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REPORT

OF THE

N.J. HACKENSACK VALLEY SEWERAGE COMMISSION

BERGEN COUNTY AND HUDSON COUNTY

NEW JERSEY

1931

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REPORT

OF THE

HACKENSACK VALLEY SEWERAGE COMMISSION

TO THE

BOARD OF CHOSEN FREEHOLDERS
OF THE COUNTY OF BERGEN

AND TO THE

BOARD OF CHOSEN FREEHOLDERS
OF THE COUNTY OF HUDSON

THE COMMISSION

THOMAS F. BOWE — GUSTAV MEYER
HORACE R. BOGLE — WILLIAM R. SMITH
THOMAS J. WASSER, Chairman

ENGINEERS

GEORGE W. FULLER — S. WOOD McCLAVE

CHEMIST AND BACTERIOLOGIST
RICHARD C. SMITH

DATED DECEMBER 16TH. 1931

OFFICE: 6 HIGHWOOD AVENUE, TENAFLY, N. J.

HACKENSACK VALLEY SEWERAGE COMMISSION

BERGEN COUNTY AND HUDSON COUNTY
NEW JERSEY

December 28th, 1931.

To the Honorable the Director and Members
of the Boards of Chosen Freeholders of the
Counties of Bergen and Hudson.

Dear Freeholders:

I have the honor to transmit herewith the report of the Hackensack Valley Sewerage Commission, appointed under the provisions of Chapter 144 of the Laws of 1930 "An Act to create a sewerage district to be called Hackensack Valley Sewerage district, to authorize the appointment and define the powers and duties of the Commissioners therefor, to provide a plan for the prevention of the pollution of the Hackensack River and its tributaries and to authorize the raising and expenditure and payment of moneys necessary for this purpose:"

Respectfully,

WILLIAM R. SMITH,
Secretary.

Acknowledgements.

THE COMMISSION feels deeply grateful for the information, advice and co-operation received from the following in the preparation of this report:

Bergen County Board of Chosen Freeholders, Hudson County Board of Chosen Freeholders, Bergen County Chamber of Commerce, the Press of the Counties of Bergen and Hudson, Public State Officials, also the Officers and Officials of the following: Jersey City, Union City, West New York, Guttenberg, North Bergen, Secaucus, Kearny, Fairview, Cliffside Park, Fort Lee, Englewood Cliffs, Tenafly, Alpine, Norwood, Rockleigh, Northvale, Ridgefield, Palisades Park, Ridgefield Park, Leonia, Bogota, Teaneck, Englewood, Bergenfield, New Milford, Dumont, Cresskill, Haworth, Demarest, Closter, Harrington Park, Old Tappan, Rivervale, Montvale, Woodcliff Lake, Park Ridge, Hillsdale, Washington, Westwood, Emerson, Oradell, Paramus, Riverside, Maywood, Hackensack, Hasbrouck Heights, Teterboro, Lodi, Woodridge, Carlstadt, Little Ferry, Moonachie, East Rutherford, Lyndhurst, and North Arlington, also the Hackensack Water Company, Regional Plan Association, State of New Jersey Department of Health, State of New York Department of Health, State Water Policy Commission, New Jersey State Board of Commerce and Navigation, North District Water Supply Commission, and Hackensack Meadows Reclamation Commission.

Foreword.

IT has been said that George Washington Bridge would open both for residential and business development one of the most beautiful sections of New Jersey. It would offer to the commuter ready and convenient access to his work and enable him to live in a section where recreational opportunities are unexcelled. It would bring to this section many new homes and home owners, with its consequent increase of business and ratables.

Bergen County, the Western Gateway to the George Washington Bridge, is now on the threshold of opportunity and seeks the necessary authority to proceed with a project that will remedy all the short comings of the present municipal sewage disposal within the area of the Hackensack Valley. That necessity has been brought about by the overloading of the treatment plants due to the rapid increase of population far beyond the population anticipated at the time the now existing municipal treatments plants were designed and built.

The anticipated increase of population in the near future warrants a system of sewage treatment of higher standard than can be obtained by adding to the present plants. A system sufficient to meet the present and future demands should embrace all the municipalities within the drainage area in practically two units calculated to be of sufficient proportions to reach their maximum of capacity about the year 1960, and so designed that additions can be made to the system.

Without sanitary conditions amply provided for along the lines carried out by the County of Westchester, New York, all the wonderful highways constructed for the purpose of developing the County, at a cost of several millions of dollars during the past decade, will not induce prospective home owners to locate in Bergen County, but will simply provide a means for transportation to points beyond.

Associated with Bergen County in the project, and also lacking the authority to proceed, is the neighboring County of Hudson, whose interest lies in the development of the County as one great municipality, the government of which will be more economical than the present system. So, with reduced taxes, the opening of the Bayonne Bridge this year, and the Midtown Hudson Tunnel in the near future providing additional transportation facilities, supplemented with improved sanitary conditions, will induce business industry to locate within the greater municipality.

The establishment of a unified system of sewers and treatment of disposal, linking up the several municipalities, will be the initial step towards the ultimate goal.

Even though we are in the midst of a world-wide economic disturbance and "economy" the watch word, let us not forget our needs.

THOMAS J. WASSER,
Chairman.

Introductory.

NEVER BEFORE in the history of public improvements has a project been submitted to the public in general, and the property owners in particular under more favorable conditions than this project is now being presented.

The proposed legislation provides for the Counties of Bergen and Hudson to act in the capacity of bankers, financing the project, and the municipalities reimbursing the Counties, by paying the principal and interest, together with the cost of operation, maintenance and repairs, on the pay-as-you-go plan, payment to be determined by the unit of million gallon flow from each municipality. The total cost to a municipality will be proportionate to the extent that it makes use of the facilities.

The Commission in its studies kept in mind the necessity of the project and the inability of the municipalities to finance it and keep within the legal debt limit.

They also realized that it was necessary to protect the principle of "Home Rule" in any legislation that they would recommend. For that reason they have provided in the proposed legislation a method by which municipalities affected would have a voice in the matter and a right to petition against entering into any contract with the counties requiring them to participate in the project if in the opinion of property owners representing 60% of assessed valuation of real property in the municipality that it would be an inadvisable procedure.

The proposed method of financing the project being sound and the interests of the municipality amply protected, the Commission does not hesitate to say that the relief and prevention of the pollution of the Hackensack River and its tributaries should be and can be accomplished, if Legislative and Municipal co-operation is assured.

DESCRIPTION OF THE PROJECT

Requirements of the Act

Chapter 144 of the Laws of 1930, which created the Hackensack Valley Sewerage Commission, authorizes the Commission to determine the most advantageous method of relieving and preventing pollution of the Hackensack River and its tributaries; to ascertain the approximate cost of a trunk sewer, disposal system and other appurtenances, or other sufficient method, necessary thereto; and to make suggestions as to the most advisable manner to finance the same.

HISTORY

Horace R. Bogle, Gustav Meyer, Thomas F. Bowe and William R. Smith, representing Bergen County, and Thomas J. Wasser, representing Hudson County, were appointed Commissioners by the Board of Chosen Freeholders of their respective counties. The Commission organized on January 6, 1931, electing Mr. Wasser, Chairman; Mr. Bogle, Vice-Chairman; and Mr. Smith, Secretary.

The Commission invited to its first meeting the Bergen County Chamber of Commerce, who had taken an active interest in the matter and who offered the services of the Chamber and of its special Sanitation Committee.

Questionnaires were prepared and sent out to ascertain any facts possible. Most of the municipalities co-operated by returning answers. (See Appendix Twelve).

The Commission then held a series of meetings in various community centers, one each in Jersey City, Englewood, Bergenfield, Closter, Hackensack, Westwood and Rutherford, to ascertain the local points of view and such other facts possible. These meetings were well attended; and at practically all, one or more members of the Boards of Freeholders were present.

On February 19th the Commission arranged a Conference of the various organizations interested in Hackensack Valley conditions. Representatives of the Hackensack Water Company, Regional Plan Association, New Jersey State Board of Health, New York State Board of Health, State Water Policy Commission, North Jersey District Water Supply Commission, Hackensack Meadows Reclamation Commission, Board of Commerce and Navigation, and the State of New Jersey Senate, were present and took part in the proceedings.

The Commission then made a personal inspection of the various sewage disposal plants located in the District, and also in the adjacent Rockland County, N. Y., area.

The Commission contracted with the Air Map Corporation of America to furnish an aerial survey, as the most practicable means of procuring an accurate map to become a permanent record and be the property of the Counties.

The Commission authorized Richard C. Smith, Chemist and Bacteriologist, to make a chemical and bacteriological survey of the river, covering a period of several months, that it might have accurate information regarding existing conditions.

Due to the unusual conditions involved, it was imperative that the Commission secure engineers of the highest degree of practical experience and technical training. After due deliberation, S. Wood McClave and George W. Fuller were unanimously appointed. In accordance with their contract, these engineers organized an efficient engineering force. George W. Fuller's staff included the following personnel: J. R. McClintock, F. G. Cunningham, E. G. Manahan, D. W. Howes, E. W. Whitlock, Wellington Donaldson, G. E. Barnes, Harold Sherman, and M. A. Ela.

S. Wood McClave's staff included the following personnel: Oscar A. Luck, James F. Madden, Joseph A. Boyle, Edwin F. Lafferty, Thomas O'Callaghan, Daniel O'Donnell, and field parties as required.

The Commission engaged the services of Mr. Joseph P. McLean, real estate appraiser; Mr. M. L. Howell, actuary; and Mr. Alexander Crawford, legislative advisor for their respective duties in preparing data for the report.

The Commission made a thorough survey of industrial pollution, sending out over 400 questionnaires, which brought very satisfactory responses.

The Commission later, in order to ascertain facts regarding municipal sewerage financing, sent out another questionnaire. This questionnaire was at variance from the methods of keeping existing records, therefore information was incomplete.

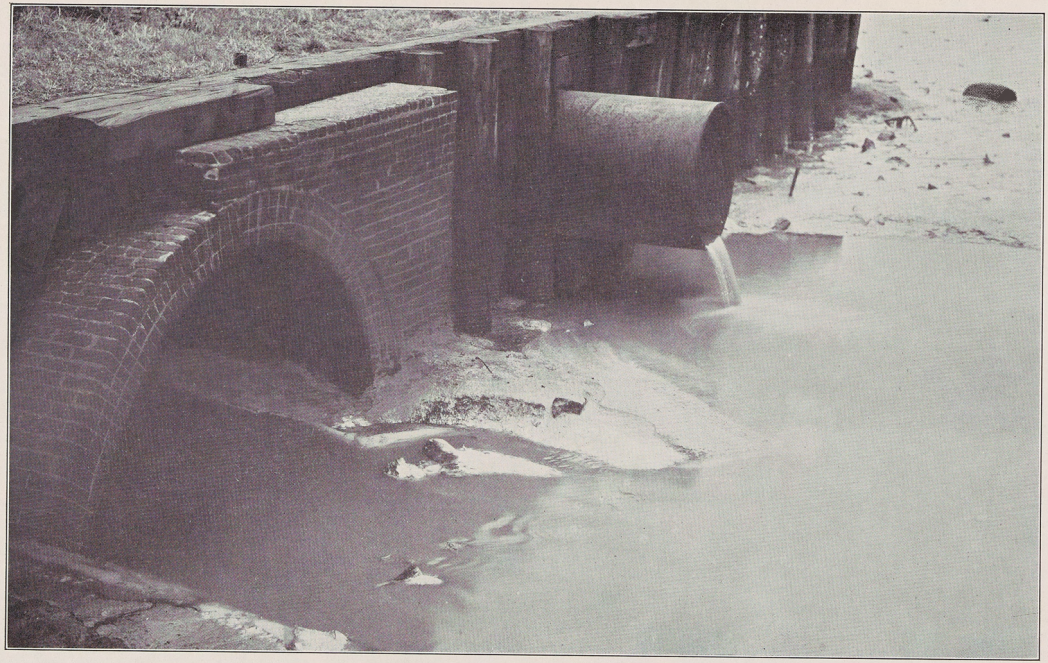
The Commission undertook a survey of the waterways together with the Engineers and the Freeholders of both Counties. Water front properties were inspected and conditions were observed first hand.

Regular meetings were held weekly, a quorum being present at each meeting. After organization, due to the duties of the Secretary and convenience to members, offices were maintaind at 6 Highwood Avenue, Tenafly, Where convenient office space was utilized at no expense to the Commission.

The Commission has prepared a detailed statement of expenditures. (See Appendix Eighteen).

EXISTING CONDITIONS

There are more than 145 square miles within the Sewerage District. Of the 94 square miles below New Milford Dam about 38 per cent, located



PHOTOGRAPH A.

TYPICAL SEWERS DISCHARGING CRUDE SEWAGE TO HACKENSACK RIVER.

in the southerly or tidal portion, is meadow land which will gradually be developed and utilized. In addition there are about 62 square miles of drainage area in Rockland County, N. Y. On the other hand, while parts of Guttenberg, Union City and West New York actually lie within the District, their existing sewers drain their entire area into the Hudson, except part of Union City which eventually must be taken through North Bergen into the District.

More than a dozen large branches as well as many small brooks drain the District into the Hackensack River.

Population has been moving northward into Bergen County, away from the Newark and Jersey City urban centers. The population of Bergen County in 1920 was 210,000 while last year it was 365,000, an increase of 73 per cent. Bergen County tax ratables rose from $419,000,000 in 1928 to $448,000,000 in 1929 and $470,000,000 in 1930. The gigantic George Washington Bridge, over which the Port Authority predicts that 10,000,000 vehicles will pass during its first year of operation, has been exerting its influence, even though recently opened.

NEED FOR ELIMINATING POLLUTION

The varying density of population is shown in colors on Map 3, which thus graphically pictures the needs of the populous sections for sewerage facilities.

Conditions which call for immediate remedy are clearly set forth in the report of Richard C. Smith, Chemist and Bacteriologist. Photographs A to F show conditions in the valley which should not be tolerated, such as those at Pinhorne Creek in Secaucus. They also show banks of sewage sludge, accumulated along the river for years which cannot quickly be eliminated.

The necessity for protection of the potable water supply derived from the upper part of the valley from future sources of pollution, and the growing need of the residents of that section for sewage facilities, are obvious. This applies as well to the area in Rockland County, N. Y. The only active interstate agency now protecting the water supply is the Hackensack Water Co. (See Appendix Seven).

Nearly half of the existing municipal plants, of which there are now 40, are already operating at rates exceeding their capacity, according to information from Harry P. Croft, Chief Engineer of the State Board of Health (Table 11, Appendix One). Many are inefficient. Unless other facilities are provided, many millions of dollars must be expended in their extension and improvement. The State Board of Health is withholding proceedings against various offenders, pending action upon this report. These facts, together with a realization that many municipalities have no means of disposal, will convince one of the necessity for immediate action.

Pollution from industrial wastes also is becoming increasingly undesirable, and requires prompt correction.

As populations and industries increase, as they necessarily must on account of proximity to the metropolitan center, higher degrees of purification will be demanded by the State Board of Health. Furthermore, a Tri-State Treaty, prohibiting pollution of New York Bay and its tributaries, may become effective in the near future. It is therefore wise to provide now, means to meet all such requirements permanently.

LOCAL VIEWPOINTS

It is generally agreed, even by those who have not taken time to give the matter thought, that something must be done to control the increasing pollution of the Hackensack River.

People generally are conversant with conditions that have prevailed in the Hudson and Passaic Rivers and with the situation in the Hackensack Valley which forebodes similar conditions.

Newspapers for the past ten years have condemned conditions as they exist and have pleaded for a constructive remedy. Many interested citizens have started individual campaigns to clean up conditions, but through lack of co-operation their efforts have been without apparent results.

There is a determined opinion in the valley that the water supply must be protected. It is more economical to provide against pollution of the present supply than to spend millions of the taxpayers' money to bring in a new water supply.

Organized sport and recreational societies have deplored the impairment of the natural advantages that exist, and are heartily in favor of a clean up. Bathing and boating on the river were enjoyed until offensive conditions developed.

Water front properties have depreciated and owners are calling for relief.

Many people, especially officials, recall the meeting held in Teaneck on September 17, 1929. They remember, with trepidation, their fears lest their municipalities lack proper facilities to handle their disposal problem. It was estimated at that time that to put into effect the 1926 Law. (See Appendix Five) providing for sand filtration for all plants north of Bellmans Creek, would cost many millions of the taxpayers' money, without fully correcting the situation or adequately solving the problem. They feel that it was through their efforts, at that time, that the Legislation known as Chapter 144, P. L. 1930, providing for this Commission, was brought into being.

The municipalities realize their short-comings and their inability to cope with this problem. It has been frequently stated to members of the Commission that something must be done to relieve and prevent the pol-

PHOTOGRAPH B.

PINHORNE CREEK SHOWING DEPOSITS OF FILTH.

lution, and that the municipalities are looking to the Commission for a solution.

A wide divergence of opinion is expressed. For instance, in one of the municipalities in the northern part of the District, where the population is less than 1,000 per square mile and where the municipality develops its own supply of water, the opinion was expressed that the natural water courses should be used to provide a means of removing their sewage waste. An official of another municipality, which lies along Berry's Creek, was faced with the following problem. The disposal works, built in 1924 and thought to have capacity ample for many years, has already proved to be hopelessly inadequate on account of the rapid increase in population. The people want immediate relief. Their opinion is insistent that this matter is too big for any one municipality and requires thought to be given to the drainage area as a whole.

A fair summary of various opinions is as follows: Something must be done to relieve and prevent the pollution. Whatever is done must be economical, provide a permanent solution of the problem and be possible of being financed.

PROPOSED LEGISLATION

The Commission, according to the duties required of it, has made a careful and thorough study of the various phases of the problem relative to suitable legislation that will be required to put in effect its recommendations. The result of these studies is the preparation of a complete form of proposed legislation, a full copy of which is given in Appendix Six of this report.

The inability of some of the municipalities within or partly within the District to finance the project without dangerously affecting their financial structure and the cumbersome methods of procedure that would be necessary to deal with fifty-eight municipalities guided the Commission in arriving at the proposed legislation.

The principal provisions of this legislation include a plan whereby the project is directed under a joint commission composed of members from both Bergen and Hudson Counties and an equitable method of financing, whereby the Counties of Bergen and Hudson, acting in the capacity of bankers, would furnish the necessary funds by issuing bonds and would be reimbursed in full by the municipalities in proportion to their individual use of the facilities. The decision relative to these important points resulted from a realization by the Commission of the financial conditions of the individual municipalities, the complex nature of the problem, and the advantages of unified action of the two Counties in its solution.

The Commission also wishes to call attention to other important features of the proposed legislation, as follows:

The appointment of a non-salaried Commission with a paid Secretary.

The provisions relative to duties and powers of the Commission.

The right of a municipality to decide whether or not it desires to enter the project.

The provision that a petition against participation, signed by owners representing sixty per cent of assessed valuation of real property, would bar a municipality from entering into a contract for service with the Commission.

The provision relative to the proportion of funds to be provided by bond issue by each County, viz. Bergen County, sixty per cent and Hudson County forty per cent, these proportions being the estimated proportional costs of required construction work within the boundaries of each County.

The provision for reimbursement to the counties by municipalities for service, based on a uniform rate per million gallons of sewage delivered into the trunk sewers.

The right of the Commission to deal with a private sewer company the same as with a municipality.

Limiting the cost of the project to a stated per cent of the ratables of each County.

INABILITY OF THE MUNICIPALITIES TO FINANCE THE PROJECT

The Commission realizing the magnitude of the project began a study of how it should be financed. Financial statements of the several municipalities within or partly within the District were prepared from the records of the State Department of Municipal Accounts for the years 1928, 1929 and 1930 to ascertain if it were possible for the municipalities to finance the project.

A comparison of the several statements disclosed the fact that there was such a wide range in the borrowing capacity of the several municipalities that a further study was made which required an additional statement, showing average valuation, present net debt, borrowing margin to 7%, 3% of average valuation for utility deduction, utility debt partly deductable (present), amount of additional utility which may be incurred, assessments receivable outstanding, assessments unconfirmed and 15% average valuation. From this latter data sufficient information was obtained to decide that many of the municipalities could not finance the project, under the present debt limit.

It was therefore necessary for the Commission to devise some method by which the project could be financed and ultimately paid for by the municipalities.

FINANCING THE PROJECT

The financing by Counties of a project constructed for the benefit of



PHOTOGRAPH C.

SEWAGE RUNNING IN STREET GUTTERS TO TRIBUTARY OF HACKENSACK RIVER.

a group of municipalities, while somewhat unusual, is not without precedent. Examples are found in Westchester County, N. Y., (Appendix Ten) and in Middlesex County, England (Appendix Eleven). Both of these projects are now under construction.

The necessity for a County method of financing, in the case of the Hackensack Valley Sewerage District, where there are fifty-eight municipalities, including Bayonne, is apparent when one realizes the cumbersome procedure otherwise necessary in order to carry out the terms of any adequate contract by the several municipalities, to say nothing of the inevitable delays required by conferences and agreements among the parties in interest.

Therefore, there has been developed a plan whereby first the Counties of Bergen and Hudson would, by issuing temporary bonds, or certificates of indebtedness, finance the project over a five year period of initial construction, assumed to extend from 1932 to 1937. Such construction would serve the needs of municipalities which already have local sewer systems and also of those which in the opinion of the Commission will require local sewer systems during this construction period.

The above initial construction is assumed to meet the needs of the municipalities until about 1947 as to treatment works and until 1960 as to main trunk sewers. During the years 1944-47, however, it is assumed that further construction will take place to meet needs up to 1960 or later, During this period trunk sewer extensions will be made to serve required additional local sewer systems as needed, and treatment plants will be extended to serve additional and increasing populations. To meet the additional cost thus incurred, temporary construction bonds will again be issued by the Counties.

In order to refund these temporary bonds, the Counties will, under the plan developed, issue serial bonds, running for a period of thirty years.

The plan developed includes the provision that each County shall be reimbursed by the several municipallities for the annual expense incurred by it for interest and redemption of the serial bonds and for the annual charges for operation, maintenance and repairs. Each municipality will reimburse the Counties in proportion to the amount of sewage which it contributes to the District system. Meters or other measuring devices will be installed at points of connection to the District sewers. In order that reliable records of the sewage may be obtained at all times, these meters will be installed in duplicate. Master meters will also be installed at the treatment plants. Each municipality will provide for reimbursement either by means of a service charge for sewage disposal or by taxation. In some municipalities the method may be optional; in others the service charge method will be necessary. The Commission suggests the service charge as preferable, but each municipality must make its own

decision, and in some cases a combination of the two methods may be desirable.

Schedules A, B, and C, Appendix Thirteen, Fourteen and Fifteen have been prepared to make clear by example the manner in which the Counties are to be reimbursed by the municipalities and the annual amounts of such reimbursements. These schedules show the total estimated cost of the 1932-37, and the 1944-1947 parts of the project, including capital and interest during construction. The refunding of the temporary bonds by means of serial bonds; also the annual charges for each year from 1937 to 1977 for interest on the serial bonds and for their successive retirement. In addition they show the estimated annual cost of operation, maintenance and repairs.

These schedules have been prepared from an estimated cost for a project when the prices were at their peak in 1929 and are only used to show by example what the project would cost if the same prices prevailed at the time the proposed project would be under construction.

The interest on bonds have been arbitrarily fixed at the rate shown. Annual cost of operation and million gallon flow have been estimated in accordance with information obtained from plants and systems now in operation.

The last column on schedule C shows the rate per million gallon flow, that a municipality will be required to pay for discharging from the local system into the trunk and interceptors of the District system.

The municipalities will be required to pay their charges semi-annually. Review and adjustment of the charges per million gallons of sewage is provided for in the proposed legislation.

In conclusion it is well to say that these County bonds will be free from taxation, and will not be included in the County gross debt; that is, they are excluded when computing the borrowing capacity of the Counties.

THE PRINCIPLE OF HOME RULE

The Commission believes that each municipality should have jurisdiction over its affairs within its territorial rights and it has endeavored to consider the principle of "Home Rule" in working out the details of this project.

The Commission also believes that a municipality which creates a nuisance affecting a neighboring municipality should take action to abate the nuisance, but when a nuisance becomes general throughout a group of municipalities, then the municipalities should become grouped within a District because unified action is necessary to abate the nuisance. However, each municipality should have the right to decide for itself whether or not it should enter such a project.

The provision in the proposed legislation that a petition against participation signed by owners representing 60% of assessed valuation of



PHOTOGRAPH D.

DRAINAGE FROM PIG FARM, SECAUCUS.

real property would bar a municipality from entering into a contract for service with the District, insures that no municipality will be forced into the project against its wishes.

Another provision of "Home Rule" is the fact that municipalities will be the sole judges as to the manner in which they may provide funds to reimburse the Counties for their proportionate share of the project, whether or not the funds shall be raised by a service charge, or by general taxation or other means.

BENEFITS OF PROJECT TO MUNICIPALITIES

Should the project become assured, the mere fact will boom the several municipalities. Should it fail to meet approval, however, serious reaction will be felt. For instance, should the proposed legislation fail to be enacted into Law, or should the municipalities fail to support the project after the enactment of the Law, then the project must necessarily be abandoned, and the enforcement of the provisions of Chapter 173 P. L 1926 (See Appendix Five) will become necessary. This enforcement will require the construction of works entailing the expenditures of vast sums of money, immediately by some of the municipalities, and in the near future by all of the municipalities north of Bellmans Creek, without by any means fully solving the problem.

The Commission calls attention to the fact that the State Board of Health of New Jersey is withholding action against several of the municipalities, within the Hackensack Valley Sewerage District, pending the outcome of the action of the legislature and of the municipalities on this report.

The Commission believes they have solved the problem by the adoption of an economical plan, which requires only the co-operation and support of the legislature and municipalities to insure its success. The co-operation and support of all municipalities is warranted and necessary.

POLICY OF THE COMMISSION

The policy of the Commission, from its organization until the filing of this report, has been one of endeavor to be both thorough and fair in making its many required decisions. The Commission believes that a careful reading of the report will show this in every case. The Commission desires to call your attention to some of the important decisions summarized as follows:

The type of system that would best serve the District.

The manner of handling isolated sections in undeveloped territory.

The manner in which it is proposed to take care of trade wastes.

Provisions for taking care of local conditions from without the District.

The basis of estimates of construction costs, from known figures of costs at peak prices in 1929.

The proportionate parts of the construction cost of the project which are to be financed by each County.

The allocation of costs to all municipalities, including private sewer companies, upon the equitable basis of a uniform charge per million gallons of sewage contributed by them.

The method of financing the project.

The intention to negotiate agreements whereby the municipalities may turn over to the District the present municipal treatment plants for the District to operate, during the 1932-1937 period of construction of new works, at no expense to the municipalities for operation, maintenance and repairs, or for such changes and improvements to present treatment plants as will eliminate or at least reduce complaints due to existing nuisances, the Commission being of the opinion that under one management it will be possible to control the situation with better results.

The estimated cost of the project does not include any figures covering an expenditure for the acquisition of these plants, as some of them have already served their usefulness, and all of them will need to be enlarged by the year 1940.

The continued use of the sewer financed by the Hackensack Water Company, an intercepting sewer now extending to, and serving Westwood, even though it will have to be paralleled eventually.

RECOMMENDATIONS

The Commission, after making a thorough study of the problem of pollution of the Hackensack River and its tributaries, and an impartial investigation of methods and plans for relieving and preventing such pollution, with its related nuisances and unhealthful conditions, finds that immediate measures for correction should be taken. The Commission summarizes its recommendations for the solution of this problem as follows:

1. The immediate construction of trunk sewers, pumping stations and sewage treatment works, divided into a northerly system and a southerly system, to be completed in 1937 of sufficient capacity to care for the growth of the District to 1947; the installation of additions, constructed as needed approximately between the years 1944 to 1947 to serve the District until 1960 or later, all as described, shown and recommended in detail in the report of the Engineers, Appendix One.

2. Financing of the 1932-37 construction project on the basis of an estimated construction cost of $20,000,000 and an average yearly operation, maintenance and repair cost during the years 1937 to 1947 of $650,000; and the additions to be made from about 1944 to 1947 on the basis of an estimated construction cost of $4,400,000 and total annual operation,



PHOTOGRAPH E.

SLUDGE DEPOSITS ON MUD FLATS, HACKENSACK RIVER.

maintenance and repair costs during the years 1947-60 of approximately $800,000, as shown in detail in the report of the Engineers.

3. A method for financing, consisting of provision of funds by means of temporary construction bonds during construction period, to be retired by serial bonds; the bonds to be issued by each County in the proportion of 60 per cent by Bergen and 40 per cent by Hudson, based on the approximate per cent of construction work located in each County: reimbursement to the Counties by the municipalities based on a uniform charge per million gallons for the measured sewage delivered into the trunk lines by each munnicipality, as described more fully hereinbefore under the heading "Financing."

4. To put in effect the foregoing recommendations by the enactment of suitable State Legislation, a proposed form of which is included in Appendix Six of this report.

Respectfully submitted,

THOMAS J. WASSER,
HORACE R. BOGLE,
THOMAS F. BOWE,
GUSTAV MEYER,
WILLIAM R. SMITH.

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PHOTOGRAPH F.

WASTE MEADOW LAND—SUITABLE SITE FOR TREATMENT PLANT.

APPENDIX ONE

REPORT OF McCLAVE AND FULLER, ENGINEERS

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APPENDIX ONE

December 2, 1931.

To the Hackensack Valley Sewerage Commission,
Tenafly, N. J.

Gentlemen:—

Pursuant to your instructions of June 4, 1931, we hand you herewith our report on the engineering aspects of means for eliminating the pollution of the Hackensack River.

1—GENERAL DESCRIPTION OF THE HACKENSACK VALLEY

The Hackensack Valley Sewerage District is defined by Chapter 144 of the Laws of 1930, under which the District was created, as comprising all that portion of Bergen and Hudson Counties lying between Newark Bay and the boundary line between the state of New York and the state of New Jersey, within the natural drainage area of the Hackensack River and its tributaries between the said points.

The natural drainage area of that part of the Hackensack River and its tributaries lying between Newark Bay and the New York State line, that is, within the District, covers 145.6 square miles. In addition however this river has a drainage area of 62.4 square miles in New York State, making a total area of 208 square miles above Newark Bay.

On this total area there was resident, according to the 1930 Census, a population of about 480,000 persons, of whom about 456,000 were resident in New Jersey, and about 24,000 in New York State.

The Act creating the Hackensack Valley Sewerage District makes no mention of the west side of Bayonne. This area drains into Newark Bay, but the pollution from it is carried by tides upstream into the lower Hackensack River. The addition to the District of that part of Bayonne which drains into Newark Bay would increase the total drainage area and the 1930 population above given by 1.2 square miles and about 23,600 persons respectively.

The Hackensack River is tidal up to the New Milford Dam of the Hackensack Water Co., in Oradell. The non-tidal upland portion of the Hackensack River, used as a source of water supply for the principal municipalities of Bergen County and also for some in Hudson County, has a total drainage area of 115 square miles on which were resident in 1930 about 33,800 persons in New Jersey and about 24,000 persons in New York State, or a total population of about 57,800.

The total drainage area of the lower Hackensack River and its tributaries, that is of the portion below New Milford Dam and above Newark Bay, comprises 93.0 square miles; or 94.2 square miles if there is in-

cluded the west side of Bayonne. On this area were resident in 1930 a population of about 423,800 persons above the Bayonne line and about 447,600 persons including the west side of Bayonne.

There are about 35.1 square miles of swampy area and water surface in the valley of the lower Hackensack River and its tributaries, leaving a net area of about 59.1 square miles inclusive and 57.9 square miles exclusive of the west side of Bayonne, respectively.

Map 1 shows the division of the drainage area of the Hackensack River into the upland portion which serves as a source of potable water supply, and the lower or tidal area where the river water is brackish and non-potable.

Map 2 shows the natural boundary line of the Hackensack River drainage area, the location of the Hackensack River and its principal tributaries, the boundaries of each of the 58 municipalities, including Bayonne, within the Hackensack Valley below the New York State boundary line, as well as the location of 40 treatment plants now existing within this sewerage District.

Additional characteristics of the area embraced in the Hackensack Valley Sewerage District are shown on the Aerial Map of the Hackensack Valley (Map 5).

Table 1 shows the population in 1930 and the area in acres of each municipality or portion of a municipality, exclusive of meadow areas and water surfaces, which lies within the boundaries of the District, including also the estimated population and area of that portion of Bayonne which drains into Newark Bay. It also shows the population and area of each municipality or portion of a municipality in the state of New York which lies within the Hackensack River drainage area. Populations given for entire municipalities have been taken from the 1930 U. S. Census. Populations of portions of municipalities having been estimated as proportionate to the upland areas draining into the Hackensack River.

TABLE 1

Areas and 1930 Populations in Hackensack Valley Drainage Area

Municipality	Area in Acres		Population	
	Total	Part in drainage area, less water and meadow areas	Total	In drainage area
BERGEN COUNTY				
Alpine	4018	1838	521	238
Bergenfield	1958	1958	8,816	8,816
Bogota	422	422	7,341	7,341
Carlstadt	435	230	5,425	2,868
Cliffside Park	596	161	15,267	4,124
Closter	2118	2118	2,502	2,502
North Bergen	1811	1348	40,714	30,303
Secaucus	1528	1528	8,950	8,950
*Union City	840	351	58,659	24,514
*West New York	611	196	37,107	11,904
Total		10,089		282,470
ROCKLAND COUNTY, N. Y.				
Clarkstown	25864	25864	9,346	9,346
Orangetown	8570	8570	8,408	8,408
Ramapo	4867	4867	2,272	2,272
Spring Valley	668	668	3,948	3,948
Total		39,969		23,974
SUMMARY				
Bergen County		60,782		197,579
Hudson County		10,089		282,470
Total for N. J.		70,871		480,049
Rockland County		39,969		23,974
Total		110,840		504,023

*Guttenberg, Union City, and West New York claim that they should not be included in the District.

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Bogota	422	422	7,341	7,341
Carlstadt	435	230	5,425	2,868
Cliffside Park	596	161	15,267	4,124
Closter	2118	2118	2,502	2,502
Cresskill	1337	1337	1,924	1,924
Demarest	1337	1337	1,013	1,013
Dumont	1212	1212	5,861	5,861
East Rutherford	499	200	7,080	2,838
Emerson	1523	1523	1,394	1,394
Englewood	3154	3154	17,085	17,085
Englewood Cliffs	1280	578	809	365
Fairview	403	375	9,067	8,437
Fort Lee	1593	622	8,759	3,640
Hackensack	2363	2363	24,568	24,568
Harrington Park	1305	1305	1,251	1,251
Hasbrouck Heights	897	465	5,658	2,933
Haworth	1311	1311	1,042	1,042
Hillsdale	1897	1836	2,959	2,864
Leonia	628	628	5,350	5,350
Little Ferry	613	613	4,155	4,155
Lodi Township	197	197	1,294	1,294
Lyndhurst	1258	337	17,362	4,651
Maywood	820	820	3,398	3,398
Montvale	2757	2446	1,243	1,103
Moonachie	662	662	1,465	1,465
New Milford	1462	1462	2,556	2,556
North Arlington	913	502	8,263	4,543
Northvale	838	377	1,144	515
Norwood	1753	1737	1,358	1,346
Old Tappan	2671	2671	600	600
Oradell	1548	1548	2,360	2,360
Palisades Park	689	689	7,065	7,065
Paramus	6749	2220	2,649	871
Park Ridge	1497	1497	2,229	2,229
Ridgefield	837	837	4,671	4,671
Ridgefield Park	670	670	10,764	10,764
River Edge	1215	1215	2,210	2,210
Rivervale	2824	2824	871	871
Rockleigh	688	57	86	7
Rutherford	1128	455	14,915	6,017
Teaneck	3399	3399	16,513	16,513
Tenafly	3045	2426	5,669	4,516
Teterboro	576	576	26	26
Washington Township	2150	1897	402	355
Westwood	1484	1484	4,861	4,861
Woodcliff Lake	2178	1970	871	788
Woodridge	679	181	5,159	1,375
Total		60,782		197,579
HUDSON COUNTY				
Bayonne	2873	763	88,979	23,633
*Guttenberg	128	18	6,535	919
Jersey City	7229	3636	316,715	159,308
Kearny	3992	2249	40,716	22,939
North Bergen	1811	1348	40,714	30,303
Secaucus	1528	1528	8,950	8,950
*Union City	840	351	58,659	24,514
*West New York	611	196	37,107	11,904
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APPENDIX ONE

TABLE II

HACKENSACK VALLEY

MUNICIPAL SEWAGE TREATMENT PLANTS

Name of Municipality	Constructed or placed in operation	Design Factors of Existing Plant		Present Status		Method of Treatment	Year Plant Expected to Reach Capacity (est.)	Remarks
		Population	Flow Gallons per day	1930 Population	Present Flow 1931			
Tenafly	1928	7,500	750,000	5,669	*445,000 Av. 8 mo	Activated Sludge; sludge beds; int. filtration; chlorination	1938±	
Westwood	Plans approved 1926	(4 filter beds)			(est.)	Sedimentation; intermittent sand fil.	Under capacity	
		3,600	360,000	4,861	450,000			
Oradell	Additions 1929	4,000	650,000	2,360	*215,000	Sedimentation	1940±	Plant designed for 160 g/cap/d Present indicated flow 100 g/cap/d
New Milford		20,000	1,125,000	2,556	(1924) 140,000			Not constructed
River Edge	1917, Additions 1929	2,900	447,500	2,208	*140,000		1940+	
Bergenfield-Dumont	1925 Additions 1928	22,500	2,500,000	14,677	*2,050,000	Sedimentation sprinkling filt.; int. sd. filt.; chlorination	1938±	
Maywood	1916 Additions 1930		1,472,000	3,398				Infiltration exceedingly high
Teaneck Township	Plan for Additions approved							
#1 W. Pl.	1926	6,000	700,000	16,513	*630,000	Sedimentation	1933±	
#2 E. Pl.	1926	10,800	1,080,000	All	*350,000	"	1940+	
#3 W. Englewood	1925	5,600	700,000	plants	*605,000	"	1933±	
#4 Vandalinda	1927	20,000	2,200,000		*1,000,000	"	1940±	
Hackensack								
North Plant	1924			24,568	*875,000	Flotation basin & Imhoff tank	Under capacity	
South Plant	1924				*1,900,000			
Bogota	1915 Additions 1930	11,500	1,150,000	7,341	*850,000	Sedimentation	1939±	
Ridgefield Park								
North Plant	1923	5,290	536,000	10,764		"		
East Plant	1922	4,740	745,000					
Little Ferry	1925	‡3,200	350,000	4,155	240,000	"	?	Only a portion of the town sewered. Sewer extensions may bring plant to capacity at any time.
Leonia	1914						1936±	
North Plant	Additions 1924	2,500	200,000	5,350	168,000	Sedimentation plus chlor.		
Central Plant		4,000	400,000		246,000			
Palisades Park	1916		200,000	7,065	420,000	Sedimentation	Under cap.	
Ridgefield	1916, Additions 1922		230,000	4,689	519,000	"	"	
No. Bergen								
North Pl.	1928	10,000	1,000,000		*1,500,000	"		Southern plant app.
Central Pl.	1926	13,200	2,000,000	40,714	* 300,000	"	1940±	2-19-24-not constr. Cap. 11,000 pop; 2,000,000 g.p.d.
Fairview	1913		980,000	9,067	2,000,000 max.	"	Under capacity	Infiltration exceedingly high
Secaucus		Nothing given		8,950		"	"	
Hasbrouck Heights	1926		152,000	4,500 est.	450,000	"	"	
Woodridge	1925	‡2,250	250,000	‡5,000 "	400,000	"	"	
Carlstadt	1910		37,400	‡4,500 "	450,000	"	"	
East Rutherford	1910		135,000	‡6,250 "	700,000	"	"	
Rutherford	1925	14,000	1,400,000	‡7,450 "	745,000	"	1940±	
Englewood	1912		125,400	17,805	900,000	"	Under cap.	
Lodi Twp.	1929	1,000	100,000	1,294	30,000	"	1939±	
Kearny	1924		8,000,000	40,716		Mechanical screen		Treatment inadequate
Lyndhurst	1917 Additions 1924	3,000	300,000	17,362		Sedimentation		Only portion of town connected
N. Arlington	1918	1,800	204,000	8,263	* 200,000	"	1932±	

*Operator's Report
#Contributing Population

Map 3 shows the classification of the drainage area of the District with respect to the density of the present population. Variations in density of population are indicated by different colors.

