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The Rahway valley trunk sewer and its relations to, and effect upon the city of Rahway

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THE RAHWAY VALLEY TRUNK SEWER AND ITS RELATIONS TO, AND EFFECT UPON THE CITY OF RAHWAY

BY

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* F O R E W O R D *

This treatise is divided into three separate parts, each portraying a particular phase of the Rahway Valley improvement. Although not directly connected with the Joint Meeting, the fact that I served as Assistant City Engineer in Rahway during 1931 and 1932 naturally presented to me the opportunity of attending meetings and studying the project especially as it pertained to the City of Rahway.

Part one is a general review of the activities of the Rahway Valley Joint Meeting, both prior to and after the completion of the trunk sewer. The second portion reveals some of the intricate problems evolving in joint propositions of this nature, where arises the difficulty of determing what provisions should be incorporated in the contract to afford equally beneficial conditions to all participating municipalities. The third part is a discussion of the proposed scheme of treatment and the various units making up the disposal works.

To one not acquainted with this particular project, it might seem, after a perusal of this report, that Rahway was somewhat unreasonable in its procedure and asked for privileges to which it was not entitled. But it

must be kept in mind that if the communities in the upper part of the valley had failed to build a trunk line to the tidal waters below the City of Rahway, they no doubt would have been compelled by the State Board of Health to erect elaborate treatment plants which would provide effluents highly purified so as not to contaminate the Rahway River which is used as a source of water supply for domestic use in Rahway. Without question, the program adopted was by far the more economical for these municipalities. On the other hand, Rahway was in a position to handle the situation entirely independent of the other towns, inasmuch as a much smaller trunk would have been required and the disposal plant would have been comparatively inexpensive as its effluent would have been discharged into tidal waters not being used as a domestic water supply.

Just why Rahway decided not to follow this latter course was a matter of choice based upon the presumption that these geographical conditions favoring Rahway would be considered in the contract and that the proposed improvement would not be delayed by dissension among the members of the Joint Meeting. The comprehensive analysis of the conditions previous to the adoption of the Supplemental Contract, disclosed many interesting facts

to bear out the contention of Rahway that it was placed in a predicament entirely unsatisfactory when measured by the advantages available to the other municipalities, and consequently Rahway had no alternative than to proceed to demand, in the interests of its taxpayers, provisions in the new contract to insure a more equitable standing. This unfortunate state of affairs was one of the chief reasons for the delay in the completion of the project.

While it is not my intention to condemn such joint proposals nor to imply that Rahway was intentionally placed in such an unenviable position, nevertheless, I have come to the conclusion that in order to insure the consummation of such improvements to a satisfactory and economical termination with as little delay as possible, the most essential feature is the establishment of an unquestionably equitable basis of apportionment of cost formulated after a careful study of all pertinent factors involving each municipality individually. It is with this purpose of bringing to light this matter that I have included the second part of this thesis showing the consequences of this case as they related to the City of Rahway.

* A C K N O W L E D G M E N T S *

The writer gratefully acknowledges the courtesy of permission accorded for the inclusion of portions of reports previously compiled by Consulting Engineer of the City of Rahway, MR. ALEXANDER POTTER, and the generosity of MR. GEORGE GOODWILL, City Engineer of Rahway, and MR. W. DARROCH, Secretary of the Rahway Valley Joint Meeting, in granting access to the various maps and plans including the plans of the Rahway Valley Treatment Plant.

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INTRODUCTION

INTRODUCTION

The protection of health relative to polluted waters has become a paramount issue in the United States in the past decade or two, consequently much time and study has been expended in research work and associate practices in treating sewage. Encouraging results have inspired the planning and execution of many new sanitary projects, and, although the science of treating or partially purifying sewage is still in its primary stage of development, sufficient progress has been made to rank the modern disposal plant with the improvements established in other branches of engineering. The sewage treatment plant is no longer looked upon as an unsightly, offensive eyesore to be shunned by the layman, but is rather, an attractive institution designed to hastem the purifying qualities of nature with little or no inconvenience or discomfiture to its immediate surroundings.

In every State in the country we now see the increasing interest in sanitary problems and the tendency to strive for ideal conditions necessary for the safeguarding of the health of the rapidly increasing population. It can hardly be expected that the desired effects be achieved at once in such a gigantic proposition, but

instead, a continuous process of improvement is required which will eventually result in the attainment of the much desired goal of insured safety.

The State of New Jersey has not been slow in realizing that a program of improvements is essential for the abatement or correction of pollutions producing injurious health conditions. It has set up a Board of Health composed of eleven members who direct the activities of the various bureaus under the department. At present the Bureau of Engineering supervises the construction and operation of 318 water supplies, 119 water purifying plants, and 368 sewage treatment works. In addition, it analyzes and reports upon samples from every water supply in the State, and examines plans and specifications for proposed sewerage systems, disposal plants, and waterworks. The regulations of the department have gradually increased in substance and rigidity, and efforts are being made to compel the municipalities to treat all sewage and objectionable wastes.

After an extensive investigation and study of the Harbor of New York and nearby coastal waters, it has been recommended that a Tri-State Compact be adopted to establish a sanitary district for this area with the intention of controlling future pollution and abating the ex-

isting nuisance. This proposed compact or agreement divides the waters into two general classes, the first of which probably includes nearly all of the municipalities in the metropolitan district and eastern New Jersey. This class pertains to waters which are expected to be used primarily for recreational purposes, shellfish culture, and the development of fish life. Under this class all sewage discharged or permitted to flow into the said waters shall first be so treated as to attain a satisfactory stage of purification as determined by analyses of the removal of floating matter, suspended solids, bacteria, and the oxygen demand of the sewage. The tentative requirements by the above analyses are: floating matter, practically 100% removal; suspended solids, a removal of at least 60%; bacteria, a reduction of organisms of the B. coli group so that the probable number of such organisms shall not exceed one per cubic centimeter in more than 50% of the samples of sewage effluent tested by the presumptive method; oxygen demand, a reduction sufficient to maintain an average dissolved oxygen content in the tidal waters of the district or point of discharge, at a depth of about 5 feet below the surface, of not less than 50% saturation during any week of the year.

To comply with these regulations, it is really compulsory for practically all of the communities in eastern New Jersey to erect sewage treatment plants which will provide effluents as specified in the sanitary laws of the State.

Economic conditions have retarded progress to a certain extent in this direction, but it is hoped that financial support will soon be available for such a worthy cause. The Rahway Valley Joint Meeting has been confronted with such an obstacle for the past year or so, but in all probability its disposal works will be started early in 1934 as efforts are being exerted to obtain aid from the Government under the Public Works Act.

PART I

THE RAHWAY VALLEY TRUNK SEWER

PART I

THE RAHWAY VALLEY TRUNK SEWER

ORIGINAL INCEPTION

The construction of a Rahway Valley Trunk Sewer to serve several towns in Union County, New Jersey, was first advocated in 1913 after the State Department of Health had notified the communities located near the Rahway River that it would be necessary to take effective measures to clean up the river by installing collecting systems and treatment plants for their sewage. A few of the towns became interested in a joint proposition but failed to come to an agreement on the distribution of costs, and the project was temporarily abandoned.

Agitation for a joint sewerage system continued, and in 1917 a commission was formed of representatives of the participating municipalities, and an engineer was appointed to study the problem. Plans were submitted by the latter describing a system of sewers ranging from 24" to 54" in diameter with a capacity at the lower end of approximately 17 million gallons per day, and a treatment plant at tidewater, with a total estimated cost of about $620,000. Again the project failed to materialize because of the War and increased construction costs.

In the meantime the conditions of the Rahway River, both above and below the intake to the Rahway Waterworks, became steadily worse until 1928 when it became apparent that the health of the people of that community was greatly jeopardized because of the pollution of the river and subsequent contamination of the water supply by adjoining towns in the valley.

From a geological survey of the Rahway River, it was found that the total drainage area of the main branch supplying water to the City of Rahway was about 41 square miles, and its flow during dry weather was as low as 5.3 million gallons per day. Taking into consideration the fact that at that time this drainage area supported a density of population of about 1500 persons per square mile as well as some twenty or thirty industrial plants; it is not difficult to conceive what a substantial influence waste products might have on such a stream.

The City of Rahway realized the advantages offered in the proposed sewerage system which would serve it two purposes; first, to safeguard its water supply, and second, to aid in the clarification of the river. Other communities too, were eager to enter into the joint proposition in order to obtain a source of disposal for their sewage and other waste matter, and reorganization began immediately.

REORGANIZATION

Reorganization of the Rahway Valley Joint Meeting for the purpose of supervising the affairs and directing the activities of the proposed improvement took place in 1928, its members representing the municipalities of Rahway, Westfield, Cranford, Springfield, Roselle Park, Kenilworth, Clark, Garwood, and Woodbridge. It was planned to build a trunk line sanitary sewer which would have a maximum capacity of 42.75 million gallons per 24 hours, and a treatment plant at the outlet to be located on the Rahway River in the Township of Woodbridge. The effluent from the plant was to discharge into the river at that point, while the sludge was to be barged to sea. The estimated cost of the work was set at a figure less than $2,000,000.

The Joint Meeting was organized under an act of the Legislature known as the Act of 1899, Chapter 36, entitled, "An Act to Authorize Two or More Municipalities in this State to Jointly Construct and Maintain Outlet or Trunk Sewers." Provisions of this act permits the formation of a commission made up of members representing their respective communities, each to have one vote on all motions, resolutions, appointments, and other proceedings, thereby giving equal voting power to each

municipality regardless of the amount of money subscribed toward the cost of the improvement. It further states that "the words 'joint meeting' as used in this act, shall be construed to mean the meeting or assembly of the members of the governing bodies or boards of the several municipalities having the authority to make and enter into a contract for the construction jointly of public improvements, pursuant to and by virtue of the provisions of this act."

Upon the reorganization of the Joint Meeting, Mr. Clyde Potts, who had studied the project previously, was retained as the Engineer for the work which was to be completed by July 1, 1930. Actually, the sewer construction was completed in that year but the treatment plant was delayed because of difficulties encountered in the adoption of the Supplemental Contract and the lack of funds to meet its requirements.

FINAL PLAN FOR SYSTEM

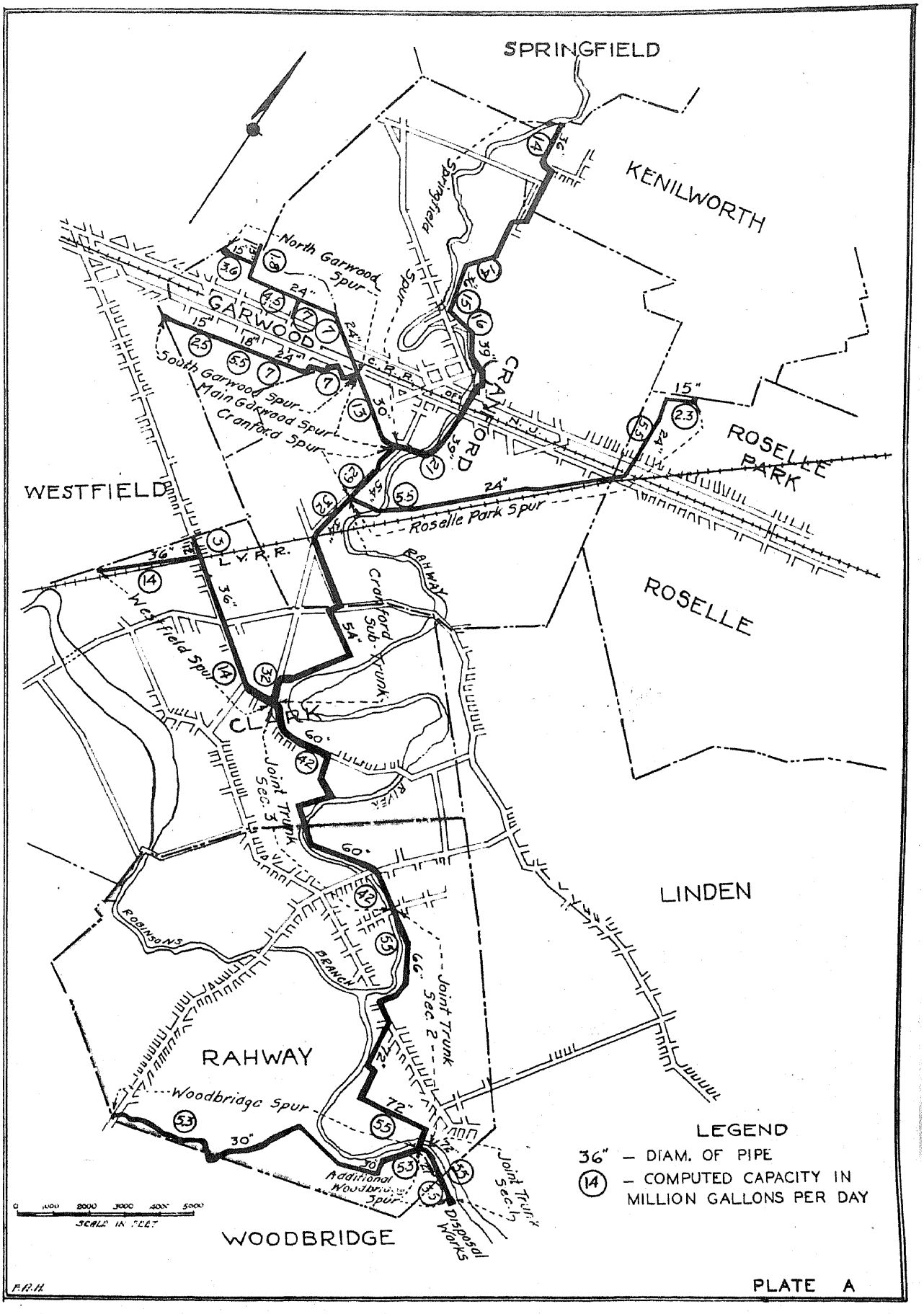
The work was divided into five units in order to facilitate the construction of the sewer, and the contract for the first section was awarded in the Summer of 1928. The final contract was not let until the Spring of the following year because of difficulties in securing rights-of-way, and alterations in certain portions

of the general plan.

