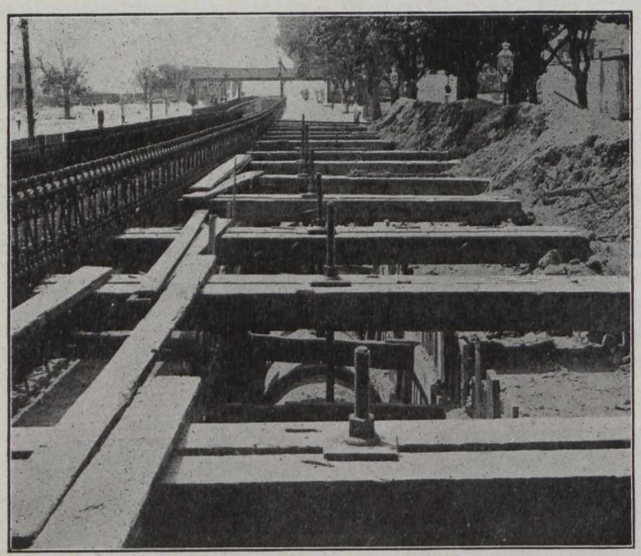
actually opened or travelled, so as to provide for future crossings. In such cases the cost to the city was to be increased so as to cover one-half of the expense of such additional bridges.

The Brighton Beach improvement is now completed, but the Bay Ridge improvement, although in an advanced stage of construction, will take about twelve months longer to complete. The work already done on this last mentioned improvement embraces the raising and depressing of about twelve miles of double track, the construction of railroad and highway bridges with reinforced concrete floors; plain and reinforced concrete retaining walls and bridge abutments, station buildings, freight and storage yards, new streets, etc. The contract for the final section of the work was recently let for a figure approximating $1,250,000, and when complete will bring the total amount expended on the Bay Ridge improvement to about $8,000,000.

The principal item on this final section of the improvement consists of a four-tube reinforced concrete tunnel, 3,500 feet in length, the building of which, in open cut, through the busy East New York section of Brooklyn,



The Atlantic Avenue Main.

bristles with engineering problems which the improvement engineers will be called upon to solve. The tunnel will cut through many of the busiest streets in East New York, and it was necessary to clear the way for the building of the tunnel by the carrying out of an immense amount of preliminary work. Sewers, gas and water mains, conduits, etc., have been diverted, and this article is intended to deal with a section of this work, viz., the raising of three 48-inch water mains. Fig. 1 shows the location of these water mains in reference to the centre line of the new tunnel. It will be noticed that they cross the tunnel comparatively close to the south portal, the end adjoining the improvement as completed to date. Difficulties were thus encountered at the very outset of the work. As finally designed, it was found that the three water mains cut through the intrados of the four arches of the tunnel, and it was therefore necessary that they be raised before the work of building the tunnel commenced. To have designed the tunnel to avoid interfering with the water mains was impossible. This would have entailed a big outlay in the shape of many thousand additional yards of excavation and concrete, and most important of all, would have given a grade vastly inferior to the one finally adopted. The additional cost would, furthermore, have been many times that entailed by the raising of the mains.

A large amount of work was necessary before the actual raising of the pipes could be undertaken. Detailed drawings showing the existing elevations and location of the water mains in relation to the proposed tunnel were prepared and submitted to the Brooklyn Department of Water