Within the District the water consumption from public water supplies for 1930 averaged about 38 million gallons daily. In addition an average of about 13 million gallons daily were obtained from sources other than public water supplies.

II—PRESENT SEWAGE TREATMENT PLANTS

For most of the 40 municipal treatment plants shown on Map 2, the types, capacities and populations served, as well as the dates when they were placed in service and the dates when they are estimated to reach their full capacity, are shown in Table II. The data in this table were furnished by Chief Engineer Harry P. Croft of the State Department of Health of New Jersey.

Practically all of these plants are south of an east and west line drawn through the valley near the Hackensack Water Co.'s pumping station at New Milford and north of another east and west line drawn across the valley from about the center of North Bergen to North Arlington. An exception to this is the treatment plant of Westwood, which although located farther north, discharges into an existing sewer built by the Hackensack Water Company and extending below the New Milford Dam, into the tidal portion of the river.

South of the latter line are isolated treatment plants for the county institutions of Hudson County on the Secaucus Ridge Road and also a fine screen plant at Kearny Point. There are no sewage treatment plants on the west slope of the Palisades south of North Bergen, nor any on the westerly slope of the Hackensack Valley drainage area west of the meadows and south of North Arlington.

In addition to the municipal treatment plants listed in Table II there are within the District about a dozen private plants treating wastes of various industrial plants. Data regarding these plants have been obtained through answers to a questionnaire sent out to industries throughout the valley by the Commission, and these data have been checked by inspection on the ground. The industries where these treatment works are located comprise principally paper mills, chemical works of various kinds and gas and coke works. The quantities of water used by the most important of these industries, not all of which of course needs treatment, averages from 50,000 to 1,500,000 gallons daily. The wastes from paper processes are generally screened and passed through save-alls, those from chemical works are neutralized or treated by sedimentation; those from gas works filtered, and those from coke works treated by sedimentation.

III.—PRESENT POLLUTION OF THE HACKENSACK RIVER AND ITS TRIBUTARIES.

The records of analyses of samples of water taken at different sampling stations along the entire length of the Hackensack River at frequent intervals from April to October, inclusive, 1931, are shown in Appendix Two, the report of Richard C. Smith, Chemist and Bacteriologist of the Commission.

Data have also been presented to the Commission as to conditions within the upland portion of the Hackensack drainage area by the Chemist and Sanitary Engineer of the Hackensack Water Co.

Briefly stated, in the terms of the sanitary engineer, the conditions may be summarized as follows:

1. Contamination of the waters of the upper portion of the Hackensack Valley drainage area, serving as the source of a potable water supply for a large portion of the population of Bergen County as well as for a portion of Hudson County has not yet reached a danger point con-

sidering the purification facilities of the Hackensack Water Co. But the expected rapid growth of Bergen County during the next few years incident to the recent opening of the George Washington Bridge indicates that this danger point may soon be reached. It is highly important that pollution of these waters within both New Jersey and New York State shall not be allowed to increase materially. In fact at present, at a number of places in the upper valley, the construction of a trunk sewer with suitable local collecting sewers will tend materially toward the protection of the public health and the welfare of the citizens.

2. In the lower valley below New Milford Dam, where the Hackensack River and its branches are tidal, pollution now exists such as to create unsanitary conditions which should promptly be eliminated in the interest of public health and the welfare of the valley. This pollution is so great as to interfere with suitable recreational uses of the stream for bathing and boating. Until these conditions are remedied the development of parks and bathing beaches such as are becoming more and more prevalent in this section of the country will be seriously interfered with.

Photographs A to E, inclusive, illustrate pollution that make the Hackensack River and its branches foul, offensive waterways.

3. Below the city of Hackensack the main river and also its branches have for many years been receiving from the flow of sewers thousands of tons of sewage solids. These solids have been deposited in the watercourses and there stranded in foul, decomposed banks of sewage mud, the contents of which are oscillated backward and forward by tidal action and by the natural stream flow of the river system at times of wet weather. It should be borne in mind that during periods of dry weather there is practically no diluting water passing over the New Milford Dam; hence the accumulations of putrefying sewage solids are becoming greater year by year and, in some portions of the river system, are being augmented by sewage brought upstream by incoming tides from communities located farther south than given points of observation. The records of analyses show that the oxygen naturally absorbed by the river from the atmosphere is either exhausted completely or reduced to limits conspicuously below those found in waterways clean enough to be fairly designated as conforming reasonably with present day requirements for the protection of the health and welfare of the public.

Taking into account the facts here summarized and the well-defined movement now on foot through the efforts of the Tri-State Anti-Pollution Commission to eliminate objectionable pollution in all tidal streams in this immediate section of the country, it is obvious that prompt construction of remedial works is necessary in order to eliminate the present objectionable pollution of the Hackensack River and its tributaries.

In connection with the present pollution of the Hackensack River

it is worth while to call attention to an interesting and valuable report made by Sanborn & Bogert, Consulting Engineers, to the Township of Teaneck, on the Effect of 1926 Legislation on Sewage Disposal in the Hackensack Valley. This report is particularly of interest in that it discusses means for removal and treatment of sewage originating in Bergen County north of Bellmans Creek.

IV.—CONDITIONS AFFECTING DECISION AS TO WHETHER THERE SHOULD BE ONE OR MORE TRUNK SEWER SYSTEMS CONNECTED WITH ONE OR MORE SEWAGE TREATMENT PLANTS.

The important decision as to whether there should be a single unit system consisting of a single trunk sewer and a single treatment plant, or whether there should be two or more trunk sewers, each discharging to a treatment plant of its own, depends upon the topographic features of the District, the distribution of the population thereon and a reasonable economic program for collecting the sewage of the various municipalities involved and delivering it to a point or points where it can be pumped and treated most advantageously.

There are several reasons why a single trunk sewer system tributary to a single treatment plant is impracticable as compared with the division of the trunk sewer and treatment facilities into two units.

In the first place it is to be borne in mind that, in the lower valley, the Hackensack River and its tributaries are tidal. This means that there is very little or no natural slope to the ground between New Milford Dam and Newark Bay, a distance in an air line of over 16 miles. Under these circumstances, and taking into account the fact that the sewer at New Milford Dam must be low enough to collect by gravity the sewage discharged from existing outlets of the municipalities, and also that sewer slopes must be sufficient to provide scouring velocities, it is evident that it is not reasonable to attempt to locate a single treatment plant as far down the valley as the vicinity of Newark Bay. A trunk sewer leading to such a location would have to be very large at its lower end in order to carry all the sewage from the entire District, and would have to be very deep unless expensive intermediate pumping were resorted to.

The most practicable arrangement for a single unit treatment plant and trunk sewer is to locate the treatment plant about midway of the tidal portion of the valley, or about opposite North Bergen. The downstream portion of the trunk sewer would then flow toward the north, and the upstream portion toward the south, to the treatment plant. This arrangement would materially reduce the depth and size of the sewer from what would be required for a treatment plant at or near Newark Bay.

Neither of the above arrangements, comprising a single unit trunk sewer and treatment plant, is at all advantageous as compared with a

division of the system into two separate units; one unit having its treatment plant located near Droyer's Point and the other having its treatment plant located south of the junction of Overpeck Creek with the Hackensack River. Such a dual system is shown on Map 4. By adopting this dual system the depth and size of the two main sewers leading to the southerly treatment plant, one coming from the north and one from the south, become much less than would those of a single sewer leading to a central plant; and for the northerly plant it is feasible to bring the several branch sewers directly to the site without uniting them into a large and deep main sewer extending to the single site opposite North Bergen, three miles or more farther down the valley.

Again it should be noted that there is a stretch of about 13,000 feet, between the north treatment plant and the south treament plant, in North Bergen where there are no sanitary sewer outlets now or to be expected in the future, and where it is perfectly feasible to eliminate the cost of a trunk sewer if trunk lines are built toward the north and south from the outer limits of this stretch.

Another reason is that south of North Bergen practically all of the sewers are on the combined system, receiving storm drainage and the consequent street wash at times of storms; whereas north of North Bergen practically all of the sewers are built on the separate system other than those of Hackensack, Ridgefield Park, and Ridgefield. Thus there is eliminated from the northerly area the need for somewhat larger trunk sewers to deal with wet weather flows, except in so far as the influence of rainfall affects the ground water seeping into the sewers.

Taking all these factors into account we are brought inevitably to the conclusion that it is far wiser and cheaper to build the trunk sewers and treatment plants in two systems rather than in one; particularly in that by so doing there would be a very substantial saving in investment cost as well as in the cost of pumping.

There is but one minor reason why a single treatment plant may be more advantageous than two separate ones, and that is that the cost of operation of two plants may be somewhat greater than that for a combined plant. Where, however, each of the plants is as large as here required, this difference in cost of operation becomes practically negligible.

Even with two trunk sewer systems there will be a few remote plants which it will be cheaper and better for the District to operate, improve and extend as necessary, rather than to go to the expense of bringing the sewage from such points to the main trunk sewers. Little consideration can be given to such plants until local development of the Meadows, which no one can foresee, warrants it.

V.—CONDITIONS AFFECTING DECISION AS TO WHETHER THE SEWAGE SHOULD BE TREATED AT SEPARATE LOCAL PLANTS.

If the sewage discharged by each municipality could be satisfactorily treated locally in plants serving small groups of municipalities, the expense of construction of trunk sewers would be reduced. On the other hand there would be incurred a much greater expense for construction and operation of the separate plants.

As regards the sewage originating in that part of the valley which is tributary to the river above the New Milford Dam, it is unquestionably necessary on account of the use of the river as a source of water supply, to divert this sewage, whether treated or not treated, to a point below the dam. While it may now be necessary to permit the highly purified effluent from a few treatment plants to enter the stream above the dam temporarily, the continuation in service of such plants for any great length of time is not to be thought of and the construction of additional plants in that portion of the watershed must not be permitted. To do so would be a serious and entirely unnecessary menace to the health of the community.

As regards the cost of construction of suitable group plants in the District, the cost of suitable small plants is always much greater than that of constructing an equal capacity as part of a large plant such as contemplated in this report. The additional cost of operation of small plants as compared with that of a single plant of equivalent size is also very great.

It is further extremely doubtful if anything like as good and uniform efficiency could be secured from the operation of numerous small plants as from the large District plants; because it is possible for large plants to have at all times the most skilled supervision obtainable.

A still further disadvantage of having a large number of small plants is the difficulty involved in securing suitably isolated sites, without constructing long and expensive outfall sewers to reach them.

VI.—MOST SUITABLE TYPES AND LOCATIONS OF SEWAGE TREATMENT WORKS.

It is necessary to come to a conclusion as to the most suitable types and locations of facilities for treating the sewage before determining the location of trunk sewers and their main branches and the needs for pumping to lift the sewage into the treatment works so that after treatment it may flow by gravity into the Hackensack River.

With this end in view we have considered various arrangements as to type and location of means of disposing of the sewage of the Hackensack Valley. The prevailing method now in vogue at the 40 plants to be found in the District is that of sedimentation in single-story or two-story tanks. This method when operated at its best efficiency will remove more than 90

per cent. of the settleable solids but not more than 30 to 35 per cent. of the total organic matter (oxygen demand). For a rapidly growing area sedimentation is not a type of treatment suitable for a permanent solution of the problem of eliminating the pollution of the Hackensack River and its tributaries.

Sedimentation, or perhaps fine screens as now installed near Kearny Point, may serve for various scattered plants too remote to be brought into the trunk sewer system, but the utility of such methods ends wih such exceptional conditions.

Sedimentation, followed by discharge of the clarified sewage into the Hudson River through a tunnel beneath the Palisades, has been suggested. In considering this there must be taken into account the certainty of opposition such as encountered by the Passaic Valley project from New York State and the United States government, and especially also the demand on the part of the public for clean waterways and the findings to be expected in the early future in the report of the Tri-State Anti-Pollution Commission. This consideration is particularly pertinent in view of the fact that the Hudson already shows the effects of pollution to such a serious extent as to call for lessening rather than increasing its contamination through sewage wastes; and in view further of the relatively high cost of a project involving sedimentation, a tunnel and works for the dispersion of the effluent in the Hudson River.

In our opinion the permissible limit of pollution of the Hackensack River and its tributaries is such as to require the construction of so-called complete treatment works. For large projects this calls for works of the activated sludge type, which can remove over 90 per cent. of the suspended matter and of the ordinary bacteria, 90 per cent. of the organic matter or oxygen demand and 95 to 98 per cent. of the bacteria in raw sewage associated with disease. When this type of treatment is supplemented by chlorination the removal of objectionable bacteria can be made practically complete.

The activated sludge process readily meets on an average the general standard laid down by the British Royal Commission on Sewage Disposal, viz: The effluent as discharged into the stream shall not contain more than 30 parts per million of suspended matter or with its suspended matter included more than 20 parts of oxygen demand based on 5-day tests at 65 degrees Fahr. This standard, it may be noted in passing, is written into the Act of Parliament setting up the District Project of Middlesex County in the Valley of the River Thames above London.

The effluents of the more important activated sludge plants in this country show on an average from 15 to 20 parts per million of suspended matter and a 5-day oxygen demand of 10 to 15 parts. An effluent of this composition, if well nitrified and well aerated, is not likely to putrefy for several days if unmixed with diluting water.

In practice the effluent of the proposed District plants would for a time be subject to the deoxygenating effects of putrefying sludge deposits on the bottom of the river, so that, ultimately these deposits would no longer make an appreciable demand on the oxygen of the river water. However, should there be no diluting water available to mix with the well-aerated effluent it may become necessary at times to supplement the re-aeration of the river water by chlorinating the effluent.

The locations most suitable for the installation of plants of the activated sludge type serving respectively the two trunk sewer systems already described are as follows:

The northerly plant can best be located on the west bank of the Hackensack River at some convenient place south of where Overpeck Creek joins the river from the east. This land is not particularly useful for other purposes, and is suitably isolated. It is feasible here to secure at a moderate price an area of 100 acres or more, sufficient for the needs of the northerly part of the District for the next 30 or 40 years.

The southerly plant can best be located at or near what is known as Droyers Point in Jersey City, on the Hackensack River, a litte more than a mile north of the Bayonne line.

Photograph F shows typical meadow land available for a treatment plant.

VII.—DESCRIPTION OF THE ACTIVATED SLUDGE PROCESS—COMPLETE TREATMENT.

In the activated sludge process, sludge is activated by aerating sewage for a sufficient time to permit the solid particles which comprise the sludge to become coated and impregnated with growths of oxidizing bacteria and other organisms. Such activated sludge, with gelatinous surfaces and oxidizing properties of a biochemical nature, is mixed with the sewage to be treated and the mixture is agitated for four or more hours in an aerating tank well supplied with atmospheric oxygen. Here suspended and colloidal matters of the sewage become attached to the activated sludge particles and dissolved organic matter is oxidized by the bacteria and their enzymes. The sludge is then separated from the liquid by sedimentation, leaving a clear and well purified effluent. A portion of the sludge is returned to the inlet of the aeration tank. The excess is disposed of preferably by first discharging it together with the raw sewage reaching the works, into the preliminary sedimentation tanks, from which tanks it is then removed and given special treatment as described beyond.

Plate I. shows a diagrammatic sketch of structures required for the treatment of sewage by the activated sludge process. This sketch does not show the structures which are required to supplement the activated sludge process in the disposal of the sludge itself. The sewage is pumped from the end of the trunk sewer into the treatment plant. It first passes into

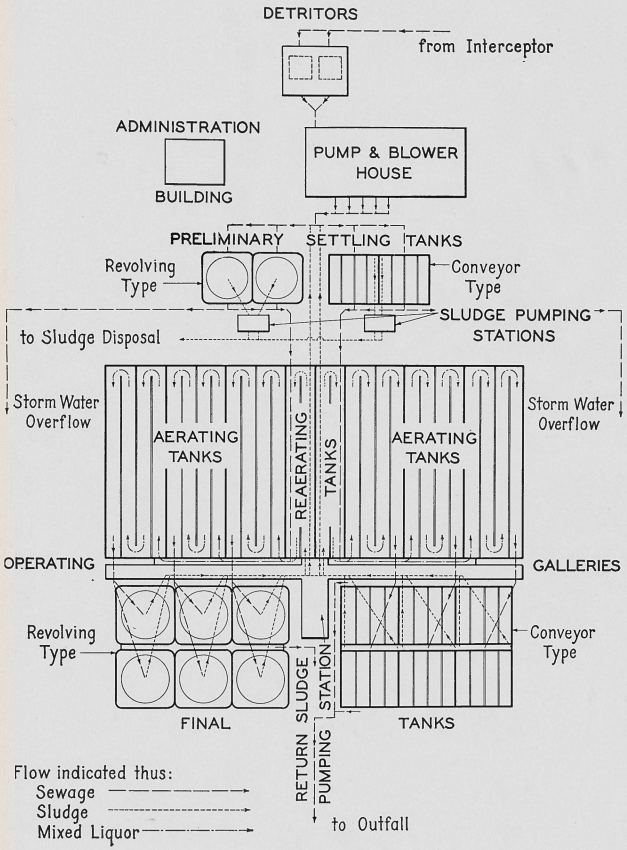


PLATE I

ACTIVATED SLUDGE PLANT

DIAGRAMMATIC PLAN

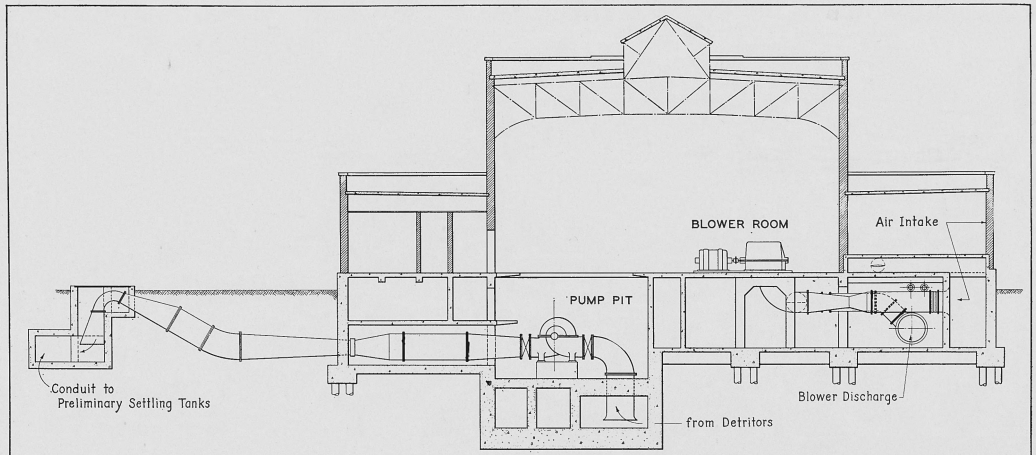


PLATE II

SECTION THROUGH PUMP AND BLOWER HOUSE

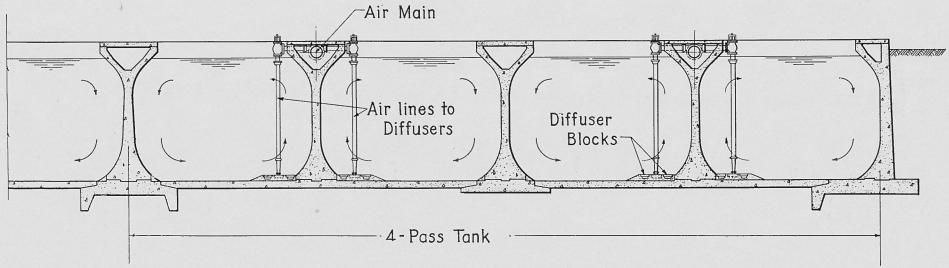


PLATE III

SECTION THROUGH AERATING TANK

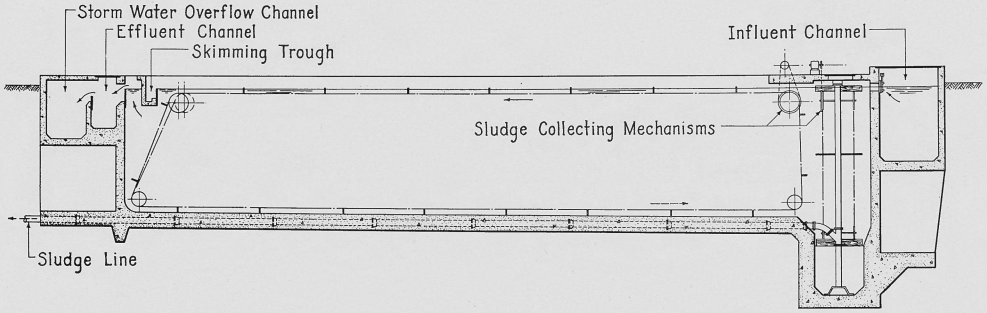


PLATE IV.

SECTION THROUGH PRELIMINARY SETTLING TANK
ILLUSTRATING CONVEYOR TYPE

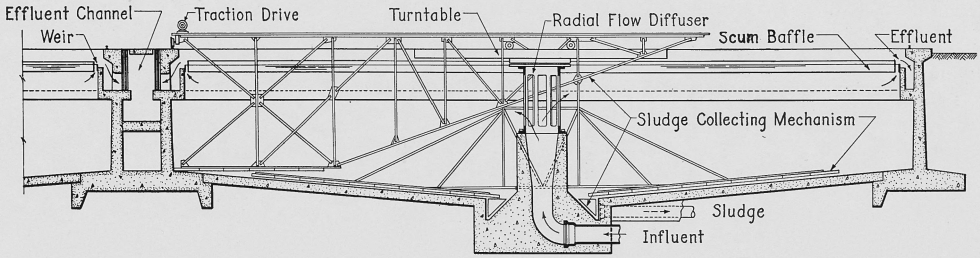


PLATE V

SECTION THROUGH FINAL SETTLING TANK

ILLUSTRATING REVOLVING TYPE

preliminary sedimentation tanks, which remove most of the settleable solids; then through the aeration tanks, where the sewage, mixed with sludge which has already been activated and returned, is agitated and aerated by means of compressed air; and last through the final tanks where the sludge is separated out and removed, and from which the purified liquid portions of the sewage flow by gravity through an outfall pipe to be dispersed in the waters of the Hackensack River.

Plates II. to V., inclusive, show typical sections through the important parts of an activated sludge plant. Plate II. shows a section through the pump and blower house which contains the electric-motor-driven sewage pumps and the electric-motor-driven blowers installed to furnish compressed air for aerating the sewage and mixing the activated sludge with a settled but otherwise unpurified sewage. Plate III. shows a section through the aerating tanks, illustrating also the way in which air distributed through porous plates at the bottoms of the tanks produces a spiral flow to bring about the desired mixing as well as aeration and at the same time prevents the deposition of solids upon the floor of the aerating tanks. Plates IV. and V. show sections through the preliminary and final settling tanks, through which the sewage passes respectively before and after passing through aerating tanks. Plates IV. and V. also show two different types of mechanisms, the conveyor type and the revolving type, for scraping the settled sludge to sumps or pockets, from which it is removed by pipes leading to sludge pumps. The shapes of the tanks vary, according to which type of mechanism is used, as is indicated on Plate I.

Under Caption IX. are discussed the arrangements for treatment and final disposal of the sludge, which contains the solid portions of the sewage. When drawn from the settling tanks the sludge is a rather thick liquid containing a small percentage of solids. These solids, if weighed after complete drying of all sludge, would amount to from two to five per cent. of the total.

The activated sludge process has been developed during the past 20 years. The first large plants in this country were installed at Houston, Texas; the North Side plant there having been put in service in 1917 and the South Side plant in 1918. Plants of this type have been installed at Milwaukee, a plant of 85 million gallons daily capacity having been put in service in 1925; at Indianapolis where a plant of 50 million gallons daily capacity went in service in 1925; and at Chicago where a plant of 175 million gallons daily capacity went in service in 1928 at the North Side works, although similar plants had then been in service for several years in the Des Plaines River District and also in the Calumet District.

The Chicago plants are of particular importance in that they show that the activated sludge type was adopted for so-called complete treat-

ment following extensive litigation in the U. S. Supreme Court whereby neighboring states sought to enjoin the Sanitary District of Chicago from diverting any water at all from Lake Michigan into the Chicago drainage canal for dilution purposes. Experts on both sides of this much litigated lake-lowering controversy agreed that the activated sludge process was the most suitable and efficient method available.

New York City has placed under construction on Wards Island in the East River an activated sludge plant of 180 million gallons daily capacity to serve a population of about 1,300,000 people. This method has already been adopted recently at Cleveland to provide treatment at its Easterly Works to serve 770,000 people, with the work capable of extension to serve 1,000,000 persons.

There are more than 50 plants of this type now built or building in this country for cities of various sizes including several sizable plants in the Los Angeles District and San Antonio, Tex., Fort Worth, Tex., Gastonia, N. C., two at Charlotte, N. C., and many smaller plants including one at Tenafly, N. J. There are about 25 plants of this type in Canada, among which may be mentioned plants at North Toronto and York Township. It is the prevailing type used for new developments in Europe and is employed at Manchester, Birmingham, Sheffield and many other sizable English cities. A plant of this type to serve about 600,000 people is now practically completed on the outskirts of Berlin at Stahnsdorf.

Photographs G, H, and I show views taken at the Wards Island, Milwaukee and Chicago North Side activated sludge plants.

VIII.—INTERMEDIATE PROCESSES OF TREATMENT.

Certain processes of sewage treatment which afford a less degree of purification than that effected by the activated sludge process are mentioned below.

Fine screens serve a useful purpose in removing solid matters of obvious sewage origin, but remove a less proportion of solids and organic matter than does sedimentation.

Sedimentation can remove from sewage more than 90 per cent. of the settleable solids by volume, but it effects removal of total organic matter having oxygen demand to the extent of only about 35 per cent.

There is a wide margin between the removal of organic matter to the extent of 35 per cent. by sedimentation and 90 per cent. by the activated sludge method.

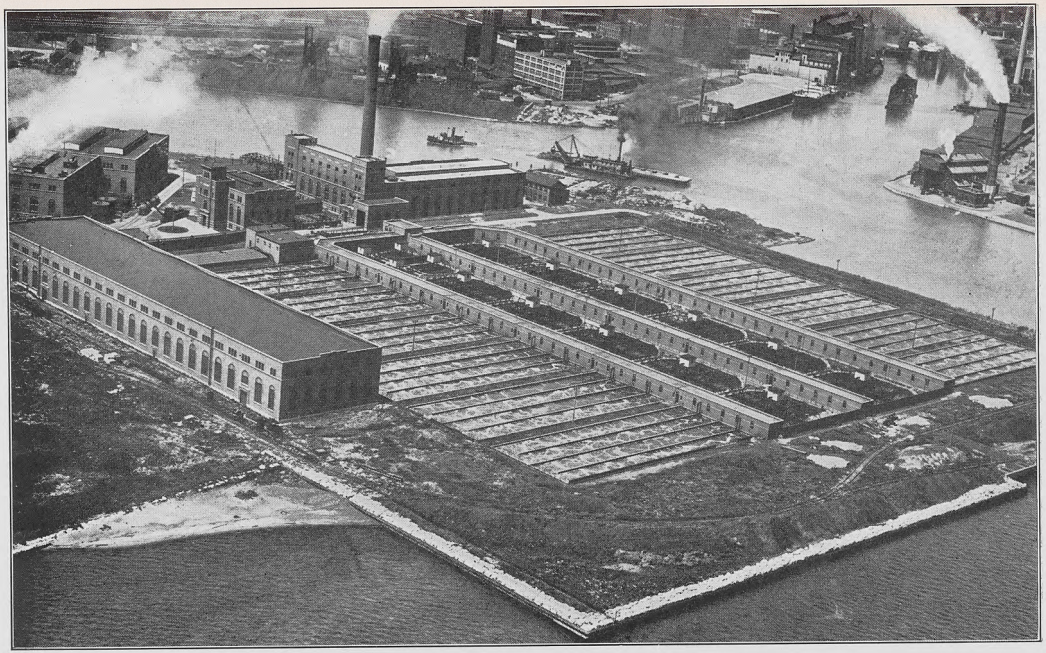
By the use of chemicals and filtering arrangements it is possible to secure practically complete clarification and a removal of organic matter or oxygen demand up to 60 per cent. or more.

Much interest is now being directed towards the accomplishments under regular daily operating conditions of a plant of the Laughlin process now being built at Dearborn, Mich., which will serve this com-



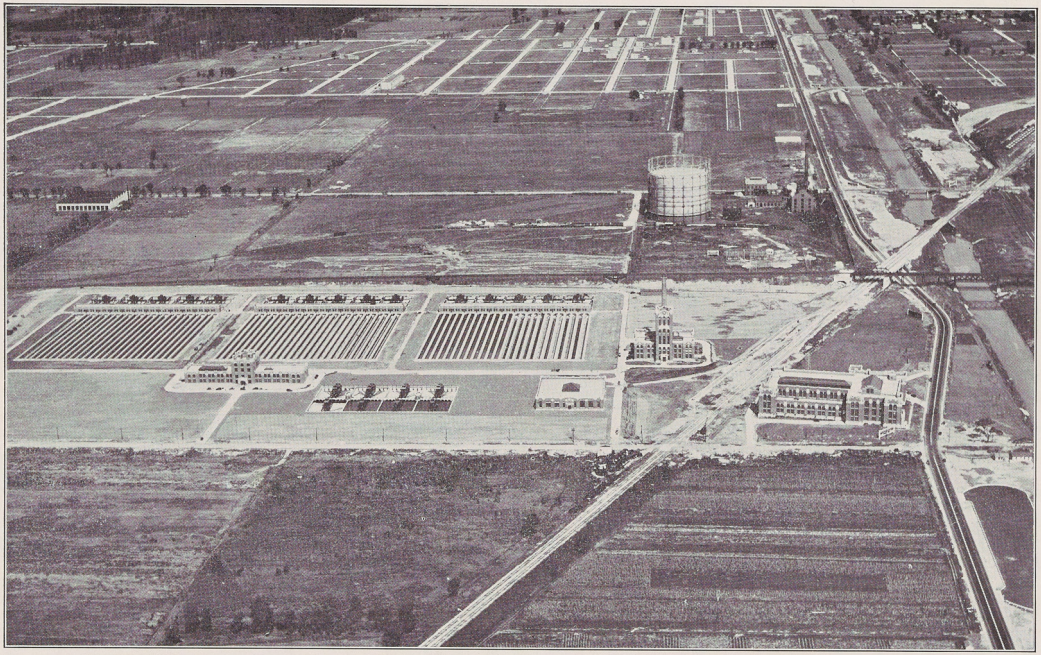
PHOTOGRAPH G.

ACTIVATED SLUDGE PLANT UNDER CONSTRUCTION, WARDS ISLAND, NEW YORK CITY.



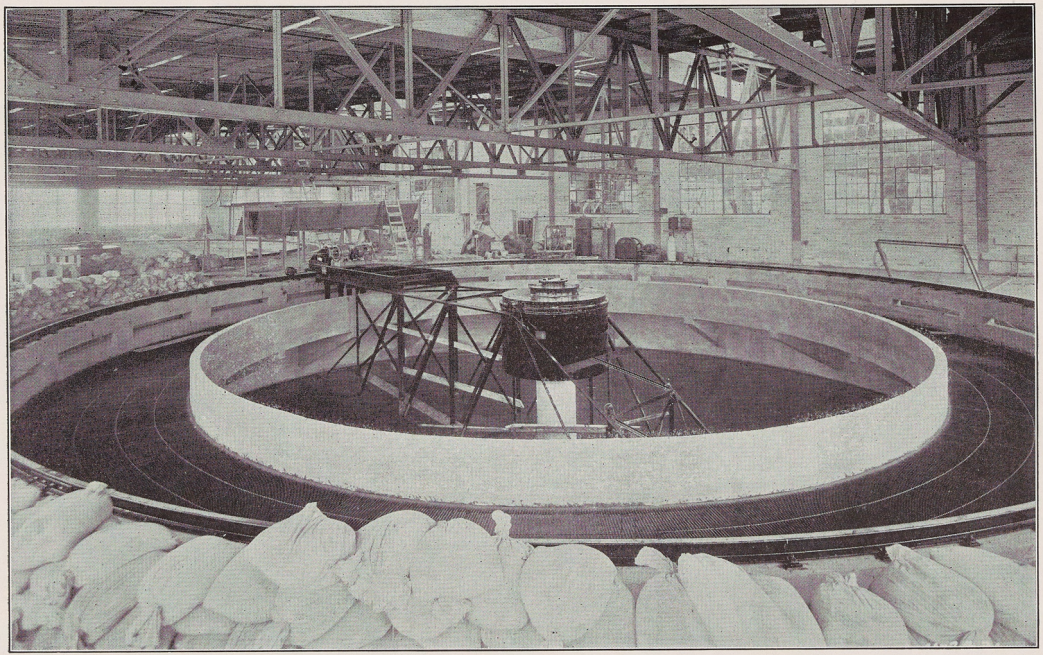
PHOTOGRAPH H.

ACTIVATED SLUDGE PLANT, MILWAUKEE, WISCONSIN.



PHOTOGRAPH I.

NORTH SIDE ACTIVATED SLUDGE PLANT, CHICAGO, ILLINOIS.



PHOTOGRAPH J.

SEWAGE TREATMENT PLANT UNDER CONSTRUCTION AT DEARBORN, MICHIGAN.

munity where the large Ford works are located and also will receive a portion of the sewage flow of the city of Detroit. These works are expected to be completed in January, 1932, but will not go into regular operation until several months later. Photograph J shows a view of the Dearborn plant. A small demonstration plant of this type has recently been in operation at Caisson 4 at Coney Island.

Extensive investigations are also pending at Winston-Salem, N. C. Methods being investigated involve chemical and mechanical means as distinguished from biological processes such as that of the activated sludge type.

Clarification of sewage by vacuum filters with the aid of suspensions of waste paper and of chemicals is also receiving attention at a number of places, including Chicago, Winston-Salem, N. C., Rockville Center, L. I., and York Township, Ont.

The use of carbon in the treatment of domestic water supply has been successfully demonstrated. Experiments are now being conducted with various carbons and coagulants in the treatment of sewage effluents.

It is too early to state the capacities and operating costs of arrangements of this sort and particularly their efficiency in point of removal of organic matter or oxygen demand under continuous daily operating conditions.

Mention is made of these chemical and mechanical treatment arrangements with a view to indicating that, while evidence is not yet adequate to justify their recommendation for projects as large as those needed for either of the District plants, it is not wise to close the doors permanently to them. This is particularly true for the southerly plant, which is located very close to Newark Bay, and where notwithstanding that the effluent will be moved periodically upstream in the Hackensack River by incoming tides it may possibly be wise to consider a less degree of purification as regards organic matter than the 90 per cent. removal obtainable by the activated sludge process, provided experiences on a working scale should show that such a process could be installed and operated at a total cost materially less than that of the activated sludge process.

For the purpose of this report, however, we are convinced of the wisdom of basing our estimates upon the activated sludge process, for both the northerly and southerly plants of the District.

It is perhaps unnecessary here to add that local conditions do not warrant the consideration of sand filters or contact beds or sprinkling filters. This is due to the large areas that would be required for the two main District plants, the lack of suitably isolated sites on upland ground, and the unusual expense involved in building either sand beds or stone filters on the meadows.

IX.—SLUDGE DISPOSAL.

At the two District plants under consideration there would be removed daily, when the plants are operating at full capacity contemplated under ultimate conditions, about 100 tons of solid matter on a dry basis. The water content of sludge is found to vary widely. If on an average the sludge of which these dry solids are a part should contain 98 per cent. water, the weight of the wet sludge would be about 5,000 tons daily; but if the water content should amount to only 95 per cent., the weight of the wet sludge would be about 2,000 tons daily.

Sludge disposal has generally proved to be a difficult and expensive task. This is due to the fact that sludge as removed from the treatment processes required for the purification of the liquid portion of the sewage putrefies quickly and is very voluminous.

Most of the large British seaport cities such as London, Southampton, Manchester, and Glasgow dispose of sludge by carrying it in specially designed sludge vessels, somewhat resembling oil tankers, to points at sea far removed from the shore. For the Wards Island project of the city of New York, Diesel-engine-driven sludge vessels similar to the most recently built British sludge boats have been designed for carrying a portion or all of the sludge to sea and there distributing it beneath the surface while the boats are cruising about, so as to insure thorough dispersion. A plant to permit the conversion of about 20 to 25 tons of dried solid matter daily into fertilizer has also been designed for the Wards Island project.

The Passaic Valley plant includes provisions for the barging of the sludge to sea on a contract basis.

For the Hackensack Valley conditions we do not favor barging to sea, especially under the handicaps that would be involved in the navigation through shallow channels of vessels large enough to go a sufficiently long distance offshore in bad weather. Navigation would also be difficult and expensive on account of the number of drawbridges which would have to be operated to permit the movement of vessels to and from the treatment works.

Neither do we favor attempts to convert the sludge into a commercial fertilizer, as has been done at Milwaukee for the past six years and at Pasadena, Calif. At these plants this is accomplished by putting the sludge through vacuum filters to reduce the water content to below 80 per cent. and then putting the sludge into rotary dryers or kilns to reduce the moisture to 10 per cent. or less as is the standard requirement of the fertilizer trade. The manufacture of sludge into commercial fertilizer is by no means as advantageous a proposition as was the case when the Milwaukee plant first went into service, or even as was the case in 1928 when a demonstration plant was recommended for the Wards Island

project of the city of New York. The reasons are two-fold. First, because the financial status of the farming industry has greatly restricted the market for this product, the marketing of which under the best conditions is handicapped by freight rates on long hauls as compared with the cost of shipping the more highly concentrated fertilizers such as nitrates. Second, the price of nitrates, which in turn controls the price of most other fertilizers, has become relatively low due to the trade war between the natural nitrate industry of Chile and the artificially-made nitrates of Germany and other places where use is made of electricity in manufacturing nitrates from the nitrogen of the air, or as by-products of the gas and coke industry.