Application for space in the trunk sewer by the Township of Union resulted in increasing the capacity to 55 million gallons per day. Union, however, later dropped negotiations and the additional space was apportioned among the remaining municipalities.

PLATE A, page 12, shows the locations, sizes, and capacities of the various spurs and the main trunk line whose general route parallels the course of the Rahway River. The entire flow in the trunk sewer and its branches is carried by gravity and is at such an elevation that all of the towns will be able to connect their internal systems by gravity, except Rahway and possibly Westfield. The trunk sewer was maintained at such a level through Rahway in order to reduce the total cost of the project.

To provide sewerage facilities for the Township of Woodbridge, it was necessary to construct another spur, hereafter referred to as the Woodbridge Spur. This branch, designed for a full-flow rate of 5.3 million gallons per day, serves Woodbridge to the extent of 3.32 million gallons per day, the remainder being allotted to Rahway. At present, this spur joins the main 72" sewer near the division point of Section 1 and 2, (See



* See page 69 regarding additional Woodbridge Spur

(see PLATE A), but will be intercepted by a separate line in the future when the 72" sewer becomes overloaded.

ALLOCATION OF SPACE

The capacities allotted to each municipality were based on the estimated future population in 1960 with the aid of flow measurements and sewage studies made in the various communities. Only portions of Roselle Park and Woodbridge are to be served by the sewer and consequently are out of proportion in respect to their total populations. As Woodbridge entered into the contract after an agreement to locate the disposal works in the Township of Woodbridge, its share of the cost was made a lump sum of $50,000 and is not shown in the following tabulation. This table shows the populations at ten year intervals, the estimated populations in 1960, and the space allotted to each municipality.

TABLE I
ESTIMATED FUTURE POPULATIONS AND
ALLOWABLE CONTRIBUTION BY ORIGINAL CONTRACT

MUNICIPALITY	POPULATION			FLOW IN M.G.D.	
	1910	1920	1930	1960	1960
Springfield	1,246	1,715	3,725	12,000	3.00
Cranford	3,641	6,001	11,126	22,000	8.31 a
Kenilworth	779	1,312	2,243	8,500	2.125
Roselle Park	---	---	---	3,000	1.5
Garwood	1,118	2,084	3,344	10,000	4.69 b
Westfield	6,420	9,063	15,801	33,500	12.50 c
Rahway	9,337	11,042	16,011	36,000	9.00
Clark	469	794	1,474	6,500	1.625

a 2.69 M.G.D. thru present sewer
b 0.31 " " " "
c 4.25 " " " "

COST APPORTIONMENT

In distributing the cost of the project to the several communities, each was required to share the expenditure made on each section or spur to which it is allowed to discharge sewage, in proportion to its respective allotment of space. Although the capacities and their relative figures were changed after the original slate, these compiled by the Engineer before the adjustments will serve to explain the method. The Township of Springfield, which is located at the upper end of the system and consequently uses the five sections, is taken as an example outlined in the following table:

TABLE II
APPORTIONMENT OF COST BY ORIGINAL CONTRACT AS APPLIED TO THE TOWNSHIP OF SPRINGFIELD

SECTION NO.	TOTAL CAPACITY M.G.D.	TOTAL COST	SPRINGFIELD SHARE % CAP.	SPRINGFIELD SHARE COST
5	4.625	$ 38,800	64.86	$ 25,200
4	12.185	175,100	24.62	43,100
3	21.875	305,700	13.71	41,900
2	33.75	216,900	8.89	19,300
1	42.75	504,800	7.02	35,400
			Total	$164,900

Estimated Cost of Treatment Plant = $234,000

Springfield Share $7.02\% = \frac{3}{42.75} \times \$234,000 = \$16,400$

Springfield Share, Grand Total = $181,300

As stated previously, there were many changes made in the plans and apportionment of capacities and

costs. The Original Contract provided for a maximum liability of $1,975,900 which was to include the cost of the treatment plant. Under this contract, the participating towns were obligated to pay in the following proportion:

TABLE III
SUMMARY OF APPORTIONMENT OF COST
TO ALL MUNICIPALITIES BY
ORIGINAL CONTRACT

MUNICIPALITY	PERCENT OF COST	MAXIMUM LIABILITY
Rahway	19.358267	$382,500
Garwood	10.511666	207,700
Roselle Park	3.810921	75,300
Kenilworth	6.412268	126,700
Cranford	19.555646	386,400
Westfield	25.072119	495,400
Springfield	8.836480	174,600
Clark	3.912141	77,300
Woodbridge	2.530492	50,000
	Total	$1,975,900

At the completion of the sewer construction, it became apparent that the sum of $1,975,900 would not be sufficient to complete the entire improvement. To meet unpaid bills and to provide for the estimated cost of the treatment plant, another contract was required to be drawn up by the Joint Meeting.

RAHWAY'S ATTITUDE TOWARD CONTRACT

There had been much discontent in Rahway because of the tremendous cost in proportion to the benefits available in the sewer in this city, and it was the con-

sensus of opinion that Rahway had not been treated as fairly as the other towns, considering the fact that it would have to build pumping stations in order to connect its internal system to the trunk sewer. The result was that the City of Rahway employed the services of Mr. Alexander Potter of New York as consulting engineer to investigate Rahway's status in the Original Contract, and to study the internal system before entering into the new contract.

After an analysis of the terms of the Original Contract, Mr. Potter pointed out that Rahway had a perfect right to refuse to contribute to the completion of the work. Under the provisions, it was allowed that in event that the maximum amount was exceeded, the municipalities had the privilege of agreeing to contribute the additional funds necessary and in such an event, the capacities of each of the municipalities should be revised so that "each municipality shall have the same percentage of the total authorized use as its payments for the improvements bear to the total payments of all municipalities for the improvements, providing, however, that the authorized use of Woodbridge shall not be affected." He further advised that if there were no inequities in the Original Contract, Rahway and every other munic-

ipality would be bound to promptly appropriate the additional funds to whatever extent might be necessary to complete the work that had been started for the benefit of the district as a whole. In face of such inequities in the Original Contract, under its terms each municipality had the right to examine into these injustices in order that they might intelligently determine what amounts they might be willing voluntarily to contribute for the completion of the improvement.

The City of Rahway proceeded to enumerate what it considered injustices in the Original Contract, and forwarded certain requests to the Joint Meeting concerning provisions of the proposed new contract. These requests are discussed in PART II, and it will be sufficient at this point to state that some of these demands were granted and incorporated in the Supplemental Contract adopted by the several municipalities of the Joint Meeting.

CHANGE IN ALLOTMENT OF SPACE

One provision in the new contract increased the space allotted to Rahway in greater proportion than to the other towns as a result of the requests made by that city. The following tabulation shows the changes made in this respect to conform with the alterations made in the capacity of the trunk sewer.

TABLE IV
CHANGE IN ALLOCATION OF SPACE

MUNICIPALITY	ORIGINAL SPACE M.G.D.	INCREASE M.G.D.	TOTAL M.G.D.	% INCREASE
Springfield	3.00	0.70	3.70	23.3
Cranford	8.31	1.94	10.25	"
Kenilworth	2.125	0.495	2.62	"
Roselle Park	1.50	0.35	1.85	"
Garwood	4.69	1.10	5.79	"
Westfield	12.50	2.92	15.42	"
Clark	1.625	0.385	2.01	"
Rahway	9.00	4.36	13.36*	48.5
	42.75	12.25	55.00	

*Space in Woodbridge Spur not included

SUPPLEMENTAL CONTRACT

The complete draft of the Supplemental Contract, with the exception of that portion pertaining to the disposal works which is included in PART III, appropriating an additional $900,000 for the completion of the project is as follows:

Recitals

"The parties hereto have heretofore under the date of the 20th day of October 1928, made a contract pursuant to an act of the State of New Jersey, entitled; 'An act to authorize two or more municipalities in this State to jointly construct and maintain outlet or trunk sewers', constituting Chapter 36 of the laws of 1899, and the acts amendatory thereof and supplementary thereto, and the parties hereto desire to supplement and amend the said contract as herein provided."

Contract

"ARTICLE I. This contract is to supplement and amend the contract between the parties hereto, dated October 20, 1928 (herein sometimes referred to as the 'original contract') and from and after the execution hereof the two contracts shall be read together."

"In case of any inconsistency between this contract and the original contract, the provisions of this

contract shall govern."

"As hereby supplemented and amended the contract of October 20, 1928, is hereby approved, ratified, and confirmed."

"ARTICLE II. The parties hereto agree jointly to construct, complete, maintain, repair, and rebuild the improvements as described in Schedule X hereto attached and hereby made a part hereof, in place and instead of the improvements as described in Schedule A attached to the original contract."

"All changes heretofore made by the Joint Meeting resulting in constructing the improvements as described in said Schedule X instead of as described in said Schedule A attached to the original contract are hereby approved, ratified and confirmed."

"That part of the disposal works described in Schedule X which is therein designated for future construction shall be constructed from time to time as the parties hereto shall determine. It is not hereby intended to defer the time for the reorganization of the Joint Meeting until such future construction shall be completed and such reorganization shall take place upon the completion of all other parts of said improvements which shall be constructed forthwith."

"The said improvements shall be constructed in general as described in the maps and plans marked 'Maps and Plans of the Rahway Valley Trunk Sewer', made and compiled as part of the Supplemental Contract, as of March 2, 1931, and filed in the office of the Joint Meeting and in the offices of the clerks of the municipalities that are parties hereto."

"ARTICLE III. The cost of construction of the improvement to be forthwith constructed in excess of $1,975,900 (which is the aggregate of the maximum liabilities of the parties hereto under the original contract) shall be paid by the parties hereto in accordance with the percentage of cost set after their respective names in the following table but no municipality shall be liable for more than the maximum liability set after its name in the following table:

TABLE V

NAMES OF MUNICIPALITIES	PERCENTAGE OF COST TO BE PAID BY EACH MUNICIPALITY	MAXIMUM LIABILITY
City of Rahway	19.860844	$ 178,748
Borough of Garwood ...	10.784569	97,061
Borough of Roselle Park	3.909860	35,189
Borough of Kenilworth	6.578743	59,209
Township of Cranford .	20.063347	180,570
Town of Westfield	25.723038	231,507
Township of Clark	4.013707	36,123
Township of Springfield	9.065892	81,593
	100.000000	$ 900,000

"All provisions of the original contract relating to payments of the cost and defaults in making such payments shall apply to the payments required to be made by this contract."

"ARTICLE IV. "Section 1 of Article IV of the original contract is hereby amended to read as follows:

1. The cost of maintaining, and operating the improvement (including as part of said cost current repairs and cleaning) for any calendar year shall be paid by the municipalities in proportion to the average number of gallons per day discharged into the entire improvement by the municipalities respectively then using the same. Such use shall be determined by flow measurements taken within two months before the estimate for the next calendar year is made and certified. Such measurements shall be taken simultaneously and shall show substantially continuous graphs of the flow for a period of one month. Provided, however, that the Township of Woodbridge shall be under no obligation to pay any part of such cost unless its use of the improvement shall then exceed 500,000 gallons per day and in determining the proportionate use of the improvement by the municipalities for the purposes of this section there shall first be deducted and not included in the computation the use

of said improvement by the said Township of Woodbridge to the extent of but not exceeding 500,000 gallons per day."

"If any municipalities, but not all, shall use the improvement before the completion of the whole improvement to be presently constructed, such cost shall be borne by the municipalities so using the improvement, and shall be determined by flow measurements taken as hereinabove provided during the period of such use as often as may be necessary to determine the amount of such use."

"ARTICLE V. Section 1 of Article VI of the original contract is hereby amended to read as follows:

1. The municipalities respectively shall have the right to use the improvement by contributing sewage to the various parts thereof at the rates of flow designated in this section and expressed in million gallons per day (M.G.D.)."

"PLATE A attached hereto and hereby made a part hereof shows the size of the pipe, the estimated capacity, and divides the entire improvement into parts for the purpose of description. The parts of the improvement referred to in the following table are the parts of the improvement as shown on said PLATE A."

MUNICIPALITY	IMPROVEMENT	RATE OF FLOW M.G.D.
Westfield:	Joint Trunk Section 1	15.42
	Joint Trunk Section 2	15.42
	Joint Trunk Section 3	15.42
	Westfield Spur	11.11
	Cranford Sub Trunk	4.31
	Cranford Spur	4.31
	Garwood Main Spur	4.31
	S. Garwood Spur	1.72
	N. Garwood Spur	2.59
Kenilworth:	Joint Trunk Section 1	2.62
	Joint Trunk Section 2	2.62
	Joint Trunk Section 3	2.62
	Cranford Sub Trunk	2.62
	Cranford Spur	2.00
	Roselle Park Spur	0.62
	Springfield Spur	2.00
Roselle Park:	Joint Trunk Section 1	1.85
	Joint Trunk Section 2	1.85
	Joint Trunk Section 3	1.85
	Cranford Sub Trunk	1.85
	Roselle Park Spur	1.85
Springfield:	Joint Trunk Section 1	3.7
	Joint Trunk Section 2	3.7
	Joint Trunk Section 3	3.7
	Cranford Sub Trunk	3.7
	Cranford Spur	3.7
	Springfield Spur	3.7
Garwood:	Joint Trunk Section 1	5.79
	Joint Trunk Section 2	5.79
	Joint Trunk Section 3	5.79
	Cranford Sub Trunk	5.79
	Cranford Spur	5.79
	Garwood Main Spur	5.79
	N. Garwood Spur	3.47
	S. Garwood Spur	2.32

"Garwood's contribution to the North Garwood Spur and the South Garwood Spur shall be made at such points as not to exceed the capacity of the improvement when added to Westfield's right of contribution to said spur.

