JOURNAL *of the*

BOSTON SOCIETY OF CIVIL ENGINEERS

1848 BOSTON SOCIETY OF CIVIL ENGINEERS

100 YEARS

1848 - 1948

APRIL - 1948

VOLUME XXXV NUMBER 2

BOSTON SOCIETY OF CIVIL ENGINEERS

OFFICERS, 1948 - 1949

PRESIDENT

FREDERIC N. WEAVER

VICE-PRESIDENTS

EVERETT N. HUTCHINS
(Term expires, March 1949)

HARRISON P. EDDY, JR.
(Term expires, March 1950)

SECRETARY

ROBERT W. MOIR

TREASURER

HERMAN G. DRESSER

DIRECTORS

GEORGE W. COFFIN
HERMAN G. PROTZE
(Term expires, March 1949)

CHESTER J. GINDER
FREDERICK S. GIBBS
(Term expires, March 1950)

PAST PRESIDENTS

CARROLL A. FARWELL
GEORGE A. SAMPSON
HARVEY B. KINNISON

SANITARY SECTION

ALLEN J. BURDOIN, Chairman
FRANK L. HEANEY, Clerk

STRUCTURAL SECTION

OLIVER G. JULIAN, Chairman
ARTHUR E. HARDING, Clerk

TRANSPORTATION SECTION

R. NEWTON MAYALL, Chairman
WILLIAM L. HYLAND, Clerk

HYDRAULICS SECTION

JOHN G. W. THOMAS, Chairman
GARDNER K. WOOD, Clerk

SURVEYING AND MAPPING SECTION

CHARLES M. ANDERSON, Chairman
HUGH P. DUFFILL, Clerk

NORTHEASTERN UNIVERSITY SECTION

WILLIAM J. DOWNEY, Chairman
ARTHUR L. QUAGLIERI, Clerk

Librarian—THOMAS C. COLEMAN

Editor—CHARLES E. KNOX

715 Tremont Temple, Boston

JOURNAL OF THE

BOSTON SOCIETY OF CIVIL ENGINEERS

Volume XXXV APRIL, 1948 Number 2

CONTENTS

PAPERS AND DISCUSSIONS

Page

Water Investigations of the U. S. Geological Survey. Presidential Address at the Annual Meeting. *H. B. Kinnison* 109

The Merrimack River Valley Sewerage District Project. *Thomas R. Camp* 115

Discussion. *T. A. Berrigan* 152

The Engineering Aspects of the Land Court. *Charles M. Anderson* 157

The Legal Aspects of the Land Court. *Edward P. Shaw, 3rd* 168

OF GENERAL INTEREST

Proceedings of the Society 171

ANNUAL REPORTS

Board of Government 180
Treasurer 185
Secretary 193
Auditing Committee 195
Editor 196
Committees
Hospitality 196
Library 197
Relation of Sections to Main Society 201
John R. Freeman Fund 202
Quarters 202
Executive Committee—Sanitary Section 204
Executive Committee—Structural Section 204
Executive Committee—Transportation Section 205
Executive Committee—Hydraulics Section 205
Executive Committee—Surveying and Mapping Section . . . 206
Executive Committee—Northeastern University Section . . . 206

Entered as second-class matter, January 15, 1914, at the Post Office at Boston, Mass., under Act of August 24, 1912

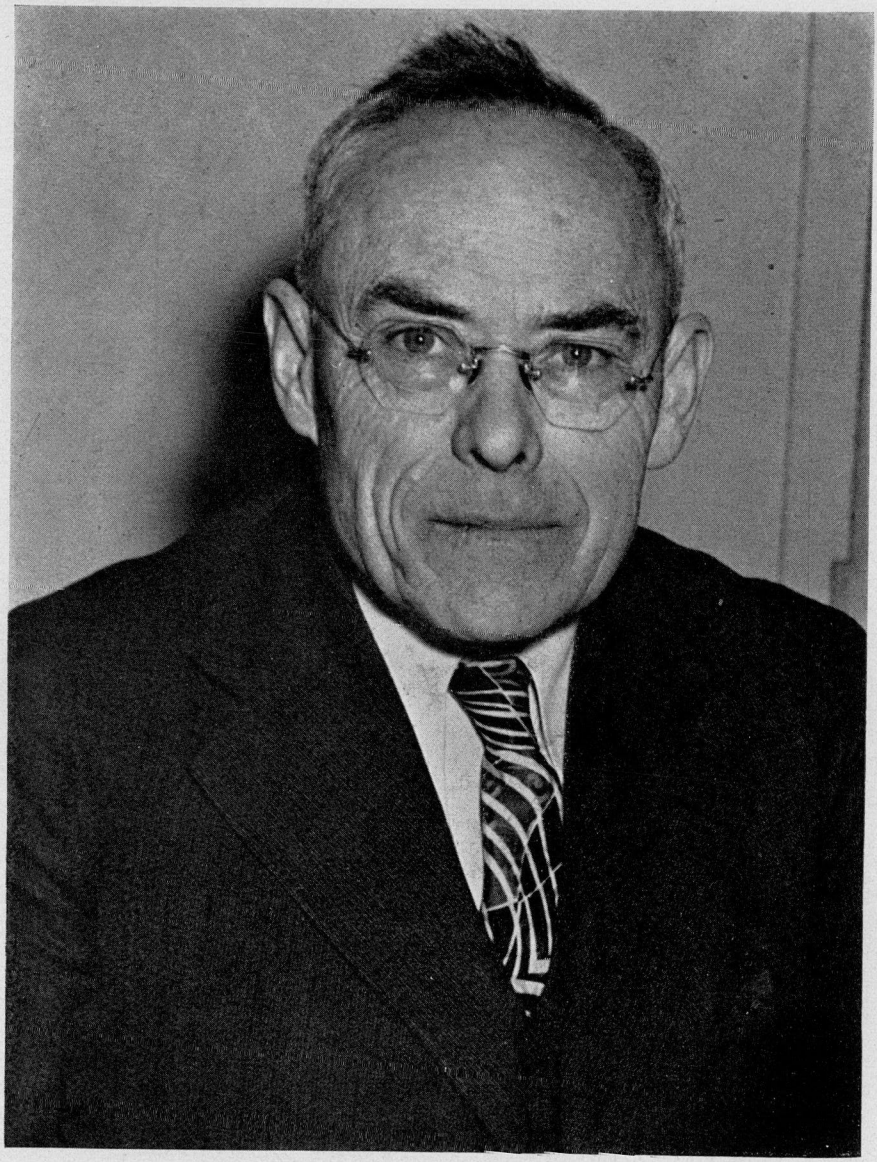
Published four times a year, January, April, July and October, by the Society
715 Tremont Temple, Boston, Massachusetts

Subscription Price $4.00 a Year (4 Copies)
$1.00 a Copy

Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized on July 16, 1918.

THE HEFFERNAN PRESS

WORCESTER, MASS.



FREDERIC N. WEAVER
President
Boston Society of Civil Engineers
1948-49

JOURNAL OF THE

BOSTON SOCIETY OF CIVIL ENGINEERS

Volume XXXV APRIL, 1948 Number 2

WATER INVESTIGATIONS OF THE U. S. GEOLOGICAL SURVEY

PRESIDENTIAL ADDRESS BY H. B. KINNISON*
U. S. Geological Survey, Boston, Mass.
Boston Society of Civil Engineers, March 31, 1948.

WHEN in 1888 Congress requested the United States Geological Survey to make an irrigation survey which necessarily included the gaging of streams and the investigation of the water supply of the United States and the methods of utilizing the water resources, the Survey realized hat it had a job to do without an organization with which to do it. The Director of the U. S. Geological Survey, Maj. John Wesley Powell, recognized the importance of the knowledge of the water supply but he had no idea of the proper method for use in acquiring this knowledge nor was his chief engineer able to help him. At about this time Maj. Powell arranged to lecture at the Massachusetts Institute of Technology. In order to show Maj. Powell proper courtesy and to insure his remembering the appointment, a graduate student was detailed to escort him to the place where the lecture was to be given. This graduate student was Frederick Hayes Newell who, as a result of this contact, was later to be known as "The Father of Systematic Stream Gaging". Mr. Newell, who had graduated from M. I. T. in 1885, asked Maj. Powell for a "job" and was given the first full-time appointment on the Irrigation Survey. Within a short time nine other young men were selected and assembled in Washington for assignment to a camp of instruction in stream gaging located on

*District Engineer, U. S. Geological Survey, Boston, Mass.

the Rio Grande at Embudo, New Mexico. On November 20, 1888, Mr. Newell was instructed to proceed to the camp on the Rio Grande and take charge of its establishment and regulation. With little to guide him he operated this experimental training camp out of which gradually evolved the modern methods used in stream gaging. From this small beginning he gradually built up a system of work and an organization of engineers, inadequately trained according to today's standards, but loyal and devoted to the task of recording stream flow. Methods and instruments were improved with experience, and personnel was enlarged as funds became available. However, the demand for stream flow data, on which depended the increase of funds, did, at that time, and will likely continue, to lag behind the actual need for the collection of the data. As a result the Survey has in many cases been unable to furnish stream flow data at the time it was first needed and to that extent has not been permitted to live up to its obligations.

Today the organization is still small, as government organizations go, and is composed of scientists who have specialized principally in river hydraulics, ground-water geology, chemistry, and physics. The Geological Survey's contribution to the field of hydrology may modestly be stated as being one of the outstanding accomplishments of government research.

The occurrence of water on the earth is subject to many vagaries. Its sojourn begins as some form of precipitation. About 50% of all precipitation, in this region, is used by nature to supply the demands of evaporation and transpiration. It is the highly variable and transient remainder that is available for the use of man to irrigate his crops, to provide domestic and industrial supplies, to generate his hydropower, to dilute his waste material and to provide much of his recreation. Congress recognized the necessity of knowing with precision, how much water flows in our streams, how much collects in lakes and reservoirs, and how much percolates into the ground to be stored in the ground water reservoirs. Without an adequate understanding of the behaviour of our natural water systems, it is impossible to utilize to the fullest our available supply for beneficial uses or to control it in the prevention of disaster. It is difficult to determine the full value of information of this type, but, in negative terms, the costs of not having such information for the proper planning, construction and operation of all hydraulic developments would be immeasurably great.

The investigations of the Geological Survey relating to water are made by Congressional authority and since 1895 Congress has annually appropriated funds for investigating the water resources of the country, and since 1902 has outlined these investigations in the following language: "for gaging the streams and determining the water supply of the United States, investigating underground currents and artesian wells, and methods of utilizing the water resources."

Since 1929 the annual appropriation acts have, among other limitations, also provided that a major specified part of each Gaging streams appropriation "shall be available only for cooperation with states and municipalities", and "that no part of this appropriation shall be expended in cooperation with states or municipalities except upon the basis of the state or municipality bearing all the expense incident thereto in excess of such an amount as is necessary for the Geological Survey to perform its share of general water resources investigations, such share of the Geological Survey in no case exceeding 50 per centum of the cost of the investigations."

The water resources investigations of the Survey are conducted by the Water Resources Branch through its four divisions: the Division of Surface Water, the Division of Ground Water, the Division of Quality of Water, and the Division of Water Utilization. The activities of the Surface Water Division relate primarily to the gaging of streams and the measurement of water on the surface of the earth; those of the Ground Water Division relate to the investigation and determination of the waters below the surface of the earth that supply wells and springs; those of the Quality of Water Division relate to the determination of the chemical quality of both surface and ground waters and the sediment load of the surface waters; and those of the Division of Water Utilization relate to the study of special water problems, including those created by floods and droughts.

As one of the Executive Branches of the government, the Survey must conform to the general laws and regulations which govern all units of the government. But Congress places no limitations upon our technical procedures and methods as long as we comply with the provisions in the Organic Act of the Geological Survey which provides "that the Director and members of the Geological Survey shall have no personal or private interest in the lands or mineral wealth of the region under survey and shall execute no surveys or examinations for private parties or corporations—." Within this general framework the

Survey operates under regulations and limitations established by the Department, Bureau or Branch.

The Geological Survey is authorized and instructed to determine the water supply of the United States. It is left to our own ingenuity what methods, devices, instruments, equipment or structures we should use as well as the arrangement and analysis of the data for publication. Our instructions are interpreted to require that we determine the capacity of underground reservoirs, the rates of recharge thereto, and the safe yield of aquifers by any or all known methods. We should devise and apply methods of determining the chemical character and the sediment content of water. During the process of determining the flow of streams and the elevation of the ground water reservoirs, the Survey collects the facts which determines the severity of droughts and the magnitude of floods with their attending damaging aspects.

Involved in the collection of all basic hydrologic information is the essential requirement that it be made available to Congress, to the cooperating parties, and to the public. In accomplishing this phase of the work, the Survey compiles, analyzes and correlates the observed facts and presents them in published form in such ways as may enhance the utility and value of the information.

Surveys and investigations cannot be made for private parties or corporations and with respect to the division of costs in cooperative programs, we are limited to "general water resource investigations." This restrictive language indicates that the information collected shall have general as well as specific value. It does not imply that special knowledge and skills gained as an incident to the collection of the information on our water supply should go unused. On the contrary, it is in the interest of good administration that general water resources investigations should, with appropriate restrictions, include organization of such knowledge and skills and the realization of some of their advantages. To this end, for example, the Survey investigates and publishes reports on methods and facilities for studying surface water, ground water, and quality of water. Not only this, but it also redesigns or improves the available instruments for use in its work or develops entirely new instruments. The plans and specifications for the improved or new instruments are furnished to the instrument manufacturers so that these new instruments become available to the public. In these ways the special

knowledge and skills developed in this specialized work are made available to the public at large so that the public which pays the entire cost shall receive the greatest possible benefits.

When the work of the Survey was first under consideration by Congress, it was opposed by those engineers who thought that such work fell properly within the field of activities of the private engineer and that its performance by a governmental agency would tend to deprive the private engineer of a portion of his means of livelihood. In a few isolated cases, this may have been true, but at the same time, the private engineer has been given a tool for use in his work that could never have been made available in any other way. Now it is realized that the great mass of hydrologic data of a continuing nature and on a nationwide scope, relating to the inventory of water—the nation's most important natural resource—could not be obtained except by a governmental agency such as the Geological Survey which is a fact finding unbiased agency with no ax to grind. It is recognized that the work of the Geological Survey, instead of depriving private engineers of a means of livelihood, has actually served to increase their work and has placed it on a sounder basis by providing the fundamental facts that are needed for the stable and full utilization of the water resources.

The members of the Survey have always been on guard lest they encroach at some time or place on the field of the private engineer by the interpretation of specific water supply information relating to the solution of a specific water supply problem. As a result of this attitude many worthwhile studies have not been made and in some instances other Federal bureaus have entered some part of the field that perhaps should have been more logically and efficiently occupied by the Survey

The difficulties in applying the legal limitations imposed on the work of the Survey arises from the definition of the Survey's "share of general water resources investigations" conducted in cooperation with states and municipalities. An exact definition of this expression has never been attempted and probably never should be because varying local conditions affect the proper definition, and there will always be border-line cases regardless of the definition. These should be decided, each on its own merits, giving due consideration not only to the work of the private engineer, but also to the needs of the public, the responsibilities of state agencies and local governmental organizations,

and the instructions and directions of Congress. It should be borne in mind that, as a fact-finding organization, the work of the Survey is essentially investigational. It should observe, analyze, explain and correlate its data and should also interpret them along broad basic lines, and should assist its cooperating parties in all problems involving these phases of work. Basic water resources information should be made available promptly to the appropriate agencies or private engineers in order to be of maximum value to them in the proper design and operation of water facilities. But the Survey should not attempt to apply these data toward the design of specific projects. This is the field of the private engineer or governmental agencies responsible for action programs, and Survey data and assistance should be made available to the greatest possible extent. The problem of proper Survey activity becomes increasingly acute, however, as the size of the munipality cooperating with the Survey becomes smaller, the financial ability correspondingly smaller, and therefore the need for technical assistance by the Survey in applying water information becomes greater. Understanding of the fundamental circumstances, discernment, tact and good judgment should serve in reaching proper decisions in all such situations.

In all questions of policy the Survey enjoys the guidance and direction of the state cooperating officials who are largely responsible for the development of the overall plan of the investigations and to this extent should be given the credit for the results accomplished. The Survey is one branch of the government in which a large amount of freedom and autonomy is enjoyed and where individual officers attempt to take advantage of all opportunities for administrative consultation to the end that policies and understandings respecting the Survey's sphere of usefulness shall be progressive and wise.

I wish to express to you my desire to discuss with any of you who are interested the work of my office and the methods used in its accomplishment. We are organized for service and cooperation. It has been my desire to conduct my work in such a manner that my engineering friends will continue to be my friends and friends of the Survey as well. It is my hope that the need for the work of the Survey will increase in future years and that maximum and most valuable public service will be rendered by it.

THE MERRIMACK RIVER VALLEY SEWERAGE DISTRICT PROJECT

By Thomas R. Camp, Member*

(Presented at a meeting of the Boston Society of Civil Engineers held on January 28, 1948).

The sanitary condition of the Merrimack River has been a matter of public concern for more than 60 years. The examination of water supplies in Massachusetts was begun in 1887 at which time both Lowell and Lawrence were using water directly from the Merrimack River. Shortly thereafter both of these cities discontinued the direct use of untreated Merrimack River water. The city of Lawrence installed a water treatment plant and has continued the use of Merrimack River water despite increasing pollution up to the present time. As a result of legislative action reports were made by the State Board of Health on the sanitary condition of the river in 1909 and in 1913. The Department of Public Health, successor to the State Board of Health, again investigated the sanitary condition of the Merrimack River in 1923 and reported upon two alternate plans for the abatement of pollution in Senate Document No. 492 of 1924.

The two plans studied by the Department of Public Health in the 1923 investigation consisted of: (1) a trunk sewer to collect the sewage and objectionable manufacturing wastes along the Merrimack River and to discharge them without treatment into the sea off Plum Island and (2) local treatment plants along the valley of the river for the treatment of sewage and the industrial wastes from each municipality, the plant effluents to be discharged into the river. The estimates of cost of the two plans were about equal. The 1924 report recommended in favor of the trunk sewer plan. No action was taken regarding this recommendation but the problem received legislative attention again in 1928, 1935 and 1937. The cost estimates presented in the 1924 report were revised in 1937 and the trunk sewer plan was again recommended, this time to include primary treatment of the sewage near the outlet.

*Camp, Dresser & McKee, Consulting Engineers, Boston, Mass.

The legislation of 1935 established the Merrimack River Valley Sewerage District and created the Merrimack River Valley Sewerage Board, but provided that the terms of the Act should cease to be effective unless ten million dollars had been allocated for construction by the Federal Government before January 1, 1936. No such funds were made available but both the District and the Board were re-established in the Acts of 1936, which again provided that the District should cease to exist if funds were not made available from the Federal Government before January 1, 1938. No funds were forthcoming but the Board was continued in existence to function jointly with the New Hampshire Water Resources Board as the Merrimack River Valley Authority.