It is possible to take the sludge immediately after it is removed from the settling tanks of the treatment process and to dewater it by means of vacuum filters, as is done at the Irwin Creek plant at Charlotte, N. C. After the sludge has become dried to a suitable condition in this manner it is sent to a dump. While this method can be made workable for small plants provided sufficient care is taken to secure adequate conditioning of the material before drying, it is to be borne in mind that the material sent to the dump is subject to further putrefaction unless there is used an adequate quantity of germicidal chemicals, such as copper sulfate, to arrest all further putrefaction. We do not advise this process of sludge treatment for either of the District plants now under consideration.

It is, however, entirely feasible to provide an inoffensive and in every way suitable method of sludge disposal by the use of covered and heated digestion tanks and drying beds of sufficient area.

Sludge digestion has been developed into a much improved process during the past few years as compared with earlier experiences. It is now practicable to deliver the sludge into covered tanks equipped with hot water coils so as to maintain temperatures of about 80° F. during all months of the year. The necessary heat is provided by collecting and using the gases liberated during digestion of the sludge. The escape into the air of gases of decomposition is thus effectually prevented. The sludge is retained in the digesting tanks for a period sufficiently long to allow all organic matter to become decomposed so that the residual digested sludge is practically a humus material resembling the humus found in a forest below the surface crop of leaves. This sludge, after drying, may be sent to a dump without fear of causing bad odors; and to a limited extent it can be disposed of to farmers, although its fertilizing properties are materially reduced incident to the digestion process.

Beds for drying the digested sludge are of sand and gravel provided with underdrains. Upon these beds the liquid sludge is spread in a layer about 8 inches thick. The beds may be open, or may be provided with covers which are frequently of the greenhouse type. They may be provided

with mechanical scrapers for removing the sludge after drying, or with tracks and cars for carrying away the dried sludge. Should open beds be used, it is advantageous to provide tank capacity to store the digested sludge in amounts sufficient to make unnecessary its discharge on to drying beds during either very cold or very wet weather.

Digestion tanks and drying beds, as described above, form a suitable basis for estimating the cost of works for sludge treatment and disposal, even though other equally suitable arrangements may eventually be adopted.

An alternate arrangement for handling the sludge would be first to provide vacuum filters, such as are used at Milwaukee and Pasadena as the first step in preparing fertilizer. Then, instead of putting the sludge cake removed from the filters through rotary dryers, as is next done at those plants, it may be mixed with fuel and incinerated. By means of vacuum filters it is feasible to reduce the water content to 80 per cent. or less, and the resulting material can then be incinerated if mixed with a suitable quantity of fuel. It may be worth while to use dryers between the filter and incinerator. Should municipal rubbish not be available as fuel it would of course be necessary to provide coal, oil, gas or some other fuel. This matter is now being actively investigated at half a dozen sizable cities in this country.

X.—INDUSTRIAL WASTES—INDIVIDUAL TREATMENT PLANTS.

Quite comprehensive data regarding the wastes discharged into the Hackensack River and its tributaries by existing industrial plants have been obtained through the medium of a questionnaire sent by the Commission to practically all of the industrial plants within the District. The answers to this questionnaire give the kind of industry in which the plant is engaged, the average and maximum rates of use of water at the plant, the percentage of water used which is discharged as waste, the amount and kind of chemicals contained in the wastes, the kind of treatment given the wastes, and statements as to where the wastes are discharged, whether into a municipal sewer system or a private sewer system or directly into the river or its tributaries.

The data show that at present there are some 30 sizable industrial plants now discharging wastes into the lower Hackensack River and its tributaries. Some of these plants discharge their wastes directly into the watercourses through sewers or drains of their own, while others discharge into the municipal sewers adjacent to them.

It is unfortunately true that some wastes are objectionable from the standpoint of their treatment in a District plant, if they are discharged from the industrial plant in such quantities and at such rates as not to allow their effect to be practically eliminated when mixed with the remaining flow in the trunk sewers. Such wastes include those from

gas works, coking plants, paint works, metal pickling processes, bleaching and dye works or other establishments producing wastes which on account of their germicidal effect upon the sewerage interfere with biological processes such as the activated sludge process.

Of the 30 or more plants mentioned above, there are about 20 plants which now discharge in excess of 50,000 gallons per 24 hours. A number of these plants produce wastes of such a character that they might reasonably be discharged directly into the watercourses provided they were freed with substantial completeness of suspended solid matter.

The policy question arises as to whether it is wiser for the District Commission to permit substantial flows of industrial wastes to enter the trunk sewer and be subjected to pumping and treatment at one of the main District plants or whether it would be satisfactory and better economy for those wastes needing only a limited amount of treatment to receive such at their point of origin. A further policy question arises as to whether the Commission will permit or direct the local industries to install and operate suitable treatment arrangements of their own or whether the Commission will install such devices and make a charge to the industry on what would practically be a rental basis for handling the industrial wastes.

In this connection it is to be borne in mind that whatever the record may show now as to a limited number of industrial plants contributing a substantial amount of wastes is not necessarily a criterion of what may be expected during the next 10, 20 or 30 years, as the lower Hackensack Valley becomes more and more completely developed.

On the one hand it is necessary under the proposed statutes to prevent to as great an extent as reasonable the entrance into the river and its tributaries of any pollution. On the other hand the program should not be such as needlessly to discourage the development of industry in this District.

The wisest policy seems to be for the District to assume the responsibility for taking care of all industrial wastes other than gas works and coke industries and from works that produce highly germicidal wastes and then to decide, as the case may be in each instance, whether the wastes should be received into the trunk sewer system or be treated separately at point of origin and with the costs of treatment suitably adjusted. For the purpose of this report it is assumed that there may be received without treatment into the trunk sewer all industrial wastes except those from the manufacture of paper, from bleacheries and dye works, from gas and coke works, from galvanizing and electro-plating works and from the larger chemical works. In general this means that the wastes of most of the industries which obtain all of their water from the public supply may be admitted to the District sewers.

Looking ahead for the loadings with which the District works may have to deal during the next 20 to 30 years, it is necessary to realize that the wastes already mentioned under this caption by no means tell the whole story. As to future developments of industrial areas, it has been concluded to make provision in the northerly and southerly systems of trunk sewers, pumping stations and treatment works for industrial areas of about 1900 and 1400 acres, respectively, and from which in 1960 there will be discharged to the District works at the time when these works have reached their maximum capacity, industrial wastes to the extent of about 23 and 17 million gallons daily, respectively, at times of maximum rates of flow.

The above areas and quantities apply only to areas adjacent to the trunk sewers which are to be built on upland ground along the edge of the meadows, and to areas in Secaucus which are tributary to the local pumping stations. They do not apply to other developments of the meadow areas.

In general, for the purpose of this estimate, the industrial area has been assumed as a strip about 1,000 feet wide along the lower part of the Hackensack Valley. The quantity of wastes per acre has been estimated by using figures which have been accurately determined for the industrial areas of Cincinnati, Milwaukee, Toledo and other cities, which figures show that for each acre of area devoted to industrial purposes a quantity of industrial wastes amounting to about 7,000 gallons daily on an average or about 12,000 gallons daily as a maximum may be expected to be discharged to public sewers and treatment works.

XI.—CONSIDERATION OF MEADOWS DEVELOPMENT.

We have considered the 1930 report of the Meadow Reclamation Commission and have noted in this report the recommended zoning in the meadow area for industrial and other types of development.

We have concluded that it is not wise, in either the northerly or southerly District projects, to provide for trunk sewers, treatment plants and pumping stations of capacities needed to include meadow reclamation and development beyond that of strips of limited width adjacent to the upland ground.

When and if substantial developments of the meadows occur at some indefinite future date, it will be early enough to decide how best to proceed with means for treatment of wastes of all types originating in such reclaimed areas, in accordance with one of the following procedures:

(a) Extension of trunk sewer system and treatment plant for the northerly portion of the District, with such pumping as may be required.

(b) Similar arrangements for the southerly portion of the District.

(c) Establishment within the District of a third sewage treatment plant to serve the needs of the reclaimed area. This plant would be of a type and at a location depending upon the results actually obtained in the practical development program for the meadows; and its establishment would depend upon the costs and benefits of thus setting up a third plant within the District as compared with those arising from the delivery of the wastes from the meadows to the northerly or southerly locations as above mentioned.

(d) The possible establishment, to serve for a time at least, of an individual treatment plant or plants, for dealing with the wastes from the limited areas of the initial development of the meadows. The establishment of such a plant or plants would depend upon consideration of the advantages obtainable as compared with the treatment of both domestic and industrial wastes at either the northerly District plant or the southerly District plant now proposed, or at a third District plant, which may for convenience be designated as the central plant.

Possibly as the development of the meadows becomes an actuality there may be at some future date a combination of solutions. That is, the wastes from some portions of the meadows could go to the northerly works, from some to the southerly works, and from some to the future central works not now needed, and finally from some to individual treatment plants.

This discussion is aimed at setting out favorable procedures which can be actually dealt with when the right time comes, but which are too uncertain as to date, location and extent to require consideration at this particular time.

XII.—REMOTE TREATMENT PLANTS.

There is now in operation a municipal treatment plant serving a portion of the town of Kearny, which plant is located at a considerable distance from the District trunk system here proposed. This is a screening plant of 8 million gallons daily rated capacity, constructed in 1924. The plant is located on the west bank of the Hackensack River about three-quarters of a mile above its entrance to Newark Bay, and serves the adjacent industrial section of the town situated on the meadows between the Hackensack and Passaic Rivers.

Chief Engineer H. P. Croft of the State Department of Health states that the treatment afforded by this plant is inadequate, and that a greater degree of purification should be provided. However, not only on account of the great expense which would be involved in connecting this remote treatment plant with the proposed District sewer, but also on account of the nature of the sewage there treated, it is undesirable to provide for taking the effluent from this plant into the District system.

For the County institutions located at Laurel Hill no sewage treatment plant has as yet been provided. On account of the remoteness of this location with respect to the proposed District sewer and further on account of the relatively small population to be served, it is disadvantageous to connect the Laurel Hill section with the proposed District system.

Unquestionably it is wiser for the District to continue to operate and if need be also to extend and improve the existing Kearny treatment plant, and to construct and operate a treatment plant for the Laurel Hill section, rather than to take them into the District system at present.

XIII.—OIL POLLUTION.

Discharges of oil, grease, gasoline and tar oils into sewers, rivers and harbors require far greater common-sense control now than formerly. This is due in large part to industrial expansion, the increased use of motor vehicles, and market conditions which make it unprofitable to recover salable products from certain oil wastes.

Mineral oils reach the sewers or are directly released into watercourses from garages, filling stations, refineries, oil storage plants, oil tankers, oil burning vessels, mosquito control programs, road washings, dry cleaning establishments, etc. Gasoline wastes are a serious menace when trapped in sewers, because a concentration of more than 1.5 per cent. in the air is explosive. Serious explosions in sewers are not infrequent and have occurred at Pittsburgh, Los Angeles, Grand Rapids, Newburgh and other cities.

These oily, greasy wastes are highly objectionable, and add to the burdens of the maintenance of sewer systems as well as of the operation of pumping stations and treatment works.

We have not investigated the ordinances in the various municipalities in the District with respect to control of these wastes nor the extent to with success in this region has attended the administration of the Federal Oil Pollution Act, Act 238 of the 68th Congress, approved June 7, 1924.

The Enabling Act which will set up a permanent authority for eliminating pollution within this District should vest in this authority adequate jurisdiction to deal at their points of origin with the oily and greasy wastes entering the river and its tributaries. This permanent authority should make due investigations leading to the adoption of a suitable program for this purpose. So far as this report is concerned, it is assumed that remedial steps will necessarily proceed in a slow, progressive fashion; and that such wastes must to some extent and for some time be taken care of by the District sewers, pumping stations, and treatment works. This burden does not relate to quantity of the wastes but to the disturbances which they may produce in treatment processes and the danger which they may bring to life and property.

As regards prevention of pollution due to the release from vessels

or from industries located at or near the water's edge of wastes of this type which do not pass into the public sewer systems, that is a question for the Commission to deal with by means of control and police measures, to supplement in so far as necessary the activities of the Federal Government in its administration of the Oil Pollution Act above mentioned.

XIV.—RELATION TO POLLUTION FROM ROCKLAND COUNTY, NEW YORK STATE.

It is of great importance to those citizens of Bergen and Hudson Counties who receive their water supply from the Hackensack Water Co. to know whether or not pollution in the valley of the Hackensack River originating north of the New York State line will, when it becomes serious in amount, be capable of adequate control.

According to the 1930 census returns the population resident in that part of New York State which lies within the Hackensack River drainage area is about 24,000 people. The only municipality which has sewers and a treatment plant is Spring Valley. Treatment at this location is by means of Imhoff tanks, trickling filters, secondary settling tanks, sand filters and chlorination, discharging the treated effluent into Pascack Creek.

The State Hospital in Rockland County is also located within the Hackensack River drainage area. This institution is intended ultimately to care for 6,000 persons. At present there are about 2,000 inmates. The hospital has its own sewer system and treatment plant. The treatment plant consists of Imhoff tanks, trickling filters and secondary settling tanks. Chlorination is provided for, but is not being used at present. The treated effluent is pumped over the divide between the Hackensack Valley and that of Sparkill Creek, and is discharged into Sparkill Creek thence passing to the Hudson River. At New City there is a small treatment plant consisting of settling tanks, trickling filters, and chlorination which serves the Court House and jail.

The only other thickly settled places of importance are Pearl River, with a population of about 3,000, and Nanuet with a population of about 1,600. Neither of these places have sewers. The remainder of the Hackensack Valley within New York State is a very sparsely settled farming area.

So far as can be ascertained, excellent cooperation exists between the sanitary engineers of the Hackensack Water Co. and the officials of the State Department of Health of New York. But the time will certainly come when sewage from New York State will be a menace unless it is collected and treated in adequate fashion; and even then, if discharged into the Hackensack River or its branches, the situation will be less satisfactory than if sewage originating in future years in Rockland County,

New York State, were to be delivered at the state line into the trunk sewers of this District.

In view of all the facts in the situation it has been deemed wise to make the trunk sewer and its branches north of the northerly plant large enough to receive, when the right time comes, the flow of sewage originating in the drainage area of the Hackensack River in Rockland County. This means that the main northerly trunk sewer and certain of its branches as shown on Plate IV. have been made slightly larger than would otherwise have been the case. The resulting increase in cost will approximate $200,000. As a matter of sound public policy however it is wiser in the interests of the public health for the trunk sewer system of the District to include provision for future inclusion of sewage from Rockland County, rather than to face consequences of pollution entering the Hackensack watershed through inadequate control of plant installations or plant operations in Rockland County, or to face the other alternative, which is to build in the future trunk lines paralleling those now contemplated, either from the state line down to the northerly treatment works or for the major portion of that distance.

In this connection we have noted engineering report on the disposal of the sewage of Closter and vicinity by treating it on areas located in New Jersey and discharging it after treatment into Sparkill Creek south of the state line, from which point the sewage effluent, flowing in Sparkill Creek, would pass through New York State and into the Hudson River near Piermont, N. Y. Physical conditions admit the carrying out of this proposition; but until interstate relations become an actuality through bi-state or tri-state treaty, it is believed unwise for the Hackensack District Commission to deal with any project which in any measure or degree affects New York State, other than by making provision, as above explained, for Rockland County sewage ultimately to come south of the New York line in the interests of New Jersey citizens in this District. To send sewage from New Jersey after partial or even complete treatment into the Hudson River through New York State seems unncessary and inadvisable.

XV.—STORM FLOWS—REGULATORS.

Certain municipalities in the District, including also Bayonne, are sewered on the combined system; that is, their sewers receive both domestic sewage and storm water. These municipalities and the number of sewer outlets from each of them are as follows:

Hackensack	2
Ridgefield	1
Ridgefield Park	2
North Bergen	2

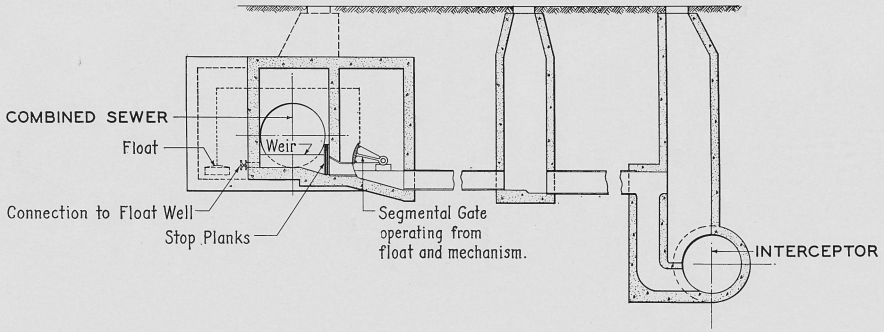


PLATE VI

STORM WATER REGULATOR.

Jersey City 13
Bayonne, ...16

The northerly plant will receive the flow of separate systems of sewers other than for six combined sewers carrying storm flows, and consequently street wash, from Hackensack, Ridgefield, Ridgefield Park and the northerly part of the west side of North Bergen.

On the other hand the southerly plant, to which the southerly part of the west side of North Bergen and the entire west side of Jersey City and Bayonne are tributary, will receive the flow from a system of sewers that is pratically all on the combined plan. Provisions must therefore be made for dealing with storm flows and street wash in the trunk sewers pumping stations and treatment works of the southerly part of the District.

It is customary in engineering practice to design intercepting sewers to care for at least some storm-water run-off in addition to the combined maximum future rates of flow of domestic, industrial and commercial sewage, together with ground water leakage. Some engineers make much greater allowances for this purpose than do others. But it is not necessary to make very great allowances; because until the time arrives when the sewage loadings approach the full capacities of the sewers there is aways ample spare capacity available for a suitable amount of storm flow; and even then there is spare capacity except during certain portions of the day when the maximum rates of flow of domestic, industrial and commercial sewage occur.

For some time after heavy rains occur, the flow in combined sewers is very foul, not only on account of street wash, but owing to the flushing out of solid matters which have accumulated in the sewers since the preceding heavy rain. This foul sewage must be taken to the treatment plants. In order not to take to the treatment plants quantities greatly in excess of those necessary to flush the sewers storm flow regulators are provided, which can be so adjusted that unnecessarily large quantities need not be received into the trunk sewers. In accordance with what has already been stated, it is obvious that during the early years of operation a much larger proportion of the storm flow may, if desired, be permitted to enter the trunk sewers than is possible when the sewers are operating under their future maximum loads.

To regulate the flow from the existing outlets into the trunk lines or interceptors it will be necessary to install 36 such regulators. These will divert storm flows up to a certain desired maximum and the remaining storm flow will pass on through existing outfalls as at present.

Regulators are arranged in several different ways, but a convenient type is that shown on Plate 6.

It is not necessary to give complete treatment to all storm water intercepted and delivered to the main pumping station and treatment

plant. For instance for the Wards Island project, having an average capacity of 180 million gallons daily, the project plans show provision for flow at the rate of 270 million gallons daily or 50 per cent above average through the entire plant, after which there will be an additional 90 million gallons daily taken through the preliminary sedimentation tanks only, thus providing at times of storm for a total flow of 360 million gallons daily or double the average ultimate dry weather flow. Flows in excess of 360 million gallons daily will overflow at the regulators along the various outlets now discharging into the Harlem and East Rivers.

For the new Easterly Project at Cleveland where the purpose of treatment is to protect bathing beaches, the treatment will be confined to 2½ times the dry weather flow with the balance spilled by the overflow regulators.

XVI.—AREAS AND POPULATIONS USED IN ESTIMATING SEWAGE FLOWS.

Areas and populations used in estimating sewage flows for the trunk sewers and sewage treatment works considered in this report are shown in Table III.

This table shows for each municipality wholly or partly in the Hackensack Valley drainage area, the total area in acres and the net area after deducting the areas covered with water, the Meadows and the parts of each located in the Passaic River and the Hudson River drainage areas. Table III also shows for the year 1930 and the year 1960, total population, density of population per acre, and population estimated for the remaining area after deducting Meadows and areas in other watersheds.

Individual population growth charts covering the period 1900 to 1960 have been prepared for each municipality.

APPENDIX ONE
TABLE III
AREAS, TOTAL POPULATION, DENSITY OF POPULATION PER ACRE AND NET POPULATION FOR MUNICIPALITIES IN HACKENSACK VALLEY DRAINAGE AREA

Municipality	Area in Acres					Total Population		Density per Acre (Based on Column 4)		Net Population for Areas Shown in Column 6	
	Total	Water and Swamp Areas	Total Less Water and Swamp Areas	In Hudson and Passaic Drainage Areas	(6) Net Area (Col. 4 Less Col. 5)	1930	1960	1930	1960	1930	1960
Jersey City	9443	2214	7229	3593	3636	316,715	358,000	43.8	49.5	159,308	180,074
Kearny	7629	3637	3992	1743	2249	40,716	95,000	10.2	23.8	22,939	53,523
North Bergen	3325	1514	1811	463	1348	40,714	100,000	22.5	55.2	30,303	74,430
Secaucus	4272	2744	1528	.....	1528	8950	22,000	5.9	14.4	8,950	22,000
Union City	840	.....	840	489	351	58,659	70,000	69.8	83.3	24,514	29,253
West New York	611	.....	611	415	196	37,107	60,000	60.7	98.2	11,904	19,248
TOTAL					10,089					282,470	411,450
ROCKLAND COUNTY, N. Y.											
Clarkstown	.....	.....	.....	.....	25864	9346	17,000	0.4	0.7	9,346	17,000
Orangetown	.....	.....	.....	.....	8570	8408	15,000	1.0	1.8	8,408	15,000
Ramapo	.....	.....	.....	.....	4867	2272	4,545	0.5	0.9	2,272	4,575
Spring Valley	.....	.....	.....	.....	668	3948	8,000	6.0	12.1	3,948	8,000
TOTAL					39,969					23,974	44,575
SUMMARY											
Bergen County					60,782					197,579	507,268
Hudson County					10,089					282,470	411,450
TOTAL FOR N. J.					70,871					480,049	918,718
Rockland County					39,969					23,974	44,575
TOTAL					110,840					504,023	963,293

plant. For instance for the Wards Island project, having an average capacity of 180 million gallons daily, the project plans show provision for flow at the rate of 270 million gallons daily or 50 per cent above average through the entire plant, after which there will be an additional 90 million gallons daily taken through the preliminary sedimentation tanks only, thus providing at times of storm for a total flow of 360 million gallons daily or double the average ultimate dry weather flow. Flows in excess of 360 million gallons daily will overflow at the regulators along the various outlets now discharging into the Harlem and East Rivers.

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Municipality	Area in Acres					Total Population		Density per Acre (Based on Column 4)		Net Population for Areas Shown in Column 6	
	Total	Water and Swamp Areas	Total Less Water and Swamp Areas	In Hudson and Passaic Drainage Areas	(6) Net Area (Col. 4 Less Col. 5)	1930	1960	1930	1960	1930	1960
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
BERGEN COUNTY											
Alpine	4018	.....	4018	2180	1838	521	1,600	0.1	0.4	238	732
Bergenfield	1958	.....	1958	.....	1958	8816	21,500	4.5	11.0	8,816	21,500
Bogota	502	80	422	.....	422	7341	15,500	17.4	36.7	7,341	15,500
Carlstadt	2677	2242	435	205	230	5425	9,300	12.5	21.4	2,868	4,917
Cliffside Park	596	.....	596	435	161	15,267	40,000	25.6	67.1	4,124	10,804
Closter	2156	38	2118	.....	2118	2502	7,500	1.2	3.5	2,502	7,500
Cresskill	1337	.....	1337	.....	1337	1924	6,500	1.4	4.9	1,924	6,500
Demarest	1337	.....	1337	.....	1337	1013	3,800	0.8	2.8	1,013	3,800
Dumont	1212	.....	1212	.....	1212	5861	14,700	4.8	12.1	5,861	14,700
E. Rutherford	2495	1996	499	299	200	7080	13,400	14.2	26.9	2,838	5,371
Emerson	1641	118	1523	.....	1523	1394	4,500	0.9	3.0	1,394	4,500
Englewood	3154	.....	3154	.....	3154	17,085	40,000	5.4	12.7	17,085	40,000
Eng. Cliffs	1280	.....	1280	702	578	809	1,870	0.6	1.5	365	844
Fairview	535	132	403	28	375	9067	17,000	22.5	42.2	8,437	15,819
Fort Lee	1593	.....	1593	931	662	8759	20,900	5.5	13.1	3,640	8,686
Hackensack	2746	383	2363	.....	2363	24,568	52,000	10.4	22.0	24,568	52,000
Harrington Park	1369	64	1305	.....	1305	1251	6,000	0.9	4.6	1,251	6,000
Hasbrouck Heights	1275	378	897	432	465	5658	21,000	6.3	23.4	2,933	10.886
Haworth	1471	160	1311	.....	1311	1042	4,300	0.8	3.3	1,042	4,300
Hillsdale	1916	19	1897	61	1836	2959	8,800	1.5	4.6	2,864	8,517
Leonia	1012	384	628	.....	628	5350	15,400	8.5	24.5	5,350	15,400
Little Ferry	1174	561	613	.....	613	4155	11,000	6.8	17.9	4,155	11,000
Lodi Township	326	129	197	.....	197	1294	2,480	6.6	12.6	1,294	2,480
Lyndhurst	3192	1934	1258	921	337	17,362	36,000	13.8	28.6	4,651	9,644
Maywood	820	.....	820	.....	820	3398	12,000	4.1	14.6	3,398	12,000
Montvale	2757	.....	2757	311	2446	1243	4,000	0.4	1.5	1,103	3,549
Moonachie	1081	419	662	.....	662	1465	4,100	2.2	6.2	1,465	4,100
New Milford	1526	64	1462	.....	1462	2556	6,000	1.8	4.1	2,556	6,000
N. Arlington	1615	702	913	411	502	8263	30,000	9.1	32.9	4,543	16,494
Northvale	838	.....	838	461	377	1144	3,000	1.4	3.6	515	1,350
Norwood	1753	.....	1753	16	1737	1358	4,400	0.8	2.5	1,346	4,360
Old Tappan	2671	.....	2671	.....	2671	600	2,300	0.2	0.9	600	2,300
Oradell	1676	128	1548	.....	1548	2360	5,850	1.5	3.8	2,360	5,850
Palisades Park	876	187	689	.....	689	7065	16,600	10.3	24.1	7,065	16,600
Paramus	6749	.....	6749	4529	2220	2649	9,500	0.4	1.4	871	3,125
Park Ridge	1497	.....	1497	.....	1497	2229	6,100	1.5	4.1	2,229	6,100
Ridgefied	1894	1057	837	.....	837	4671	12,000	5.6	14.3	4,671	12,000
Ridgefield Park	1228	558	670	.....	670	10,764	19,200	16.1	28.7	10,764	19,200
River Edge	1247	32	1215	.....	1215	2210	6,000	1.8	4.9	2,210	6,000
Rivervale	2824	.....	2824	.....	2824	871	3,200	0.3	1.1	871	3,200
Rockleigh	688	.....	688	631	57	86	700	0.1	1.0	7	58
Rutherford	1663	535	1128	673	455	14,915	33,000	13.2	29.3	6,017	13,312
Teaneck	3954	555	3399	.....	3399	16,513	57,000	4.9	16.8	16,513	57,000
Tenafly	3045	.....	3045	619	2426	5669	14,000	1.9	4.6	4,516	11,154
Teterboro	576	.....	576	.....	576	26	200	0.1	0.4	26	200
Washington Twp.	2150	.....	2150	253	1897	402	1,500	0.2	0.7	355	1,323
Westwood	1484	.....	1484	.....	1484	4861	13,000	3.3	8.8	4,861	13,000
Woodcliff Lake	2319	141	2178	208	1970	871	2,500	0.4	1.2	788	2,261
Wood Ridge	723	44	679	498	181	5159	20,000	7.6	29.5	1,375	5,332
TOTAL					60,782					197,579	507,268
HUDSON COUNTY											
Bayonne	2873	.....	2873	2110	763	88,979	118,500	31.0	41.2	23,633	31,474
Guttenberg	128	.....	128	110	18	6535	10,300	51.1	80.5	919	1,448
Jersey City	9443	2214	7229	3593	3636	316,715	358,000	43.8	49.5	159,308	180,074
Kearny	7629	3637	3992	1743	2249	40,716	95,000	10.2	23.8	22,939	53,523
North Bergen	3325	1514	1811	463	1348	40,714	100,000	22.5	55.2	30,303	74,430
Secaucus	4272	2744	1528	.....	1528	8950	22,000	5.9	14.4	8,950	22,000
Union City	840	.....	840	489	351	58,659	70,000	69.8	83.3	24,514	29,253
West New York	611	.....	611	415	196	37,107	60,000	60.7	98.2	11,904	19,248
TOTAL					10,089					282,470	411,450
ROCKLAND COUNTY, N. Y.											
Clarkstown	.....	.....	.....	.....	25864	9346	17,000	0.4	0.7	9,346	17,000
Orangetown	.....	.....	.....	.....	8570	8408	15,000	1.0	1.8	8,408	15,000
Ramapo	.....	.....	.....	.....	4867	2272	4,545	0.5	0.9	2,272	4,575
Spring Valley	.....	.....	.....	.....	668	3948	8,000	6.0	12.1	3,948	8,000
TOTAL					39,969					23,974	44,575
SUMMARY											
Bergen County					60,782					197,579	507,268
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TOTAL FOR N. J.					70,871					480,049	918,718
Rockland County					39,969					23,974	44,575
TOTAL					110,840					504,023	963,293

XVII.—ESTIMATED SEWAGE FLOWS USED IN DETERMINING SIZES AND CAPACITIES OF SEWERS AND TREATMENT WORKS.

To determine capacities for trunk sewers and treatment works, it is necessary to estimate the volume of sewage from the future population both under conditions which result in maximum amount of sewage and under conditions of average flow. This may best be done by taking into account various local factors such as water consumption and its relation to sewage flow, conditions which affect leakage of ground water into the sewers, industrial and commercial development of the territory and, in the case of areas having combined storm water and sanitary sewers, the effect of storm water run-off. Another factor to be considered in the design of trunk sewers and treatment works is the marked fluctuations in the quantity and strength of sewage, particularly in the case of relatively small communities having short trunk lines. In many such instances the entire flow during certain hours at night is almost entirely made up of ground water infiltration into the sewers. However, the variation of flow between average and minimum conditions is not substantial at the outlet of long trunk lines receiving daily peak flows at various intervals.

Ultimate Maximum Sewage Flow

For determining sizes and grades of the trunk sewers considered in this report and which are shown on Plate IV., estimates of ultimate maximum flow have been based on the areas and the future population figures shown in Table III. The ultimate maximum flow for portions of the district having separate systems of sewers and for those portions not sewered at present has been considered as being made up of three general items; domestic sewage, ground water infiltration and industrial sewage. Commercial sewage has not been considered as a separate item, as the nature of the territory is such that it is a small factor and it is reflected in the estimates for other items. Following is a description of points considered in estimating maximum domestic sewage, ground water infiltration and industrial sewage.

Maximum Domestic Sewage

The present average consumption of water for sewered municipalities in the District is approximately 50 gallons per capita daily and in many of the smaller communities of the District it is as low as 40 gallons per capita daily. In 1960 the anticipated average water consumption per capita from public water supplies is approximately 60 gallons daily and although sewage flow would be somewhat less than water consumption 60 gallons per capita daily is estimated as the ultimate average flow,

inasmuch as some water will reach the sewers from private water supplies. Based on flow records at certain places such as Tenafly, where accurate daily records of sewage flow have been kept for the past few years, and considering the influence of a small flow of commercial sewage, it is estimated that the maximum rate of flow of domestic sewage will at times be as high as 225 per cent. of the average daily flow of 60 gallons per capita or 135 gallons per capita per day.

Maximum Ground Water Infiltration

The amount of ground water which finds its way into sewers, called ground water infiltration or leakage, depends largely upon the relative elevation of the sewers and the ground water level, the character of ground in which the sewers are built, the materials and workmanship used in building the sewers and the care taken in making connections to the sewers after they are built.

The character of the ground, presence of ground water and its depth from the surface and the tightness of existing sewerage systems in the Hackensack Valley vary to a considerable extent. Ground water is present very close to the surface of the ground in the low areas along the streams at all times and, in certain higher areas, during portions of the year, the ground water level is above the normal depths of sewers. A study of existing flow records of certain municipalities in the District, indicates a maximum rate of infiltration of from less than 500 gallons per acre per day to more than 1,500 gallons per acre per day, depending largely on the factors mentioned above.

An estimate of maximum ground water infiltration for each municipality in the District has been made by applying rates of 500 gallons per acre per day to the portions estimated to have a low rate of leakage and 1,500 gallons per acre per day to the portions where infiltration would be relatively high. Only areas estimated to be sewered in 1960, based on a population density of 5 per acre, have been considered in computing ground water flow. This method resulted in an average infiltration allowance of 1150 galllons per acre per day for the areas estimated to be sewered in 1960, which is equivalent to 129 gallons per capita daily for the municipalities having separate systems of sewers.

Industrial Sewage

An estimate of 7,000 gallons average flow and 12,000 gallons maximum flow per acre has been used in estimating probable industrial wastes for the year 1960. These estimates are based on measurements of sewage flow in industrial districts in various cities. The above figures have been applied to areas that in all probability would be devoted to future industrial development and in general include the districts which are now developed for industry and a strip in the lower part of the valley approxi-

mately 1,000 feet wide extending along the toe of the slops and out into the meadows. For the northerly part of the District this method results in a maximum flow of 44 gallons per capita and for the southerly part of the District 47 gallons per capita per day.

For municipalities having combined storm water and sanitary sewers a maximum per capita flow of 310 gallons per day has been used in estimating sewer sizes and slopes. This is equivalent to approximately two and one-half times the ultimate estimated average flow and provides for a capacity of one and one-half times the average flow for first flushings of storm water in times of average flow and for a small quantity of storm water at the time of ultimate maximum flow. Inasmuch as the trunk sewers are designed for anticipated future requirements, there will be a considerable excess capacity for flushing with storm water during the early years when light average flows will tend to cause deposits to form in the trunk lines.

Table IV. shows comparative data used as bases of design of certain interceptors and trunk sewers for various cities, relative to domestic, industrial, commercial sewage flow, ground water infiltration and total maximum sewage flow. In this table g. c. d. means gallons per capita daily and g. a. d. means gallons per acre daily.

APPENDIX ONE

TABLE IV.

RELATION OF MAXIMUM DOMESTIC, INDUSTRIAL, COMMERCIAL; GROUND WATER ALLOWANCES AND TOTAL MAXIMUM SEWAGE FLOW USED AS BASES FOR DESIGN OF TRUNK SEWERS.

Location	Maximum Domestic Sewage g. c. d.	Industrial Sewage: Maximum Rate g. a. d.	Industrial Sewage: Maximum Rate g. c. d.	Maximum Commercial Sewage g. c. d.	Ground Water Leakage: Maximum Rate g. a. d.	Ground Water Leakage: Maximum Rate g. c. d.	Total Maximum Sewage g. c. d.
Milwaukee	125	16,800	65.0	33.0	1620	64.0	287.0
Detroit	228	12,000	38.4	23.4	500 }		
					1000 }		
		13,000 }			1000 }		
Buffalo	285	16,000 }	90.8	46.6	1850 }	31.4	453.8
Cincinnati	135	9,000	103.5	40.5	750	87.0	366.0
Louisville	200	24,000	65.0	8.6	1960	66.6	340.2
Fitchburg	150	8,000	115.0				
Toledo	118	12,000	63.5	32.0	800	38.0	251.5
Passaic Valley	150	15,000	38.0		1100	28.0	216.0
Hackensack Valley (separate sewers)	135	12,000	29.0		500 } 1500 }	129.0	293.0
Hackensack Valley (combined sewers)							310.0*

* Total Maximum flow estimated as 2.6 times average flow.

Average Sewage Flow

Average sewage flow for the area that will discharge into the northerly treatment plant has been estimated at 115 gallons per capita per day. With the exception of parts of three municipalities, the present sewered areas in the Northern District have separate systems of sewers and it is anticipated that all of the future sewers in this area will be of this type. In estimating the average flow at 115 gallons per capita per day, the following quantities for average domestic sewage, average industrial sewage and average ground water infiltration have been used.

Average industrial sewage	15 g. c. d.
Average domestic sewage	60 g. c. d.
Average infiltration	40 g. c. d.
Total average sewage flow	115 g. c. d.

For the areas that will discharge sewage into the southerly treatment plant the average sewage flow has been estimated at 120 gallons per capita per day.

The estimated average per capita flow for each plant is approximately two-fifths of the estimated maximum flows of 293 gallons and 310 gallons, respectively, for the northerly and southerly treatment plants; or stated conversely, maximum flow quantities per capita used are approximately two and a half times average flow quantities.

Estimated Flow for Each Treatment Plant in 1937, 1947 and 1960

The estimated average daily flow at each treatment plant, in million gallons daily and the corresponding population figures, for the years 1937, 1947 and 1960, based on the average rate of sewage flow stated above for each plant and from the population curves which have been prepared, are shown in the following tabulation. The estimates given for the southerly plant include the population and sewage flow for Bayonne.

	Estimated Connected Population			Daily Average Flow M. G.		
	1937	1947	1960	1937	1947	1960
Northerly Treatment Plant	267,500	391,600	589,343	30.5	45	68
Southerly Treatment Plant	260,000	284,750	320,427	31	34	38
Both Plants	527,500	686,350	909,770	61.5	79	106

The above population figures do not include Kearny. Kearny is now

connected to the Passaic Valley Sewer with the exception of an industrial area which is sewered to an existing treatment plant.

XVIII.—VELOCITIES, GRADES AND CAPACITIES USED IN PRELIMINARY DESIGN OF SEWERS.

In order to provide sufficient velocity to keep the sewers flushed out and clean, slopes have been assumed for the trunk sewers such as to provide velocities of at least two feet per second when the sewers are flowing at three-quarters full depth. Table V. shows the minimum falls in feet per 1,000 feet which will produce a velocity of practically two feet per second in circular sewres of various diameters and the corresponding capacities of the sewers, in million gallons daily, when flowing at three-quarters full depth. Slopes and capacities have been computed by using the Williams and Hazen formula, with C=120, which corresponds approximately to n=0.013 in the Kutter formula.

TABLE V.

Diameter of sewer in inches	Fall in feet per 1000	Capacity ¾ full M. G. D.
12	1.50	0.91
14	1.31	1.27
16	1.09	1.64
18	0.95	2.06
20	0.85	2.56
24	0.69	3.70
30	0.53	5.76
36	0.42	8.30
42	0.36	11.30
48	0.31	14.87
54	0.27	18.80
60	0.24	23.10
66	0.21	27.90
72	0.19	33.20
78	0.17	38.60
84	0.16	45.20
90	0.15	52.60
96	0.14	59.00
102	0.13	67.60
108	0.12	75.40
114	0.11	83.30

The sewers shown on Map 4, although designed for 1960 estimated populations, have maximum capacities substantially in excess of the estimated requirements for that date. One reason for this excess capacity is that the sewers have been computed as running only three-quarters full depth. Another is that the capacities have been computed for the entire estimated future population, whereas some of the population, particularly in the northerly part of the District will probably not be connected with the sewers at that date. Still another reason is that the average daily flow and the consequent maximum rates of flow have been estimated on quite a liberal basis.

XIX.—BASIC DATA FOR TREATMENT PLANTS, INCLUDING PUMPING STATIONS AT THE TREATMENT SITES.