MUNICIPALITY	IMPROVEMENT	RATE OF FLOW M.G.D.
Clark Township:	Joint Trunk Section 1	2.01
	Joint Trunk Section 2	2.01
	Joint Trunk Section 3	2.01

"Also Clark Township has the right to contribute to the various spurs and sub-trunks within its limits for a total contribution at the rate not to exceed 2.01 M.G.D. but such contribution shall be made at such points as not to exceed the capacity of the improvement when added to the rights of contribution to such spurs and sub-trunks of Westfield, Cranford, Garwood, Kenilworth, Springfield, and Roselle Park,"

MUNICIPALITY	IMPROVEMENT	RATE OF FLOW M.G.D.
Cranford:	Joint Trunk Section 1	10.25
	Joint Trunk Section 2	10.25
	Joint Trunk Section 3	10.25
	Cranford Sub Trunk	10.25

"Also Cranford has the right to contribute to the various spurs and sub-trunks within its limits for a total contribution at the rate not to exceed 10.25 M.G.D. but such contribution shall be made at such points as not to exceed the capacity of the improvement when added to the rights of contribution to such spurs and sub-

trunks of Westfield, Garwood, Kenilworth, Springfield, Roselle Park, provided, however, that Cranford shall have no right to contribute to the Garwood Spurs and shall have no right to contribute in excess of 1.5 M.G.D. to the Roselle Park Spur."

MUNICIPALITY	IMPROVEMENT	RATE OF FLOW M.G.D.
Woodbridge:	Present Woodbridge Spur	3.32

"Woodbridge shall have the right to use the Disposal Plant to be presently constructed to the extent of 700,000 gallons per day (instead of 500,000 per day as in the original contract); and shall have the right to use the completed disposal plant to the extent of its total maximum flow through the Woodbridge Spur."

MUNICIPALITY	IMPROVEMENT	RATE OF FLOW M.G.D.
Rahway:	Joint Trunk Section 1	13.36
	Woodbridge Spur	1.98

"Also Rahway has the right to contribute to Joint Trunk Section 2 ..... 13.36 M.G.D."

"Also Rahway has the right to contribute to Joint Trunk Section 3, but such contribution shall be limited to an amount which will not exceed the capacity of the improvement when added to the rights of contribution of Westfield, Garwood, Kenilworth, Springfield, Cranford, Roselle Park, and Clark Township."

"When the necessity arises an additional spur

shall be constructed by the contracting municipalities, for the use of Woodbridge, Cranford, and Rahway, as shown in Schedule X at a maximum rate of flow of 3.32 million gallons per day for Woodbridge; at a maximum rate of flow of 3 million gallons per day for Cranford; and at a maximum rate of flow of 1.98 million gallons per day for Rahway. Until the contracting municipalities authorize the construction of said additional spur, and until such use is made available to Woodbridge, Cranford, and Rahway, neither Woodbridge, Cranford, nor Rahway shall be penalized as set up in paragraphs 3 and 4 of Article VI of the original contract for the maximum use above mentioned, of Rahway and Woodbridge at and below the point of connection of the Woodbridge Spur and of Cranford at and below the point of connection of the old Cranford sewer. When constructed, this spur shall be paid for in accordance with the percentages set forth in Article III of the Supplemental Contract."

"The rate of flow herein stated is the maximum rate of flow permitted, and no municipality shall have the right to exceed such rate for any period of time however brief."

"The rate of flow herein stated for any part of the improvement means the total rate of the municipality

at such part including not only the contribution made to or at such part but also the contribution made to any upper parts which must pass through such part."

"The allocations set up in the tables in this contract, granting space to the several municipalities, are based upon the calculated capacity of the Trunk Sewer, but should the capacity as actually determined be greater or less than these in the aggregate, the allocations to the municipalities are to be either increased or decreased in the proportion of the rates of flow as allocated herein."

"ARTICLE VI. Section 4 of Article III of the original contract is hereby amended to read as follows:

The municipalities shall pay for the construction of the remainder of the disposal plant to be constructed in the future in accordance with the percentage of said cost set after their respective names in the following table:

TABLE VI

NAME OF MUNICIPALITY	PERCENTAGE OF COST TO BE PAID BY EACH
City of Rahway	23.137131
Borough of Garwood ..	9.095320
Borough of Roselle Park	3.297436
Borough of Kenilworth	5.548277
Township of Cranford	21.873113
Town of Westfield ...	21.693890
Township of Springfield	7.645849
Township of Clark ...	3.385017
Township of Woodbridge	4.323967

"If space be sold in the improvement prior to the completion of the entire plant the agreement under which the sale is made shall provide for a revision of the percentage of cost to be paid by the parties to the contract and the Joint Meeting shall use such revised percentages when additional units are constructed."

"ARTICLE VII. Unusual Repairs and Rebuilding

Section 1 of Article V of the original contract is hereby amended as follows:

"The cost of unusual repairs and rebuilding of the trunk sewer with the exception of the Woodbridge Spur shall be paid by the municipalities in accordance with the table of percentages shown in Article III of this Supplementary Contract."

"The cost of unusual repairs and rebuilding of the Woodbridge Spur shall be paid by the municipalities as follows:

Woodbridge ..... 62.5% of the total cost and the remaining 37.5% to be apportioned among the municipalities as above provided for the trunk sewer."

"Unusual repairs and rebuilding of the first unit of the disposal plant made prior to the construction of a second unit shall be paid by the municipalities in accordance with the table of percentages of cost shown in

Article III of this Supplemental Contract."

"ARTICLE VIII. In order to induce certain of the Municipalities that are parties to this Agreement to join in it and appropriate the additional funds which they hereby undertake to raise and pay, it is agreed in confirmation of the resolution that was adopted by the Joint Meeting on April 16, 1931, and under the provisions of Section 2 of Chapter 19, P.L. 1903, and Section 7a of Article XXI of Chapter 152, P.L. 1917, that while the additional work herein provided for shall be done under the supervision of the Joint Meeting as now organized, nevertheless, the salaries of the Secretary and Treasurer of the Joint Meeting shall be at the rate of $1500.00 and $1000.00 respectively, per year; the salary of the Permanent Chairman shall be at the rate of $2500.00 per year; that the salaries of the specially designated representatives from the Municipalities, shall cease from and after February 29, 1932, and that when the Joint Meeting shall reorganize for maintenance after the completion of the improvement there shall be no salaried officials other than a Superintendent."

"ARTICLE IX. Section 1 of Article II of the original contract is hereby amended to read as follows:

1. The Township of Woodbridge in consideration

of special rights accorded to it under this contract hereby confirms the consent heretofore given by it and hereby consents that such a disposal works as the Joint Meeting may consider necessary and proper: together with such additions and alterations thereto within the area acquired or to be acquired therefor as may hereafter be made shall be located within its boundaries."

"ARTICLE X. Section 2 of Article VI of the original contract is hereby amended to read as follows:

2. Any Municipality's authorized use shall be its own individual property. Nothing herein shall be construed to prevent a Municipality from assigning its authorized use in whole or in part except that in no such assignment shall be made unless the assignment is first offered to any or all Member Municipalities in writing at a meeting of the Joint Meeting and unless within thirty days thereafter such offer has not been accepted in writing mailed to the Clerk of the Municipality making the offer. If more than one Member Municipality desires to share in such assignment the authorized use shall be assigned to them in proportion to their authorized use according to the terms of this contract."

"ARTICLE XI. Article VIII of the original contract

is hereby amended by adding thereto a new section reading as follows:

3. Should any municipality default in any payment, required to be made in accordance with this contract other than payments for the cost of operation or maintenance of the Trunk Sewer and Disposal Works, in addition to any and all remedies to which the member municipalities are entitled, and should such default continue for a period of three months, the remaining municipalities, or any one of them, may voluntarily contribute such additional amounts as may be necessary to meet the share of the defaulting municipality; and in that event the authorized use of the defaulting municipality shall be reduced in the proportion as the amount of its default shall bear to its total contribution; and such reduction of authorized use shall be allocated to the municipalities contributing to the default in proportion to their contribution."

"ARTICLE XII. In case any part or clause of this contract should be illegal, such illegality shall not affect the other parts of this contract."

"In Witness Whereof the said municipal corporations parties hereto, have hereunto caused their respective names to be signed hereto by their respective mun-

icipal officers thereunto duly authorized and their respective corporate seals to be hereto affixed on the day and year first above written in eleven original counterparts."

SCHEDULE X

"Description of Rahway Valley Trunk Sewer and Disposal Works; Main Trunk as Constructed.

P.R.W. indicates Private Right-of-way
Capacities in million gallons per day

The parts of the improvement as referred to herein correspond to the parts referred to in the same words in PLATE A hereto attached.

SPRINGFIELD SPUR

In Kenilworth: On	To	Length Ft.	Size Ins.	Capacity M.G.D.
P.R.W., Thrid St.	Washington St.	1277	36	14
Washington St.	Fifth St.	500	36	14
Fifth St.	Cranford line	1700	36	14
In Cranford:				
Fifth St.	Venetia Ave.	568	36	14
Venetia Ave. ext.	Elmora St.	668	36	14
Elmora & ext.	Dunham Ave.	1044	36	14
Dunham Ave.	Hanley Ave.	255	36	14
Hanley Ave.	Riverside Ave.	788	36	14
Riverside Ave.	Normandy Ave.	889	36	14
Riverside Ave.	Orange Ave.	897	36	15
Riverside Ave.	Casino Ave.	461	36	16
Riverside Ave.	Union Ave.	967	39	19
Union Ave.	Forest Ave.	151	39	19
Forest Ave.	P.R.W.	795	39	19
P.R.W.	North Ave.	515	39	19
Centennial Ave.	South Ave.	575	39	21
P.R.W.	Lincoln Ave.	1923	39	21
Lincoln Ave.	School Prop.	561	39	21

In Cranford: On	To	Length Ft.	Size Ins.	Capacity M.G.D.
	CRANFORD SPUR			
School Prop.& P.R.W.	Walnut St.	1340	54	29
Walnut St.	Junction M.H.	210	15	3
	CRANFORD SUB-TRUNK			
Walnut & Lexington	Raritan Rd.	3920	54	32
In Clark Township:				
Raritan Rd.	Broadway	362	54	32
Broadway	Riverside Rd.	1216	54	32
Riverside Rd.	Park Rd.	543	54	32
Park Rd.	P.R.W.	1432	54	32
P.R.W.	Walnut Blvd.	81	54	32
Lincoln Blvd.	Central Ave.	941	54	32
	JOINT TRUNK SECTION 3			
Central Ave.	P.R.W.	2322	60	42
P.R.W.	Lincoln Blvd.	1271	60	42
Lincoln Blvd.	Gloria St.	801	60	42
Gloria, Park Prop.	Rahway line	678	60	42
In Rahway:				
Park Drive & River St.	Church St.	3696	60	42
	JOINT TRUNK SECTION 2			
Park Drive & River St.	Linden Ave.	2711	66	55
Linden Ave.	Grand St.	456	66	55
Grand St.	Penna. Ave.	729	72	55
Penna. Ave.	Essex St.	223	72	55
Essex St.	Washington St.	1317	72	55
Washington St.	Lawrence St.	450	72	55
Lawrence St.	Milton Ave.	781	72	55
Milton Ave.	Lennington St.	2166	72	55
Lennington St.	River Crossing	474	72	55
River Crossing	P.R.W.	217	2-42	55
	JOINT TRUNK SECTION 1			
P.R.W.	Woodbridge line	1440	72	55
In Woodbridge:				
P.R.W.	Treatment Plant	585	72	55

CRANFORD CONNECTING SPUR

In Rahway: On	To	Length Ft.	Size Ins.	Capacity M.G.D.
Milton Ave.	Lennington St.	400	20	3

WESTFIELD SPUR

In Clark Township:				
P.R.W.	Central Ave.	3022	36	14
Central Ave.	P.R.W.	207	12	3
Central Ave.	Walnut Ave.	5245	36	14

SOUTH GARWOOD SPUR

In Garwood:				
Myrtle Ave.	Centre St.	2405	15	2.5
Myrtle Ave.	East St.	770	18	5.5
Myrtle Ave.	New St.	1509	24	7
New St.	Willow Ave.	285	24	7
Willow Ave.	P.R.W.	603	24	7
P.R.W.	South Ave.	240	24	7
South Ave.	Elise St.	304	24	7
In Cranford:				
Elise St.	P.R.W.	289	24	7
P.R.W.	Lincoln Ave. (joining Garwood)	542	24	7

NORTH GARWOOD SPUR

In Garwood:				
Union St.	Westfield line	520	15	1.8
Fourth Ave.	Union St.	701	24	3.6
Fourth Ave.	Walnut St.	193	24	4.5
Walnut St.	Third Ave.	341	24	4.5
Third Ave.	N. Oak St.	1703	24	4.5
N. Oak St.	Third Ave.	737	18	3
Third Ave.	Division St.	1047	24	7
Division St.	North Ave.	989	24	7
Lincoln Ave.	Cranford line	299	24	7
In Cranford:				
Lincoln Ave.	Connection with south lateral	644	24	7

GARWOOD MAIN SPUR

In Cranford:				
Lincoln Ave.	Trunk Sewer M.H.	2273.6	30	13

ROSELLE PARK SPUR

In Roselle Park & Cranford: On	To	Length Ft.	Size Ins.	Capacity M.G.D.
Colfax Ave.	Beachwood Ave.	1025	15	2.3
Beachwood Ave.	Grand St.	568	24	5.5
Grand St.	P.R.W.	1762	24	5.5
P.R.W.	Fifth St.	3310	24	5.5
Fifth St.	Meeker Ave.	117	24	5.5
Meeker & Winans	Winans Ave.	141	24	5.5
Lehigh Ave.	P.R.W.	3389	24	5.5
P.R.W.	Walnut Ave.	1867	24	5.5

WOODBRIDGE SPUR

In Rahway:				
P.R.W.	Inman Ave.	3112	30	5.3
Inman Ave.	Leesville Ave.	653	30	5.3
Leesvile Ave.	Hazelwood Ave.	3004	30	5.3
Hazelwood Ave.	Witherspoon St.	2975	30	5.3
Witherspoon St.	P.R.W.	469	30	5.3
P.R.W.	Junction M.H.	916	30	5.3
P.R.W.	Treatment Plant	1186	36	8.3

This completes the synopsis of the trunk sewer as described in the Supplemental Contract, while the description of the disposal plant and the provisions related to it will be reviewed in PART III.