Chapter 62 of the Resolves of 1945 established a Joint Board comprising the Merrimack River Valley Sewerage Board and the Department of Public Health and directed the Joint Board to re-study the whole matter of pollution abatement in the Merrimack River Valley in Massachusetts. The Joint Board employed the author to make the engineering studies directed by the Resolve and to submit an engineering report embodying the results of these studies together with recommendations and estimates of cost. The plan recommended by the engineer comprises intercepting sewers and six regional treatment plants, the effluents of which are to discharge into the river. The Joint Board concurred with this recommendation and submitted its report to the General Court together with proposed legislation on December 1, 1946. The report of the Joint Board which includes the engineer's report was published as Senate Document No. 550 of 1947.

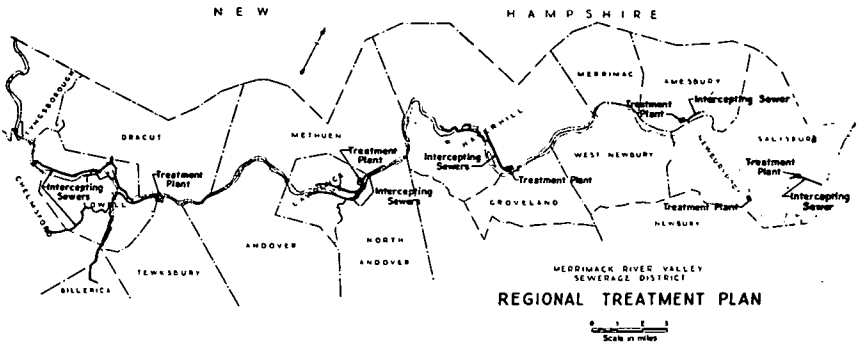
The proposed legislation was passed by the 1947 General Court with some minor changes and is embodied in Chapter 653 of the Acts of 1947. The Act, which is to become effective if approved by a majority vote within the District at the 1948 elections, re-establishes the Merrimack River Valley Sewerage District to comprise the cities of Haverhill, Lawrence, Lowell, and Newburyport and the towns of Amesbury, Andover, Billerica, Chelmsford, Dracut, Groveland, Merrimac, Methuen, Newbury, North Andover, Salisbury, Tewksbury, Tyngsborough and West Newbury. The Act will give power to the Board to construct and operate the proposed works. The Act provides that the cost of construction, maintenance and operation of the works shall be assessed within the District in accordance with a method of apportionment to be determined by three commissioners

to be appointed by the Supreme Judicial Court. The matter of equitable assessments is of paramount importance in this project because most of the pollution load comes from the manufacturing industries.

As a result of previous studies and our preliminary investigations two alternate general plans were indicated, one involving a trunk sewer and the other local or regional treatment. The plan for local treatment as studied by the Department of Public Health in 1923 comprised 13 separate sewage treatment plants. The growth and development in the District and improvements in treatment methods since that time, however, have been such as to indicate that regional rather than purely local treatment is more economical. The plan recommended by the engineer calls for intercepting sewers and large regional plants for the Lowell metropolitan region, the Lawrence metropolitan region and the Haverhill metropolitan region, with three smaller plants serving Newburyport, Amesbury and Salisbury in the harbor region. Studies were made of the relative economies of combining two or more of the four regions by means of short trunk sewers so as to reduce the number of treatment plants, but these studies indicated that in the regional treatment plan the shorter the length of trunk sewer involved the lower the overall cost. On the other hand separate treatment plants for the suburban municipalities around Lowell and Lawrence were found to be more costly than combined regional plants with the necessary intercepting sewers.

The alternate plan, comprising intercepting sewers, a trunk sewer from Lowell to the ocean off Plum Island, a main treatment plant in Newbury and a separate treatment plant for Salisbury, was thoroughly studied; but it was not recommended because it would be very much more costly and would offer no advantages over the regional treatment plan. The two plans are indicated in Figure 1 and are described in more detail later.

The total estimated cost of construction of the regional treatment plan was $27,581,100, of which $11,957,600 is for interceptors and $15,623,500 is for treatment works. The total estimated cost of construction of the trunk sewer plan was $56,392,800 of which $45,117,100 is for the trunk sewer and appurtenances, $5,558,100 is for interceptors and $5,717,600 is for treatment works. The estimated toal annual charges, based on 40-year bonds at 1¾% interest and including maintenance and operation, was $1,339,020 for the regional treatment plan and $1,905,930 for the trunk sewer plan.



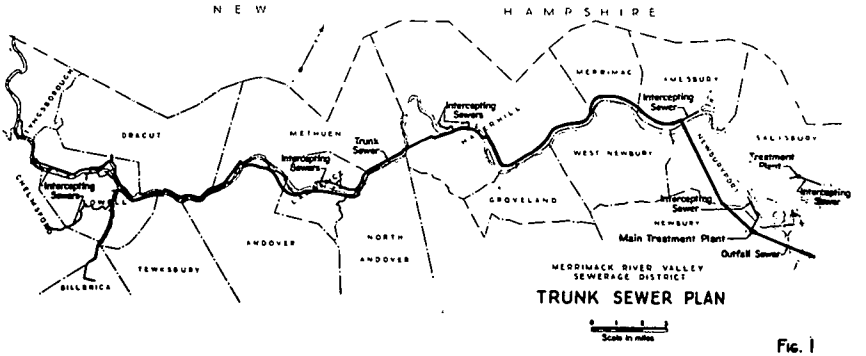


FIG. 1

Legislation was introduced to the Congress in 1946 to establish a Merrimack Valley Authority with powers similar to those held by the T.V.A. The proponents of this bill (which was not passed) claimed that the construction of reservoirs in New Hampshire would so increase the dry-weather flow of the river in Massachusetts as to make unnecessary most or all of the pollution abatement works proposed by the Merrimack River Valley Joint Sewerage Board. This matter was thoroughly investigated by the author's staff, and it was found that no feasible program of reservoir construction would serve as a substitute for any part of the pollution abatement works recommended.

The degree of treatment proposed is based on maintaining satisfactory river water quality at all flows in excess of 1500 cubic feet per second (cfs), which is exceeded 90% of the time. Since the average flow of the river is only about 7,000 cfs, it is probably not feasible to regulate the dry-weather flow to a minimum in excess of about

3,000 cfs by any reservoir system. This would be equivalent to a dilution factor of only 2 to 1, which is much less than the required dilution factor. In order to maintain sufficient oxygen in the river, treatment of the sewage and wastes is required to effect an average removal of about 87% of the organic matter of which 27% may be expected in primary and 60% in secondary treatment. The river flow would have to be increased 8-fold to effect a dilution equivalent to complete treatment and about 5.6-fold to serve as a substitute for secondary treatment. In order to maintain satisfactory bacteriological quality of the river water, chlorination of the effluents of all plants will be required to effect an overall removal of coliform bacteria in excess of 99.9%. Regulation of the river by reservoirs would therefore be of no consequence in reducing bacterial pollution.

Numerous studies of the sanitary condition of the river have been made by the Massachusetts Department of Public Health over a period of many years. The Department has maintained sampling points along the river at which monthly samples of river water have been taken for analysis. We have studied the results of these analyses and have selected the records during the dry-weather months from June to November inclusive for the ten-year period from 1936 to 1945 as being indicative of the present condition of the river. The constituents in the sewage and wastes which are most damaging to the river water are organic matter and bacteria. The organic matter serves as food for the bacteria which in their feeding processes utilize the oxygen dissolved in the river water and thus reduce the oxygen content of the water. The oxygen is replenished from the atmosphere above the water surface, but if the organic content of the wastes is too great the rate of depletion of the oxygen by the bacteria may exceed the rate of replenishment from the air and thus reduce the oxygen content to dangerously low levels. If the oxygen content falls below about 4 parts per million (ppm) the water is unsafe for fish life and if the oxygen is completely exhausted the river water will become black and will emit obnoxious sulfide odors. Figure 2 shows the oxygen content in the river over the ten-year period from 1936 to 1945. The average values during the warmer six months of the year are shown in the upper graph and the lowest values obtained during the ten-year sampling period are shown in the lower graph. The record reveals that the oxygen has been completely exhausted below Lowell and also in the river stretch from above Haverhill to

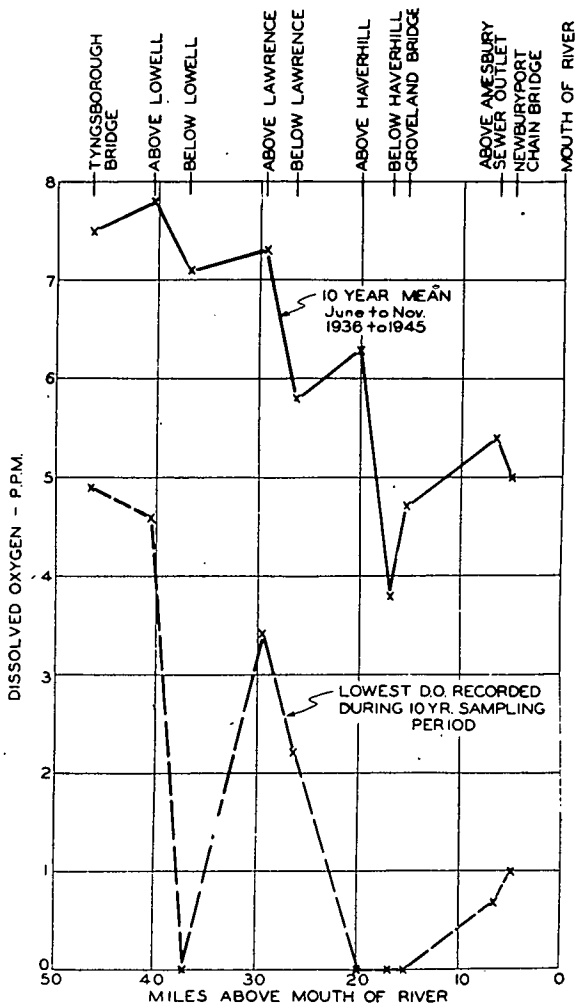


FIG. 2 DISSOLVED OXYGEN CONTENT OF MERRIMACK RIVER

the Groveland Bridge. Undoubtedly there have been times during which the oxygen was exhausted all the way from below Lowell to Groveland Bridge. The graph does not show complete depletion of oxygen below Lawrence because the time of monthly sampling did not happen to coincide with the lowest oxygen content at these points.

Polluting organic matter is commonly measured by means of the biochemical oxygen demand (B.O.D.) test which indicates the amount of dissolved oxygen which will be used up by the bacteria in a five-day period at 20°C. From the B.O.D. tests made on the river water collected at the sampling stations above and below Lowell, Lawrence and Haverhill we have estimated the B.O.D. loading contributed from these three metropolitan areas. These estimated loadings are shown in Table 1. Since the river samples were collected during the day-

Region.	Daytime B. O. D. Load (Pounds per Day). (1)	Population Equivalent[1] (2)	Sewered Population, 1945. (3)
Lowell	154,000	810,000	101,229
Lawrence	253,000	1,330,000	110,453
Haverhill	41,000	216,000	46,162

[1] At 0.19 pounds per capita per day.

TABLE 1.—DAYTIME B.O.D. LOADING AS INDICATED BY ANALYSIS OF RIVER WATER.

time, when the heaviest industrial pollution load was being discharged, the values in the table are not a true indication of the average daily load on the river. They do, however, show the heavy daytime loading. In the third column of the table is shown the estimated population tributary to sewers in 1945, and the second column shows the equivalent population based on 0.19 lbs of B.O.D. per person per day which is the average value found for the domestic sewage in the District. The average daily B.O.D. load on the river as determined from the industrial wastes survey and sewage samples is about half that shown in Table 1. The figures in the table are significant in that they indicate a very heavy industrial pollution load and in that they further indicate that the organic load added at Lawrence exceeds the total for the rest of the District.

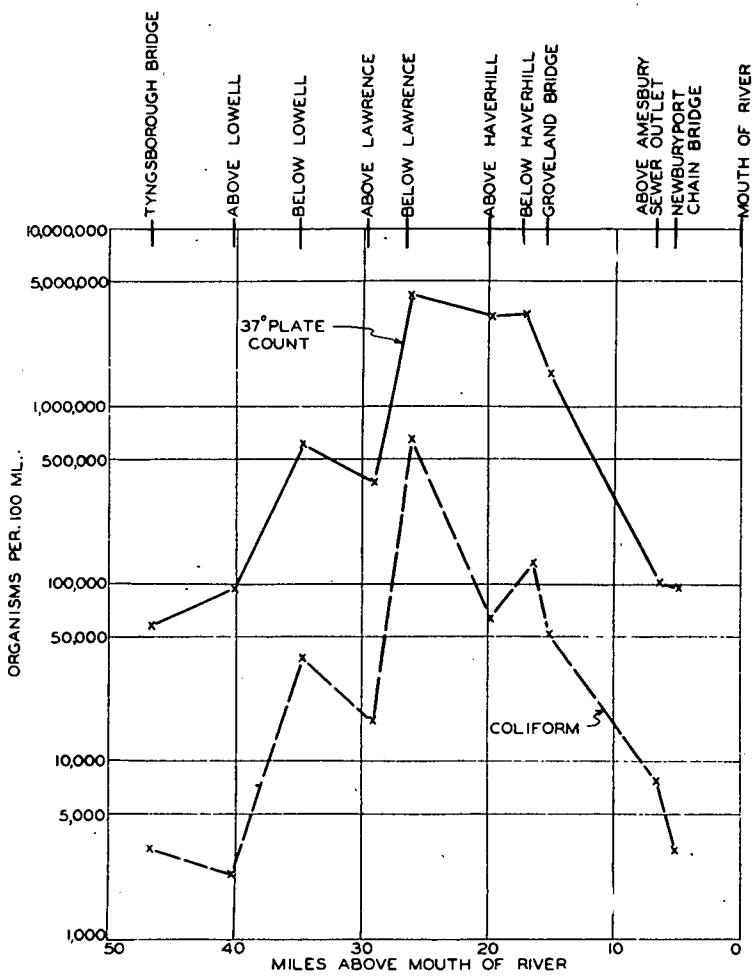


FIG. 3 BACTERIA IN MERRIMACK RIVER

The effect of bacterial pollution of the river is shown in Figure 3. The top graph shows the total count of all bacteria which grow at 37°C and the bottom graph shows the count of the coliform bacteria which are characteristic of the intestinal tract of man. Nearly all of the bacteria are contributed with the domestic sewage and the coliform count is an index of the concentration of sewage solids. When coliform bacteria are present disease germs may also be present. If the water is to be safe for drinking the coliform count should be less than 1 per 100 milliliters (ml). For the safe use of the water for swimming and recreational purposes the coliform count should be less than 1,000 when counted by means of the E coli index and less than about 2,300 when counted in terms of the most probable number (M.P.N.). For the taking of shellfish without chlorination, the coliform count should be less than 70 per 100 ml based on the M.P.N. If the shellfish are to be chlorinated before use, the coliform count in the river water should be less than 700 per 100 ml. The values in Figure 3, therefore, indicate gross bacterial contamination of the river water throughout its entire course in Massachusetts.

The works under consideration for the Merrimack River Valley Sewerage District are of such magnitude that it was deemed desirable to design them to serve any populations that may reasonably be expected during a period of at least forty years or until 1987. Studies were made of the population trends of all the communities within the District and the trends were projected in order to forecast probable populations for 1965 and 1987. The 1945 populations together with the forecasts are shown in Table 2. The total population in 1945 was 343,316. The forecast for 1965 is 374,010 and the forecast for 1987 is 408,470. Most of the present population in the three larger cities is served by sewers but many of the towns are only partially sewered and some of them have no sewers. In estimating the population tributary to sewers in 1987 it has been assumed that for towns now having municipal sewers the sewered population will increase in proportion to the total population and that for towns not presently sewered 50% of the 1987 population will be served by municipal sewers.

In the sanitary survey 24-hour gagings were made of the flow of sewage from the principal sewer outlets within the District during which samples of sewage were collected at hourly intervals for analysis. A survey of industrial wastes was made by the Department of

City.	Population, State Census (1945).	Population in 1965.			Population in 1987 Forecast by Camp (1947).
		Forecast by Department of Public Health Report, Senate No. 492 (1924).	Forecast by State Planning Board and Department of Public Health, Senate No. 100 (1937).	Forecast by Camp (1947).	
Lowell	101,229	161,000	113,000	103,700	106,000
Lawrence	85,603	172,000	98,000	88,100	91,000
Haverhill	46,162	85,700	56,000	51,000	56,500
Methuen	23,160	41,000	26,000	29,500	36,800
Newburyport	14,079	18,700	15,000	15,000	16,000
Andover	11,920	14,600	13,000	14,500	17,800
Amesbury	10,824	14,500	12,000	12,000	13,400
Billerica	8,504	6,700	-	10,900	13,500
Chelmsford	8,726	9,900	9,500	10,600	12,600
North Andover	7,936	10,500	8,000	9,200	10,600
Dracut	7,434	11,300	8,000	8,700	10,100
Tewksbury	5,949	8,500	9,000	7,200	8,600
Salisbury	2,622	2,850	2,700	3,300	4,000
Merrimac	2,384	3,000	2,210	2,600	2,860
Groveland	2,150	4,050	2,220	2,280	2,400
Newbury	1,636	-	1,600	1,900	2,180
West Newbury	1,503	2,100	1,500	1,620	1,750
Tyngsborough	1,495	1,720	1,600	1,910	2,380
Total	343,316	568,120	379,330	374,010	408,470

TABLE 2.—MERRIMACK RIVER VALLEY SEWERAGE DISTRICT POPULATION STUDIES.