The data are given here which have been assumed in determining the sizes and capacities of the various structures comprising the northerly and southerly District treatment plants, including the pumping stations located at the treatment sites.

First are given the populations and sewage flows for the two plants as they should be constructed. The plants should first be constructed to serve the needs of the District for a period of about ten years after they have been completed and made ready for service, or say until about the year 1947. They should then be enlarged to serve the needs of the District for a further reasonable length of time, say until 1960 or somewhat later.

Approx. date,	1947	1960
Approx. population served.		
Southerly plant,	284,800	310,400
Northerly plant,	391,600	589,300
Ave. sewage flow, million gallons daily,		
Northerly plant,	45	68
Southerly plant,	34	38
Max. rate of flow through entire plant, million gallons daily,		
Northerly plant,	68	100
Southerly plant,	51	57

The period of time required for the sewage to pass through each of the various structures or tanks of the activated sludge process is assumed to be the same in the case of both the northerly and southerly plants. These periods, or capacities in terms of hours, are as follows:

Preliminary tanks, based on average daily flow,	1.0 hour

Aeration tanks, based on average daily flow plus 25% of returned sludge,	5.6 hours
Reaeration tanks, based on 25% of returned sludge,	4.0 hours
Final settling tanks, based on average daily flow plus 25% of returned sludge,	2.4 hours
Final settling tanks, based on average daily flow plus 25% of returned sludge,	1,000 gals. daily per sq. ft. of horizontal area.

The maximum capacity of blowers for supplying air to the aeration and reaeration tanks is about 2.4 cu. ft. and the average rate of application provided for is about 1.0 cu. ft. of free air per gallon of average daily sewage flow, although it is expected that not more than 0.8 cu. ft. may be needed.

The above capacities are in line with those allowed in the design of the most recent activated sludge plants, including those for Wards Island and Chicago, except that in the above reaeration is provided for to an extent much greater than is usually the case.

For the disposal of the excess sludge the following capacities are provided:

Sludge digestion tank capacity,	
Northerly plant,	3 cu. ft. per capita
Southerly plant,	4 cu. ft. per capita
Tank capacity for storing digested sludge during the colder months,	
Northerly plant,	2.1 cu. ft. per capita
Southerly plant,	2.8 cu. ft. per capita
Sludge drying bed area,	
Northerly plant,	0.6 sq. ft. per capita
Southerly plant,	0.8 sq. ft. per capita

The weight of dry solids brought daily to the plant in the sewage is assumed at 90 grams per capita in the case of the northerly plant, which receives sewage from municipalities practically all of which are sewered on the separate plan, and at 120 grams per capita in the case of the southerly plant, which receives sewage from municipalities practically all of which are sewered on the combined plan. Of these solids it is assumed that 40 per cent. will be removed in the preliminary tanks before

activation, and that 50 per cent. will be removed by the final tanks; a total removal of 90 per cent.

The sludge drying bed area is assumed to be covered, but not entirely enclosed. Thus delay to drying due to wet weather will be avoided; but during the colder months of the year very little drying will be possible. In order to avoid putting sludge on the beds during the colder months, tanks for storing the digested sludge during cold weather conditions are assumed to be provided.

For lifting the sewage from the trunk sewer into the treatment plant electrically-operated centrifugal pumps are assumed to be provided, of sufficient capacity, in addition to spare units, to meet requirements at maximum rates of flow. These pumps will be housed in the same building with the electrically-operated blowers which supply air to the aeration tanks. In this building, called the pump and blower house, there will also be installed apparatus for conditioning the air supplied to the blowers, an electrical substation, heating boilers, a repair shop, etc. Pumps for transporting wet sludge to and from various parts of the plant will be installed in various smaller buildings in convenient locations. A building called the administration building will be provided for general offices, laboratory and storage of tools and supplies.

XX.—FOUNDATION CONDITIONS.

Information relative to foundation conditions in the Hackensack Valley at proposed locations for treatment plants and trunk sewers was obtained from auger borings made by us. The locations of borings are shown on Map 4. Additional data were obtained from records of subsurface conditions found during construction of sewers, sewage treatment works, bridge piers, factories and storm water outfalls in various parts of the valley.

A study of these data shows that it is feasible to construct the sewers and treatment plant structures at reasonable costs. A solid, compact blue clay formation is found under three to eight feet of decayed vegetable matter throughout a considerable portion of the meadow areas. In some parts of the valley, particularly in the northern section in the vicinity of the Oradell Reservoir and extending south to Hackensack, wet sand is present which involves considerable expense for sheeting and handling water, and in certain locations foundation conditions are such that piles are required for adequate support of structures.

In preparation of estimates of cost of structures considered in this report, careful consideration has been given to the question of foundation conditions, particularly as they relate to necessity for sheeting in excavation work, removal of water from trenches and use of piles and spread foundations under structures to avoid possibility of settlement.

XXI.—ESTIMATED COST OF CONSTRUCTION OF TRUNK SEWERS, TREATMENT PLANTS AND PUMPING STATIONS.

Trunk Sewers

Following is the estimated cost of construction, including allowances for engineering and contingencies, of the trunk sewers, including connections, meters, regulators, river siphons, railroad crossings, road crossings, replacement of pavement, relocation of gas and water mains, etc., and also booster stations and force mains for lifting sewage into the trunk sewers at a few locations. In this estimate Bayonne is assumed to be included in the District.

The estimate is divided into two parts; one part including sewers which should be constructed at once, or between 1932 and 1937, and the other including sewers which will be needed from time to time between 1947 and 1960 or later. The sewers which are needed at once are shown on Map 4 by full lines. Those whose construction may be deferred are shown by dash lines.

For immediate construction:		
Northerly sewers:		
Main trunk, Northerly Treatment Plant to Oradell,	$2,468,000	
Main trunk, Oradel to Tenafly,	763,000	
West Overpeck branch,	843,000	
East Overpeck branch,	428,000	
N. Bergen-Fairview branch,	242,000	
North Arlington branch,	642,000	
		$ 5,386,000
Southerly sewers:		
N. Bergen-Jersey City interceptor,	$1,347,000	
Bayonne-Jersey City interceptor,	638,000	
		1,985,000
Total for immediate construction		$ 7,371,000
For later construction:		
Miscellaneous northerly sewers,		1,461,000
Grand total,		$ 8,832,000

Northerly Treatment Plant

Following is the estimated cost of construction of the northerly treatment plant, including allowances for engineering and contingencies. In column 1 is given the estimated cost for a plant to be constructed during the next five years and sufficient to serve the needs of the District until

about 1947; in column 2, the cost of additions to be made at about 1945 to 1947, necessary to meet conditions occurring in 1960 or somewhat later; and in column 3, the total cost.

	1	2	3
Plant to serve needs until at least	1947		1960
Capacity of plant, m. g. d.,	45	23	68
Pump and blower house,	$ 1,140,000	$ 500,000	$ 1,640,000
Preliminary tanks,	125,000	55,000	180,000
Aeration and reaeration tanks,	1,220,000	645,000	1,865,000
Final tanks,	485,000	240,000	725,000
Sludge digestion tanks,	760,000	385,000	1,145,000
Sludge storage tanks,	210,000	105,000	315,000
Sludge drying beds,	550,000	275,000	825,000
Administration building,	75,000	30,000	105,000
Miscellaneous items, including roads, walks, landscaping, outside steam and electric conduits, water and gas mains, etc.,	190,000	90,000	280,000
Total	$ 4,755,000	$2,325,000	$ 7,080,000

Southerly Treatment Plant

Following is the estimated cost of construction of the southerly plant, including allowances for engineering and contingencies. In this estimate Bayonne is assumed to be included in the District.

As in the case of the northerly treatment plant, estimates are given of total costs to meet approximate 1947 and 1960 conditions. The structures are the same in number and type as for the northerly plant, except that there is added to the southerly plant a grit chamber for removing heavy inorganic matter received from the combined sewers of this part of the District. In column 1 is given the estimated cost for a plant to be constructed during the next five years and sufficient to serve the needs of the District until about 1947; in column 2 the cost of additions to be made at about 1945 to 1947, necessary to meet conditions occurring in 1960 or somewhat later; and in column 3 the total cost.

	1	2	3
Plant to serve needs until at least	1947		1960
Capacity of plant, m. g. d.,	34	4	38
Grit chamber,	$ 120,000	$	$ 120,000
Pump and blower house,	855,000	65,000	920,000

Preliminary tanks,	95,000	10,000	105,000
Aeration and reaeration tanks,	940,000	105,000	1,045,000
Final tanks,	370,000	45,000	415,000
Sludge digestion tanks,	725,000	80,000	805,000
Sludge storage tanks,	205,000	20,000	225,000
Sludge drying beds,	530,000	55,000	585,000
Administration building,	60,000		60,000
Miscellaneous items, including roads, walks, landscaping, outside steam and electric conduits, water and gas mains, etc.,	150,000	20,000	170,000
Additional foundation work,	500,000	50,000	550,000
Total	$4,550,000	$450,000	$5,000,000

Remote Plants

In addition to the northerly and southerly plants of the District, there are to be taken into account remote plants already referred to under Caption XII. The extension and improvement of the plant near Kearny Point and the construction of a plant to treat the sewage of the Laurel Hill institutions constitute the construction requirements as far as they are now known. The need for construction of additional plants, if any, will arise only in connection with the future development of the meadows, referred to under Caption XI., and it is therefore unnecessary to attempt here any definite consideration of such plants.

However, as a liberal estimate of the cost of construction and improvement of remote plants needed to meet conditions in the immediate future, an allowance of $250,000 has been made; and to meet ultimate conditions such as may occur in 1960 or somewhat later, an additional allowance of $150,000, making a total of about $400,000. These estimates are sufficient to include engineering and contingencies.

Summary of Construction Costs, Including Real Estate

Following is a summary of the estimated construction costs above given, including allowances for engineering and contingencies and also for real estate and rights of way. The figures include in column 1 estimates for that part of the construction which is to be commenced as soon as possible and completed ready for service at about the year 1937; those in column 2 include additions after that date to serve until 1960 or later, and those in column 3 for total construction of the complete project. Estimates for the southerly part of the District assume that Bayonne is included in the District.

	1 1932-37 Construction	2 1944-47 Construction	3 Total Construction
Trunk Sewers and Appurtenances, Northerly part of District,	$ 5,386,000	$ 1,461,000	$ 6,847,000
Southerly part of District,	1,985,000		1,985,000
Treatment Plants and Main Pumping Stations, Northerly plant,	4,755,000	2,325,000	7,080,000
Southerly plant,	4,550,000	450,000	5,000,000
Allowances for Remote Plants,	250,000	150,000	400,000
Real Estate and Rights of Way, including also cost of operating existing municipal treatment plants during the first construction period,	3,000,000	*	3,000,000*
Total construction cost,	$19,926,000	$ 4,386,000*	$24,312,000*

*These figures do not include the cost of rights of way for sewers which are not included in the 1932-37 construction, because reasonable estimates of this cost cannot be made at the present time.

Construction Cost if Bayonne Is Not Included in District

Should Bayonne not become a part of the District, the construction cost would be reduced approximately to the following:

	1 1932-37 Construction	2 1944-47 Construction	3 Total Construction
Trunk Sewers and Appurtenances, Northerly part of District,	$ 5,386,000	$ 1,461,000	$ 6,847,000
Southerly part of District,	1,455,000		1,455,000
Treatment Plants and Main Pumping Stations, Northery plant,	4,755,000	2,325,000	7,080,000
Southerly plant,	4,087,000	413,000	4,500,000

Allowances for Remote Plants,	250,000	150,000	400,000
Real Estate and Rights of Way, including also cost of operating existing municipal treatment plants during the first construction period,	3,000,000	*	3,000,000*
Total construction cost without Bayonne,	$18,933,000	$ 4,349,000*	$23,282,000*

*These figures do not include the cost of rights of way for sewers which are not included in the 1932-37 construction, because reasonable estimates of this cost cannot be made at the present time.

Unit Prices

The unite prices which have been used in computing the above construction costs are those which prevailed during the period of high prices ending in 1929. At the present time in many localities the cost of construction by contract is frequently one-fourth to one-third lower than in 1929, due partly to the fact that within recent years the use of labor-saving machinery has become more and more general, partly to the low prices of materials and labor, and partly to the fact that, on account of scarcity of construction work, contractors have been taking work at practically its cost to themselves.

In considering unit prices it is well to bear in mind that the recent months have seen a number of records of surprisingly low bids, such for example as the tank system of the Wards Island plant for New York City where the 1929 estimate showed a cost of $6,100,000 in comparison with an awarded price of $3,900,000 in round figures, or a percentage of about 64. On the other hand Engineering News-Record's cost index shows figures based on 1913 prices as 100, as follows:

Average 207.02
November, 1931 .....169.29 (82%)
June, 1922 .....166.62 (80.5%')

At a period when construction costs are practically the lowest for 10 years and prices of labor and materials and the desire of contracting organizations to keep their personnel together are such as to make for very abnormally low bids, it is highly important to bear in mind that construction work during the next four or five years is not likely to be placed under contract for 70 to 75 per cent. of 1929 prices as would be probably the case for contracts awarded during the next few months. On the contrary it should be kept in mind that prices will no doubt increase as the demand for labor and materials becomes greater and it is

unwise to assume that this project can be built at a cost less than from 80 to 85 per cent. of 1929 prices.

XXII.—ESTIMATES OF COST OF OPERATION AND MAINTENANCE OF TREATMENT PLANTS, INCLUDING PUMPING; ALSO OF THE COST OF MAINTENANCE OF THE TRUNK SEWERS AND INSPECTION OF RIVER CONDITIONS.

Northerly Treatment Plant

The estimated annual cost of operation, maintenance, and repairs, for the northerly treatment plant, is given below. Estimates are given for the year when the plant is assumed to go into service, for the year when enlargements of the plant are assumed to become necessary, and for the year when the ultimate capacity of the plant will be reached.

Approx. Date,	1937	1947	1960 or later
Aver. sewage flow treated million gals. daily,	30.5	45	68
Plant administration,	$ 12,000	$ 15,500	$ 23,000
Pumping,	28,000	38,000	57,000
Treatment of liquid,	125,000	179,500	271,000
Treatment of sludge,	47,500	67,500	103,000
Care of grounds,	14,500	15,500	23,000
Total for northery plant,	$227,000	$316,000	$477,000
Per million gallons,	$ 20.04	$ 19.27	$ 19.22

Southerly Treatment Plant

The estimated annual cost of operation, maintenance, and repairs, is similarly given for the southerly treatment plant. In this estimate Bayonne is assumed to be included in the District. In the cost is included an approximation of the probable cost of operating remote plants. In addition there are included in the pumping costs not only those for the main pumping station at the plant itself but also the cost of power and of maintenance and repair work for the small pumping stations needed at Secaucus. It is assumed that these small stations will operate automatically, and that therefore, as far as labor is concerned, they can be taken care of through daily visits of a man from the main pumping station at the treatment plant.

Approx. Date,	1937	1947	1960 or later
Aver. sewage flow treated at main southerly treatment plant only, million gals. daily,	31	34	38
Plant administration,	$ 11,500	$ 12,000	$ 13,000

Pumping,	28,000	30,500	34,000
Treatment of liquid,	126,000	138,000	154,000
Treatment of sludge,	63,500	68,500	76,000
Care of grounds,	12,000	12,000	12,000
Approx. allowance for operating remote plants	6,000	12,000	20,000
Total for southerly plant, minor pumping stations and remote treatment plants,	$247,000	$273,000	$309.000
Per million gallons, southerly plant only,	$ 21.30	$ 21.05	$ 20.84

What Is Included in Estimates for Plant Operation, Maintenance and Repairs

In the above estimates for the northerly and southerly treatment plants, plant administration includes the general superintendence of the plant and the laboratory work; pumping includes the labor, power, supplies and repairs for operating the pumps; treatment of liquid includes the labor, power, supplies and repairs for operating the blowers, the aeration and reaeration tanks and the preliminary and final settling tanks, or in other words for operating the activated sludge process; and treatment of sludge includes the labor, power, supplies and repairs for operating the sludge digestion tanks, the attendance and repairs to the sludge storage tanks, and the labor, supplies and repairs for spreading the sludge on the drying beds and removing the dried sludge, including also the necessary resanding of the surface of the drying beds from time to time.

The above annual costs do not include the general expenses incurred by the Commission for clerical, legal and other overhead expenses.

Sewer Maintenance and River Inspection

In addition to the operation of the treatment plants and pumping stations, it will be necessary to maintain the trunk sewers, meters, regulators and connections to municipalities. Particularly during the early years of operation, when flows are small and velocities low, it may be necessary occasionally to flush out or clean portions of the sewers. Minor repairs to the sewers must be made. In addition, aside from all work in connection with operation and maintenance of the treatment plants, it will be necessary to inspect the river and its tributaries to detect possible sources of pollution. Laboratory tests needed in this connection will be made at the treatment plants.

For the above purposes it will be necessary to employ a sewer superintendent, as well as meter and regulator inspectors, a river inspector,

foremen and laborers. Automobiles and a boat must be furnished and operated. Labor and materials for repair work must be provided. The annual cost of maintenance and repair of the trunk sewers and their appurtenances, including also inspection of the watershed for sources of pollution, is estimated as follows:

	1937-47	1948-60
Northerly part of District,	$ 65,000	$ 75,000
Southerly part of District	45,000	50,000
Total for entire District,	0110,000	$125,000

Summary of Annual Cost of Operation, Maintenance and Repairs

Following is a summary of the estimated annual cost of operation maintenance and repairs for the entire District for critical years which represent the beginning of operation, the date when the enlargement of the treatment plants will become necessary and the time when the capacity of the enlarged works will have been reached. In this estimate it is assumed that Bayonne is included in the District.

Approx. Date,	1937	1947	1960
Northerly treatment plant,	$227,000	$316,000	$477,000
Southerly treatment plant and remote plants and pumping stations,	247,000	273,000	309,000
Trunk sewers, including river inspection, entire District,	110,000	110,000	125,000
Total for entire District,	$584,000	$699,000	$911,000

Cost of Operation, Maintenance and Repairs

The estimated approximate cost of operation, maintenance and repairs per million gallons, including that of the remote plants as well as of the northerly and southerly plants is as follows:

	1937	1947	1960
Cost per million gallons,	$25.60	$23.25	$22.00

Cost of Operation, Maintenance and Repairs if Bayonne Is Not Included in District

Should Bayonne not become a part of the District, the annual cost

of operation, maintenance and repairs would be reduced to approximately the following:

Approx. Date,	1937	1947	1960
Northerly treatment plant,	$227,000	$316,000	$477,000
Southerly treatment plant and remote plants and pumping stations,	222,000	246,000	280,000
Trunk sewer and river inspection,	106,000	106,000	120,000
Total annual cost of operation, maintenance and repairs, without Bayonne,	$555,000	$668,000	$877,000

XXIII.—RELATION BETWEEN PRELIMINARY AND PROJECT REPORTS.

The data given in this preliminary report are for the purpose of making estimates of cost for trunk sewers, pumping stations and treatment plants and all their appurtenances so as to arrive at the amount of needed investments in a way which will be clearly understandable for purposes of financing.

When this undertaking gets under way under the administration of the Commission dealing with construction, one of the first steps which will be required is to prepare a comprehensive project report and plan which will make more definite the methods and various details of the undertaking than is at the present time either necessary or feasible with the time and money available.

As discussed in connection with sewage treatment arrangements, it is the intention of this report to show clearly and frankly the plan and scope of undertakings that are worthy of consideration and to base estimates of cost upon methods having known records of satisfactory performance, and of known cost for both construction and operation.

At the same time it is considered unwise to close doors against improvements now considered promising as being developed at a number of places; but it is considered best to take up such matters later in a project report and adopt them if it is found that they would give satisfactory service at less cost than the undertakings adopted for the purpose of preparing the estimates given in this report.

XXIV.—DISPOSAL OF SEWAGE WHICH NATURALLY DRAINS INTO THE HUDSON RIVER.

Disposal of Sewage Originating North of Fort Lee That Naturally Drains Into the Hudson

The municipalities north of Fort Lee along the Palisades naturally drain partly to the Hackensack and partly to the Hudson River. Since this report relates only to the Hackensack Valley District, we have considered only the population actually within the drainage area of the Hackensack, in making estimates of cost and capacities of the northerly and southerly sewerage systems. However, due to the nature of the ground, sewage from those areas which naturally drain into the Hudson could readily be pumped over the divide and connected to the northerly sewerage system of the District. This would result in increasing the needed capacity of the system by approximately 4,000 people in 1947 and 8,000 in 1960. This is an increase of approximately 1 per cent. of the 1947 and 1¼ per cent. of the 1960 load.

Disposal of Sewage Originating South of Englewood Cliffs That Naturally Drains Into the Hudson

From Englewood Cliffs south the municipalities that naturally drain partly into the Hackensack and partly into the Hudson River are now sewered along their easterly slopes into the Hudson. Unlike the case of the municipalities north of Fort Lee, it is difficult to take this sewage over the divide to the Hackensack Valley. This is due to the fact that these municipalities either border on the Hudson River or extend far down the east slope of the Palisades. Therefore the cost of pumping this sewage over the divide into the Hackensack Valley would be very expensive.

It is not to be expected that any of these municipalities will take care of their sewage in any other way than they are now doing unless the Tri-State Anti-Pollution Commission through its future regulations shall make it prohibitive to discharge untreated sewage into the Hudson River.

In the future, if and when this should occur, it would be possible to build a trunk sewer from Fort Lee toward the south to intercept the sewage of the eastern slopes of all the municipalities that drain into both watersheds, and also that of Edgewater, Weehawken and Hoboken, and to take this sewage south ot the Old Morris Canal cut. The sewage originating on the east slope of Bayonne south of the canal could also be brought north to the same point. From this point the combined flow could be pumped through a force main laid in the channel of the Old Morris Canal to an addition to the southerly treatment plant now proposed, and the purified effluent discharged into the Hackensack River or into Newark Bay.

XXV.—SUMMARY AND CONCLUSIONS.

Description of Project

This report deals with the engineering aspects of the problem set forth under the Act creating the Hackensack Valley Sewerage District, whereby the Commission was instructed to make comprehensive studies and report its findings as to the most economical and practicable program for relieving and preventing present and future pollution by collection and treatment of sewage of the entire District, which comprises all that portion of Bergen and Hudson counties lying between Newark Bay and the New Jersey-New York boundary line, within the natural drainage area of the Hackensack River.

Although Bayonne is not mentioned in the Act, pollution from the west portion, which drains into Newark Bay, is carried up stream into the lower Hackensack River and therefore this portion has been considered as a part of the District.

The boundary lines of the District and of the 57 municipalities wholly or partly within the District are shown on Map 2. Table V. shows total areas, meadow lands, population and density of population per square mile for the entire Hackensack Valley, for the District as defined in the Act and for certain portions of the Valley.

APPENDIX ONE
TABLE V.
HACKENSACK RIVER VALLEY AREAS AND POPULATIONS

	Area	Population in Thousands				Population Density per Square Mile			
	Sq. Mi.	1930	1937	1947	1960	1930	1937	1947	1960
Total drainage area above Newark Bay	208.0	480	607	706	932	2310	2920	3400	4480
Total Drainage area above Newark Bay plus that of Bayonne	209.2	504	633	735	963	2410	3030	3500	4600
Drainage area above Newark Bay and in New Jersey (District as defined by Act)	145.6	456	581	671	887	3130	3980	4600	6900
Drainage area of District, plus that of Bayonne	146.8	480	607	700	918	3270	4130	4770	6250
Total drainage area above New Milford Dam	115.0	58	66	88	141	504	574	765	1125
Drainage area above New Milford Dam and within New Jersey	52.6	34	41	53	96	646	780	1050	1825
Drainage area below New Milford Dam and above Newark Bay	93.0	422	538	618	791	4540	5790	6650	8500
Drainage area below New Milford Dam, plus that of Bayonne	94.2	446	567	647	822	4730	6020	6890	8740
Total Meadow land	36.1*								
Meadow in Bergen Co.	20.3								
Meadow land in Hudson Co.	15.8								

* One square mile of this area is above New Milford Dam.

Pollution of the Hackensack River and the Need for Eliminating It

The problem divides itself into two portions, one relating to the watershed above the New Milford Dam, now used as a source of potable water supply for the greater part of Bergen and for a portion of Hudson County, and the other to the lower tidal portions of the river and its branches below the New Milford Dam.

Due to the activity of the Hackensack Water Company, coordinating with the state departments of health of New Jersey and New York, pollution of the Hackensack River and its tributaries above the New Milford Dam does not at present, cause objectionable results. However, there are several individual municipalities in this area whose growth is retarded due to their inability to construct sewers without the necessity for extremely expensive treatment methods or long and costly outfall sewers to carry the effluents below New Milford Dam or to some other point outside the drainage area.

In the tidal area below New Milford Dam, offensive putrefactive conditions with objectionable odors are found, due in part to present continuing pollution, and in part to the effect of sewage sludge accumulated for years. These conditions which arise largely from the discharge of domestic sewage into the river and its branches and to some extent from the discharge of certain industrial wastes, are well set forth in Appendix Two, the Report of Richard C. Smith, Chemist and Bacteriologist.

The existing pollution, particularly between New Milford and an easterly and westerly line drawn through North Bergen, has not been adequately taken care of by some 40 individual sewage treatment plants, some of which are wholly inadequate in capacity or degree of treatment or both. Below this line sewage from Jersey City, Bayonne and other municipalities is discharged without treatment into the Hackensack River and adjacent parts of Newark Bay.

Another phase of the problem relates to pollution of the river from New Milford to and through the City of Hackensack where conditions now show serious detraction from those necessary for a clean waterway suitable for recreational use and the development of parks and where increasing pollution will seriously affect real estate values.

It has been the almost universal experience throughout the world that difficulties, delays, enormous increase in expense and other unfortunate consequences have attended failure to take steps in time for remedying pollution such as found in the tidal portions of the Hackensack River and its branches.

Unquestionably there is a genuine need at this time for removing the possibility of pollution from a growing population on the watershed above the New Milford Dam, for providing suitable outfall sewers for munici-

palities that need sewerage facilities in this area and for remedying the existing pollution below New Milford Dam.

Arrangement of Trunk Sewers and Treatment Plants

The topography of the valley, the distribution of the population and the uses made of the water of the river show conclusively that the best arrangement for collecting and treating the sewage of the District is to provide two separate systems. One system is located almost wholly in Bergen County and the other in Hudson County. Each system comprises trunk sewers, a pumping station and a treatment plant. This arrangement is shown on Map 4.

Such an arrangement provides suitably for all needs at minimum expense. It removes all sewage from that portion of the valley which supplies potable water. Trunk sewers are reduced to reasonable lengths and depths, thereby keeping sizes of sewers, quantities of excavations and pumping lifts at a minimum. Each treatment plant is sufficiently large so that it can be operated as efficiently and at practically as low a cost as a single plant of their combined capacity.

In addition there will be required a few separate plants to serve areas which are so remote from the trunk sewers that their construction rather than that of long branches to the trunk sewer system is warranted.

The objections to several treatment plants each serving a group of municipalities and to a single system for the entire District has been covered in detail previously in this report.

Sites for District Treatment Plants

No treatment plant should be located north of Little Ferry. For the northerly plant a suitable location is close to the river somewhat south of where Overpeck Creek joins it; and for the southerly plant in the vicinity of Droyers Point, in Jersey City, a short distance north of the Bayonne line.

Activated Sludge Method of Treatment of Sewage

Conditions encountered in the Hackensack Valley make it advisable to provide for so-called complete treatment of the sewage; that is, for the removal of 90 per cent. or more of the suspended solids and of the organic matter contained in the sewage, as well as of 95 to 98 per cent. of the objectionable bacteria. For this purpose the activated sludge process is the most suitable, and is the method adopted at Chicago, Milwaukee, Indianapolis, New York City and many smaller American cities, and for a number of large cities in Europe. In estimating costs we have assumed that the activated sludge process will be adopted.

Disposal of Sludge

The Hackensack River has insufficient draft for the advantageous use of sludge vessels of the ocean-going oil tanker type suitable for the delivery of sludge in all weathers at an adequate distance from shore and the manufacturing of fertilizer is not advantageous due to unfavorabe market conditions. Hence it is necessary to resort to other methods than those ordinarily considered for large seaport cities.

The most satisfactory demonstrated process for sludge disposal comprises the digestion of the sludge in tanks heated in cool weather by using gas collected from the sludge during digestion and followed by drying beds upon which the rotted and inodorous solid matter is separated from the water. Marked improvements in sludge digestion procedures have been developed recently at various plants in this country and the method can be relied upon as satisfactorily workable.

At half a dozen cities active consideration is now being given to the use of vacuum fiters and incinerators for dewatering and burning sludge. But the data now available are insufficient to justify basing our estimates upon this method alone for the disposal of sludge. However we believe that dewatering by filtration followed by incineration will prove thoroughly practicable and somewhat preferable to the digestion process as to complete disposal of organic matter and that the cost of this method may be somewhat lower for installation and with the cost for operation, maintenance and repairs little if any more than by sludge digestion and drying beds.

Basic Data for Treatment Plants

In determining the capacities of the component parts of the treatment plants, the following basic data have been used:

	Northerly plant	Southerly plant
Tributary population, 1947,	391,600	284,750
Tributary sewer systems,	Mostly separate	combined
Ave. sewage flow, gals. per cap. daily,	115	120
Ave. sewage flow, million gals. daily, 1947,	45	34
Prelim. sedimentation tanks, ave. hours detention,	1.0	1.0
Aeration tanks, ave. hours detention,	5.6	5.6
Reaeration tanks, ave. hours detention for 25% returned sludge,	4.0	4.0

Final tanks, ave. hours detention,	3.0	3.0
Sludge digestion tanks, cu. ft. per cap.,	3.0	4.0
Sludge storage tanks, cu. ft. per cap.,	2.1	2.8
Sludge drying beds, sq. ft. per cap.,	0.6	0.8
Ave. air used, cu. ft. per gal.,	1.0	1.0

Alternative Methods

The Laughlin Process has been considered as an alternate method of sewage treatment especially for the Southerly Plant, and working results from the plant now being constructed at Dearborn, Mich., should be investigation when this project is developed to the designing stage. For present purposes it is wisest to arrange financing on the basis of the activated sludge process as above summarized.

General Information in Regard to Proposed Sewerage Systems for the Hackensack Valley

The following table gives for the whole District the estimated connected population, average daily sewage flow and daily power consumption for the years 1947 and 1960. This table also gives the miles of trunk sewers and the total construction costs of trunk sewers, treatment works, pumping stations and all appurtenances, including engineering but not including land and rights of way to meet the needs of 1947 and 1960. These construction costs are also given in terms of average daily 1947 and 1960 flows and connected populations.

	1947	1960
Connected populations,	676,350	899,700
Average sewage flow, million gallons daily,	82.4	113.2
Miles of sewers,	60	84
Power consumption in kilowatt hours daily,	61,500	82,000
Cost of trunk sewers,	$ 7,371,000	$ 8,832,000
Cost of treatment plants, and pumping stations,	$ 9,555,000	$12,480,000
Cost of trunk sewers per million gal. daily ave. flow,	$ 89,000	$ 78,000

Cost of treatment plants and pumping stations per million gal. daily ave. flow,	$ 116,000	$ 110,000
Cost of trunk sewers per capita (connected population)	$10.90	$9.80
Cost of treatment plants and pumping stations per capita (connected population)	$14.10	$13.90

Construction Costs

The prices used in this report for estimating construction costs are those which prevailed during 1929. Present prices are much lower. It is not possible to predict what they may be during the construction period, but they should be less than 1929 prices. The estimates of cost represent a fully completed system.

Cost of Operation, Maintenance and Repairs

Average estimated costs of operation, maintenance and repairs for the entire District per million gallons of sewage treated are $24.40 and $22.60, respectively, for the periods 1937-47 and 1947-1960; and similarly, the annual costs per capita are $1.06 and $1.02. These costs include river pollution inspection, but do not include general expenses that would be incurred by the Commission for legal, clerical and other administrative purposes.

Recommendations

To remedy the serious and increasing nuisances and menaces to health due to pollution of the Hackensack River, to provide badly needed outlet and treatment facilities for unsewered areas and to avoid the costly, ineffective and haphazard development inevitable with uncoordinated independent activities of the separate municipalities, we recommend the immediate construction of the following comprehensive program of improvement:

(a) The construction of two comprehensive systems of trunk sewers, pumping stations and sewage treatment plants, a northerly system and a southerly system, with the respective treatment sites and trunk sewers located approximately as shown in full lines upon Map 4; all to be completed by 1937.

(b) Trunk sewers, because not capable of ready expansion, to be built during the initial stage to meet needs of 1960, treatment plants, which can readily be expanded to meet the 1947 needs.

(c) Financing of the 1932-37 program to be based on an estimated

construction cost of $20,000,000 and an average annual maintenance, operation and repair cost during the years 1937-47 of $650,000.

(d) Enlargements to be made during 1944-47 to meet needs to 1960 or later, at an estimated construction cost of $4,400,000, increasing the average annual operation, maintenance and repair cost during the years 1947-1960 to approximately $800,000.

Status of Project, 1932-37

Assuming that legislation is enacted early in 1932 so as to enable the project to be constructed, design can be started and a large part of the necessary land and rights of way acquired during that year. Construction can then be started during 1933 and that part of the project sufficient to meet the needs of the District to 1947 should be ready for operation by the middle of 1937.

Very truly yours,

S. WOOD MCCLAVE,
GEORGE W. FULLER.

PASSAIC COUNTY
HUDSON
RIVER

MAP I



PLAN SHOWING WATERSHED
FOR
POTABLE WATER SUPPLY
IN THE
HACKENSACK RIVER DRAINAGE AREA
BERGEN AND HUDSON COUNTIES, N. J.
ROCKLAND COUNTY, N.Y.
HACKENSACK VALLEY SEWERAGE COMMISSION.

COMMISSIONERS

WILLIAM R. SMITH — HORACE R. BOGLE
GUSTAVE MEYER — THOMAS F. BOWE
THOMAS J. WASSER

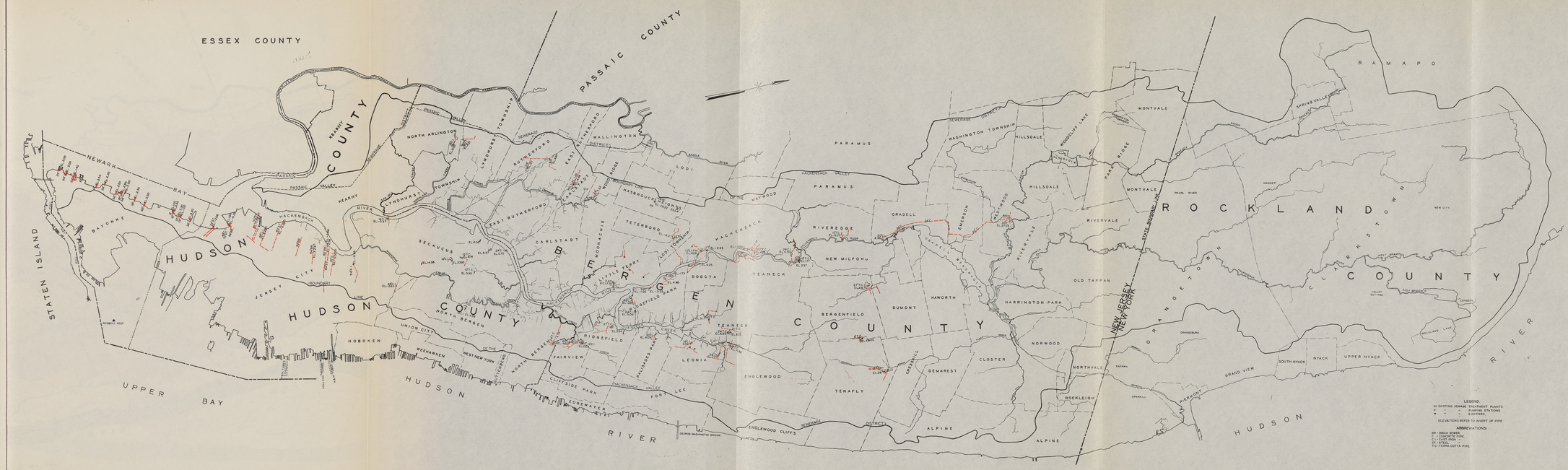
ENGINEERS

S. WOOD McCLAVE — GEORGE W. FULLER

SCALE:
THOUSAND FEET

SEPTEMBER 1931.

MAP 2



LEGEND

XX EXISTING SEWAGE TREATMENT PLANTS
● - PUMPING STATIONS
■ - EJECTORS

ELEVATIONS REFER TO INVERT OF PIPE

ABBREVIATIONS:

BR-BRICK SEWER
C - CONCRETE PIPE
CI - CAST IRON "
ST-STEEL "
TC-TERRA COTTA PIPE

U.S. GEOLOGICAL SURVEY DATUM

PLAN SHOWING ELEVATIONS FOR PORTIONS OF EXISTING SEWERAGE SYSTEMS IN THE HACKENSACK RIVER DRAINAGE AREA

BERGEN AND HUDSON COUNTIES, N. J.
ROCKLAND COUNTY, N. Y.

HACKENSACK VALLEY SEWERAGE COMMISSION.

COMMISSIONERS

WILLIAM R. SMITH — HORACE R. BOGLE
GUSTAVE MEYER — THOMAS F. BOWE
THOMAS J. WASER

ENGINEERS

S. WOOD McCLAVE — GEORGE W. FULLER

SCALE

1 0 1 2 3 4 5 6 7 8

SEPTEMBER 1934



PLAN SHOWING DENSITY OF POPULATION
PER SQUARE MILE FOR 1930
IN THE
HACKENSACK RIVER DRAINAGE AREA
BERGEN AND HUDSON COUNTIES, N. J.
ROCKLAND COUNTY, N.Y.
HACKENSACK VALLEY SEWERAGE COMMISSION.

LEGEND
AN EXISTING SEWAGE TREATMENT PLANTS
PROPOSED " " "
A,B,C,D,E,F,G,

DENSITY OF POPULATION PER SQUARE MILE FOR 1930
- BELOW 1000
- 1000 TO 5000
- 5000 TO 10000
- OVER 10000
- MEADOW AREA

COMMISSIONERS

WILLIAM R. SMITH — HORACE R. BOGLE
GUSTAVE MEYER — THOMAS F. BOYLE
THOMAS J. WASSER

ENGINEERS

S. WOOD McCLAVE — GEORGE W. FULLER

SCALE
THOUSAND FEET

SEPTEMBER 1931.



PLAN SHOWING NORTHERLY AND SOUTHERLY
TRUNK SEWER SYSTEMS
IN THE
HACKENSACK RIVER DRAINAGE AREA
BERGEN AND HUDSON COUNTIES, N. J.
ROCKLAND COUNTY, N.Y.
HACKENSACK VALLEY SEWERAGE COMMISSION.