GENERAL CONSTRUCTION

The entire trunk sewer as described in the Supplemental Contract consists of pipe conduits varying from 1.8 to 55 million gallons per day in capacity and ranging from 12" to 72" in diameter. The total length is approximately 18 miles in the aggregate, including the Woodbridge Spur extension and the Cranford sewer connection to be constructed in the future. With the except-

ion of the smaller sizes, which are of double strength vitrified tile, the sewer is of reinforced concrete structure, most of which was cast on land near the site of the sewer. The approximate quantities of the various sizes are as follows:

12" -	207 feet	39" -	5,487 feet
15" -	4,861 "	42" -	434 "
18" -	1,507 "	54" -	10,682 "
20" -	400 "	60" -	8,766 "
24" -	20,142 "	66" -	3,167 "
30" -	13,403 "	72" -	8,165 "
36" -	17,314 "		

Where rights-of-way were required, it was found that a width of twenty feet was ample to provide for construction purposes.

An inverted siphon was built at the foot of Lennington Street in Rahway, consisting of two 42" cast iron pipes designed to carry the estimated maximum flow of 55 million gallons per day. A small grit chamber and bar racks were installed in the inlet chamber to the siphon to collect the heavy settleable solids and the larger pieces of floating material which might cause stoppage in the underpass. In order to provide for the cleaning of the structure and the removal of grit, the inlet and outlet compartments were equipped with a series of wooden stop planks arranged so as to enable the diversion of flow to one channel while working in the

other.

A further precaution against the possible objectionable conditions resulting from interference to flow was made in the Supplemental Contract which provides for the construction of a by-pass at the inlet chamber, to be used for such emergencies. This provision was inserted in the contract after attention was called to the Joint Meeting by the City of Rahway to the probable damages which might result from the backing up of the sewage and river water in the trunk sewer and the internal system in Rahway.

Special manholes with flow measuring devices were installed at proper locations on the trunk lines to facilitate the estimation of flows contributed by each municipality and to supply data for future construction programs.

PRESENT USE OF TRUNK SEWER

On March 26, 1931, the Joint Meeting granted permission to use the sewer in its condition at that time to Cranford, Springfield, Kenilworth, Clark Township, Roselle Park, and Garwood, subject to approval by the State Board of Health. The latter body subsequently approved the permits and those towns which had applied

for use of the sewer made their necessary connections, after a temporary outlet ditch had been dug from the end of the sewer to the Rahway River at the site of the disposal plant.

The other municipalities also obtained permission later, and at present every municipality enjoys the use of the trunk sewer, although Rahway has connected only one lateral, an 8" sewer. The flow in January 1933 varied between 4 and 5 million gallons per day. This low rate of flow is due to the fact that all possible connections in each town have not been made as yet.

PART II

THE RELATIONS TO, AND EFFECT OF THE RAHWAY VALLEY JOINT PROJECT UPON THE CITY OF RAHWAY

PART II

THE RELATIONS TO, AND EFFECT OF THE RAHWAY VALLEY JOINT PROJECT UPON THE CITY OF RAHWAY

GEOGRAPHICAL CONDITIONS IN RAHWAY

The City of Rahway, situated in the southern part of Union County, New Jersey, in general constitutes a pentagon-shaped area of approximately four square miles most of which is comparatively level; thr ground surface varying from elevation +5 to elevation +35, except for an undeveloped section in the westerly corner of the city where the contours attain an elevation of +75. A City Zoning Ordinance adopted in 1930 classified certain districts of the community as made up of five separate zones, namely; Residence A, Residence B, Residence C, Business, and Industrial, in the following proportions:

TABLE VII
PERCENTAGES OF AREAS AS CLASSIFIED BY CITY ZONING ORDINANCE

CLASSIFICATION	AREA (acres)	% TOTAL AREA
Residence A	628.9	25.3
Residence B	904.5	36.3
Residence C	78.8	3.16
Business	216.9	8.7
Industrial	492.0	19.76
Parks, Rivers, etc.	168.9	6.78
	2490.0	100.00

Of the network of streets aggregating about 72 miles in length, about one half are now served by a system of sewers which discharge untreated sewage directly into the various branches of the Rahway River at convenient points.

The Rahway River, nourished by three small arteries, flows through the heart of the community very close to the main business section, and finally disperses into the Arthur Kill some three or four miles southeast of the city.

In relation to the other municipalities interested in the Rahway Valley Joint improvement, the City of Rahway is located at the lower end of the system where it naturally is substantially affected by the wastes of every other community in the upper part of the valley, and consequently suffers most from the resulting pollution of the stream.

PRESENT SEWERAGE SYSTEM

The internal sewerage system in Rahway is made up almost entirely of combined sewers, some of which are overloaded and surcharged near the outfalls during periods of abnormal precipitation, the result of which presents a difficult and costly problem to be overcome in planning future sewer extensions and connections to the trunk

sewer. The maximum rate of discharge during storms exceeds the allowable contribution of sewage, or will in the near future, and therefore some means of diverting portions of the flow will be necessary.

These combined sewers, ranging from 8" to 30" in diameter in the circular sewers and from 2' x 3' to 3'6" x 4' in the egg-shaped conduits, discharge into the several branches of the river by means of some twenty outfalls distributed along the streams.

In one or two instances reference is made to a so-called Cranford sewer. This sewer is really a trunk line which was constructed over 30 years ago to provide a source of disposal of sewage for Cranford. Entering Rahway at Ross Street, it extends southeasterly and finally empties into the Rahway River at the foot of Barnett Street. Rahway was allowed to contribute to this sewer in exchange for rights-of-way accorded to Cranford, and at present the sewer is taxed to its capacity of 3 M.G.D. and surcharged during storms.

A regulator will be installed at Milton Avenue where the sewer is to be intercepted and connected to the trunk sewer, so that storm water in excess of the dry weather flow will be diverted into the river through the present outfall.

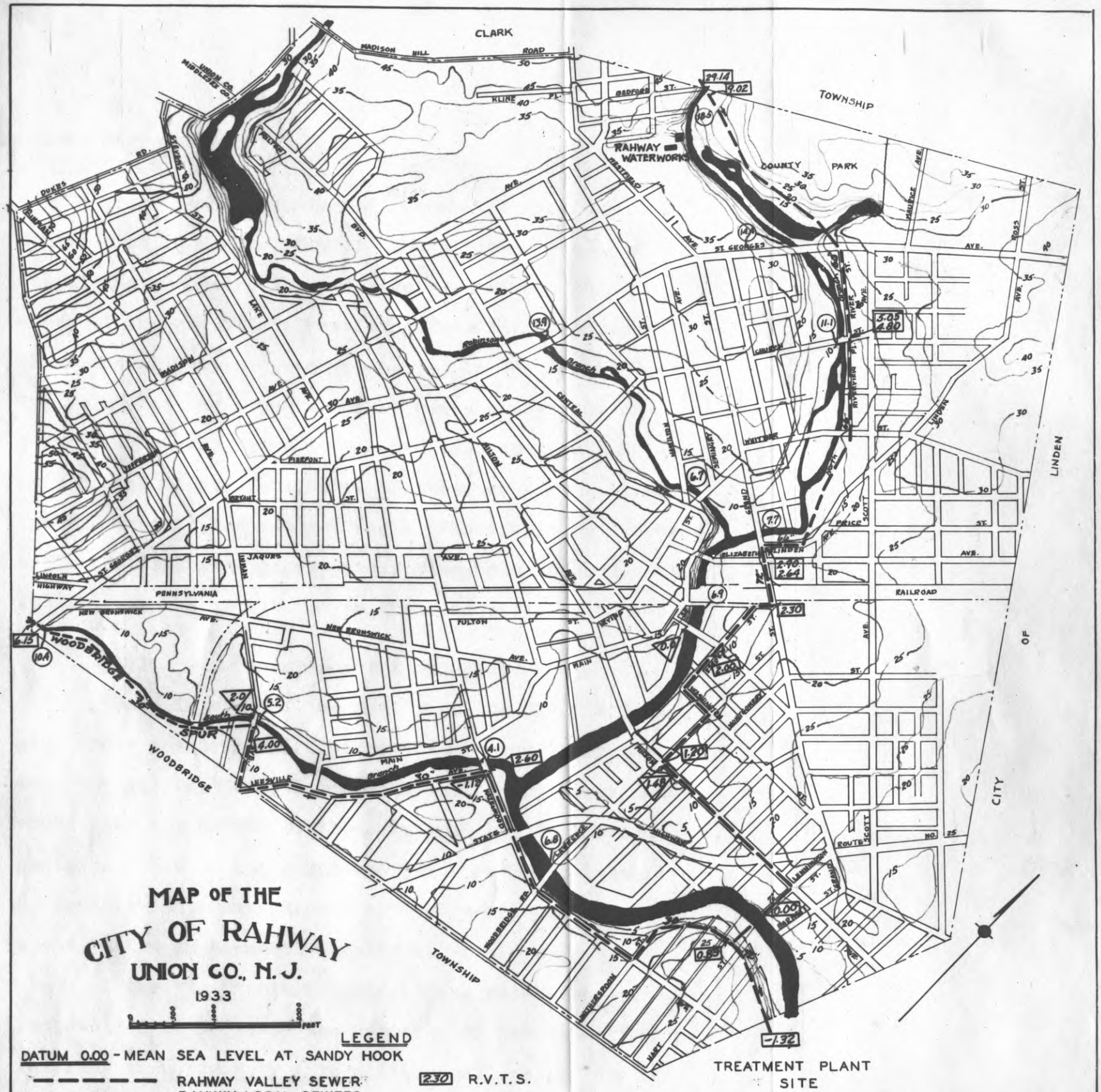
INVERT ELEVATIONS OF TRUNK SEWER IN RAHWAY

The Joint Sewer enters Rahway at Bedford Street near the Clark Township line (See PLATE B, page 45) as a 60" pipe and has an invert elevation of +29.14, from whence it makes an abrupt drop of 20 feet to pass under the river above the Rahway Waterworks through a 36" pipe. From here it progresses through the County Park as a 60" pipe to Church Street where the invert is +5.05.

At this point the diameter increases to 66" with an invert elevation of +4.80, and continues to Grand Street where the invert has dropped to +2.90. Here another 6" increase in diameter results in lowering the invert to +2.64 in the 72" section. When the sewer reaches the inlet chamber of the siphon in Lennington Street its invert is 0.00 or Mean Sea Level Datum of Sandy Hook.

After crossing under the river, the trunk sewer continues to the site of the disposal plant where the invert is at elevation -1.32.

The Woodbridge Spur enters the city near St. Georges Avenue, being 30" in diameter and having an invert elevation of +6.15. This line continues on a grade of 0.04% and joins Section 1 of the trunk sewer at Hart Street where the invert at the junction manhole is at elevation +0.83.



MAP OF THE CITY OF RAHWAY UNION CO., N. J.

1933

FEET

LEGEND

DATUM 0.00 - MEAN SEA LEVEL AT SANDY HOOK

- RAHWAY VALLEY SEWER
- RAHWAY LOCAL SEWERS
- 35 — SURFACE CONTOUR LINES
- 2.30 R.V.T.S.
- 2.0 RAHWAY OUTFALL SEWERS
- (7.7) HIGH WATER ELEVATIONS

F.A.H.

PLATE B

REQUESTS MADE BY RAHWAY RELATIVE TO THE SUPPLEMENTAL CONTRACT

Prior to the framing of the new or Supplemental Contract in 1932, the City of Rahway with the aid of its consulting engineer, Alexander Potter, made a through study of the conditions resulting from the execution of the Original Contract, and presented to the Rahway Valley Joint Meeting a number of requests concerning adjustments and additions to the proposed contract. After many heated discussions, some of these were granted and incorporated in the new contract. These will be discussed in the following pages, presenting both the request and the reasons attributed to their adoption by Rahway.

(a). Re-allocation of Space

That, in view of the fact that the City of Rahway, under the Original Contract, was inequitably dealt with and will not be afforded the use of the sewer under conditions comparable to those enjoyed by all the other municipalities of the Joint Meeting, provisions should be made to compensate Rahway by the re-allocation of space in the Supplemental Contract.

