the contractor to protect and preserve more carefully the marks given him and save the engineer much duplication of work and the consequent saving in time and money.

I mention this matter to call the attention of the contractors here to-night to the value and influence such care on their part would have in promoting better relations with the engineer.

MR. DENNIS FARRELL, Member of the Society.-It is really very pleasant to sit here and hear how nice the contractor has been talked about, and, to judge from the general discussion, those who drew up specifications did not know quite what they were doing. That is what I understand from it, and that they were too harsh and too severe, and that they were not quite just and, in many cases, were doing what was of no importance at all, just to fill in with printed matter, etc. I do not like to say anything hard about contractors. We all know that they would not do anything but just what they are required to do, plus what they can do otherwise. We do know that if a contractor is a real good, sincere, honest man and he has a good, large plant to start with, that he will certainly have an engineer to go over all the work that he intends to bid on. His engineer will make calculations and estimates of what the different parts can be done for and each and every item is taken up by the engineer. Now, when the contractor bids on that piece of work he knows just as well what he is doing as the city engineer knows, or the chief engineer. He is bidding on just what he wants to make money on and that very fact is the first point to the contractor. And after he has reached his conclusion, he, with the engineer, will go over the work and see just what they have to do. After that they bid. They make a contract with the city, so to speak, or a railroad company, as the case may be, with their eyes wide open, knowing all the possibilities that are to be met with and the chances they are taking, and all that is covered in the amount bid for the work. Now, let a city engineer be sent on that construction to follow up the specification and the contract that the contractor has entered into with the city and see where that engineer comes in if he is going to try to get near the mark at all of keeping the contractor up to his agreement. I think all engineers

who have had charge of construction know that in all classes and kinds of work that they have been put over that, here and there, the contractors themselves may not be to blame and very often they are not, but they will have a class of foremen and a class of workmen and a class of assistants who will take particular pains to get in the work as rapidly as possible to get the results. Getting in the work as rapidly as possible does not mean following the lines in the specifications at all; it simply means to get in the work as soon as they can and, to their mind, just as good as the specification requires. Many times those workmen will get that work in and they will cover some of it up when they are not seen, and, if the engineer comes along while they are fixing it over and the engineer does not see it, they are entirely interested in showing how good they are carrying on that work; but inside of twenty minutes or half an hour after the engineer has passed, the chances are they will be right at the same game again. That will run on day after day.

Take masonry work, where it is intended that the stones shall be made of such and such shape, laid on a really flat base, a natural bed. A stone mason, if he can put that stone in standing edgewise and can balance it up and then put a little mortar on the outside, will do it. That is a common occurrence with all masons. Their foreman is there to show it.

Take another case, where the city calls for a fill; in case they have equal rock, or nearly so, and earth, it calls for a fill of one to one. If they have a large quantity of rock and the embankment is to be made very close by, they will come pretty near putting in four of rock to one of earth, if they can.

Take another case. It is called making a fill of clean, There is a point that is very fine. We would wholesome earth. not say the contractor is a sinner in that particular case, but somebody finds that he can get a whole lot of fill and get paid for allowing to dump it. Now, it does not make any difference to the contractor. It should, of course, in the fact that he has agreed to do the work right, but it does not make any difference to the foreman whether the fill comes out of a stable or an old cellar or anywhere else, fill of rock or muck, or anything he can get hold of, so that he can get just so much material in and be ready to cover it over if he finds any danger of approach by the engineer. I do not like to say those things about the contractor, but I just say that the employees either are educated by themselves to carry on the work and do it as quickly as possibly, or they are instructed in that particular line. Of course, we know the class of men that are employed on the work; they are not generally intelligent people; they are hard-working men and they will carry the thing along as best they know how. The

foreman will very likely instruct them just how he wants the work done. That being the case, of course it comes back to the same point, that he is pushing the thing for all it is worth.

Now, a contractor that has a large plant and has a big contract can certainly live up to the letter of his contract in carrying on the work. The man that goes into the contracting business and has a small plant, or no plant at all, certainly is in a bad fix if he cannot get just a little skin work in. He has a small contract and he has no particular facilities to carry it out. A small contractor in that case needs the sympathy of the constructing engineer or the engineer that may be over the work. But as one gentleman has said, the class of contractors, such as small ones, are going out of existence and now we are getting competition mostly from large contractors, so that, at the present day, it occurs to me there is not, so far as I can see, one word wasted in a specification in the city and, in many cases, they might be added to, making them tighter and closer, so that the big contractors will be able to be kept just where they be-They are bound to bid enough to make money and therefore long. they ought to produce for the city just as exact and just as complete work as they would for a private corporation if they were putting up a great structure.

J. V. DAVIES, the Author.—In regard to matters to which two speakers referred: I was carrying out, as Chief Engineer, a very expensive piece of railroad construction work in West Virginia, which involved nearly 100 miles of railroad in a heavy country, costing some \$45 000 or \$50 000 a mile, and I had quite a number of divisions on the work. I had one resident engineer with whom I was staying in camp, who, one night, told me, in grave seriousness, that he was just rawhiding his contractor. I said, "You quit that," and he quit my service just as quickly as I could find a good reason to get rid of him.

I had another engineer on a tunnel division who was an extremely competent man, but who had a mortal antipathy to the contractor. It was so marked that he would not have his camp at the same end as the contractor. He set up his camp at the other end and had to walk two or three miles, night and morning, simply because he would not have any association with the contractor.

Those things do not tend to the harmony and co-operation mentioned in Mr. Meem's paper, and it was a considerable part of my work on that construction to keep peace between my resident engineers and the contractors.

In relation to the classification question, which was brought up, I have had the identical experience in that work in West Virginia that the gentlemen spoke of in the case of solid rock disintegrating

and breaking up. We found shale rocks, which, on exposure, would disintegrate; and we had the same experience with clay, in which we would bore holes, fill them with powder and blast, with the result of simply blowing a pot hole, which would hold a few gallons of water. I had two railroads under construction at the same time in West Virginia, some little distance apart, but the same general character of soil. In the first case I was committed and could not avoid letting the work as a classified piece of construction. I had four classifications: solid rock, loose rock, hardpan and earth, at varying prices. I was in everlasting fights with the contractor as to what was loose rock. The instance mentioned was a counterpart. This shale rock, that was solid when exposed, but the next day was loose rock, the contractor claimed was and should be paid for as solid rock at 65 or 70 cents a yard. I claimed, as my resident engineer held, that it was loose rock, because when it was taken out it was loose. It was a continual bickering and squabbling. At the close of the work the entire average of a couple of million yards totaled out at an average price of 42‡ cents a yard. The other contract on the other railroad, upon which there was a non-classified bid, where the engineering work had been done first, where we had dug test pits at the expense of the company and shown the contractor what was going to be the condition of the soil and what were the rocks, the average price worked out to 41¹/₄ cents, about 1 cent a yard difference. The cost price was practically the same, but about the smoothness of operation there was no question. The one case was friction continually; the other case was harmony from first to I think that if nothing else that one thing would warrant one last. in arriving, if possible, at a non-classified scale for excavation, but it has got to be understood that your engineering work is done first.

I thank you, gentlemen, for your courtesy.

THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK

Paper No. 13.

SUBAQUEOUS WATER MAINS.

BY WILLIAM D. LINTZ, MEMBER OF THE SOCIETY.

PRESENTED NOVEMBER 23D, 1904.

Mr. President and Fellow Members:

The paper to be presented this evening has been prepared by request, and I shall attempt to give only a history of the methods adopted by the City of New York in laying subaqueous pipe lines, pipe lines laid on the beds of rivers or waterways to convey water from shore to shore. I desire to mention that the data on all of the pipe lines with flexible joints and lantern slides have been prepared by myself from personal observation.

Fig. 1 shows a condensed map of the East River with the islands supplied by water from the mainland—a 6-in. and a 12-in. line to Blackwell's Island, a 6-in. and a 12-in. to Ward's, a 3-in, a 12-in. and a 6-in. to Randall's, a 6-in. to North Brother, and a 6-in. to Riker's Island. There are several other lines owned by the City —two lines laid by the Westchester Water Company, one an 8-in. crossing the Eastchester Creek at Pelham Bridge, but not now in use, it having been carried away by the dredge working on the foundations for the piers of the new bridge, and to be replaced by an 8-in. or a 12-in. line in the near future, an 8-in. supplying City Island and Hart's Island, a 10-in. line across the Harlem from Lincoln to Second Avenue, a 36-in. line across the Harlem River from Fordham Road to Two Hundred and Ninth Street, and a 12-in. across an inlet of Little

Neck Bay, between Bayside and Douglaston, Borough of Queens. The Department has several other lines under consideration—a 48-in. across the Harlem River at Two Hundred and Nineteenth Street, two 48-in. lines crossing the Harlem at Jerome Avenue, a 12-in. between Riker's and North Brother Island, and a 20-in. line across the Bronx River at Westchester Avenue.



The islands in the East River were deeded to the city in 1857 and the charter of 1870 commanded the city to furnish them water.

In the year 1862 a 2-in. lead pipe in a wooden box filled with pewter was laid to supply the House of Refuge on Randall's Island. In 1864 a 2-in. gutta-percha pipe was laid from the foot of Seventyninth Street to Blackwell's Island. It was weighted to keep it on the bottom. It was successful for a time, and its completion was

considered a wonderful feat and the occasion of a city celebration; but after being frozen in the winter it soon got into the habit of furnishing the East River with water; it thereby became useless and was shut off. The islands at that time were not so thickly populated as now, and, having wells, this was no great privation to the inhabitants.

In March, 1873, a 6-in. wrought-iron pipe with screw joints was laid from the foot of East Sixty-second Street to Blackwell's Island. The bottom and two sides of a box of oak over 1000 ft. long were constructed on the land, the pipe laid and jointed together in this box, which was then filled with cement and the top bolted on. It was then hauled across the river by tugs. This line was quite successful and is still in service; but the wood of the box must have disappeared long ago, as I saw a portion of a similar box which had been in the water for five years and which was a mere shell, it being honeycombed by Teredos. A similar line of pipe 10 in. in diameter was laid across the Harlem from Second Avenue to Lincoln Avenue in November, 1874. This line is also serviceable; a 6-in. line to Randall's Island from the foot of East One Hundred and Twentythird Street in August, 1876, and in December, 1883, a 4-in. pipe 2 200 ft. long, was laid to North Brother Island and abandoned in 1889, being replaced by a pipe of more modern design. These lines were all of the wrought-iron box-encased type.

During this time the population in the islands increased rapidly, and a demand for a larger water supply became very pressing. Before experimenting further with pipe lines to convey water to these islands, partly on account of the high velocity of the current in the East River making it a very difficult operation to lay such lines, a suggestion was made to get potable water from deep wells. It was necessary at that time to get funds from the State Legislature to provide for this work, and on account of delay in getting this authority, a contract was entered into to lay a flexible pipe line so that both contracts were under construction about the same time. When the funds for the wells became available one was sunk on Blackwell's Island opposite Seventy-ninth Street in October, 1888, to a depth of 608 ft. at \$6.95 per ft., or a total cost of \$4 225. After an exhaustive test it proved to be a failure, its maximum yield being

.132

PLATE XXVII. THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK. LINTZ ON SUBAQUEOUS WATER MAINS.



FIG. 1.-TWELVE-IN. LINE TO BLACKWELL'S ISLAND, STARTING FROM FOOT OF EAST 79TH STREET.



FIG. 2.-LAYING 12-IN. LINE TO BLACKWELL'S ISLAND, MIDSTREAM.

but 3 gal. per min., as also another sunk on North Brother Island in May, 1889, to a depth of 602 ft. at a cost of \$6.85 per ft., a total of \$4123. The Department then determined to lay larger and more substantial mains. Mr. James Duane, since deceased, then Assistant Engineer in charge of laying water mains, and whom I assisted, designed a pipe with hub and spigot, on the well-known ball-and-socket principle, a modification of the Ward joint (Fig. 2) used for the same purpose. The first subaqueous line of this pattern (Fig. 3), a 6-in., of 12-ft. lengths, was laid to Blackwell's Island from the foot of East Seventy-ninth Street in October, 1888, about 950 ft. long and costing, including meters, etc., \$8 410, or about \$8.90 a foot. The method of laying this pipe is shown on Plate XXVII, Fig. 1. A heavy chain was



Section of Sinch WARD FLEXIBLE JOINT PIPE PATENTED - 1886

laid from shore to shore and securely fastened to piles driven for this purpose; this chain acted as a guide; a large floating derrick, with the separate lengths of pipe on board, floated in position and the chain picked up and laid across the deck; at the bow and stern heavy anchors were placed and assisted in keeping the float on line; the derrick hoisted a length of pipe, the spigot was entered in the hub of the last pipe laid (Plate XXVII, Fig. 2), the caulkers poured the joint full of lead, which completed the ball and socket joint, and, after caulking, it was lowered down the length of the pipe and the operation repeated; the chain was slowly hauled across the deck and the anchors reset by a tug when required. The pipe line itself is a veritable chain, the links of which are the length of each section of

pipe, and each joint capable of being rotated through 10 to 15° of arc. During the process of laying there are a number of joints unsupported from the bed of the river to the deck of the scow, and the strain on these joints from the weight of this unsupported pipe assists in making them water-tight. This method of laying has given the best results of several tried. When the water was turned on in this line with a pressure of about 40 lb. at Seventy-ninth-



F16. 3.

Street but a few pounds were observed on the Island end; as the 6-in. meter was recording its utmost capacity, it was evident that the line was broken. An examination was made by a diver, and the tops of several hubs were found to have burst off; as all the fractures were identical, it was concluded to have been caused by the excessive strain at the top of the hub. The breaks in this line were repaired by the use of clamps and sheet lead, and continued in service till replaced by a 12-in. in 1891. To remedy the defects of

this line, Mr. Duane designed a hub with a heavy wrought-iron band shrunk on the rim of the hub (Fig. 4). It has been found by experience that this band, when properly proportioned and shrunk on, absolutely insures the hub from bursting against any tensile or crossstrain to which it can reasonably be subjected. In repairing a line on which a large vessel had sunk it was necessary to cut the pipe in order to obtain free ends to splice. To accomplish this a powerful derrick of a wrecking boat was used, and the joints parted, either by the spigot shearing through the lead joint, or, in case of sharp bending, by the crumbling away of the metal of the inner edge of the hub a sufficient extent to allow the spigot with its lead ball to escape. In no case was a hub burst as in the failure of the first line. Also in



Section of Ginch DURNE FLEXIBLE JOINT PIPE ADUPTED IT NEW YORK (117) 1888

FIG. 4.

the first line another defect was noted—the sharp cutting edge was left just as it came from the planer and it was found that when the joint rotated this sharp edge acted itself as a planer and took off a shaving of lead with each motion, and it was difficult to pull the joints tight. This difficulty was remedied by rounding off this inner edge of the hub, and the result has been very satisfactory. The lengths of each section of pipe was also reduced from 12 to 9 ft. with an occasional 6-ft. length, so that the pipe can more readily accommodate itself to an irregular bottom on account of a greater flexibility, for splicing breaks, lengths as short as 4 ft. have given excellent results on account of handling and shortness of curve.

In December, 1888 (Fig. 5), a 6-in. line was laid to North Brother

Island from East One Hundred and Fortieth Street. This line was the banded design, 1 760 ft. long and cost \$16 245, about \$9.80 per ft. The New York shore slopes off at an angle of more than 1 to 1, with a depth in one place of 90 ft.; added to this there is a current of great velocity, 6 to 8 ft. per sec. being common observation, with slack of water at times of less than 15 to 20 min. and a large volume of commerce to be avoided. All this made the work extremely difficult, but the pipe was laid successfully in three days.



B-INCH CASI INCH FEETDEL CONTH BROTHER ISLAND 1888

The leakage as recorded by meter readings was about 0.3 cu. ft. per min., less than one-half of 1% of the capacity of the main. This main is still in operation, although it was repaired on several occasions on account of being broken by the anchors of vessels fouling it. The Chapman Wrecking Company relaid it in August, 1893; 594 ft. was furnished and laid and 806 ft. relaid at a cost of \$3,097, and again in November, 1902, another break cost \$2 000. This line is still in service.

PLATE XXVIII. THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK. LINTZ ON SUBAQUEOUS WATER MAINS.



Ţ

FIG. 1.-DEEP DREDGING, OPPOSITE 209TH STREET, FOR 36-INCH PIPE LINE.



FIG. 2.-LAST 36-IN. PIPE, FOOT OF 209TH STREET.



The Seventy-ninth Street line to Blackwell's Island was carried away by anchors of vessels, and on account of the lightness of the pipe and also the small diameter, the Department, through its Chief Engineer, Mr. G. W. Birdsall, decided to replace it with a larger pipe of 12 in. in diameter, and of 9-ft. lengths, weighing 1950 lb. per length. This line was laid successfully in June, 1891; a test with the 6-in. meter showed an extraordinary small leakage of 2 cu. ft. in 5 min., about $3\frac{1}{2}$ gal. per min.; it was about 1050 ft. long and cost \$11 528, about \$11 per ft. A 12-in. line was laid to Ward's Island from the foot of West One Hundred and Sixth Street in September, 1891; it was about 1266 ft. long and, including two meters, cost \$11 711, about \$9.30 per ft. This line was also a success.

The next was a 12-in. line laid to Randall's Island from the foot of East One Hundred and Twenty-first Street in November, 1896; it was about 885 ft. long and cost \$7 691, about \$8.70 per ft.

The next (Plate XXVIII, Fig. 1), a 36-in. line, was laid across the Harlem River from Fordham Road to Two Hundred and Ninth Street; it was commenced in June, 1899, and finished December, 1899. This was 1248 ft. long and the cost, including dredging, was \$55 450. This line is remarkable chiefly (Plate XXVIII, Fig. 2) for the excessive weight of the pipe sections.

At the point of crossing, the Harlem River is 1 200 ft. wide, and to meet future demands of commerce in this improved waterway it was necessary to dredge a trench across the river bottom to a depth of 25 ft. below mean low water (Plate XXIX, Fig. 1). As there is a strong tidal current in the river since its improvement by the Government, this trench gave considerable trouble and constant dredging was required to remove the silt which rapidly accumulated by action of the current; a total of 44 500 cu. yd. of material was removed by dredging. This work alone, at 52 cents per yd., the contract price, cost over \$23 000. The flexible joint pipe used, (Plate XXIX, Fig. 2) was 36 in. inside diameter and each length was 13.1 ft. over all, to lay 12 ft.; the hub was 5 ft. extreme outside diameter; the cast iron in the pipe weighs 13 725 lb. and the wroughtiron band 663 lb., making a total of 14388 lb. over 7 tons per pipe length complete. The cost of furnishing and laying the pipe was \$26 per ft., exclusive of other work.

I quote extracts from the specifications:

"36-INCH FLEXIBLE PIPE:—In crossing the Ship Canal, and for such distance on either shore as the Engineer may direct, the line will be laid with special pipe having flexible joints. The flexible joint pipe shall be made in strict conformity with the plans on file in the office of the Chief Engineer. The inner surface of the hub and that portion of the exterior of spigot coming in contact with the same shall be turned truly spherical, and no pipe will be accepted which differs at these points by more than 1/100 of an inch from the prescribed dimensions.

"The cast iron employed shall have a tensile strength of not less than 20 000 pounds per square inch, and must in other respects conform to 'the specifications for furnishing straight pipe. Wrought iron or steel bands shall be shrunk on as shown. The bands will be • preferably rolled on a tire mill, but should the Contractor employ any other method in their manufacture, such method must be approved by the Chief Engineer before the work on them is commenced.

"Both the interior surface of band and the exterior surface of band seat shall be turned truly cylindrical. The diameter of band seat to be greater than interior diameter of band by not less than $\frac{1000}{1000}$ nor more than $\frac{15}{1000}$ of an inch. Wrought iron used for bands must have a tensile strength of not less than 45 000 pounds per square inch.

"In shrinking bands on the hub, the end of band next to shoulder shall be cooled in such manner as to secure a proper grip and close joint at shoulder, and to better accomplish this object, the inner corner of band is to be rounded and corresponding corner of casting to be filleted with a clearance as shown.

"The Contractor shall furnish a plan showing the method he proposes to employ in laying the flexible jointed pipe, and said plan must be approved by the Chief Engineer before work is commenced.

"The trench in which the flexible jointed pipe is to be laid shall be excavated and dredged to a bottom width of 12 feet, with side slopes of 1 to 1, and the bottom of said trench between the established bulkhead lines shall be 27 feet below mean high water, and at other places at such depth as the Engineer shall direct. The material excavated below high water to be measured in scows.

"The joints of the flexible pipe will be run solid with lead, and must be run at one pouring; all others will be made 4 inches in depth.

"After the pipe has been laid and tested to the satisfaction of the Engineer, filling shall be placed over the pipe for such distance from either shore and to such depth as the Engineer shall direct.

PLATE XXX. THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK. LINTZ ON SUBAQUEOUS WATER MAINS.



FIG. 1.-METHOD OF LAYING \$6-1N. PIPE,



FIG. 2.-LAYING 36-IN. PIPE. LOOKING FROM DERRICK TO SHORE.

PLATE XXXI. THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK. LINTZ ON SUBAQUEOUS WATER MAINS.



METHOD OF RUNNING JOINT IN 36-IN. FLEXIBLE PIPE.

All surplus material dredged from river bed shall be removed by the Contractor at his own cost and expense. After the filling has been placed, it shall be protected by riprap, as may be required; none of the stone in the riprap shall be larger than can be readily handled by one man."