COMMISSIONERS

WILLIAM R. SMITH — HORACE R. BOGLE
GUSTAVE MEYER — THOMAS F. BOWE
THOMAS J. WASSER

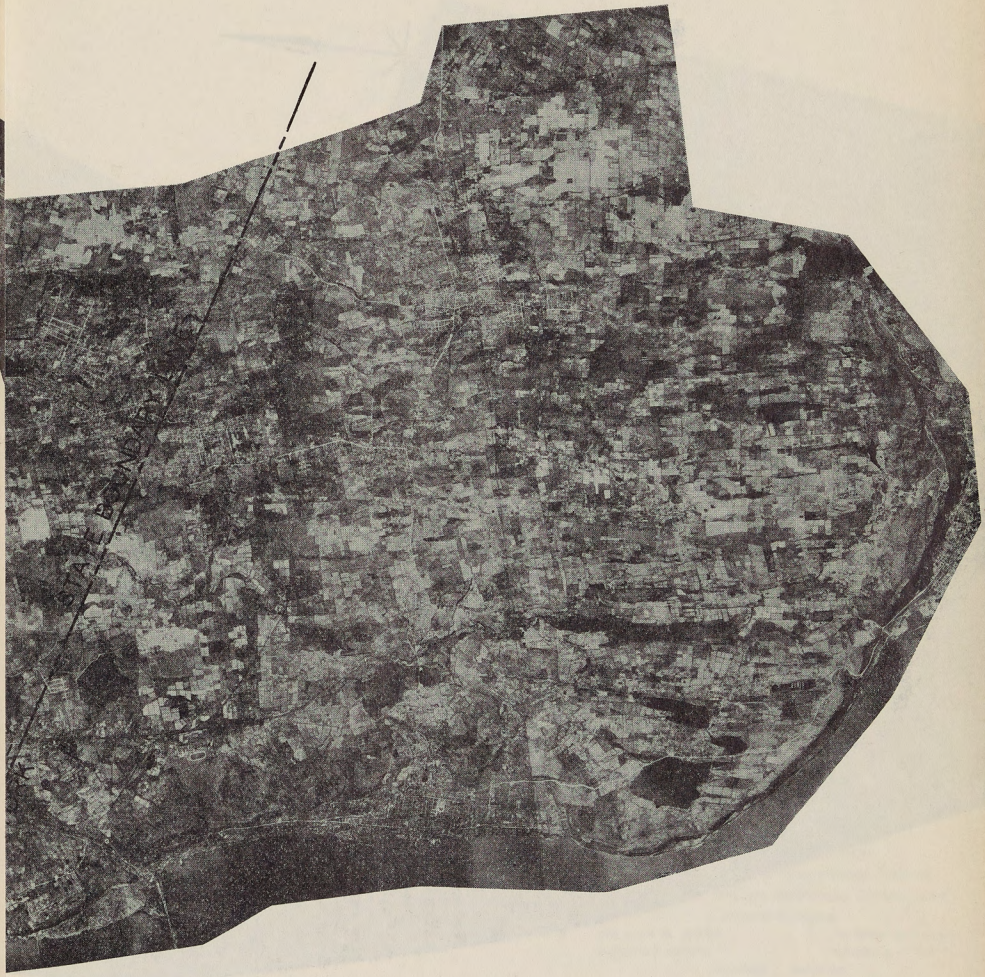
ENGINEERS

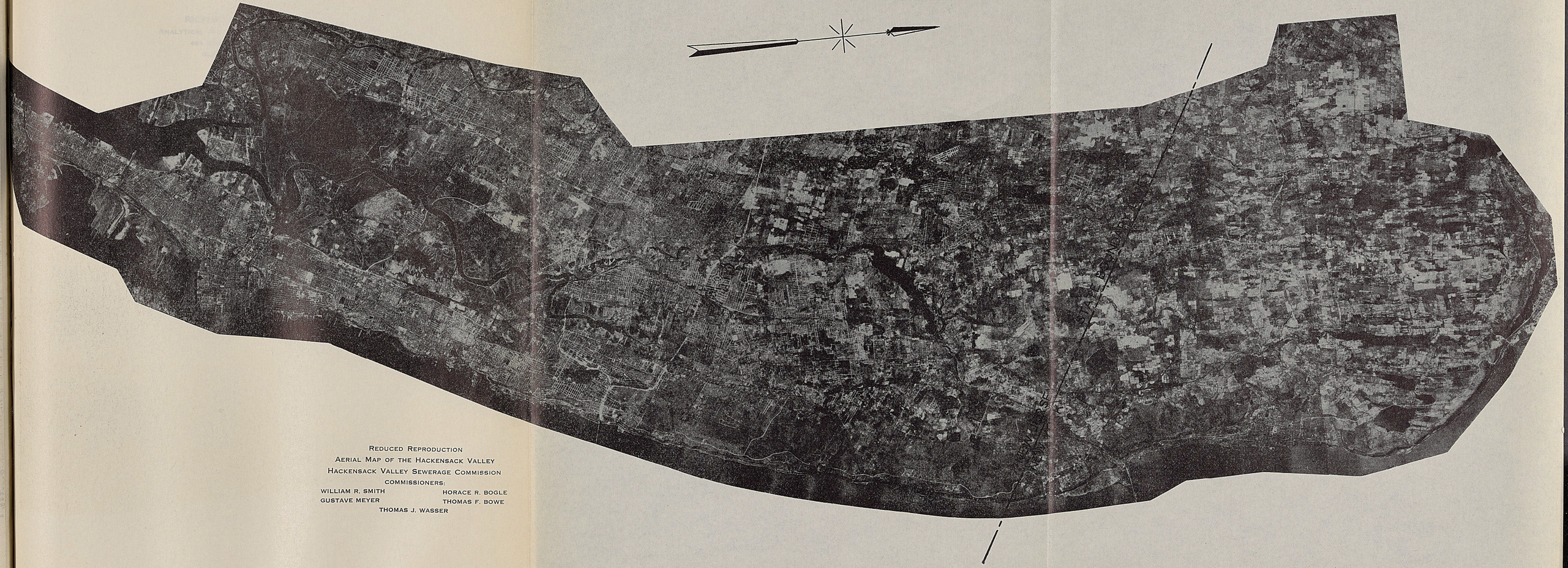
S. WOOD McCLAVE — GEORGE W. FULLER

SCALE
THOUSAND FEET

SEPTEMBER 1931

ESSEX COUNTY
NEWARK
BAY
HUDSON
STATEN ISLAND
UPPER
BAY


STATE BOUNDARY



Reduced Reproduction
Aerial Map of the Hackensack Valley
Hackensack Valley Sewerage Commission
commissioners:
WILLIAM R. SMITH — HORACE R. BOGLE
GUSTAVE MEYER — THOMAS F. BOWE
THOMAS J. WASSER

REDUCED RE-PRODUCTION
AERIAL MAP OF THE HACKENSACK VALLEY
HACKENSACK VALLEY SEWERAGE COMMISSION
COMMISSIONERS:
WILLIAM R. SMITH HORACE R. BOGLE
GUSTAVE MEYER THOMAS F. BOWE
THOMAS J. WASSER

HACKENSACK VALLEY SEWERAGE COMMISSION

RICHARD C. SMITH
ANALYTICAL AND CONSULTING CHEMIST
463 BELLEVILLE AVENUE
GLEN RIDGE, N. J.

December 1, 1931.

The Hackensack Valley Sewerage Commissioners,
Tenafly, N. J.

Gentlemen:—

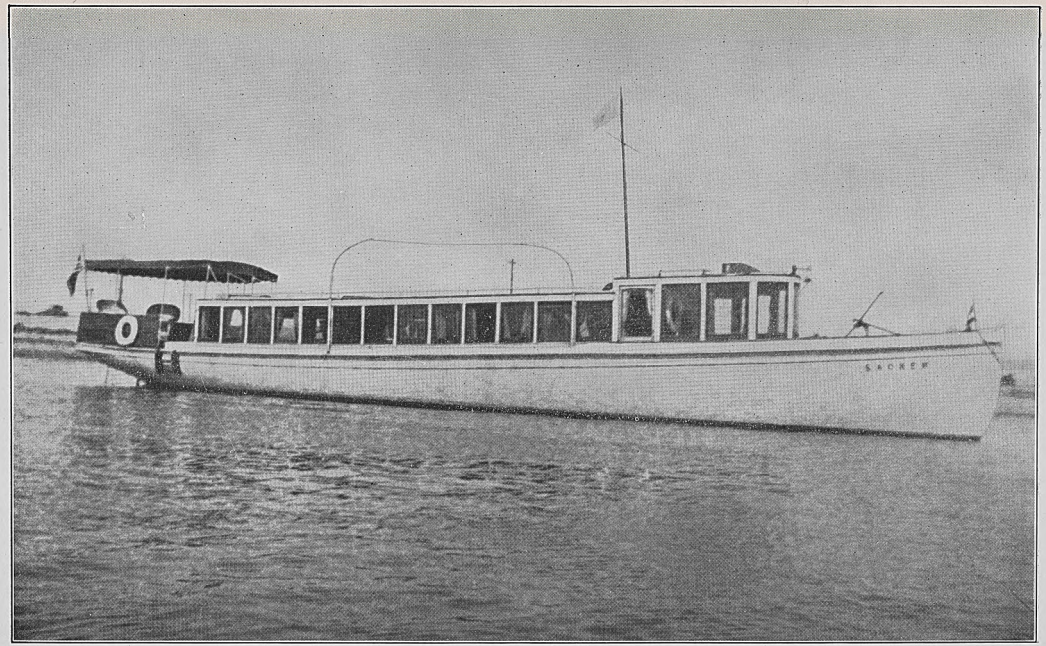
I have the honor of submitting to you herewith a report on the chemical and bacteriological survey of the condition of the Hackensack River, some of its tributaries and partly of Newark Bay.

The numerous examinations and analyses are submitted as averaged results, being less unwieldy and more easy of comparison.

To avoid breaking the continuity of the report the tables of data and the charts of the graphic plottings of the results are placed at the back of the report.

Respectfully submitted,

RICHARD C. SMITH.



PHOTOGRAPH K.

SHOWS FLOATING LABORATORY "SACHEM".

CHEMICAL AND BACTERIOLOGICAL SURVEY OF THE HACKENSACK RIVER 1931

Introductory

Rising in New York State and safeguarded in a potable watershed, the Hackensack River enters New Jersey and continues under protected conditions with some of its tributaries into the reservoir at Oradell, N. J. Until it has passed the dam below the reservoir at New Milford, where it comes within the sphere of tidal influence, the stream is not befouled by pollution.

Below the dam, the situation begins to take on a different aspect, for contamination soon begins, and the river in its course to Newark Bay receives successive increments of pollution carried into it by some of its lower tributaries, open ditches, and sewers.

From Oradell dam down to North Bergen the pollution is mostly of sewage which has received some treatment, not nearly approaching complete purification, in many instances the discharged liquids not differing much from raw sewage. Industrial wastes add their burden to the river, the most important of these being paper-board, dyeing and bleaching, laundry and chemical process wastes.

South of North Bergen the pollution received by the river is largely of municipal sewage which has not had any form of treatment applied, the sewage discharging directly to the river through sewers, open ditches and creeks.

Some of the effects of this pollution may be observed in the turbidity of the river water; the unpleasant odors arising from the water at times; the suspended fine particles, partly of sewage origin; bubbles of gas rising briskly from the foul carpet of black mud decomposing on the river bottom; the formation of mud flats, gassing with disagreeable odors when exposed by the receding waters; floating clumps of gross solids of sewage origin; dead fish floating, sometimes in large groups; greasy scums derived from soaps floating on the water; oil films and scums of tar.

Not always are the pollutional effects so outwardly apparent in the Hackensack, but under the closer scrutiny of laboratory tests the defilement of the river is revealed as evident at New Milford, becoming generally more intense downstream to the mouth, as measured by the numbers of bacteria of kinds usually associated with human filth and sewage. In these waters, liable to carry disease germs from the contained sewage,

many people swim apparently in ignorance of the dangers of infection, when the weather is warm.

In addition to the health hazards indicated by the presence of numerous bacteria in the river, a menace to property values and future development along the valley lies back of the warning of the dissolved Oxygen figures which show that the natural dissolved Oxygen reserve of the river has been heavily depleted to a point beyond which not much safety lies. The Oxygen balance is the insurance against intolerable nuisance developing from the river and if this balance is entirely destroyed by increasing pollution or shrinkage of flow, the stream, instead of being an asset, will become a serious liability.

The accumulated effects of the pollution are mostly evident in the lower river between the City of Hackensack and the river mouth, the wastes, slowly decomposing in the stream, being swung back and forth on the successive tides, escape from the river not being complete on the ebb, and the flood backing up and returning, much of the degenerated water.

The incoming flood tides, while offering more dilution, do not refresh the lower river as much as might be expected because the Oxygen in the flood tide water, which the polluted river badly needs, has been considerably depleted in Newark Bay by the sewage from sewers along its borders, and partly also by the sewage continually pouring into the Hackensack River near its mouth.

The lower Hackensack is an unclean river, over-burdened with pollution which it is unable to assimilate, the situation being aggravated by the oscillation of the tides.

Sampling Stations and Methods

For the purpose of obtaining information regarding the condition of the Hackensack River, and to determine in what degree the stream was suffering from the effects of the pollution burden imposed upon it, samples of the water were frequently taken and submitted to certain chemical and bacteriological tests.

So that an average view of the situation should be obtained, the sampling was conducted at fairly regular intervals from April 15 to October 1, 1931, thus including variations in tide and weather, factors which greatly influence the data collected in an investigation of this kind.

Sampling was carried out at points or stations selected to show the effect of successive increments of pollution and also to allow of convenient access. The territory covered was extensive, stretching from the New York State line to the end of Newark Bay on the main stream, with the addition of some points on the more important tributaries. The stations on the upper portions of the river were reached by automobile, the lower stretches and the bay being sampled from boats. The

sampling stations are described in Table 1 and are also plotted at their relative distances on the charts. Tables and charts of analytical results are attached at the end of this report.

Coincident with the collection of samples such observations as the physical appearance of the water, time, temperature, state of tide, occurrence of odor, etc., were made. The dissolved Oxygen analyses and the determinations of chloride in the water were completed promptly in the field, the necessary chemical solutions and apparatus being carried on the trips. Bacteriological samples were kept chilled in a portable refrigerator and promptly plated for incubation after arrival in the laboratory, usually within three hours of taking.

All the analytical results and averages are based on samples taken approximately at midstream. No cross sections of the river were made in sampling. Higher bacteria and lower Oxygen would possibly be the result on samples taken close to shore because the sewage discharging from sewers at the river edge tends to cling to the banks on ebb tide.

At slack water which occurs between each tide change, and on flood tides, the sewage is pushed out more to the middle, and the tidal changes which occur about every six hours assist in bringing about intermingling of the waters. No samples were taken in direct and visible sewage streams so the figures are of average water conditions in the river.

Hackensack River in Two Classifications

The Hackensack River falls readily into two classifications in a survey of its chemical and bacteriological qualities. Above the dam at New Milford it is not tidal and is within a watershed for potable supply protected by stringent regulations.

Below the dam, the river is tidal and the dam is considered a division between the clean, non-tidal upper portion and the lower tidal section which becomes defiled by pollution.

Upper Hackensack a Clean Stream

The sanitary quality of the upper section of the river is used here as a basis for comparison in the features shown in the analyses of the river water at the different sampling stations and it is necessary to keep this in mind through all the discussion which follows.

Samples were taken frequently on the main stream below the State line and above the Oradell Reservoir. This point is used as the example of a clean stream and is described on the analytical data charts as Old Tappan. There are other tributary streams joining the main stream into the reservoir. Occasional samples were taken at various points on these tributaries which indicate the generally good quality of the water. These tributaries do not appear in the charts of comparative data.

The appearance of the water and the clean river bed, low solids, low

organic matter, low bacteria, low B. Coli, and high Oxygen dissolved, sufficiently establish the purity of the water and indicate that the upper Hackensack is a clean stream not defiled by sewage.

Significance of the Oxygen Dissolved in the Water

Because the assimilation of organic pollution within a stream takes place at the expense of the Oxygen which is naturally dissolved in the river water, and further, since the disappearance of the Oxygen in being used up in the decomposition causes the inoffensive assimilation to become unpleasant putrefaction, frequent measurement of the dissolved Oxygen is a ready index for judging the condition of a stream as to whether it is handling satisfactorily the pollution load, or if danger of nuisance from putrefaction is imminent or remote.

Surface waters when free from pollution are ordinarily found to be well saturated with Oxygen obtained from the atmosphere by absorption. When such waters receive organic pollution as by sewage, there commence natural processes of resolving the complex organic matter into more simple and stable compounds. These assimilative processes are carried out by bacterial agencies which utilize the Oxygen dissolved in the water.

Pollution therefore causes a depression in the Oxygen content of the water but if the pollution is not too heavy in proportion to the dilution offered, or there is opportunity for a long period of flow before more pollution is added, when the assimilation has proceeded fully the Oxygen will begin to increase again to normal.

If the points of pollution are too close together and the river has not the necessary length of flow to allow itself to rehabilitate in Oxygen, the capacity of the stream for self-purification is lost.

The decomposition must proceed and the breaking down of the organic matter, when the dissolved Oxygen has disappeared, continues by other methods accompanied by the evolution of foul odors and commonly called putrefaction.

Particles of solid sewage material, suspended in the water and subsiding along the river bed or forming banks of sludge, also use up Oxygen from the water in contact with them.

Dissolved Oxygen in the Hackensack River

Many determinations of residual dissolved Oxygen were made on the Hackensack River in samples from various depths and on different tides.

The amount of dissolved Oxygen existing at a given point in the stream is not a fixed quantity. There is usually variation to be noted from hour to hour or day to day because of water movement, temperature, weather changes, etc. A tabulation of the numerous individual determina-

tions makes an unwieldy mass of figures difficult to interpret, and as it is a general assessment of conditions which is desired, the analyses are averaged to allow of easier handling and more simple comparison.

In these averages the inequalities are levelled out and in viewing the average picture it must be remembered that on some days conditions are better and on others much worse, than indicated in this mean. Such averages relating to the Hackensack River and Newark Bay are to be found in Tables 2 and 3, and plotted graphically in Chart 1.

The heavy line in Chart 1 gives a very broad view of average Oxygen content over all conditions throughout the period between April 15 and October 1, 1931. A gradual decline in the integrity of the river is shown from New Milford to North Hackensack which is followed by a marked slump below the City of Hackensack, from which point the river does not show much recovery until just above the mouth where the influence of dilution from Newark Bay tides is appreciable. This line shows in a general way that great inroads have been made into the Oxygen supply of the river and that after reaching Hackensack a marked pollution load is evident in the stream.

Dissolved Oxygen During Warm Months in Hackensack River

In cold weather a stream can stand the strain of pollution much better than in the warm months mainly because cold water can hold more Oxygen in solution and the bacterial activities which carry on the decomposition are restrained.

In summer temperatures the bacterial activities are stimulated, decomposition proceeds more rapidly and consequently a hastening of the using up of the available Oxygen is the penalty. Unfortunately, when the river most needs a generous Oxygen supply, it is not available because water at summer temperatures can only dissolve about half the amount of Oxygen as can water at winter temperatures. Further deprivation of Oxygen supply is usually working against the river in decreased dry weather flow, the dilution being reduced and the volume of pollution remaining the same. In summer time therefore, most of the factors are the reverse of helpful to a polluted river, the Oxygen situation is more critical and the danger of odor formation more pronounced.

Because the conditions are more critical and the effects more acute it is of importance to scrutinize the summer Oxygen content.

In this investigation on the Hackensack River no winter examinations were made but the figures of the warmer months of June, July, and August have been separately averaged and plotted on Chart 1.

It is to be noted that the average summer line is generally lower than that for the whole period and shows that the trend of the river to lower Oxygen content is somewhat more marked from Hackensack almost to the mouth.

The Lowest Oxygen Figures Encountered on the Hackensack River

The general average Oxygen of the summer months, while indicating serious attacks upon the integrity of the river by the pollution, is still an average in which many inequalities are smoothed out and in which some of the significance of how badly the river may degenerate is lost.

During the summer it was observed in making the tests that several times the Oxygen was declining to very low content in the river during dry warm periods and that after rains, which were somewhat frequent and heavy, the Oxygen was increased. This of course is to be expected but it results in a higher summer Oxygen average in a wet season than would be the case in a dry summer of low river flow.

If then, the lowest Oxygen contents or worst conditions encountered are considered, a more critical measure of the effects of the pollution is made available.

Referring to Chart 1 again, the lowest line on the graph plots the minimum Oxygen encountered during the investigation at the several sampling points, and it is demonstrated that the Oxygen descended to dangerously low levels. The significance lies in the fact that at times the Oxygen supply was nearly exhausted and had the river not been relieved by rains, conditions were ripe for the establishment of offensive and widespread nuisance.

Tides Intensify Pollution Effects in Lower Hackensack River

Further interpretation of the Oxygen figures reveals that the harmful effects of the pollution are intensified in the lower Hackensack and are spread again upstream because of tidal interference with the flow.

When the ebb tide is well under way, the river is flowing for a few hours in its normal direction to the sea. All the polluting matter is being carried downstream away from the successive points of entry and if the river continually flowed in this direction, downstream points would suffer from the effects of upstream pollution. Reversal of tidal currents brings back much of the pollution damage to the vicinity of the original offense.

Referring to Chart 2, the heavy unbroken line represents the average Oxygen content of the river over almost six months during 1931 on ebb tides. The more important entrances of pollution are indicated on the chart at their relative distances on the course of the river.

In following this line it is seen that from North Hackensack to Little Ferry the river has suffered a serious decline, hastened apparently after receipt of Hackensack sewage and the voluminous paper mill wastes from Bogota.

Proceeding downstream, in spite of the entry of three heavily polluted creeks the general trend of the line seems to show recovery even after the setbacks indicated by the dents following the inflow of Berry's

Creek Canal and the foul contributions of Penhorne Creek. Newark Bay also experiences a jolt from the Jersey City and Bayonne sewers.

This appearance of improvement in the quality of the water is deceptive because, though the river is growing in volume from the addition of the tributary flows, fresh increments of pollution are being poured in, and in the relatively short distance of flow this pollution has not had time to rob the river of its Oxygen.

The decomposition of the wastes in the river continues without cessation and as the tide reverses, the water is pushed back in the river, using up Oxygen all the time, together with pollution from downstream which also takes toll from points above its origination.

The volume of water passing out on the ebb is greater than that returning on the flood otherwise there would be no escape for the run-off of the river, but there is no complete flushing on each ebb tide and the net result of the two ebbs and two floods in each twenty-four hours is a restraint within the river and zones of accumulated pollution swinging back and forth.

The broken line in Chart 2 represents the Oxygen averages of the returning flood currents, and from the mouth in an upstream direction the depletion is rapid and severe. At the sampling station marked Kopper's Coke plant (so described as a convenience for locating the point only), the decline in Oxygen is very marked on the flood tides, resulting probably from the concentration of the pollution effects of the local sewers and Penhorne Creek. The depression in the line at Erie Main Line Bridge is a setback due at least in part, to Berry's, Paunpeck, Bellman's and Overpeck Creeks.

Between Little Ferry and the Kopper's plant, great inroads are made into the Oxygen supply on flood tides, and here the greatest burden appears to be borne by the river, indicating the extent of the zone of the accumulated pollution oscillating on the tides.

Little Ferry appears to be a point which receives the largest burden on the ebb tides from pollution above, and derives no benefit on either tidal current. It is shown in the chart as also suffering the adverse effects of the aforementioned zone of pollution concentration from downstream on flood currents, and appears further to be at the beginning of another smaller zone of backward intensification of pollution effect which extends upstream to North Hackensack on flood tidal directions.

These areas of pollution accumulation which are indicated in the average Oxygen conditions (not the worst conditions encountered), over a period of six months, point a warning of a danger zone in the river between the City of Hackensack and approximately the Newark Turnpike bridge, where the river is so overloaded with pollution that it may easily succumb to the strain.

A complete breakdown in the river would cause in this area intolerable

nuisance by the evolution of malodorous gases which, besides being a source of discomfort and possible menace to health, would damage and discolor the paint work on property.

Demand for Oxygen Is Not Satisfied in Lower Hackensack River

The determinations of the residual dissolved Oxygen measure the state of the river after the pollution has exerted its effect under practical conditions of water movement. It does not indicate whether there is a further demand for Oxygen not yet satisfied from fresh increments of pollution or where the time factor has not had full sway.

Some indications of this are to be found in the preceding section where the ebb currents, known to be heavily polluted, had not yet had time to show a great Oxygen depletion, but the returning flood currents showed great depletion having had more time to allow of decomposition.

The full Oxygen demand had not been satisfied in the returning depleted water as was shown by incubated samples in sealed bottles. In most cases such samples exhausted the Oxygen remaining in them, usually in less than twelve hours, showing that there was considerable further need for Oxygen to complete their oxidation.

Suspended Solids in Hackensack River

The amount of solids, both suspended and dissolved, serves as an indicator in judging the quality of a water, and determinations of the proportions of mineral and organic matter assist in deciding whether the solids are those naturally present or have been added by pollution. Pollution by sewage and organic wastes adds appreciably to the solids in the water both in organic and mineral matters.

A number of determinations of the dissolved solids in the Hackensack River water were made, but as the salt from the tidal water obscures the value of the analyses they are not included in this report.

Sewage carries in suspension as well as in solution, considerable organic matter. In the journey through long sewers and in the streams much of the grossly solid material becomes broken up into smaller particles and these are carried along suspended throughout the river water.

In the Hackensack River, particularly from Hackensack downstream the suspended particles are very evident to the eye, especially when the water is viewed in strong sunlight and at close range. These solids are also usually very obvious to the eye in a sample bottle. These visual observations indicate a very high suspended solid content in the river water and the laboratory determinations of the amount confirm this. Averages of suspended solids in the Hackensack samples are shown in Table 5 and Chart 3.

Determinations were not made in sufficient number to warrant split-

ting of the averages on ebb and flood tides and the figures submitted are averages over all tides in samples taken just below the surface.

In the upper river above the dam the suspended solids are seen to be very slight, representing at most only turbidity, but a large increase begins to show at New Milford and the general trend downstream is to considerably larger amounts. Whether the apparent decreases shown at Court Street, Hackensack, and Paterson Plank Road, are due to dilution, tidal effect or subsidence is not clear, but it is evident from examination of the samples by the eye and also aided by the microscope, that the large amounts of suspended solids are not entirely due to sewage but are largely derived from the finely divided paper pulp from the paper board mills. This finely divided material is at times distinctly appreciable in the samples taken at considerable distances from the mills, and may account for the high suspended solids at North Hackensack probably carried upstream by the tides.

Because of the presence of this paper pulp, too large to be accounted for as being derived from sewage, the high organic proportions of the suspended solids in the river water cannot be attributed entirely to sewage particles.

In daily amount the fine paper pulp escaping from the mills to be carried by the Hackensack River is considerable. Calculated from the volumes of the wastes as stated in the questionnaires sent out by the Hackensack Valley Sewerage Commissioners and the amount of paper pulp found in the wastes by analysis of samples taken as discharging from the mills, the river receives from 4 mills a total of approximately 9,000 pounds of paper pulp fragments, every twenty-four hours.

The proportion of suspended matter in the river derived from sewage cannot be determined because the volumes of river and tide water are not known.

Referring back to Chart 3, the average suspended solids shown verify the findings derived from other factors, that the Hackensack River below New Milford is carrying a heavy burden of pollution which starts above the City of Hackensack and is considerably added to all the way to the mouth.

Comparisons of Charts 1, 3 and 4, will show that where the dissolved Oxygen is lowered, suspended solids, bacteria and B. Coli indicate an increase. This is corroboratory, inasmuch as the increases of suspended solids and bacteria show the additions of pollution in a positive way, a corresponding negative indicator being seen in the loss of dissolved Oxygen.

Bacteriological Conditions in the Hackensack River

Members of the B. Coli group of bacterial organisms exist in great numbers in fecal matter and are always found in sewage as are other types

of bacteria acclimated to body temperature, and river water is not their natural habitat.

Waters which on examination yield a high count of bacteria growing readily at body temperature (37° Cent.), indicate pollution by sewage of recent origin. High counts of the Coli group provide more specific evidence of the pollution being due to fecal or excrementitious origin, their natural environment being intestinal and not in natural waters. Pollution from human wastes is the route by which large numbers of these organisms gain access to natural waters.

In the Hackensack River the bacterial counts are found to be low above the dam where the river is clean, while below the dam the numbers are high, indicating gross pollution of the lower river from sewage material.

The bacterial counts are expressed as the number found in one cubic centimeter of water, a volume amounting to fifteen small drops. The numbers of bacteria vary on each sampling occasion and the figures submitted in the tabulation are averaged counts over several months this making comparison more ready.

The graphs on Chart 4 present a picture of the large increase of these bacterial organisms resulting from the consecutive additions of sewage to the Hackensack River below New Milford and a general trend to increasing intensity to the mouth.

It must be remembered that the river increases in volume as it nears the bay and that were it not for the frequent additions of fresh sewage material on the way down, reduction in bacterial numbers by reason of dilution might be expected. This reduction is not generally indicated until the river passes out into the bay.

From a bacteriological viewpoint the lower Hackensack shows marked contamination at New Milford and from then on rapidly degenerates into a filthy stream.

As a menace to public health, the bacteriological condition of the lower river is potential rather than direct because there is no question of its use for potable or household purposes, but in summer time many people bathe or swim in the lower Hackensack, frequently close to where sewers are disgorging crude sewage. Under such conditions intimate contact is made with organisms derived from sewage and which may readily enter the mouth, eyes, ears, nose and throat.

B. Coli is not considered as a specific disease organism but since it is largely associated with intestinal discharges there is a great possibility of disease germs being present in its company. It is hard to trace or determine the numbers of infections which develop subsequent to bathing in polluted waters but there is no doubt that it is decidedly unsafe to

bathe in such waters, and in the case of the lower Hackensack the bacteriological pollutions are very pronounced.

Signs of Pollution in River Bed

Sewage solids carried in suspension in the river cling to the edges of the banks on roots, stick, stones or other impediments and the small particles also subside in places where the flow is slow, covering mud flats with a foul deposit of putrescible organic matter. These deposits of sewage solids also occur in the channels where the flow is not very rapid, and where conditions are favorable for shoaling, deep layers of sewage sludge are formed.

These banks and layers of putrescible material gradually putrefy, evolving gases, usually of foul odor. Freshly deposited sludge is frequently dark gray in color but as decomposition proceeds the color becomes black and the odor of the mud may be then somewhat tarry.

Evolution of the gases from sludge decomposition may be observed in the myriads of bubbles rising to the surface of the water and breaking, particularly in warm weather when the decomposition is hastened by warmer temperatures.

When the tide recedes, the surfaces of some of the mud flats are exposed, and in the heat of the sun the decomposition goes on unabated, the gaseous products escaping directly into the air. The odors are usually more pronounced under such conditions.

Brisk evolution of gases and occurrence of unpleasant odor were noted most frequently during the investigation as arising at Court Street, Hackensack; Little Ferry; Kopper's plant; New Highway No. 25; Mouth of river; Overpeck Creek at Bergen Turnpike, Ridgefield Park; Berry's Creek at Paterson Plank Road; Penhorne Creek at County Road and at Secaucus Road, Secaucus.

Dredgings of material from the river bottom in the middle of the stream appeared as follows:—

Upper Hackensack

Old Tappan:—Clean, fine gravelly sand, and small clean pebbles.

Lower Hackensack

New Milford:—Much sand and fine silt. The sand grains are coated black and dark gray. The fine silt is dark gray and resembles sewage debris.

Court St., Hackensack:—Fine dark gray silt and stones. The silt resembles sewage debris.

Little Ferrys—Thick sticky mud like moist clay, grayish brown in color but superimposed by thick layer of black mud resembling digested sewage sludge.

Paterson Plank Road (Hackensack River):—Sand and mud, dark gray in color.

Erie Main Line Bridge (HX):—Dark gray fine silt resembling sewage debris.

Kopper's Coke Plant:—Pieces of rock, coal and cinders. Fine silt almost black. (Large boats frequently unload coal in this vicinity).

New Highway No. 25:—Fine black silt.

Berry's Creek at Paterson Plank Road:—Thick black mud resembling digested sewage sludge.

Penhorne Creek at County Road, Secaucus:—Thick, black, foul, gassing odorous mud. Resembling fermenting sewage sludge.

As will be seen in the tables of analytical data, with the exception of Old Tappan, all the samples of dredgings indicate high organic content and are undoubtedly of sewage origin.

Foul Mud Deposits Assist in Robbing River of Oxygen

Sewage sludge covering the mud flats and the river bed while undergoing slow putrefaction tends to deoxygenate the supernatant water. In the dissolved Oxygen averages of the lower Hackensack River, slightly lower Oxygen saturation is generally indicated in the samples taken at the lower depth. The difference is not very marked but in the case of a purer water flowing over the fouled depths, it would undoubtedly be more pronounced.

Rainfall in Hackensack Valley During Investigation

Conditions of stream flow have considerable bearing upon the intensity of the pollution effect within the stream. An abnormally wet season results in a higher dilution and, conversely, a drought season would cause shrinkage in river flow, the amount of pollution received being substantially the same.

Alterations in the proportions of pollution to river volume have some bearing on the condition of the stream and in judging of the pollutional effect it is necessary to consider whether the season has been normal.

Rainfall as affecting the Hackensack River is measured at the gauging station at New Milford and in order to compare the amount of rainfall during the period of the investigation with a normal, an average was made over the corresponding periods of ten years prior to 1931.

In making this comparison it is seen that the 1931 period when the sampling was in progress experienced slighty less total rainfall than is indicated in an average of the totals of similar periods in the ten years of 1921 to 1930 inclusive.

The total rainfall during the April-September period of 1931 was about 2.4% less than the 10-year average, indicating that the investigation

period was not abnormally wet or dry and that the river's condition was judged in an average season.

The three months, June, July and August, averaged in a similar manner indicate 8.5% less total rainfall in the 1931 period than that derived as an average from the summer periods of the preceding decade.

Infrequent Indications of Free Chlorine in Lower Hackensack River

Because of the large volumes of wastes received into the Hackensack River from several paper mills where Chlorine is used, and bleachery wastes liable to contain Chlorine being present, with the further possibility of Chlorine being used at some of the inadequate sewage treatment plants, it was considered advisable to test all the river samples for free Chlorine or compounds offering available Chlorine.

Most of the tests for Chlorine proved negative but some indications of its presence were found for a short period during the summer and this makes discussion necessary. Chlorine must not be confused with Chlorides, a term often used to designate the salt content of water.

Chlorine affects the dissolved Oxygen figures first by affecting the chemical reactions in the testing but for which corrections are applied when its presence is known, and second, because Chlorine retards decomposition of sewage it decreases the rate of depletion of Oxygen, resulting in a higher degree of residual Oxygen being present than would otherwise be the case. Being strongly germicidal, appreciable amounts of Chlorine would decrease the bacterial numbers in the stream.

Towards the end of July, indications of free Chlorine were encountered in the Hackensack River and on several subsequent occasions in August. As tests were not made every day it cannot be stated whether the presence was constant or intermittent.

The source of the Chlorine was not definitely traced but Berry's Creek gave the strongest indications of being the source and it is possible that the tides carried it up and down stream.

The Chlorine is not reported as pollution or as the effects of pollution, it was necessary to record it because it may have some effect of restraining bacterial development and decomposition of sewage in the main stream during the summer months, relieving the strain of the pollution somewhat in the Hackensack River.

Newark Bay in Its Relation to the Lower Hackensack River

Newark Bay is discussed because there is a feature of mutual interdependence between the river and the bay. In fact, there is a chain of dependency, in a scale of descending importance, between the welfare of the lower Hackensack, lower Passaic, Newark Bay, Kill van Kull and New York Bay, Arthur Kill and Staten Island Sound.

Newark Bay, into which the Hackensack flows, is a body of water

about 4¾ miles long from north to south and in width approximating 1¼ miles. It is relatively shallow except in the dredged channels and is tidal, having two outlets at its south end, one into the Kill van Kull and the other into Arthur Kill. Flood tide brings water into the bay from the two latter sources which water has been polluted considerably, particularly that from Arthur Kill.

Besides being affected indirectly by the pollution of outside waters, Newark Bay is polluted directly by sewage from Bayonne and Jersey City. It receives considerable pollution from the Hackensack River and a glance at the dissolved Oxygen charts will indicate that the Oxygen supply is sometimes heavily depleted. Evolution of gas from the decomposing sewage material is brisk at times, and examination of samples taken from the bottom and also examination of the dredgings being sucked up by Government contract dredges, show that the bottom of the bay is covered with a carpet of sewage sludge.

Besides backing up the polluted water of the Hackensack River on flood tides and allowing it to putrefy therein, Newark Bay water enters the lower Hackensack and a large part of the dissolved Oxygen which should assist the lower river has been used up by pollution received in the bay.

The bay water offers dilution to the lower Hackensack on flood tides but any Oxygen benefit which it may confer upon the river is quickly lost, as is indicated in Chart 2.

Conditions of Some of the Tributaries of the Hackensack

With the exceptions of Berry's Creek and Overpeck Creek, sampling on the tributaries was not conducted frequently.

Tributaries Above Dam

Tributaries above the dam indicate from visual inspection that they are clean, the water appearing clear and sparkling and the stream beds sandy and undefiled. Dissolved Oxygen was high in average content and bacteria counts reasonably low for surface waters, the low B. Coli particularly indicating freedom from sewage pollution.

Casual samples taken on Pascack Brook at the State line and in Montvale, Park Ridge and Hillsdale, with Bear Brook at Park Ridge, and Musquapsink Brook at Westwood, show that the waters of these streams are not defiled by pollution.

Tributaries Below Dam

Tests below the dam on those tributaries which were examined indicate their gross pollution, parts of the total burden finally assumed by the Hackensack River.

Overpeck Creek

This creek is an important arm of the Hackensack, large enough to be used for navigation by boats of limited draught. The water was sampled regularly at the Bergen Turnpike bridge in Ridgefield Park. The creek receives pollution from raw sewage, partly treated sewage, and some industrial wastes, most prominent among the latter being waste from manufacture of paperboard.

Visual observation at times indicates a grossly polluted condition. Gassing from the bottom may be observed and odor is sometimes apparent, the water appearing black and the mud flats disagreeable on such occasions. The mud flats are extensive as may be observed at low tide.

The dissolved Oxygen figures show generally slightly better conditions in Overpeck Creek at this point than at the nearby sampling station on the main river at Little Ferry, in the averages over the whole investigation.

In the critical warm months, the average Oxygen in Overpeck Creek at Ridgefield Park was appreciably less than that in the main river at Little Ferry suggesting a considerable pollution burden on the creek before entering the river.

Comparing the Overpeck Creek water with that of the river at Little Ferry bridge (which is just above where creek enters river) on averages of ebb currents Overpeck averaged during the April-October period 45.2% and the river at Little Ferry, 36.6%. When the tide is ebbing, the waters may be considered to be largely free from complications of the flood tides, and when the averages of the ebb currents are examined it is indicated that the pollution has seriously reduced the Oxygen content in the creek itself, but as the decompositino of sewage is not yet complete, the remaining burden is transferred to the main river on ebb tides.

The Oxygen average on the return flood currents, which shows markedly lower Oxygen content returned at most of the sampling points on the river, exhibits a similar occurrence in Overpeck Creek, the average on flood tides being even lower than that at Little Ferry with its average of 37.6% and Overpeck 35.7%.

The average total suspended solids were high in average, being likely influenced by large volumes of paper mill wastes. The suspended matter averaged 21 parts per million and ranged from 7 to 34 parts per million.