Public Health to determine the rates of discharge and the composition and strength of the wastes. All laboratory analyses of samples of sewage and industrial wastes were made by the Department of Public Health. Table 3 shows the volume and strength of industrial wastes from each process and Table 4 shows the industrial wastes from each region. Table 5 shows the total average daily discharge from each community in 1946 and the estimated discharge for 1987. The table shows not only the total discharge of all wastes but the separate amounts of sanitary sewage, ground water infiltration and

Type of Industry	Total Daily Discharge (m. g. d.).	M. G. D. Analyzed.	Per Cent Analyzed.	Pounds per Day of —					Per Cent of Total.			
				B. O. D.	Suspended Solids.	Volatile Suspended Solids.	Fats.	Caustic Alkalinity.	Discharge.	B. O. D.	Suspended Solids.	Fats.
Wool scouring and carbonizing.	2.611	1.492	57	50,832	162,855	114,203	147,416	13,803	5.36	27.08	50.68	52.28
Wool washing	1.650	1.621	98	17,558	31,814	13,569	22,915	—57	3.39	9.36	9.90	8.13
Wool dyeing	7.434*	5.418*	73	3,270*	2,210*	1,891*	454*	—958*	15.27*	1.74*	0.69*	0.16*
Wool finishing	13.031	9.142	70	73,287	28,535	24,659	79,137	21,697	26.77	39.05	8.88	28.06
Hat manufacturing	0.283	0.107	38	49	83	75	72	—442	0.58	.03	0.03	0.03
Gray goods	7.485	6.513	87	10,029	8,153	7,451	6,718	26,687	15.37	5.34	2.53	2.38
Tanning and leather working	3.173	-	-	9,560	14,775	8,333	6,850	-	6.52	5.09	4.60	2.43
Pulp mills	1.042	1.042	100	636	24,000	6,050	0	12,771	2.14	0.34	7.47	-
Paper machines	8.624*	5.161*	60	4,482*	41,318*	14,159*	1,499*	0	17.72*	2.39*	12.86*	0.53*
Breweries	0.887	0.645	73	2,860	550	416	169	0	1.82	1.52	0.17	0.06
Distilleries	0.075*	-	-	4,800*	7*	4*	300*	-	0.15*	2.56*	0.00	0.11*
Laundries	0.712	-	-	2,369	1,188	790	7,120	-	1.46	1 26	0.37	2.52
Dairies	0.559	-	-	2,795	1,861	1,242	2,795	-	1.15	1.49	0.58	0.99
Non-organic wastes (sewered).	0.057	-	-	-	-	-	-	-	0.12	-	-	-
Non-organic wastes (not sewered).	0.381*	-	-	-	-	-	-	-	0.78*	-	-	-
Soft drinks	0.059	-	-	245	49	33	-	-	0.12	0 13	0.02	-
Soft drinks (Newpuryport only).	0.013*	-	-	54*	11*	7*	-	-	0.03*	0.03*	0.00	-
Meat industries	0.170	-	-	3,575	3,055	2,045	5,245	-	0.35	1.90	0.95	1.86
Miscellaneous	0.439	-	-	1,290	860	572	1,290	-	0.90	0.69	0.27	0.46
Grand total	48.685	31.141	64	187,691	321,324	195,499	281,980	73,501	100.00	100.00	100.00	100.00
Totals, excluding items marked with an asterisk.	32.158	20.562	64	175,085	277,778	179.438	279,727	74,459	66.05	93.28	86.45	99.20

* Wastes not to be intercepted initially

TABLE 3.—TOTAL VOLUME AND STRENGTH OF INDUSTRIAL WASTES FROM EACH PROCESS (1946 SURVEY).

Region and City or Town.	Total Discharge (m. g. d.).	All Industrial Wastes. Total pounds per day of —					Industrial Wastes to be intercepted. Discharge (m. g. d.).	Industrial Wastes to be intercepted. Total pounds per day of —				
		B. O. D.	Suspended Solids.	Volatile Suspended Solids.	Fats.	Caustic Alkalinity.		B. O. D.	Suspended Solids.	Volatile Suspended Solids	Fats.	Caustic Alkalinity.
1. Lowell region:												
Lowell	6.708	20,077	32,661	19,868	26,209	4,037	6.123	19,945	32,572	19,791	26,190	4,073
Dracut	0.608	1,826	779	690	1,744	1,108	0 454	1,760	734	652	1,735	1,126
North Chelmsford	0.893	18,870	60,553	42,403	54,863	5,962	0 893	18,870	60,553	42,403	54,863	5,962
Billerica	0 575	4,345	2,308	1,665	4,353	433	0.418	4,277	2,262	1,626	4,344	451
Total	8.784	45,118	96,301	64,626	87,169	11,540	7.888	44,852	96,121	64,472	87,132	11,612
2. Lawrence region:												
Lawrence	29.709	115,273	188,781	110,291	170,506	58,647	20.432	110,520	165,993	103,506	169,920	59,371
Methuen	0.274	988	412	323	1,729	172	0.215	962	395	309	1,726	179
Andover	2.634	9,604	3,872	3,242	10,079	2,317	1.793	9,250	3,628	3,033	10,029	2,414
North Andover	0.586	2,157	825	703	2,616	532	0.393	2,074	769	655	2,605	556
Total	33.203	128,022	193,890	114,559	184,930	61,668	22.833	122,806	170,785	107,503	184,280	62,520
3. Haverhill	4.923	8,847	26,989	12,863	8,197	537	1.120	6,925	10,264	7,047	7,580	571
4. Amesbury	1.544	478	3,716	3,166	899	—244	0.184	130	198	142	250	—244
5. Newburyport	0.231	5,226	428	285	785	-	0.133	372	410	274	485	-
Grand total	48.685	187,691	321,324	195,499	281,980	73,501	32.158	175,085	277,778	179,438	279,727	74,459

Table 4.—Industrial Wastes for Each Region (1946 Survey).

Region and City or Town.	Discharged into River in 1946.				Discharge to be Intercepted (1987).				Industrial Flow to River (1987).	1987 Totals.
	Sanitary.	Ground Water.	Industrial.	Total.	Sanitary.	Ground Water.	Industrial.	Total.		
1. Lowell region:										
Lowell	6.08	6.64	6.71	19.43	6.36	6.95	6.12	19 43	0.59	20.02
Tyngsborough	–	–	–	–	0.10	0.19	–	0.29	–	0.29
Chelmsford	–	–	0.89	0.89	0 25	1.01	0.89	2 15	–	2 15
Dracut	–	–	0.61	0.61	0.20	0.81	0.45	1 46	0.16	1.62
Billerica	–	–	0 58	0.58	0.34	1.08	0 42	1 84	0.16	2.00
Tewksbury	–	–	–	–	0.34	0.69	–	1.03	–	1.03
Total	6.08	6.64	8.79	21.51	7.59	10.73	7 88	26 20	0.91	27.11
2. Lawrence region:										
Lawrence	6.00	4.04	29 71	39.75	6.37	4.28	20 43	31 08	9.28	40.36
Methuen	0.99	0 82	0 27	2.08	1.58	1.30	0 22	3 10	0.05	3.15
Andover	0.52	0.73	2.63	3.88	0.78	1.09	1 79	3.66	0.84	4.50
North Andover	0.35	0.87	0.59	1.81	0.47	1.16	0.39	2.02	0.20	2.22
Total	7 86	6.46	33.20	47.52	9.20	7.83	22 83	39.86	10.37	50.23
3. Haverhill region:										
Haverhill	4.16	3 21	4.92	12 29	5.10	3.93	1.12	10.15	3.80	13.95
Groveland	–	–	–	–	0 10	0.19	–	0.29	–	0.29
Total	4.16	3.21	4.92	12.29	5 20	4.12	1.12	10.44	3.80	14.24
4. Merrimac	–	–	–	–	0.14	0.23	–	0.37	–	0.37
5. Amesbury	0.47	0.30	1 54	2.31	0.58	0.37	0.18	1.13	1.36	2.49
6. West Newbury	–	–	–	–	0.07	0.14	–	0.21	–	0.21
7. Newbury	–	–	–	–	0.09	0.17	–	0.26	–	0.26
8. Newburyport	0.81	1.29	0.23	2.33	0.92	1.47	0.13	2.52	0.10	2.62
9. Salisbury	0.25	0.25	–	0.50	0.71	0.82	–	1.53	–	1.53
Grand total	19.63	18.15	48.68	86.46	24.50	25.88	32.14	82 52	16.54	99.06

Table 5.—Total Average Daily Discharge (m.g.d.).

industrial wastes. The total estimated flow of wastes in 1987 is 99.06 mgd of which 82.52 mgd is to be intercepted for treatment and 16.54 mgd is to be permitted to flow directly to the river without treatment.

Table 6 is a summary of the average B.O.D. loadings for both 1946 and 1987 determined from the sanitary survey. As indicated in Table 5 a part of the weaker industrial wastes are to be permitted to discharge directly to the river untreated. Table 6 shows the B.O.D. load to be intercepted in 1987 and the B.O.D. load which will be discharged to the river both in the treated effluent and untreated. It will be noted that the population equivalent of the total 1946 B.O.D. load is 1,273,856. The population equivalent of the B.O.D. load to be intercepted in 1987 is 1,284,463 and the population equivalent of the B.O.D. load on the river after treatment in 1987 is estimated at 256,654. The wastes that may be discharged to the river untreated include paper mill white waters, certain dye liquors and other miscellaneous wastes of large volume but with low organic content. The B.O.D. estimated for the treated effluents is based upon 90% removal at Lowell and Lawrence and 30% removal elsewhere. The reasons for adopting these degrees of treatment and the estimated effect upon the oxygen content of the river water are discussed below.

Computations were made to determine the probable oxygen balance in the river water for various degrees of treatment based on a river discharge of 1500 cfs below Lowell. It is expected that a discharge of 1500 cfs or less will occur approximately 10% of the time or about 36 days during the summer. Figure 4 shows the computed oxygen sag curves.

The average dissolved oxygen content of the river water at the Tyngsborough Bridge during the period of record was 7.5 ppm and the lowest recorded value was 4.9 ppm. We have taken 6.0 ppm as a reasonable average future value for the dissolved oxygen content above Lowell assuming no B.O.D. removal in New Hampshire. Curve I shows the computed oxygen concentration in the river below Lowell with no treatment and a B.O.D. loading similar to that found in 1946. This curve compares favorably with the measured values shown in the lower curve of Figure 2, but the values are somewhat more extreme. The curve indicates that the river would contain no oxygen from below Lawrence to the Newburyport Chain Bridge. Curve 2 indicates the effect of primary treatment only. Curve 3 indicates the effect

Region and City or Town.	B. O. D. Load upon River in 1946.				B. O. D. Load to be Intercepted (1987).				B. O. D. Load on River (1987).			
	Domestic[1] (Pounds per Day).	Industrial (Pounds per Day).	Total (Pounds per Day).	Total Population Equivalent.	Domestic (Pounds per Day).	Industrial (Pounds per Day).	Total (Pounds per Day).	Total Population Equivalent.	Treated Effluent (Pounds per Day).	Untreated Industrial (Pounds per Day).	Total (Pounds per Day).	Total Load. No Treatment (Pounds per Day)
1. Lowell region:												
Lowell	19,234	20,077	39,311	206,900	20,140	19,945	40,085	210,974	3,954	132	4,086	40,217
Tyngsborough	-	-	-	-	226	-	226	1,189	22	-	22	226
Chelmsford	-	18,870	18,870	99,316	1,197	18,870	20,067	105,616	2,004	-	2,004	20,067
Dracut	-	1,826	1,826	9,611	960	1,760	2,720	14,316	269	66	335	2,786
Billerica	-	4,345	4,345	22,868	1,282	4,277	5,559	29,258	552	68	620	5,627
Tewksbury	-	-	-	-	817	-	817	4,300	80	-	80	817
Total	19,234	45,118	64,352	338,695	24,622	44,852	69,474	365,653	6,881	266	7,147	69,740
2. Lawrence region:												
Lawrence	16,265	115,273	131,538	692,305	17,290	110,520	127,810	672,684	12,734	4,753	17,487	132,563
Methuen	2,698	988	3,686	19,400	4,287	962	5,249	27,626	513	26	539	5,275
Andover	988	9,604	10,592	55,747	1,475	9,250	10,725	56,447	1,068	354	1,422	11,079
North Andover	1,036	2,157	3,193	16,805	1,383	2,074	3,457	18,195	342	83	425	3,540
Total	20,987	128,022	149,009	784,257	24,435	122,806	147,241	774,952	14,657	5,216	19,873	152,457
3. Haverhill region:												
Haverhill	8,771	8,847	17,618	92,726	10,735	6,925	17,660	92,947	12,159	1,922	14,081	19,582
Groveland	-	-	-	-	228	-	228	1,200	155	-	155	228
Total	8,771	8,847	17,618	92,726	10,963	6,925	17,888	94,147	12,314	1,922	14,236	19,810
4. Merrimac	-	-	-	-	272	-	272	1,432	186	-	186	272
5. Amesbury	1,378	478	1,856	9,768	1,705	130	1,835	9,658	1,252	348	1,600	2,183
6. West Newbury	-	-	-	-	166	-	166	874	113	-	113	166
7. Newbury	-	-	-	-	207	-	207	1,089	141	-	141	207
8. Newburyport	2,185	5,226	7,411	39,005	2,483	372	2,855	15,026	1,952	4,854	6,806	7,709
9. Salisbury	1,787	-	1,787	9,405	4,110	-	4,110	21,632	2,799	-	2,799	4,110
Grand total	54,342	187,691	242,033	1,273,856	68,963	175,085	244,048	1,284,463	40,295	12,606	52,901	256,654

[1] 0.19 of a pound per capita per day for sewered population.

[2] 90 per cent removal at Lawrence and Lowell, 30 per cent elsewhere.

TABLE 6.—SUMMARY OF AVERAGE B.O.D. LOADINGS.

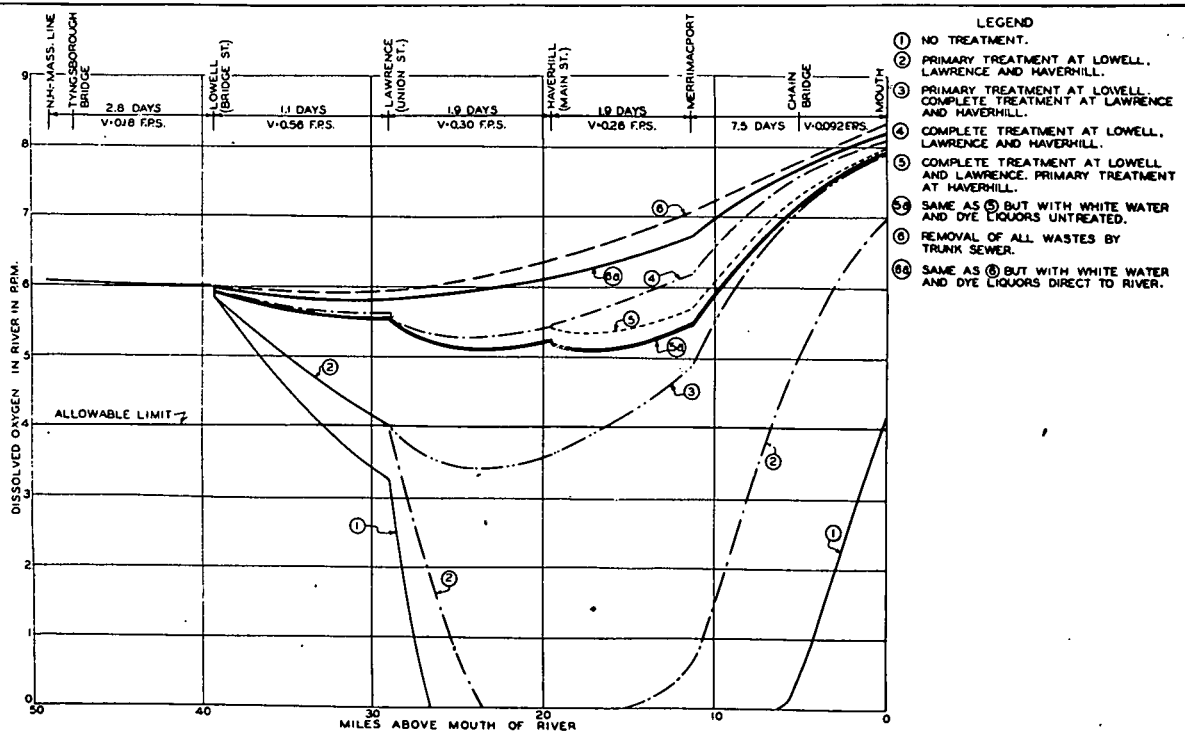


FIG. 4 COMPUTED DISSOLVED OXYGEN BALANCE IN THE RIVER FOR FLOW OF 1500 C.F.S.

of primary treatment at Lowell and complete treatment at Lawrence and Haverhill. Curve 4 indicates the effect of complete treatment at Lowell, Lawrence and Haverhill. Curve 5 indicates the effect of complete treatment at Lowell and Lawrence and primary treatment at Haverhill. Curve 5a indicates the effect of complete treatment at Lowell and Lawrence and primary treatment at Haverhill but with dye liquors and paper mill white water untreated. Curve 6 indicates the effect of the removal of all wastes by means of a trunk sewer to the ocean. Curve 6a indicates the effect of the trunk sewer but with the white water and dye liquors discharged direct to the river. It will be noted that all of the schemes from 4 to 6a inclusive will leave a residual oxygen content in the river in excess of the allowable limit of 4 ppm. Scheme 5a was found to be the cheapest of all the workable schemes and was therefore recommended.

The regional treatment plan was further developed so as to produce the result indicated by Curve 5a. The trunk sewer plan was further developed so as to produce the results indicated by Curve 6a. In the regional treatment plan complete treatment is required at Lowell and Lawrence and only primary treatment at Haverhill, Amesbury, Newburyport and Salisbury.

The effect of these two alternate plans on the bacterial contamination of the river was next studied. The study was made in terms of the coliform count in the river water. The results are shown by the graphs in Figure 5. The rate of die-off of the coliform bacteria in the river was assumed to be the same as found in the Ohio River by Streeter. In order to reduce the coliform count to acceptable limits it will be necessary to disinfect the effluents of all the proposed treatment plants with chlorine. It is assumed that a kill of 99.99% can be obtained with complete treatment followed by chlorination and that a kill of 99.95% can be effected by primary treatment followed by chlorination. Curve 1 shows the computed coliform count in the river for the regional treatment plan based on a coliform count at the Tyngsborough Bridge which conforms to the present average count. Curve 2 shows the coliform count for the regional treatment plan if New Hampshire undertakes treatment such as to reduce the coliform count at the Tyngsborough Bridge to acceptable standards. Curve 3 shows the coliform count computed for the trunk sewer plan based on the existing coliform count at the Tyngsborough Bridge. Curve 4 shows the computed coliform count for the trunk sewer plan if New

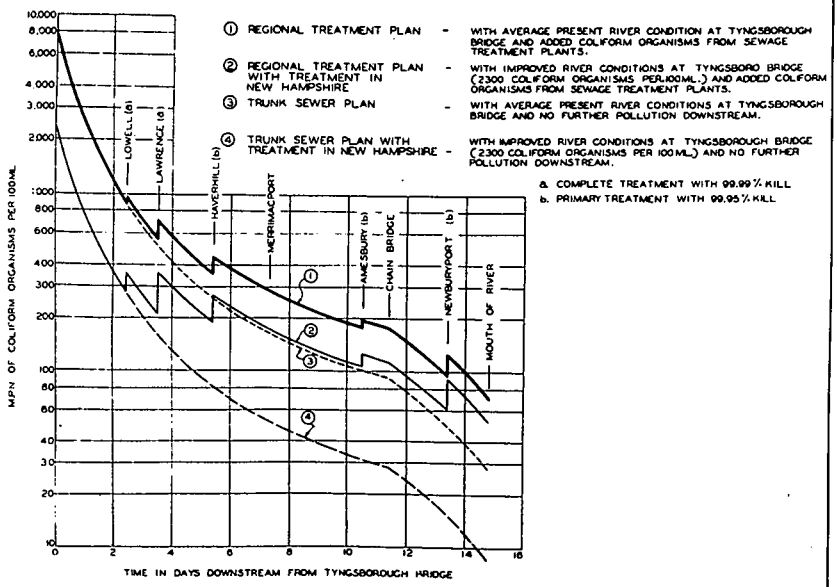


FIG. 5 COLIFORM DIE-OFF CURVES FOR IMPROVED RIVER CONDITIONS AT FLOW OF 1500 CFS.