The work was commenced in June, 1899, and completed in December, 1899; the method adopted by the contractor to lay the flexible pipe may be seen in the picture, Plate XXX, Fig. 1; a strong float 97 ft. long and 35 ft. wide, provided with a steam derrick for handling the pipe sections, blocking for holding about five lengths of pipe and a launching way at one end with steel cables reaved through heavy blocks attached to end of the float and anchors on the shore. These were used to retard the too sudden launching of the pipe; a couple of heavy anchors attached to bow of the float were used to steady it against the tide (Plate XXX, Fig. 2). As each joint was completed the steel cables were slackened and the weight of the pipe pushed the float towards the other shore as one length after the other was launched. The joints of each pipe required an average of 1 100 lb. of lead, and as the joints were required to be completed at one pouring (Plate XXXI), the contractor made several expensive experiments with a pouring pot before being successful. The method finally adopted is shown; a short nipple of 1¹/₂-in. pipe was tapped in the lead pot, an ordinary cut-off value on the other end; then a piece of $1\frac{1}{2}$ -in. pipe, an elbow and a piece of pipe of sufficient length to guide the hot lead to the joint to be run; the first few joints of the flexible pipe came under the tracks of the New York Central and New York and Putnam Railroads, making it impossible to place the furnace and lead pot near these joints, which necessitated a considerable distance for the lead to travel before reaching the joint. An asbestos 2-in. pipe was tried, but after the joint was half run the asbestos pipe burst. The pouring, being therefore a failure, the joint had to be burned out by making a wood and coke fire around it to melt out the lead. This operation required many hours; several joints missed in this way, but after the furnace could be placed near the joints there was no further trouble.

After the ends of this line were connected up and the water turned on, an examination was made by a diver and several joints

on the shore were found to be leaking, but, after caulking, these were made tight, the reason being that the last few lengths never had a pulling strain exerted on them to tighten them, each section being laid in the trench and the joints poured at low water. A test made by readings taken by pressure gauges on hydrants connected directly with the 36-in. main, on each side of the river at the same time, showed a loss of about $\frac{1}{2}$ lb., which was considered very satisfactory; this will carry 20 000 000 to 25 000 000 gal. per day.

In July, 1900, the Department laid a 12-in. water main from the Bayside Pumping Station to Douglaston, Borough of Queens. This line was intercepted by an inlet from Little Neck Bay and navigable at high water. The commerce of this waterway is not very extensive, but nevertheless the main road crosses it with a swing bridge, which made it necessary to lay the pipe line on the bottom and the usual 12-in. flexible joint pipe was adopted (Plate XXXII, Fig. 1). A light cradle was constructed by driving two parallel rows of piles across this waterway; these were driven by a water jet, the water being available by capping the main when it reached this bridge, a suitable connection being made with a nipple, a rubber hose and a length of 1-in. pipe for the jet. A framework was constructed on these piles at about high water mark, the sections of the pipe were then laid on the cross-pieces of this framework, and well up on the banks on either side the spigots were entered in the hubs and jointed up properly with lead, ropes were attached to the pipe and the free ends secured so as to permit of the lowering of the pipe smoothly. The cross-pieces on which the pipe rested were all cut at a given signal and the pipe lowered down (Plate XXXII, Fig. 2). When it reached the bottom, the water jet was again put in operation and the pipe sunk about 8 ft. in the mud, the distance from the top of the pipe to the sill of the bridge being prescribed in the specifications. The ends were then connected to the ordinary 12 in., with special connecting pieces having hubs 8 in. deep to allow of subsequent settlement of the flexible pipe in the mud. This allowance was not large enough, as the main has apparently not reached solid bottom yet, and these slip joints have had to be lengthened several times.

The 12-in. pipe sections of this line were 9 ft. $9\frac{1}{2}$ in. over all and

PLATE XXXII. THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORX. LINTZ ON SUBAQUEOUS WATER MAINS.



FIG. 1.--12-IN. PIPE IN TEMPORARY SUPPORTS, LITTLE NECK, L. I.



FIG. 2,--AFTER 12-IN. PIPE WAS LOWERED DOWN, LITTLE NECK. L. I.

laid 9 ft. $2\frac{1}{2}$ in. and weighed 1 900 lbs. each; 332 ft. were laid and cost, to furnish and lay, \$4 per ft. As the flexible pipe was part of a large contract, this price would be ambiguous.

In the fall and winter of 1903 a line of 6-in. flexible-joint pipewas laid to supply water to Riker's Island from the foot of Manida Street, Borough of The Bronx. This island is under the control of the Department of Correction, who have planned vast improvements to meet the growing demand for homes for the criminal classes of the city. Work was commenced on this water main on September 8th, 1903. The first method attempted in laying was quite novel. A calculation was made by the contractor of the displacement of the pipe when submerged, and the buoyancy of an empty oil barrel, the idea being to attach a sufficient number of barrels to the pipe to float it just clear of the bottom, and not high enough to cause traffic on the river to interfere, this floating pipe to be hauled across by a cable. But no consideration was given to the river current, and this caused the failure. A launching way of plank set on edge was constructed on the Bronx shore, about 150 ft. long, extending from the top of the bank well out beyond low tide. About ten sections of the pipe were laid on this way and jointed together, each joint requiring 25 lb. of lead; a wood plug was driven in the spigot end of the pipe, a fender and a heavy chain securely lashed to this end, which, in turn, was fastened to a steel hawser (one of the old Broadway car cables), which was laid across the river to the island. To the sections of pipe oil barrels were lashed, three and two barrels alternately. A floating derrick with a steam hoist was anchored, fore and aft, near the Riker's Island shore, the steel hawser reaved through a block fastened to the piling of the dock, and the end carried on board; when an opportunity offered and the river was clear of vessels, the hawser was slowly drawn across and the first lot of pipe was launched; but the shore end of the pipe broke from its fastenings and slipped out into deep water, which necessitated the moving of the derrick to the Bronx shore, a diver going down with a chain and making fast the end, which was hauled on board. Then, with considerable difficulty, another batch of pipe was laid on the way; the derrick in the meantime was kedged over to its first position at the island and preparations made for another

haul. But, after putting on all the strain the engine was capable of exerting on the hawser, the pipe did not move. Then after another delay a diver went down and attempted to locate the trouble, but this took several days, as he could work only on the slack tides for perhaps a maximum time of 30 min. In the channel at this point there is 75 and 80 ft. of water and entire absence of slack water is frequently noted by divers working here, the water on the surface running in an opposite direction from that near the bottom. for a short time. It was found that the hawser, becoming slack after the first haul, had been swept into a great bow by the tide down the river, and it had fouled between huge boulders on the bot-On account of this delay many of the oil barrels burst and tom. floated to the surface. After all these unexpected conditions which were not considered in the calculation of the buoyancy formula, this method of laying the pipe was abandoned on January 7th, 1903. About 50 lengths of pipe were laid by this method. On the following day a well-equipped floating derrick was employed, the pieces of old line were picked up and a start was again made from the Bronx shore, and work proceeded by laying from the deck of this float satisfactorily till the end of the pipe was finally landed on the island in about three weeks. After the shore connections were made water was turned on the island March 2d, 1903. There were used 153 lengths of 6-in. flexible pipe, each laying 11.91 ft., and 10 lengths each laying 6.1 ft.; the line was 1 904 ft. long and cost, with fish trap, \$3,908, about \$2 per ft. After the water was turned on the following test was made to determine leakage: As will be seen on this plan, Plate XXIX, Fig. 3, A represents a hydrant at the foot of Manida Street, B a stop-cock on the main line at the same location, C a hydrant, and D a stop-cock on Riker's Island. Threequarter-inch taps were driven on either side of the stop-cock B and coupled up, with a 1-in. meter intercepting, which, when B was shut down, made a by-pass; B and meter closed, pressure at Aequals 43 lb. B open, D closed, pressure at D equals 46 lb. Elevation of D being lower than B accounts for the higher pressure recorded. B closed and D closed and water feeding through meter from many observations, some lasting 24 hr., an average leakage was noted of 3.75 cu. ft. per min.

On Sunday morning, January 3d, 1904, a telephone message was received by the Department that they had no water on Riker's Island. To those interested that message was alarming, not alone from the island being out of water, but because the weather at this time was abnormally cold and deep snow had fallen. A hasty examination was made, pressures taken and found normal down to the crossing at the river at Manida Street; so it was decided that owing to lack of circulation from small consumption on the island and cold weather, the pipe was frozen under the riprap on the shore ends; this at the foot of Manida Street was removed down to low water, 3 or 4 in. of sand left over the pipe, and hot fires built over this and kept burning all night; a request was sent to the island by telephone for the warden to do the same; but this was not done for many hours after, as it was impossible to send our men over that night, and, in fact, next day, on account of the floating ice, the work was not done properly. During the following day a 1-in. hole was drilled in the pipe near low water and a screw tap inserted, and normal pressure was found. It was then decided that the trouble was on the island shore. Our men went over and attempted to thaw it out by building fires, but the high tides and floating ice put them out. The weather still remaining extremely cold, it was decided to try other methods. By courtesy of the Fire Department, an engine and an engineer were sent to the island on Friday and began work by forcing steam into the pipe through the nearest hydrant, about 50 ft. from the supposed location of the frozen portion, but after 12 hours' work no satisfactory results were obtained. Then the flexible pipe just outside the sea wall was cut and lifted up and found to be frozen solid. A number of lengths of 1-in. pipe were procured and with hose coupled to the engine, and the other end of this thaw pipe inserted in the frozen end. Quite rapid progress was made; the thaw pipe had to be drawn back every 10 min. to heat up the melted ice in the larger pipe to prevent it from freezing again. Steam at 150 lb. pressure was kept up for two days and two nights continuously by this gang of six men during the worst weather recorded in many winters, working on an exposed shore without protection of any kind. High northeast winds, accompanied with driving sleet storms and the thermometer at zero, is hardly a

position to be envied, and makes a record of loyalty to duty well worthy of honorable mention.

After thawing out to a distance of 110 ft. a sudden bend in the flexible pipe resisted all efforts to pass it, and as the meter on the Bronx shore was recording slower and slower, it was finally decided that the line was frozen all the way across. To determine this I rigged a self-registering thermometer in a piece of tin pipe to protect it. This was attached to a line with sufficient lead to sink it, and on January 13th I took a reading off the dock in 20 ft. of water for 10 min. and found the temperature at the bottom to be 30°. Further effort to thaw out the line being useless, work was suspended and the island had to be supplied with water brought in barrels from Manhattan. As there were only about 200 inhabitants, this was not a serious hardship, but supply by this method had to be continued until the line was repaired in August, 1904. Such a mishap, however, would be of serious consequence to an island like Blackwell's, where the last census showed 6 454 inhabitants. A day or two before work was begun with the steam engine a report was received that during the storm an abandoned hull of a yacht about 75 ft. long dragged her anchor till it fouled the water pipe, and hung there during a tide, then drifted back, and that this had parted the pipe. As we had noted no loss of pressure, this was doubted, but a subsequent examination showed this theory well founded. The main was frozen on both sides of the break, and consequently there was no escape of water and no loss of pressure. On March 2d, 1904, after the ice had begun to disappear in the river, I took another observation of the temperature, and at a depth of 75 ft. found a reading of 29¹/₂°, temperature of the air being 38°. On March 22d, 1904, the main gate at the foot of Manida Street was opened full with the hopes of blowing out the line, but this had no effect till during the night of March 26th, 1904, when a complaint came in from the people along Manida Street that they had no water. We knew what that meant-the line was parted in the river. The gate was then shut down, which restored the water on Manida Street district. On March 28th, 1904, the Merritt-Chapman Wrecking Company began an examination of the line and made some repairs, taking 29 days, at a cost of \$2 000. A number of the leaks were

PLATE XXXIII. THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK. LINTZ ON SUBAQUEOUS WATER MAINS.



FIG. 1.--REPAIRING 6-IN. LINE TO RIKER'S ISLAND, SHOWING SLEEVES AND CLAMPS USED.



FIG. 2.---REPAIRS TO 6-IN. LINE TO RIKER'S ISLAND. FLOATING DERRICK SUPPORTING PIPE.

located by means of an air compressor pumping air into the line, and noting the locations of bubbles coming to the surface. Unless the day was calm it was difficult to see those coming up through the deep water as the tide would carry them a long distance before they reached the surface. This examination showed some six serious breaks in the line; one joint entirely pulled apart and the hub and spigot separated 2 or 3 ft.; at the other joints the spigot ends of the pipe were partially pulled through the lead joints. It is possible that the joint that was separated was the result of the anchor fouling at this point, and the joints that were partially pulled out may have been caused by the power exerted at the time of the freezing. As none of the pipe were split, this expansion may have been confined so as to act longitudinally and push the lead joints apart.

As all available funds were used up for this work, a contract was prepared on an estimate of the Merritt Chapman Company to do the work complete for \$3 000, and by permission of the Board of Aldermen the contract was awarded to them. Work was commenced on the repairs on June 29th, 1904, and took a floating derrick, 2 divers and 7 men 44 days to complete; they used 5 half sleeves (Plate XXXIII) fitting over the entire hub and spigot and 1 pair of clamps and draw bolts; the leaks were all in water of from 30 to 78 ft. deep and the longest working time of the divers on a slack tide was 1 hr. and 30 min.; more frequently it was but 15 to 20 min.

When the divers had repaired all the breaks that had been reported, a test was made similar to that made when the line was first laid (Plate XXIX, Fig. 3); with D shut and B shut, a pressure of 47 lb. was noted on A; with D shut and B open, a pressure of 41 lb. was noted on A; with B open and D shut, a loss of 5 cu. ft. per min. was noted, which, when compared with the original, was not satisfac-The divers then walked along the line from shore to shore with tory. the water on and found another joint leaking, which they repaired by caulking. The test was again repeated and it was found that the pressure had increased with B open and D closed to 44 lb.; with Bclosed, to 46 lb., a loss of but 2 lb. from leakage. In cubic feet through the meter it was 4.3 per min.; by opening a 1-in. tap on the line the combined leakage was 4.4 cu. ft. per min., so it was decided to accept the work, and the main is now in service.

Fig. 6 shows joints for subaqueous pipe of the ball and socket pattern, one invented by James Watts, for the Glasgow Water Company, in 1810, and laid across the River Clyde and described in the "History of Water Supply to Glasgow, 1869." The other a joint of more modern times adopted by the Spring Valley Water Company of San Francisco.



WATTS JOINT SUBMERGED PIPE LINE GLASGOW 1810



FLEXIBLE JOINT **FIPE** SPRING VALLEY WATER CO. SAN FRANCISCO 1887

F1G. 6.

Addenda.

Before completing the design for the 36-in. flexible-joint pipe a letter was sent to an officer of the Ordnance Department at Washington—an expert in designing large guns—with a request for information on the required size of the wrought-iron band for this purpose. A very prompt and courteous reply was received containing much information that may be of interest to the reader.

WASHINGTON, Feb. 20, 1896.

DEAR SIR:

It would be difficult in any event to accurately estimate the strains in the problem given in your letter, and the lack of information as to the quality of cast iron, &c., to be used does not enable me to do more than suggest the proper dimensions of wrought iron band and the shrinkage it should have on the cast iron pipe. I believe, however, that it is on these points more particularly that you request data.

I have assumed the following values for material as being probably within safe limits:

	Elastic limit.	8 0	00	lb.	\mathbf{per}	sq.	in.
Cast Iron (pipe) {	Tenacity	$23 \ 0$	00	"	"	"	"、
	Mod. of Elas-						
	ticity	16 000 00	00	"	"	"	"
Wrought Iron (band)	E. L	18 00	00	"	"	"	"
	Ten	$45 \ 00$	00	"	"	"	"
	(Mod	22 000 00	00	"	"	"	"

A rude calculation gives the probable stress per square inch on the interior of the pipe (under band)—800 lb. per sq. in., due to anticipated strain. Making this stress 3 000 lb. per sq. in.—factor of safety $3\frac{3}{4}$ —and limiting the strains on pipe and band to the elastic limits 8 000 and 18 000 lb. per sq. in., it is found:

The wrought iron band should be $2\frac{1}{4}$ in. thick and should have a shrinkage of 1/100 in. on the diameter 56 in. This means—the band being in place—that a pressure of 3 000 lb. per sq. in. on the interior of the pipe (directed radially) would stretch the interior of the pipe to a strain of 8 000 lb. per sq. in., and the interior of the iron band to a strain of 18 000 lb. per sq. in. I would then suggest the following dimensions and allowed variations:

than the interior of band (shrinkage) 0.01 in. to 0.015 in.

This allowance of 0.005 in turning ought to be sufficient for any workman.

It will require but little heat to assemble the band with this light shrinkage—a measured expansion of 0.05 in. ought to be sufficient for slipping the band in place, and I would advise to avoid any more heating for this purpose than is necessary. When the band is in place and nearly closed in it might be well to cool the end next the shoulder in order to make it first grip the cylinder there and avoid an open shoulder joint. I suppose the wrought iron bands will be rolled on a tire mill as the most economical and best method of manufacture. Should it be proposed to forge and weld the band it would perhaps be as cheap and better to take steel as rolled for car wheel tires. The steel band could be left without machining on outside faces, and the dimension (about 2 in. thick):

Exterior	diameter	 •	 				• •	• •	 	•	60	to	60 1	in.
Interior	"	 •	 • •	•	• •	••	••	•	 • •	•	56	in.	±	

and shrinkage 0.01 to 0.015, the same as for wrought iron band.

The inner corner of the band ought to be rounded and the cast iron correspondingly filleted, with a clearance:

Radius for round on band say..... $\frac{3}{8}$ in. " fillet in cast iron $\frac{1}{4}$ "

I have prescribed a shrinkage somewhat greater than the least that might be allowed, with a view to give the band a good grip, but it would be well to insist upon care in boring the hoop and turning the shrinkage surface on the cast iron. A little roughness of machinery would not be detrimental, but the diameters ought to be carefully measured. If, for example, a shrinkage of 0.05 in. were given it would stretch the interior of the band to the limit of 18 000 lb. sq. in., and leave no residual elastic strength when an additional interior stress should be brought about by strains due to laying the pipe and setting, &c.

I will be pleased if you find this useful in your work.

Very truly yours,

To James Duane.

(Signed) R. BIRNIE.

DISCUSSION.

MR. GEORGE S. RICE, Member of the Society.—I would like to ask the author if he made a practice, in laying the pipes across the river, of dredging out a trench and covering the pipes afterwards with earth.

WILLIAM D. LINTZ, the Author.—In no case has this been done, with the exception of Two Hundred and Ninth Street, where we were obliged to dredge on account of the shallow condition of the river. But in ordinary subaqueous pipe laying we simply lay it on the river bottom as we find it. In some places it lays over boulders and takes very sharp bends, and in one case, in the Riker's Island line, from information of the divers, there was a place where there was a drop of 12 or 15 ft. over a rock or reef and the pipe is lying over that, several lengths being unsupported.

MR. RICE.-I am very much pleased to hear what the author has said. The same experience which has been met with here has been encountered before in the City of Boston. Some pipes were laid in the early Nineties across from the mainland to Deer Island, an island in the harbor situated about like Riker's Island is here. The pipe, as I recollect it, was small in size, either 4 in. or 6 in., and the same fact about the freezing of the water in the pipe was revealed. When investigated, the cause of the freezing was apparent. The fresh water which was inside of the pipe was frozen by the broken pieces of ice flowing in the salt water outside of the pipe, the principle being the same as in an ice-freezing machine. The salt water outside of the pipe freezes at a lower temperature than the fresh water inside of it under these conditions. To obviate the difficulty, the method that would naturally suggest itself would be to put the pipe underneath the water and cover it to a considerable depth with earth or other material.

MR. LEWIS.—You think, then, Mr. Rice, that had this been fresh water it would not have frozen so quickly?

MR. RICE.—Whether or not freezing would have taken place if the water outside the pipe had been fresh instead of salt is a reasonable question. Of two different liquids, like fresh and salt water, the greater density of the latter would favor its freezing slower.

MR. LEWIS.—I imagine a good many members were startled to hear that a temperature of 29° was found in 75 ft. of water. Did you have that confirmed by other observations?

THE AUTHOR.--I took those observations myself and was very

150 DISCUSSION ON SUBAQUEOUS WATER MAINS.

much surprised at the low temperature recorded, but 29° was the correct reading. The thermometer used was of the self-registering type, supplied by Tagliabue. I asked him as to its correctness and he said he would vouch for it. The temperature of the air was 38° . I mentioned it to quite a number of my engineering friends and they were surprised, too.

My theory as to the pipe freezing during the winter, under salt water, is that it may be likened to the principle of an ice-cream freezer. The fresh water from the street mains at a temperature of about 45° enters the subaqueous pipe line, which is surrounded by salt water at a temperature of 29°; it rapidly chills and ice begins to form on the inside of the iron shell of the pipe and the rapidity with which it freezes depends on the circulation of the water in the pipe. In the case of Riker's Island there was a very small consumption of water during the nights, and when the line failed there had been zero weather and high northwest winds blowing on the exposed shore of the island, with large quantities of floating ice in the river, which caused the line to freeze up, and as upon examination none of the pipe was found split, as happens when the street mains freeze, but a number of the lead joints were pulled out, I am led to believe that at the moment of freezing the enormous pressure exerted by the expansion of the water changing to ice, and also owing to the thickness of the shell of metal in the pipe being 1 in., it was strong enough to resist the strain; this pressure was then exerted in a longitudinal direction, and the lead being weaker, the joints were forced apart.

Now, I would like to ask whether any of the members have ever had a like experience, and their opinion as to my theory as to the pushing apart of the joints by the action of expansion of the water when the pipe froze.

MR. LEWIS.—Did you backfill over the trench dredged across the Harlem River at Fordham Heights?

THE AUTHOR.—We did; yes, sir; with riprap; not in the channel; only on the shore ends.

WILLIAM FOULKE JOHNES, Member of the Society.—I would like to inquire in regard to the case you mentioned where pipe was laid on short stringers, jointed up, then supported by ropes, and the stringer cut and the pipe lowered; what method did you take of securing uniform lowering?

THE AUTHOR.—They used blocks and tackle, a number of men lowering the pipe at the same time. This pipe was only about 300 ft. long.