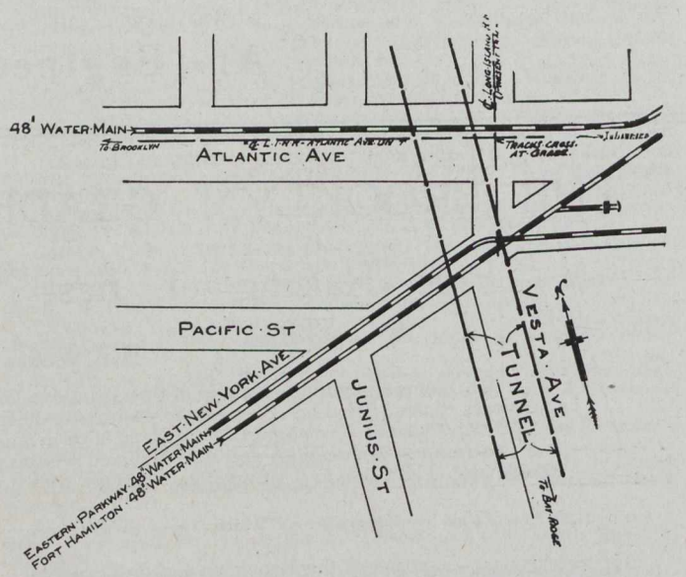


Fig. 1.—Sketch Showing Location of Water Mains.

Supply, who have jurisdiction over all mains laid in the borough of Brooklyn. This department in turn drew up a large scale plan, embodying a general scheme of the method to be pursued in the carrying out of the work.

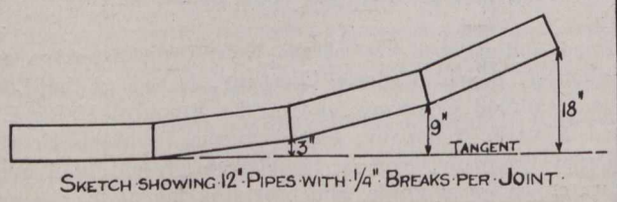
In Fort Hamilton and the Eastern Parkway water mains, or rather the portions of them which required raising, pass underneath the existing Long Island tracks and provision had to be made for the carrying on of the railroad traffic

Table I.

Dia. of Pipe in Inches	Break in Inches per Joint	Offset in Inches for No. of Lengths									
		1	2	3	4	5	6	7	8	9	10
12	1/4	3	9	18	30	45	63	84	108	135	165
	3/8	4½	13½	27	45	67½	94½	126	162	202½	247½
	1/2	6	18	36	60	90	126	168	216	270	330
	5/8	7½	22½	45	75	112½	157½	210	270	337½	412½
16	1/4	2¼	7½	15	25	33⅜	52½	70	90	112½	137½
	3/8	3⅜	10⅛	20¼	33¾	50⅝	70⅞	94½	121½	151⅞	185⅝
	1/2	4½	13½	27	45	67½	94½	126	162	202½	247½
	5/8	5⅝	16⅞	33¾	56¼	84⅜	118⅛	157½	202⅞	253⅛	309⅜
20	1/4	1⅞	5⅛	10⅞	18	27	37⅞	50¼	64⅞	81	99
	3/8	2¾	8⅛	16⅛	27	40½	56¼	75⅜	97⅛	121½	148½
	1/2	3¾	10⅞	21⅝	36	54	75⅜	100¾	129⅝	162	198
	5/8	4½	13½	27	45	67½	94½	126	162	202½	247½
30	1/4	1⅛	3⅜	7⅛	12	18	25⅛	33⅝	43⅛	53	66
	3/8	1⅝	5⅛	10⅝	18	27	37½	50¼	64⅝	81	99
	1/2	2¼	7⅛	14⅜	24	36	50¾	67½	86⅜	106	132
	5/8	3	9	18	30	45	63	84	108	135	165
48	1/4	¾	2¼	4½	7½	11¼	15¾	21	27	33¾	41¼
	3/8	1⅛	3⅜	6¾	11¼	16⅞	23⅝	31½	40½	50⅝	61⅞
	1/2	1½	4½	9	15	22½	31½	42	54	67½	82½
	5/8	1⅞	5⅝	11¼	18¾	28⅛	39⅜	52½	67½	84⅜	103⅛

$$\text{Constant for any Break in Joint} = \text{Break in Joint in Inches} \times \frac{144}{\text{Dia. of Pipe in Inches}}$$

$$\text{Offset from Tangent at any Pipe Length} = \text{Number of Pipes} \times \left(\frac{\text{Number}+1}{2}\right) \times \text{Constant}$$



Sketch showing 12" Pipes with 1/4" Breaks per Joint.

during the progress of the work. The portion of the Atlantic Avenue main raised did not interfere with the railroad, the end adjoining some stripping quite close to the tracks.