After the Original Contract was entered into, it was decided to increase the capacity of the Joint Trunk Sewer by approximately five million gallons per day at

the upper end of the sewer. This increase in capacity amounted to more than five million gallons per day, but the available increase throughout the length is approximately that quantity. Under Chapter 48 of the Laws of 1929, the Joint Meeting was granted the right to provide for an increase in the capacity of such sewer system, but the law did not make this right effective, if it involved, as it did in this improvement, additional cost without all of the municipalities agreeing by ordinance to appropriate additional funds as were necessary for such enlargement.

These required ordinances were not passed, maximum cost being guaranteed by the Joint Meeting, and such provision for additional capacity was illegal in Rahway's opinion.

As a result of this change in plans, Rahway was faced with an additional appropriation of 50 percent in excess of that considered a maximum liability, and in Mr. Potter's opinion, Rahway had a percentage of the capacity right of this addition in the upper section of the sewer and could dispose of these rights to the other municipalities who are able to make use of them.

(b). Pumping Station

That because of its low elevation, the trunk sewer in Rahway will be heavily surcharged by the river water at high tide, which condition will cause overflow of sewage into the streets in addition to reducing the velocity of flow of the sewage to a rate which is incapable of preventing deposits. Therefore some provision, such as a pumping station at the disposal plant, should be made to obviate these conditions in Rahway.

1. Surcharge of Trunk Sewer

Referring to PLATE B, page 45, you will find a complete layout of the City of Rahway showing surface contours, sewer locations and elevations, and other relative data, which, with the aid of the table of elevations on the succeeding page, should clarify the subsequent discussions on surcharge and velocity. These elevations were taken from the plans of the Rahway Valley Trunk Sewer, records of the Rahway sewer system, and a report by Alexander Potter.

As shown in TABLE VIII, page 49, the "predicted" Mean High Water elevation as forecast by the United States Coast and Geodetic Survey, is +2.35, Mean Sea Level at Sandy Hook being used as Datum 0.00. However,

during certain seasons this predicted tide varies to as high as +3.7 even without the effect of storms, when, according to gaugings taken by Alexander Potter, the water reaches an elevation of about +6.7.

The maximum or Extreme High Water mark assumed by the Engineer of the Rahway Valley Joint Meeting is +5.5, and will be used in the ensuing discussion, although it is probable that conditions will be substantially worse at times.

TABLE VIII
ELEVATIONS OF TIDAL WATERS, TRUNK SEWER, AND TREATMENT PLANT UNITS

TIDAL ELEVATIONS:	
Datum - Mean Sea Level at Sandy Hook	0.00
Mean Low Water (S.J.T.S. Data)	-2.35
Mean High Water "	+2.35
Assumed Extreme High Water (R.V.J.M.)	+5.5
Assumed Extreme Low Water "	-2.1
Observed High Water (Potter)	+6.7
ELEVATIONS OF MAIN TRUNK AND WOODBRIDGE SPUR:	
Woodbridge Spur at Junction, invert	+0.83
crown	+3.33
Main Trunk at Treatment Plant, invert	-1.32
crown	+4.68
ELEVATIONS AT TREATMENT PLANT:	
Invert of Outfall Sewer in River	-8.5
Minimum Elevation, Settling Tank Eff. Weirs	+1.00
Top of Settling Tank Walls	+7.50

Loss of Head Through Plant = 1.1 feet

Using a loss of head thru the plant of 1.1 feet, the elevation of the tide water will be +6.6, and the water will flow back through the main 72" trunk as far as the County Park, and to the present terminus of the Woodbridge Spur near St. Georges Avenue.

Assuming a flow of 55 million gallons per day, the capacity of the trunk sewer when flowing full, with a tide of +5.5 and a plant loss of 1.1 feet, the actual elevation of the water surface at the entrance to the plant will be +6.6 as mentioned above. As the invert at this point is -1.32 and the crown +4.68, the surcharge will accordingly be 1.92 feet.

It is obvious then, that serious conditions can be expected at various locations in Rahway such as the intersection of Monroe and Essex Streets where the invert of the trunk sewer is +2.00 and the street surface is below the height the sewage and river water would attain (+9.92) if there were no means of dispersing.

The lengths of the trunk sewers which would be affected by tidal waters when various stages of tide are encountered are shown in TABLE IX on the next page.

TABLE IX
EXTENT OF TIDEWATER BACKFLOW
IN TRUNK SEWERS

	LENGTH OF SEWER INVERT		
	MAIN 72" TRUNK	WOODBR'GE SPUR	TOTAL
Below Mean Sea Level, Datum 0.00	1,800'	0'	1,800'
Below Mean High Water, Datum +2.35	7,200'	3,600'	10,800'
Below Extreme High Water, Datum +5.5	11,900'	9,700'	21,600'

	LEMGTH OF SEWER CROWN		
	MAIN 72" TRUNK	WOODBR'GE SPUR	TOTAL
Below Mean Sea Level, Datum 0.00	0'	0'	0'
Below Mean High Water, Datum +2.35	0'	0'	0'
Below Extreme High Water, Datum +5.5	1,800'	3,900'	5,700'

2. Analysis of Low Velocities

For a sewer to operate efficiently, the sewage flow at all times should be maintained at a velocity sufficient to prevent permanent settlement of solid matter in the sewer. It is generally agreed that a mean velocity of 2 feet per second will generally prevent deposits in separate sewers under normal conditions, although a velocity of at least 3 feet per second is desirable. To design trunk sewers to transport sewage at this latter rate during low depth flows is not often an economical proposition as the cost increases greatly when the depth of the sewer is increased.

In the particular case of the Rahway Valley Trunk Sewer, the velocity of flow is estimated at approximately 3 feet per second when flowing full under normal conditions. However, when the depth of sewage drops below the center of the conduit, the velocity decreases rapidly, and at a depth of 1.55 feet in the 72" sewer the velocity will be 2.0 feet per second with a corresponding discharge of about 7.0 M.G.D. Below this depth the sewage flow falls below the desired rate of 2 feet per second.

These figures, as was pointed out before, relate only to flow conditions when there is no unfavorable influences such as the backing up of tidal waters in the sewer. Just what effects such resistance to flow may be anticipated, is described in the computations to follow.

In the analysis of the velocities in the trunk sewer during the early operation of the disposal works, a flow of 7.0 M.G.D. in the main trunk and 0.45 M.G.D. in the Woodbridge Spur were adopted with the intention of obtaining a conservative estimate of the anticipated unfavorable conditions. It is reasonable to assume that flows will be much lower than these selected for records show that the minimum hourly flow varies as much as 50 percent of the average at certain times of the day. In

addition to this, the estimated population of the municipalities of the Rahway Valley Joint project is only 73,600 for the year of 1940, which corresponds to a flow of about 101 gallons per capita per day, a comparatively high figure.

TABLES X and XI are computed with the use of the diagram, PLATE C, which was formulated by employing Kutter's formula for velocity at varying depths. In the analysis showing the decrease in velocity in the sewers because of tidewater effects, four different elevations of tide were used as described below.

CASE I — This represents conditions at Mean High Water and accordingly this or approximately equal conditions can be anticipated daily. Tides rising above Mean High Water will aggravate the conditions in CASE I.

CASE II — This case represents conditions with a tide approximately 1 foot below Mean High Water.

CASE III — This case represents the most favorable velocity conditions which will occur under the existing plans. Regardless of how far below elevation +0.90 the tide may go, no increase in velocity can be obtained because of the barrier formed by the effluent weirs on the settling tanks.

CASE IV — This represents the conditions obtained when the tide is 1.15 feet higher than Mean High Water, and investigation of the tide tables shows that a tide of +3.50 or higher is predicted to occur 25 times a year even without the influence of storms.

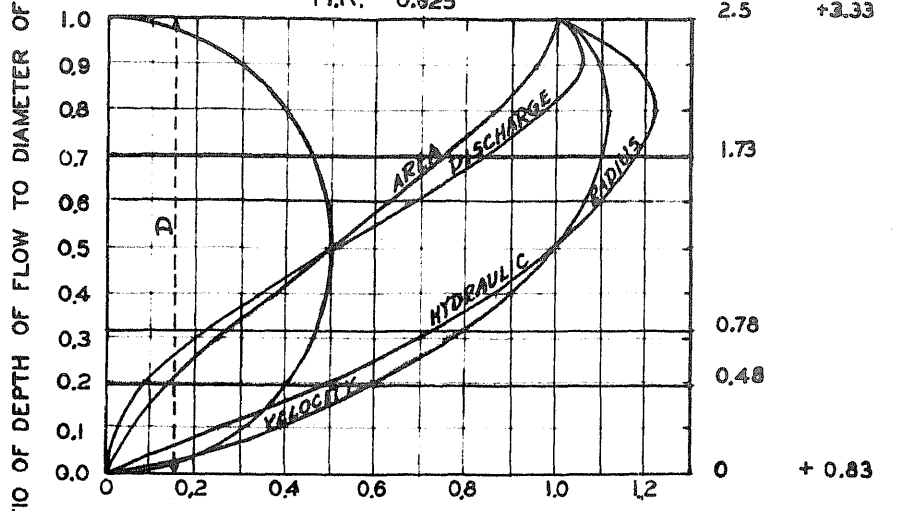
HYDRAULIC ELEMENTS OF CIRCULAR SEWERS

WOODBRIDGE SPUR

N = 0.013 S = 0.0004 D = 30" A = 9.41 SQ. FT.

Q = 8.2 C.F.S. OR 5.3 M.G.D. V = 1.67 FT./SEC.

H.R. = 0.625



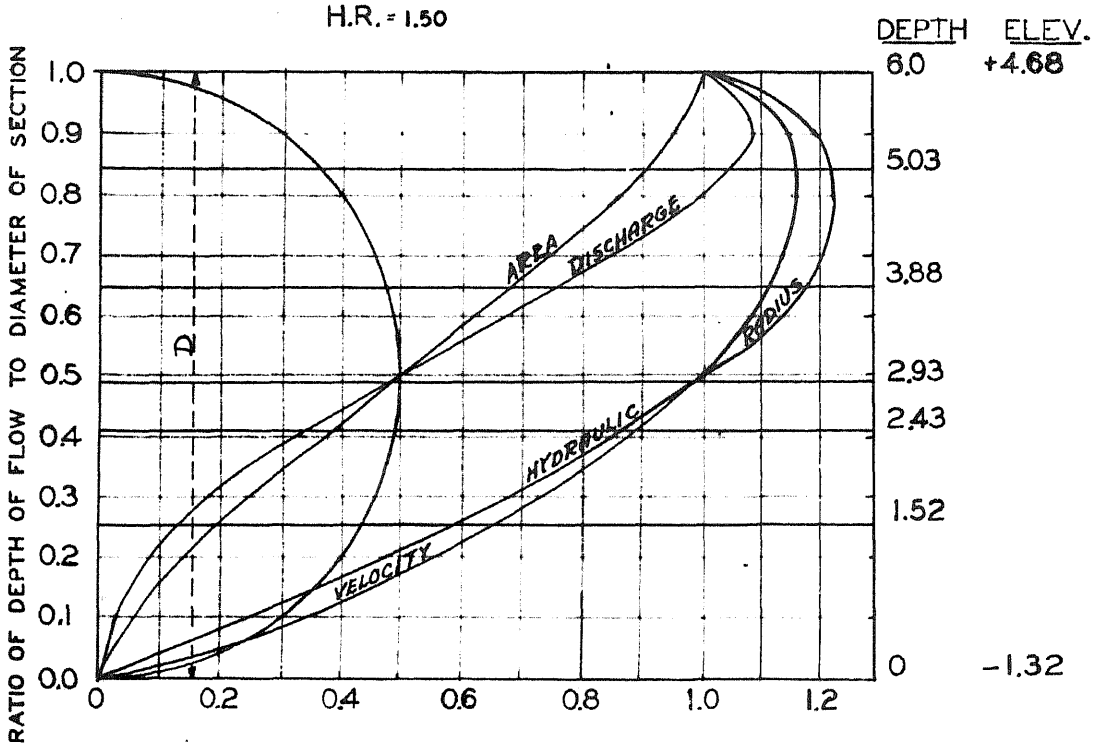
RATIO OF HYDRAULIC ELEMENTS OF FILLED SEGMENT TO THOSE OF ENTIRE SECTION

MAIN TRUNK

N = 0.013 S = 0.0004 D = 72" A = 28.274 SQ. FT.

Q = 81.5 C.F.S. OR 55 M.G.D V = 3.02 FT./SEC.

H.R. = 1.50



RATIO OF HYDRAULIC ELEMENTS OF FILLED SEGMENT TO THOSE OF ENTIRE SECTION

F.B.H.

PLATE C

TABLE X
ANALYSIS OF VELOCITIES IN 72" TRUNK SEWER

	CASE I	II	III	IV
2. Elevation of tide in river	+2.35	+1.40	+0.90	+3.50
3. Elevation of Crest of Settling Tank Eff. Weirs	+2.45	+1.50	+1.00	+3.60

1	4	5	6	7	8
CASE	Elev. of W.L. in 72" Trunk at Plant ent.	Sewage Flow M.G.D.	Depth at Point of Worst condition Ft.	Sectional Area Flow Sq. Ft.	Estimated Velocity Ft/Sec.
* Full Flow		55.0	6.0	28.27	3.02
* Normal Flow		7.0	1.52	5.51	1.97
I	+2.56	7.0	3.88	19.2	0.57
II	+1.61	7.0	2.93	13.9	0.78
III	+1.11	7.0	2.43	9.5	1.15
IV	+3.71	7.0	5.03	25.4	0.43

* If sewer were not affected by tidal water

Explanation of Computations

Column (2) Taken from Tide Tables
(3),(4) Estimated from plant losses
(5) Assumed average normal flow
(6) Column 4 plus 1.32 (Invert below 0.00)
(7),(8) Calculated from diagram, PLATE C, i.e.