MR. DANHEL ULRICH, Member of the Society.—Ball and socket joints nearly always leak to a small extent, and it is almost impossible to locate and repair small leaks.
I saw a very successful remedy applied for small leaks in these joints where about 1 200 ft. of pipe was laid and the pressure was applied and it fell off considerably. When the pipe was closed several bushels of bran were placed in the water for the test and the pressure of about 60 lb. applied again, and in a very short time no perceptible loss could be found. This could be applied on any line of ball and socket pipe and small leaks would no doubt be clogged and the bran would certainly remain until such time as the leaks would be sealed with rust and silt.

MR. HENRY I. LURYE, Member of the Society.—I would like to ask if electricity could not be used in thawing out the pipes?

THE AUTHOR.—That subject was discussed when we found the main frozen supplying Riker's Island, but it was impossible to get a current of electricity at that point or we certainly would have tried it. An electric lighting company, operating a plant in the Bronx, said they could do it in a very short time if they could get their wires there, but it would cost more to lay their trunk line than it would cost to thaw the pipe out. That method is being adopted very extensively now in the Borough of The Bronx by the electric company in thawing out service pipes where they can get current from a street cable. In Queens also I understand it is being done. This may tend to open up a very interesting subject for discussion at some future meeting.

MR. LEWIS.—Does not the Department of Water Supply propose to carry one or more 48-in. mains under the Harlem River from Jerome Park Reservoir?

THE AUTHOR.---Two 48-in. are proposed.

MR. LEWIS.—The weights of the 36-in. pipe were very unusual, as was the outside diameter of the hub, which, I believe, you said was 5 ft. What was the thickness of that pipe, Mr. Lintz?

THE AUTHOR.—Two inches for the 36-in.

MR. LEWIS.—I doubt if any one here present has known of castings of equal weight for that size of pipe. Do you know of any other instance?

THE AUTHOR.-No, sir.

MR. CAMILLE MAZEAU, Member of the Society.—I would like the author to tell us something more about his water-jet experience in Queens. I heard him say something about water jets.

THE AUTHOR.—After the ordinary main was laid as far as the draw bridge at Douglaston, the contractor put a cap on the 12-in. pipe, attached a nipple, etc., and I think, if my memory serves me right, he used a 2-in. pipe with ordinary hose pipe connected up with a straight piece of iron pipe to act as a jet. Those piles for supporting the pipe were not sunk to any great depth, I do not think over 4 or 5 ft. in the mud, just enough to prevent them from

toppling over, and not intended to hold up a heavy weight for any length of time; after the pipe was laid and lowered down in the mud, with the ropes and tackle, this jet was used to blow out the mud underneath the pipe, and gave very satisfactory results, as we could see it slowly drawing down the ends and settling in the mud. Further than the actual result in this case I could not give any information.

MR. LEWIS.—You did not get down to sand?

THE AUTHOR.—I don't believe it has gotten down to sand yet. That pipe line is giving us considerable trouble at the present time. The shore ends are leaking occasionally and we put in short pieces of pipe to lengthen it and thereby compensate for this settlement, and then drive up the slip joint again. There seems to be bottomless mud at that point. There was some talk of adopting a new method of relaying this line across the creek at Douglaston.

MR. ARTHUR S. TUTTLE, Member of the Society.—I want to express my appreciation of this paper, which I believe to be the first presented to a technical society on submerged pipe in the City of New York.

It is very difficult to secure and maintain a tight joint in a submerged pipe, and I believe that in a great many cases large leakages exist which are not detected. I noted the method used for testing at the crossing to Riker's Island, and would ask if it is a method in continuous use, or whether dependence is ordinarily placed on the ability of the people on the island to detect and report leakage as they happen to note a material falling off in pressure.

Another question that I would like to ask is whether the author can tell us what the actual cost of the work amounted to. In work of this kind, where the contractor has to take large risks, it is evident that the contract price does not afford a fair criterion as to the cost. There is one pipe line that I think might be added to the list the author has given, which otherwise seems to be complete, and that is the line laid from Brooklyn to Governor's Island, which obtains its supply from the city.

THE AUTHOR.—I did not know it was controlled by the city.

MR. TUTTLE.—At the same time it is one of the pipe lines supplied by water from the city service.

THE AUTHOR.—Yes. There is also another line I might mention, the line crossing the Eastchester Creek on the Boston Road. It is only about 50 ft. long and should hardly be classed as a flexible-joint pipe line. As to the actual cost of those lines I am not able to state. All I deal with is the contractor's prices, which range from \$8 to \$11 a foot, depending on the size of the pipe.

The general test for leakage on subaqueous pipe lines is the

pressure test; the ends of the line where it emerges from the river should show the same pressure, and generally does; where the pressure fluctuates very much we know there are serious breaks. We have occasionally tested by inserting a meter in the line, but meters of large size are very expensive-two 8-in. meters to be set under contract in the near future for this purpose will cost \$850 each, without the necessary brick vault. Considering the difference of cost, the gauge test costing nothing, it is doubtful if the result justifies the expense; but, of course, the result is positive by showing the amount of leakage in cubic feet, and it also may be desirable to know the quantity of water consumed through the line; but, on the other hand, after such meters have remained in the line for a year or over, the screens and meter become clogged by sediment, which reduces the flow to a marked degree. Where it may seem desirable to test a line with a meter, a roundabout may be constructed around the main-line gate at the shore end of, say, 2-in. connections with a 2-in. meter intercepting and controlled by the valves in the taps, similar to the one described in the test of the Riker's Island line; but in this case we used a 1-in. water meter which I have found by experience to be too small.

Tests for leakage are not made periodically, only when a complaint is made by a consumer, and they are sent in on a slight provocation. The Department employs an inspector to investigate the cause of these complaints and also by taking an observation of the pressure on the nearest hydrant. This is compared with former pressures taken at that point, and if there is any marked difference, a further investigation generally locates the cause. With the exception of some seven Bristol self-recording gauges set up in the repair gang yards, which show instantly any marked change in the service, the Department does not make any continuous test for leakage. Speaking of tests on subaqueous lines, I desire to mention that the Department is at present engaged in replacing the 6-in. or shore end portion of the Blackwell's Island line at the foot of East Seventy-ninth Street. The river portion of the original 6-in. line was replaced with a 12-in. flexible several years ago, which I mentioned in the paper, but about 150 ft. of the old 6-in. line remained, and the numerous complaints from the island for some time, on account of a shortage in the supply, we have decided are caused by this 6-in. line not being able to deliver the quantity required and effectually throttling the line. When this 12-in. pipe is laid two 8-in. meters will be placed in the line, one in the main line and one in a roundabout, so that one or both may be used. When this is completed, we will make a test through the meters for leakage and note what is lost in cubic feet per minute. I had hoped that I

would be able to present the result of this test in the paper to-night, but owing to the delay in the delivery of the meters and connecting parts I was very much disappointed.

MR. TUTTLE.—In connection with leakage of submerged pipe lines, I recall an experience in Jersey City some four years ago. The supply was then obtained from the East Jersey Water Company at Belleville, and the delivery pipe lines, comprising one 20-in. and two 36-in. lines, crossed under the Hackensack River. All of these lines were old, and at irregular intervals leakage at the river crossing was investigated, the same being a subject of interest when a shortage in supply or drop in pressure was noted. In 1899, meters were placed on all of these lines at Belleville, and the meter records were thereafter regularly made and sent daily to the office in Jersey City. From the day when the meters were installed the diver's business in repairing these mains at the river crossings increased immensely, and while his revenue increased, it seems hardly necessary to add that the city saved large volumes of water, the value of which was much more than sufficient to justify the expense.

The previously undetected losses must have been very large, and the same never would have been appreciated or detected without the meters. This danger of leakage is one which must be contended with in all cases of submerged mains, and it is one which may readily prove to be very troublesome.

MR. MAX L. BLUM, Member of the Society.-What does the author consider the life of a line like that?

THE AUTHOR.—I do not know further than the experience we had on the ordinary mains which were laid in the sections of the city where the tide water acts on it, like South and West Streets; that is about 25 years. They corrode very rapidly when they once start.

THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK.

Paper No. 14.

CHEMICAL PRECIPITATION PLANTS, CONTACT BEDS AND SEPTIC TANKS, AS CONSIDERED IN A DESIGN FOR A PORTION OF BROOKLYN'S SEWERS.

BY HENRY R. ASSERSON, MEMBER OF THE SOCIETY.

In 1894 there were annexed to the then City of Brooklyn the Towns of Flatbush, New Utrecht and Gravesend. In 1896 the town of Flatlands was annexed. These towns were made the Twenty-ninth, Thirtieth, Thirty-first and Thirty-second Wards of the City of Brooklyn. All of these wards are south and west of a ridge of land commonly known as the backbone of Long Island, which extends from Fort Hamilton Avenue through Greenwood Cemetery, Prospect Park, and easterly along the Eastern Parkway Extension through to Evergreen Cemetery and the Ridgewood Reservoir, continuing thence easterly throughout the whole length of Long Island.

It will be noted that the old City of Brooklyn, prior to the annexation of this land, lay to the north and west of this ridge of ground, excepting that territory known as East New York, now the Twenty-sixth Ward of the Borough of Brooklyn; that almost the entire territory of the Twenty-ninth, Thirtieth, Thirty-first and Thirty-second Wards is south of this ridge, excepting a small portion of New Utrecht, known as Bay Ridge. The old City of Brooklyn was practically sewered, before this annexation, by gravity sewers, their discharge leading to the East River and to New York Bay.

BROOKLYN SEWAGE DISPOSAL.

The completion of the sewering of the Twenty-sixth Ward was practically concluded in 1896, or concluded to the extent of the then built-up territory. A chemical precipitation plant was built for the disposal of the sewage of this ward, and was constructed in marsh lands at the location of Hendrix Street and Vandalia Avenue.

It is not my intention to set forth within the limits of this paper a complete description of the design of the sewerage system for these new wards, and the different considerations given to said design other than from a topographical standpoint. For particulars of this kind I refer to the issue of the *Engincering Record* of June 11th, 1904, wherein Mr. Alfred D. Flinn, associate editor of said paper, has very fully and clearly set forth the scheme of this design. It will be necessary, however, for me to point out the topographical features of this territory to clearly explain the necessity for the consideration of chemical precipitation plants or biological treatment of sewage by septic tanks, contact beds or sewage farms.

The topographical trend of the territory slopes from the ridge towards Jamaica, Sheepshead and Gravesend Bays. As the law calls for the treatment of sewage before entering these bays, it was found that if the sewers were laid entirely in the direction of the drainage, precipitation plants or biological treatment of sewage would be necessary. Owing to the great cost of either of the methods, it was deemed advisable to conduct as much of the drainage as possible, of the 16 673 acres involved, by gravity sewers to the waters of New York Bay to be oxidized by the dilution method.

By referring to Plate XXXIV, which shows the adopted sewerage and drainage district of this territory, it will be found that the areas U and V, being on the side of the ridge trending towards New York Bay, this acreage was readily provided for.

Map T drains through the mains in the direction of the natural trend of the territory, and is then conducted through this ridge by a tunnel discharging at the foot of Sixty-fourth Street.

Map W has the same characteristics as to drainage, with a tunnel through the divide, discharging at the foot of Ninety-second Street, with the additional feature of carrying drainage practically



PLATÉ XXXIV. THE MUNICIPAL ENGINEERS' OF THE CITY OF NEW YORK. ASSERSON ON BROOKLYN SEWAGE DISPOSAL.

BROOKLYN SEWAGE DISPOSAL,

from tidewater at Gravesend Bay along the shores of Bath Beach to the swift currents of the Narrows. This was made possible by the bluff of land of considerable elevation along this shore line, its extreme height being at about Bath Avenue.

The storm drainage of Maps Z and AA will discharge into branches of the Coney Island Canal at the points shown on the plate. The dry-weather flow from Map AA will be pumped to the point of discharge of Map Z, then the drainage from both areas will be pumped from this latter point to the mains of Map W, to be cared for by the dilution process.

Map BB will discharge its storm waters into Garrettson's Canal, while the dry-weather flow will be pumped to the swift currents of Rockaway Inlet.

Thus it will be seen that of the total of 16 673 acres considered, 11 273 acres are conducted to swift tidal currents, and the sewage from this acreage disposed of by the dilution process of purification.

It will not be out of place here for me to state that had the sewers been designed to run with the grade of the territory the disposal of sewage by the next cheapest method, economical precipitation, would have necessitated the construction of at least five precipitation plants, and the annual maintenance imposed upon the city for such method of disposal, considering the area fully populated, would have been at least \$1 000 000 per annum and probably more. It is estimated that the cost of each precipitation plant would have been \$350 000 at least.

It was at first supposed that the first cost of tunnel sewers would be greater than the cost of sewers running with the trend of the territory, that is, considering the item of sewers alone; but it was found that the sewers, if carried in the direction of the natural grade, would have been for a considerable distance from their outlets necessarily of special design, wide and flat topped, due to lack of headroom obtained on account of the low elevation of the land near said outlets.

Owing to the location of territories X and Y, and the extreme difficulty in caring for the sewerage therefrom by the dilution process, it became necessary to study said areas from a standpoint of the disposal of the sewage therefrom, either by precipitation plants or by biological treatment. The Twenty-sixth Ward being adjacent to Map X, and the sewage therefrom being disposed of by chemical precipitation, it was natural to consider the three areas at one time, that is, from a standpoint of chemical precipitation or biological treatment of the sewage.

As we are to discuss chemical precipitation plants, it may be well for me to point out for the edification of those who have not seen a structure of this kind certain details of the Twenty-sixth Ward plant, which was erected by the City of Brooklyn at a cost of \$350 000.

In the general arrangement of the building (Plate XXXV) it will be noticed that the sewage enters a trap basin from the twin sewers, and is conducted in grooves in the floor to the connecting culvert entering the building. Said building is divided into two distinct parts, whereby sewage can be turned into one set of precipitation tanks when the other set of tanks are being emptied and the sludge cleared from same. The sewage passes through the tanks in the course as indicated by the arrows and passes under dip boards and through screens, over a weir, and is finally siphoned into the central well, where it is pumped to the outfall sewer. Its velocity is much retarded, to the extent that the sewage is allowed to settle for a period of about 30 minutes. Milk of lime, in the quantity of about 4 grains per gal., is used as a precipitant. This lime enters the tanks at the location of the valves. Perchloride of iron is also used to the extent necessary, averaging in quantity comparing with the foulness of the sewage. During periods of storm the precipitation tanks are not used, but the storm water goes through the trap basin and the outfall sewer, the elevation of the invert of the outfall sewer at its junction with the trap basin being some 2 ft. higher than the elevation of the inverts of the twin sewers.

A hydraulic gate, when opened, permits the sewage to enter one set of tanks being operated from the main floor of the building, which is above the precipitating tanks.

Plate XXXVI, Fig. 1, is a view showing one set of precipitating tanks with one of the screens used, and the narrow gauge railway upon which small dump cars are run to collect the heaviest pre-

PLATE XXXV. THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK. ASSERSON ON BROOKLYN SEWAGE DISPOSAL.



.

cipitant. These cars are elevated to the main floor of the building, then wheeled over a trestle, and their contents discharged upon the spoil bank adjacent to the building.

Four 12-in. siphons, two for each set of tanks, conduct the clarified effluent from the precipitating tanks to the central well, whence said effluent is pumped to the outfall sewer.

Chlorine gas is generated each day and is passed through the precipitating tanks, as well as into the central well, by a series of perforated pipes.

Three Scotch marine boilers, each of 150 h. p., are used in supplying steam for two 10 000 000-gal. Worthington triple-expansion pumping engines. These engines are situated in the engine well, and just below the main floor of the building.

The lime tanks are revolved by steam power, insuring a thorough mixture of the lime with water. The milk of lime is then fed into the head, as it were, of the precipitation tanks immediately under the main floor of the building. Two 8-in. centrifugal pumps, with suction pipes so arranged that both can be used in either tank, or in both tanks at the same time, are located at the extreme ends of the precipitation tanks to pump the liquid sludge to the spoil banks. The average amount of sewage treated in this plant per diem is 8 000 000 gal. The cost of operating the works is about \$11 per 1 000 000 gal.

In the Glasgow Precipitation Plant, I note from the report of the Sewage Commission of the City of Baltimore that for the years 1894 and 1895, when 12 000 000 gal. of sewage per day were treated, the cost per 1 000 000 gal. was \$13.60. The cost for treatment in our precipitation plant compares favorably with other large plants abroad, especially so with the large plants of the City of London, and it is believed that a clarification of sewage is obtained equaling the effluent of any plant of its kind.

In one of the precipitation plants at Coney Island (Plate XXXVI, Fig. 2) the method is precisely the same as in the Twentysixth Ward plant, excepting that the arrangement of the tanks is as shown. Thus the sewage enters alternately the right and left hand series of tanks, one set being cleaned out while the other receives and precipitates the sewage; the sewage enters the tank, passes

BROOKLYN SEWAGE DISPOSAL.

through screens and siphons to the next tank, and so on to the third, the pump well, and from thence is pumped to tidewater. The bucket and trolley originally removed the precipitated sludge.

The plate shows a 6-in. centrifugal pump used in pumping the liquid sludge to the spoil banks, the bucket still being used for heavier matter.

The plant has a 2 500 000-gal. direct-acting Deane pump, and a smaller pump of 1 500 000 gal. capacity. An average of about 1 000 000 gal. of sewage per diem is treated by this plant.

In the Sheepshead Bay plant, the tanks and building are similar to the Twenty-sixth Ward plant, that is, circular in form. This plant treats about 2 000 000 gal. of sewage per diem, but is arranged reversing the operation of precipitation as is performed at the Twenty-sixth Ward plant. The sewage is conducted to the central well and there lifted by a Worthington 10-in. centrifugal pump to the precipitating tanks, which are upon the level of the main floor of the building, the clarified effluent draining into the outfall sewer. Two 6-in. centrifugal pumps are used in pumping the liquid sewage from the precipitating tanks to the spoil banks adjacent to the building.

In all of the precipitating plants chlorine gas is generated each day and passed through the sewage being treated.

The excessive use of chemicals does not result in purification of sewage to any marked degree over a moderate use of same; in fact, as shown by W. J. Dibdin, F. I. C., F. C. S., formerly chemist to the London County Council, in his book on the purification of sewage and water, in experiments made by him with London sewage, considering a volume of sewage treated at 156 800 000 gal. per day, the expenditure of \$67 525 would result in 11% of reduction of cxidizable organic matter in solution, whereas the expenditure of more than \$4 000 000 for chemicals would result in a reduction of the percentage of 31% only.

It is evident from this that the use of a precipitation plant for the treatment of sewage, the effluent therefrom to discharge into a water supply stream, should not be tolerated; in fact, it is agreed among authorities that the only method of obtaining purification is by filtration. It is also agreed that purification is not obtained by

PLATE XXXVI. THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK. ASSERSON ON BROOKLYN SEWAGE DISPOSAL.



F1G. 1.



FIG. 2.

filtration unless the sewage is precipitated and clarified either by precipitation plants or by septic tanks, the clarified effluent to be deposited upon the filters. Crude sewage deposited upon filter beds invariably reduces them to a state of uselessness.

There has been a wide divergence in the result of experiments in the rapidity of filtration through filter beds made up of different materials varying from 60 000 gal. per acre, as obtained in the Massachusetts experiments, to 1 000 000 gal. per acre in the cities abroad. I am of the opinion that the latter standard can be safely used in contact beds of coke 3 or 4 ft. in thickness.

Mr. Dibdin describes one of a series of contact beds, which appears to me to present very acceptable features in its lay-out. I quote from his book describing said bed:

"Each series of beds will be served by main supply channels, 18 ft. and 16 ft. wide, with subsidiary channels, 6 ft. and 5 ft. wide, as required in the several cases.

"The latter are constructed with draw-off or pick-up channels of the same width below for economy of area and construction.

"The beds are, with few exceptions in each series, of uniform shape and dimensions, and the point of admission of sewage to each bed is in the center of the longer side adjoining the supply channel, which serves, as a rule, an equal range of beds on either side, so that in general the distributing centers fall in pairs opposite each other.

"Supply channels are of adequate width and gradient to permit of delivering the volume of sewage necessary for filling two beds at once on the same channel in the minimum required time by gravitation to each distributing center in the scheme.

"The supply to and discharge from each bed are radial, delivering from one center outwards over the surface, and converging towards the same center by the under-drainage below. The sewage is admitted from the supply channel to a distributing reservoir, from which it flows over a sill or weir of circular form, and thence along channels cut in radiating form over the surface of the bacteria bed. These channels are lined with fine grade material, which tends to arrest suspended matters on its surface, and retain them from entering into the body of the bed.

"The under-drainage of each bed is also laid out in radial form, the drainage lines converging into a main collecting drain, which is concentric with the distributing weir, and which communicates at each end with manholes, or at the center with an outlet well, from which the discharges enter the draw-off channel. "The under-drains are channels formed in the concrete bottom of the bed, covered with stoneware perforated slabs, set in rebates, so as to be flush with the surface of the bottom.

"The average depth of the clinkers forming the body of the bacteria beds is 3 ft. 4 in., each bed having a cross fall of $2\frac{1}{2}$ in., and the space between the radial drainage lines being formed with a ridge in the center to facilitate the discharge of the final drainage at the bottom.

"The body of the bacteria beds is composed of furnace clinkers from which the fine material has been removed by screening, and the coarsest material is used for covering more particularly the radial drainage lines, and also the concrete bottom as far as practicable."

The question naturally arises, if purification is to be obtained necessitating precipitation and then filtration, to what degree of purification should sewage be reduced to discharge into salt water? I am of the opinion that if the sewage is clarified to a degree of 11%, which is usually obtained, all solids and inorganic matter having been separated from the effluent, the said effluent appearing reasonably clear, that a result has been obtained which would permit a discharge of said effluent into salt water, but the cultivation of oysters should be prohibited until such reasonable distance had been reached from an outfall sewer as to insure oxydization by dilution.