Hampshire undertakes treatment so as to reduce the coliform count at the Tyngsborough Bridge to acceptable limits.

The above curves indicate the expected bacterial content of the river during dry weather for the two plans. The curves show that below Lowell either plan will produce water of sufficiently good quality for bathing and recreational use and for the taking of shellfish. It should be noted, however, that the existing sewerage systems at Lowell, Lawrence and Haverhill are on the combined plan and that overflows of mixed sewage and storm water may therefore be expected during rainstorms. A study was made of the effect of such overflows upon the quality of the river water in order to determine how much, if any, of the storm water should be intercepted for treatment. The result of this study has been previously reported to the Boston Society of Civil Engineers by Dr. J. E. McKee in a paper entitled "Loss of Sanitary Sewage Through Storm Water Overflows" which was published in the JOURNAL of April 1947.

The study indicated that it is not economical to design the intercepting sewers and the treatment works for a capacity greater than

the peak dry-weather flow of sewage and industrial wastes. When so designed less than 3% of the domestic sewage on the average will reach the river through the overflows and the effect on the oxygen content of the river will thus be negligible. Nevertheless during the period of overflow a considerable portion of the raw sewage and bacteria will go overboard even at low rainfall intensities. For example, about 82% of the sewage will go overboard during a rainstorm having an intensity of 0.10-in per hour. Thus, each period of overflow will be responsible for substantial bacterial contamination of the river water at and near the point of the overflow. A study was next made of the probable frequency of such overflows. The results of this study are shown in Figure 6.

It will be noted from Figure 6 that overflows may be expected to occur about 5 to 6 times per month on the average if the interceptors are designed with a capacity equal to the peak dry-weather flow, which for the municipalities in the District varies from about twice to three times the average dry-weather flow. This is too frequent to permit unrestricted use of the river for swimming. The important feature of the graph, however, is that it shows that effective relief from this intermittent bacterial contamination cannot be obtained with large capacity intercepting sewers. For example, if the interceptors are designed for 10 times the dry-weather flow, overflows may be expected about 3 times per month. In other words a five-fold increase in capacity of the interceptors will reduce the frequency of overflows by less than 50%. The only effective solution of this problem is the separation of the sanitary sewerage systems from the storm drains within the cities. Both the trunk sewer plan and the regional treatment plan are adequate to produce a river water which is safe for recreational and bathing purposes during periods of dry weather, but storm-water overflows will occur under both plans. Certain stretches of the river will therefore not be safe for bathing during rainstorms and immediately thereafter.

The Trunk Sewer Plan

In the trunk sewer plan, the proposed trunk sewer begins on the south bank of the river at Lowell and follows the river valley as a grade line sewer all the way to the treatment plant in Newbury. The design calls for reinforced-concrete construction with a semi-elliptical cross-section ranging in size from 6.5 ft at Lowell to 11.25 ft at

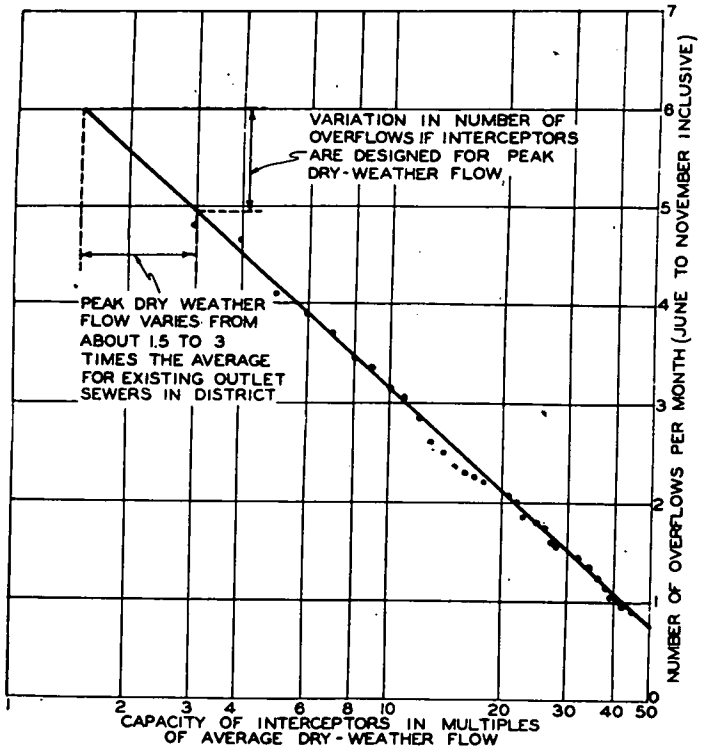
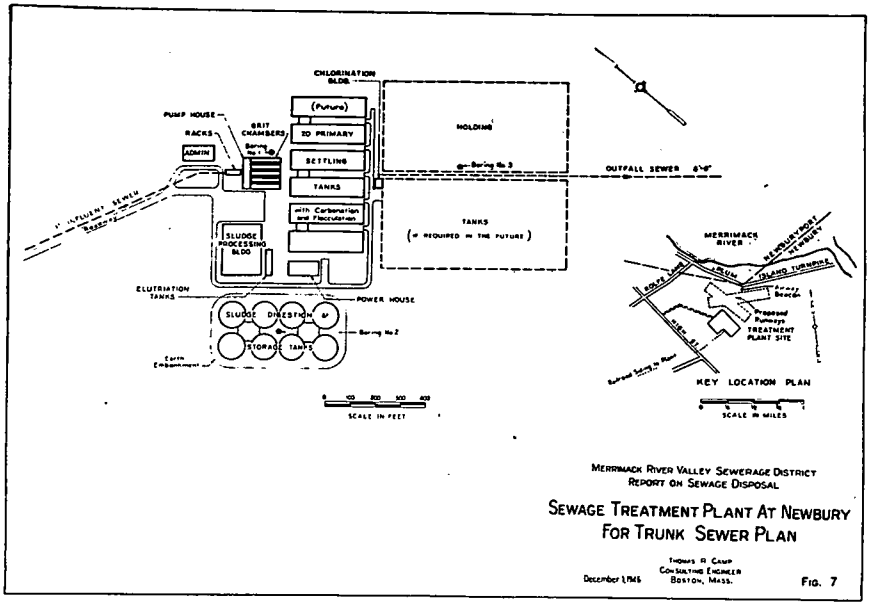


FIG. 6 EFFECT OF INTERCEPTOR CAPACITY ON FREQUENCY OF OVERFLOW OF SANITARY SEWAGE

Newburyport. Seven river crossings are required each of which would be a single pressure sewer of circular cross-section. A number of modified sections are also required for brook crossings. The design provides for a tunnel one mile long through Ward Hill in Haverhill and another tunnel two miles long in Newburyport. Grit chambers are proposed as part of the trunk sewer just below Lowell, Lawrence and Haverhill. The length of the trunk sewer including passage through the treatment plant and the ocean outfall is 36.5 miles. At the treatment plant the sewage will be pumped to a higher level and will flow by gravity through the plant and through an 8.5-foot circular pressure outfall sewer to the ocean outlet. The estimated first cost of the trunk sewer, including outfall sewer and outlet, is $45,117,100. The estimated first cost of the interceptors is $5,558,100.

The layout for the main sewage treatment plant for the trunk sewer plan is shown in Figure 7. The plant consists of rocks, pumping station, grit chambers, carbonation channels, grease flotation and flocculation tanks, primary settling tanks, chlorination building, sludge digestion and storage tanks, elutriation tanks, vacuum filters and accessory sludge handling equipment, power house and an administration and laboratory building. The racks will consist of three channels each 2.3 ft in width containing manually cleaned coarse racks and mechanically cleaned medium racks. Grinders will be provided for the screenings. The raw sewage pumps will consist of nine units, each having a capacity of about 15 mgd. Grit chambers will be attached to the pumping station and will consist of ten chambers having an effective length of 89 ft with velocity control and flow measurement at the outlet ends.

Each bank of four settling tanks will be preceded by a carbonation channel equipped with facilities for diffusing carbon dioxide gas into the sewage. Between the carbonation channels and the settling tanks sewage will pass through flocculation and grease flotation tanks consisting of two tanks in series for each settling tank. Settling tanks will consist of five parallel banks containing four tanks each. Each of the 20 tanks will be 18 ft wide, 238 ft long and have an average water depth of 5 ft. Chlorine will be applied into the outfall sewer which will have an ample contact period. For the digestion of sludge four primary tanks and four storage tanks are to be provided each with a diameter of 100 ft and a side wall depth of 26.5 ft. The primary tanks are to have floating covers and the storage tanks gas-



holder covers. The digested sludge is to be elutriated and dried on vacuum filters, and the filter cake is to be hauled away for dumping. All power required for the plant is to be produced by means of dual-fuel engines using sludge gas from the digestors. The average daily flow of sewage and industrial wastes to the treatment plant is estimated at 75.2 mgd and the peak flow in 1987 is estimated at 121.6 mgd. The estimated first cost of the treatment plant is $5,278,000, not including the outfall sewer and outlet.

Float studies were made in connection with the trunk sewer plan to determine the probable effect of winds, currents and tides on the dispersal of the sewage from the proposed submerged outlet off Plum Island. The site proposed for this outlet is 4,000 ft off shore, which is the minimum distance required to avoid shifting sands. The float studies indicated that sewage would be carried into the shore on incoming tides and out to sea on outgoing tides. The float studies tended to indicate the desirability of storing the sewage so that it could be released only on outgoing tides.

The preliminary design for the submerged outlet is shown in Figure 8. The design was based upon the method developed from the experiments of Rawn and Palmer (Transactions, American Socie-

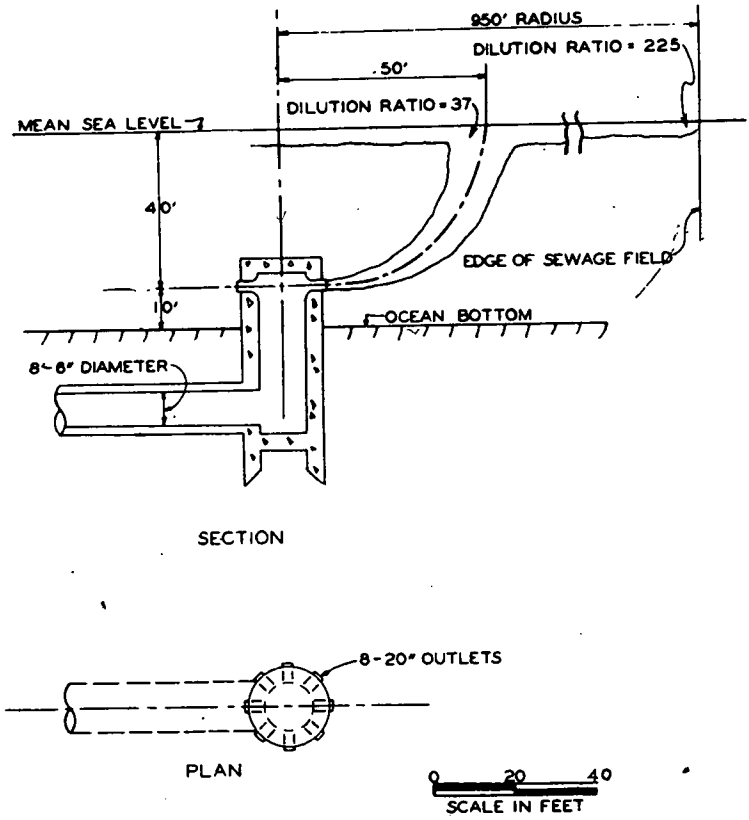


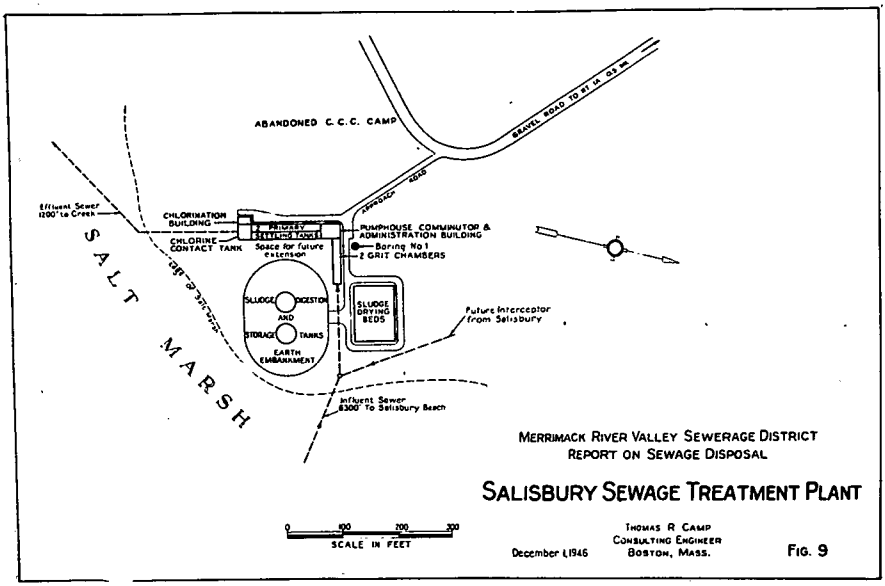
FIG. 8 TRUNK SEWER OCEAN OUTLET

ty of Civil Engineers, 1930, Page 1036). The proposed outlet structure consists of a vertical concrete shaft capped at the top and equipped with eight horizontal 20-in pipe outlets directed radially at equal intervals around the periphery of the shaft. The site selected for the shaft is in 50 ft of water and the outlets were designed for a depth of 40 ft below mean sea level. Figure 8 shows the pattern of the sewage field computed in accordance with the method of Rawn and Palmer. The count of coliform bacteria to be expected at the edge of the sewage field, based on primary settling of the sewage followed by chlorination, was estimated at 16 per 100 ml of water which is well within the allowable limit for bathing waters.

It will be noted from Figure 8 that the computed radius of the sewage field in still water is 950 ft. In order for the edge of the sewage field to reach the shore an incoming tide and east wind would be required sufficient to produce a current velocity of about 6.2 ft per second. During the course of the float studies the maximum current velocity observed was 2.4 ft per second. With such an on-shore current velocity, the field would extend about 2,130 ft from the outlet or within about 1,870 ft of the shore.

The Rawn and Palmer experiments indicate that the depth is important but the diameter of the outlet pipe is critical in determining the extent of the sewage field. Computations showed, for example, that if 24-in outlet pipes had been selected instead of 20-in pipes the radius of the field would have been about twice as great. This is a very important observation in that it indicates that with properly designed outlets considerable savings may be made in the cost of treatment. For this project, for example, holding tanks are shown to be unnecessary. The estimated cost of the holding tanks is about $1,000,000 and if holding tanks were used it would be necessary to duplicate the ocean outlet and the outfall from the plant at an estimated cost of about $3,160,000. Thus, a saving of $4,160,000 is indicated by the proper design of the ocean outlet.

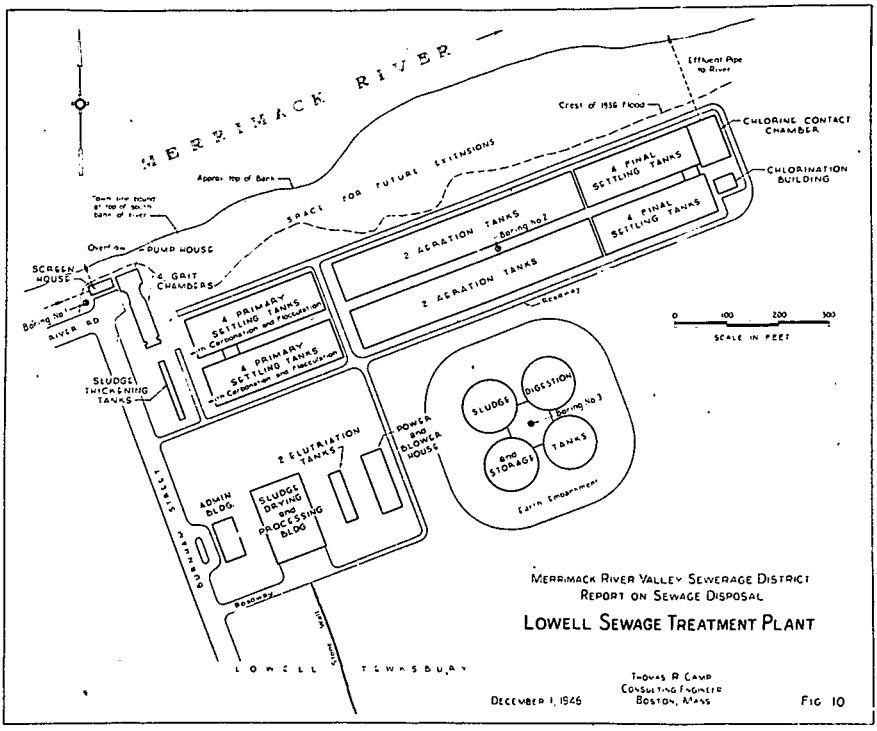
The Salisbury treatment plant, which is common to both the trunk sewer plan and the regional treatment plan, is shown in Figure 9. The primary purpose of this plant is to care for the sewage from the existing system at Salisbury Beach, but its location has been selected so that the plant may also serve Salisbury in the future. The plant will consist of two grit chambers, duplicate comminutors, raw sewage pumps, flocculation and grease flotation tanks, primary



settling basins, a chlorine contact chamber, sludge and grease pumps, sludge digestion and storage tanks, open sludge drying beds and an administration building in conjunction with the pump house. Power will be purchased but sludge gas will be used to heat the digestion tanks. The plant is designed for a heavy summer load. The estimated average daily summer flow in 1987 is 1.98 mgd, the maximum daytime flow is 5.54 mgd and the peak flow is 8.47 mgd. The estimated cost of construction of this plant is $439,600 not including the cost of intercepting sewers. The estimated cost of constructing the intercepting sewer from Salisbury Beach is $339,200.