In average and maximum bacteria counts, the two points under comparison are practically duplicate. In average B. Coli, Overpeck Creek is high with 330 per C. C., while Little Ferry averages 140 per C. C. Maximum counts, or worst pollution indications of B. Coli encountered, are duplicated at both points.

These results indicate that Overpeck Creek is grossly polluted and adds considerably to the total burden of pollution imposed upon the

Hackensack River. The creek is detrimentally affected on flood tides by the return of the degenerated water and the physical backing up of its flow.

Berry's Creek

Berry's is a creek of considerable size and large enough to allow navigation by boats of limited draught, as evidenced by the number of boats anchored in Berry's Creek north of the Paterson Plank Road bridge at Carlstadt. This was the point at which the creek was regularly sampled during the tests.

Originating in several ditches of swamp drainage in the vicinity of Hasbrouck Heights and Teterboro, and receiving drainage from marshes and effluents from several disposal plants, the creek follows a winding course through the marshy meadows and passes under the Erie Railroad about a mile below the Plank Road bridge. At the present time the passage is conducted under the railroad through a small culvert. Formerly there was a drawbridge through the railroad to allow of passage of boats, when the creek flowed in its original course to join the Hackensack River about the south end of Rutherford. This lower course of the creek still exists but because of the narrow culvert and its partial stoppage by debris, not much of Berry's Creek flows down on ebb tides by the original route.

Some years ago, to avoid necessity of maintaining the drawbridge on hte railroad, a canal was cut from the upstream side of the present culvert to the Hackensack River, the canal running fairly straight in a southeasterly direction joining the river north of where the Erie main line crosses.

It is this canal which takes most of the flow of the creek to the river on ebb tides, some water returning through the constricted culvert from the old lower portion of Berry's Creek proper on flood tides. The canal seems the more important as far as carrying pollution directly to the river is concerned.

Berry's Creek and the canal receive pollution from the sewage and industrial wastes of the boroughs of Hasbrouck Heights, Woodridge, Carlstadt, East Rutherford, and Rutherford. The sewage has passed through treatment plants before arriving in the creeks but as most of the treatment works are obsolete, overloaded and inadequate, the effluents they discharge are not much improved over crude sewage. The effluent from Carlstadt appears black and septic.

As the amount of dilution available in the creek is small and there is a relatively large burden of pollution received, with the tidal interference to contend with, the creek is gravely affected and serious nuisance from odors of putrefying sewage has been experienced.

At Paterson Plank Road bridge over Berry's Creek Oxygen was entirely absent at times, odors were appreciable and the appearance of the

mud and water indicated the grossly polluted condition of the creek.

In average Oxygen dissolved, Berry's Creek at Paterson Plank Road showed 33.9% saturation. On flood tide the Oxygen was considerably lower than on the ebb, flood averaging 29.5% and ebb, 42,9%. The average over the warm months was lowered to 17.1%, and the worst Oxygen conditions encountered were zero.

In bacteria the average resulted in 41,000 per C. C., with maximum encountered of 151,000 per C. C. In B. Coli, the index of fecal pollution, the average was 1,400 per C. C. with a maximum, encountered once, of 10,000 per C. C.

In suspended solid content great variation was encountered, the high figures being due to the raising of sewage sludge from the bottom by the gases of putrefaction. The proportion of organic matter in the suspended solids averaged almost 50% of the total. Suspended solid content ranged from 5 to 79 parts per million.

These figures indicate that Berry's Creek is polluted to an extent entirely beyond its capacity to handle, and that the effects of the pollution are intensified within the creek itself when the tide is on the flood. Further, as the Oxygen of the creek is entirely used up at times, it indicates that the waters received from Berry's Creek account for another severe strain imposed eventually upon the lower Hackensack River.

Bellman's Brook

This brook flows in a generally southwesterly direction from the vicinity of Fairview and makes a conjunction with the Hackensack River on the east bank. In size the brook is not important as a tributary, but it receives considerable pollution from untreated sewage and industrial wastes of large volume and of polluting character from bleaching, printing and dyeing of textiles. No analyses of the brook waters were made but the nature of the industrial pollution is indicated in the tables of analytical data.

Penhorne Creek, Cromakill Creek and Paunpeck Creek

These are considered together because they are really one continuous waterway although on some maps they are shown as two separate creeks rising and flowing north and south of the Paterson Plank Road at Secaucus.

As a continuous creek the waterway, which is tidal, enters the Hackensack River at both ends and makes an island of that ground on which is situated the Borough of Secaucus. The Paterson Plank Road crosses the creek in an easterly and westerly direction.

From its southern end where it joins the Hackensack River just above the Public Service Railroad Power Plant at Jersey City, the creek follows a somewhat sinuous but generally northern course through Secau-

cus, which is on the west bank, and thence under the Paterson Plank Road. At the northern side of Paterson Plank Road there is a tidegate which divides the creek into two separate waterways, when it is closed. Up to the Paterson Plank Road from its southern end the creek is known as Penhorne (or Pinhorne) Creek. North of the Plank Road beyond the tide gate it is called Cromakill and further north is merged into Paunpeck Creek. This end joins the Hackensack River beyond the northern end of Secaucus.

Penhorne Creek is crossed by four highways and several railroads and at many of these crossings the free flow of water is somewhat restricted by the small culverts, and further by the filthy accumulations of decomposing sewage deposits which are piled so deeply as to clog the channel.

Penhorne Creek is indescribably filthy and its foul condition and malodorous emanations bring forth perennial complaints.

Shortly south of the Paterson Plank Road in Secaucus there is a large settlement devoted to the breeding and raising of pigs. Related to this animal industry are slaughter houses and manufacturing establishments where products derived from pigs are made.

The extent of the animal industry at Secaucus is well described in the "Fifty-Sixth Annual Report of the Board of Health and Vital Statistics of Hudson County" year 1929. From a report of a very careful survey of conditions on Penhorne Creek contained in the above volume, the following synopsis is quoted:—

> "There are fifty-five individuals or corporations engaged in the business . . . .Some have been there forty years—several thirty years. Forty-three are married with a total of one hundred and fifty-nine children. The largest family is eleven children. There are three hundred and twenty-one employees. They have 43,756 pigs; 24 cows; 8 horses; 5 goats and 1,000 chickens.
> Thirty-two sewer into the meadows.
> Twenty-one sewer into Penhorne Creek.
> Two sewer into cesspools.
> Forty-four dispose of refuse in meadows; eight on dumps and three cart away to farmers."

The number of employees and pigs quoted signify the extent of the industry and its economic importance. That some of the business has been located there for thirty or forty years, its present size and the large number indicated as sewering into the meadows or directly to the creek, are all significant facts which explain conditions in the creek and the vast accumulations of putrefying solid filth which have choked its channel.

North of the animal industry premises, at the Paterson Plank Road, Penhorne Creek appears like an open sewer and the liquid it carries differs little from very strong sewage. South from the Plank Road the

creek spreads itself amongst the houses and large pig pens. The creek may not be described as flowing because the channel is choked with the large deposits of filthy sewage sludge and hog wallow. As the tide rises, the foul liquid is spread in wide pools and settles in the low parts of dirt streets and the back and front yards of some of the houses. These pools of filthy liquid are left as the tide recedes giving the impression that the whole soil is sewage soaked or numerous cesspools are overflowing. Open gutters, dug in the dirt streets, appear to be relied upon for drainage and as there are many dips and hollows in the grade of these open channels they retain pools of the house and other drainage which they are intended to carry to the creek. Similar open channels may be observed carrying the liquid or semi-liquid filth from some of the large pig pens.

So full is the creek channel with the accumulations of foul sludge that the slightest disturbance, such as by the careful lowering of a bottle for sampling, stirs up clouds of foul black sediment in the water.

The clogged channel with deep banks of black, gassing and putrefying sludge is evident all the way to where the creek makes confluence with the Hackensack in Jersey City. The liquid carried in the creek is dark gray and opaque, smelling of the piggery refuse, fresh gross clumps of unbroken human feces float along, and the water is vigorously gassing as the liquid, and the solids on the bottom, actively putrefy lending to the creek the appearance of a long filthy cesspool.

The waters of Penhorne Creek were not frequently sampled but the tests made are sufficient to indicate their character as foul and filthy, having the characteristics of strong crude sewage.

At Paterson Plank Road on the south side of the culvert much of the pollution from the piggeries is backed up by the flood tide. On ebb tides the tide gate at the north side is closed and the polluted water remains in this vicinity. Samples taken at this point showed high suspended solids amounting to 132 parts per million and largely organic in composition. This is due to the particles of sludge easily arising from the bottom in the shallow water. Dissolved Oxygen was usually absent.

At Secaucus Road, in the heart of the piggery industry, the pollution is intense as shown by high suspended solids of 102 parts per million and absence of dissolved Oxygen. The bacterial counts varied between 750,000 and 1,000,000 per C. C., the B. Coli averaging 10,000 per C. C.

Lower down the creek, at County Road bridge, Secaucus, below all the piggery pollution, the mud banks of putrefying sludge, the choked channel, bad odors and active gassing are very apparent. Dissolved Oxygen was always absent in the tests. Suspended solids were high and largely organic. Two counts of bacteria of 3,000,000 per C. C. were the maximum obtained and a maximum positive test for B. Coli indicated 100,000 per C. C. Several samples tested for B. Coli were positive at 10,000 per C. C.

These observations indicate unbelievable conditions of foulness existing in the length of Penhorne Creek, the burden ultimately being placed upon the Hackensack River.

Cromakill Creek on the north of Paterson Plank Road is polluted separately from what it may receive from Penhorne Creek through the tidegate. Industrial wastes from textile dyeing, some crude sewage from sewers, and effluents from disposal plants which have settled out some of the solids before discharge, constitute the pollution.

No regular sampling was carried out in this creek which goes north and joins Paunpeck Creek. The effects of the pollution are to be observed in the black bed and the blackened banks when the water is low. One casual sample indicated a bacteria count of 600,000 per C. C. and B. Coli 10,000 per C. C.

All tributaries examined below the dam show signs and effects of heavy pollution, some excessively so. They indicate some of the successive increments of pollution received by the river. Not all sources are included, as there are small ditches, many of them obviously open sewers, and further, sewers discharging directly to the river were not tested. To examine and test every source of pollution in the area covered in this investigation of the Hackensack River could not be done in a few months and was beyond the scope of the investigation.

Industrial Wastes on the Lower Hackensack

Industry is well represented in the Hackensack Valley, but compared with some other rivers, the types of industry producing large volumes of polluting wastes are not numerous on the Hackensack.

Undoubtedly the largest group of industries similar in nature and affecting the Hackensack by the discharge of wastes more or less polluting are the paper board mills which predominate on this river.

The highly colored and usually putrescible wastes from the dyeing and finishing of different textiles are not prominent, woolen scouring and dyeing being absent, silk dyeing and finishing is very small in extent, and the bleaching, dyeing, printing and finishing of cotton fabrics is largely represented in one big mill.

There appears to be one laundry of outstanding size and wastes of a strictly chemical nature seem to be mostly represented in a large plant producing lacquer solvents, a large gas works, a large coke oven by-products plant, and a large motion picture film printing and developing plant.

The wastes from the piggeries and slaughter houses at Secaucus should be considered as industrial wastes because they are in a large group.

In order to obtain an idea of the extent of industrial waste pollution, the Hackensack Valley Sewerage Commissioners sent out several hun-

dred questionnaires on a list which covered mostly, if not entirely, the total industries in the valley in the drainage area.

A consideration of the answers returned allowed of segregation of the probably significant plants by reason of elimination of plants out of business, industries not producing any wastes, and places where the volumes of waste were small and contained in the general sewage of the community where they were situated.

Some typical places likely to produce wastes of large volume were selected for closer examination to determine their quality with regard to pollution of the river and their significance of effect on sewage treatment processes.

The paper mill wastes in the aggregate throw a considerable burden of organic matter in solution, and solids in suspension, upon the river and usually operate 24 hours in the day. The organic matter in solution is derived from the beating of paper and wood pulp with water into the mash from which the paper is made on the machines. The water sucked from the pulp after it is laid on the machines, and the sprays washing off the felts, account for the large volumes of the paper mill waste and its chemical quality. Before discharge to the river the wastes are passed through "save-alls" which strain out and recover some paper fibers on wire screens about 50 mesh to the inch. A considerable amount of fine paper pulp escapes through the mesh and nothing is removed from solution.

The water used in the beating of the pulp is clean, having been usually taken from the river and heavily chlorinated, chemically coagulated and filtered through sand filters.

The waste resulting from the paper machines is detrimental to the river because of the fiber content, and though the organic matter does not decompose as readily as that contained in sewage, under some circumstances it assists in the production of bad odors and uses up dissolved Oxygen.

The wastes from dyeing and printing of cotton are objectionable because of intense color, soap, gums, and acid or alkali content. They have a considerable Oxygen demand. The wastes from bleaching of cotton are not all objectionable from the pollution standpoint, but the kier liquors are extremely heavy in organic matter of a type which is hard to break down but which needs plenty of Oxygen for its oxidation. These liquors are usually strongly alkaline and the first discharges and first washes from the kiers are very concentrated and objectionable.

The wastes from the lacquer solvent manufacture consist of a light brown but clear solution of dilute Sulphuric Acid. This is extensively diluted again by large volumes of cooling water from the stills. It is still further diluted with water in a large lagoon and its final effect on the Hackensack River is negligible.

The gas house waste is purified by settlement, skimming, chemical coagulation and sedimentation, then filtered through sand filters. Before discharge to the river this waste has been purified to as high a degree as practicable.

Residues from ammonia stills, strongly colored and high in alkalinity, ammonium compounds and phenols, from the pollution standpoint are objectionable in some measure, although they are well diluted with condenser water before discharge at the coke oven plant.

The wastes from a large laundry are discharged to the river untreated through a city sewer. This is a highly polluting waste.

Conclusions

The data obtained and presented in this appraisal of chemical and bacteriological conditions of the Hackensack River lead to the following conclusions:—

Above the New Milford Dam the river and its tributaries within the potable watershed are not polluted by sewage and industrial wastes to any appreciable extent. It is not within the scope of this report to discuss possible need of sewage outlet for growing communities in close proximity to the watershed.

Below the watershed, pollution is appreciable in an increasing degree from New Milford to below North Hackensack. From the City of Hackensack down to the mouth of the river pollution grows in intensity until the stream is loaded beyond its capacity to assimilate.

Lower tributaries are heavily polluted particularly Overpeck Creek, Berry's Creek and Penhorne Creek, the latter being an example of gross foulness.

The increments of pollution from inadequately treated sewage, industrial wastes chiefly from paper board mills, and crude untreated sewage, arrive in the river in such rapid succession that there is not sufficient length of flow between each addition to allow of much self-purification within the stream. The situation is rendered more acute by the tidal interference which causes an accumulation of pollution and degenerated water within the stream for which escape is slow, and it is swung back and forth on the successive tides. The zone affected by this extends along the main stream from North Hackensack to the mouth and in the main tributaries.

In this zone the dissolved Oxygen margin of safety is very slight, particularly in warm dry periods. Through June and July 1931 especially, the river and lower tributaries suffered serious Oxygen depletion. Oxygen disappeared entirely from Berry's Creek and Penhorne Creek during the summer of 1931 and odors arising from the stream were appreciable at many points.

From the public health standpoint the lower river is a direct menace because of the frequent use of its waters for bathing and swimming. Indirectly there is a health hazard in discomfort from disagreeable odors and the breathing of gases which may lower the bodily resistance to disease.

Newark Bay being directly polluted from many sewers and having its Oxygen supply considerably depleted especially during the warm dry months, does not assist the lower Hackensack greatly in Oxygen refreshment.

The data all indicate the gross pollution of the tidal portion of the Hackensack River and the need for relief from this burden if the dangers of widespread odor nuisance, depreciation of realty values and prevention of improvement and development in the lower valley are to be avoided.

Respectfully submitted,

RICHARD C. SMITH.

4 charts
8 tables
attached

TABLE I.

DESCRIPTION OF SAMPLING STATIONS, HACKENSACK RIVER AND TRIBUTARIES.

Above New Milford Dam

Old Tappan: At bridge dividing Rivervale Township and Old Tappan at Rivervale Road and Tappan Road. Approximately two miles below where river crosses State line. Non-tidal.

Pascack Brook near State line. Montvale, Summit Ave., and Kinderkamack Road. Non-tidal.

Pascack Brook, Montvale. Grand Avenue and South Avenue. Non-tidal.

Pascack Brook at Ridge Avenue, Park Ridge. Non-tidal.

Pascack Brook below Woodcliff Lake. Hillsdale Avenue, Hillsdale.

Bear Brook at Pascack Road, Park Ridge. Non-tidal.

Musquapsink Brook at 4th Avenue, Westwood. Non-tidal.

Below New Milford Dam

New Milford: Near filtration plant of Hackensack Water Company. Below dam. Tidal.

North Hackensack. At bridge by old Steuben House. Main Street and New Bridge Road. Tidal.

Court Street. At Court Street bridge, Hackensack. Tidal.

Little Ferry. At drawbridge, Bergen Turnpike. Tidal

Paterson Plank Road. Hackensack River at drawbridge. Tidal.

Erie Main Line. Drawbridge at crossing of Erie main line. Called HX bridge. Tidal. Between confluences of Berry's Creek Canal and Berry's Creek proper.

Snake Hill. Midchannel opposite main buildings of County Institutions at Snake Hill (Laurel Hill). Tidal.

Kopper's Coke. Midchannel between Kopper's Coke plant and Public Service Railroad Power House, Jersey City. Tidal.

New Highway No. 25. Midchannel at new elevated highway bridge (No. 25), at present under construction between Belleville Turnpike and Lincoln Highway bridges. Tidal.

Mouth. Midchannel at Newark Bay in mouth of river. At drawbridge of Central R. R. of New Jersey. Tidal.

Newark Bay. Midchannel at Lehigh Valley R. R. crossing to Greenville Yards. About one-third down bay. Tidal.

Newark Bay. Red Can Buoy No. 6. Midchannel. About middle of Newark Bay. Tidal.

Newark Bay. At drawbridge midchannel through long bridge of Central R. R. of N. J. Practically lower end of Newark Bay. Tidal.

Berry's Creek at drawbridge. Paterson Plank Road. Tidal.

Overpeck Creek at drawbridge. Ridgefield Park, Bergen Turnpike. Tidal.

Penhorne Creek, County Road, Secaucus. Tidal.

Penhorne Creek, Secaucus Road, Secaucus. Tidal.

Cromakill at Paterson Plank Road, Secaucus. Tidal.

APPENDIX TWO
TABLE 2

Average Percentage Saturation dissolved Oxygen, April to October, 1931

Sampling Stations	Ebb Tides: Ave. Low Depth	Ebb Tides: Ave. 2 Feet	Ebb Tides: Gen. Ave. on Ebb Tides	Flood Tides: Gen. Ave. Low Depth	Flood Tides: Ave. 2 Feet	Flood Tides: Gen. Ave. on Flood Tides	Gen. Ave. All Tides All Depths
Old Tappan	.....	.....	.....	.....	.....	.....	84.0%
New Milford	.....	82.5	82.5	.....	84.5	84.5	83.4
No. Hackensack	.....	82.2	82.2	.....	80.9	80.9	81.7
Court St., Hackensack	63.9	64.2	64.1	50.2	54.5	52.3	58.8
Little Ferry	32.0	41.2	36.6	38.1	37.2	37.6	37.3
Paterson Plank Road	51.3	49.4	50.6	37.5	37.7	37.6	42.5
Erie Main Line, HX	46.0	48.0	47.0	31.5	31.7	31.5	42.4
Snake Hill	54.9	53.7	54.3	36.9	37.1	37.0	43.5
Kopper Coke Plant	48.1	51.7	49.9	25.6	30.2	27.9	36.1
New Highway No. 25	48.9	53.3	51.1	42.9	58.8	50.9	51.0
Mouth of Hackensack	54.1	55.1	54.6	56.3	62.3	59.3	56.6
Newark Bay, L. V. R. R.	54.1	53.3	53.7	59.2	62.0	60.6	56.8
Newark Bay, Red B. 6	54.6	50.5	52.6	62.4	69.2	65.8	57.9
Newark Bay, Long Bge.	61.1	59.9	60.5	54.6	53.2	53.9	57.8
Overpeck Creek	40.7	48.3	45.2	36.8	34.8	35.7	40.2
Berry's Creek	46.0	39.8	42.9	29.3	29.8	29.5	33.9
xPascack Br St. Line	.....	.....	.....	.....	.....	.....	87.3
xPascack Br. Montvale	.....	.....	.....	.....	.....	.....	87.2
xPascack Br. Park Ridge	.....	.....	.....	.....	.....	.....	87.3
xPascack Br. Hillsdale	.....	.....	.....	.....	.....	.....	87.3
xBear Br. Park Ridge	.....	.....	.....	.....	.....	.....	87.2
xMusquapsink Brook	.....	.....	.....	.....	.....	.....	89.0
xCromakill, Pat. Pl. Rd.	.....	0.0	0.0	.....	.....	.....	0.0
xPenhorne, County Rd.	.....	0.0	0.0	.....	.....	.....	0.0
xPenhorne Secaucus Rd.	.....	0.0	0.0	.....	.....	.....	0.0

x Infrequent Samples.

APPENDIX TWO

TABLE 3

Percentage Saturation Dissolved Oxygen, Hackensack River and Tributaries. Warm Months, June, July and August, 1931
Averaged over all Tides and Depth
and
Minimum Oxygen or Worst Condition Encountered During Investigation.

Sampling Stations	Percentage Saturation Oxygen	
	Warm Month Average	Minimum or Lowest Encountered
Old Tappan	89.8	70.0
New Milford	87.5	34.7
North Hackensack	77.9	62.5
Court St. Hackensack	49.7	9.6
Little Ferry	30.9	13.1
Paterson Plank Road	35.9	13.3
Erie Main Line HX	26.9	10.6
Snake Hill	24.0	9.4
Kopper Coke	27.9	12.0
New Highway #25	43.8	27.7
Mouth of Hackensack	39.5	18.2
Newark Bay, L. V. R. R.	41.6	30.6
Newark Bay. Red Buoy 6	42.7	24.7
Newark Bay. Long Bridge	48.3	28.4
Overpeck Creek	28.2	19.8
Berry's Creek	17.1	0.0
Penhorne Creek (County Road)	0.0	0.0

APPENDIX TWO

TABLE 4

BACTERIOLOGICAL DATA

Plate Counts of Bacteria Per. C.C. Growing in 24 Hours at 37° Centigrade and B. Coli, (Presumptive Tests)

Sampling Stations	Bacteria per Cubic Centimeter			
	Plate Counts 37°		B. Coli (Presumptive)	
	Average	Maximum	Average	Maximum
Old Tappan	3,000	8,000†	12	100x
New Milford	28,500	151,000	104	1000
North Hackensack	29,400	83,500	255	1000
Court Street, Hackensack	17,750	85,600	336	1000
Little Ferry	15,900	33,000	141	1000
Paterson Plank Road	61,650	237,600	409	1000
Erie Main Line (HX)	30,800	70,200	262	1000
Snake Hill	22,500	48,600	70	100
Kopper Coke Plant	56,500	145,600	535	1000
New Highway No. 25	46,500	145,800	164	1000
Mouth of Hackensack	47,275	135,000	355	1000
Newark Bay. L. V. R. R.	16,250	50,000	74	100
Newark Bay. Red Buoy No. 6	9,200	29,400	48	100
Newark Bay. Long Bridge	9,750	25,000	66	100
Overpeck Creek	15,300	31,000	330	1000
Berry's Creek	41,000	151,000	1,400	10,000
xPascack Brook, State line	2,170	3,250	5	10
x " " Montvale	2,500	3,700	1	1
x " " Park Ridge	1,300	1,700	0	0
x " " Hillsdale	1,800	2,000	1	1
xBear Brook, Park Ridge	2,700	3,250	1	1
xMusquapsink Brook, Westwood	180	300	0	0
xPenhorne Creek. County Rd. Secaucus	2,000,000	3,000,000	40,000	100,000
xPenhorne Secaucus Rd.	875,000	1,000,000	1,000	1,000
xCromakill, No. Plank Rd.	600,000	600,000	10,000	10,000

x Infrequently sampled.

† During the investigation two high counts were obtained entirely out of proportion to the usual. As B. Coli was low on both these occasions the counts were attributed to some contamination in the samples from handling. These counts were excluded.

x This maximum B. Coli was only encountered once during investigation.

APPENDIX TWO

TABLE 5

Average Suspended Solids, Hackensack River and Tributaries
Parts per Million

Sampling Stations	Suspended Solids		
	Total	Organic	Mineral
Old Tappan	9.0	3.0	6.0
New Milford	19.1	5.4	13.7
North Hackensack	37.6	24.8	12.7
Court St. Hackensack	30.7	15.9	14.8
Little Ferry	44.0	26.3	17.7
Paterson Plank Road	17.4	6.6	10.8
Erie Main Line (HX)	57.1	30.7	26.4
Snake Hill	44.9	18.1	26.8
Kopper Coke Plant	45.8	22.2	23.6
New Highway No. 25	x31.4	6.0	25.4
Mouth of Hackensack	x27.5	6.0	21.5
Overpeck Creek	21.0	9.0	12.0
Berry's Creek	31.0	22.0	9.0
† Penhorne Creek, County Rd.	69.0	59.0	10.0
† Penhorne Creek, Secaucus Rd.	102.0	35.0	67.0
†Cromakill, North Plank Rd.	132.0	125.0	7.0

x Dredging in upper Newark Bay may have affected these.
† Infrequent samples.

APPENDIX TWO
TABLE 6
Examinations of Dredgings from River Bottom. Taken in Channel.

Station	Appearance wet as dredged	Appearance Dried and Ground	Per Cent. Organic Matter
Tappan	Clean sand and small pebbles	Sand grains, small pebbles. Some fragments of leaves and twigs. No grease	1.19%
New Milford	Sand grains coated black. Fine dark gray silt	Gray fluffy powder. Traces of grease. Occasional microscopic fiber of wood pulp	6.40%
Court St. Hackensack	Sand in mud. Dark gray in color	Dark gray and granular. Marked presence yellow grease. Occasional microscopic fibers of cotton and wood	8.10%
Little Ferry	Thick layer of black mud resembling digested sewage sludge	Gray fluffy powder. Marked light yellow grease. Occasional fibers of wood	8.70%
Paterson Pl. Road	Sand in mud. Dark gray in color	Dark gray and fluffy. Marked light yellow grease. Occasional fibers cotton and wood	4.60%
Erie Main Line. HX.	Dark gray fine silt	Dark gray, almost black. Traces grease. Few fibers cotton and woody	8.50%
Snake Hill	Small pieces rock coated with dark gray silt	Gray fluffy powder. Marked light yellow grease. Few microscopic fibers.	5.50%
Kopper Plant	Rock, coal, cinders. Fine silt almost black	Dark gray granular powder. Considerable brown oil and grease extracted	9.30%
New No. 25 Highway	Fine black silt	Dark gray powder. Marked yellow grease	8.2 %
Berry's Creek	Thick black slimy mud resembling sewage sludge	Dark gray granular. Considerable yellow grease. Fragments root tendrils	12.40%
Penhorne Creek County Rd.	Thick, black, gassing mud of evil odor. Resembling fermenting sewage sludge	Almost black. Many fine fibers of woody origin. Considerable yellow grease	61.90%

APPENDIX TW(

TABLE 8

Industrial Wastes I

Wastes from Paperboard Mills

	Total Solids			Dissolved Solids	
	Tot.	Org.	Min.	Tot.	Org.
Mill A	8208	1893	6315	8002	1715
Mill B	7191	1485	5706	7083	1404
Mill C	11818	2346	9382	11617	2286
Mill D	9128	5654	3474	8848	5402

Wastes from Textile Bleaching, Printing and Dyeing

Type of Waste	Total Solids			Dissolved Solids		
	Tot.	Org.	Min.	Tot.	Org.	Min.
Cotton Kier Liquors	39116	15568	23548	.....	.....	.....
Cotton Bleach House	8531	2812	5719	8474	2756	5718
Cotton Dyeing and Printing	8845	3545	5300	8637	3341	5296
Silk Dyeing from Vats	32800	16220	16580	.....	.....	.....
Silk Dyeing Soap Boiloff	29380	23452	5928	.....	.....	.....
Plush Dyeing	1050	280	770	.....	.....	.....

APPENDIX TWO

TABLE 8

Industrial Wastes Data

Wastes from Paperboard Mills

	Total Solids			Dissolved Solids			Suspended Solids			Ox.	B. O. D.	Tot.
	Tot.	Org.	Min.	Tot.	Org.	Min.	Tot.	Org.	Min.	Cons.	5-day	Alk.
Mill A	8208	1893	6315	8002	1715	6287	206	178	28	52	23.2	142
Mill B	7191	1485	5706	7083	1404	5679	108	81	27	46	14.2	110
Mill C	11818	2346	9382	11617	2286	9331	201	150	51	140	.....	60
Mill D	9128	5654	3474	8848	5402	3446	280	252	28	18000	.....	.....

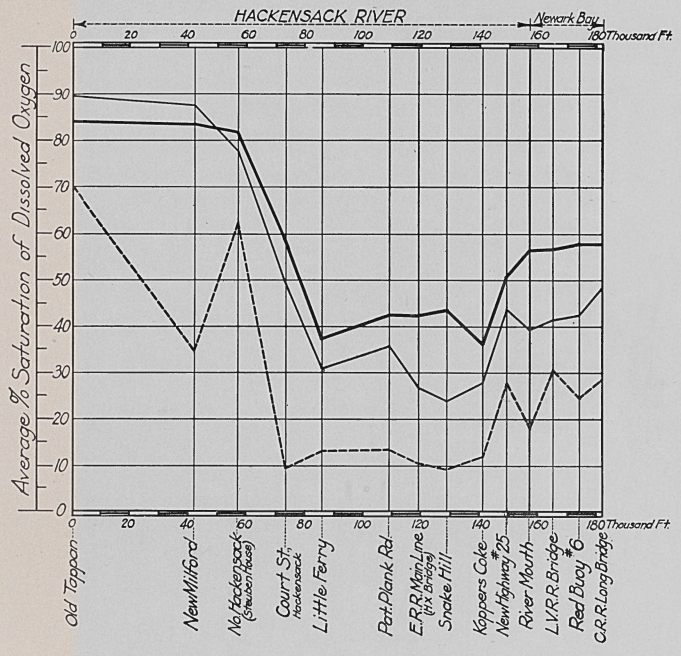
Wastes from Textile Bleaching, Printing and Dyeing

Type of Waste	Total Solids			Dissolved Solids			Suspended Solids			Ox. Cons.	B. O. D. 5-day	Tot. Alk.	Acid
	Tot.	Org.	Min.	Tot.	Org.	Min.	Tot.	Org.	Min.				
Cotton Kier Liquors	39116	15568	23548	.....	.....	.....	.....	....	.....	82000	.....	11000	0
Cotton Bleach House	8531	2812	5719	8474	2756	5718	57	56	1	40	58.2	0	216
Cotton Dyeing and Printing	8845	3545	5300	8637	3341	5296	208	4	204	920	73.2	0	450
Silk Dyeing from Vats	32800	16220	16580	.....	.....	.....	.....	....	.....	22000	.....	0	0
Silk Dyeing Soap Boiloff	29380	23452	5928	.....	.....	.....	.....	....	.....	30000	.....	5100	0
Plush Dyeing	1050	280	770	.....	.....	.....	.....	....	.....	90	.....	0	0

Chart 1.

Average Dissolved Oxygen
Hackensack River & Newark Bay
Averages over all Tides & Depths.

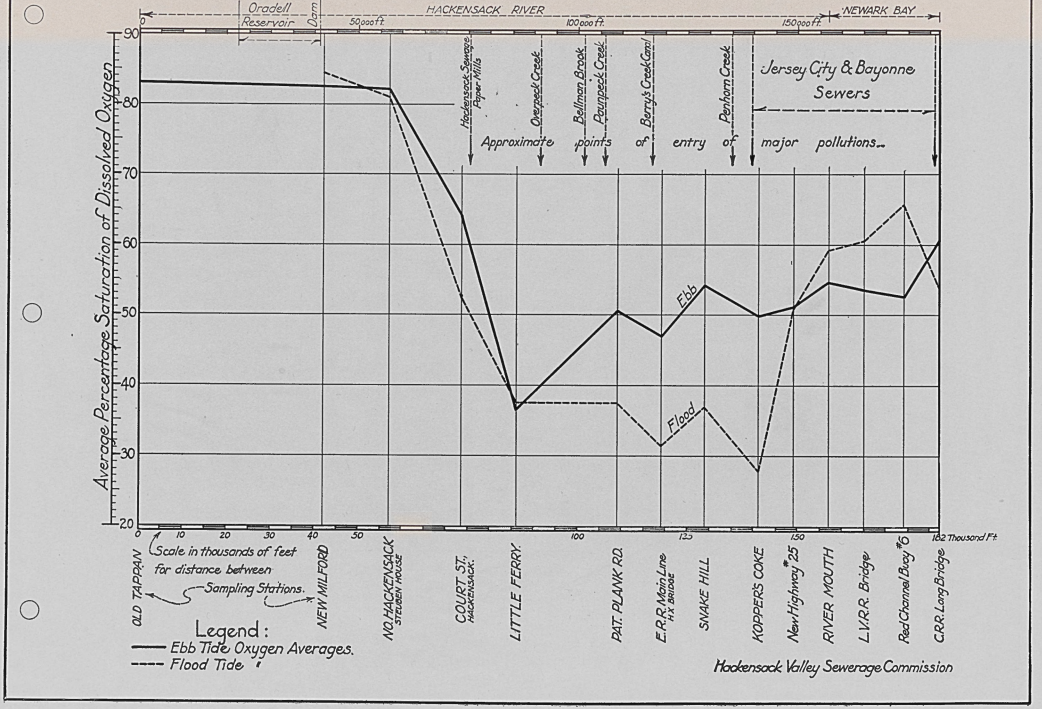
Legend : ——— Average Apr. 15 to Oct. 1, 1931.
——— Avg. warm mos. June to Aug., incl.
- - - - - Min., or worst condition encountered.



Hackensack Valley Sewerage Commission

Chart 2.

Dissolved Oxygen Averages at all Depths on Ebb & Flow Tides.



Hackensack Valley Sewerage Commission

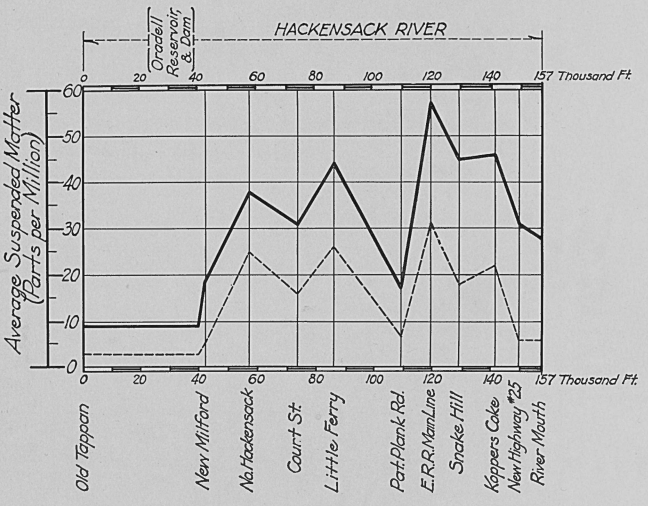
Chart 3.

Average Suspended Solids.
Hackensack River

Legend :

——Total Suspended Solids.

----Organic Portion, Suspended Solids.



Hackensack Valley Sewerage Commission

APPENDIX THREE

CHAPTER 144, LAWS OF 1930

AN ACT to create a sewerage district to be called Hackensack Valley Sewerage District, to authorize the appointment and define the powers and duties of the commissioners therefor, to provide a plan for the prevention of pollution of the Hackensack river and its tributaries and to authorize the raising and expenditure and payment of moneys necessary for this purpose.

BE IT ENACTED BY THE SENATE AND GENERAL ASSEMBLY OF THE STATE OF NEW JERSEY:

1. All that portion of Bergen and Hudson counties situate, lying and being between Newark bay and the boundary line between the State of New York and the State of New Jersey, within the natural drainage area of the Hackensack river and its tributaries between the said points and constituting the city of Jersey City, the city of Union City, the town of West New York, the town of Guttenberg, the town of North Bergen, the town of Secaucus and the town of Kearny, in the county of Hudson, and the borough of Fairview, the borough of Cliffside Park, the borough of Fort Lee, the borough of Englewood Cliffs, the borough of Tenafly, the borough of Alpine, the borough of Norwood, the brough of Rockleigh, the borough of Northvale, the borough of Ridgefield, the borough of Palisades Park, the village of Ridgefield Park, the borough of Leonia, the borough of Bogota, the township of Teaneck, the city of Englewood, the borough of Bergenfield, the borough of New Milford, the borough of Dumont, the borough of Cresskill, the borough of Haworth, the borough of Demarest, the borough of Closter, the borough of Harrington Park, the borough of Old Tappan, the township of Rivervale, the borough of Montvale, the borough of Woodcliff Lake, the borough of Park Ridge, the borough of Hillsdale, the township of Washington, the borough of Westwood, the borough of Emerson, the borough of Oradell, the borough of Paramus, the borough of Riverside, the borough of Maywood, the city of Hackensack, the borough of Hasbrouck Heights, the borough of Teterboro, the township of Lodi, the borough of Woodridge, the borough of Carlstadt, the borough of Little Ferry, the borough of Moonachie, the borough of East Rutherford, the borough of Rutherford, the township of Lyndhurst, and the borough of North Arlington, in the county of Bergen, shall be and is hereby constituted a sewerage district under the name and title of Hackensack Valley Sewerage District.

2. The board of chosen freeholders of the county of Bergen shall appoint four residents within such district and the board of chosen free-

holders of the county of Hudson shall appoint one resident within such district who shall constitute a board of commissioners for said sewerage district to be known as the Hackensack Valley Sewerage Commissioners, and the persons so appointed shall serve without compensation and shall hold office for a term of one year or until their successors shall have been appointed and shall have qualified. Any vacancy occurring in the said commission by death, resignation or otherwise shall be filled in the same manner as the original appointment for the balance of the term. Each of said commissioners so appointed shall before they enter into the duties of their office take and subscribe an oath that they will faithfully and impartially execute the duties imposed upon them by law and shall cause the same to be filed with the clerk of the board of chosen freeholders of their respective county.

3. When duly organized the said commissioners shall proceed to investigate methods and plans for relieving the said Hackensack river and its tributaries from pollution and preventing the pollution of same and to determine the most advisable and advantageous method in respect thereto and to ascertain the approximate cost of a trunk sewer with such intercepting sewers, pumping stations, disposal system and other appurtenances necessary thereto or such other plan or method as may appear sufficient for the present and future disposal of the sewerage of the district within the Hackensack river drainage area between the above stated points in order to prevent the pollution of the Hackensack river and its tributaries in the present and in the future.

4. Said commission shall have power to employ such engineers and other agents and employees as may be necessary for the purpose of making the survey and investigation herein provided for and may determine their duties and compensation and remove the same at its pleasure. The said commission shall organize by the choice of one of its members as chairman and may elect a clerk who may or may not be a member of said board.