Bearing the above in mind, let us refer to Plate XXXVII and analyze the territories of X and Y as to how they should be cared for. Let me first explain the system of these two territories, considered with the Twenty-sixth Ward, which I shall hereafter designate as territory S, as they have been laid down and adopted for drainage, and to compare several other methods in which drainage could be accomplished, then comparing these results with contact beds, septic tanks and sewage farms.

The storm water from Map X has been devised to flow into Fresh Creek Basin of Jamaica Bay, the dry-weather flow to be conducted to the system of sewers in Map S by a 48-in. main, and thence to Map S Purification Works, to be there precipitated.

The storm water from Map Y will flow into Paerdegat Basin, and the dry-weather flow pumped to the gravity mains of Map X, thence conducted to the East New York Purification Plant. Of course it is anticipated to enlarge this plant, to provide additional

PLATE XXXVII. THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK. ASSERSON ON BROOKLYN SEWAGE DISPOSAL.



pumping engines for same, and larger precipitation tanks when the territory becomes thickly populated.

The first cost of the entire system of Maps X and Y is estimated at \$4 107400.

It is also estimated that the maintenance charge for the treatment of sewage at the purification works will not exceed in five years to come \$74 000 per annum.

In order to make a complete comparison of this method and the four other methods which I will lay before you, it will be well to consider the three territories thickly populated, say, at 140 persons per acre, with a water consumption of 100 gal. per capita.

I will explain the other methods and their ultimate comparative estimated costs and estimates of maintenance.

Ultimate

Project 1 as above described. U Outlet sewers of Map X at the foot of Williams Avenue. Storm water into Fresh Creek Basin. Dry-weather flow to East New York Precipitation Works. Storm-water discharge of Map Y into Paerdegat Basin at Flatlands Avenue. Dry-weather flow pumped into gravity sewers of Map X, thence to Map S Precipitation Plant

Project No. 2.

Outlet of Map Y at Flatlands Avenue, also the greater part of Map X at same point, that is, the territory as far east as East Ninety-eighth Street. Storm waters to enter Paerdegat Basin, and dry-weather flow to be treated by Precipitation Works at outlet. A small portion of Map X territory to be conducted to Map S... *Project No. 3.*

The same as Project No. 1, with the erection of a Precipitation Plant at the foot of Williams Avenue, and eliminating the dry-weather flow to the East New York Plant......

Ultimate Cost. Maintenance.

\$4 870 900

\$517 000

4 808 400

438 000

4821900

BROOKLYN SEWAGE DISPOSAL.

Project No. 4.		
The sewers the same as in Project		
No. 1. The drainage of Map X to be		
treated in the Map S Precipitation		
Plant, the drainage of May Y to be	~	
pumped to the mains of Map T	$4\ 822\ 900$	390 000
Project No. 5.		
The same as Project No. 2, with the		
elimination of the Precipitation		
Plants, sewage from both areas X		
and Y pumped to gravity sewers in		
Мар Т	$4\ 472\ 900$	$278\ 000$

Comparing the above with the addition of contact beds, considering the acreage, required in each case the purchase of land, and the building of the beds in the only property available, low marsh-lands, also the fact that from said contact beds must be excluded all ground or tidewater to obtain nitrification, we find estimates of cost as follows:

Cor	ıtact	Beds.	Ultimate Cost	Ultimate. . Maintenance.
Project	No.	1	. \$13 153 900	$$617\ 000$
ű	"	2	. 12 557 400	538 000
"	"	3	. 12 861 700	628 000
"	"	4	. 9 629 100	$490\ 000$
"	"	5 (East New York beds).	. 7 304 100	378000

It is evident that the treatment by contact beds under any of the above projects is entirely too costly to be considered, although it is a fact that under any of the contact bed methods purification of sewage to discharge into Jamaica Bay would be accomplished. The same purification would obtain with septic tanks, although the item of maintenance would remain the same, as it would be necessary to pump the water from said septic tanks upon the contact beds, due to the necessarily low elevation of the outlets. The tanks would be necessarily low and their cost would be enormous, considering the fact that storage capacity, double that of the water consumption of the territories to be treated, would be required, in order that one day's discharge would have a period of settling and clarification of 24 hours.

If septic tanks were used, the natural consideration for the territories would be to locate one at the foot of Williams Avenue, the

other at Flatlands Avenue, for the clarification of crude sewage, the East New York Plant to be continued as a Precipitation Works for clarification.

In order to provide one day's storage for the territories X and Y it would be necessary to construct 66 tanks, 300 ft. long, 100 ft. wide and 7 ft. $2\frac{1}{2}$ in. high, and the purchase of at least 50 acres of ground whereupon to build them. I need but say that consideration along this line would not be feasible, when it is estimated that the cost to the city would be \$15 861 700, and that the ultimate maintenance would be \$628 000 per annum.

A sewage farm would be out of the question, from the fact that the only available territory would be marsh-land, with a depth averaging 5 ft. of mud and silt, unavailable for filtration, before sand would be reached. Even under conditions of the very best filtration land, the acreage to be purchased would be enormous. For instance, in Berlin 46 000 000 gallons per diem were filtered upon 11 542 acres in the years 1893 and 1894. Considering more favorable land, such as was proposed in the filtration of Baltimore's sewage, it was estimated that to dispose of 150 000 000 gallons of sewage per day it would require 5 400 acres of land. Upon this basis, taking the most favorable land conditions, it would require to treat the sewage of Maps X, Y and S, 3960 acres, an area almost four-fifths as large as the area to be cared for. No attempt was made to compute the cost to the city along these lines. The expense would be enormous in preparing the land, bearing in mind the removal of meadow mud, and also from the fact that the citizens would not tolerate sucha procedure. Besides, this large sewage farm, no matter how carefully prepared, would be useless during the winter period, when it would become a monstrous nuisance.

It will be seen that consideration necessarily had to be given to one of the five projects of precipitation plants, in order that the three territories, X, Y and S, should have clarified effluents entering Jamaica Bay. At first glance it would appear that Project No. 5 should have been adopted; after that, Project No. 4, on account of 5's lesser cost, and the lesser ultimate maintenance cost of both Σ and 4, but other items are to be considered.

In the first place, it would not be well to conduct too many gallons of sewage to New York Bay through Sixty-fourth Street, or

BROOKLYN SEWAGE DISPOSAL.

cxydization by dilution would not be efficient; therefore the city might, at some future day, be compelled to erect a precipitation plant, at great cost, to care for the volume of sewage discharged.

In the second place, the annual maintenance charge would be greater than under any project set forth.

In Project 5, 76 000 000 gallons per diem extra would be conducted to New York Bay. In Project 4, 45 000 000 gallons extra.

Project 1 was deemed the most advisable, from the fact that the citizens of Map S had paid for their precipitation plant by assessment, and its use should not obtain by other territories, excepting something was given to Map S in return for the usage of the plant. This will be accomplished in the following manner.

There now exists from the purification plant to Jamaica Bay a wooden flume as an outfall sewer, so constructed for economic purposes. If the territories of both X and Y use this plant, twothirds of the cost of the replacement of this flume by a permanent brick outfall sewer will be borne by said territories. To replace this flume will cost, with additional settling tanks and pumping plant necessary, \$768 000. The citizens of East New York will be saved the expense of more than \$500 000 and all territories placed in equity as to cost for these sewage systems.

The most important consideration from a standpoint of farsightedness was that eventually 'all precipitation plants would be removed from the city, considering the impossibility of purification of the clarified effluent from them by contact beds, sewage farms or septic tanks, due to extreme cost, and that the ultimate solvement of the problem would be by the dilution method, even to the extent of carrying a force main across Jamaica Bay and extending same into the ocean to such distance as would insure purification by this method. Such being the case, each territory would have its storm outlet. The pumping of sewage from Map Y into Map X would be discontinued, and the sewage therefrom pumped through a force main to a junction of the force main from the Map S plant, thence with one main to the Atlantic Ocean. The cost of installation of these force mains would be considerable, but the method would be practical. If this is accomplished, as I believe will be the final result, the maintenance charge to the city will be reduced to about \$216 000 per annum.

DISCUSSION.

MR. OTTO HUFELAND, Member of the Society.—In Manhattan the conditions are different from Brooklyn and our work is therefore of a different nature. Our sewerage areas have outlets into the rivers, and consequently no other method of disposal than by gravity into tidewater has been necessary or even seriously discussed. Of course, all kinds of propositions have been made by people more or less informed, one man even proposing that we place floating tanks at the end of each of our outlets, and, when filled, that they be towed out to sea and dumped.

There are about 160 outlets into both rivers, draining areas ranging from $1\frac{1}{2}$ to 700 acres, which cover all kinds of sewerage districts, from the most thickly populated in the world on the so-called east side to the sky-scraper district on the lower end of the island.

One of these large outlets at Clarkson Street, draining 468 acres of practically impervious territory, we have lately rebuilt, and, like all the other large outlets, it is carried some 600 ft. out under a great pier, where it empties into the strong current and deep water. This one is a heavy box sewer 8 ft. 2 in. wide by 5 ft. 6 in. high, but most of our outlets under the piers are barrels, built up of staves, held together by iron bands passing around the sewer every 4 ft.; some of these have been in use nearly twenty years, and are still in good condition where they have not been shaken to pieces by heavy boats running against the piers, causing them to sway enough to break the sewer. Formerly these sewers were built in sections about 20 ft. long and floated into place under the pier and fastened.

Now we build them continuous and in place, laying the staves so that they break joints every 4 ft. under the iron bands which keep them together. These barrels are of creosoted wood and withstand the weather well, and, after being used a short time, become very smooth; in fact, they are often so slippery that it is dangerous for the men to go into them without having a rope fastened to their bodies. We have no gates of any kind, our efforts being directed to securing a flow as uniform as possible to the end of the pier, which is generally difficult on account of the flat grades and the great submersion of our outlets.

I should like to hear from the Bronx members something about the disposal works used in their borough. Where I live we are having an interesting discussion about a big sewer scheme through the valley of the Bronx River, which is to be drained through a long tunnel into the Hudson River, just north of the city line. Perhaps some of the members from the Bronx can tell us of a plan for a similar tunnel which was to drain part of their borough.

MR. EDWARD L. HARTMANN, Member of the Society.—In 1902 Borough President Haffen of the Bronx had some preliminary work done and studies made with the view of draining the eastern section of the borough to the Hudson River, by tunnelling under Woodlawn Heights and the hill east of Riverdale.

The intention was, I believe, to take in also, at least in part, the drainage of the Bronx valley and other districts lying north of the eity line.

Major E. F. Austen was in charge of this preliminary work and ran two lines: one beginning at the Hudson River and Two Hundred and Forty-seventh Street and crossing Woodlawn Heights at the Gun Hill Road, and the other beginning at the Hudson River and about Two Hundred and Fifty-sixth Street and crossing Woodlawn Heights at about Two Hundred and Fifty-third Street.

The project, so far as I know, has been abandoned and it is now proposed to drain the eastern section of the borough to the Long Island Sound, as it has been found that by this plan the cost will be materially less.

MR. NELSON P. LEWIS, President of the Society.—But they do propose now to relieve Webster and Brook Avenues?

MR. HARTMANN.—At about Wendover Avenue, tunneling under Claremont Park and crossing the valley near Inwood and Jerome Avenues in open cut; then again by tunnel to a point on the Harlem River just north of Highbridge. This work has been rendered necessary in order to relieve Brook Avenue outlet sewer of some of its drainage by providing an overflow, especially in times of heavy rainfall. More territory is now drained into this sewer than it was originally designed for, as, for instance, at Bedford Park sewage is taken in which has been carried across the Bronx valley from Williamsbridge. I believe that the plans for this tunnel are almost complete, and the contract is to be let in the near future.

MR. EDWARD WEGMANN, Member of the Society.—As I live in White Plains, in the Bronx Valley, I can give a little information about the proposed trunk sewer for this valley, which has been mentioned by one of the speakers. This sewer is to chain White Plains, Mount Vernon and part of Yonkers. A commission, consisting of the mayors of the three places named, is preparing a bill authorizing the construction of the proposed trunk sewer, which is to be introduced in the Legislature during the present session.

For some years White Plains has been disposing of its sewage by chemical precipitation, the effluent from the works being discharged into the Bronx River below White Plains. This has pol-

luted the river to such an extent that suits have been brought on this account against White Plains, and have been decided in favor of the plaintiffs. The courts have granted White Plains two years' time in which to introduce some better method of disposing of its sewage. Besides polluting the Bronx River, the present sewage works cause, at times, an odor which is very offensive to those residing in the vicinity of the works.

Whether the best thing for White Plains to do is to assist in the construction of the proposed trunk sewer is still an open question. Such a sewer could not be built in the time granted by the courts; would probably cost more than estimated, and might create a nuisance at its outlet in the Hudson River, which might lead to further suits. The construction of the proposed trunk sewer for the Passaic Valley has thus far been prevented by legal proceedings on account of the nuisance it might cause in the harbor of New York, and the Bronx Valley sewer might experience a similar fate.

Chemical precipitation is one of the earlier methods of sewage disposal and gives a purification of only about 85 per cent. Better results are obtained by some of the new methods, such as septic tanks and contact beds, intermittent filtration, etc., which have been introduced in many places. Some method of this kind may be cheaper and safer, as regards lawsuits, for White Plains to adopt than the construction of the costly trunk sewer.

A MEMBER.—I would like to ask if there is any bad odor in connection with the plants in Brooklyn?

THE AUTHOR.—No, sir; there is no bad odor. The sewage is pretty well precipitated. I would say clarified, but not purified. I doubt if we obtain a purification of more than 11 per cent. There is a slight odor occasionally in the tanks at the houses, but that is taken away by disinfectants. I really believe the only way you can purify sewage is (as in the purification of water) by filtration. The method is costly and would be very costly to Brooklyn, from the fact that the available lands for the filtration beds to be built upon would necessitate great expense per acre in preparation; that is, a concrete bottom and concrete sides would be necessary for each contact bed to prevent the ground-water or tidewater from entering them, the beds under this condition becoming a nuisance. The contact beds must be filled with the precipitated sewage alone to secure nitrification.

MR. LEWIS.—I would like to ask Mr. Asserson a question. Referring to the disposal of the Flatlands sewage, you spoke of pumping the dry-weather flow across Flatlands Bay to the swift waters of Rockaway inlet; would you pump all the time, on the incoming as well as the outgoing tide?

THE AUTHOR.—Yes, pump all the time.

MR. LEWIS.—Would you find yourselves in conflict with the State Board of Health? Your sewage would certainly be carried back into the bay by the incoming tides.

THE AUTHOR.—In our plan we carry this out to just beyond the Rockaway inlet. The point of discharge is just beyond the point where the tide would not bring the sewage back. That point was determined by a series of experiments with floats. There was a suit against the city in that connection; for sewage discharge was brought back into the bay from a sewer outlet at Flatbush Avenue by the tide. They used a number of floats, and, after carefully watching them, it was found where a safe point to discharge sewage to prevent its return would be.

MR. FREDERICK WILCOCK, Member of the Society.—I beg permission of Mr. Asserson to call his attention to another case of bad odors. The sewer outfall at Seventy-ninth Street and New York Harbor is upon the beach, and the winds bring a stench ashore, a nuisance which is the only objectionable feature of that attractive locality. As the water front is under the control of the Park Department, I am at a loss to know who is responsible for the present construction, and should be glad to learn that the Sewer Department intends to carry the sewer outfall into the tidal stream, thus to abate the nuisance.

THE AUTHOR.-It certainly has this intention. It has been authorized by the Board of Estimate to do so, and has contracted to extend the existing sewer from the beach line to and out beyond the bulkhead line. It would be quite interesting to explain why that outfall sewer was not built in the beginning. It was the first sewer built in that section—in the new section of the city—and when it came to building the outlet, jurisdiction troubles arose. Jurisdiction was claimed by the Park Department, also by the Dock Department, over the piers through which sewers would be built at that location. Our argument was to build this sewer while they were fighting to ascertain who had jurisdiction. The mere construction of the sewer itself to the beach line only would soon bring this out. It resulted as we anticipated. After the sewer was built a nuisance was created and the outfall was authorized. Decision was given to the Park Department. The only way we secured consent then was in using a little diplomacy. In authorizing that sewer they wanted no piers at that location, so we got up a sketch of a recreation pier at the foot of Seventy-ninth Street, showing the sewer running through and under the recreation pier, flags floating on it, and all that business. It took the Commissioner's eye immediately and permission was granted. There was no necessity for a recreation pier there, because the whole shore front from Sixty-fourth Street down to Fort Hamilton was a park. 922

That outlet is being built now. The contract was registered by the Comptroller only about four weeks ago. Notwithstanding that, we ordered the contractor to go ahead in the winter weather. He can drive piles and do considerable work in the winter time. The nuisance will soon be removed.

MR. LEWIS.—Will not the outlet of your great Ninety-second Street tunnel have to be carried some distance out from the shore in order to reach the swift current?

THE AUTHOR.—That is also carried from the shore some 400 ft. MR. JOHNES.—I would like to ask one question in regard to one of those schemes for carrying the sewage through the divide; would the tunnel as now constructed be large enough to accommodate the additional 75 000 000 gal. from X and Y?

THE AUTHOR.—I think so. That is for the dry-weather flow. Of course, it will be at a very remote date, and considering the territory populated at 140 per acre and the water consumption at 100 gal. per capita.

MR. LEWIS.—When you spoke of Project No. 5, Mr. Asserson, as requiring treatment, did you have in mind the ultimate treatment which would be required when the volume of sewage becomes so great that even New York Harbor would not give the necessary dilution? You would pump your dry-weather flow from what you called both X and Y, both over to T? I assume that no treatment will be necessary until you pass beyond the point where the waters of New York Bay will not sufficiently dilute the effluent.

THE AUTHOR.—That was the point exactly.

MR. LEWIS.—It might not be needed for many years?

THE AUTHOR.—No; but if it was, when that time came it would require an enormous amount of property and you would entail a maintenance charge reaching up perhaps into the millions of dollars. That was the trouble with maintaining sewers that discharged into the Thames; they expended \$20 000 000 to carry the mains down from London, down the river to the precipitation plants, and then merely clarified the sewage. The nuisance is removed; that is, the nuisance to the eye-sight.

MR. HUFELAND.—As to the number of pumping plants there, how small is the smallest pumping station in Brooklyn? How many gallons does it pump? The smallest and largest?

THE AUTHOR.—The smallest station pumps about 1 000 000 gal. All these estimates are given from a standpoint of built-up territory. The pumping plant, as I said in the beginning, would probably cost \$74 000 for maintenance per annum for five years to come. Ultimately it would cost \$517 000 to maintain.

MR. HUFELAND.—How high does that force the water? THE AUTHOR.—Not over 10 ft.

MR. HUFELAND.—Not over 10 ft.? Approximately, what does it cost to pump 1 000 000 gal. 10 ft.?

THE AUTHOR.—It would cost about \$2 000 per 1 000 000 gal. pumped each day for a year; that is, considering electrically-driven pumps.

MR. HUFELAND.—How do you think that would vary by pumping, say, 50 ft.? How much would that increase the cost?

THE AUTHOR.—I would not like to answer that question directly. I know we computed in this 30-in. main that there would be practically no friction in a head of 10 ft. with a 30-in. main. I based my computations on electrically-driven pumps. I used 4 cents per horse-power-hour.

MR. HUFELAND.—I meant raising the sewage over a hill 50 ft. and letting it run down on the other side by gravity where you go from one map to another.

MR. ARTHUR S. TUTTLE, Member of the Society.—I believe that there would not be a large increase in the cost. It seems to me probable that the duty might be, say, three times greater with a higher lift, in which case the total cost of coal would be increased 66 per cent. There would be little increase in the force; repairs and supplies would be increased somewhat, but by no means in proportion to the increase in lift; interest and sinking fund charges might be doubled. I believe that the total cost would be from 75 to 100% more, although the increase would be contingent upon the character of the equipment.

I would like to ask Mr. Asserson whether his estimate includes every charge, such as sinking fund and interest on the plant, or whether it is limited to supplies, repairs and salary?

THE AUTHOR.—It takes in everything. I did think at one time to make it \$3 000. I would rather be a little high.

MR. TUTTLE.— On the basis of 4 cents per pump horse-power-hour, the cost of pumping 1 ft. 1000000 gal. 10 ft. high would be about \$600 per year. A quotation of \$2000 per year per 10 ft. 1000000 gal. daily corresponds with a rate of about 13 cents per pump h-p-hr., or about 55 cents per ft. 1000000 gal. This is expensive pumping, and, on the basis of reduction of cost per foot 1000000 gal. between a lift of 10 ft. and a lift of 50 ft., it would make the cost with the higher lift about 20 cents per ft. 1000000 gal., which is still very high. I believe that there would be no difficulty in pumping the required volume of sewage to a height of 50 ft. at a cost of not more than 7 cents per ft. 1000000 gal., or even less. It is possible that chemicals are included in the cost given by Mr. Asserson.

THE AUTHOR.—No; the chemicals and pumping would cost about \$4 000 per year. It is also based on the fact that the laws of

the State of New York require an eight-hour day. For instance, we could have one engineer and one fireman and let the fireman run the pumps, but in the City of New York we must have three engineers and three firemen for each shift of the day all the way through.

MR. TUTTLE.—There is one item that always comes in that is difficult to determine, unless a weir or a meter is connected with the plant, and that is the volume pumped. I would like to ask Mr. Asserson how he estimates the amount of pumping?

THE AUTHOR.—I estimate the amount of pumping from the water consumption.

MR. TUTTLE.—How about subsurface water?

THE AUTHOR.—That did not enter into the consideration.