The Regional Treatment Plan

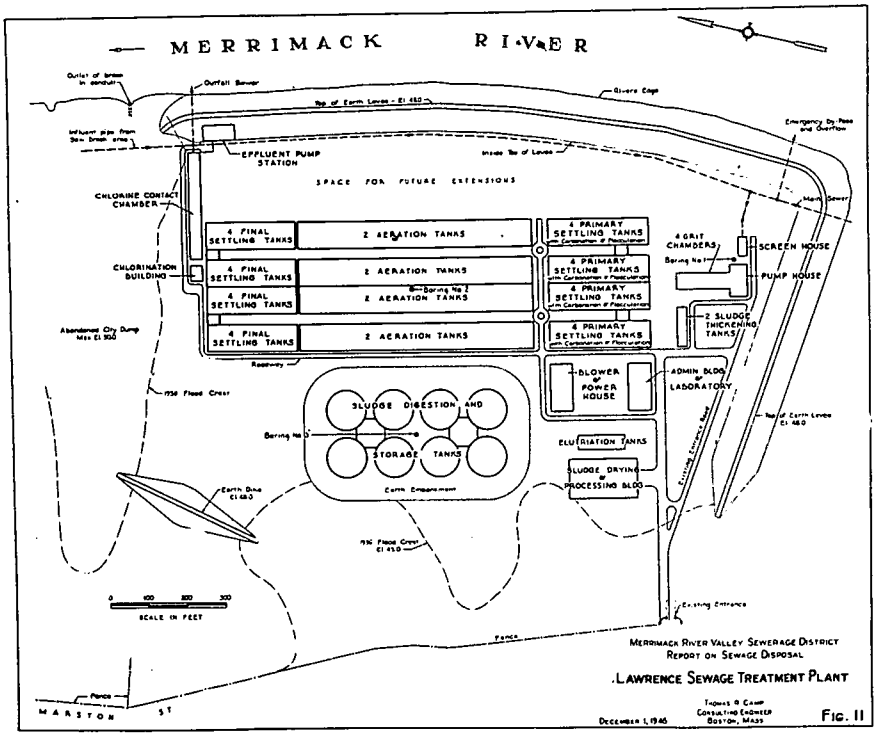
Figure 10 shows the layout for the sewage treatment plant to serve the Lowell region in the regional treatment plan. The plant is of the activated sludge type and comprises racks, pumps, grit chambers, carbonation channels, grease flotation and flocculation tanks, primary settling basins, aeration tanks, secondary settling basins, a chlorine contact chamber, sludge and grease pumps, sludge thickening tanks, sludge digestion and storage tanks, elutriation tanks, vacuum filters with accessory sludge handling equipment, power and blower



equipment and an administration and laboratory building. The plant is designed so as to permit operation as two separate systems, each consisting of two grit chambers, a carbonation channel, eight grease flotation and flocculation tanks, four primary settling basins, two aeration tanks and four secondary settling basins. The plant is designed for an average discharge of 23.4 mgd and an estimated peak 1987 flow of 39.2 mgd. The screen house is to include one coarse rack and two mechanically cleaned medium racks provided with shredding equipment. There are to be six 8-mgd raw sewage pumps discharging to four parallel grit chambers each 6.8 ft wide and having an overall length of 100 ft. Each bank of four settling tanks is to be preceded by a carbonation channel discharging into four parallel units for flocculation and grease flotation, each unit consisting of two tanks in series. Each of the eight primary settling tanks is to be 18 ft wide by 200 ft long with an average water depth of 5 ft. Each of the four aeration tanks is to be 506 ft long, 37 ft wide with an average water

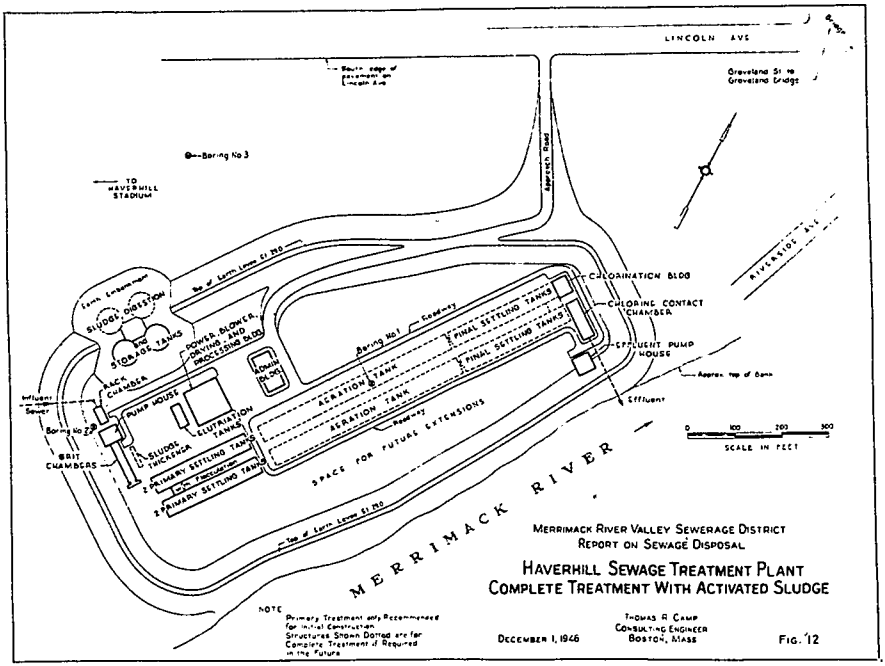
depth of 15 ft. Each of the eight final settling tanks is to be 240 ft long, 18 ft wide with an average water depth of 6 ft. The chlorine contact chamber is to have an average contact period of 21 minutes. The sludge is to be thickened, digested, elutriated and dried on vacuum filters, and the dried cake is to be hauled for dumping. The digestor design is similar to that described for the trunk sewer sewage treatment plant with tanks 100 ft in diameter. All power is to be generated by means of dual-fuel engines using gas. The estimated cost of construction of the treatment plant is $4,283,680 and of the intercepting sewers is $3,366,900.

Figure 11 shows the sewage treatment plant for the Lawrence region in the regional treatment plan. This is the larger of the two proposed activated sludge plants. The plant is similar in design to the Lowell plant but it has been laid out so as to permit operation as four parallel independent systems. Each system consists of one grit chamber, a carbonation channel, eight grease flotation and floc-



culation tanks, four primary settling basins, two aeration tanks, and four secondary settling basins. The estimated average flow to the plant is 38.5 mgd and the estimated peak 1987 flow is 64.5 mgd. The screen house includes two coarse racks and two medium racks with mechanical rakes. The pump station is designed for six 14-mgd pumps which discharge to four parallel grit chambers each 9 ft wide and with an overall length of 133 ft. Each of the primary settling tanks is to be 200 ft long by 16 ft wide with an average water depth of 5 ft. Each of the eight aeration tanks is to be 600 ft long by 33 ft wide with a water depth of 15 ft. Each of the 16 final settling tanks is to be 220 ft long by 16 ft wide with a water depth of 6 ft. The chlorine contact chamber will provide an average contact period of 23 minutes. An effluent pump station is required for this plant in order to discharge the effluent to the river during flood stage together with the storm water which collects inside the dikes. The effluent pump station is to be provided with eight pumps having a total capacity of 104 mgd. Sludge is to be handled in a similar manner as described for the Lowell plant. Each of the eight sludge digestion and storage tanks is to be 100 ft in diameter. All power is to be produced by dual-fuel engines using digestor gas. The administration building at this plant is to provide facilities for the District administration offices. The estimated cost of construction of the Lawrence regional treatment plant is $8,601,200 and of the interceptors is $5,479,300.

Figure 12 shows the Haverhill regional treatment plant laid out so as to permit expansion to complete treatment by the activated sludge process if required in the future. The estimated average flow to this plant is 9.46 mgd and the estimated peak 1987 flow is 17.1 mgd. The rack chamber is to house one coarse rack and one medium mechanically cleaned rack and shredding equipment. There are to be four raw sewage pumps with a total capacity of 23 mgd discharging into two parallel grit chambers each 6.5 ft wide and having an overall length of 96 ft. No carbonation channels are required at the Haverhill plant because the wastes are not highly alkaline as is the case at Lawrence and Lowell. Each of the two grit chambers will discharge to two parallel units for flocculation and grease flotation which discharge directly to the primary settling tanks. Each of the four primary settling tanks will be 200 ft long, 16 ft wide and will have an average water depth of 5 ft. The primary settling tanks will dis-



charge through a chlorine contact chamber providing an average contact period of 23 minutes. This plant also requires an effluent pump house to discharge against flood stage in the river. Five effluent pumps will be provided having a total capacity of 43 mgd. Sludge will be processed as described for the other plants. Only two digestion tanks will be constructed for the primary treatment plant but space has been provided for two additional tanks in case the plant is expanded for complete treatment. The digestors will have a diameter of 55 ft. Power is to be supplied for the plant by means of dual-fuel engines using digestor gas. The estimated first cost of this plant is $1,591,800 and of the interceptors is $2,572,700.

Cost studies were made of two alternate plans for complete treatment at Haverhill, one involving the activated sludge process and the other involving high-rate trickling filters. The costs were about the same for the Haverhill plant, but the studies indicated that the activated sludge process would be more economical for the larger plants at Lowell and Lawrence.

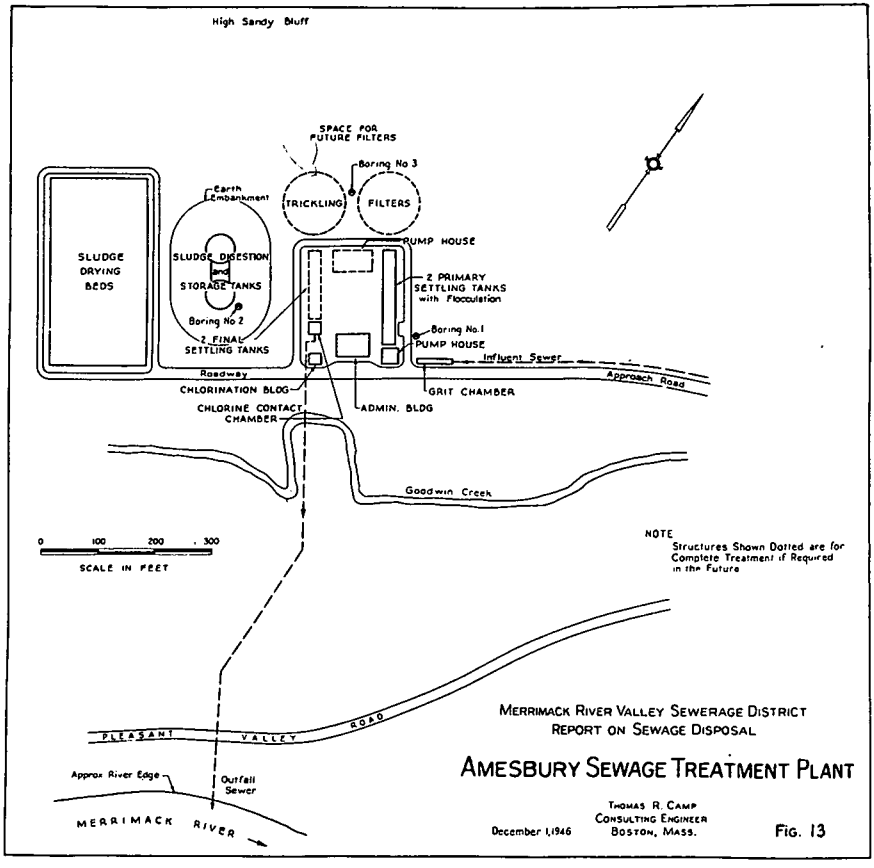
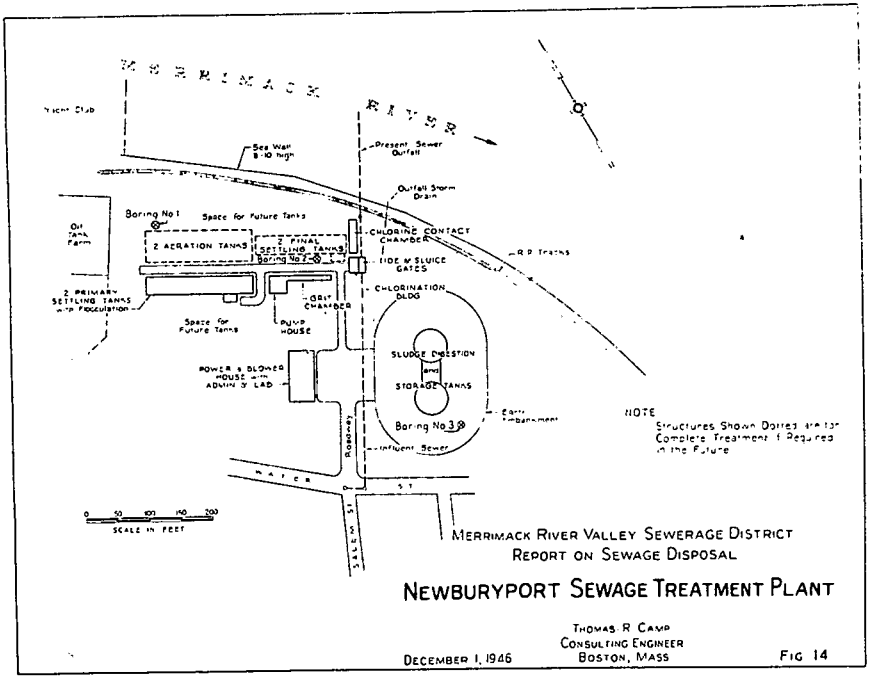


Figure 13 shows the proposed design for the treatment plant at Amesbury. The estimated average flow for this plant is 1.04 mgd and the estimated 1987 peak flow is 3.62 mgd. The proposed plant consists of a grit chamber, a comminutor, raw sewage pumps, flocculation and grease flotation tanks, primary settling basins, a chlorine contact chamber, sludge and grease pumps, sludge digestion and storage tanks, open sludge drying beds and an administration building containing office and laboratory. Provision has been made for expanding the plant to complete treatment by high-rate trickling filters if found necessary in the future. The plan provides for four raw sewage pumps having a total capacity of 4.4 mgd which will receive the effluent from a single grit chamber 4 ft wide and having an over-

all length of 66 ft. The grit chamber will discharge through a comminutor to the pump suction well. The pumps will discharge to two parallel flocculation and grease flotation units, each consisting of two tanks in series and each discharging into a primary settling tank. Each of the two primary settling tanks is to be 100 ft long by 10 ft wide with an average water depth of 5 ft. The primary settling tanks are to discharge through a chlorine contact chamber having an average contact period of 35 minutes which in turn will discharge by gravity to the river. The sludge will be digested and stored in two tanks each having a diameter of 40 ft. The digested sludge will be dried on sludge drying beds. Capacity will be provided in the sludge storage tank and in the open drying beds to accommodate digested sludge from Newburyport where space limitations preclude the use of drying beds. Power for this plant will be purchased. The estimated cost of construction of the Amesbury treatment plant is $363,200 and of the interceptor is $199,500.

Figure 14 shows the proposed treatment plant for Newburyport.



The estimated average flow to this plant is 2.38 mgd and the estimated 1987 peak flow is 5.19 mgd. The design is for primary treatment only but provision has been made for expansion to secondary treatment by the activated sludge process if found necessary in the future. Activated sludge is preferred to high-rate trickling filters because of space limitations and aesthetic requirements which also preclude the use of open sludge drying beds at Newburyport. It is proposed to haul the wet digested sludge to the Amesbury plant for drying and ultimate disposal. The proposed primary treatment plant will consist of a grit chamber, a comminutor, raw sewage pumps, flocculation and grease flotation tanks, primary settling basins, a chloride contact chamber, sludge and grease pumps, sludge digestion and storage tanks and an administration building. Power will be purchased but sludge gas will be used to heat the digestion tanks and buildings. Four raw sewage pumps are required with a total capacity of 6.0 mgd. There will be one grit chamber having a width of 4.75 ft and an overall length of 79 ft. The grit chamber will discharge through the comminutor to the pump suction well. The pumps will discharge to two parallel flocculation and grease flotation units consisting of two tanks each in series. Each flocculation and grease flotation unit will discharge to a primary settling tank. Each of the two primary settling tanks will be 140 ft long by 12 ft wide and will have an average water depth of 5 ft. The settling tanks will discharge to the chlorine contact chamber having an average contact period of 23 minutes which in turn will discharge to the existing outfall sewer. There will be two sludge tanks, each having a diameter of 35 ft. The estimated first cost of this plant is $344,000.

Administration and Finance

Proper and economical designs of the proposed works and efficient operation of the entire District require that definite policies be adopted regarding the allocation of responsibilities. In the course of our studies certain policies have been assumed in order that reliable estimates of cost could be made. Because these policies appear to be logical and fair it was recommended that they be adopted by the District. The following five points represent the proposed policy with regard to interception of sewage and wastes: (1) The District will assume the obligation of treating or otherwise satisfactorily disposing of all sewage and organic industrial wastes which are now

being discharged into the river or may be so discharged in the future, which in the opinion of the Department of Public Health requires such action to safeguard the quality of the river water. (2) As a part of its obligation under (1) above, the District will provide interceptors for all existing and future municipal sewer outlets required to be intercepted provided that these outlets cannot be more economically diverted into other parts of the sewerage system of the municipality. (3) The District will have the right to terminate the upper ends of its interceptors at suitable points for future municipal sewers or sewerage systems and to require such sewers or systems to be extended to such terminal points. (4) The District will have the right to require sewage from one municipality to flow through sewers of another municipality provided that in so doing any additional expense for construction, maintenance and operation incurred thereby by the latter municipality will be borne by the District. The District may at its option acquire trunk sewers now being used or proposed to be used jointly by more than one municipality. (5) The District will have the right to set rules and regulations subject to the approval of the Department of Public Health regarding the type, quantity and strength of industrial wastes which are to be intercepted by the District and to require the municipalities to construct or cause to be constructed whatever connecting sewers may be required for collection of such wastes.

The problem of equitable assessments of the annual costs of the District has been thoroughly studied. The cost of the sewers and certain units in the treatment plants are determined primarily by the quantity of sewage and manufacturing wastes to be handled. The costs of secondary treatment are determined primarily by the amount of organic matter in the sewage and wastes as represented by the biochemical oxygen demand and the costs of disposal of sludge are determined primarily by the amount of suspended solids in the sewage and wastes. When the works are completed, it is estimated that 61.2% of the annual cost will be attributable to the quantity of sewage and wastes, 15.4% to the amount of biochemical oxygen demand and 23.4% to the amount of suspended solids.