5. Before determining upon the final plan or route for the building or construction of any work investigated or proposed under this act, the said commission may by its officers, agents, servants and employees enter at all times upon any lands or waters for the purpose of exploring surveying, leveling and laying out the route of any drain or sewer, locating any disposal, pumping or other works, establishing grades and doing all necessary preliminary work in the way of designating locations, doing, however, no unnecessary damage or injury to private or other property.

6. The necessary cost and expenses of said commission in carrying out the provisions of this act shall from time to time be certified by said commission to the boards of chosen freeholders of the counties of Bergen and Hudson and shall be paid by the boards of chosen freeholders of said

counties of Bergen and Hudson out of such funds as may be appropriated therefore by said boards of chosen freeholders in the following manner: eighty (80%) per centum of such costs and expenses by the county of Bergen and twenty (20%) per centum of such costs and expenses by the County of Hudson; PROVIDED, HOWEVER, that nothing contained herein shall be construed to authorize a total expenditure for the purpose of carrying out the provisions of this act of a sum in excess of thirty-five thousand dollars ($35,000) or incurring of any expense or obligation of any nature whatsoever until sufficient funds for the payment of their respective shares shall have been appropriated therefore by the boards of chosen freeholders of said counties of Hudson and Bergen, and the said commission shall at all times keep full and accurate account of all expenditures made hereunder, which shall be open to public inspection, and shall at least once a year certify and furnish a detailed statement thereof to the boards of chosen freeholders of the counties of Bergen and Hudson and to the governing bodies of each of the municipalities either wholly or partly within the drainage area of the Hackensack river and its tributaries in the counties of Bergen and Hudson.

7. After said commission shall have completed the investigation of plans and methods herein provided to be made, they shall prepare and submit to the boards of chosen freeholders of the counties of Bergen and Hudson and to the governing bodies of each of the municipalities in the counties of Bergen and Hudson being wholly or partly within the drainage area of the Hackensack river and its tributaries, a report and their recommendations as to the most feasible plans or methods for the relief and prevention of the pollution of the said river and its tributaries together with an estimate of the cost of carrying out such plan or plans, with such suggestions as said commission may have as to the proper and most advisable manner to finance the same, and said commission shall particularly report on the advisability of the construction of a trunk sewer with appurtenances for the area affected.

8. Pending the submission of the report provided for in section seven hereof no suit or action, either at law or in equity, shall be instituted or brought to enforce the terms of the provisions of the act entitled "An act to provide for the purification of the waters of the Hackensack river," approved March twenty-sixth, one thousand nine hundred and twenty-six until after May first in the year one thousand nine hundred and thirty-one.

9. This act shall take effect immediately.

Approved April 15, 1930.

APPENDIX FOUR

CHAPTER 178, LAWS OF 1931

AN ACT to amend an Act entitled "An Act to create a Sewerage District to be called Hackensack Valley Sewerage District, to authorize the appointment and define the powers and duties of the Commissioners therefore, to provide a plan for the prevention of the pollution of the Hackensack river and its tributaries, and to authorize the raising and expenditure and payment of moneys necessary for this purpose," approved April fifteenth, one thousand nine hundred and thirty.

BE IT ENACTED BY THE SENATE AND GENERAL ASSEMBLY OF THE STATE OF NEW JERSEY:

1. Section eight of the Act to which this Act is an amendment be and the same is hereby amended to read as follows:

8. Pending the submission of the report provided for in section seven hereof no suit or action, either at law or in equity, shall be instituted or brought to enforce the terms of the provisions of the act entitled "An act to provide for the purification of the waters of the Hackensack river," approved March twenty-sixth, one thousand nine hundred and twenty-six, until after May first in the year one thousand nine hundred and thirty-two.

2. This act shall take effect immediately.

Approved April 21, 1931.

APPENDIX FIVE

CHAPTER 173, LAWS OF 1926

AN ACT to provide for the purification of the waters of the Hackensack river.

BE IT ENACTED BY THE SENATE AND GENERAL ASSEMBLY OF THE STATE OF NEW JERSEY.

1. Every person and municipality is hereby prohibited and forbidden to discharge, directly or indirectly, any sewage or other polluting matter into the waters of the Hackensack river at any point above the mouth of Bellmans creek or into any tributaries, including Bellmans creek, of the Hackensack river which empty into the Hackensack river above said point, after the first day of May in the year one thousand nine hundred and thirty unless said sewage or other polluting matter is subjected to a minimum purification process including sedimentation and intermittent sand filtration.

2. The State Department of Health is authorized and empowered to institute in the name of the State suits at law or in equity, as may be deemed necessary or appropriate to enforce the provisions of section one of this act after said first day of May, in the year one thousand nine hundred and thirty; and the Court of Chancery of this State is hereby vested with special jurisdiction to enforce the provisions of section one of this act in a summary manner upon application of the State Department of Health.

3. Nothing in this act contained shall be constructed to operate as a repeal of any act of the Legislature designed to secure the purity of public supplies of potable waters, or to prevent the pollution of streams whether such streams be potable streams or not, but this act shall be deemed only to be additional legislation.

4. The word "person" as used herein shall mean and include any individual, copartnership, association, corporation or joint stock company, their lessees, trustees, or receivers appointed by any court whatsoever. The word "municipality" as used herein shall mean and include every political subdivision of the State of New Jersey.

5. This act shall take effect immediately.

Approved March 26, 1926.

APPENDIX SIX

PROPOSED LEGISLATION

AN ACT to provide for the relief and prevention of the pollution of the Hackensack river and its tributaries within the Hackensack Valley Sewerage District, authorizing the appointment of a Commission and defining its powers and duties and creating the right for the Commission to deal with municipalities and private companies for the disposal of sewage and providing the necessary funds for the construction and operation of a trunk sewer system and treatment works and its enlargement or extension and the acquisition of lands and providing for the reimbursement to the Counties for the payment of the principal and interest on bonds and certificates of indebtedness issued therefore and providing for the collection of any sums due the Counties.

BE IT ENACTED BY THE SENATE AND GENERAL ASSEMBLY OF THE STATE OF NEW JERSEY.

1. The Hackensack Valley Sewerage Commission, which shall consist of six members, is hereby created. As soon as practicable after this act takes effect the members of this Commission shall be appointed by the Boards of Chosen Freeholders of the County wherein are situated the Municipalities comprising the Hackensack Valley Sewerage District, as defined in Chapter 144 of the Laws off 1930. Upon written application to the Commission created by this act, and Municipality within the territorial limits of the Counties affected hereby will be permitted to contract for the disposal of sewage through any and all systems established or to be established by the aforesaid commission. Provided, however, that written notice of said application shall be given by the Municipality to the Board of Chosen Freeholders of the County in which said Municipality is located. The Boards of Chosen Freeholders may by concurrent resolution authorize the Commission to enter into a contract with any Municipality so applying. The Board of Chosen Freeholders of each County shall appoint three members to serve on such Commission as follows:

The Board of Chosen Freeholders of the County of Bergen shall appoint three members; one for the term of two years, one for the term of four years and one for the term of six years or until their successors are oppointed and qualified.

The Board of Chosen Freeholders of the County of Hudson shall appoint three members; one for the term of two years, one for the term of four years and one for the term of six years or until their successors are oppointed and qualified.

At the expiration of the terms of the Commissioners first appointed

their successors shall be appointed for a full term of six years. The members appointed as aforesaid shall constitute the Hackensack Valley Sewerage Commission. Every person appointed as a member of the commission shall be a resident of the County from which he is appointed. A vacancy occurring in the office of a member of such Commission shall be filled for the unexpired term by the members of the Board of Chosen Freeholders of the County affected. The Commission may elect a Chairman and Vice-Chairman from among its own members who shall serve for two years or until their successors are appointed and qualify and a Secretary-Treasurer who need not be a member of the Commission. Each of said Commissioners so appointed shall before they enter into the duties of their office take and subscribe an oath that they will faithfully and impartially execute the duties imposed upon them by law. They shall cause the same to be filed with the Clerk of the Board of Chosen Freeholders of their respective county. The members of said Commission shall receive no compensation for their services but shall be paid their actual and necessary expenditures in the performance of their official duties. The Commission may adopt a seal for the Commission and four members of the Commission shall constitute a quorum for the transaction of business. The meetings of said Commission shall be public and its records open to public inspection at all reasonable times. The Commission is further authorized and empowered to institute in the name of said Commission suits at law or in equity as may be deemed necessary or proper to enforce the provisions of this act.

In any action or special proceeding in a court of record involving the constitutionality of this act or the statutes or the boundaries of said sewerage district established or created as provided by this act or the validity of amount of any assessment imposed by this act, the Counties of Bergen and Hudson shall be necessary parties.

The Commission is hereby empowered to hire necessary office facilities and to furnish the same with necessary and suitable equipment for the proper transaction of the business of the Commission.

The Commission is further empowered to employ all necessary clerical and engineering services and to fix the compensation therof. It is also directed and empowered to fix the salary of the Secretary-Treasurer of the Commission which shall not exceed $6,000.00 per annum. The Commission is also empowered to fix the reasonable compensation of counsel whom they are hereby authorized to employ.

The Commission is authorized to adopt rules and regulations for the conduct of the business of the Commission.

The Commission is authorized with the concurrence of the Boards of Chosen Freeholders to contract with any Municipality or private or public corporation who may now or hereafter be found to be discharging

sewage directly or indirectly into the Hackensack River or its tributaries.

2. The Commission, after examining the report submitted by the Commission as provided in Chapter 144 of the Laws of 1930, and the amendments thereof and supplements thereto, and after making the necessary studies and investigation thereof, may adopt, in whole or in part, the findings of such Hackensack Valley Sewerage Commission created as aforesaid.

The Commission hereby created shall, from time to time, prepare preliminary plans and maps of such proposed assessment areas in the Counties which in the judgment of such Commission require therein the construction of sewers. Such plans and maps shall show:

1. The proposed location of the sewer;
2. The area which in the judgment of the Commission is benefitted thereby;
3. A suitable description of such area; and
4. Such other information as the Commission shall deem necessary, including estimates of the cost of same.

The Commission shall, from time to time, prepare preliminary plans and maps of treatment plants and/or pumping stations as in its judgment may be necessary to care for the sewage of any trunk sewer or sewers heretofore or hereafter constructed in said sewerage district.

In order to carry out the purposes of this act, the Commission and its employees may enter upon private or public lands, and make such reasonable use of the same as the Commission may deem necessary and proper.

The Commission shall, prior to the award of any construction contract or contracts fix and determine the area or district to be benefitted thereby. Before fixing and determining any such area, a public hearing thereon shall be held by said Commission after notice thereof is given by publication in such manner as said Commission shall direct. All lots or parcels of land and within any such district or area when so fixed and determined, are hereby declared to be benefitted by the construction of any such sewer and/or treatment plants and pumping stations to be constructed and maintained under the provisions of this act and shall be subject to the assessments to be imposed as provided by this act to pay the cost of operation, maintenance and repair of such sewers and/or treatment plants and pumping stations and to reimburse the respective Counties for the payment of principal and interest on bonds and certificates of indebtedness issued as provided by this act.

Notwithstanding the provisions of any general, special or local law specifically or otherwise to the contrary, no lots or parcels of land in any such district shall be exempt from the taxes and assessments to be imposed as provided by this act, except such as may belong to the United States or

used as a cemetery or are exempt from taxes and assessments under the provisions of Chapter 110 of the Laws of 1918, as amended or supplemented.

The action of said Commission fixing and determining any such district or area shall describe the same.

3. The Commission shall have full right and power and responsibility to engage experienced designing and a supervising engineer or engineers. They shall have full right, authority and responsibility to secure surveys and borings and to make a project report to indicate definite locations of trunk sewers and branches, together with the location of all the main characteristics of all pumping stations and treatment works, preparation of contract, plans, specifications, forms of contract and all other work necessary to advance the entire project up to the letting of contract stage; to supervise all construction work to its completion, and to have authority and responsibility over all the engineering work, including the management of field forces, supervision of working drawings needed during construction, preparation and approval of monthly and final estimates, the supervision and preparation of record drawings of all structures as actually built and the preparation of current annual and final reports, including directions as to operations of the works; designing and supervising engineer or engineers to have the right to employ men of wide experience as resident engineers to direct the field forces of the engineering staff of the Commission. Upon the completion of the work, the designing and supervising engineer or engineers to take charge of the operation of the plant or plants and instruct the operating force of the Commission as to what their duties are in order to get efficient and economical results.

The Commission, may also, from time to time, employ or appoint such experts, engineers, officers, agents, employees, workmen and servants, as it may deem necessary or proper to enable it to perform its duties and carry out the objects and purposes of this act; and said Commission may fix and determine the duties and compensation of said experts, engineers, officers, agents, employees, workmen and servants, and remove or discharge the same or any of them at pleasure.

The Commission may purchase such equipment as in its judgment may be necessary to carry out the objects and purposes of this act.

The Commission shall have the right to enter into a contract for the services of the designing or supervising engineer or engineers but before the execution of said contract the Commission shall by resolution request from the Boards of Chosen Freeholders of the respective Counties a sum equal in amount to the amount of said contract which sum shall be concurred in by the Boards of Chosen Freeholders and upon receipt of same by the Commission it shall establish a fund and make progressive payments

to the designing or supervising engineer or engineers for his or their services in accordance with the provisions of the contract.

Before advertising for proposals for any contract for work or equipment authorized by this act the Commission shall, from time to time, submit a full statement of the work or equipment necessary and proposed to be executed or purchased at that time with the estimated cost of such work or equipment, prepared by a competent designing engineer and a requisition to each Board of Chosen Freeholders for the amount of such cost. The concurrence of the Board of Chosen Freeholders shall be necessary before the Commission shall proceed.

A petition signed by property owners, whose property equals in value sixty per cent of the assessed valuation of real property within a municipality, objecting to the municipality participating in the use of the proposed Hackensack Valley Sewerage System shall act as a bar to the rights of the said Commission to include any such municipality within the assessment area. Provided, however, that said petition shall be filed with the Clerk of the Board of Chosen Freeholders of the County in which such municipality is located within thirty days after any public hearing called by the Commission and, provided further, that the sixty per cent. of the assessed valuation shall be construed to mean the assessed valuation of the taxable year preceding the date of such petition and the County Board of Taxation shall upon the request of the Commission certify the amount of the assessed valuation of real property within the area of the objecting municipality.

4. Before proceeding with construction of any kind whatsoever, the plans and specifications therefore shall be submitted to the State Department of Health for approval as a sanitary measure and a permit obtained from the State Department of Health to proceed with the work.

After the works have been completed and put in operation and before final payment has been made on same, the acceptance of the works by the State Department of Health as to its satisfactory sanitary conditions must be obtained before the final acceptance of the works by the Commission.

5. The Commission after completion of maps or plans provided for in this act, shall report the same to the Boards of Chosen Freeholders of the respective Counties, together with such recommendations as it shall deem necessary and proper.

6. The Boards of Chosen Freeholders of the respective Counties are hereby authorized to appropriate, in any year, for the purpose of carrying out the provisions of this act, such sum or sums as such Boards may deem proper. The Commission shall, however, report to the Boards of Chosen Freeholders of the respective Counties what amount or proportion of the preliminary appropriations so made by said Boards was expended by said Commission in the formation of such districts and chargeable to such districts heretofore or hereafter created and the amount so stated shall con-

stitute a part of the cost of construction of the sewer therein and shall be refunded to the respective Counties out of the first money raised for such purpose. The cost of any such sewer system shall include all the expenses of the Commission and shall also include interest on certificates of indebtedness and bonds issued on account of such district, together with the operation, maintenance and repair charges, if any, for such district payable prior to the levy of the first assessment within such district.

7. The expenses of the Commission for capital costs and administration and maintenance shall be divided among the Counties affected by this act in the proportion of sixty per cent to the County of Bergen and forty per cent to the County of Hudson.

The concurrence of the Boards of Chosen Freeholders shall be necessary before the Commission shall assume any financial obligation.

The above ratio may be changed from time to time by concurrent action of the Boards of Chosen Freeholders.

8. The amount of money any municipality or private sewer company will have to pay for the right to discharge sewage from their local systems into the trunks and intercepters of the Commission will be based on the million gallon flow as a unit of measurement using the most approved measuring device that the Commission may be able to obtain. The rate per million gallon flow fixed by the Commission will be an amount just sufficient to pay the principal and interest of bonds and certificates as they become due together with the cost of operation, maintenance and repairs of the Hackensack Valley Sewerage system. The rate per million gallon flow as fixed by the Commission for each year following the putting into service of the sewer system shall be subject to review and adjustment every three years.

Before any municipality or private sewer company may discharge sewage from their local systems into the trunks and interceptors of the Commission they shall enter into a contract with the Commission for the privilege in accordance with the terms and conditions of said contract.

Any municipality within the Hackensack Valley Sewerage district may enter into a contract with the Hackensack Valley Sewerage Commission without providing a specified appropriation to cover the estimated cost of the contract, provided, however, that a clause shall be inserted in the contract specifying that the necessary funds to finance the cost of the municipality for the aforesaid purposes will be provided in the annual appropriation bill.

9. Said Commission shall have full power in its name to acquire by purchase, gift, grant, devise or condemnation, of lands, rights and interests in lands within the limits of said sewerage district, which may be necessary for the building or construction of any sewer or sewers and the necessary appurtenances thereto, to the point or points of discharge or dis-

posal determined by said Commission. The said Commission may with the concurrence of the Boards of Freeholders have full power in its name to acquire by purchase, gift, grant, devise or condemnation any existing sewage treatment plant or plants or any part thereof, of either public or private ownership. Provided however: If in the judgment of the Commission with the concurrence of the Boards of Freeholders they shall deem it advisable to take over any existing plants before the completion of the first construction period, they are hereby authorized so to do and to operate the same or otherwise dispose of the sewage as in their judgment will better provide for the temporary relief from existing conditions.

In case condemnation proceedings shall be instituted the procedure shall be in accordance with the provisions of an act entitled "An Act to Regulate the Ascertainment and Payment of Compensation for Property Condemned or taken for Public Use (Revision of 1900)" Approved March 20th, 1900.

Whenever the aforesaid Commission shall enter into a contract with a private sewer company for the right to discharge sewage from their local system into the trunks and intercepters of the Commission it shall be under the same terms and conditions as the Commission is authorized to enter into between Commission and Municipality and any charges accruing to the Commission for services rendered to such private sewer company shall be a lien against the property of said company.

10. The Hackensack Valley Sewerage Commission is hereby vested with absolute discretion in the determination of the size and capacity of all sewers, intercepting sewers, plants and works.

11. The Commission shall have the right to enter into contract or contracts for separate treatment plants and/or sewers with private or public industries, if deemed advisable. Such industries shall pay an annual charge sufficient to liquidate capital costs, including interest, operation, maintenance and repair, when due, and may also provide for temporary relief to existing private industrial plants, if deemed advisable, and any such charges accruing to the Commission for services rendered to such private or public industry or industries shall be a lien against the property of such private or public industry or industries.

12. When any work to be performed or material to be furnished shall involve an expenditure of any sum of money exceeding the sum of $2,000.00, the Commission shall designate the time when it will meet at its usual place of meeting to receive proposals in writing for doing the work and furnishing the material; and said Commission shall order its Secretary-Treasurer to give notice by advertisement inserted in at least one newspaper printed and circulated respectively in each of the Counties, at least ten days before the time of such meeting, of the work to be done and material

to be furnished, of which at the time of such order, it shall cause to be filed in its office particular specifications.

13. All proposals received shall be publicly opened by the said Commission and it shall award the contract to the lowest responsible bidder; all contractors shall be required to give bond, satisfactory in amount and security, to the Commission.

14. For the purpose of obtaining money to acquire the necessary land and to erect thereon such building or buildings, and to purchase and install the necessary equipment to effectuate the purposes of this act and for the acquisition of any existing public or private sewerage system or systems it shall be lawful for the Board of Chosen Freeholders in the case of the County of Hudson to issue and sell the bonds of said County to an amount not to exceed one percentum of the assessed valuation on real property including improvements for the three preceeding years of said County and in the case of the County of Bergen it shall be lawful for the Board of Chosen Freeholders thereof to issue and sell the bonds of said County to an amount not to exceed four percentum of the average assessed valuations on real property including improvements for the three preceeding years of said county; said bonds shall be issued under the provisions of an act entitled "An Act to Authorize and Regulate the Issuance of Bonds and Other Obligations and the Incurring of Indebtedness by County, City, Borough, Town, Township or any other Municipality Governed by an Improvement Commission," Approved March 22nd, 1916, and the amendments thereto and the supplements thereof. But said indebtedness and bond issue to be held to be authorized in addition to the amount of indebtedness and bonds fixed by the Charter or general act as a limitation beyond which said County or Counties may not incur indebtedness or issue bonds. The said indebtedness and bonds authorized by this act shall not to be taken to be included within or governed by any such limitation but the amount of bonds issued for the purposes of the Commission shall be deducted from the gross debt.

15. Upon the completion of any sewer or intercepting sewer or sewers, plant and works, and appurtenances, the Commission is authorized and directed to retain and have the sole control and charge of the said sewer or sewers, plant and works and appurtenances, and every municipality and private or public corporation using such intercepting sewer or sewers, plant and works, is hereby required to pay semi-annually to the Commission on demand its proportion of the cost of operation, maintenance and repair of the same together with the principal and interest due on capital investment as the same may be certified to it or them from time to time by the Commission, pursuant to the terms of said contract or contracts.

16. It shall be the duty of the Commission to employ the services of

the Department of Municipal Accounts of the State of New Jersey to annually audit the books and accounts of the said Commission. Upon the completion of said audit, a copy of the same shall be kept as a permanent record by the Commission at its office and a duplicate original filed with the Board of Chosen Freeholders of the respective Counties.

17. The said Commission shall at all times keep full and accurate accounts of its receipts, expenditures and liabilities and shall annually cause detailed statements thereof to be published and a copy thereof mailed to the Clerks of the respective Boards of Chosen Freeholders. The members of said Commission shall be liable for any unlawful act as are the members or officers of any public body and no member of said Commission shall be directly or indirectly interested in any contract awarded under the provisions of this act, or in furnishing material or supplies therefore to any contractor or in furnishing security for the performance of any contract.

18. For the purpose of removing any doubt as to the corporate power and authority of the Hackensack Valley Sewerage Commission to enter into and perform the contracts herein and hereby authorized and to execute and perform the duties herein imposed upon said Commission, the said Hackensack Valley Sewerage Commission, and their successors in office are and shall continue to be a body politic and corporate with the perpetual succession under the name of Hackensack Valley Sewerage Commission, with power to sue and to be sued, with power to adopt and use a corporate seal, and with the right, power and authority to acquire, hold use and dispose of all such property, real or personal, as may be proper or necessary and with all other power or authority proper or necessary to carry out and effect the purposes for which said Commission is created.

19. The Boards of Chosen Freeholders of the respective Counties shall each year before the levy of taxes make up an estimate or budget for any such district established or created as provided by this act, which shall give the estimated sums required for the operation, maintenance and repair of the sewers, and/or intercepting sewers, and/or treatment plants. and/or pumping stations within such district and all other lawful charges against such district, including the funds necessary to reimburse the respective Counties for the payment of principal and interest on bonds and certificates of indebtedness issued as provided by this act for the benefit of any such district.

Said Boards of Chosen Freeholders of the respective Counties shall apportion and certify annually on or before December 31st to the several municipalities within any such district the total amount of the estimate or budget made up for any such district according to the manner and degree in which the sewers, and/or intercepting sewers, and/or treatment

plants, and/or pumping stations have been used by the respective municipalities.

It shall be the duty of the governing body of each of the several municipalities within the said sewerage district to include the amount so certified in the annual budget of the municipality.

20. It shall be the duty of the Collector or other officer having the custody of the collected taxes on or before the fifteenth day of June in each year to pay to the County Treasurer of the County one-half of the amount of the county tax required to be assessed and raised in his taxing district for the aforesaid purpose and on or before the fifteenth day of December in each year to pay to the County Treasurer the remaining one-half of the tax to be provided for the aforesaid purpose. On any part of the tax payable to the County Treasurer by the taxing district which shall remain unpaid after the time within which they are required to be paid by this act the taxing district which may be in arrears shall pay to the County Treasurer interest at the rate of six per cent per annum.

21. If any such municipality within any such district shall neglect to pay over to the County Treasurer the amount due him or any part there of on account of the assessments provided for in this act to be paid by any such municipality, the County Treasurer may and he is hereby authorized to borrow on the credit of the County the amount of the deficiency and certificates of indebtedness therefore payable within one year from date may be issued by him and the amount of such deficiency shall be repaid by any such municipality in any such district and unless so paid shall be levied upon the taxable property of any such municipality by the Boards of Chosen Freeholders of the respective Counties as part of the next county tax payable by such municipality.

22. Anticipated payments made by any such municipality within any such district for which such municipality shall not have been reimbursed by taxes which it is entitled to retain shall be forthwith refunded by the County. In case the provisions of this act authorizing or requiring anticipated payments by any such municipalities are unconstitutional or for any reason unauthorized, or in case such payments were unauthorized by reason of any unconstitutional or other defects in this act, or in the proceedings thereunder, except the failure of any such municipality or officers thereof to perform some duty lawfully imposed on them by this act and all payments made by any such municipality on account of taxes which cannot be collected or on account of taxes which any such municipality shall be obligated to refund, shall be forthwith refunded by the County to such municipality whenever the inability to collect or the obligation to refund such taxes shall arise by reason of any such constitutional or other defect in this act or any procedings thereunder, except the failure of such municipality or officers thereof to perform some duty law-

fully imposed upon them, but in any such event, the County shall be entitled to be reimbursed by the district for the amount so paid to any such municipality within such district to the extent that taxes therefor may be lawfully imposed and collected under this act, or any amendment thereof or supplement thereto.

23. If any part or parts of this act shall be declared invalid or unconstitutional, the remainder of the act shall stand.

All acts or parts of acts inconsistent herewith are repealed and this act shall take effect immediately.

APPENDIX SEVEN

HACKENSACK WATER COMPANY
WEEHAWKEN, N. J.

November 13,1931

Subject PURIFICATION.

Hackensack Valley Sewerage Commission.
Tenafly, New Jersey.

ATTENTION OF MR. THOMAS J. WASSER, CHAIRMAN

Gentlemen,

In order to protect the New York State portion of the watershed from possible contamination, rules and regulations were adopted by the New York State Health Department in 1900 and 1903, one set applicable to the Village of Nyack covering a part of the watershed and the other to this Company covering the entire watershed. The Health Department with ample jurisdiction, the Nyack Water Board and this Company actively co-operate on all watershed matters where possible contamination is involved.

The Company maintains a systematic and complete patrol of the entire watershed at regular intervals, weekly or bi-weekly, locating and abating any existing violations and offering advice and suggestions which are effective in preventing new violations arising from new construction. From ninety-eight sampling stations on the watershed of which thirty-six are in New York State, samples are collected by watershed patrolmen at varying but regular intervals, analyzed and the results tabulated. The condition of any stream is accurately known and any unsatisfactory condition given the proper attention. The activities of watershed sanitation are under the supervision of a trained sanitary engineer with several assistants, supplemented by the regular laboratory staff at the filtration plant.

Inspections, analyses and the condition of the water near the state line and at the inlet of Oradell Reservoir, indicate that the sanitation of the entire watershed is now well in hand and the excellent character of the supply can readily be continued in co-operation with the New York State Health Department and other state agencies.

Looking into the future, the centers of population along the Pascack in New Jersey and New York, should, no doubt, be ultimately provided with sewerage facilities and an effluent conduit such as the present intercepting sewer to Westwood heretofore constructed by the Company. Other

centers of population that may develop in the future on the watershed in New York State can economically be provided with outlets into the Hudson River or its tributaries. This is well illustrated by the case of the recently constructed Rockland Hospital where joint co-operation of the New York State Department of Mental Hygiene, the State Health Department and the Water Company, provided a satisfactory outlet for treated effluent into Sparkill Creek.

Yours very truly,

HACKENSACK WATER COMPANY

Nicholas S. Hill, Jr.,

President.

APPENDIX EIGHT

STATE OF NEW JERSEY
BOARD OF COMMERCE AND NAVIGATION
FIRST NATIONAL BANK BUILDING
No. 1 EXCHANGE PLACE
JERSEY CITY, N. J.

November 17, 1931.

Mr. T. J. Wasser, Chairman,
Hackensack Valley Sewerage Commission,
6 Highwood Avenue,
Tenafly, N. J.
Dear Sir:

May I request that your Commission in its studies and reports give adequate consideration to the fact that the discharge of sewage into a tidal navigable river, like the Hackensack River, is detrimental to the State's navigation and riparian interests.

The pollution of this waterway by the discharge of sewage and other wastes, by rendering less attractive the appearance of the stream, reacts adversely upon the riparian values. Furthermore, the deposit of sludge into the waterway, by causing the formation of shoals, markedly impairs the waterway's utility from the standpoint of navigation. This also necessarily reacts adversely upon the riparian values inasmuch as it necessitates maintenance dredging to preserve the navigable depths required.

The Board of Commerce and Navigation, as you know, was created in 1915 as a consolidation of several State commissions including the Riparian Commission and the Harbor Commission. As successor to the Riparian Commission, the Board stands in a position of trustee in administering the lands flowed by tidewater which are by statutory and constitutional provision dedicated to the support of free public schools. As successor to the Harbor Commission, the Board is charged with the duty of investigating and reporting upon the condition of waterfront or harbor facilities and other matters incident to the movement of commerce upon navigable waters within or bounding on this State, and is also charged with the duty of studying all plans for the development of waterfront which involve the construction, change, alteration or modification of a dock wharf, pier, bulkhead, bridge, pipe line, cable, etc., the construction of which all require permit of the Board as successor to the Harbor Commission (See Chapter 123, Laws off 1914).

Respectfuly submitted,
VICTOR GELINEAU,
Director.

APPENDIX NINE

Hudson County Mosquito Extermination Commission
Trust Company of New Jersey Building
Bergen and Sip Avenues
Room 1010

November 9, 1931.

Hackensack Valley Sewerage Commission,
Tenafly, N. J.

Attention:—Mr. Thomas J. Wasser, Chairman,

Gentlemen:—

The blockage of flow in Penhorne Creek at and south of Secaucus Road caused by the accumulation of sludge from the piggeries in Secaucus, which has proved a serious detriment to the drainage operations of this Commission for a number of years, resulted in the season just closed in a particularly troublesome situation in that mosquito breeding could not be satisfactorily controlled in the marsh areas lying to the east of the Creek, north and south of Secaucus Road. These areas have been ditched by this Commission, as in the case of all other marsh areas of the County, but due to the blockage of the Creek there is no outlet for the ditches and water accumulates not only in the ditches but upon the surface of the land thus establishing bad mosquito breeding conditions difficult of control.

Nowhere else in the County is there a similar condition and it is certainly apparent that the accumulation of sludge now in the Creek should be removed and the discharge of sludge into the stream thereafter should be prevented.

Your co-operation, as Chairman of the Hackensack Valley Sewerage Commission, looking to the correction of the existing unfavorable conditions is urged in the interest of mosquito control and public health.

Yours very truly,

L. E. Jackson,

Executive Secretary.

APPENDIX TEN

EXCERPT FROM 1929 REPORT OF THE SANITARY COMMISSION OF WESTCHESTER COUNTY, N. Y.

Preliminary Approximate Estimate

Total ultimate cost to complete county-wide sanitation:

Trunk sewer projects— State of progress	Number of projects	Approximate cost
Authorized and Appropriated for	5	$16,750,000*
Submitted to Board of Supervisors	2	9,900,000
Plans Detailed	2	3,500,000
General Plans Outlined	3	8,650,000
Preliminary Studies Made	3	17,050,000
Total	15	$55,850,000

* Includes $3,800,000 for existing Bronx Valley Sewer.

During the more than three years which the Westchester County Sanitary Commission has been carrying out its extensive program of improvement, all of its legal work has been done under the personal direction of County Attorney William A. Davidson. The engineering work has been in charge of W. W. Young, Consulting Engineer, who was largely responsible for the design of the Bronx Valley Sewer and who has been assisted by a competent, efficient and loyal force of engineers. The office work has been economically and effectively transacted under the management of Eugene S. Martin, who was named secretary of the Commission upon its initial appointment by the Board of Supervisors. Valuable help and advice has been extended by the State Commissioner of Health, Dr. Matthias Nicoll, Jr., and Mr. C. A. Holmquist, Chief of the Sanitation Division of the State Department, and it is the desire of the Commission to express its appreciation of their co-operation and prompt consideration of plans submitted for approval.

In the great preponderance of its work the Westchester County Sanitary Sewer Commission has almost invariably met the heartiest co-operation. It is the desire of the Commission to express its appreciation of this attitude to the members of the Board of Supervisors, other county officials and governing boards and municipalities and to large groups of citizens with whom it has had occasion during the past three years to come in contact. This spirit of helpfulness has been of the greatest value in furthering the work of the Commission.

APPENDIX ELEVEN

August 24, 1931.

From Engineering News-Record,
August 20, 1931; p. 313.

22 BRITISH TOWNS TO BUILD LARGE ACTIVATED-SLUDGE PLANT

"An activated-sludge plant to treat the sewage of 22 municipalities in Middlesex County, England, with a population estimated at 700,000 in 1930, is a part of a joint sewerage project recently authorized by Parliament. This plant would replace 27 sewage-works now owned and operated by 21 of the 22 places, one small community having no sewerage system. The effluent from all the plants flows into the Thames or its tributaries above London, that from several of the works going into tributaries above the Thames River intakes of the Metropolitan Water Board. The average total dry-weather flow of sewage to the 27 works in 1928, from a total estimated resident population of about 610,000, was 28,500,000 gal. (U. S. standard,) or an average of 47 gal. per day. Ministry of health requirements for sewage-works capacity are full treatment for three times and sedimentation only for another three times the dry-weather flow.

"The new works will be located at Mogden, which is 5 miles above the boundary of the county of London and 2½ miles below Teddington Weir, at the head of the tidal flow of the Thames. The estimated cost of trunk sewers and new sewage-works up to the close of 1940 is $21,900,000. In addition some $3,400,000 will be paid to the 21 municipalities for the 27 works that are to be abandoned and for land on which the new works are to be located. It is estimated that ultimately the works will treat the sewage from a population of 1,800,000 and that the total capital cost will be more than $29,200,000.