MR. TUTTLE.---I think it would have a great influence on the record. All of these sewers I believe are low, and at least partly below the ground-water level. I was once called upon to investigate why it was that such a large volume of water had to be pumped at one of the Coney Island caissons. This was shortly after it had been turned over to the town authorities by the contractor. Ι measured the flow and found it to be many times the consumption. A short time afterwards the contractor endeavored to find the cause of the trouble, and started to uncover the pipe so that the joints could be examined. Cement pipe had been used, and it was found to be badly disintegrated; in fact, the line had entirely disappeared in sections, and most of the work done at the station up to that time consisted in pumping salt water from the adjoining bay. I should say that this work was done before the district was annexed to the city, and that it was not under Mr. Asserson's jurisdiction.

THE AUTHOR.—That is a fact in our Sheepshead Bay plant; a good many defects have been remedied there, but it still leaks. We pump about 3 000 000 gal. per day there. It should not be over 1 000 000.

MR. LOUIS L. TRIBUS, Member of the Society.—I was very much interested in Mr. Asserson's prophecy, that we will probably see a large portion of the sewage of Brooklyn and some of the other districts mentioned pumped across Jamaica Bay to the ocean. It may be somewhat a matter of interest to members here to-night to learn that for about two years the New York State authorities have been invesigating the sewage conditions of New York Harbor and vicinity, in connection with the probable injury that will be done to the harbor by the great New Jersey Passaic Valley trunk sewer if it should be built as proposed.

Our investigations have been conducted along various lines, chemical, bacteriological, tidal and sewage flow. At the present time there are probably upwards of 450 000 000 gal. of sewage enter-

ing New York Harbor daily, taking in the East River, both sides of the Hudson to the Yonkers line, both sides of New York Bay, and the sewage through the Kills coming from New Jersey. It is a decided question how great a power the waters of New York Harbor have to assimilate further quantities. There are places now where perhaps a few gallons more will turn the scale from a point where it is not offensive to one where it will be decidedly so. This is going to be one of the problems of New York City, and I will say more than New York; for a portion of New Jersey as well, in what might be called, perhaps, the metropolitan district, including Newark, Jersey City, Bayonne, Hoboken, etc.

It seems certain to many that the ultimate end to be reached and one that perhaps some of us may see, will be collecting the dryweather flow and sewage in interceptors from practically the whole of New York City, the opposite shores of New Jersey, and the Hackensack and Passaic Valleys, and conducting it by a great trunk outlet to the ocean. I believe that that is coming, and our studies for two years past seem to be pointing that way. The present sewage outlets are scattered all along the shores: some deliver in large quantities and some in small quantities, but any day may turn the scale from a present non-nuisance to a condition of decided danger, and so I was very glad to hear that partial prophecy of Mr. Asserson's as a condition that is being looked forward to seriously for **a** part of the city at least.

The different purification systems are practically out of the question for the City of New York, because it is going to be impossible to secure sufficient land to use in connection with any complete disposal or utilization plant. Chemical systems only postpone the putrification, and it is putrification that accomplishes the purification; perhaps oxidation would be a little pleasanter word for the process. As has been said in other discussions here, the percentage of purification by the chemical process is practically nil: it simply postpones the action, which will take place wherever the effluent passes. If it goes into tidal water the currents would probably care for it for a while, and it would not be, of course, as offensive as untreated sewage, because of removal of most of the solids. Sewage from septic tanks alone, without contact beds, would scarcely be a safe product to turn into any waterway, unless there were unusually strong outgoing tidal currents. The tidal currents of New York Harbor are such that it would theoretically take sewage deposited at the Battery at least five days normally to get outside of Sandy Hook under favorable conditions; it would get down part way and come back, ebbing and returning, but each day getting out a little further. There are some, however, of those who have investigated the question, who are not so optimistic, but consider that none of the sewage will ever reach the ocean by ordinary tidal action, consequently the harbor would be in time an immense cesspool. Probably a compromise between those opinions would be fair, but, at all hazards, the question is one of serious import.

MR. LEWIS.—I would be glad to hear from Mr. Tribus on the larger phases of this problem. You doubtless all know that as a member of the Newark Bay Commission he has given a great deal of study to this matter, but I hoped that he would touch upon a phase of the problem nearer home.

MR. TRIBUS.—On the easterly side? No, it is very deep water and has channels within reach of the piers; on the southerly but less densely populated side the waters of the lower bay are quite shallow.

The conditions in Richmond give us no trouble at all. Almost all of the drainage areas are small. I think the largest, with the exception of some of the salt marshes, will be probably eight square miles in area and the topography is so hilly that the sewers can be of comparatively small diameter. Probably for many years to come Staten Island's sewage can all enter tidal water and be carried by the swift currents, but I think that the time will come when even that sewage will all be collected by interceptors and be conducted also to the great metropolitan trunk ocean sewer.

MR. JOHNES.—I would like to inquire if the rate of purification obtained by chemical precipitation is only 11%, whether it is sufficient to justify the cost of the plants?

THE AUTHOR.—It perhaps does result in New York's benefit to the extent that the crude sewage is not discharged into Jamaica Bay, flowing back on the meadow lands and resulting in suits against the city. As I said before, the effluent looks clear. The inorganic matter is settled and there is 89%, say, of organic matter held in solution, but this is very deadly. Of course, the question answers itself; that is, if 11% only is the purification obtained, it is obvious that little is gained in this direction.

MR. WISNER MARTIN, Member of the Society.—I would like to ask Mr. Asserson if he would be kind enough to explain the comparative economy and efficiency of the two designs that he mentioned for the precipitation plants, the one at East New York and the one at Sheepshead Bay. In the East New York precipitation plant the crude sewage went into the outside tanks first, and in the other it went into the inside tanks first. What is the difference between them, practically?

THE AUTHOR.—Well, the only difference is that the pumps in the East New York plant lift the clarified sewage to the outfall sewer, and in the Sheepshead Bay plant they lift the crude sewage to the tanks on the upper floor. The arrangement is reversed in the one, *i. e.*, the sewers in Sheepshead Bay discharge into the

inner well and the crude sewage is lifted into the tanks on the floor level. In the East New York plant it is discharged into tanks at low level, siphoned into the well, and then pumped to the outfall sewer.

MR. MARTIN.—I understand that, but, from the results you have had, which do you think the better design? Has one worked easier or cheaper than the other?

THE AUTHOR.—The one at East New York is by far the best.

MR. MARTIN.-What advantage has that over the other?

THE AUTHOR.—It has the advantages that Mr. Tuttle brought out of building a sewer at a very low level you find leakage from the bay. In the Sheepshead Bay plant the leakage came from the inlet pipes being at a very low level, taking the water from the marsh lands through which they ran. In fact, I have heard—and I have no doubt it is a fact—that they dug up about 1 000 or 2 000 ft. of this pipe down in that location.

MR. LEWIS.—The degree of purification is about the same at both plants?

THE AUTHOR.—Yes. We obtain practically the same result as they do in London and Manchester. It is something to please the evesight; that is about all.

MR. MARTIN.—Is it easier to handle the sludge from the inside tank?

THE AUTHOR.—Yes, from the plant that I described as the East New York plant. At one time we mixed sawdust into the sewage to form a matrix, but it was found, after the tanks had been closed and the siphoning ceased into the well, it left a good deal of liquid matter. This is pumped now by centrifugal pumps to the spoil banks until you get down to the heavy sludge. Then they shovel this into the cars and wheel them to the elevators to be raised to the upper floor to be discharged in the spoil bank.

MR. MARTIN.—Is there much difference in the maintenance cost between the two?

THE AUTHOR.—The maintenance cost for the three plants at Coney Island is about the same as the East New York plant. They pump about 5 000 000 gal. at the Coney Island plants. In fact, the Coney Island plant is a little more expensive, but from the fact of employing three engineers, three firemen and three stokers, and so on, to satisfy the civil service laws of the State. For instance, at one plant where were pump not quite 1 000 000 gal. a day, we had one engineer, who lives near the place, and we got along with one engineer and a couple of firemen for years. We have now three engineers and three firemen.

MR. MARTIN.—Is the capacity of Sheepshead Bay and East New York about the same?

THE AUTHOR.—No, the Sheepshead Bay plant would probably not care for more than it does to-day, and a good deal of that is tide-water. The capacity of the East New York plant is about 20 000 000 gal. We pump now, however, about 8 000 000 gal. per diem.

ADDRESS

医血管的 医颈骨骨的 医胆管

ere the Caro

Mr. Nelson P. Lewis, President of the Municipal Engineers of the City of New York.

PRESENTED AT THE ANNUAL MEETING OF THE SOCIETY, JANUARY 25TH, 1905.

The Constitution of the Municipal Engineers makes it incumbent upon me to address you in a general review of the progress of the Society and of municipal engineering work in New York City during the twelve months last past. They have gone by so quickly and great engineering undertakings move so slowly that it is necessary to consult memoranda or look over the last annual address to see what has been accomplished during that time, or note what was omitted in that cursory sketch.

First, as to our Society: A year ago our membership was 306. At the present time it is 345. This does not show a very large increase, you will say. That may be true, but, as was remarked a year ago, the proportion of those eligible for membership who joined us during the first year was remarkably large. I feel justified in saying, however, that the Society is much stronger than it was at this time last year. Those who have attended our meetings have been much impressed at the number of members present, the high character of the papers presented, and the spirited discussions which they have brought out. There have been no failures on the part of the Publication and Library Committee to provide an attractive programme for each meeting, while that Committee succeeded in publishing our first volume of proceedings in most creditable form and at an actual profit to the Society. The House Committee has contributed to the attractiveness of these meetings by the excellent collations it has provided.

The Society has secured comfortable rooms, which have been made attractive and homelike by the same Committee, while the Publication and Library Committee, through the enthusiastic work of a capable sub-committee, has installed in these rooms an excel-

\mathbf{OF}

h

lent beginning of a technical library and has provided a generous supply of engineering and other periodicals. I have been recently assured that our Society will be given the space for which it applied in the Carnegie Union Engineering Building. The architects are now employed in the planning of the rooms for the three national societies in whose custody the building is to be placed, and as soon as this has been done the remaining space will be allotted.

During the year the Society has authorized the appointment of three special committees, one to investigate and report upon the differences in datum planes used by the various departments in different boroughs, one to investigate and report upon standard forms for data regarding asphalt pavements, and the other to consider and report upon an uniform system of sewer design in the five boroughs. The first named of these committees has collected a large amount of information, and expects to submit a report in the near future.

It has been suggested that the membership of the Society could be materially increased and the sphere of its influence enlarged if engineers engaged in what might be called municipal work, but who are not in the service of the city, were made eligible to membership. Municipal engineering is a very comprehensive term. Many of the technical men in the employ of the various public service corporations, or who are engaged as contractors in the construction of work done under your supervision on behalf of the city, are certainly municipal engineers who would be valued additions to our numbers. In organizing the Society, however, it was limited to men in the service and pay of the City of New York, and it may be wise to so restrict its membership until it is more firmly established.

You who attended the Annual Banquet, held a fortnight ago, will appreciate its success. Our guests on that occasion were unanimous in their expressions of surprise at the rapid progress of the Society, their approval of its aims, and their confidence in its influence for good upon the city, as well as upon the profession.

In looking back upon the engineering achievements of the past year, the most conspicuous event will be conceded to have been the successful opening and operation of the municipal Rapid Transit Railroad. This great engineering work has attracted the attention

cf the civilized world. Our city has long looked forward to the day when it would have real rapid transit. For a work of such magnitude and involving such difficulties, it has been completed in a remarkably short time. Thoroughnes in every detail has characterized it. The organization of the engineering force engaged in carrying it out will doubtless be a model for future enterprises of a similar nature. Disputes and controversies with the contractors have been conspicuously absent. The congratulations of this Society are due, and I will assume the agreeable responsibility of offering them, to the engineers engaged upon this great work, so many of whom are valued members of our organization.

Recognition of the engineering profession has never been more freely given in municipal government than during the past year. The Mayor of this city has invariably shown a disposition to recognize the value of technical advice. Late in 1903 the Board of Aldermen authorized the creation of a commission to consider and report upon a comprehensive plan for the development of the city, a plan which should take account of the enormous increase in population and business now taking place and which will follow closely upon the extension of the Rapid Transit system and the improvements in progress by transportation companies. This commission was named by the present Mayor, and includes the Chief Engineers of the Department of Bridges, the Department of Docks and Ferries, the Board of Estimate and Apportionment, and the Landscape Architect of the Department of Parks. I venture to say that the inclusion of these engineers in a commission of this kind would not have been thought of a few years ago. The commission has submitted a preliminary report outlining various plans which it has had under consideration, but making no specific recommendations. A further report will be made during the present year.

The demand for what are known as local improvements in the different boroughs has been great, though not so emphatic as during the two preceding years, which followed the four years of comparative inactivity succeeding consolidation. About four millions of dollars a year seems to be a fair estimate of the average annual cost of assessable improvements in this city. During the past year the value of such improvements authorized has been, in round figures, as follows:

Manhattan	$473\ 500$
Brooklyn	1439000
The Bronx	1488500
Queens	665 500
Richmond	90 000
Total for the city	\$4 156 500

As already intimated, Municipal Engineering, in its broad sense, does not only apply to the construction work incidental to sewers, pavements, docks, water supply, bridges, lighting, transit, parks, etc., but it should take account of all the structures which go to make up the modern city and the physical characteristics which make it beautiful or ugly, healthy or unsanitary, dignified or trivial, stimulating to our civic pride or prompting apology to our visitors. We have been shown during the year how the work done by members of this Society for the Board of Education has made the buildings of that department, as well as its curriculum, contribute to the uplift of the city and its people. Your attention was called in my former annual address to the vast improvements being made by the Pennsylvania and the New York Central Railroads in the construction of great terminal stations. An admirable illustration of the education of the public taste for more creditable structures and the responsiveness, even of railroad companies, to this demand is furnished in the revised plans of the New York Central Railroad Company for their terminal station, which have recently been submitted to the city officers for their approval. The original plans contemplated the erection of a station building which might prove profitable to the company by its use for other than station purposes, and it was proposed to include in it a hoted, a theater or other place of amusement, offices for rental, and possibly a large department store or a series of shops. In fact, the station was to be a huge building, which would represent a maximum of earning capacity by the rental of space not needed for railroad purposes. Upon more mature consideration, however, the Railroad Company has decided to erect a monumental building which will be one of the most notable additions to the architecture of the city, and which will be nothing

but a great railway station for the accommodation of the public. In order to give such a building a proper and dignified setting, it is proposed it place it 40 ft. inside of the building line of Fortysecond Street, and 70 ft. within the easterly line of Vanderbilt Avenue, thus relinquishing to the use of the public an area equal to twenty-five city lots, each 25 by 100 ft. in size, the value of which for profitable commercial development would be very great.

Another evidence lately given us that public service corporations are manifesting a willingness to voluntarily assume large expense for improvements which neither the city nor the State could compel them to undertake is the recent action of the New York, New Haven and Hartford Railroad Company in planning to convert its Harlem River Branch into a modern six-track, electrically operated railroad, and to eliminate every grade crossing along its line within the limits of the city. The situation has been a peculiar one. Many of the streets crossing this line did so at grade. To carry them over or under the railroad would have involved the depression or elevation of their tracks, as well as the raising or lowering of the streets. Numerous complaints of these dangerous crossings had been received, and it was realized that the impossibility of carrying additional streets across the tracks was retarding the development of the adjacent territory. Had the city taken the initiative in their elimination, it could have proceeded only under the existing gradecrossing law, under the provisions of which the city would have been obliged to bear one-half of the expense. As the readjustment of the railroad grades on both sides of a crossing is held by the Railroad Commission to be an expense which must thus be shared by the company and the municipality, and as the crossings were not far distant from each other, the city would have been obliged to pay half of the expense of the entire change in the railroad grades, which would have been enormously expensive. In the proposition of the New York, New Haven and Hartford Railroad Company, consent was asked for the discontinuance of a short portion of one street, for slight changes in the grades of several other streets (the changes being in all but one case limited to a few inches), and the Railroad Company offered to pay the entire expense, not only of the changes of its track grades, but also of the building of the bridges over all
existing streets and such other streets as may hereafter be opened, and to pay all damages for the closing of the street above mentioned, to which the courts may determine the property owners affected to be entitled.

The combination of companies which control the lighting of the public streets; parks, buildings, etc., have not been governed by so wise and liberal a policy. Having an absolute monopoly of this business, they have endeavored to exact such terms that the city has been obliged to consider the building of a plant to do its own lighting, and a commission of three has been appointed to prepare general plans, specifications and estimates for such a plant, and, although it is held that the city already has power under its present charter to embark in such an enterprise, legislation is asked for which will render this right unquestionable and prevent interference with the work by a so-called taxpayers' action.

But you will say that I am devoting my attention to broad questions of city administration and of public policy, which lie outside the domain of the municipal engineer, instead of dealing with the engineering problems of construction and maintenance of municipal work. This may be true, and my excuse is that a general review of existing conditions and an appreciation of the expansion of municipal functions and activities which are being brought about by the phenomenal growth of the city is both timely and pertinent. I do not propose to discuss the wisdom or folly of municipal ownership or operation, or both, of the various public utilities. These questions will be determined by publicists and by an intelligent public opinion. This city has already made its first venture in a conservative degree of municipal ownership by the construction of our Rapid Transit Railroad, and, if public opinion is correctly interpreted by the press, it is desired that, in future extensions, the public control shall be rendered more direct by building first, and leasing afterward, under contracts running for much shorter terms than those granted the contractor for the sections now in operation or under construction.

have the opportunity to discuss the more technical side of municipal work. There are two features of this work which are so conspicu-

-183

ous as to demand notice. The City of New York has not heretofore thought it necessary to filter its public water supply, except a very small part of that used by the Borough of Brooklyn. The Commission on Additional Water Supply has, however, strongly recommended the filtration of the entire supply, not only that taken from the Croton Valley and from Long Island, where the population is becoming so considerable as to render pollution likely, but the additional supply which may be taken from new territory on either side of the Hudson, which is now very sparsely settled. The Chief Engineer of the Aqueduct Board has recommended that work be suspended on the easterly section of the Jerome Park Reservoir, and that the plans be so changed as to convert it into a covered reservoir, from which filtered water may be distributed. The Commission on Additional Water Supply has cordially approved this recommendation, and it is quite probable that the change will be made. The adoption of such a policy will materially increase the cost of supplying water to the city, but it will place its quality above suspicion.

The other subject to which I referred is the increasing use of concrete instead of stone masonry. Those who have examined the platforms and stairs of the subway stations have been impressed with the great economy, as well as the satisfactory results, attained in its use for these purposes. In the Brooklyn Extension, concrete is being used to a greater extent than in the first contract. Construction is facilitated and both time and money are saved by its use. In this country we have been slower to recognize its advantages than have the French and German engineers, but the increase in its use in the future will doubtless be very great.

Reference was made a year ago to the triangulation of the City of New York under a plan of co-operation between the City and the United States Coast and Geodetic Survey. This work has been in progress during the past year, and very satisfactory results have been attained, notwithstanding the difficulty attending the making of observations in a great manufacturing city. These difficulties are forcibly shown by a statement of the number of days of each month during which observations could be made. In 1903 they were as follows: August, 6; September, 11; October, 5; No-

vember, 9; December, 3. During the year just past the record is about the same, namely: January, 5; February, 8; March, 9; April, 9; May, 12; June, 16; July, 11; October, 6; November, 6; December, 3.

During the month of August no observations were made, as the parties took their vacations during this month, one-half during the first two weeks, and the other half during the remaining two weeks. In September, the entire force was occupied in laying out, staking and measuring the Ocean Parkway base. The Coast and Geodetic Survey has given every assistance possible to the city in the prosecution of its work, having placed at the disposal of the party the observing theodolites, heliotropes and some other instruments needed on the work. Most of the observations were made with a 10-in. repeating theodolite, made by Gambey, of Paris, some thirty or forty years ago, but which had been regraduated by the Coast and Geodetic Survey. It has steel spindles, and is read by two verniers to 5 seconds. The telescope has an objective of 2 in. clear aperture. Another instrument of the same make and size was furnished, but it was found more diffcult to use with good results by one not accustomed to it. We were also furnished with a 6-in. theodolite recently made in the instrument division of the Coast and Geodetic Survey. This instrument has glass-hardened spindles, and the telescope tube and the upper works are of alumi-The axis extends below the leveling screws and stand, while num. the stand and the outer covering of the axis is of bronze. This method of construction lowers the center of gravity and increases the stability of the instrument, while the light upper portion reduces the friction on the centers to a minimum. It is read by two verniers to 10 seconds. The points from the platforms of the observing towers were transferred to monuments beneath by a vertical collimator, also furnished by the Survey. This is a short telescope with cross-hairs in its diaphragm, mounted vertically, with a very delicate level. The observer, looking down the telescope, can fix the point on the bolt set in the monument directly beneath the telescope, while transferring a point of observation from a platform 70 ft. or more in height by the usual mechanical methods is exceedingly difficult. The heliotropes used were of two kinds,

wooden and telescopic, and were mounted on tripods like those used for the theodolites. The city purchased two (2) Buff & Berger 7-in. transits reading to 10 seconds, which were used for measuring angles at a number of the secondary stations. While made in accordance with the Coast and Geodetic Survey specifications, I am advised that they were not entirely satisfactory, being top-heavy, and, the weight resting on very short brass spindles, the plates turned with difficulty and with too much friction for fine work. The results obtained with them were not equal to those of the 6-in. theodolite furnished by the Survey, while they were much larger and weighed about twice as much as the 6-in. theodolite.

The Ocean Parkway base is nearly 13 000 ft. long. While the site proved an admirable one for accurate measurement, it was shut in by trees, so that observing platforms, 52 ft. in height, were erected at each end.