At the present time the capacity of the river for receiving pollution is shared in proportion to the amount of B.O.D. and suspended solids contributed by each person and industry in the District. These rights are in a sense to be preserved by the remedial measures to be under-

taken by the District. The District will assume the obligation to treat whichever of these wastes require treatment in order to protect the quality of the river water, and the District should be permitted for purposes of economy to allow certain of the wastes to be discharged directly to the river without treatment if the standards of quality of the river water are not impaired thereby. It is recommended therefore that the portion of the cost of remedial works attributable to B.O.D. (i.e. 15.4% of the annual cost) and the portion of the cost attributable to suspended solids (i.e. 23.4% of the annual cost) be assessed throughout the District in proportion to the amount of B.O.D. and suspended solids produced without regard to whether the wastes are treated or not. It is proposed for assessment purposes that the B.O.D. and suspended solids produced by municipalities be computed on the basis of 0.19 lbs of B.O.D. per person per day and 0.25 lbs of suspended solids per person per day for the entire population of each municipality whether sewered or not. It is proposed that the B.O.D. and suspended solids produced by each industry be estimated from surveys of the industries by the District staff.

Since sewage and industrial wastes are composed principally of water, the volume of sewage and liquid wastes now being discharged to the river is unrelated to the capacity of the river for receiving pollution and has no bearing upon the cost of remedial measures unless these wastes are intercepted and treated. It is proposed therefore to assess the portion of the annual cost attributable to quantity (i.e. 61.2% of the total) against the municipalities and industries whose wastes were treated by the District during the past year in proportion to the quantity contributed by each. The quantities of sewage and industrial wastes to be used for assessment purposes are to be based on gagings and measurements made by the District staff.

It is estimated that when the proposed works are completed and in full operation, the above plan will result in the assessment of $777,023 or about 58% of the total annual cost against the manufacturers and approximately $561,997 or 42% against the municipalities. The average annual cost per capita for disposal of municipal sewage, based on the 1945 populations of the municipalities, is estimated at $1.64. If the estimated annual cost for disposal of the municipal sewage is assessed against the general tax, the increase in the tax rate will be approximately $1.70 per $1,000 of valuation, based upon the assessed valuations in 1946.

Region, and City or Town.	Population, 1945.	B. O. D., 1947.				Suspended Solids, 1947.			
		Domestic.	Industrial.[1]	Total.	Per Cent.	Domestic.	Industrial.[1]	Total.	Per Cent.
I. Lowell region:									
Lowell	101,229	19,234	20,077	39,311	15 54	25,307	32,661	57,968	14.24
Tyngsborough	1,405	284	0	284	0 11	374	0	374	0.09
Chelmsford	8,726	1,658	18,870	20,528	8.12	2,182	60,553	62,735	15.41
Dracut	7,434	1,412	1,826	3,238	1.28	1,858	779	2,637	0.65
Billerica	8,504	1,616	4,345	5,961	2.36	2,126	2,308	4,434	1.09
Tewksbury	5,949	1,130	0	1,130	0.45	1,487	0	1,487	0.37
Total	133,337	25,334	45,118	70,452	27.86	33,334	96,301	129,635	31.85
II. Lawrence region:									
Lawrence	85,603	16,264	115,273	131,537	52.00	21,401	188,781	210,182	51.62
Methuen	23,160	4,400	988	5,388	2.14	5,790	412	6,202	1.52
Andover	11,920	2,265	9,604	11,869	4.69	2,980	3,872	6,852	1.68
North Andover	7,936	1,508	2,157	3,665	1.45	1,984	825	2,809	0.69
Total	128,619	24,437	128,022	152,459	60.28	32,155	193,890	226,045	55.51
III. Haverhill region:									
Haverhill	46,162	8,771	8,847	17,618	6.97	11,540	26,989	38,529	9.46
Groveland	2,150	408	0	408	0.16	538	0	538	0.13
Total	48,312	9,179	8,847	18,026	7.13	12,078	26,989	39,067	9.59
IV. Merrimac	2,384	453	0	453	0.18	596	0	596	0.15
V. Amesbury	10,824	2,056	478	2,534	1.00	2,706	3,716	6,422	1.58
VI. West Newbury	1,503	286	0	286	0.11	376	0	376	0.09
VII. Newbury	1,636	311	0	311	0.12	409	0	409	0.10
VIII. Newburyport	14,079	2,675	5,226	7,901	3.12	3,520	428	3,948	0.97
IX. Salisbury	2,622	498	0	498	0.20	656	0	656	0.16
Grand total	343,316	65,229	187,691	252,920	100.00	85,830	321,324	407,154	100.00
Per Cent	-	25.79	74.21	100.00		21.08	78.92	100.00	-

Table 7.—Basis of Assessment for Organic Loadings.

Table 7 shows the basis of assessment for organic loadings distributed according to municipality and based upon the 1947 loadings. Table 8 shows the basis of assessment in proportion to the 1947 flow distributed according to municipality. Table 9 shows the relations between the domestic and industrial assessments.

Region, and City or Town.	Average Discharge to be Intercepted, 1947.					
	Sanitary and Ground Water.		Industrial.		Totals.	
	m. g. d.	Per Cent of Grand Total.	m. g. d.	Per Cent of Grand Total.	m. g. d.	Per Cent of Grand Total.
I. Lowell region:						
Lowell	12.72	18.19	6.12	8.76	18.84	26.95
Tyngsborough	0	0	0	0	0	0
Chelmsford	0	0	0.89	1.27	0.89	1.27
Dracut	0	0	0.45	0.64	0.45	0.64
Billerica	0	0	0.42	0.60	0.42	0.60
Tewksbury	0	0	0	0	0	0
Total	12.72	18.19	7.88	11.27	20.60	29.46
II. Lawrence region:						
Lawrence	10.04	14.36	20.43	29.22	30.47	43.58
Methuen	1.81	2.59	0.22	0.31	2.03	2.90
Andover	1.25	1.79	1.79	2.56	3.04	4.35
North Andover	1.22	1.74	0.39	.56	1.61	2.30
Total	14.32	20.48	22.83	32.65	37.15	53.13
III. Haverhill region:						
Haverhill	7.37	10.54	1.12	1.60	8.49	12.14
Groveland	0	0	0	0	0	0
Total	7.37	10.54	1.12	1.60	8.49	12.14
IV. Merrimac	0	0	0	0	0	0
V. Amesbury	0.77	1.10	0.18	0.26	0.95	1.36
VI. West Newbury	0	0	0	0	0	0
VII. Newbury	0	0	0	0	0	0
VIII. Newburyport	2.10	3.00	0 13	0.19	2.23	3.19
IX. Salisbury	0.50	.72	0	0	0.50	.72
Grand total	37.78	54.03	32.14	45.97	69.92	100.00

Table 8.—Basis of Assessment in Proportion to 1947 Flow.

Component.	Flow.		B. O. D.		Suspended Solids.		
	Per Cent. (a)	Annual Charge. (b)	Per Cent. (c)	Annual Charge. (d)	Per Cent. (e)	Annual Charge. (f)	Total Annual Charge. (g)
Domestic	54.03	$442,765	25.79	$53,182	21.08	$66,050	$561,997
Industrial	45.97	376,715	74.21	153,027	78.92	247,281	777,023
Totals	100.00	$819,480	100.00	$206,209	100.00	$313,331	$1,339,020

Col. (b) = Col. (a) × Flow Factor (0.612) × 1,339,020.
Col. (d) = Col. (c) × B. O. D. Factor (0.154) × 1,339,020.
Col. (f) = Col. (e) × Suspended Solids Factor (0.234) × 1,339,020.

Table 9.—Relation Between Domestic and Industrial Assessments (Based on 1946 Surveys).

The investigation described in this paper was a cooperative venture in which many persons took part. The author is indebted to Mr. Thomas A. Berrigan, Chairman of the Joint Board and to Mr. Arthur D. Weston, Director of the Division of Sanitary Engineering, Department of Public Health, whose counsel and assistance were most helpful. The cooperation of the Vice-Chairman of the Joint Board, Dr. Vlado A. Getting, Commissioner of Public Health, and of the other members of the Joint Board is greatly appreciated. The author gratefully acknowledges the contribution of the Department of Public Health in making the surveys of the manufacturing wastes and in furnishing the laboratory analyses of samples. The cooperation of the officials of the municipalities in the Valley in furnishing existing plans and assistance with the gagings is gratefully acknowledged. The author is particularly indebted to his partners, Herman G. Dresser and Jack E. McKee, and to other members of his staff who were active throughout the investigation and did most of the work.

POLLUTION ABATEMENT IN THE MERRIMACK RIVER

By T. A. Berrigan, Member*

(A discussion of Paper by Thomas R. Camp at a meeting of Boston Society of Civil Engineers held on January 28, 1948).

Pollution of the Merrimack River immediately raises the question "By what right do municipalities and industrialists discharge their untreated waste products into natural water courses?" Inquiry discloses that the right to use the river water for any purpose, including dilution of wastes, accrues in the first instance to riparian owners in accordance with the needs of the land, having in mind that the needs of any particular land adjacent to the river must take into consideration the needs of other land along the river. A doctrine of reasonable use and of balancing the benefit among the various riparian owners appears to determine how much use any riparian owner may make of the river water. Thus taking of water from a stream for sale elsewhere is held to be an unreasonable use if objection is made by a lower riparian owner since the water taken does not directly accrue to the benefit of land bordering on the stream.

These relationships between riparian owners respecting the reasonable use of river water may be substantially changed where one riparian owner has purchased that interest of another riparian owner which touches upon the use of water from the river. For example, a lower riparian owner may purchase the right to construct, maintain, and operate a dam on his premises at an elevation that causes a portion of an upper riparian owner's land to become inundated and with the stipulation that the upper riparian owner will not use the water in the river for irrigation or other purposes which reduce flow. Similar rights may also be acquired by prescription where one openly, and against the interests of other riparian owners, exercises a use of the river water for a period of more than twenty years. The situation in the city of Lawrence in the Merrimack Valley is particularly interesting on this point. Here it appears that the city of Law-

*Chairman Merrimack Valley Joint Sewerage Board.

rence has been obtaining water from the river and discharging its domestic wastes into the river for more than twenty years. The question arises—How much and what quality of water is Lawrence entitled to as a matter of law for water supply purposes, and to what extent may it use the river to absorb the organic and bacterial load discharged from its sewers? Further complications appear when it is noted that the population of Lawrence is changing and that the present requirements for water supply and sewage disposal are somewhat different from what obtained twenty years ago.

The relationship between riparian owners above-referred to obtains until such time as the public health and welfare of the inhabitants as a whole are affected. Thus, when it appears that use of the river is not conducive to the general health and welfare, the Commonwealth, by an exercise of police power, may restrict the use of a vested property right to the river water. Such exercise is manifest by Mass. Acts of 1945, Chapter 615, wherein the Department of Public Health is vested with authority to prevent pollution of Massachusetts rivers.

After considering the legal aspects as indicated above, and pursuant to authority contained in Mass. Resolves of 1945, Chapter 62, and Resolves of 1946, Chapter 47, the Merrimack Valley Joint Sewerage Board, comprised of the Merrimack River Valley Sewerage Board and the Department of Public Health, received an appropriation of $50,000 and undertook to make a sanitary survey and prepare general plans covering the works considered appropriate to abate pollution. After carefully considering the matter, the Board decided it would be more economical and expeditious to employ consulting engineers rather than set up an engineering organization of its own. Accordingly, Thomas R. Camp was selected as a general sanitary consulting engineer to furnish the sanitary engineering services required, and the firm of Thompson & Lichtner Company was employed to supervise and interpret soil explorations.

The Joint Board, having constantly in mind the natural characteristics of the Merrimack River, finds that it is substantially polluted before it enters Massachusetts, but notes nevertheless that it has recuperated to fairly good condition at the Massachusetts border and this condition improves until wastes from Lowell are encountered. More particularly, the Board finds that, as the Merrimack River enters Massachusetts, flows of less than 1500 c.f. per second may

be expected less than 10% of the time, that the lowest dissolved oxygen recorded during the previous 10-year sampling period amounted to 5 p.p.m. and that the highest B.O.D. recorded amounted to 5 p.p.m. However, from Lowell to the sea, the river is surcharged beyond its capacity with an organic and bacterial load, with the result that the river becomes unsightly in appearance and depleted of oxygen to a degree inimical to aquatic life. After carefully studying the matter the Board concluded that an E. Coli index in excess of 1000 per hundred m.l., and concentrations of dissolved oxygen in amounts of less than 5 p.p.m. if discovered in the river reflect an abuse of the river.

To reduce the load on the river to within reasonable limits the Joint Board considered three schemes as follows:

1. Flood control works by the Federal Government to increase the capacity of the stream to handle pollution during dry weather.
2. A trunk sewer adjacent to the river to intercept polluting outfalls and discharge effluent after treatment into the Atlantic Ocean.
3. Regional treatment plants to intercept and reduce polluting load and discharge effluent into the river at selected points.

The flood control scheme, considered desirable for flood control purposes, was not recommended for the following reasons, to wit: The flood control scheme would not increase the flow sufficiently to maintain the necessary concentration of dissolved oxygen, nor would it sufficiently reduce the bacterial concentration. Further inquiry showed that the dry weather flow in the river amounted to 1500 c.f. per second and that more than $60 million would be required to cover the cost of impounding reservoirs to double the flow in the river during dry periods.

The Board found that the trunk sewer scheme would satisfy the sanitary requirements set but did not recommend its construction for the following reasons:

a. A trunk sewer is more expensive to finance than a regional treatment plant scheme.

b. Property damages in connection with condemnation proceedings to implement the trunk sewer scheme would run very high and would divest certain industries of water and power rights in the river.

c. Trunk sewer schemes would substantially reduce the natural power and water sources of the river.

d. A trunk sewer, because of its length, might prove undesirable because of odors from stale sewage, especially on weekends when industry was shut down, and because further substantial impacting of grease in sewer conduits might reduce capacity.

e. Trunk sewer scheme could not be integrated as well as regional treatment plant scheme into a program where benefits accrued in proportion as money is expended.

f. Trunk sewer scheme would concentrate the discharge of sewage in close proximity to a principal bathing beach on the Atlantic Coast.

The regional treatment plants scheme was recommended by the Board because it would reduce the load on the river to within reasonable limits at an estimated cost substantially less than that of the other schemes. The regional treatment plants scheme is divided into four parts, with estimated construction costs as follows:

1. Lowell metropolitan region (Lowell, Billerica, Chelmsford, Dracut and Tewksbury), intercepting sewers and activated sludge treatment plant with chlorination	$7,650,000
2. Lawrence metropolitan region (Lawrence, Methuen, Andover and North Andover), intercepting sewers and activated sludge treatment plant with chlorination	14,080,500
3. Haverhill metropolitan regional (Haverhill and Groveland), intercepting sewers and primary sedimentation plant with chlorination	4,164,500
4. Newburyport Harbor, intercepting sewers and primary treatment plants with chlorination at Amesbury, Newburyport and Salisbury	1,685,500
Total	$27,581,100

Financing, maintenance, and operating costs for the regional treatment plants predicated on 40-year bonds at 1¾% are estimated as follows:

Fixed charges	$964,570
Maintenance and Operation	1,303,910
Income from sale of grease	929,460
Net cost to function (per annum)	$1,339,020

It should be appreciated that the dry weather flow of the Merrimack River is approximately one billion gallons per day, and that

this river in its natural state has a capacity to handle a limited amount of organic load. In view of this, it is important to view the situation as a whole from Tyngsborough to the sea. Having this in mind, the Joint Board recommends that there be one sanitary district embracing the whole territory administered by the Merrimack River Valley Sewerage Board. Under this arrangement there will be no divided responsibilities and the Merrimack River Valley Sewerage Board will have exclusive cognizance over the construction, maintenance, and operation of regional treatment plants located at Lowell, Lawrence, Haverhill and Newburyport Harbor.

In the event that the public works recommended by the Joint Board come into being, then the Merrimack River within its course through Massachusetts will be relieved of the pollutional load with which it is now surcharged, and this will be manifest by a rejuvenation of aquatic life and recreational activity, including fishing, boating and swimming, except for a short period after heavy rainfall, when pollution will escape until such time as local collectors of sewage predicated on the combined systems are eliminated.

The Joint Board considered that it was beyond the scope of its inquiry to suggest a method for apportioning the cost of the proposed works. However, it recommended that a special board be appointed by the Supreme Judicial Court to determine the equities. Unquestionably, this board in its deliberations will give consideration to the population of the districts, to property valuations, to parties to whom service is rendered by the sewerage authority, and to the value of products salvaged during treatment. A board of such high order would be expected to be fair and practical in securing the best interest of all concerned.

Opportunity is taken at this time by the Chairman of the Joint Board to express his appreciation to the Department of Public Health for substantial amounts of information furnished and incorporated in this report and for conducting the industrial wastes survey and furnishing analyses of samples, and particularly to Commissioner Vlado A. Getting, M.D., Chief Engineer Arthur D. Weston, and Senior Sanitary Engineers Joseph Knox and Joseph McCarthy, who were especially active. Appreciation is also acknowledged of the Board's consulting engineer, Thomas R. Camp, for the exceptional leadership furnished, and to Miles N. Clair of the Thompson & Lichtner Company, for competence and devotion to duty in connection with soil explorations.

THE ENGINEERING ASPECTS OF THE LAND COURT

By Charles M. Anderson, Member*

(Presented at a joint meeting of the Boston Society of Civil Engineers and Surveying and Mapping Section, B.S.C.E., held on November 19, 1947).

The engineering department of the Land Court exists for three purposes: first, to prepare a map for each parcel of land registered under the provisions of Chapter 185 of General Laws (Ter. Ed.); second, to prepare a similar map each time a new ownership line is created within any parcel so registered; and third, to furnish assistance to the Court in any other technical matter. It appears wise therefore, to emphasize to any engineer whose work may enter into registration proceedings that he is dealing with a Court and not merely an engineering office. He should realize that every plan submitted and every word of testimony offered is examined from a legal point of view, and it gets that legal ex-ray whether or not it needs it. Likewise, he should keep in mind that occasions do arise from time to time when parts of such plans and testimony may not be examined from the engineer's point of view, necessary as that might seem to a technical man.

This latter statement cannot be more clearly illustrated than by referring to the registrations of the first few years of the Court's existence. The Court of Land Registration as it was called prior to 1904, apparently thought little was to be gained by preparing what we now call an adequate picture of the land being registered. The law neither then nor now makes any provision for an engineer or an engineering department. It does provide for technical assistants to the Recorder, engineers as well as clerks and stenographers coming under this heading. Is it any wonder, then, that in some early cases, no real plans were submitted, and that sketches form the registry records, sometimes traced with pencil and ruler by a title examiner, were the basis for decrees by which the Commonwealth guaranteed those lines forever! Many of the plans which were submitted were nothing but similar sketches drafted in ink on tracing cloth. A few

*Assistant Civil Engineer, Land Court, Boston, Mass.

were bona fide plans. Some of these plans are filed in the envelopes of "papers" in the case, some in the "abstracts" of titles, and others in the correspondence files of the engineering department. These four things, the plan, the papers, the abstract and the engineering files are the chief sources of information in each case.