"The parliamentary act authorizing the project was promoted by the Middlesex county council, the several municipalities and their engineers cooperating. The project is based on reports made in 1929 and 1930 by John D. Watson, consulting engineer, Birmingham, who for many years was engineer and who is now consulting engineer for the Birmingham, Tame and Rea District. The firm of Dodd & Watson, Birmingham, of which Mr. Watson and his son are members, is now drawing plans and specifications for the project, which will be carried out by the Middlesex county council, which has become responsible for providing all trunk sewers to convey sewage emanating from the districts to be served. The council will levy a charge upon the districts to pay for sewers, treatment

	13	14
H MADE A LANT? OF THE	ARE THERE ANY PRIVATE DISPOSAL PLANTS WITHIN THE AREA OF YOUR MUNICIPALITY? IF SO, GIVE THE NAME OF CONCERN MAINTAINING SAME.	IS YOUR MUNICIPALITY WHOLLY, OR IN PAR WITHIN THE AREA OF THE HACKENSACK VALL
	NO	WHOLLY
	NONE TO MY KNOWLEDGE	WHOLLY
	NO	IN PART
	NONE	
	NONE KNOWN	
	NONE	
	NO	

HACKENSACK VALLEY SEWERAGE COMMISSION

TABULATION OF MUNICIPAL DATA ON SEWAGE DISPOSAL

MUNICIPALITIES of the	1	2	3	4	5-A	5-B	5-C	6	7	8	9			10	11	12	13	14	15	16
	WHAT RECORDS HAVE YOU OF EXCEPTIONALLY HIGH WATERS OR FLOODS IN THE HACKENSACK RIVER OR ITS TRIBUTARIES WITHIN THE LIMITS OF YOUR MUNICIPALITY?	TO WHAT EXTENT HAS DAMAGE BEEN DONE TO PROPERTY WITHIN YOUR MUNICIPALITY BY SUCH HIGH WATERS OR FLOODS?	DOES YOUR MUNICIPALITY MAINTAIN A SEWAGE DISPOSAL PLANT?	DOES ALL SEWAGE OR WASTE DISCHARGE THAT WILL TEND TO POLLUTE THE HACKENSACK RIVER OR ITS TRIBUTARIES PASS THROUGH YOUR DISPOSAL PLANT?	FROM WHAT SOURCE DOES SEWAGE OR WASTE DISCHARGE THAT TENDS TO POLLUTE THE HACKENSACK RIVER OR ITS TRIBUTARIES THAT DOES NOT PASS THROUGH THE DISPOSAL PLANT ARISE?	IF FROM MANUFACTURING PLANTS, GIVE THE NAMES.	IF FROM RESIDENTIAL MOTOR, GIVE NUMBER AND SIZE OF OUTLETS PASSING, AND LOCATION OF SAME.	DOES STORM WATER PASS THROUGH YOUR DISPOSAL PLANT?	WHAT IS THE PRESENT CONDITION OF YOUR DISPOSAL PLANT? (A) SATISFACTORY. (B) UNSATISFACTORY. (C) INSUFFICIENT IN CAPACITY.	WHAT CAPACITY IN MILLION GALLONS PER DAY WAS YOUR DISPOSAL PLANT DESIGNED FOR? (24 HOURS)	GIVE CENSUS OF YOUR MUNICIPALITY AS FOLLOWS FOR THE YEARS			IN WHAT YEAR WAS YOUR DISPOSAL PLANT BUILT?	WHAT METHOD OF SEWAGE TREATMENT IS EMPLOYED IN YOUR DISPOSAL PLANT?	HAS THE STATE BOARD OF HEALTH MADE A REPORT ON YOUR DISPOSAL PLANT? A IF SO HOW RECENT? B WHAT WAS THE GIST OF THE REPORT?	ARE THERE ANY PRIVATE DISPOSAL PLANTS WITHIN THE AREA OF YOUR MUNICIPALITY? IF SO, GIVE THE NAME OF CONCERN MAINTAINING SAME.	GIVE APPROXIMATE AREA OF YOUR MUNICIPALITY WHOLLY, OR IN PART, WITHIN THE AREA OF THE HACKENSACK VALLEY	GIVE APPROXIMATE AREA OF YOUR MUNICIPALITY IN SQUARE MILES.	GIVE APPROXIMATE AREA IN SQUARE MILES OF YOUR MUNICIPALITY LYING WITHIN THE AREA OF THE HACKENSACK VALLEY.
											1910	1920	1930							
BERGEN COUNTY																				
ALPINE BOROUGH																				
BERGENFIELD BOROUGH	NO OFFICIAL RECORDS HAVE BEEN KEPT, BUT THERE IS ALWAYS HIGH WATER FOLLOWING THROUGH THE BOROUGH AFTER HEAVY RAINFALL.	DAMAGES HAVE NEVER BEEN TABULATED.	YES	YES	THERE IS NONE SUCH TO OUR KNOWLEDGE	NONE	NONE	No	(A) YES (C) YES	4 MILLION GALLONS.	1891	5867	6816	PART IN 1925 PART IN 1929	BOTH PRIMARY AND SECONDARY.		NO	WHOLLY	4	4
BOGOTA BOROUGH	NONE EXCEPT HEARSAY. THE AVERAGE TIDE VARIES BETWEEN 5.73 AND 6.00 FEET. I AM INFORMED THERE HAVE BEEN 7.5 TO 8.0 TIDES.	NONE TO MY KNOWLEDGE.	YES	NO	MANUFACTURING WASTE FROM FACTORIES OPERATING ON THE BANK OF THE RIVER.	BOGOTA PAPER AND BOARD CO. FEDERAL PAPER BOARD CO. CONTINENTAL PAPER CO.	NONE	NO	(C) NEW PLANT PRACTICALLY COMPLETE	0.295 " " (OLD PLANT) 0.655 " " (NEW)	1129	8906	7341	1915	PRIMARY SEDIMENTATION.	(A) 2 YEARS AGO (B) ORDERED TO ENLARGE PLANT WHICH IS BEING DONE, AND THE NEW PLANT SHALL BE IN OPERATION WITHIN A FEW MONTHS.	NONE TO MY KNOWLEDGE.	WHOLLY	1	1
CARLSTADT BOROUGH	NONE.	NONE	YES	YES	NONE			NO	(A) SATISFACTORY.	0.25	1807	4472	5425	1910	ORDINARY SEPTIC TANK WITH EFFLUENT DISCHARGING INTO OPEN DITCH.	NO	NO	IN PART	8.5	3
CLIFFSIDE PARK BOROUGH	NONE	NONE	YES	NO	STORM WATER			NO			3394	5709	15267				NO	IN PART	0.93	0.22
CLOSTER BOROUGH	NO RECORDS HAVE BEEN KEPT.	CAUSED TEMPORARY FLOODED CONDITION.	NO	NO PLANT	NO SPECIAL SOURCE.			NO PLANT			1483	1840	2308				NO	WHOLLY	4.3	4.3
CRESSKILL BOROUGH	NONE.	NONE	NO		NONE	NONE	NONE				553	942	1924					NO	2	NONE
DEMAREST BOROUGH	NONE	NONE	NO	NO	SEEPAGE THROUGH SOIL AND ROAD DRAINS INTO TENAKILL BROOK.	NONE	NONE	NO			560	854	1013				NONE	WHOLLY	2	2
DUMONT BOROUGH	STREAM NOT SUBJECT TO TIDAL INFLUENCE, LOWEST ELEVATION 25 FEET ABOVE TIDES.	NO RECORDS OF DAMAGE NOTED AS PROPERTY IS GENERALLY UNDEVELOPED ALONG BANKS.	YES	YES	NONE	NONE	NO UNSEWERED AREAS ADJACENT TO STREAMS.	NO	SATISFACTORY	2.5 " "	1785	2537	5811	1924 AND 1929	SEPARATE SETTLING AND DIGESTION UNITS, TRICKLING AND SAND FILTERS, FINAL SETTLING-CHLORINATION.	(A) JULY 1930. (B) TURNING OUT SATISFACTORY EFFLUENT.	NO	WHOLLY	1.5	1.5
EAST RUTHERFORD BOROUGH	NONE	NONE	YES	YES	TWO FACTORIES.	TROBICA CHEMICAL WORKS ARE E. RUTHERFORD ALLIANCE HOSIERY MFG. CO. WHICH HAS CONSENT TO DISCHARGE INTO SEWER BUT NOT YET CONNECTED TO SEWER AT PRESENT.	NONE.	NO	(A) YES (C) NO - STABILITY GOOD.	0.3 " "	4275	5483	7080	1908	AS REQUIRED BY STATE BOARD OF HEALTH.	(A) 1930. (B) AS FAR AS CAN BE EXPECTED FOR TYPE OF PLANT.	NO	PARTLY- ONE PART IN PASSAIC VALLEY SEWER	6	4.5
EMERSON BOROUGH	NONE	NONE	NO		NONE	NONE	NONE	NO			767	973	1394				NO	YES	2.5	2.5
ENGLEWOOD CITY	HIGH WATER FLOOD IN THE BRANCH OF THE NORTH RIVER WHICH PASSES THROUGH THE CITY. THE FLOOD OF AUGUST 1924 WAS THE HIGHEST ON RECORD. IT WAS 5.5 FEET ABOVE THE PRESENT GRADE OF HORSENECK BROOK.	DAMAGES HAVE NEVER BEEN DETERMINED. THE LOWER SECTIONS OF THE CITY ARE SUBJECT TO FREQUENT FLOODING.	NO-- PRIVATE COMPANY DOES.	EXCEPT WHEN BY-PASSED.	ONLY WASH WATER FROM LAUNDRIES.			YES, AND OVER IT ALSO.	(B) YES (C) NOT OPERATED PROPERLY.	4.5 " " (NO CITY RECORD.)	9324	11,827	17,085	1911	MODIFIED IMHOFF TANK AND SLUDGE DRYING BED.	THE ENGLEWOOD SEWERAGE CO. REPORTED THAT THEY HAVE NO STATE REPORTS ON FILE AT THEIR OFFICE.	ENGLEWOOD SEWERAGE COMPANY.	WHOLLY IN A TRIBUTARY VALLEY.	6	6
ENGLEWOOD CLIFFS BOROUGH	NONE AT ALL	ABSOLUTELY NONE	YES	YES, INTO THE HUDSON RIVER.	OUR SEWAGE DOES NOT ENTER THE HACKENSACK RIVER.			NO	(A) YES		400	594	809	1926-27	FILTRATION	(A) 1929. (B) SATISFACTORY. THE SYSTEM WAS APPROVED.	NONE	NO		NOT IN THE VALLEY.
FAIRVIEW BOROUGH	NONE	NONE	YES	NO	NONE FROM OUR BOROUGH, TO MY KNOWLEDGE.			YES	(C) YES	DO NOT KNOW. DESIGNED FOR POPULATION OF 40,000.	5441	4852	9047	1914	BACTERIA	(A) 1930. (B) NOT LARGE ENOUGH.	NONE	PARTLY	1	0.125
FORT LEE BOROUGH	NONE	NONE	NO	NO	NO SEWAGE INTO HACKENSACK.			NO			4472	5781	8759		NONE		NO	NOT IN IT	10	NONE
HACKENSACK CITY	NONE.	NONE	YES	YES	NONE.			YES	(C) YES	1.0 MILLION GALLONS	14,050	17,697	24,586	1923	SETTLING TANKS AND SLUDGE BEDS.	(A) 1930. (B) STATE BOARD OF HEALTH REPORTS SATISFACTORY CAPACITY.	NO	YES	4.8	4.8
HARRINGTON PARK BOROUGH	NONE	NEGLIGIBLE, IF ANY.	NO								377	627	1251				NO	WHOLLY	4	4
HASBROUCK HEIGHTS BOROUGH	NONE	NO DAMAGE	YES	NO	THROUGH AN AUXILIARY PLANT (SEPTIC TANKS) SERVING ABOUT 100 PEOPLE.	NO MANUFACTURING PLANTS ARE LOCATED IN OUR BOROUGH.	TWENTY-SEVEN HOUSE CONNECTIONS (6) IN EXTREME NORTH OF TOWN.	NO			2155	2895	5858	1926	DIGESTION AND FILTRATION.		NONE	PARTLY	1	
HAWORTH BOROUGH	NONE	NONE	NO								388	748	1042							
HILLSDALE BOROUGH	NONE	NONE	NO	NO	SEPTIC TANK OVERFLOW AND CESSPOOLS FROM RESIDENCES.		SIZE 4'x 8' LOCATED THROUGHOUT ENTIRE BOROUGH.			0.87 MILLION GALLONS	1072	1720	2859				NONE	WHOLLY	2.94	2.94
LEONIA BOROUGH	NONE	NONE	YES-2	YES	NONE	NONE	NONE	NO	(A) YES	2.5 " "	1486	2979	5350	1911, 1914, 1 BUILT 1928, 1 BUILT 1926.	IMHOFF-1 PLANT — STAN. 2	(A) 1930. (B) WORKING SATISFACTORILY.	NO	WHOLLY	1.5	1.5
LITTLE FERRY BOROUGH											2341	2715	4155							
LODI TOWNSHIP	NONE AVAILABLE		YES	YES. (EXCEPT AS NOTED UNDER NO. 5 BELOW)	OPEN DITCH DRAINAGE CARRIES SOME SUCH WATER.	NONE		NO	(A) AS TO SIZE.	0.1 " "	6193	9917	12791	1929	PRIMARY-BAR SCREEN PUMP WELL. A TWO COMPARTMENT SETTLING TANK AND SLUDGE DRYING BED.	(A) OCTOBER 1930. (B) LONG DETENTION PERIOD CAUSES EXCESSIVE LIBERATION OF GAS. EXCESSIVE INFILTRATION NOTED. CHLORINATION SUGGESTED.	NONE	IN PART	0.7	0.0
LYNDHURST TOWNSHIP	NONE	NONE	YES- IMHOFF TYPE - TWO STORY.	YES	RAILROAD SHOPS. D.L.& W. RAILROAD CO.	SMALL PLANTS AT FOOT OF SMITH STREET, FORMERLY LOCATION OF AMMUNITION PLANT.	NONE	NO	(A) YES (C) NO	0.49 " "	4078	9515	17,352	1917	NO TREATMENT.	(A) 1930 + SUPERINTENDENT MARKS MONTHLY REPORT TO TRENTON. (B) SATISFACTORY.	NO	PARTLY	7.0	3.75 DRAIN FROM MILL MDW. + MEADOWS.
MAYWOOD BOROUGH	NO DETAILED RECORDS	AFFECTS THE OPERATION OF THE DISPOSAL PLANT	YES	YES	NONE			NONE EXCEPT INFILTRATION.		0.12 " " OLD TANK. 0.69 " " NEW " "	1889	1818	3398	1916 AND 1930.	SEDIMENTATION TANKS.	BEFORE THE CONSTRUCTION OF THE RECENT ADDITION THE STATE BOARD REQUIRED INCREASED CAPACITY.	NONE	IN PART FOR SURFACE WATER- WHOLLY FOR SANITARY SEWERS.	1.25	NOT DETERMINED.
MONTVALE BOROUGH	NONE	NONE	NO		NONE			NO			522	779	1243				NO	YES- WHOLE		
MOONACHIE BOROUGH											838	1194	1465							
NEW MILFORD BOROUGH	NONE AT HAND	NONE	NO			NEW MILFORD DYING AND CLEANING ESTABLISHMENT.					1141	1768	2356				NO	YES	6.0	6.0
NORTH ARLINGTON BOROUGH			YES	YES	NONE		NONE	NO	(C) TO JUST ABOUT FULL CAPACITY.	0.5 " "	4137	7787	8263	1915	IMHOFF SLUDGE DIGESTION; NO SPRINKLING FILTERS OR AERATORS.	(A) ABOUT TWO YEARS AGO. (B) UNABLE TO LOCATE IT, UNDERSTAND EVERYTHING WAS O. K. AT THAT TIME.	NO	ABOUT 5/8 OF AREA IN HACKENSACK VALLEY.	2.4	1.6 SQ MI. OF WHICH 0.8 SQ MI. IS MEADOW.
NORTHVALE BOROUGH					CESSPOOLS						588	827	1144							
NORWOOD BOROUGH	NONE	NONE	NO								564	820	1358					WHOLLY	4.0	4.0
OLD TAPPAN BOROUGH	NONE		NO			NO MANUFACTURING PLANTS WITHIN THE LIMITS OF THE BOROUGH OF OLD TAPPAN.	NONE				369	404	600				NONE	YES	6.0	6.0
ORADELL BOROUGH	NONE		YES	YES		NONE		NO	(A) YES " "	0.65 " "	1005	1286	2360	1929	BAR-SCREENS, PLAIN SETTLING, MECHANICAL SLUDGE REMOVAL, SEPARATE SLUDGE DIGESTION, OPEN SLUDGE BEDS.	(A) YES "ROUTINE" FALL 1930. (B) O.K.		WHOLLY	3.5	3.5
PALISADES PARK BOROUGH	NONE	NONE	YES	YES	NONE	REUTERS SOAP FACTORY.	NONE	NO	(A) YES (C) NO	TO TAKE CARE OF POPULATION OF 10,000 PEOPLE	1411	2833	7085	1918	NATURAL CURE OF IMHOFF SETTLING TANK.	(A) NOT TO THIS BOROUGH. (B) NONE	NO	WHOLLY	1.0	1.0
PARAMUS BOROUGH											890	1320	2249							
PARK RIDGE BOROUGH	VERY HIGH WATERS IN 1904.	BRIDGE CARRIED AWAY 1904.	NO								601	1481	2229					WHOLLY	2.0	1.0
RIDGEFIELD BOROUGH		FLOODING OF SWAMP LAND.	YES	YES	NONE			YES		0.2376 MILLION GALLONS	1965	1360	4871	1922	SEDIMENTATION TANK.	(A) YES JULY 1930. (B) THE MUNICIPALITY MUST IMPROVE ITS SEWAGE TREATMENT WORKS.	NO	WHOLLY	2.96	2.96
RIDGEFIELD PARK VILLAGE	NONE		YES-TWO	NO	SEVERAL SMALL HOUSES EXEMPT BY THE BOARD OF HEALTH OF NEW JERSEY 1915.	IDEAL COONEY FUR DRESSING CO. PLINTKOTE CO.	TWO-ONE 24 INCH OUTLET AT ELM STREET, ONE AT FOOT OF RIDGEFIELD AVENUE AND BERGEN BLVD.	SIX BY-PASSES.	(A) YES	0.7 " " EAST PLANT 0.536 " " WEST " "	4512	8375	10,764		2 IMHOFF TANKS	(A) INSPECTED ABOUT ONE YEAR AGO. (B) VERBAL- GOOD.	NOT TO OUR KNOWLEDGE.	WHOLLY	4.0	4.0
RIVER EDGE BOROUGH	1903 DAMS BUILT SINCE THAT DATE FOR WATER SUPPLY STORAGE.		YES	YES				NO	(A) YES	0.4 " "	736	1077	2,210	1929	IMHOFF TANKS AND GLASS COVERED SLUDGE BEDS.			WHOLLY	3.75	3.75
RIVERVALE TOWNSHIP											450	553	871							
ROCKLEIGH BOROUGH	NONE	NONE	NO			ADVANCE PIEGE AND DYE WORKS. ERIE AVE. & FERONIA WAY, RUTHERFORD.					--	--	86				NO	NO	1.0	NONE
RUTHERFORD BOROUGH	NONE	NONE	YES	NO	FROM SILK MILL.			NO	(A) SATISFACTORY.	0.4389 " "	7065	9697	14,915	1924	NONE- SETTLING-TANK.	(A) YES- ABOUT FOUR MONTHS AGO. (B) THE MUNICIPALITY MUST TAKE CARE OF THE SEWAGE FOR MANY YEARS.	NO	PARTLY	3.0	2.0
TEANECK TOWNSHIP	SOME OF OUR MAPS SHOW AN APPROXIMATE HIGH WATER MARK.	OCCASIONALLY FOR WATER AT A FLOOD PERIOD (1895 PEAK) WOOD'S SCHOOL IN UNIT LOCATED HAS TO BE EVACUATED. (ELEVATION 18.5 FT. ABOVE MEAN TIDE)	FOUR PLANTS - NO'S. 1, 2, 3 AND 4.	YES				NO	(A) YES	NO. 1 1.5 " " 2 1.0 " " 3 4.0 " "	2082	4192	9313	TWO IN 1926 AND TWO IN 1927	PRIMARY TREATMENT PLANTS CONSISTING OF SCREENING, GRIT CHAMBER, SETTLING TANK CHAMBERS. SLUDGE DIGESTED BY IMHOFF METHOD.		WHOLLY	6.0	6.0
TENAFLY BOROUGH		SLIGHT	YES	YES	NONE TO OUR KNOWLEDGE.	NONE	NONE	NO	(A) SATISFACTORY.	0.75 " "	2756	3585	5869	1928	ACTIVATED SLUDGE.	(A) YES - 1929. (B) GENERALLY SATISFACTORY WITH IMPROVEMENT IN SLUDGE DRYING.	NO	0.33 SQ MI. IS HUDSON VALLEY.	2.48	2.15
TETERBORO BOROUGH											--	24	26							
WASHINGTON TOWNSHIP											100	194	402							
WESTWOOD BOROUGH			YES	YES				NO		0.35 " "	1870	2597	4861	1923-28	GRIT AND SCREEN CHAMBER; SEDIMENTATION TANKS; SAND FILTERS.	(A) YES- 1930 (B) ADD SEPARATE SLUDGE DIGESTION AND SPRINKLING	NONE	WHOLLY WITHIN HACKENSACK VALLEY.	2.3	2.3
WOODCLIFF LAKE BOROUGH	NONE.	NONE	NO	NO							470	587	871			INDIVIDUAL CESS-POOLS FOR HOMES.		WHOLLY IN PASCACK VALLEY.	4.0	IN PASCACK VALLEY.
WOOD RIDGE BOROUGH											1043	1923	3159							
HUDSON COUNTY																				
BAYONNE CITY											55,545	76,754	88,979							
GUTTENBERG TOWN	TOWN OF GUTTENBERG IS AT LEAST ONE MILE AWAY FROM HACKENSACK RIVER.	NONE	NO	NO DISPOSAL PLANT; SEWER RUNS INTO THE HUDSON RIVER.							5847	6726	6355				NO	NO	6 BLOCKS LONG, 4 BLOCKS WIDE.	NONE
JERSEY CITY CITY	NONE.	I HAVE NO KNOWLEDGE OF ANY DAMAGE TO PROPERTY.	NO								267,779	298,103	316,715				NONE	PARTLY	38.4	20.0
KEARNY TOWN	NO RECORDS OF FLOOD FLOWS.	NO APPRECIABLE DAMAGE.	YES								18,659	28,724	40,716	1924	SCREENING AND DILUTION	(B) NO COMPLAINT HAS BEEN MADE.	NONE KNOWN.	PARTLY	8000 ACRES	50 ACRES (APPROX.) OUTSIDE OF PASSAIC VALLEY SEWER DISTRICT, AND 4,000 ACRES (APPROX.) INCLUDED IN PASSAIC VALLEY SEWER DISTRICT (INCLUDES IMPOUNDMENT AREA)
NORTH BERGEN TOWNSHIP	THE HIGHEST RECORDED TIDE AT THE CENTRAL DISPOSAL PLANT (- MAIN ST & ERIE R.R.) IS ELEV. 12.3 MSD ON MAIN HIGH WATER IN HUDSON RIVER.	BACKING UP OF SEWERS AND FLOODING CELLARS.	TWO- NORTHERN AT MYER & 4TH STREET. CENTRAL AT MAIN ST. & ERIE R.R.	SOUTHERN SECTION HAS NO DISPOSAL PLANT AS YET, BUT PLANS AND SPECIFICATIONS HAVE BEEN ORDERED BY THE COURT.				YES, STORM WATER COMING FROM ROOF LEADERS.	NEW	NORTHERN 5.0 MILLION GALLONS AT 2 HRS. SET. CENTRAL 7.75 " " " " " "	15,662	23,344	40,716	NORTHERN 1926 - CENTRAL 1929	GRIT CHAMBER- PRIMARY SEDIMENTATION TANKS- SLUDGE DIGESTION GLASS ENCLOSED SLUDGE DRYING BEDS.	(A) FINAL REPORT ON INSPECTION: (B) PLANTS BUILT IN ACCORDANCE WITH PLANS AND SPECIFICATIONS AND OPERATION APPROVED.	NONE	PARTLY	5.5	4.6
SECAUCUS TOWN											4,740	5,423	8,550							
UNION CITY CITY	NONE	NONE	NO		WESTERN SLOPE OF CITY DRAINS INTO PENHORN CREEK.		550 MORE OR LESS SMALL DWELLINGS ONE AND TWO FAMILY, AND SOME APARTMENT HOUSES.				56,626	80,725	58,659					PARTLY	830 ACRES	50 ACRES
WEST NEW YORK TOWN											13,560	29,928	37,107							

MUNICIPALITIES	1	2	3
BERGEN COUNTY	WHAT RECORDS HAVE YOU OF EXCEPTIONALLY HIGH WATERS OR FLOODS IN THE HACKENSACK RIVER OR ITS TRIBUTARIES WITHIN THE LIMITS OF YOUR MUNICIPALITY?	TO WHAT EXTENT HAS DAMAGE BEEN DONE BY SUCH HIGH WATERS OR FLOODS?	DOES YOUR MUNICIPALITY MAINTAIN SEWAGE DISPOSAL PLANT?
ALPINE BOROUGH			
BERGENFIELD BOROUGH	NO OFFICIAL RECORDS HAVE BEEN KEPT BUT THERE IS ALWAYS HIGH WATERS IN THE BROOKS THROUGH THE BOROUGH AFTER HEAVY RAINS OCCUR.	DAMAGES HAVE NEVER BEEN TABULATED	YES
BOGOTA BOROUGH	NONE EXCEPT HERAWAY THE AVERAGE TIDE VARIES BETWEEN 5.75 AND 6.00 FEET 1 AM IMPROVED THERE HAVE BEEN 7.5 TO 8.0 TIDES	NONE TO MY KNOWLEDGE.	YES
CARLSTADT BOROUGH	NONE	NONE	YES
CLIFFSIDE PARK BOROUGH		NONE	YES
CLOSTER BOROUGH	NO RECORDS HAVE BEEN KEPT.	CAUSED TEMPORARY FLOODED CONDITION.	NO
CRESSKILL BOROUGH	NONE	NONE	NO
DEMAREST BOROUGH	NONE	NONE	NO
DUMONT BOROUGH	STREAM NOT SUBJECT TO TIDAL INFLUENCE. LOWEST ELEVATION 25 FEET ABOVE TIDES.	NO RECORDS OF DAMAGE NOTED, AS PROPERTY IS GENERALLY UNDEVELOPED ALONG BANKS.	YES
EAST RUTHERFORD BOROUGH	NONE	NONE	YES
EMERSON BOROUGH	NONE	NONE	NO
ENGLEWOOD BOROUGH	PECKMAN RIVER AT THE BRANCH OF THE DEAD RIVER AT THE WATER FLOWS OVER THE PRESENT DAM OF POREY ROAD.	DAMAGES HAVE BEEN DETERMINED. THE LOWER SECTIONS OF THE CITY ARE SUBJECT TO FREQUENT FLOODING.	NO-- PRIVATE COMPANY DOES.
ENGLEWOOD CLIFFS BOROUGH	NONE AT ALL	ABSOLUTELY NONE	YES
FAIRVIEW BOROUGH	NONE	NONE	YES
FORT LEE BOROUGH	NONE	NONE	NO
HACKENSACK MOONACHIE LAKE	NONE	NONE	YES
HARRINGTON PARK BOROUGH	NONE	NEGLIGIBLE IF ANY.	NO
HASBROUCK HEIGHTS BOROUGH	NONE	NO DAMAGE.	YES
HAWORTH BOROUGH	NONE	NONE	NO
HILLSDALE BOROUGH	NONE	NONE	NO
LEONIA BOROUGH	HIGH WATER NONE	NONE	
LITTLE FERRY BOROUGH			YES
LODI BOROUGH	NONE AVAILABLE		YES
LYNDHURST TOWNSHIP	NONE	NONE	YES-- TWO STORY.
MAYWOOD BOROUGH	NO DETAILED RECORDS	AFFECTS THE OPERATION OF THE DISPOSAL PLANT	YES
MONTVALE BOROUGH	NONE	NONE	NO
MOONACHIE BOROUGH			
NEW MILFORD BOROUGH			NO
NORTH ARLINGTON BOROUGH	NONE AT HAND	NONE	YES
NORTHVALE BOROUGH			
NORWOOD BOROUGH	NONE	NONE	NO
OLD TAPPAN BOROUGH			

works and maintenance in proportion to the assessable value of each district after allowing for a national government grant equal to 50 per cent. of the constructional cost of sewers and works.

"The communities in the joint district now having sewers are sewered on the separate or the "partly separate" plan. All these sewage-works have sedimentation tanks for the regular sewage flow and many of them have stormwater tanks as well. Three of the works provide sedimentation only; five of the other works have both contact beds and percolating filters; eighteen have percolating filters only and four have contact beds only."

APPENDIX THIRTEEN

Schedule "A"—Showing

Estimated Construction Cost and Bond Issue Requirement

Estimated Expenditure 1932-1937		Estimated Int. to date at Computed Rate of 6%	Total Interest	Total
Year 1932	$ 3,000,000.00			
7/1/32-12/31/32		$ 90,000.00		
1933		185,400.00		
1934		196,500.00		
1935		208,314.00		
1936		220,812.84		
			901,026.84	3,901,026.84
Year 1933	3,000,000.00			
7/1/33-12/31/33		90,000.00		
1934		185,400.00		
1935		196,500.00		
1936		208,314.00		
			680,214.00	3,680,214.00
Year 1934	4,000,000.00			
7/1/34-12/31/34		120,000.00		
1935		247,200.00		
1936		262,032.00		
			629,232.00	4,629,232.00
Year 1935	5,000,000.00			
7/1/35-12/31/35		150,000.00		
1936		309,000.00		
			459,000,00	5,459,000.00
Year 1936	5,000,000.00		300,000.00	5,300,000.00
	$20,000,000.00		$2,969,472.84	$22,969,472.84
Estimated Bond Issue Requirement				$23,000,000.00

APPENDIX FOURTEEN

Schedule "B"—Showing

Estimated Construction Cost and Bond Issue Requirement

Estimated Expenditure 1944 to 1947		Estimated Int. to date at Computed Rate of 6%	Total Interest	Total
Year 1944	$ 500,000.00			
7/1/44-12/31/44		$ 15,000.00		
1945		30,900.00		
1946		32,754.00		
			78,654.00	578,654.00
Year 1945	1,800,000.00			
7/1/45-12/31/45		54,000.00		
1946		111,240.00		
			165,240.00	1,965,240.00
Year 1946	2,100,000.00		126,000.00	2,226,000.00
	$ 4,400,000.00		$369,894.00	$4,769,894.00
Estimated Bond Issue Requirement				$4,800,000.00

APPENDIX FIFTEEN

Schedule "C" — Yearly Principal and Interest Requirements of Bond Issue and Yearly Operating Costs with Estimated Yearly Rate per Million Gallon Flow

		23 Million Dollars — 30 Years Issue as of Jan. 1, 1937				4 Million Dollars — 30 Years Issue as of Jan. 1, 1947									
	Year	Amount Outstanding Jan. 1st.	Payment on Principal Jan. 1st.	Interest 5%	Yearly Payment	Amount Outstanding Jan. 1st.	Payment on Principal Jan. 1st.	Interest 5%	Yearly Payment	Total Yearly Payment Acccount of Bond	Total Yearly Average Sewer Flow M. G.	Yearly Rate Per. M. G. Acct. of Bond Issue	Estimated Yearly Operating Cost	Yearly Rate per M. G. Acct. of Operating	Estimated Yeary Rate per M. G. to Meet Bond Issue Requirement and Operating Charges
	1937	$23,000,000.00	$	$ 1,150,000.00	$ 1,150,000.00	$	$	$	$	$ 1,150,000.00	22812.5	$50.41	$584,000.00	$25.60	$76.01
	1938	23,000,000.00	0	1,150,000.00	1,150,000.00					1,150,000.00	23506.	48.92	595,000.00	25.31	74.23
(A)	1939	23,000,000.00	657,200.00	1,117,140.00	1,774,340.00					1,774,340.00	24199.5	73.32	607,000.00	25.08	98.40
	1940	22,342,800.00	657,200.00	1,084,280.00	1,741,480.00					1,741,480.00	24961.2	69.77	618,000.00	24.76	94.53
	1941	21,685,600.00	657,200.00	1,051,420.00	1,708,620.00					1,708,620.00	25586.5	66.78	630,000.00	24.62	91.40
	1942	21,028,400.00	657,200.00	1,018,560.00	1,675,760.00					1,675,760.00	26316.5	63.68	641,000.00	24.36	88.04
	1943	20,371,200.00	657,200.00	985,700.00	1,642,900.00					1,642,900.00	27083.	60.66	653,000.00	24.11	84.77
	1944	19,714,000.00	657,200.00	952,840.00	1,610,040.00					1,610,040.00	27889.2	57.73	664,000.00	23.81	81.54
	1945	19,056,800.00	657,200.00	919,980.00	1,577,180.00					1,577,180.00	28543.	55.26	676,000.00	23.68	78.94
	1946	18,399,600.00	657,200.00	887,120.00	1,544,320.00					1,544,320.00	29309.5	52.69	687,000.00	23.44	76.13
	1947	17,742,400.00	657,200.00	854,160.00	1,511,360.00	4,800,000.00	0	240,000.00	240,000.00	1,751,360.00	30076.	58.23	699,000.00	23.24	81.47
	1948	17,085,200.00	657,200.00	821,300.00	1,478,500.00	4,800,000.00	0	240,000.00	240,000.00	1,718,500.00	30927.	55.57	715,000.00	23.12	78.69
	1949	16,428,000.00	657,200.00	788,440.00	1,445,640.00	(A) 4,800,000.00	137,200.00	233,140.00	370,340.00	1,815,980.00	31645.5	57.38	731,000.00	23.10	80.48
	1950	15,770,800.00	657,200.00	755,580.00	1,412,780.00	4,662,800.00	137,200.00	226,280.00	363,480.00	1,776,260.00	32448.5	54.74	748,000.00	23.05	77.79
	1951	15,113,600.00	657,200.00	722,720.00	1,379,920.00	4,525,600.00	137,200.00	219,420.00	356,620.00	1,736,540.00	33251.5	52.22	764,000.00	22.98	75.20
	1952	14,456,400.00	657,200.00	689,960.00	1,347,160.00	4,388,400.00	137,200.00	212,560.00	349,760.00	1,696,920.00	34221.	49.59	780,000.00	22.79	72.38
	1953	13,799,200.00	985,800.00	640,670.00	1,626,470.00	4,251,200.00	137,200.00	205,700.00	342,900.00	1,969,370.00	34967.	56.32	797,000.00	22.79	79.11
	1954	12,813,400.00	985,800.00	591,380.00	1,577,180.00	4,114,000.00	137,200.00	198,840.00	336,040.00	1,913,220.00	35806.5	53.43	813,000.00	22.71	76.14
	1955	11,827,600.00	985,800.00	542,090.00	1,527,890.00	3,976,800.00	137,200.00	191,980.00	329,180.00	1,857,070.00	36682.5	50.62	829,000.00	22.60	73.22
	1956	10,841,800.00	985,800.00	492,800.00	1,478,600.00	3,839,600.00	137,200.00	185,120.00	322,320.00	1,800,920.00	37661.4	47.82	846,000.00	22.46	70.28
	1957	9,856,000.00	985,800.00	443,510.00	1,429,310.00	3,702,400.00	137,200.00	178,260.00	315,460.00	1,744,770.00	38471.	45.35	862,000.00	22.41	67.76
	1958	8,870,200.00	985,800.00	394,220.00	1,380,020.00	3,565,200.00	137,200.00	171,400.00	308,600.00	1,688,620.00	39383.5	42.88	878,000.00	22.29	65.17
	1959	7,884,400.00	985,800.00	344,930.00	1,330,730.00	3,428,000.00	137,200.00	164,540.00	301,740.00	1,632,470.00	40332.5	40.48	911,000.00	22.59	63.07
	1960	6,898,600.00	985,800.00	295,640.00	1,281,440.00	3,290,800.00	137,200.00	157,680.00	294,880.00	1,576,320.00	41431.2	38.05	911,000.00	21.99	60.05
	1961	5,912,800.00	985,800.00	246,350.00	1,232,150.00	3,153,600.00	137,200.00	150,720.00	287,920.00	1,520,070.00	41318.	36.79	911,000.00	22.05	58.84
	1962	4,927,000.00	985,800.00	197,060.00	1,182,860.00	3,016,400.00	137,200.00	143,860.00	281,060.00	1,463,920.00	41318.	35.43	911,000.00	22.05	57.48
	1963	3,941,200.00	985,300.00	147,795.00	1,133,095.00	2,879,200.00	205,800.00	133,670.00	339,470.00	1,472,565.00	41318.	35.64	911,000.00	22.05	57.69
	1964	2,955,900.00	985,300.00	98,530.00	1,083,830.00	2,673,400.00	205,800.00	123,380.00	329,180.00	1,413,010.00	41431.2	34.10	911,000.00	21.99	56.09
	1965	1,970,600.00	985,300.00	49,265.00	1,034,565.00	2,467,600.00	205,800.00	113,090.00	318,890.00	1,353,455.00	41318.	32.76	911,000.00	22.05	54.81
	1966	985,300.00	985,300.00	0	985,300.00	2,261,800.00	205,800.00	102,800.00	308,600.00	1,293,900.00	41318.	31.31	911,000.00	22.05	53.36
	1967					2,056,000.00	205,800.00	92,510.00	298,310.00	298,310.00	41318.	7.22	911,000.00	22.05	29.27
	1968					1,850,200.00	205,800.00	82,220.00	288,020.00	288,020.00	41431.2	6.95	911,000.00	21.99	28.94
	1969					1,644,400.00	205,800.00	71,930.00	277,730.00	277,730.00	41318.	6.72	911,000.00	22.05	28.77
	1970					1,438,600.00	205,800.00	61,640.00	267,440.00	267,440.00	41318.	6.47	911,000.00	22.05	28.52
	1971					1,232,800.00	205,800.00	51,350.00	257,150.00	257,150.00	41318.	6.22	911,000.00	22.05	28.27
	1972					1,027,000.00	205,800.00	41,060.00	246,860.00	246,860.00	41431.2	5.96	911,000.00	21.99	27.95
	1973					821,200.00	205,300.00	30,795.00	236,095.00	236,095.00	41318.	5.71	911,000.00	22.05	27.76
	1974					615,900.00	205,300.00	20,530.00	225,830.00	225,830.00	41318.	5.47	911,000.00	22.05	27.52
	1975					410,600.00	205,300.00	10,265.00	215,565.00	215,565.00	41318.	5.22	911,000.00	22.05	27.27
	1976					205,300.00	205,300.00	0	205,300.00	205,300.00	41431.2	4.95	911,000.00	21.99	26.94
	Totals		$23,000,000.00	$19,433,440.00	$42,433,440.00		$ 4,800,000.00	$ 4,054,740.00	$ 8,854,740.00	$ 51,288,180 00					

(A) First installment shall fall due not more than two (2) years from date of issue.

APPENDIX SIXTEEN

M. L. HOWELL
WEST TRENTON, N. J.

December 16, 1931.

Hackensack Valley Sewerage Commission,
6 Highwood Avenue,
Tenafly, New Jersey.
Attention: Hon. T. J. Wasser, Chairman.
Gentlemen:

In accordance with the instructions of your Chairman and based upon the estimated cost of construction, estimated operating cost, and estimated sewage flow furnished by your engineers, together with method of finnacing and rates of interest given, I have prepared and submit the three preceding schedules:

Schedule "A" showing estimated cost of construction, including the necessary financing charges during the construction period (Year 1932-1937) and bond issue requirement of the same. Schedule "B" showing the estimated cost of construction including the necessary financing charges during the construction period (Year 1944-47) and bond issue requirement of the same. Schedule "C" setting forth yearly principal and interest requirements of bonds issued on serial basis over a period of thirty years, the yearly operating cost and the estimated yearly rate per million gallons of flow necessary to meet these charges.

Schdules "A" and "B" are computed on the basis of the estimated cost of this construction as furnished by your engineers. The rate of interest used is 6% and the calculation measures on the basis of the figures furnished the extreme requirement to meet the carrying charges while these projects are under construction. The result of this calculation determines the amount of Bond Issue necessary.

Schedule "C" is computed on the basis of the bond issue requirement indicated as necessary by Schedule "A" and "B", your engineers' estimate of operating cost and yearly million gallon flow. The bonds are retired on a serial basis over a period of thirty years, the rate of interest allowed being 5%. From these basic figures the yearly rate per M. G. on account of the Bond Issue, the yearly rate per M. G. on account of operating cost, and the yearly rate per M. G. to meet the combined bond issue requirement and operating charges has been determined, and presents accurately the yearly charge necessary to meet the construction and operating cost of the proposed sewerage system.

Yours very truly,
M. L. HOWELL,
Actuary.

APPENDIX SEVENTEEN

REAL ESTATE AS A FACTOR IN THE LOCATION OF PROJECTS

by Joseph P. McLean, Real Estate Appraiser

In considering location of treatment plants and easements for pipe lines efficiency is of paramount importance. Economy is so closely related to efficiency as to be an obvious factor. Lines entailing costly construction or operation are not cheap or economical at any price.

Easements should be so located as to take advantage of the lowest and most uniform elevations, thus utilizing gravity and avoiding the necessity of frequent pumping stations. This suggests the lines of natural drainage or creek bottoms.

As real estate is developed the upland areas are first employed, and until available space is exhausted the creek bottoms are ignored and their lands have but nominal value. Eventually the low lands would be reclaimed by filling to such grade as would warrant use, but the time for this is so remote that no speculative value has accrued which would render these lands at all comparable with undeveloped contiguous upland areas.

Where creek bottoms are not practical for any reason the use of existing roads along or across the lowlands provide the logical location for intercepting drains.

Both creek lines and roads involve minimum damages through avoiding all structures. Many easements required are in line for extensions of existing roads and will assist ultimate development.

The sites for treatment plants should be remote from residential areas, inaccessible if possible, preferably not adapted to higher types of use. This would involve minimum loss of tax ratables, a very desirable feature.

Almost the entire area included in the present study was the subject of speculative prices when the projected Hudson River Bridge first promised realization. The effect of the boom was enhanced by the prevailing easy money market, prices anticipated value for many years.

The collapse of the boom and diminished available investment funds have brought market prices and sound value into close relationship. Recent plot sales and building construction afford an index to the trend and intensity of development and to the requirements as to location and capacity of drainage.

From a real estate standpoint the time was never more propitious for undertaking the proposed drainage system.

APPENDIX EIGHTEEN

In accordance with Section Six of Chapter 144 P.L. 1930 the Commission through their Secretary certifies that the detailed statement of expenditures is a true copy thereof.

FINANCIAL STATEMENT

Bergen County 4/5th's
Hudson County 1/5th

Budget $35,000.00

		Bergen County	Hudson County
Printing and Compiling Advance Copy of Report		$ 503.65	$ 125.92
Printing Commission Report; including Etchings, Photographs, Charts, Color Plates, etc.		1,770.41	442.60
Air Map; Survey and Additional Copies		2,880.00	720.00
Financial Reports; Data and Schedules for Report		165.60	41.40
Legal Services		40.00	10.00
Legislative; Advice, Conferences, Drawing Bill for Report		200.00	50.00
Real Estate; Valuation Appraisements, etc.		200.00	50.00
Engineering; Personal Services, Consulting and investigations, and services of Staff of Engineers (office and field)		16,000.00	4,000.00
Chemist; Bacteriological and Chemical Work including Service of Laboratory		2,000.00	500.00
Commission Expense:			
Miscellaneous Printing	$ 87.50		
Stenographic Report on Conferences of Municipalities and Agencies	199.50		
Office help; including Stenographers, Typing, etc	1,696.85		
Inspection Trips; Transportation, etc.	469.56		
Office Supplies	482.98		
Telephone	165.29		
Postage	274.88		
Photography	30.00		
	$3,406.56	2,725.25	681.31
		$26,484.91	6,621.23
Unused Balance of Appropriation		1,515.09	378.77
	TOTAL	$28,000.00	7,000.00