It is admirably located with respect to the stations of the primary triangulation. The Park Department offered every facility for doing the work, and gave the party in charge substantial assistance in the erection of the observing platforms. This base was measured with four (4) carefully standardized tapes, each 150 ft. in length. The measurement was done at night, when the temperature is more uniform and there is less interference with the work of the party on the part of those passing along the street and attracted to the operation by idle curiosity. Sections about 3 300 ft. in length were measured at a time, one tape being used in measuring in one direction, and another in the reverse direction. The same two tapes were not used for any two sections. It was originally expected that the tape lines used in these measurements would be standardized by comparison with a line measured with the 5-meter standard bar of the Coast and Geodetic Survey, immersed in melting ice. The 5-meter bar was during the past summer at the St. Louis Exposition, and could not be obtained until after December 1. Its use is difficult, expensive and tedious. Stable monuments must first be set at each end of the line. Posts 6 in. square must then be set 5 meters apart, on which are mounted powerful microscopes, to mark the end of each application of the ice bar. A small railroad track is built parallel with these posts on which runs the carriage which

bears the bar and its load of melting ice. It is also necessary, when this work is done in a city, to enclose the entire track by a building which can be securely locked. It was decided, therefore, to standardize these four tapes by comparison with three tapes secured from the Survey; two of these were 100 meters long and the third 50 meters ·long. They had been many times compared with the ice bar, and a dozen or more bases have been measured with them during the past ten years. Their lengths were known within one part in a million and had been found to be constant during the time of their use. The four tapes purchased by the city were made by Fauth & Company, of Washington, and were ordered to be of the same material and of the same dimensions in every way as those of the Coast and "Geodetic Survey, and the coefficients of expansion obtained by many comparisons of the Coast and Geodetic Survey tapes at different temperatures with the ice bar were used in computing the actual length of the Ocean Parkway base. A description of the operation of standardization would be too long to give in this connection. It is described in detail in a report made by Mr. A. T. Mosman, the - engineer detailed by the Survey to take charge of this work, which will be printed, together with illustrations of the instruments used, in the annual report of the Chief Engineer of the Board of Estimate and Apportionment.

It was not originally expected that the triangulation would be extended over the Borough of the Bronx, but the borough officials have requested that this be done, and stations are now being prepared for this purpose and the old Unionport base line has been remeasured.

The plan of co-operation with the United States Coast and Geodetic Survey for this triangulation has proved to be very advantageous for the city. The work has been in progress about eighteen months, and the entire expense to the city up to December .31st, 1904, has been \$17 944.61, and this includes not only the payrolls of the men employed, the subsistence of the engineer detailed by the Federal Government, the expenses of himself and his parties. the building of observing stations, the purchase of instruments, and .all other expenses, but it also includes \$1 000 paid for land upon which to erect one of the stations. It does not include the pay of

an observer furnished by the President of the Borough of Richmond for the entire period, another observer furnished for a short time by the President of the Borough of Queens, a laborer furnished by the President of the Borough of Brooklyn, nor the cost of erecting observing stations in the Borough of the Bronx. In the work of the last-named borough we have had the hearty and efficient co-operation of its Topographical Bureau.

You will have seen that I have again superficially reviewed the general situation in the City of New York in its relation to the engineering profession, without attempting a description in any detail of the work accomplished or the methods employed during the past year. I will not assume the role of prophet, but in striving to look forward to the New York City of the future I fancy I can see the greatest city in the world, greatest, not only in area, population and wealth, but in those attributes which go to make up the truly great metropolis-greatest in her public buildings, in her temples consecrated to religion, music and the drama, in her institutions of learning, in her provision for amusement and recreation, in her zealous and efficient care for the public health, in the wisdom shown in her public and private charities for the care of the unfortunate and helpless, and in the justice combined with mercy shown in her treatment of vice and crime. I see a great city welded into a homogeneous whole by easy, rapid and ample facilities for transportation, enabling the residents of each portion to reach any other portion with comfort and speed, and where provincialism has given way to a broad metropolitan spirit; where great public works are undertaken, not in response to ill-considered and hysterical public clamor, but in conformity with carefully considered plans made after mature study by experts in the permanent service of the city, and which will not be changed at the caprice of those holding office for brief periods. In their execution a policy of broad liberality, without extravagance, and economy free from niggardliness will prevail. You ask me what potent influence will result in the creation of such conditions and produce an enlightened public sentiment which will demand them. My answer is a simple one: If the Municipal Engineers of the City of New York will live up to the highest standards of their profession; if they will demon-

strate their efficiency and devotion to the highest ideals; if they will serve the city with singleness of purpose, and give to it the best that is in them, not stopping to consider whether they are giving in effective work more than they are receiving as compensation, the public will soon learn to believe in them, will rely upon their judgment, and will demand that the control of our public works shall be placed more and more completely in their hands. When this shall have been done, I am optimistic enough to believe that the conditions I have endeavored to describe will result.

MORRIS HIGH SCHOOL, 166th STREET AND BOSTON, ROAD, BOROUGH OF THE BRONX.

INSPECTED BY THE SOCIETY MARCH 19TH, 1904.

Description of Building prepared by C. B. J. Snyder, M. Mun. Engrs., Superintendent of School Buildings.

The new building designed as a permanent home for the Morris High School, which was scattered in three different structures in various parts of the Borough of the Bronx, occupies the block fronting on the northerly side of East One Hundred and Sixty-sixth Street, between the Boston Post Road and Jackson Avenue.

In style the building is designated as English Collegiate Gothic adapted to modern uses and construction.

The exterior is of gray brick, with limestone and terra-cotta trimmings, of the same general color as many of the modern buildings erected in this city. The most striking feature is the greatcentral tower, nearly 50 ft. square and about 169 ft. in height, which contains the large ventilating shafts that conduct away from the building the vitiated air that has been exhausted from the class-rooms and other parts of the building. In one of the corner turrets of this tower is placed the boiler chimney, which could not well have been disposed of otherwise without disfiguring the appearance of the building. The upper floors of the tower have been arranged to provide laboratories for the special work of the professors, a provision which, while badly needed, has often been overlooked in many high-school buildings.

Advantage has been taken of the fact that the building occupies a plot which gave free access from Boston Post Road to design the auditorium as a feature harmonious with the rest of the building, but marking strongly its purpose of use for the public as well as for the school by direct entrances thereto from the street. This auditorium, with seats for 1700 persons, is intended for use on public occasions, as well as for the daily exercises of the High School.

The plot is naturally some 10 ft. above the grade of the street,

MORRIS HIGH SCHOOL.

except at the west end, and, being for the most part rock, it was deemed best to take advantage of the situation and thus, in the frontage of the building of 312 ft., to form the basement story at the easterly or lowest end, extending under somewhat more than half the structure.

Beneath the extreme easterly side is the sub-basement, containing the battery of boilers for heating, power, and also the coal supply.

Above the basement are five stories of rooms for school work, seventy-one rooms in all, not counting those used for stores, toilets, preparation, lockers, teachers' and other purposes, all necessary in like modern structures.

Of the seventy-one rooms, there are forty-six section rooms of the usual size, but placed with the long side, of about 28 ft., to the light, so that the shorter dimension of 21 ft. is the depth of the room, bringing the farthest seats sufficiently near the light. Each room is amply lighted by a large window, or, rather, a group of windows, in a single opening, measuring as a minimum an area of 160 sq. ft.

In addition to the section-rooms there are twelve laboratories for chemical, physiological, biological, physiographical and other purposes, and three lecture-rooms to be used in connection therewith. Independent of the lecture-rooms there will be provided four large study halls, one on each of the floors. A large library has been provided for the second floor, and five other rooms to be assigned for special purposes. Separate gymnasiums have been provided for boys and girls, each with its running track, shower baths, locker rooms, doctor's examination room, etc., etc.

The lighting is by electricity throughout, obtained from one of the lighting companies.

An exterior telephone system is so arranged that the principal is in constant touch with all parts of the building.

In the basement provision has been made for lunch-rooms for boys and girls; also for bicycle-rooms.

The cost of the building, \$469 383.

THE FILTRATION PLANT OF THE EAST JERSEY WATER COMPANY, AT LITTLE FALLS, N. J.

INSPECTED BY THE SOCIETY JUNE 11TH, 1904.

Description of Building Prepared by William B. Fuller, Civil Engineer, 170 Broadway.

Water is taken by gravity from the head-race leading from above the dam, and enters the large coagulating basin underneath the floer of the machinery and storage-rooms of the filter, this floor being 1 ft. higher than the level of the head-race canal. The raw water enters a large concrete stand-pipe, 10 ft. in diameter and 43 ft. high, and passes into the coagulating basin from the bottom of this stand-pipe, receiving its dose of coagulant while in the stand-pipe. After remaining in the coagulant basin for a short time, the water is taken from the further end of the basin and passes into the filters, of which there are thirty-two, all of concrete. Each of these filters has a nominal working capacity of 1 000 000 gal. in twenty-four hours, and a maximum capacity of 1 500 000 gal. in twenty-four hours, making the maximum capacity of the plant 48 000 000 gal. in twenty-four hours.

After passing through the filters, which consist of a layer of sand 3 ft. in thickness, and a strainer system, the water is regulated through a controller, and drops into a clear-water basin, 30 ft. deep, directly under the filters. From this basin it is taken by suction to the power pumps in the pumping station, and from there is distributed to the points of supply. The coagulant is sulphate of alumina, and is mixed in a 4% solution in large solution tanks underneath the floor of the machinery-room. From these tanks it is pumped continuously to an orifice tank kept at a constant level, and the rate of application of the coagulant is governed by the opening of the orifice on this tank. The filters are washed with filtered water and with air. The wash-water pump is run by electricity, and is started from the table opposite any filter by pressing a button. The air-blower is in the machinery-room and is also started from any table in a similar manner.

THE EAST JERSEY WATER COMPANY.

In washing the filters, the raw water is first shut off and the filter allowed to drain to within 9 in. of the surface of the sand. Air is then applied for three minutes and then shut off, and then wash-water is applied for five minutes. It is not the intention to clean the beds completely, as this would result in a poor effluent on starting the new bed. The average run of the beds is about eight hours. The entire plant, as far as it was possible, was built of concrete, for permanence of construction and a low cost of maintenance.

FACTORY OF KEUFFEL & ESSER COMPANY, HOBOKEN, N. J,

INSPECTED BY THE SOCIETY SEPTEMBER 24TH, 1904.

Description Prepared by C. M. Bernegau, Treasurer of the Keuffel & Esser Company.

The Municipal Engineers of the City of New York visited the factory of the Keuffel & Esser Company on September 24th, 1904. They assembled in the office of the factory shortly after 1 p. M., where they were received by the Treasurer, Mr. C. M. Bernegau, and the Secretary, Mr. W. L. E. Keuffel, and members of the staff of the company. Under the guidance of these gentlemen, they started their inspection at the pump-house, with its automatic firepump, which connects with the complete sprinkler system by which the entire plant of the company is protected.

The next stop was made at the power-house, where there are two high-speed engines driving the generators which furnish the power for all the various departments. From there, passing through the court-yard, the machine shop was reached, in which drawing-tables and thumb-tacks are made, as well as the larger machine pieces used in the special machinery constructed by the company for its own use. This room also contains the smithy. Crossing the inner yard, the visitors then reached the fire-proof (corner) building, in which are housed, on the lower floor, two very interesting machines, one for printing profile and cross-section papers from copper rollers, and the other an automatic machine for making thumb-tacks. This machine produces one thumb-tack for each revolution of the drivingwheel.

The next floor visited was the tool floor, where the tools and dies used in the manufacture of the company are made, as well as the fine special machinery used by the company for many purposes. On the same floor, at the other end of the building, the brass-finishing and tape-assembling room was reached, and from there, through the chemical laboratory, the visitors entered the blue-print-paper preparing room, where a number of large coating machines were running, preparing the various kinds of blue-print, brown-print and black-print papers, so well known to the users of Keuffel & Esser goods.

Passing up to the third floor, the visitors came into the screwmachine room, where the screws, nuts, bolts, etc., used in the manufacture of the various instruments are made. The south end of this room is devoted to the manufacture of nautical instruments, such as binnacles, peloruses, illuminated peloruses, etc.

Above this floor is located the surveying-instruments department, which, with its long rows of precision lathes, furnished the visitors with an idea of the importance of this branch of the Keuffel & Esser business. This floor is directly connected with the adjusting-room, where all the instruments are carefully examined and adjusted before they are sent out. The adjusting is done in the tower of the southeast end of the building, which affords every opportunity, not only for adjusting the instruments, but also for testing the telescopes, because it affords long sights. The floor of the tower is very solidly constructed and connected with the foundation of the building, so as to avoid vibration. The working floor is a false one, so that the columns on which the instruments are mounted when being tested are not affected by any vibration of this floor.

Passing the bronzing and nickel-plating rooms, the visitors entered the foundry, where all the brass and aluminum castings used in the manufacture of Keuffel & Esser instruments are made. Great care is taken in this work, so that the finished pieces will scarcely ever show blow-holes.

From the foundry the visitors entered the large loft on which the patternmakers and part of the cabinetmakers are located, the latter being busy making triangles, T-squares and chests of drawers, drawing-tables, etc., with all of which the users of Keuffel & Esser goods are quite familiar.

The party then came to the oldest part of the factory, reaching it at the top floor, which is partly used by the printing department. The other part of this floor is occupied by the varnishing department, and it also contains the very ingenious machines used by the company for cutting railroad curves. These curves are not cut from templets, but they are constructed by the afore-mentioned machine as accurately as they can be laid out with a beam compass of the range of the curves.

Passing down through the various floors of this building, which is 5 stories high, was seen woodworking in all its branches, planing, sawing, grooving, dovetailing, lock-cornering, all of which processes are employed in the manufacture of the various wooden goods manufactured by Keuffel & Esser Company. Before passing out of this building, the optical department was entered, where lenses are roughed and fine-ground out of the raw glass, and where nearly all the lenses and prisms are ground which are used in the telescopes of the various instruments manufactured by Keuffel & Esser Company.

The visitors then crossed Adams Street and entered that part of the factory which is situated between Adams and Jefferson Streets. A large space on that side of the factory is devoted to the lumber yard and dry kilns, where they have a large stock of lumber stored, most of it half finished, in order to give this material the most thorough seasoning.

The last building visited contains the leather-working department, in which leather-tape cases and cases for instruments are made, and the bindery, where cases for mathematical instruments are made. Two other floors are occupied by the paper-mounting department. They are each 60 by 100 ft. and the huge mounting tables permit of mounting sheets as large as 20 by 90 ft.

THE SCHERZER ROLLING LIFT BRIDGE OVER NEWTOWN CREEK.

INSPECTED BY SOCIETY NOVEMBER 19TH, 1904.

Description Prepared by Edward A. Byrne, M. Mun. Engrs., Assistant Engineer, Department of Bridges, in Charge of Work.

Newtown Creek forms the boundary between the Boroughs of Brooklyn and Queens for a distance of about four miles, three and one-half miles of which are navigable. The creek, for its greater part, is 250 ft. in width, with a depth of water of 23 ft. at mean high tide. Its commerce is greater than that of any similar waterway in this part of the country.

The creek is spanned by five bridges, all of which are under the care of the city. Four of them are located on the navigable part of the creek, and each has a center-pier drawspan; the fifth, located at the head of navigation, is a fixed timber trestle.

The bridge at Vernon Avenue, which is now in course of construction, is located about 1 500 ft. from the mouth of the creek, and, when completed, will be the main connecting-link between two populous sections of the city—Greenpoint, in the Borough of Brooklyn, and Long Island City, in the Borough of Queens.

To illustrate the commercial importance of this creek, and also the heavy land traffic at this crossing, the results from actual count of the water and land traffic taken at the temporary bridge, located about 300 ft. further up the creek, which was built to accommodate the traffic during the construction of the new bridge, are hers given.

The average number of pedestrians crossing this bridge daily is 18 600, while 1 900 vehicles cross during the same time. There is no accommodation for street-railway traffic on this temporary bridge.

The average number of times the draw-span is opened daily to allow the passage of vessels is 70. These openings consume seven hours and fifty minutes daily. During this time 333 vessels of all descriptions pass through the channel at this bridge. The traffic at

198 THE SCHERZER ROLLING LIFT BRIDGE.

the old bridge was equally as great as that at this temporary bridge.

The old Vernon Avenue Bridge was a low-level structure with a center-pier drawspan, and totally inadequate to accommodate the very heavy traffic. It was built in 1879, and within a few years after its completion agitation was commenced for a new structure, but it was not until after consolidation of the various municipalities into the Greater City that plans were adopted for a bridge of sufficient capacity to properly accommodate the land and water traffic with the least inconvenience and delay to each.

These plans called for a high-level bridge, allowing 24 ft. clearance at mean high water, and a clear center channel 150 ft. in width. These requirements necessitated the use of the bascule type of bridge, and the plans submitted by the Scherzer Rolling Lift Bridge Company were adopted. The contract for the construction of this bridge was made on December 9th, 1901, at an estimated cost of \$547 046.

GENERAL DESCRIPTION OF THE BRIDGE.

The length is 1 699 ft., 332 ft. of which is occupied by the Scherzer span. The Brooklyn approach is 334 ft. in length, and 1 033 ft. of approach is required to bring the bridge to street grade on the Queens side of the creek, this length of structure being necessary to obviate the crossing at grade the tracks of the Long Island Railroad, some 400 ft. north of the creek.

The roadway, on which railway tracks will be laid, is 40 ft. in width, and two sidewalks, each 8 ft. in width, are provided.

The approaches consist partly of steel viaducts, with either buckle-plate or through-plate floor, and partly of walls of limestone masonry backed with Portland cement concrete, which retain the earth filling on which the pavements are laid. Asphalt and granite blocks, both on concrete foundation, are used for roadway, pavements being used on the heavy grades. The sidewalks are of Portland cement concrete.

The Scherzer span consists of a double-leaf through span, with a length of 172 ft. from center to center of bearings, and two approach fixed spans, each 80 ft. in length. Each leaf has two trusses, 45-ft. centers, and so counterweighted that it is at rest in any position, and when closed to receive land traffic acts as a cantilever, with PLATE XXXVIII. THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK. EXCURSION TO VERNON AVE. BRIDGE.



SCHERZER ROLLING LIFT BRIDGE OVER NEWTOWN CREEK AT VERNON AVENUE, BROOKLYN.

anchors extending from the inshore end of top chord through the anchor piers, some 16 ft. below high water.

This span, with its clear roadway of 40 ft. in width, necessitating 45 ft. center to center of trusses, is, I believe, the largest double-leaf highway bridge designed by the Scherzer Bridge Company.

Each leaf is operated by two 40-h. p. electric motors connected by gearing and shafting to two operating streets, which, in turn, are connected by piers to each leaf at the center of the rolling segment produced. The movement of the operating streets is 27 ft. 11 in., and the angle made between the closed and opened position of each leaf is 80 degrees.

The control is so devised that each leaf can be operated separately from its side of the creek, and, by means of submarine cables, switches, etc., the control of both leaves will be located on one side of the creek.

Each leaf is furnished with a reversible gravity band brake, which is operated by electric solenoid. An auxiliary foot-lever bandbrake is also provided for each leaf, to be used in case of emergency.

Two tail latches are provided for each leaf. They are applied by gravity and opened by electric solenoids.

All the operations will be controlled from houses erected on the approach spans, and the wiring and contacts so arranged that one controller will operate each leaf separately from its side of the creek, or, as stated above, both leaves can be operated from one side of the creek.

The following figures of the weights of materials in the superstructure of the Scherzer span are worthy of note: 1060 tons of structural steel, 626 tons cast-iron counterweight, and 87 tons of machinery, exclusive of the electrical equipment, have been used. It will require the driving of 52 000 "field" rivets to complete the Scherzer span. The roadway and sidewalks of the Scherzer span will be yellow pine timber, supported in the roadway on steel beams, while the sidewalk planking rests on timber stringers.

The substructure of the Scherzer span consists of timber piers in pairs. Eight of these piers are located in the creek. The rest piers, four in number, are of limestone masonry facing with Portland cement concrete backing and coping of granite. These piers are

THE SCHERZER ROLLING LIFT BRIDGE

200

carried to rock, at 42.2 ft. below mean high water, on the Queens side of the creek, and to boulders with coarse sand, at 42.8 ft. below mean high water, on the Brooklyn side by means of pneumatic caissons. Dimensions of these caissons are 23 ft. in length, 17 ft. in width and 17 ft. in height.

The anchor piers, four in number, are similar in design to the rest piers, but are founded on piles (cut off at 18 ft. below mean high water), on which a Portland cement footing rests. This footing is carried to a point 7 ft. below high water, at which elevation the limestone facing begins.

The four rear piers are of Portland cement resting on piles cut off at low water. On this concrete foundation rest granite bases supporting steel columns, which carry the superstructure of the approaches, as well as the fixed approaches of the Scherzer span.

A structure of this magnitude, located as it is, is another realization of the effect of consolidation. For who would care to prophesy a few years ago that over \$1 000 000 (includes cost of land required) would be expended for the construction of a bridge over Newtown Creek?

THE SHOPS AND MILLS OF THE PASSAIC STEEL COMPANY, PATERSON, N. J.

INSPECTED BY THE SOCIETY DECEMBER 10TH, 1904.

Description Prepared by Mr. E. McLean Long, Civil Engineer, No. 220 Broadway.

The inspection was started at the slabbing or billet mill, and the processes of rolling a beam from the ingot was witnessed.

The ingot was taken from the soaking pit, where it had been heated to the necessary temperature for rolling, and put in the table of the slab mill, which conveyed it by a train of rolls to the slabbing rolls, where, by repeated passes through these rolls, the ingot was worked down into long slab, after which, by means of a table of rolls, it was conveyed to the shears and cut into lengths suitable for the finished beams to be made. After shearing, the short slabs were put into a heating furnace and heated, after which, by means of a universal crane, they were transferred to the roughing mill, and from there on through different rolls by a continuous process until the finished beams were produced. The succeeding steps were sawing the beams, while hot, to the required lengths, straightening, inspecting and allotting them to their special orders.

The process of handling large masses of red-hot metal, and working the same to any required shape, was spectacular and interesting, and showed the small space of time required to convert a large block of cast steel into light beams weighing only 10 lb. per ft.