The "Surveyor for the Court" in those early years drafted a copy of such sketches and plans, often in an even more abbreviated form, as a plan to accompany the decree. Such "decree plans" were usually drawn to scale with overall distances, street names and some abutting owners lettered thereon, but they showed no data for the reproduction of the lines upon the ground. However, the Court took care of this feature by stating in the decree, and in the subsequent certificate of title, that the decree plan is a "copy of a plan on file in the Land Registration Office", this "plan on file" being the plan submitted by the petitioner. A corresponding notation may be found at the lower margin of the decree plan itself.

This plan reference has been an important feature throughout the years and undoubtedly will continue to be so. To a surveyor the reference should be interpreted to mean that any information upon the petitioner's filed plan which supports the data shown upon the Court's decree plan is thereby incorporated into the decree of the Court. Thus, the petitioner's plan is many times most important to the surveyor.

Every decree contains one of three plan references. The first and most common states that

> "All of the said boundaries (except .....) are determined by the Court to be located as shown on a plan numbered ..... which will be filed with the original certificate of title issued on this decree, the same being compiled from a plan drawn by ....., (surveyor), dated ..... and additional data on file in the Land Registration Office, all as modified and approved by the Court."

When this reference is found an examination of such "additional data" may be advisable. The second and simplest of these references states that

> "All of the said boundaries (except .....) are determined by the Court to be located as shown on a plan drawn by ....., dated ....., as modified and approved by the Court, filed in the Land Registration Office, a copy of which will be filed with the original certificate of title issued on this decree."

In such a case the surveyor's plan probably shows all the information available. The third plan reference is relatively rare. By it

> "All of said boundaries (except .....) are determined by the Court to be located as shown upon plan numbered ..... drawn by ....., Engineer for Court, dated ..... as approved by the Court, which will be filed with the original certificate of title issued on this decree."

These plans are prepared from such a diversity of information that no one surveyor's work could be cited.

The surveyor's dependence upon the petitioner's plan for data with which to reproduce the registered property lines has gradually decreased over the years. Under the progressive direction of Mr. Clarence B. Humphrey, the recently retired Engineer for the Court, and of Mr. William T. Fairclough, the present Engineer, the Court's decree plans have shown an ever increasing proportion of really helpful information. Forty years ago physical features, such as stone walls, fences and buildings were incorporated. Thirty-five years ago partial distances, some angles and some street line data appeared. Twenty-five years ago complete property line traverse data and complete street line data became the rule. Fifteen years ago offsets, ties and descriptive notes improved the plans. Each of these steps could be made only after the judges and recorders had been subtly convinced of the desirability of including it. The preaching of the gospel of engineering has converted the decree plans into useful, reliable maps of the registered parcels.

Turning from this history of Land Court plans, let us trace the course of the surveyor's plan as it is used in Land Court proceedings. The first the Court sees of it is when the petitioner's attorney presents it with his petition. One of the clerks in the main office examines it to be sure that it give certain general information all of which is necessary for the issuance of the subsequently published citation. These clerks see that the north point, the property lines distances, the abutting owners' names, the names and character of the streets and the widths thereof, the scale, the date, the engineer's name, and the name of the municipality wherein the land is located are upon the plan as well as the surveyor's signed statement "I certify that this survey was made in accordance with Land Court instructions". A case number is then assigned and the original is sent to the engineering department for numbering and indexing while a

blueprint copy is sent to the title examiner. The number of the petitioner's plan now-a-days is the case number with the exponent "A".

More than two weeks later the plan is again before one of those clerks while he drafts the citation by which all persons interested are referred to that plan. One can readily understand how important it is to show clearly, by actual angles and distances, and not by scale only, the relationship of the lines claimed to buildings, bounds, or other stable features. The abutting owner who receives the citation, and who examines the plan, wants to take his tape, or his yardstick, and, by measuring from some object which he recognizes as existing upon the ground, see for himself just where each line is claimed to be. Many appearances and answers could be avoided by keeping this layman who reads the citation in mind.

Three weeks or more after the citation is issued, the plan is placed before one of the three judges along with the papers, the abstract, the title examiner's report and any answers which may have been filed. If, after reading all this evidence, the judge is satisfied as to the title, he issues an order, briefly outlining what he wants included in the final decree. The case is then sent to the engineering department to have the decree plan drafted in accordance with that order. In a contested case this occurs after the decision becomes final. Almost all such orders for decree refer to some deed or plan in the abstract of title which the department must consider in properly drafting the decree plan. Reference to other material in, and outside of, the Land Court are not unusual. Thus, the plan may be partly "modified by the Court".

The next step, the engineering department's examination of the plan, may often disclose more ways in which the Court desires the plan "modified". It is examined as to mathematical accuracy, as to descriptive clearness and as to title conformity. Changes may be made in any of these respects to enable the preparation of a plan which reflects certain general customs of the Court as well as the specific treatment of the individual cases. It now seems to be in order to discuss some of these modifications.

The quality of the survey work required is merely that which is regularly done by any engineer who knows his business. A summary of the details of a satisfactory survey is contained in the Land Court's "Instructions for Engineers" which any practicing surveyor may have for the asking as long as they last. This manual also contains much

other information respecting the preparation of plans specifically for the Land Court. A brief statement as to the accuracy expected is that the error of closure may vary from 1:3000 in a forest, or low value farm area, to 1:10,000 in an urban area. The traverse of the property line dimensions should be submitted. If inaccuracies are apparent, corrections, or additional information, are required. (One surveyor, during recent months, submitted three plans of the same parcel of land, each supposed to have been made in accordance with the "Instructions", after which the Court required a wholly new plan by a different engineer in order to get the job done correctly.) In cases of conflict between surveys, a statement indicating the method used to obtain the results shown on each plan is in order. However, the department at the present time has no facilities for checking the mathematics of every plan nor the field work of any! Thus, a dishonest engineer, if any exist, can easily mislead the Court. This brings to mind a letter which the Court received some years ago from an engineer who was asked to explain why a fifty foot error of closure existed in one of his plans. That letter began with a story of the survey party working on the frozen marsh with the wintry winds chilling the men to the bone and ended with those same men in their bathing suits standing waist-deep in the swamp mud. While a field survey might well be spread out over a six month period, a reading of that letter suggests that the writer's difficulty with the weather resulted from his enthusiastic search for excuses.

The Court uses every available means to see that the newly registered lines conform with the abutting, previous registrations. These prior cases are indexed by two card systems; one, a locality index, where case numbers are entered by municipality and street; and the other, a petitioner index, where case numbers are entered under the alphabetically arranged petitioners' names. If atlases are available, the perimeter of the parcel registered is outlined thereon in color. In some instances, chiefly at Cape Cod and other coastal localities, the Land Court, with the authorization of Section 117 of Chapter 185, prepares its own atlases in order to show registered parcels. These "Sectional Plans", as they are called, are drawn on a scale of 300 feet to an inch on double elephant size mounted paper. They cover one minute fifteen seconds of latitude and two minutes thirty seconds of longitude. The geographical coordinate lines form a border about one inch from each edge of the sheets. Whenever they

may prove useful, coordinate lines of other coordinate systems are also plotted thereon. An effort is made to place all nearby cases on the same meridian. If possible, all cases in one locality are reduced to a common coordinate system, whether that system is merely an expansion of a set of values assumed for a specific case or one set up by another authority such as the Boston Board of Survey or the Norfolk County Engineers. The statutory Massachusetts Coordinate System is preferred.

In the matter of descriptive clearness, the Court requires sufficient data to avoid any ambiguity as to where and how the lines fit upon the ground. Initial street line points and the monuments thereof, ties to intersecting streets, locality sketches, stone and concrete bounds, location of lines through or near brick walls, and measurements fixing any ways across the property, are all illustrations of this.

In the matter of title conformity, the engineering department's interest is to ascertain that the area sought to be registered is of the same extent and in the same location as the land to which title has been proved. It has happened that the wrong parcel of land has been registered. In the Cape Ann area, title was proven to a certain lot on a certain street although the petitioner's plan and the court's decree plan both showed an identically shaped lot further along the same street. The decree had been issued about twenty-five years before the discrepancy was discovered. Of course, under the law no change can be made after the first anniversary. Other such cases exist, although it is doubtful that any have slipped by in a great many years.

A more common difficulty arises when the parties stipulate, or the Court decrees, alterations in lines, perhaps without realizing that these alterations are mathematically or physically impossible or that they require new survey work. In one of the recent cases, the attorneys stipulated that the line between the petitioner and one of the abutters should be the "middle line of the ditch the same being shown on the petitioner's plan as (the southerly) line". However, the plan showed the ditch as wandering off the line toward the north, then turning, crossing the line, and then meandering off to the south. When asked for an explanation of the intention of the parties in drawing the stipulation, one attorney said that under the agreement, he thought the Land Court should draft the plan so that the middle line of the ditch would follow the line on the plan. Of course, he saw

the fallacy when it was pointed out to him that a mere agreement could not alter the facts existing upon the ground! In another case the petitioner and one of the respondents would not come to an agreement over the location of the property line between them, even though the value of the land in dispute was very small compared with the expense of the resulting trial to each party and to the Commonwealth. Judge Smith, with a bit of a twinkle in his eye it seems, came up with the decision that the line in dispute was fixed by the fence marking the limits of occupation, and that therefore he determined it to pass along the face of each of the lower stringers and around the circumference of each fence post along the way from stringer to stringer. Thus the engineering department had to obtain sufficient survey data to enable it to draft the plan showing the diameter of each of the fourteen posts and the relative locations of all the posts and stringers!

After the examination in regard to these three things, the mathematical accuracy, the descriptive clearness, and the title conformity, the decree plan is drafted by copying the essential parts of the petitioner's plan upon the 10″ by 15″ bond paper plan sheets which are eventually sent to the registry to be bound with the first certificate of title issued after the decree of the Court. Such petitioner's plans are reduced to the Court's small plan size either by pantograph or by photography. This latter method was introduced by Mr. Llewellyn T. Schofield, one of the assistant engineers. It has proven so satisfactory that a review of the process seems advisable. A suitable plan is reduced to a film negative 10″ by 15″ in size, which is then opaqued with a special paint, as to all items which should not be reproduced. From this opaqued film a Van Dyke contact print is obtained, to which is added, in India ink, all items which will make the plan complete and ready for the judge to use in drafting the decree. Note that the petitioner's plan has to be "suitable". Its suitability is determined by two things: the quality of the drafting and the direction of the lettering. Since the Land Court plans are drawn with the shorter dimension in the horizontal position and the north end of the north point above the horizontal, only those surveyor's plans are chosen which may be oriented so that they may be read from the bottom and right side of the sheet and yet keep the north point in a desirable position. In addition, the lettering must be large enough, and so well formed, that after it is reduced it will

still be legible. The records indicate that this method adds about three dollars to the cost of each plan so treated and averages a saving of about forty percent in time.

Complete information about the registered lines usually appears to be upon the recent Court plans. Surveyors, however, should beware of being misled in this respect. Nothing short of an examination of the certificate of title together with the plan will tell the whole story. Consider a few instances where the property lines may not be as the plan, taken by itself, indicates.

Water lines are ordinarily not determined by the Court. A more or less sign will almost always be found after any distance which reaches to a water mark—even that of a flowed pond. Yet, in the latter case, the certificate may recite that the water line is determined by the Court to be at the definite elevation fixed by a certain deed on file a the registry. Such a note may or may not be upon the plan.

In the case of lines across flats from high toward low water, Land Court plans will occasionally imply these are fixed as drafted thereon, whereas the certificate may specifically state that these lines are not determined.

Many plans show the limit of registration as being the edge of a marsh or swamp approximately shown thereon, while the certificate of title by its reference to the petitioner's plan, may definitely fix that edge. Thus through the plan reference, a location fixed by the surveyor upon his plan becomes part of the decree without being reproduced upon the Court's plan.

Street lines, though almost always determined by the Court, are occasionally excepted. Whether they are determined or not, the Land Court plans give the appearance of fixing them, and only an examination of the certificate will disclose their true status.

There is at least one case in which the decree states that none of the lines shown upon the decree plan are determined.

Very often, other features shown upon the Land Court plans are modified or eliminated by documents or Orders of Court referred to and endorsed upon the certificate of title. The location of a way, for instance, may be only approximate upon the plan, but may be definitely fixed by a certificate reference. Such a way may be later relocated or modified by a subsequent document filed at the registry of deeds and endorsed upon the certificate and still later may be eliminated altogether by a similar document so filed and endorsed. A

study of such entries upon the certificate may disclose such restrictions as building lines which the engineer must consider before staking the location of a structure. It may disclose a taking for street, sewer or water purposes which must be observed when performing other survey or engineering work upon the registered parcel. All such changes by endorsement upon the certificate may transpire without notice to the Land Registration Office in Boston, since Land Court practice does not require a plan to be prepared by the Court except for decree and a conveyance of a part of the fee.

Which brings us to the last step in Land Court plan work—the plans of subdivisions of the registered parcels. The voluntary conveyance of a portion of the fee must be accompanied by a Court plan showing that portion. This Court plan is prepared from one which is submitted to the Court by the registered owner with the statutory five dollar fee. It is prepared substantially as decree plans, including reproduction by the film method outlined above, and ordinarily deals only with the part which the owner intends to convey either immediately or in the future. Each plan is numbered by the same case number as the corresponding decree plan but has a different exponent, the exponents ranging from the letter "B" through the alphabet and then from the number one consecutively upward. These subdivision plans are eventually sent by the Court to the registry with a note near the lower margin indicating which lots shown thereon may be conveyed.

Other subdivision plans may be occasioned by an Order of Court. For example, an involuntary conveyance may be in the form of a taking in fee for street purposes. The taking is effective when endorsed upon the owner's certificate although no subdivision plan is made. The taking authority may then petition the Court for a certificate of title and, the Court, if satisfied as to title, may order such a certificate in accordance with a new plan of the area so taken.

Thus it behooves an engineer to keep the certificate of title in mind whenever dealing with registered land. The certificate and the documents noted thereon are of paramount importance and subservient to it are the Court's decree plans and subdivision plans as well as all other data.

Every once in a while the engineer discovers that the figures shown upon the Land Court plan with which he is working are inconsistent with the facts as he finds them upon the ground. Minor

errors, which may have existed in the data submitted to the Court or which may have been introduced during court plan work, may be corrected without any great formality. For example, a letter from the Court to the registry, outlining the corrections may be sufficient, or perhaps the incorporation of the corrections into the succeeding subdivision plan may be the most desirable method. But a major change, no matter how logical, in most instances requires formal court action in order to safeguard the rights of others who may be interested. This takes the form of "subsequent petition", which is drawn much the same as a bill in equity, and sets forth the ownership, the errors, the correct data (generally by reference to a plan submitted with the petition), the names of all parties in interest and requesting the Court to order the old certificate and plan be cancelled and to order that a new certificate, referring to a new plan, be issued to the petitioner. The Court then issues citations (sometimes after a brief examination of the title) to those whom it deems to be interested parties, unless they have already assented to the petition. These parties, if they answer, may be heard on the question of the proposed corrections. In any case the Court considers the evidence independently, and, if satisfied that the requested changes are proper, allows the petition. The Order of Court then issues, the erroneous plan cancelled at least in part, and a correct one placed on file, with corresponding changes in the certificates. Since the other parties interested usually want the error corrected, and therefore readily assent to the petition, the procedure often is relatively simple.

So far as the Court is able to do so, it endeavors to prepare plans of maximum usefulness. That is true even though there yet remains much room for improvement. Now and then an odd plan will be sent from the engineering department without those qualities of helpfulness which should be in every plan. Economic considerations, both as to the wealth of the petitioner and as to the relative value of the land, do not warrant expensively accurate field work and calculations, in some rare instances. Lack of time and lack of help to draft survey details or to perform desirable computations still plague the Court. These are problems yet to be solved.

With the long range view in mind, it may be said that these present problems are mere molehills compared with the mountains of difficulty ahead. Consider the fact that, except when an unregistered mortgage is foreclosed (an uncommon happening), land once regis-

tered remains registered forever and one can readily conceive of a time when all land in the Commonwealth will be registered land. Consider also the fact that a plan must be on record to show the limits of each parcel being conveyed and one can readily picture that, under the present system, the Land Court eventually will prepare a plan every time a new ownership line is created anywhere in Massachusetts. Long before that day arrives the Court will be the chief factor in the determination of the standards of property line surveys and of the plans thereof. Competent administration in the meanwhile must include an ever-present consciousness of these facts and be constantly originating or adopting practices which will make registered land transactions simple as well as secure.

THE LEGAL ASPECTS OF THE LAND COURT

By Edward P. Shaw, 3rd*

(Presented at a joint meeting of the Boston Society of Civil Engineers and Surveying and Mapping Section, B.S.C.E., held on November 19, 1947).

Registration of titles to land in Massachusetts is part of the exclusive jurisdiction of what is now the Land Court, which was created in 1898. It is an unique court having judges, engineers and other personnel who are specialists in conveyancing matters. Created to determine the status of titles and to provide a procedure to perfect and quiet them when possible, the personnel of the court from its judges to the newest file clerk has always been most cooperative with all who do business with it while maintaining a judicial dignity equal to our other courts. Because of its judicial and administrative ability, its jurisdiction is constantly being enlarged. Its home office is at Boston, and each registry of deeds is a branch office.

The registration of titles to lands is in some states known as the Torrens System. It was originated by Sir Robert Torrens in South Australia in 1858. Statutes of similar nature exist in Great Britain, Hawaii, the Philippines, Canada and some of our States.

The purposes and advantages of registration are many. A defective unmarketable title can become a good record title. An increasing number of owners, especially corporations are registering their titles as a sort of title insurance. With each decree, there is an official Land Court plan showing the bounds. The court may order bounds placed on the land. Registration in proper cases can eliminate streets and easements. For a developer of a large tract of land with a lengthy, complicated back title, registration will expedite his sales by giving him a simple certificate. Registration binds the world and is an action in rem operating on the land itself. The law is constitutional.

Individuals, minors and corporations are among those which can register, but the petition must include all owners. Several parcels coming through one title in one district can be joined in one petition

*Deland and Rockwood, Attorneys at Law, Boston, Mass.

but the ownership interests must be the same in both parcels. Provision is made for outstanding mortgages to become part of the registration. It is desirable usually for a mortgage to do so for otherwise if his mortgage is later foreclosed, the title again becomes unregistered.