CASE I

Ratio of depth of water to diameter of sewer is 3.88/6 = 0.648. Drawing horizontal line thru 0.648 to point where it meets Area Curve and projecting downward, the ratio value of 0.68 is obtained.

Area = 0.68 x 28.27 = 19.2 sq. ft.

Since flow is at constant rate, the velocity will be decreased by the ratio of the normal area to the area of the entire flow section, or

$$\text{Velocity} = 1.97 \times \frac{5.51}{19.2} = 0.57 \text{ ft/sec.}$$

TABLE XI
ANALYSIS OF VELOCITIES IN WOODBRIDGE SPUR

	CASE I	II	III	IV
2. Elevation of tide in river	+2.35	+1.40	+0.90	+3.50
3. Elevation of Crest of Settling Tank Eff. Weirs	+2.45	+1.50	+1.00	+3.60

1	4	5	6	7	8
CASE	Elev. of W.L. in 30" Spur at Junction	Sewage Flow M.G.D.	Depth at Point of Worst condition Ft.	Sectional Area Flow Sq. Ft.	Estimated Velocity Ft/Sec.
* Full Flow		5.3	2.5	9.41	1.67
* Normal Flow		0.45	0.48	0.68	0.98
I	+2.56	0.45	1.73	3.68	0.18
II	+1.61	0.45	0.78	1.29	0.52
III	+1.11	0.45	---	0.68	0.98
IV	+3.71	0.45	2.88	9.41	0.14

* If sewer were not affected by tidal water

PUMPING AS A MEANS OF PREVENTING OBJECTIONABLE SURCHARGE AND LOW VELOCITY CONDITIONS

Through the courtesy of Mr. Alexander Potter, I am able to include herein a portion of his report to the Rahway Valley Joint Meeting, insofar as it relates to his proposed scheme of maintaining desirable velocities of flow in the trunk sewer.

"Pumping at certain periods may be considered as a practical and comparatively economical method of maintaining in the trunk sewer at all times during low flows, a velocity of not less than 2 feet per second, which is a minimum requirement if nuisance from the depositing of solids in the trunk sewer through Rahway is to be prevented."

"Pumping would be required only at high stages of the tide, and means could be provided for discharging the effluent from the plant by gravity through a by-pass during the low stages of the tide."

"The by-pass would be provided with a flap gate, and when the tide rises to an elevation which would make gravity discharge impossible without backflooding the effluent weirs and thereby reducing, below the allowable minimum velocities in the sewer entering the plant, then the pumps could be started automatically by float control."

"Pumping would then continue during the high water interval and until the tide had dropped to an elevation which would again permit gravity discharge.

"This scheme would involve the installation of adjustable weirs which would be set at a low enough elevation to insure 2 feet per second velocities in the sewer entering the plant, and as the flow increased these weirs could be raised.

"The effluent channel of the settling tanks could be utilized as a pump well, and the high water in this effluent channel should be maintained slightly below the effluent weirs, in order to provide undisturbed flow over the weirs at all times.

"The increase in power used from year to year, due to the increase in flow, is largely offset by the decrease in head and decrease in period of tidal interference because of the progressive raising of the effluent weirs and the consequent raising of the high water level in the effluent channels.

"These effects are illustrated in TABLE XII attached hereto."

ESTIMATED ANNUAL COST OF PUMPING LOW FLOWS DURING HIGH STAGES OF TIDE TO MAINTAIN MINIMUM VELOCITY OF 2 FEET PER SECOND

"The elevation of the river above which pumping becomes necessary, the pumping head, the number of hours daily operation, and the estimated annual cost of power with demand charges, together with the fixed charges on equipment, are shown in the table for various rates of flow from 8 to 23.5 M.G.D.

"The necessity for pumping in order to maintain 2 feet per second velocities in the sewer entering the plant, ceases during normal tides when the flow reaches a rate of about 30 M.G.D.

"An examination of the pumping cost on TABLE XII indicates at once that for a substantial period after the plant is put into operation, the cost of pumping will be no greater than the cost otherwise necessary for the employment of labor and equipment to properly maintain the sewers.

"Aside from the relative cost of pumping versus cleaning of the trunk sewer, it is believed that the former method is much to be preferred, in that it does not involve the obstructions to traffic due to manholes being open, and the nuisance of removing settled material from the Trunk Sewer.

TABULATION SHOWING ESTIMATED ANNUAL COST OF PUMPING LOW FLOWS DURING HIGH STAGES OF TIDE TO MAINTAIN MINIMUM VELOCITY OF 2 FEET PER SECOND (With Various Rates of Flow)

TABLE XII

RATE OF FLOW - M.G.D.	8	10	15	20
Elevation of River Above Which Pumping is Necessary	-0.25	-0.11	0.23	0.79
Average Static Head - (Ft.)	3.23	3.23	3.11	2.91
Average Dynamic Head- (Ft.)	4.23	4.23	4.11	3.91
No. of Hours per High Stage of Tide During Which Pumping is Required	12.7	12.0	11.3	9.7
No. of KWH per Month, Power Consumed	3240	3800	5160	5500
Estimated Average Annual Power Cost	$900	$1050	$1330	$1390
Annual Demand	$540	$ 675	$1020	$1350
Interest on Equipment Cost (6%)	$360	$ 590	$ 590	$ 830
TOTAL COST	$1800	$2315	$2940	$3570

(c). By-pass

That an overflow or by-pass be constructed near the inlet chamber of the inverted siphon in Lennington Street to allow the sewage from the trunk sewer to discharge directly into the river at that point, thereby establishing a safety appurtenance in event that the undercrossing becomes clogged, or difficulty is encountered in the cleaning of them, either of which might result in the sewage backing up into the Rahway sewerage system.

Considering the fact that storm water and street

washings will be carried by the trunk sewer into the siphon, it is not unreasonable to suppose that this structure may become partially obstructed by the deposits of grit and other heavy material, - in fact, these pipes and grit catchers have been cleaned a few times since being put into operation, although the flow has been comparatively low and Rahway's combined sewers have not as yet been intercepted.

Incidently, observations made during these cleaning processes has borne out the contention that much difficulty will be attended in this particular phase of maintenance work.

(d) Additional Spur

That the additional spur to be constructed parallel to the present 72" trunk sewer and to extend from the junction of the existing Woodbridge Spur and the main trunk line, to the disposal plant, should be temporarily abandoned until such time as additional flows warrant its construction.

As shown on PLATE A, Page 12, an additional spur to have a capacity of 8.3 M.G.D. is to be constructed in order to provide for the increase in capacity made in the trunk sewer. The rate of flow, contributed by

both the main trunk and the Woodbridge Spur, will not exceed the capacity of the 72" sewer for a few years, and therefore it was decided to advise the Joint Meeting to postpone the building of the said spur as a measure of economy.

(e). Underpasses

That the cleaning of the temporary underpasses which the Joint Meeting constructed in the Rahway sewerage system should be accomplished at the expense of the Rahway Valley Joint Meeting until Rahway has a reasonable time to build its own pumping station and make its necessary connections.

During the construction of the trunk sewer through Rahway, it was discovered that in a number of places Rahway sewers lay at elevations which conflicted with the proposed grade of the trunk sewer. Consequently, it became necessary to break the continuity of grade of these lateral sewers and build underpasses or traps to provide flow facilities. These structures number about nine in Rahway, and handle both domestic sewage and storm water.

As these special structures were inserted for the convenience of the Joint Meeting, it was believed only fair that this body should bear the expense for their maintenance.

(f) Covered Sludge Beds

That the sludge drying beds should be covered with greenhouse structures instead of being open and unprotected.

It was Rahway's contention that the sludge drying beds should be enclosed to diminish the possibility of odor nuisances and at the same time provide more efficient drying facilities for the digested sludge. Mr. Potter advised that the type of treatment as proposed in the plans, namely, the thermophilic or high temperature sludge digestion, often produced highly disagreeable odors and resulted in times in sludge which was extremely difficult to dewater on sand beds.

Inasmuch as the original plans specified that the sludge was to be carried to sea by barges, Rahway considered the request quite reasonable.

(g) Miscellaneous Requests

A number of other requests of lesser consequence were made by the City of Rahway, but were not acceded to because of their apparent lack of importance. These are later noted in the summary of a report by Alexander Potter to the Rahway Common Council.

SUMMARY OF CONCLUSIONS IN THE REPORT
OF ALEXANDER POTTER, CONSULTING ENGINEER,
SUBMITTED TO THE MAYOR AND COMMON COUNCIL
OF THE CITY OF RAHWAY, NEW JERSEY, IN
CONNECTION WITH THE PARTICIPATION OF
RAHWAY IN THE SUPPLEMENTAL CONTRACT FOR
THE COMPLETION OF THE RAHWAY
VALLEY TRUNK SEWER Dec. 9, 1931

First. "That Rahway, under the present contract, is paying towards the construction of the Joint Trunk Sewer and Sewage Disposal Works, far more than any other municipality in relation to the benefits received."

Second. "That the elevation at which the Joint Trunk Sewer has been built through Rahway has been designed economically as far as all the other municipalities are concerned, and that in doing so, Rahway is compelled to pump a substantial part of its sewage, and as such additional burden on Rahway is very much greater than Rahway's contribution to a sewer constructed at such a grade that it would not be required to pump its own sewage, that the cost of the pumping should be absorbed by the Joint Meeting who are the greater beneficiaries by reason of the elimination of pumping for the entire district, with the exception of the portion of Rahway above referred to."

Third. "After the passage of the ordinance, the capacity of the sewer was enlarged so as to permit the entry of 5 M.G.D. at the upper ends of the trunk sewer."

"Since this enlargement was made after the signing of the original contract without the passage of the necessary ordinances, the rights which each municipality has in the excess capacity thereby obtained, should be proportionate to the payments towards that excess capacity.

"I am of the opinion, therefore, that Rahway has a percentage of the capacity right of this addition in the upper section of the sewer and is in a position to dispose of these rights to the other municipalities who are able to make use of them.

Fourth. "The value of the pumping stations, their maintenance, and the excess cost of the enlargement as represented by the rights referred to above, represents a total value of $160,000.

Fifth. "Under the supplementary contract there has been assigned to all other municipalities, upstream from Rahway, 25% in excess of the use under the original contract, and this 25% increase absorbs the entire capacity of the sewer in the throttling section extending from the Cranford line to Church Street in the City of Rahway, with the exception of 360,000 gallons available for Rahway's local use in this section, leaving a capacity of 13.36 M.G.D., of which the other municipalities cannot

"avail themselves, which I recommend should be assigned to Rahway in lieu of the claim that Rahway has for the construction and maintenance of the pumping stations and the value of the enlargement which has been assigned to the other municipalities above the Rahway City Line.

"This 13,360,000 gallons, coupled with the 1,980,000 gallons assigned to Rahway in the Woodbridge Spur, will give Rahway a total capacity in the joint project, of 15,340,000 gallons per day.

Sixth. "A part of the capacity through Rahway not assigned to the other municipalities, is owned by Rahway in the proportion of its original rights to the total original rights. The excess capacity is owned co-jointly between Rahway and the other municipalities, and the transference of these rights to Rahway is, in my opinion, a quid pro quo for the claims that Rahway has against the Joint Meeting above stated, when taken in connection with such requests as are contained in Rahway's resolution of October 14th which seem just and reasonable.

Seventh. "The cancellation of the obligations of the Joint Meeting to Rahway, and the transference of rights from the Joint Meeting to Rahway for capacity in the first and second sections of the sewer which cannot physically be used by the other municipalities can be accom-

"plished without any added cost to the municipalities.

Eighth. "The addition of the so-called Woodbridge Spur should be made large enough for the full flow now contemplated in the Woodbridge Spur and the flow in the Cranford Sewer. The additional amount involved for this increase is small and the entire construction can be deferred for many years.

Ninth. "That the requests of Rahway, outside of those included in the recommendations hereinabove mentioned, should be accepted by the Joint Meeting, namely .....

"That the outlet of the disposal plant should be extended to empty into the Rahway River at as great a distance below the treatment plant as is possible.

"That the matter of the use of the Cranford sewer by Rahway be subject to private negotiations between Rahway and Cranford.

"That overflows be made as requested by Rahway at the siphon crossings or elsewhere, to protect those portions of Rahway's lateral sewer system outside the pumping district from being flooded."

ACTION OF THE RAHWAY VALLEY JOINT MEETING UPON THE REQUESTS MADE BY THE CITY OF RAHWAY

(a). In lieu of the claim that Rahway had for the construction and maintenance of the pumping stations and the value of the enlargement of the trunk sewer which had been assigned to the other municipalities above Rahway, provisions were made in the Supplemental Contract allocating 13.36 M.G.D. capacity in the sewer below Church Street, thereby giving Rahway a total capacity in the joint project of 15.34 M.G.D. of which 1.98 M.G.D. is available in the Woodbridge Spur.

(b). Provisions for a low lift pumping station to be located at the disposal works consists of pumps providing a total capacity of 60 M.G.D. under heads varying from 2 to 7.5 feet.

(c). It was generally agreed at the Joint Meeting that Rahway was justified in asking for the construction of a by-pass in the trunk sewer near the siphon in Lennington Street in order to divert the flow into the river whenever such emergencies as clogging occur.

(d). It was also decided to dispense temporarily with the building of the additional branch until such time as the additional capacity is required.