From the rolling mill, the party proceeded to the new open-hearth steel plant. This plant contains two 50-ton basic open-hearth furnaces of the latest and most approved type. It was the intention of the company to tap a heat of steel during the inspection of this plant, but, owing to defective material in the furnace lining, the melted steel could not be held, so the furnace was tapped earlier in the day.

While this plant was not seen in operation, the method of charging the furnace by electrical chargers was investigated, as was also furnace construction, and the methods employed in operating the same, casting the ingots and handling them after they are cast.

The tour of inspection, after leaving the open-hearth furnaces, was through the stock yards, where beams were being sawed to lengths while cold. The saw for this purpose was run at a very high velocity, and the heaviest 20-in. beams were sawed in two in less than a minute. While it is the general practice to saw beams while they are hot, cold sawing has many advantages, for it allows the mill to keep a large stock of beams and saw them to lengths as ordered, and the lengths can be gotten more accurate than when they are sawed hot, since measurements can be made exact and no allowance has to be made for shrinkage.

After leaving the stock yards and cold saw, the party proceeded through the shop yard, where finished work is painted and loaded on cars for shipment, and thence into the shops, where methods of shop work were inspected. Here was seen punching, assembling and riveting of work and machining of the ends of columns, and special structural work of various kinds.

After leaving the shops, the rolling of plates was witnessed, after which a rapid inspection was made of the electrical plant of the works. This finished the excursion of inspection through the mills and shops.

The original Passaic Rolling Mill Company was established in 1867, and the mills and shops at Paterson, N. J., have been in continuous operation since 1870. On February 16th, 1903, the Passaic Street Company purchased the property of the Passaic Rolling Mill Company, and the company is now known as the Passaic Steel Company.

The Passaic Steel Mills are the only mills nearer New York than Philadelphia where structural shapes are rolled. Its location is away from the steel centers of Pennsylvania, and while it is not as conveniently located to the raw materials as some of the other large mills, it has the advantage of being most conveniently located to the New York market. Its capacity at present is 100 000 tons per annum.

Among other structures, the steel for the Washington Bridge and a large portion of steel work for the elevated railroads of New York City were furnished by these rolling mills.

The second annual dinner of the Municipal Engineers of the City of New York was held at the Vendome Hotel, Thursday evening, January 12th, 1905. There were 157 present.

President Nelson P. Lewis gracefully greeted the members and guests and introduced the speakers of the evening.

The Hon. George Cromwell, President of the Borough of Richmond, said of his part of the city:

"The Borough of Richmond is the most beautiful heritage the city has obtained, particularly from an engineering point of view. "It has a topography that is equalled by no other part of the city, and it has the most inviting scenes and field for engineers to come to and help us to develop. It is practically virgin territory. We have the highest hills, overlooking the sea and the most beautiful water front. Topographical engineers are welcome by the score, I might say by the hundred, to help us develop the island. Our water system is not yet complete; we need engineers with talent in the direction of water supply and engineers to develop our water front; our docks are as yet undeveloped. And although in many respects we have things which we are very proud of, in fact, we are very proud of everything we have, still there are a great many things we expect to have almost right away, with your kind assistance. Therefore, I think it is the most inviting field in the City of New York.

"We are complimented by the splendid character of our highways, due to certain members of your Society, who have worked very hard in their construction and careful maintenance. We have a Street Cleaning Department which is, if I do say it myself, equalled by none in any other city of the globe. This has been said by engineers. In almost every direction there is an elementthere is a something about Richmond to invite a large population. and particularly to invite engineers to help us bring it there and encourage it to stay there. We have plans, and contemplate joining ourselves with Brooklyn, and engineers will assist us in building a tunnel across to Brooklyn to help develop Brooklyn. It was the people of South Brooklyn who urged us to assist them in carrying through this plan, and I assure you we are anxious to co-operate with them; and, after I have a few more conferences with Mr. Rice and some of the other engineers, we will formulate plans and. I hope, carry them out in the very near future. Our means of trans-

portation to Manhattan we have, for the present, to leave to ferries, but we are planning the most splendid ferryboats in the world to begin going down there next summer and to bring an enormous influx of people. We have not begun to realize what is going to happen there shortly; however, I can assure you that Staten Island is one of the most desirable places to go to, the most desirable place to stay in, and the place that has the greatest future of any part of the city, if not of this part of the hemisphere.

"I realize from what those of you who have worked in the Borough of Richmond have done for us thus far, and I realize from what I have seen of the work of engineers how true it is that the work of the engineer is at the foundation of the commercial success, the healthfulness and the building up of any city."

Mr. Calvin Tomkins, President of the Municipal Art Society, said:

"You may think there is a certain anomaly in a Municipal Art Society suggesting constructive ideas for the development of the great municipality of the City of New York to the engineers who are directly in the employ of the city and have charge of the city's evolution. However, I shall venture the task and I hope to impose upon your broad shoulders some of the burdens which have been resting on me and on my Society, or to at least induce you to consider assuming a responsibility.

"The Municipal Art Society started out with the idea of municipal decoration, and for one or two years it was conducted on that basis. We soon began to recognize the fact, which lies at the bottom of all good art, that you cannot have real beauty in a city any more than you can in a statue or a picture unless constructive ideas underlie superficial decoration. In other words, design should precede decoration; and, with that end in view, we have proceeded to suggest certain principles for the development of New York. We have done this in two ways: First, during Mayor Low's administration we sought to bring about the appointment of a City Improvement Commission. The Mayor recommended the suggestion to the Board of Aldermen, and in the latter part of his term they passed a resolution authorizing such a commission to be appointed, but they made no appropriation. We endeavored fruitlessly to induce Mayor Low to make the appointments without the appropriation, trusting to the public spirit of the appointees to carry on the work if no appropriation should be made. We believed that it would be made, but the Mayor declined to appoint. He thought that the responsibility should go to his successor, who could also make a requisition for the money. It went over to Mayor McClellan, and he promptly appointed the Commission, and the

Board of Aldermen made the appropriation, and the Commission has recently reported. It has made a very excellent report, which you have doubtless read and are familiar with. This report embodies many of our ideas, many of the ideas of other associations, ideas that are common property, and many original suggestions of their own. It is a most admirable report, which sets clearly before the people of the city the necessity for great improvements and reorganizations.

"The other method that we have followed has been to publish a series of bulletins, setting forth the ideas we have had in mind. We have sought opportunities to publish these when, for particular reasons, the matters discussed had the public ear. We have issued a series of such bulletins as follows: On the improvement of the City Hall section and reorganization of the civic center in the vicinity of City Hall; a report on the passenger transportation system, which has been revised recently; a report on civic centers; a report by the Thoroughfares Committee regarding the revision of thoroughfares in lower Manhattan—this has been taken up and very largely extended by the City Improvement Commission: a report on the decoration of public buildings by Professor Hamlin, of Columbia College; a report on the decoration of public schools, where we believe municipal decoration should begin. There is power for the Board of Estimate and Apportionment to appropriate \$50 000 annually for municipal embellishment, and we are in hopes that we will be able to induce the city to apply some of this to the schools, believing that if this small appropriation is made annually, it will increase, and ultimately New York will regard civic beauty in the same way that Paris, Berlin and Vienna regard it—as an important municipal asset. Also a report on parks and park extensions; a bulletin which is an abstract of your President, Mr. Lewis's report to the Board of Estimate and Apportionment: a report on pipe galleries for New York by Mr. Baylis; a report on the discussion of the proposed changes in the Manhattan Bridge plans, not with a view of agitating for one set of plans or for the other, but with a view of imposing some regular, systematic procedure in those cases where it seems desirable to change plans. Plans are likely to be changed with the changing administrations, and it is most important, in our opinion, that plans for great public works should not be changed without careful consideration and under some process of open public procedure. And, finally, a series of reports on rapid transit. The City of New York is rapidly becoming the great commercial metropolis of the world. It is the port of exchange for the commerce of two-thirds of the North American Continent, by way of the Great Lakes and Hudson and Mohawk Valleys, and the commerce coming over the Atlantic Ocean

from Europe. The land route through these valleys is such as to compel all other railroads to come to New York, and every one of the important trunk lines have been deflected from Norfolk, Baltimore and Philadelphia here to New York City, so that we are now the railroad terminus as well as the commercial center of the United States.

"These forces are bringing about an unprecedented growth for New York City, and that is the condition which we have to face. The situation is a critical one. What is done now is going to determine the main lines of improvement that we shall follow for generations to come, and it is most important that within the next few years a series of improvements shall be initiated and comprehensive plans adopted which can be followed up so that the city may develop systematically. What is needed, in our judgment, more than anything else, is a comprehensive development plan for the City of New York. A lack of this has been the source of most of our troubles up to the present time. Heretofore, the enterprising men at the head of our transportation systems, the enterprising real estate operators in various parts of the city, have determined the development of the city. That is not as it ought to be. The city has been developed primarily with a view to private interest and not primarily in the public interest, and we still have had no comprehensive plan of development. The result has been that public improvements get in the way of subsequent public improvements. Further than that, private improvements, which private enterprise is driving ahead irresistibly, interfere with public improvements. The public improvement of a city should precede private improvements which should be made subservient. They should not interfere with each other, and there should be some plan that will obviate this. In Europe, on the continent, and to a very great extent in England, municipal plans are imposed upon the cities by the strong governments which exist there, and by an order of procedure which has placed the government and control of cities in the hands of trained experts, who are educated in the smaller cities and passed up to the more important cities, and matters are left in their hands. Those men are engineers, for the most part, or lawyers, skilled municipal directors. They develop the plans and their plans are followed. That kind of procedure is impossible here under our form of government and it is undesirable.

"My experience in the Municipal Art Society during the past two years confirms me in the belief that the only security which we have for sound judgment is the development of an intelligent public opinion. I believe that any plan which is proposed by such a Commission as the City Improvement Commission, such plans as are suggested by ourselves, such plans as are suggested by other regu-

larly constituted city officials, if large and comprehensive and requiring time to carry out, are only likely to be carried out if they are backed up by an overwhelming, irresistible public opinion, which must be gradually built up, which shall have eliminated what is bad in those plans and which stands for what is good. I think the building up and developing of such kind of public opinion is the only effective means of killing off bad plans and accomplishing the final adoption of desirable ones.

"The great problem in large cities is to provide for expansion without congestion. This matter is directly connected with the development of the transit facilities of the city. Here is a question which we must face. We are expanding very rapidly, but not without a great deal of congestion and a great deal of friction as regards the relations of the suburbs to the central portions of the city. Transit development, highway development, the matter of topography in relation to highways and parks, the question of parkways, the grouping of the public buildings, and the control of the public streets and their uses for all kinds of transportation above ground and under ground, are matters that ought to be very carefully thought out and determined as we proceed, otherwise we are likely to find ourselves in the very near future in inextricable confusion and disorder. Unless thought out in advance, every improvement means many added complications.

"The question of the reorganization of Manhattan will be attended with very great expense. The City Improvement Commission has made one admirable suggestion. I am glad they have had the courage to make it. No other official organization has had the courage, up to the present time, to do so. They have recommended that, in connection with public works of great magnitude, the city should condemn private property in excess of what it actually needs for public improvements, with the intention of making the improvements and subsequently disposing or selling off the excess property that is not required at a profit, allowing the city by this means to recoup itself, in whole or in part, for the improvement. I believe that only some such plan, which is the plan generally adopted in foreign cities and the only plan which has made possible the improvements in Paris and Vienna, will enable us to reorganize and modernize our insufficient street system in lower Manhattan so as to make it commensurate with the twenty-story system of buildings which we have imposed upon a street system intended for five to ten-story buildings.

"In Queens and in Richmond we have an unusual opportunity for intelligent development. There is virgin soil. There we have an opportunity for the topographical engineer and the map maker to proceed with the physical development of the locality and to

create beautiful suburbs, to avoid the mistakes that have been made elsewhere. It should be the endeavor of organizations like your own and ours to bring about the accomplishment of this end. Our Borough President, Mr. Cromwell, has well said that there is no borough in the city which has the possibilities that the Borough of These possibilities should be taken advantage of Richmond has. and a checker-board system should not be laid out and imposed on a section so capable of artistic treatment. The mistakes that have been made in the older parts of the city should certainly be avoided in connection with the development of the newer parts. The possibilities of utility and beauty in New York City are unequalled by any city in the world. I shall not dwell upon them. You know, better than I can tell you, what magnificent opportunities we have. We cannot make an ugly city of New York, but we can, by design, provide a far more useful and beautiful city than we shall have by allowing it to develop in a haphazard manner or at the instance of private interest, as has been the policy in the past. Utility and beauty are here synonymous.

"Finally, gentlemen, I think that it is pre-eminently the duty and the opportunity of the Society of Municipal Engineers to express this idea. I do not think an artistic association like the Municipal Art Society should be placed continually in the front. We have only taken up this matter because others, better qualified, have not done so. We should like very much to turn it over to your organization. We should like very much to enlist the public spirit of any body of men who are associated in the public estimation with more practical ideas than those which are generally supposed to control Municipal Art Societies. The truth that structure underlies all ideas of municipal beauty, and that if you wish a beautiful city you must make it constructively a beautiful city first, is paramount, and I think that it is your special duty to keep it to the front. Т say it is not only a duty which you owe the people of the City of New York, but it is a great opportunity as well. I know of no way in which you can increase your own prestige, in which you can accomplish more for your profession than by working on these lines. Political conditions are subject to frequent changes, so that it is very difficult for individual engineers to stand out against political influences, but a society composed of as large a membership as you have need have no fear of such influences. You can impose your will upon the politicians and upon the selfish interests of the city, instead of allowing their will to be imposed upon you. I commend the duty to your careful consideration."

Mr. J. V. Davies expressed the opinion that it would be impossible to lay out a preconceived plan of transportation for the city,

considering the rapidity with which the city is growing. "Who can foretell ten years hence," he said, "where the city will have grown to? Three or four years ago who would have supposed that the Pennsylvania Railroad was coming to build an immense railroad depot, covering 28 acres of ground in the heart of the City of New York? Isn't that going, in itself, to change things considerably in the planning of lines of communication for the future from any ideas contemplated four years ago?

"One trouble in the way of real rapid transit here, and one trouble with the Subway, is that we have too many stations. We cannot get real rapid transit out to the outlying districts—and that is where we want it, to get to and fro quickly, with so many stopping points. We want even less stopping points than on the express tracks of the Subway, to get out into those distant districts. We cannot expect to travel 60 miles an hour with stops every half mile. The very fact of introducing these stops must, of necessity, reduce our ability to get real rapid transit. Our city is growing and growing out to the ends and growing far away out into the suburbs, and it seems to me that possibly for the future we are going to have to put in other tunnels, other rapid transit routes that will go down deep below the level of anything existing and by which we can go in all directions right out to the ends."

Mr. John F. O'Rourke spoke in part as follows:

"New York, as we know from one of the scientific books of the past which was written by our great and exact historian, Washington Irving, was laid out by the cows; and anybody who tried to buy any property along these cow-lines knows that the cows laid it out very properly, otherwise it could not be so valuable. No matter how good or how well any other part of the city was laid out, the land is very much cheaper than that part in which the cows laid out the streets.

"The city, however, is now up to that point where we have got to deal with the modern problems of time and distance. We have got to deal with structures which will concentrate within a limited area almost the whole business community. Some of the gentlemen here present spend part of their time in a building where there are 15 000 to 20 000 people a day passing in and out. That is known by actual count. You have got to furnish the skeleton upon which everything else is carried. You have got to furnish more than the skeleton; you have got to furnish the flesh and blood as well, because, after all, the functions of the Municipal Art Society, while they are very great, are, unfortunately, in the hands of very few men like Mr. Tomkins. Of course, there are frills that are necessary for beauty, but still they are frills. Mr. Tomkins will admit

you can take them off, and that what was left would be like taking the frills from the bottom of frilled trousers, pretty good trousers still. Every word that Mr. Tomkins has said to-night I am willing to stand for. Anything we can do to further the ends of the Municipal Art Society we should do, so far as we approve of what they propose. I think that is a safe position to take. There is no doubt about it that you will get very much better art if you take that position. There is no doubt that you will get better results in your own work, because, after all, the line of beauty is the line of strength. No man ever designed a homely bridge that it was not a poor one. No man ever designed anything which did not look well that was right. There is something in Nature which nobody has ever described, and nobody, perhaps, ever will, which makes whatever is right look right. That is really at the bottom of all the things that we try to do. I have seen enough of work to know that complicated things are only simple things multiplied. I know also that by going along on the right lines, by getting all your municipal constructions right, by getting the right kind of sewers and mains of all kinds, by having the proper municipal regulations in regard to buildings, not fool regulations, but proper ones; by seeing that the money is provided, by the proper expenditures, protected by a proper Chief Engineer of the Board of Estimate and Apportionment, by looking after all these things you can make New York, not only the greatest city in size and beauty in the world, as it is now the greatest in many other ways, but you can make it in every sense æsthetic; æsthetic in the best sense; æsthetic in the sense that our friends of the Municipal Art Society approve, so that if possible we will be more proud of our city even than we are to-day.

"I just want to say one more thing. When the city began it started off with its cow-paths from Bowling Green. After a while it got up to the Bowery; then to Murray Hill, and over to the West Side, and, after a time, in what might be called the extravagance of Nature, after exhausting Manhattan it reached the Bronx. Mr. Davies, with his tunnels, is helping Jersey and Hoboken, helping them to be almost like New York. Then we have Brooklyn on the other side of the river, which is perfectly lovely as a city of homes, where there is such an air of serenity and quiet that they call a very slow railroad there a Rapid Transit Road.

"After all these places are developed you have yet the Borough of Richmond. That place in which the topographical engineer revels. That place in which there is no difficulty in building docks, laying out streets, and applying all the arts and sciences to the making of the perfect city, where even the mosquito cure can be used with advantage. Most of all, you get there at a time in which you best understand municipal developments and in which you will

be able to realize the dreams of the gentleman who so ably and acceptably represents it here to-night, officially, as its President, and, personally, as one of its most public-spirited and popular residents."

Mr. Charles Whiting Baker then made a few remarks on the general tendency to exaggerate one thing or another according to our education, and the ability of the great engineer or statesman to see things in their true proportion.

Mr. J. C. Meem entertained the diners with a few anecdotes, and Mr. Charles H. Haswell, who is 96 years young, made a bright response, in which he repeated the original text of "Yankee Doodle," which he said he had from a man who fought in the battles of Lexington and Bunker Hill. The words were as follows:

> "Father and I went down to camp Along with Captain Goodwin, And there we saw the men and boys As thick as hasty pudding.

"There they had a swamping gun As big as a log of maple, Upon a deuced little cart, A load for father's cattle.

"And every time they fired it off It took a horn of powder. It made a noise like father's gun, Only a nation louder."

INDEX OF ADVERTISERS.

PAGE.

BRIDGE CONSTRUCTION.

MACHINER	Y.
----------	----

PAVING.

PAGE

Pennsylvania Steel Co	14
John A. Roebling's Sons Co	16
Scherzer Rolling Lift Bridge Co	16

BUILDERS.

Edmund D. Broderick	5
Luke A. Burke & Sons	34
Clarke & Stowe	36
T. Cockerill & Son.	10
Thomas Dwyer	35
Fuller & O'Čonnor	33
William Horne Co	3
George Hildebrand.	22
John Kennedy & Son	38
Thomas B. Leaby	19
Thomas McKeown	3
The Norcross Brothers Company	4
Chas. H. Peckworth	- 8
John Peirce Company	2
Daniel A. Ryan	31
Ryan & McFerron	32
John R. Sheehan & Company, Inc	30
George L. Walker Co	5
Richard L. Walsh Co	6
Charles Wille	5
A. Winternitz	37

BUILDING MATERIALS.

Alberene Stone Co	26
Fordham Stone Renovating Co	27
Hudson River Blue Stone	39
Robert A. Keasbev Co	27

CARPENTERS.

Alexander R. Brown	
L. E. Butterworth	
James I. Newman	
Joseph Ohlhausen	
Laurence I Rice	

CEMENT.

	**
Alsen Portland Cement Works 1	1
Glens Falls Portland Cement Co 1	7
Vulcanite Portland Cement Co 1	7

CONTRACTORS.

C. W. Collins	19
Frank J. Gallagher	19
J. C. Rogers	20

ELECTRICAL CONTRACTORS.

C. Frederick Jackson	
James Reilly Repair & Supply Co	
James Reilly's Sons Co	
George Weiderman Electric Co., Inc.	
-	

ELECTRICAL SUPPLIES.

Manhattan Electrical Supply Co...... James Reilly Repair & Supply Co.....

Sicilian Asphalt Paving Co U. S. Wood Preserving Co Warren Brothers Co	24 23 25
PLUMBERS.	~
Wm. C. Ormond	7
PLUMBING SUPPLIES.	
Ronalds & Johnson	7
PORTABLE HOUSES.	
Ducker Company	28
PROFESSIONAL CARDS.	
Watson G. Clark	44
Chas. W. Leavitt, Jr	44
Louis H. Voss	44
PUBLICATIONS.	
Wm. T. Comstock	39

White I. Comstook	- 12
Engineering News	41
Evening Post Job Printing Office	40
E. Belcher Hvde	39
McGraw Publishing Co	39

SHIP BUILDING.

Columbia Engineering Works...... 11 John F. Walsh, Jr..... 11

STEAM HEATING.

Babcock & Wilcox	12
Edwin Burhorn	11
Jos. T. Ryerson & Son	11
United Heating Co	9

STEAM SUPPLIES.

Dearborn Drug & Chemical Works	13
Richard Dudgeon	23
L. Katzenstein & Co	_9
Robert A. Keasbey	26

STRUCTURAL STEEL.

American Structural Steel Co	15
Fort Pitt Bridge Works	15
Pennsylvania Steel Co	14
Snare & Triest Co	18

SURVEYING AND DRAFTING INSTRUMENTS.

INGINUMENIS.