(e). The cleaning of the several underpasses in the Rahway system was considered a duty of the Joint Meeting

which agreed to pay the cost of such maintenance instead of charging it to the municipalities in which they are located.

(f) As a compromise to Rahway's request that the sludge drying beds should be covered, provisions were made in the Supplemental Contract to cover approximately one half of the area of these beds with greenhouse structures.

Also the additional spur referred to in (d) was increased to a capacity of 8.3 M.G.D. instead of 3.5 M.G.D. as originally planned.

* Reference from PLATE A, page 12

There is a discrepancy between PLATE A and the contents of the Supplemental Contract in regard to the additional spur to intercept the present Woodbridge Spur. PLATE A was reproduced from a map attached to the contract, and apparently the intention is to change the 27" spur of 3.5 M.G.D. capacity to one of 36" diameter and an 8.3 M.G.D. capacity.

PART III

THE TREATMENT PLANT

PART III

THE TREATMENT PLANT

TYPE OF TREATMENT AND GENERAL SCHEME

The sewage treatment plant of the Rahway Valley Joint Meeting, as proposed in its specifications and plans, will be located in the Township of Woodbridge on the south bank of the Rahway River between the Borough of Carteret and the City of Rahway, New Jersey.

Local conditions and the character of the sewage permitted the omission of secondary or high degree treatment in the plans, primary and auxiliary processes being considered quite satisfactory. In general, the proposed routine is to consist of screening, chlorination, settling, pumping, sludge digestion, and the disposal of sludge after drying on sand beds. As discussed in PART II, the potential effects of discharging the effluent into the tidal waters of the river at such an elevation as proposed, induced the Joint Meeting to provide for a pumping station near the outlet end of the settling tanks in order to collect the effluent in a wet well prior to forcing it through the outfall sewer at intervals at the discretion of the plant operator.

Consistent with the present trend of sewage treatment practice, this plant is to employ a considerable

number of mechanical appliances, both for reducing the amount of hand labor necessary and for performing functions impracticable by hand - the latter being the more important. Those included in the specifications are; automatic chlorinators, mechanical rakes and shredders for the removal of screenings, apparatus for the continuous removal and concentration of sludge in the settling tanks, automatic-starting pumps, motor driven sluice gates, and miscellaneous equipment for handling floating matter and sludge. The removal of sludge and the handling of equipment will be facilitated by an elaborate system of roadways encircling the various units, and hand operated cranes and conveyors.

Greenhouse structures over the sludge drying beds situated near the outer limits of the plant proper were specified to serve two main purposes; to eliminate the odor nuisance, and to improve the appearance of the disposal works.

SUPPLEMENTAL CONTRACT

That portion of the Supplemental Contract pertaining to the Disposal Works reads as follows:

Disposal Works

"The plant is to be located in Woodbridge Township on the south bank of the Rahway River between the

City of Rahway and the Borough of Carteret on property acquired or to be acquired by the Joint Meeting by purchase or condemnation.

The plant is to be of the type known as sedimentation and disinfection with sludge digestion and drying.

The portion of the plant to be presently constructed consists of:

(a). A battery of eight concrete settling tanks each approximately 110 feet long, 32 feet wide, and 11 feet depth of water, or an equivalent capacity, mechanically equipped for the continuous removal of floating and settleable solids.

(b). Covered sludge digestion tanks, devices to collect the gas evolved from digestion will be provided.

(c). Sludge drying area consisting of 6 inches of gravel and 6 inches of sand together with the necessary appurtenances will be constructed. Area equivalent to one-half of the total area of the sludge drying beds shall be of glass covered instead of open, construction.

(d). Necessary building with equipment to house pumps, chlorinating apparatus and facilities for operating employees.

(e). Machinery and apparatus necessary for chlorination.

(f). Macadam roadways around plant with the necessary concrete gutters.

(g). Piping and drains around plant with appurtenances thereto.

(h). Seventy-two inch pipe discharge from plant into Rahway River.

(i). Other work necessary and incidental to the above.

(j). The Trunk Sewer or Disposal Plant shall be provided with a suitable device at Lennington Street River crossing, whereby the flow in the sewer may be bi-passed into the river only in case of the clogging of the syphon under the river at Lennington Street.

(k). That there shall be included in the Disposal Plant to be constructed under the Supplemental Contract an adequate low-lift pumping station with proper equipment and appurtenances for pumping the plant effluent; said pumping station to be operated during such periods and in such manner as to prevent at all times, as far as possible, surcharging of the trunk sewer, except by

reason of surcharge resulting from the contribution of sewage by the City of Rahway at a rate of exceeding 15.34 m.g.d. or its then authorized use. Said installation shall also be used for any other purpose which can, from the standpoint of efficient operation of the Trunk Sewer and Disposal Plant, be most efficiently and economically effected thereby.

The entire pumping installation, including that portion for further construction, shall be designed as a comprehensive unit, with a capacity equal to the capacity of the trunk sewers entering the plant when such sewers are flowing full and under normal flow conditions. Previous to the construction of the first unit of the pumping installation, gaugings shall determine the capacity which appears necessary to prevent, for a reasonable period of time, such surcharging, and such capacity shall be installed in connection with the portion of the Disposal Plant to be presently constructed. Gaugings shall be taken for a sufficient period to establish controlling flows.

The Specifications and Plan of said pumping in-

stallation to be so prepared as to obtain the above mentioned results and to be submitted as soon as possible.

That the cost of installation of said pumping station shall be paid as follows:

(1). Out of the sum of $900,000 provided in the Supplemental Contract if said sum shall be found sufficient to meet the cost of the entire project, including Disposal Plant and site, payment of other obligations of the Joint Meeting and cost of said pumping station.

(2). If not, then up to the sum of $60,000 additional cost, Rahway agrees to pay fifty percent of the cost of installation of said pumping station with proper equipment and appurtenances and the other fifty percent of the amount in excess of said $900,000 not to exceed $60,000 is to be borne by the other eight municipalities in the ratio of percentages of costs set forth in the table of percentages in the Supplemental Contract, Article III.

Provided, however, That if any contracting Municipality or Municipalities shall not be able (at the time of entering into the Supplemental

Contract) to finance its or their share of the cost of the pumping station in excess of $900,000 then such Municipality or Municipalities shall bind itself or themselves to transfer space equivalent to its or their unpaid shares of the cost to those of the other Municipalities which agree to finance the share or shares of the Municipality or Municipalities unable to do so.

Provided, That such space so transferred shall be retransferred to the Municipality or Municipalities from which it is thus taken upon repayment of the money advanced with interest at the rate of six percent (6%) per annum calculated from the date of such advance.

Provided, Further, That for the expenditure of $60,000 or any portion thereof in excess of $900,000 for a pumping station, no allocation of space is to be made to any Municipality, except as hereinabove provided.

The portion of the plant for further construction - Items (a), (b), (c), and part of (k) are for future duplication with such additions as may be required from time to time."

ANALYSES OF RAW SEWAGE

During the Winter months of the past year, I was fortunate in being able to obtain samples of the sewage from the present outfall of the trunk sewer and analyze them personally at a well equipped laboratory, thereby determining some of the characteristics of the sewage. Although I realize that in order to obtain very accurate results, truly representative samples are imperative, I feel that the analyses of these "grab samples" are of some significance as they were obtained at the same hour and day of each week, - provided the results are interpreted wisely after careful study and comparison with similar sewages on record. Just what value may be attached to such tests is problematical, although they might be used to an advantage in planning the operation of the various units in the disposal works.

Using the methods as described in "Standard Methods of Water Analysis", only a few of the most important tests were performed, namely; total and suspended solids, ammonia nitrogen content, and biochemical oxygen demand.

Conditions under which the samples were taken, and the results of the analyses compared with recorded data are as follows:

TABLE XIII
ANALYSES OF RAW SEWAGE
RAHWAY VALLEY TRUNK SEWER

1933

Dates of Sampling and Analyses: February, March
Time of Sampling: Wednesday, 5 PM
Sewage: Raw Sewage of Rahway Valley Trunk Sewer
Approximate Rate of Flow: 4 M.G.D.
Average Temperature: 40°-50° F
Quantity of Sample: 1 liter (3 liters reduced)
Location of Sampling: Outfall of Trunk Sewer at site of Treatment Plant

CONSTITUENTS	Parts Per Million RAHWAY VALLEY SEWAGE	AMERICAN RESIDENTIAL *& RURAL COMMUNITIES
1. Total solids	760	603
2. Susp. solids	200	342
3. B.O.D. (5 day @ 20° C)	160	143
4. Ammonia Nitrogen	40	27.2

* See "Sewerage and Sewage Disposal" - Metcalf & Eddy

Comparison of these results, if they may be used as a guide to measure the strength of the sewage, seem to indicate that the Rahway Valley sewage is about average. The fact that the B.O.D. and Ammonia content are a little high comparatively, is probably due mostly to the staleness of the sewage. The time required for the sewage to be transported from the upper sections of the system to the outlet is a matter of hours, consequently

the anaerobic bacteria become very active in the absence of sufficient oxygen and attack the suspended matter to form the ammonia compound and cause rapid depletion of the remaining oxygen, hence the staleness.

ESTIMATE OF FUTURE POPULATION

In order to discuss the design features of the treatment plant units, it was necessary to estimate the probable future populations of the municipalities participating in the improvement, both for ten years and thirty years hence. Admittedly, such forecasts of future development is a hazardous proposition at best, and quite often the predicted changes are rebuked by substantial deviations because of unforeseen developments and phenomenal growth. However, for the purpose intended, a rough estimate is sufficiently accurate. With this in mind, I constructed a series of curves using data from census records and estimates made for the probable populations in 1960 by the consulting engineer of the Rahway Valley Joint Meeting, using as a guide the constant percentage increase method to determine the intermediate points on the diagram. The curve representing the growth of the City of Rahway, taken from a comprehensive report of that city's consulting engineer, is a result of a thorough study of all factors affecting

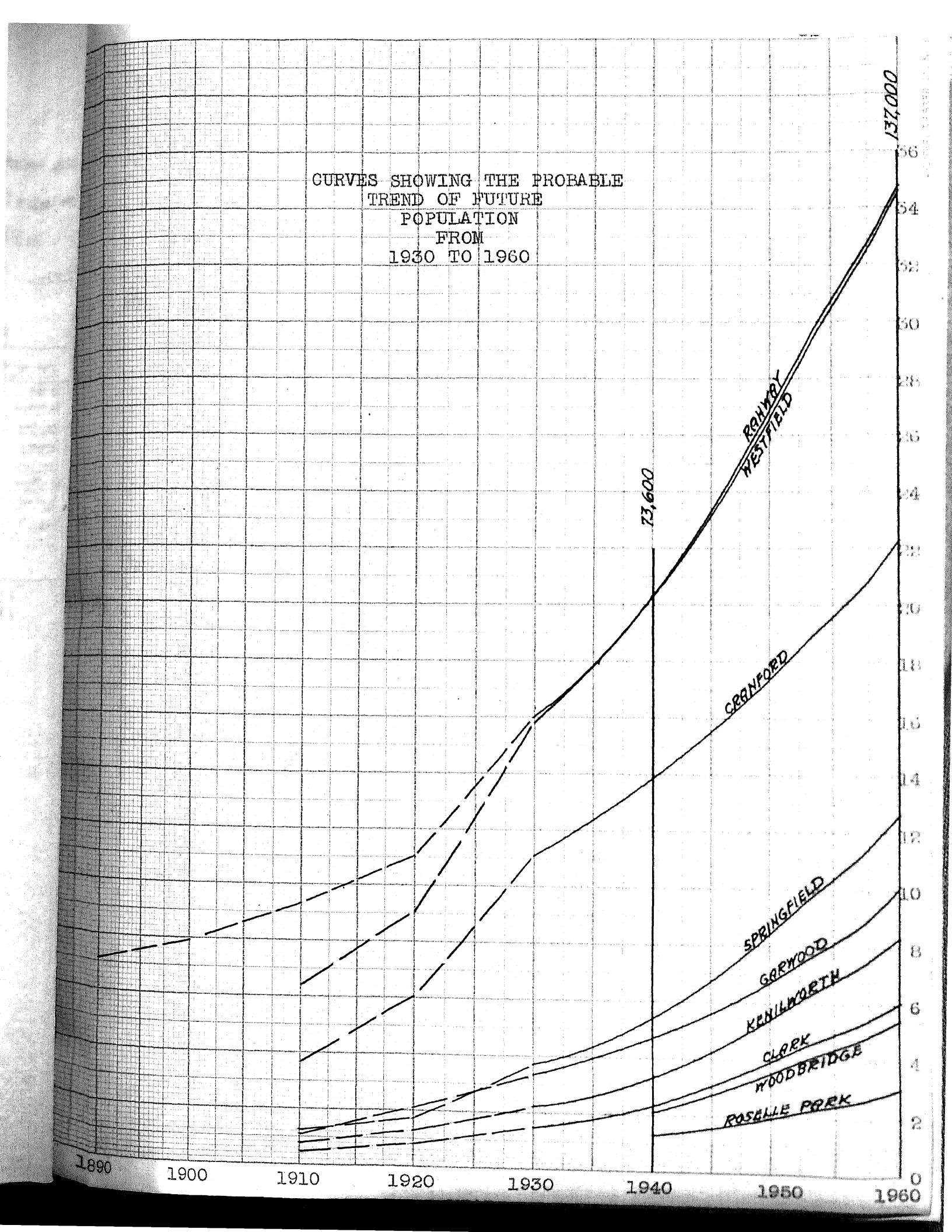
future development, and was computed on practically the same basis as I have used.

The following table shows the results of this compilation.