F. E. Brandis Sons' Co	1
Eugene Dietzgen	43
Keuffel & Esser	42
Kolesch & Co	44
E. G. Soltmann,	44

213

9799





NEW CUSTOM HOUSE, BOWLING GREEN, NEW YORK CITY Cass gilbert. Architect

JOHN PEIRCE COMPANY, 277 BROADWAY

CONTRACTORS FOR NEW HALL OF RECORDS, NEW YORK CITY U.S. CUSTOM HOUSE, NEW YORK CITY, INTERBOROUGH Power House, New York City, U.S. Post office, Chicago, Ill., U.S. Post office, Indianapolis, IND., GRANITE DRY DOCK, PORTSMOUTH, N. H., ACADEMIC GROUP, ANNAPOLIS, MD.

:=

TELEPHONE, 2286 79TH STREET

ALEXANDER R. BROWN Interior Mood Mork

501-505 EAST 70TH STREET

NEAR AVENUE A

NEW YORK CITY

Telephone 5886-38th St.

LAURENCE J. RICE MASON AND BUILDER

5 and 7 EAST 42D ST.

TRANSIT BUILDING

NEW YORK

HENRY SIEFKE, PRESIDENT

WILLIAM HORNE, TREASURER

WILLIAM HORNE CO. BUILDERS AND CONTRACTORS 245 WEST 26th STREET

Telephone, 794 Chelsea

NEW YORK

James I. Newman, ^{243 Euclid Avenue} BROOKLYN

Telephone, 1258 East New York

CARPENTER WORK, Alterations and Rebairs.

TELEPHONE, 389 J TREMONT

J. E. BUTTERWORTH CARPENTER AND BUILDER 2070 RYER AVENUE NEAR 180TH STREET NEW YORK

TELEPHONE: 1679 MORNINGSIDE

THOMAS McKEOWN

General Contractor

521 WEST 110th STREET,

NEW YORK.



THE NEW YORK PUBLIC LIBRARY

THE NORCROSS BROTHERS COMPANY, BUILDERS

ĺΫ

GEO. L. WALKER PRESIDENT S. B. WALKER VICE-PRESIDENT GEO. L. WALKER GEO. L. WALKER GEO. L. WALKER SEC'Y AND TREAS. BROADWAY AND 104th STREET NEW YOR K

JOSEPH OHLHAUSEN

CARPENTER AND BUILDER

443 Stanhope Street,

Brooklyn, N. Y.

CHARLES WILLE Builder and General Contractor

39 East 42d Street, New York City

Branch Office: Woodside, Borough of Queens, New York City

TELEPHONE 3097 79TH

EDMUND D. BRODERICK

Mason, Builder and General Contractor

OFFICE :

1382 LEXINGTON AVENUE

NEW YORK

v


STABLE OF MR. C. K. G. BILLINGS Fort Washington Road and 195th Street, New York City Richard L. Walsh Co., Builders 100 William Street, New York

> GUY LOWELL. Architect,

> > Bastan, December 11th, 1903.

NEW YORK. F. W. Rreef

Mr. Richard L. Walsh, 11 Liberty Street, Jew York City.

Dear Sir,-

1128 TREMONT BUILDING. HOSTON.

CARLE ADDRESS. OF YLOW, BOSTON

I wish to tell you that Mr. Billings is very much pleased indeed with all the work you have done for him on his stable at 195th Street and Fort Washington Rond, which you have recently completed.

The material and workmanship throughout both the exterior and interior are very satisfactory.

G.R.L. è.

Yours very truly, Guy Arroll

In re C. K. G. Billings' Stable.

TELEPHONE, 1663 SPRING

O'BRIEN & RYDER <u>IDractical IPlumbers</u>

147 SPRING STREET, NEW YORK STEAM HEATING GAS FITTING GENERAL CONTRACTORS SANITARY EXPERTS

TELEPHONE, 240 BUSHWICK

WILLIAM C. ORMOND PLUMBING CONTRACTOR 430 Kosciusko Street

NEAR LEWIS AVENUE

BROOKLYN

RONALDS & JOHNSON CO.

Manufacturers

FINE PLUMBING MATERIAL, PIPE, FITTINGS, VALVES

NEW YORK

BROOKLYN

PHILADELPHIA



vii



71ST PRECINCT POLICE STATION HOUSE EIGHTY-SIXTH STREET AND FIFTH AVENUE, BROOKLYN WALTER E. PARFITT, ARCHITECT

ERECTED BY

CHARLES H. PECKWORTH

Building Contractor

415 HUDSON STREET, NEW YORK

TELEPHONE, 131 SPRING

GEORGE WEIDERMAN ELECTRIC CO., Inc.

Electrical Engineers and Contractors

21.27 New Chambers St., New York telephone, 4946 franklin 267 Flatbush Ave., Brooklyn Telephone, 677 prospect

AGENTS FOR GENERAL ELECTRIC CO.'S MOTORS

T. F. JACKSON ELECTRICAL CONTRACTOR 592 Columbus Avenue

Bet. 88th and 89th Sts.

NEW YORK

F. JAMES REILLY, TREAS.

WM. F. REILLY, MANAGER

JAMES REILLY'S SONS' CO.

GENERAL ELECTRICAL REPAIRS

122-130 CENTRE STREET, NEW YORK

J. J. PEARSON

T. P. MCGLYNN

H. B. HAYS

PEARSON, MCGLYNN & CO.

ELEVATORS & HOISTING MACHINERV

ALTERATIONS TEL. 904 FRANKLIN REPAIRS SUPPLIES 10 READE ST., NEW YORK



TELEPHONE CALL, 1141 SPRING L. KATZENSTEIN & CO. General Machinists and ENGINEERS' SUPPLIES KATZENSTEIN'S METALLIC PACKING Flexible Tubular Metallic Packing for Slipjoints and

 Flexible Tubular Metallic Packing for Slipjoints and on Steam Pipes. Highest Grade Anti-Friction Metal for Bearings.
358 WEST STREET, NEW YORK

United Heating Company

Contracting Engineers

174 WOOSTER STREET

NEW YORK



ARNOLD H. BRUNNER ARCHITECT

PAVILION AT THOMAS JEFFERSON PARK 111TH ST AND EAST RIVER

THOS. COCKERILL & SON BUILDERS

×



BUILDINGS, VESSELS, ALTERATIONS AND REPAIRS

136 Charlton Street, near West Street

TELEPHONE CONNECTION

NEW YORK



xii

DEARBORN METHOD OF TREATING BOILER FEED-WATERS IS A COMMON SENSE IDEA

SUPPORTED AND PERFECTED BY A KNOWLEDGE OF CHEMISTRY AND LABORATORY GUIDANCE

Dearborn Treatment is composed of vegetable and bark extracts. There are no damaging after effects such as follow the use of soda and chemical compounds.

Our compounds are scientifically prepared to meet the requirements of the case to be treated, as determined by analysis of the feed-water, and the general conditions in the steam plant.

Boiler scale disintegrated, and new formation prevented; oil in boilers neutralized; corrosion and pitting stopped immediately.

Zinc, which has been used more or less in boilers in marine work to prevent pitting, is wholly unnecessary when *Dearborn Treatment* is used.

Eighteen years' experience in stationary and marine work.

We have a distinct *Marine Department*, and are giving this branch of the work special attention.

WE CAN BE OF SERVICE TO YOU INVESTIGATE WRITE FOR BOOKLET "X"

DEARBORN DRUG & CHEMICAL WORKS

CHEMICAL ENGINEERS

NEW YORK 299 BROADWAY CHICAGO POSTAL TELEGRAPH BUILDING



CANTILEVER ERECTION OF 150-FT. SPANS ON WESTERN MARYLAND RAILROAD

Bridge and Construction Department

The Pennsylvania Steel Company

STEELTON, PENNA.

STEEL STRUCTURES OF ALL DESCRIPTIONS

siv



RING OF TROOP C ARMORY, BROOKLYN, SPAN 180 FT., LENGTH 310 FT.

Fort Pitt Bridge Works of Pittsburg, Pa. MANUFACTURERS OF STEEL WORK

Eastern Office : 45 BROADWAY, NEW YORK

American Structural Steel Company

ENGINEERS AND CONTRACTORS

Fuller Building, 23d St. and Broadway

NEW YORK





SCHERZER ROLLING LIFT BRIDGE

ACROSS THE GREAT NEVA RIVER AT THE WINTER PALACE, ST. PETERSBURG, RUSSIA SCHERZER ROLLING LIFT BRIDGES ARE MODERN, SCIENTIFIC, ECONOMICAL, SAFE, EFFICIENT, ARTISTIC. THEY ARE SUPERSEDING AND REPLACING SWING BRIDGES, AND OTHER OLD AND OBSOLETE TYPES OF MOVABLE BRIDGES IN GREATER NEW YORK, CHICAGO, BOSTON, CLEVELAND, BUFFALO AND MANY OTHER PROGRESSIVE CITIES AT HOME AND ABROAD, AND ALSO FOR THE PRINCIPAL STEAM AND ELECTRIC RAILROAD COMPANIES THROUGHOUT THE WORLD.

WRITE US FOR INFORMATION, PHOTOGRAPHS, SKETCHES AND ESTIMATES.

THE SCHERZER ROLLING LIFT BRIDGE COMPANY

MAIN OFFICES: MONADNOCK BUILDING,

CHICAGO, U. S. A.





Peculiarly adapted to the finer uses

VULCANITE PORTLAND CEMENT COMPANY

ALBERT MOYER, MGR. SALES

FLAT IRON BLDG., N.Y.

The Snare & Triest Co. Contracting Engineers

xviii



RECREATION PIER, FOOT OF MARKET STREET, NEW YORK

BUILDINGS STEEL AND MASONRY CONSTRUCTION

BRIDCES PIERS AND SHEDS COALING PLANTS

MAIN OFFICE 39 Cortlandt Street, New York City

Havana Office, Mercaderes II

THOMAS B. LEAHY <u>BUILDER</u> 9 EAST 42D STREET NEW YORK CITY

xix

TELEPHONE, 2350 38TH STREET

FRANK J. CALLACHER GENERAL CONTRACTOR

Grading and Sewering. Water Mains and Electric Conduits Laid. Cellar Excavating, Road Construction, Paving Block, Cobble and Macadam. Sand Furnished.

574 Park Place,

Brooklyn, N. Y.

TELEPHONE, 1524 **PROSPECT**

C. W. COLLINS GENERAL CONTRACTOR BRONX, NEW YORK



CAISSON FOR BROOKLYN TOWER FOUNDATION, MANHATTAN BRIDGE, NEW YORK CITY

J. C. ROGERS <u>Contractor</u>

1909 AMSTERDAM AVENUE

NEW YORK

TELEPHONE, 2987 MORNINGSIDE

 $\mathbf{x}\mathbf{x}$



xxi



PUBLIC SCHOOL NO. 85 EVERGREEN AVENUE AND COVERT STREET, BROOKLYN LENGTH 135 FEET, WIDTH 85 FEET; WEIGHT 7,500 TONS RAISED 34 INCHES, JULY, 1904

GEORGE HILDEBRAND

BUILDER and GENERAL CONTRACTOR

POTTER BUILDING

38 PARK ROW

NEW YORK

xxii

		•		
ΧХ	1	1	1	



100 TON DUDGEON HYDRAULIC JACKS UNDER LIFTING GIRDERS, SUPPORTING SIX STORIES OF THE TIMES BUILDING, N. Y. LEWINSON & CO., CONTRACTORS

RICHARD DUDGEON, Inventor, Patentee and Manufacturer of HYDRAULIC JACKS HYDRAULIC PUNCHES, AND ROLLER TUBE EXPANDERS 24-26 COLUMBIA ST 82 BROOME ST. NEW YORK





THE HOW, WHY AND WHAT

Warren's Bitulithic Pavement

HOW is Bitulithic Pavement constructed?

It is constructed of the hardest crushed stone, the various sizes of which are so skillfully combined that the smaller sizes fill the voids between the larger ones so completely that the resultant mass is 92 per cent. solid stone. This mineral aggregate is thoroughly coated in mechanical mixing machines with specially prepared bitumens and when the combined mass is spread upon the street and compressed to the required thickness with heavy steam rollers, the result is a thoroughfare of the greatest durability; absolutely impervious to moisture, smooth but not slippery, free from dust and mud, affording the most secure footing for horses and providing the lightest tractive resistance of any known pavement.

${f WHY}$ is Bitulithic Pavement superior to all others ?

Because it cannot crack or disintegrate. Of the 2,500,000 square yards of Bitulithic laid in 85 cities of the United States and Canada, from Glace Bay, N. S., to Shreveport, La., and from Portland, Me., to Portland, Ore., a single crack or disintegration is yet to be found. It is practically noiseless and as the nearest approach to the ideal pavement was awarded, the ONLY GOLD MEDAL for pavements at the St. Louis World's Fair.

WHAT is Bitulithic's field?

The busy thoroughfare of the crowded city, the streets of its most refined residential sections, the highways of villages and country roads, resurfacing macadam roads, asphalt, brick, stone block or cobble stone pavements, in fact, anywhere that a good substantial high class roadway is desired.

THE FULLEST INFORMATION

IS YOURS ROR THE ASKING

Warren Brothers Company

General Offices : 93 Federal Street, Boston, Mass.

Our Trade Marks: "BITULITHIC, "BITROCK, "BITUMINOUS MACADAM," "PURITAN"

xxv

xxvi



PITKIN AVE. PUBLIC BATH, BROOKLYN, N. Y. L. H. VOSS, ARCHITECT

ALBERENE STONE

WAS USED FOR THE

SHOWER COMPARTMENTS, URINAL AND TOILET COM-PARTMENTS, WAINSCOTING AND STAIR TREADS

ALBERENE STONE CO.

NEW YORK

CHICAGO

BOSTON

xxvii



TELEPHONE, 371 MADISON.

ESTABLISHED 1883.

Fordham Stone Renovating Co.

STONE AND BRICK BUILDINGS

CLEANED, REPAIRED, PAINTED

OFFICE

1123 BROADWAY, NEW YORK.

xxviii



"Erected without nail or screw."

THE DUCKER PORTABLE STRUCTURES have received the highest commendations from engineers, and City, State and National officials, by whom they are extensively used. The United States Government have adopted this construction as a STANDARD OF EXCELLENCE.

The DUCKER HOUSES are exceedingly simple, and can be erected by unskilled labor, taken down and re-erected. They are comfortable in all grades of temperature.

DUCKER COMPANY, 277 BROADWAY, NEW YORK



DUCKER BUILDINGS AT BELLEVUE



xxix

WALDORF-ASTORIA IRONING ROOM SHOWING THREE AMERICAN MANGLES AT WORK

THE AMERICAN LAUNDRY MACHINERY COMPANY

COMPLETE EQUIPMENTS FOR MUNICIPAL USE

132-134-136-138 W. 27th Street

NEW YORK



XXX

xxxi



68TH PRECINCT POLICE STATION HOUSE AVENUE U AND EAST 15TH ST., BROOKLYN

L. H. VOSS, ARCHITECT.

TELEPHONE CALL, 220 SOUTH

DANIEL J. RYAN

Contractor and Builder

721 THIRD AVENUE

Borough of Brooklyn NEW YORK CITY

xxxii



ARMORY FOR THE SECOND BATTALION, NAVAL MILITIA, 52D STREET AND FIRST AVENUE, BROOKLYN

LORD & HEWLETT, ARCHITECTS

RYAN & MCFERRAN Building Contractors

106 EAST 23d STREET

NEW YORK



70TH PRECINCT POLICE STATION, BATH AVENUE AND BAY 22D STREET, BROOKLYN. FULLER & O'CONNOR, BUILDING CONTRACTORS

TELEPHONE, 3537 MAIN.

26 COURT STREET, BROOKLYN.



110 AND 112 FIFTH AVENUE, NEW YORK Robert Maynicke, Architect

LUKE A. BURKE & SONS

BUILDERS. ENGINEERS AND CONTRACTORS

401 W. 59th Street, Telephone 4037-4038 Columbus New York FIREPROOF BUILDINGS A SPECIALTY



INNER CORNER OF QUADRANGLE NEW BUILDINGS FOR THE COLLEGE OF THE CITY OF NEW YORK ST. NICHOLAS TERRACE AND 140TH STREET

THOMAS DWYER

BUILDER

1613 AMSTERDAM AVENUE,

NEW YORK CITY

Among other buildings erected by Mr. DWYER are:

EAST WING METROPOLITAN MUSEUM OF ART, CENTRAL PARK; SOLDIERS AND SAILORS MONUMENT, 89TH STREET AND RIVERSIDE DRIVE; FOUNDATIONS FOR HIGH SERVICE WORKS, WASHINGTON HEIGHTS; RECEPTION HOSPITAL, FOOT OF EAST 16TH STREET; LIGHTHOUSE, PORTLAND, MAINE; NEW HALL OF RECORDS, BROOKLYN, ETC.

xxxv





PROGRESS PHOTOGRAPH, JULY 27, 1905

PUBLIC SCHOOL 147 Bushwick Avenue and Seigel Street Eorough of Brooklyn

CLARKE & STOWE

Builders

229 KENT AVENUE

BROOKLYN



FIREPROOF BALCONIES, KINGS COUNTY HOSPITAL

A. WINTERNITZ Builder and General Contractor OFFICE 237 EAST 72d STREET NEW YORK

TELEPHONE, 1817 79TH

xxxvii



xxxviii

ARMORY BUILDING FOR TROOP C, N. G. N. Y., BEDFORD AVENUE BETWEEN PRESIDENT AND UNION STREETS, BOROUGH OF BROOKLYN, NEW YORK CITY.

JOHN KENNEDY & SON

MASONS, BUILDERS AND GENERAL CONTRACTORS

175 and 177 FRONT STREET, BROOKLYN, N. Y. CITY

TELEPHONE CONNECTION

xxxix

Hudson River . . BLVE STONE Genuine North River

CURB, FLAG, CROSSING, SILLS, LINTELS, WATERTABLE, STEPS, COPING, ETC.

ANY DESIRED FINISH FOR STREET OR BUILDING WORK 280 BROADWAY, NEW YORK

C. C. BULL, SALES AGT.



This book was printed

by

The Evening Post Job Printing Office

156 Fulton Street

New York



Other Printing, of whatever nature, will be done equally as well \therefore \therefore

ENGINEERING NEWS

POINTS THE WAY TO

The Broadening of your field of Technical Knowledge. The Study of Engineering Specialties.

The Securing of Valuable Contracts and other Profitable Business.

The Economical Purchase of Machinery and Supplies. The Engaging of Efficient and Experienced Help.

The Procuring of Remunerative Employment in all lines of Engineering Work.

Engineering News has an extensive circulation throughout the world among Engineers in all branches of the profession; Contractors; Manufacturers; Supply Firms; Railroad Officials; Purchasing and Commission Agents; Colleges; Libraries, etc, and everywhere is it recognized as the leading Reference and Authority on Engineering Matters and as an invaluable Business Producer.

Subscription Rates (payable in advance): United States and points in the domestic postal service, One Year, \$5.00; Six Months, \$2.50. To Foreign Countries (Regular Edition), One Year, \$9.00; Thin Paper Edition (Construction News Supplement omitted). One Year, \$5.00, (21 shillings, 25 Frances or 21 Marks). Single Copies of any number in Current Volume, 15 cents.

Trial Subscription (United States, Canada, Mexico, Cuba, or Porto Rico), Ten Weeks, \$1.00.

PUBLISHED EVERY THURSDAY AT 220 BROADWAY, NEW YORK CITY

SEND FOR SAMPLE COPY AND CATALOGUE OF BOOKS

xli


xlii

EUGENE DIETZGEN CO.

xliii

Drawing Materials and Surveying Instruments

No. 119=121 West 23d Street, New York

No. 181 Monroe Street CHICAGO No. 14 First Street SAN FRANCISCO No. 145 Baronne Street NEW ORLEANS



Manufacturers of the highest grade Transits and Levels and of other Field Instruments, Leveling Rods, Ranging Poles, Steel and Metallic Tapes, Steel Tape Chains.

Our "**Gem Union**" Drawing Instruments have no equal and are Standard. Correct in mechanical principal and construction, and are made of the best material.

The "Mack Improved Slide Rule."

engine divided, adjusts itself automatically and is superior to all others. We also carry a variety of other slide rules.

Large assortment of **Drawing Materials** of the highest quality ; Tracing Cloths and Papers, Drawing Papers, **Perfect** Profile and Cross Section

Papers, Scales, T Squares, Triangles, etc., etc.

Blue and Black Print Papers.

Our "**Vandyke**" Solar Black Print Paper has no equal. Samples cheerfully furnished.

SEND FOR OUR ILLUSTRATED 411-PAGE CATALOGUE.



KOLESCH & CO. 138 Fulton St., New York MANUFACTURERS SURVEYING INSTRUMENTS of High Grade SURVEYING INSTRUMENTS "PRECISION" S LIDE RULER SELECTED ASSORTMENT OF DRAWING MATERIALS

xlıv

SEND FOR ILLUSTRATED CATALOGUE Q

ELECTRIC LIGHT PRINTS MADE DAY OR NIGHT



E. C. SOLTMANN DRAWING MATERIALS 125 E. 42d Street, New York

Special Prices for trial orders for PRINTS ON PAPER

Up to 4½ x 12 Ft.

BLACK PRINTS, 3 cents square foot BLUE '' 2 cents square foot Smallest Prints from 5 cents each up.

Write for Price List of DRAWING MATERIALS and Samples of Paper

CHARLES W. LEAVITT, Jr.

LANDSCAPE ENGINEER

PARK WORK WATER SUPPLY DRAINAGE 15 CORTLANDT ST.,

BOROUGH OF BROOKLYN

NEW YORK

LOUIS H. VOSS

ARCHITECT

65 DEKALB AVENUE

NEW YORK

Telephone Connection

CITY SURVEYOR

WATSON C. CLARK CIVIL ENGINEER

1125 BROADWAY, NEW YORK

BRIDGES SEWERAGE WATER WORKS DOCK CONSTRUCTION TEST BORINGS FOR FOUNDATIONS