TABLE XIV
ESTIMATE OF FUTURE POPULATION

MUNICIPALITY	1930 (census)	1940	1960
Rahway	16,011	20,300	34,800
Westfield	15,801	20,300	34,600
Cranford	11,126	13,900	22,300
Garwood	3,344	4,700	10,000
Kenilworth	2,243	3,300	8,300
*Woodbridge	---	2,100	5,400
Springfield	3,725	5,400	12,600
*Roselle Park ...	---	1,300	3,000
Clark	1,474	2,300	6,000
	#53,724	73,600	137,000

* Only portion of community served by sewer
\# Excluding Woodbridge and Roselle Park


CURVES SHOWING THE PROBABLE
TREND OF FUTURE
POPULATION
FROM
1930 TO 1960
137,000
73,600
RAHWAY
WESTFIELD
CRANFORD
SPRINGFIELD
GARWOOD
KENILWORTH
CLARK
WOODBRIDGE
ROSELLE PARK
1890
1900
1910
1920
1930
1940
1950
1960
0
2
4
6
8
10
12
14
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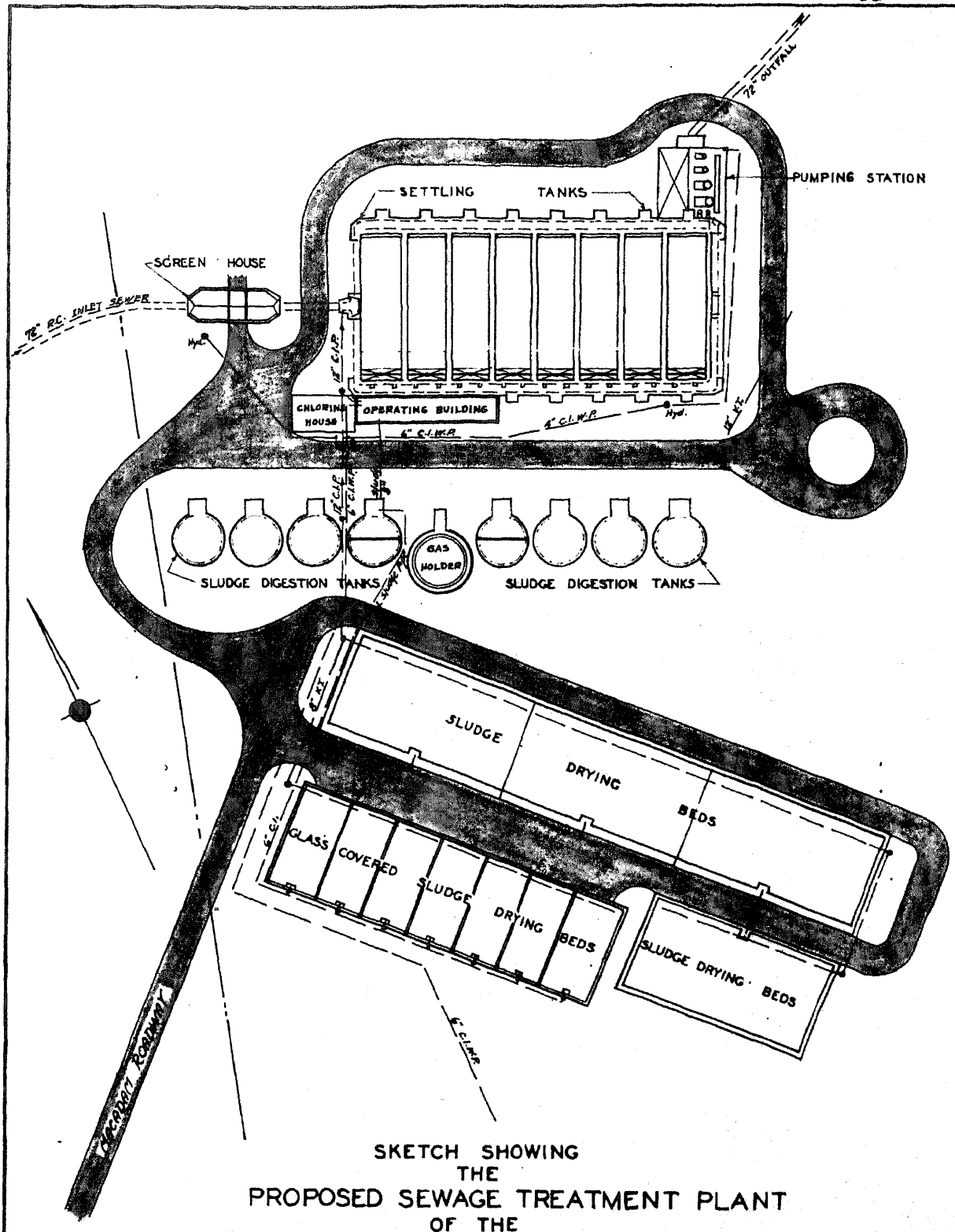

SKETCH SHOWING
THE
PROPOSED SEWAGE TREATMENT PLANT
OF THE
RAHWAY VALLEY JOINT MEETING
TO BE LOCATED IN
WOODBRIDGE TOWNSHIP
NEW JERSEY
1933

F.A.H.

PLATE D

PART III

THE TREATMENT PLANT (cont.)

DESCRIPTION OF TREATMENT UNITS

TRUNK SEWER:

Section 1 of the trunk sewer, extending from a point near the outlet end of the siphon at the foot of Lennington Street in Rahway to the treatment plant site, traverses low marshy land which necessitated the building of a protective earthen embankment to cover the conduit. The plant itself will be relatively low as may be realized by the fact that the sewage will flow through the Screen House and Settling Tanks by gravity, entering the plant at an invert elevation of -1.32 as compared with observed high water marks of +6.7 in the river.

SCREEN HOUSE:

As the sewage reaches the plant it will pass through a Screen House consisting of two separate channels, each capable of handling about one half the maximum hourly flow, or the total maximum hourly flow for many years. These channels will be fitted with bar racks made up of 12" sections and having a total overall width of 10 feet, cleaned by a reciprocating rake so arranged as to displace the screenings into small removable storage hoppers. The racks will be made from 3"

x 3/8" steel bars spaced to leave a clear opening of 1" between them and will be carried to the height required to discharge the bulk into the hoppers. The rakes and shredders will be operated by electric motors controlled from a switchboard in the Screen House.

The screened sewage will continue to the influent channel of the Settling Tanks, which contains a flow meter connected to the automatic chlorinators housed in a small building nearby.

CHLORINATORS:

The Chlorinators, solution feed vacuum type, will be four in number - two fixed capacity of 720 pounds per day each and two variable capacity automatically controlled. Each Chlorinator will have a chlorine meter to indicate the flow in pounds per 24 hours.

Chlorine handling equipment will include two lines of roller conveyors, each having a continuous load capacity of 2000 pounds, and three lines of track consisting of two 5-inch rails.

SETTLING TANKS:

The entire eight Settling Tanks will be constructed at present, each tank having inside dimensions of 32 feet in width, 101 feet in length, and an effective water depth of approximately 12.5 feet, with

a sludge hopper at the influent end to collect the sludge. Based on an average flow of 110 gallons per capita per day and a population in 1960 of 137,000, a detention period of 4 hours will be provided. Although the present design specifies the construction of the complete battery of eight tanks, it is probable that only four or five of them will be used for the present-design period of ten years. Using the same method of analysis for five tanks and the estimated population of 73,600 for 1940, a detention period of 4.5 hours is obtainable. These figures fall within the requirements of the State Department of Health which specify a minimum displacement period of 4 hours for single story sedimentation tanks with separate sludge digestion. The extra tanks available will serve as relief units, thus facilitating operation and periodic cleansing.

Sewage will flow from the influent channel to the settling chambers through a series of inlets and flow equalizing units. These units, four to each tank, will include 24" cast iron pipes, 18 inches long, set in the wall of the concrete influent trough, adjustable baffles attached thereto to encourage good distribution of flow in the Settling Tanks. In the effluent weirs there will be installed regulators made of finished spruce or

fir with bronze or Everdur hinges and fittings.

Apparatus for the continuous removal of sludge will collect the settled solids to the sludge hoppers and floating solids to the opposite end. The selection of the type of mechanism for this purpose will be decided by the final bids on the treatment units, but in all probability the conveyor type, consisting of a continuous chain of wooden flights similar to the Straightline collectors made by the Link Belt Company; or the crane type, consisting of a bridge crane spanning the tank and traveling back and forth along the long dimension of the tank, will be chosen.

Sludge will be drawn from the settling tank hoppers by a centrifugal sludge pump, capable of handling 800 gallons per minute against a total dynamic head of 46 feet, located in the Operating Building. From this point, the sludge will be forced through 8" pipes to the Sludge Digestion Tanks by two ejectors, each having a capacity of 50 gallons per minute against a 50 foot discharge head measured at the ejector discharge.

PUMPING STATION:

The Pumping Station, approximately 47' x 55' in plan, located near the effluent end of the Settling Tanks, will house the pumping equipment connected

to a wet well of sufficient capacity to smooth out the pumping operation. Electrically driven low lift pumps of varying capacity will provide a range of flow of 5 to 65 million gallons per day in steps of not more than 5 M.G.D. when the installation is complete, but the present installation will be determined by gaugings taken previous to the building of the plant. These pumps will be of the vertical shaft propeller type, connected directly to slip ring motors and will have the following minimum capacities and efficiencies at the heads specified.

TABLE XV
SPECIFICATIONS FOR PUMP CHARACTERISTICS

HEAD Feet	EFFICIENCY %	CAPACITY IN M.G.D.			
		5 MGD	10 MGD	20 MGD	30 MGD
7.5	72	4.5	10.0	20	30.2
7.0	72	4.6	10.5	21	31
6.0	70	4.8	10.8	21.5	32.5
5.0	65	4.9	11.0	22	33.5
4.0	60	5.1	11.5	22.2	35
3.0	50	5.1	11.8	22.5	36
2.0	40	5.2	12	23	37
Motor Horsepower		10	20	40	60

Sewage will be pumped from the wet well to the 72" outfall sewer, which empties into the river at an invert elevation of -8.5. Because of the present condition of the river bed at this point, it will be necessary to resort to dredging to clear away the silt now deposited there.

SLUDGE DIGESTION TANKS:

Present design of the sludge digestion facilities calls for five Digestion Tanks, 36 feet in diameter and 20 feet in depth. Based on the 1940 estimated population of 73,600 these tanks will have a capacity of 1.3 cubic feet per capita, and an ultimate capacity with eight such tanks of 163,000 cubic feet or 1.2 cubic feet per capita for a population of 137,000 in 1960. Two of these tanks, immediately flanking the Gas Holder, will be equipped with floating covers, both gastight and watertight.

The sludge will be heated by three hot water heaters, two of which will have gas-fired boilers, the other coal-fired, located in the Operating Building. Hot water from the heaters will be forced through 4" pipes to the heating coils of the Digestion Tanks by two circulating pumps, each to have a capacity of 170 gallons per minute against a total head of 12 feet. Digested sludge will be pumped to the Sludge Drying Beds by a 4-inch double suction and discharge pump geared to a 5 H.P. electric motor. The minimum capacity of this pump will be 15 gallons per minute against a total head of 25 feet.

GAS HOLDER:

The Gas Holder will be 43 feet in diameter and have a capacity of 20,000 cubic feet. Its container will be constructed of sufficient weight to give the required gas pressure of 5 inches of water, while the walls will be made of 1/4" steel plates electrically welded with guide rollers working against diagonally braced standards of 9" I-beams extending from the bottom of the tank to an elevation 20' 6" above the top of the tank.

SLUDGE DRYING BEDS:

Three separate units of Sludge Drying Beds will furnish a total area of approximately 59,000 square feet or a per capita of 0.80 square feet for a population of 73,600. Additional beds will be built in the future as they are needed.

One unit, 75' x 260', will be covered by a greenhouse structure, while the other two, 70' x 420' and 70' x 140', will be made up of open beds.

The filter media of the beds will be composed of 6 inches of sand supported by a 6 inch layer of gravel or broken stone passable through a 3" ring. Liquid filtering through this media will be drained into a system of 4" tile underdrains connected to 8" collectors, and will eventually reach the influent to the Settling Tanks by means of a 12" return sewer.

OPERATING BUILDING:

The Operating Building, located adjacent to the Settling Tanks, will be a three story brick structure, two of the floors being below grade. The upper story or superstructure will be partitioned into a number of compartments consisting of a Joint Meeting and Superintendent's office, chlorine feed room, laboratory, control room with flow meters and indicators, supply and tool house, and an operator's room. On the intermediate floor there will be housed the pump motors, displacement pump, air compressor, chlorine evaporators, and heaters connected to a low pressure steam heating system to heat the building. In the basement there will be such equipment as pumps, ejectors, boilers, and sludge preheaters.

Water will be supplied to the Operating Building through a 6" cast iron main fed by the Rahway system.

COST OF TREATMENT PLANT:

At this time it is impossible to discuss the costs of the various units of the treatment plant to any degree of accuracy for many of the bids reviewed by the Joint Meeting in June 1933, have been recalled by the contractors because of the delay in making the arrangements necessary to start the work. Since June, material and labor costs have risen so sharply, and will

probably continue to do so in the next few months, that the figures in the re-bids, when taken, will no doubt be substantially higher than the original ones.

The lowest bid received by the Joint Meeting last June for the construction of the entire works, approximately $321,300, would probably increase to about $378,000 at this time (December 1933) if the figures were adjusted in accordance with the cost-index numbers compiled by several engineering journals.

* B I B L I O G R A P H Y *

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