Registration procedure requires a plan to be made under Land Court instructions. The petition, in duplicate on Land Court forms, preferably describes the land by abutters and not by metes and bounds. It sets forth appurtenant rights, encumbrances, the valuation, title reference, name of spouse, claims as to street rights, and is executed under oath. Corporations should attach a vote authorizing the registration. A form to be signed by the assessors includes a rough sketch of the land. A notice of the petition having been filed is recorded in the registry of deeds.

The plan and papers can be filed at the Land Court at Boston or at any registry of deeds. The usual filing fee deposit is now $45 plus 1/10 of 1% of the last assessed value of the property.

After filing the papers, the title is referred to a Land Court examiner, who examines the title and makes a report to the court. The court can require additional facts at any time. Transactions affecting the land may take place during registration. The court has broad powers of amendment. Usually it is better not to deal with land during the proceedings.

If the examiner's report is favorable, or if it is unfavorable and the petitioner elects to proceed, the court issues a citation by publication and registered mail usually returnable in twenty to sixty days. A notice is posted on the land. Notices are given to the Attorney-General and to municipalities, if necessary, due to street lines or other reasons.

Provision is made for guardians ad litem, agents, military attorneys. Anyone wishing to object should file an answer before the return day. Thereafter, a motion for a general default is made. If there is any contested issue, it is assigned on motion for hearing by the court. A claim for a jury trial in the Superior Court may be made. The court may appoint a master.

On uncontested registrations or after any disputed issues have been finally determined by the court, jury, master or otherwise, the proceedings and title are further considered by the court as to what order for a decree should be entered. The court may order that the

petition be allowed in full or in part, qualifiedly, or be dismissed. If a favorable order is made, the case goes to the Land Court Engineer for an official plan which becomes part of the decree. After the plan is ready a decree is entered in accordance with order of the court, the petitioner pays the balance of the fees and the matter is referred to the Land Court Office of the registry of deeds where the land is situated. The assistant recorder there runs the title from the date of the examiner's report to date, and if the record is clear, the decree is formally entered in the registry. Later, the owner gets an owner's duplicate certificate of title.

The decree operates on the land. It is binding on all persons, the state, minors, absentees, disabled, whether they have received notice or not, subject to certain rights of appeal and exceptions.

Every registration decree is subject to claims of the United States, two years taxes, certain provisions as to undetermined lines of ways, leases of less than seven years, betterments, riparian rights and a few other matters, all of which are set forth in section 46 of the registration law. Appurtenant rights are not affected by registration unless the decree so provides.

The law provides for a limited right of review and reopening the decree within one year. Rights of appeal or exceptions are provided on questions of notice and law.

OF GENERAL INTEREST

PROCEEDINGS OF THE SOCIETY

MINUTES OF MEETINGS

Boston Society of Civil Engineers

JANUARY 28, 1948.—A regular meeting of the Boston Society of Civil Engineers was held this date at the American Academy of Arts & Sciences, 28 Newbury Street, Boston, Mass.

President Kinnison presided at the meeting and announced the death of the following member:

Harry M. Steward who was elected a member May 15, 1918, and who died January 3, 1948.

President Kinnison stated that at the last meeting of the Society held December 17, 1947, the Secretary presented recommendations relative to the Permanent Fund and the Current Fund which had been acted upon favorably at that meeting and final action on the recommendatons would not be taken.

The Secretary read the following motions:

Motion "That the Board of Government be authorized to use an amount not to exceed $2000 from the principal of the Permanent Fund for Current Expenses".

Motion "That the Board of Government be authorized to increase the Current Fund to $3000 by a transfer of $1500 from the Permanent Fund to the Current Fund".

The motions were each duly seconded and voted in the affirmative.

These votes represent final action on these matters.

The Secretary announced that the following had been elected to membership on January 26, 1948:

Grade of Student.—Bradford A. Hixon, Jr., Jerome T. McCullough, John J. Prendergast, Justin L. Radlo, Robert Yanofsky.

President Kinnison introduced the speakers of the evening:

Mr. Thomas R. Camp, Partner, Camp, Dresser & McKee, Consulting Engineers, who spoke on "The Merrimack River Valley Sewerage District Project", and Mr. Thomas C. Berrigan, Chairman, Merrimack River Valley Joint Sewerage Board, who gave a discussion on the paper. The talk was illustrated with slides.

At the close of the meeting the members gathered in the lounge where a collation was served.

There were 125 persons present at the meeting.

EDWIN B. COBB, *Secretary*

FEBRUARY 18, 1948.—A regular meeting of the Boston Society of Civil Engineers was held this evening at the American Academy of Arts & Sciences, 28 Newbury Street, Boston, Mass. This was a joint meeting with the Structural Section, B.S.C.E.

President Kinnison presided at the

meeting and announced that the Annual Meeting would be held on March 31, 1948, at the Boston City Club. Speakers to be Professor Charles B. Breed, Dean Gordon M. Fair, Professor Charles M. Spofford, Professor Howard M. Turner. Subject, "Centennial Symposium — Contributions of the Members of America's Oldest Engineering Society to 100 Years of Progress in Civil Engineering".

President Kinnison called upon Henry I. Wyner, Chairman, Structural Section, to conduct any business matters necessary for the Structural Section.

The Secretary announced that the following were elected to membership on February 16, 1948:

Grade of Student.—Fred P. Blanchard, Donald F. Brackett, Henry C. Briggs, John W. Bunker, Harold E. Cady, Ben Colton, Joseph A. Corbisiero, Edward J. DePina, Robert E. Devlin, Francis X. Donegan, Charles G. Ellis, Ernest H. Fagerstrom, Arno Filipetti, Leo Gabriel, Robert W. Howes, Carl M. Jacobson, Leonard R. Johnson, Paul J. Kennedy, Robert E. Kirby, D. Y. Lee, Royal E. Livingston, Merle I. Locke, Roland W. Martineau, William E. Mylott, Robert B. Nunley, William D. O'Connell, Charles F. Quigley, Joseph J. Randall, Richard D. Raskind, Charles J. Reichenbacher, Arthur D. Ritchie, Jr., Arthur J. Romanelli, Anthony G. Sandonato, James M. Simmons, William L. Tribou, Robert G. Venne, Gerald J. Wayne, Joseph F. Willard.

President Kinnison introduced the speaker of the evening: Dr. Ruth Terzaghi, Geologist, who spoke on "Carbonic Acidosis of Concrete". The talk was illustrated with slides.

At the close of the meeting the members gathered in the lounge where a collation was served.

There were eighty-nine persons present at the meeting.

EDWIN B. COBB, *Secretary*

MARCH 31, 1948.—The One Hundredth Annual Meeting of the Boston Society of Civil Engineers was held this date at the Boston City Club, 14 Somerset Street, Boston, Mass.

Business Meeting. — The business meeting was held in the 9th floor ballroom. The meeting was called to order by President Kinnison at 4:30 P.M.

The Secretary announced that the minutes of the following meetings of the Society have appeared in the JOURNAL since the last Annual Meeting—November 20, 1946; December 18, 1946; January 22, 1947; February 26, 1947; March 21, 1947; April 16, 1947.

It was *Voted* "That the minutes of the meetings listed be approved as printed."

The report of the Secretary on expenditures and receipts, the Treasurer, the Auditors, and of the Board of Government were read. Each report was voted in turn to be accepted and published as a part of the Annual Report.

The reports of the following committees appointed by the Board of Government were read: John R. Freeman Fund; Relations of Sections to Main Society; Welfare; Library; Hospitality; Subsoils of Boston; Editor; Advertising; Publicity; Safety; Canon of Ethics; Tendency of Requesting Bids for Engineering Service; Membership; Quarters Committee and Committee on Building Laws and Building Construction.

It was *Voted* "That the reports of the various committees be accepted and published as a part of the Annual Report".

The Annual Reports of the various sections were read.

It was *Voted* "That the Annual Reports of the various Sections be accepted and published as a part of the Annual Report".

The report of the Tellers of Election, C. Frederick Joy, Jr., and George W. Coffin was presented and in ac-

cordance therewith the President declared that the following had been elected officers for the ensuing year:

President—Frederic N. Weaver
Vice-President (for two years)—Harrison P. Eddy, Jr.
Secretary (for one year)—Robert W. Moir
Treasurer (for one year)—Herman G. Dresser
Directors (for two years)—Chester J. Ginder, Frederick S. Gibbs
Nominating Committee (for two years) — George F. Brousseau, Frank L. Cheney, William E. Stanley

The retiring President, Harvey B. Kinnison, gave his address entitled "Water Investigations of the U. S. Geological Survey".

One hundred and twenty-five members and guests attended this part of the meeting.

The meeting adjourned to assemble at 7:30 P.M., the Annual Dinner being held during the interim in the main ballroom on the fourth floor.

The President called the meeting to order at 7:30 P.M.

Following general remarks and the introduction of persons at the head table the various prize awards were made.

The Secretary read the various prize awards and the President awarded the prizes. The awards were as follows:

Award	*Recipient*	*Paper*
Desmond FitzGerald Medal	Jack E. McKee	"Loss of Sanitary Sewage Through Storm Water Over-flows".
Clemens Herschel Award	Henry L. Kennedy	"Recent Development in Concrete Durability".
Structural Section Award	Arthur Casagrande	"The Pile Foundation for the New John Hancock Building in Boston".
Transportation Section Award	Alexander J. Bone	"Planning the Airport Site".
Hydraulics Section Award	Howard M. Turner	"Repairs to Dam, South Barre".
Northeastern University Award	Leonard B. Loitherstein	"Ship Surveying".

The President introduced the President elect, Professor Frederic N. Weaver.

The President introduced the various speakers of the evening listed below with their subjects: Centennial Symposium—"Contributions of the Members of America's Oldest Engineering Society to 100 Years of Progress in Civil Engineering":

Speakers.—Prof. Charles B. Breed, "The Developments in Transportation Engineering"; Dean Gordon M. Fair, "The Contributions in Sanitary Engineering"; Prof. Charles M. Spofford, "The Progress in Structural Engineering"; Prof. Howard M. Turner, "The Advancement in the Field of Hydraulic Engineering".

All talks were illustrated by slides.

Two hundred seventy-nine members and guests were present at the dinner.

President elect Weaver assumed the chair and adjourned the meeting at 9:30 P.M.

EDWIN B. COBB, *Secretary*

SANITARY SECTION

OCTOBER 1, 1947.—The meeting was called to order by Mr. George F. Brousseau in the Society Rooms at 7:00 P.M., following an earlier dinner in the Ambassador Restaurant.

Professor William E. Stanley announced the December meeting which is to be held at M.I.T. in conjunction with the dedication of the "William Thompson Sedgwick Laboratories of Sanitary Sciences".

Mr. A. E. Griffin of Wallace and Tiernan, Inc. was the speaker of the evening, taking the subject of "Chlorine in Waters and Wastes".

Attendance was 49 at the meeting and approximately 35 at the dinner..

KENNETH F. KNOWLTON, *Clerk*

DECEMBER 3, 1947.—A regular meeting of the Sanitary Section was held at 7:00 P.M., at M.I.T., following a dinner at the Campus Room, Graduate House, M.I.T.

It was moved and seconded that the Chairman appoint a Nominating Committee to present a slate of officers at the annual meeting in March. Motion was carried and the following were appointed: M. H. Mellish, F. S. Gibbs, W. L. Hyland.

Prof. William E. Stanley of M.I.T., and J. F. Berberich of Permutit Company jointly presented a detailed paper entitled "B.O.D. Loading of Activated Sludge Plants". A prepared discussion was presented by Dr. Sawyer of M.I.T., and a general discussion period followed.

This meeting was held to coincide with the dedication of the new William Thompson Sedgwick Laboratories of Sanitary Science at M.I.T. and the laboratories were open for inspection by members of the section.

Attendance at dinner was 47 and 68 were present at the meeting.

KENNETH F. KNOWLTON, *Clerk*

MARCH 3, 1948.—The Annual Meeting was called to order in the hall adjacent to the Society quarters in Tremont Temple at 7:30 P.M., by Chairman, George F. Brousseau.

The report of the nominating committee was read and no further nominations were made from the floor. It was duly moved and voted that the Clerk cast one ballot for the slate of officers read by the Committee. This ballot was cast for the following officers: Chairman, Allen J. Burdoin; Vice-Chairman, Kenneth F. Knowlton; Clerk, Frank L. Heaney; Executive Committee, George F. Brousseau, William E. Stanley, Fozi M. Cahaly.

The annual report of the Executive Committee was read and accepted.

Dean Gordon M. Fair, of the Graduate School of Engineering, Harvard University, presented a paper entitled "Europe Revisited" in which he recounted his impressions of the present status of Sanitary Engineering research and education throughout Europe at the present time.

Attendance was 81.

At a dinner gathering at the Smorgasbord Restaurant prior to the meeting there was an attendance of 50.

KENNETH F. KNOWLTON, *Clerk*

STRUCTURAL SECTION

JANUARY 14 1948.—Following dinner at the Ambassador Restaurant a meeting of the Structural Section was held at the Society Rooms 715 Tremont Temple. The meeting was called to order at 7:10 P.M.

The minutes of the last meeting of the Section were read and approved. Official notification from the Board of Government of the change in name of the Section was also read.

A motion was presented by Mr. Harding and seconded by Mr. Cundari that "the Chair appoint a Nominating Committee to present a slate of officers for the coming year". The motion

carried and the Chairman appointed the past three Section Chairmen to this Committee, their report to be presented at the March meeting of the Section.

Chairman Wyner then introduced the speaker Prof. Albert G. H. Dietz, Dept. of Bldg. Engineering and Construction, M.I.T., who spoke on "Structural Sandwich Materials".

The speaker briefly traced the origin of the use of laminated materials, enumerated the various combinations of materials which have been used as laminates, discussed their strength-weight ratio, jointing methods, bonding materials and developed formulas for the computation of buckling, bending and shear stresses. The talk was illustrated with lantern slides and numerous samples were exhibited.

A lively discussion period followed.

Sixty-one members and guests were present.

The meeting was adjourned at 8:55 P.M.

ROBERT W. MOIR, *Clerk*

FEBRUARY 18, 1948.—On this date, a joint meeting of the Boston Society of Civil Engineers and the Structural Section was held at the American Academy of Arts and Sciences, 28 Newbury Street, Boston, Mass.

President Kinnison called the meeting to order at 7:10 P.M. The President announced that the next meeting of the Main Society would be the 100th Anniversary Meeting and would be held at the Boston City Club on March 31.

Chairman Wyner of the Structural Section was asked if he had any business to transact, and reported there was none to be presented at this time.

President Kinnison then presented the speaker, Dr. Ruth Terzaghi, whose subject was "Carbonic Acidosis of Concrete". The talk was illustrated by numerous lantern slides.

Prepared discussions of Dr. Terzaghi's paper were then read by Miles N. Clair, Herman G. Protze and Prof. Walter C. Voss.

The meeting, attended by 86 members and guests, was adjourned at 8:55 P.M.

A collation was served after the meeting.

ROBERT W. MOIR, *Clerk*

MARCH 10, 1948.—This meeting was called to order at 7:15 P.M., in the Society Rooms by Chairman Henry I. Wyner, after a dinner at the Ambassador Restaurant.

The first business was the report of the Nominating Committee of Dean Peabody, Jr., Chairman, Lawrence M. Gentleman and Frank L. Lincoln, for officers for the year 1948-1949. At the election that followed the following were elected: Chairman, Oliver G. Julian; Vice-Chairman, Ernest L. Spencer; Clerk, Arthur E. Harding; Executive Committee, Frank A. Cundari, Albert G. Dietz, Leonard J. A. Fenocketti.

A very interesting paper was given by Dr. Robert J. Hansen, Research Association, Dept. of Civil Engineering, M.I.T. His subject was "Long Duration Impulsive Loading of Simple Beams".

Dr. Hansen went into detail on the Experimental Techniques used in his research work as to the effect of dynamic forces such as bombs or projectiles on reinforced concrete. He went into detail on the design of a testing machine to assimilate the sudden force and release which was obtained by a cylinder and poston actuated by a gas up to 1000 lbs pressure. This machine had several ingenious devices, notably the one used to actuate solenoid switches to start and stop the various parts such as the recording high speed camera, gas injection, and gas release. Dr. Hansen showed the development of

formula to be used in design and pointed out that the unit stresses were different than used in normal design. The talk was illustrated by pictures and slides of the machine and a short moving picture of a test of a concrete beam in the machine.

After a discussion period the meeting adjourned at 9:10 P.M. There were 37 members and guests present.

ARTHUR E. HARDING, *Clerk*

APRIL 14, 1948.—This meeting was called to order at 7:15 P.M. in the Society Rooms, by Chairman Oliver G. Julian, after a dinner at the Smorgasbord at which 39 attended.

The minutes of the last meeting were read and accepted.

Oscar H. Horowitz of the Oscar H. Horowitz Company showed a very fine moving picture on "Steel Erection", both Structural and Reinforcing. The pictures were taken during the last eleven or twelve years and were both black and white and colored. The various methods in the use of equipment on different types of jobs and the improvement in techniques used was quite noticeable. Mr. Horowitz explained each job as shown describing the types of equipment and methods used. A few of the examples were a heavy plate girder bridge on which a guy derrick set in the middle of the stream assisted by a shovel was used. One very interesting project was the erection of the Wyman Gordon Building constructed over an existing foundry which was kept in operation. The permanent traveling crane beams were erected and a truck crane was removed from the truck basis and mounted on the traveling crane beams. The steel was hoisted up to the traveling crane beams which traveled to the location and the roof trusses erected on false work made up of derrick parts trussed. Another interesting job was the erection of heavy girders at the S. S. Pierce Building on which a lifting hook was welded to the girders and lifted by railroad wrecking crane. The bridge over Cottage Farm Circle provided interest in the problems encountered because of the length and curvature on some of the girders. The erection of light towers at Fenway Park was also shown. Several other jobs were shown using stiff leg derricks, gin poles, guy derricks and the latest truck cranes which used up to 100 ft. pin connected booms.

The extended discussion period that followed brought out some of the things that designers can do to simplify and incidentally save money by details in structural steel and reinforcing steel, particularly in regard to using straight bars in place of trussed bars and also having the hooks in stirrups bent out instead of in.

Welding vs. riveting was discussed.

The meeting adjourned at 9:25 P.M. Attendance was 100.

ARTHUR E. HARDING, *Clerk*

TRANSPORTATION SECTION

APRIL 23, 1947.—The Transportation Section of the Boston Society of Civil Engineers held a regular meeting at the society rooms on this date. An Executive Meeting was scheduled at 5:15 P.M. Six members were present at this meeting and an informal discussion was held on the tentative program for the coming year.

At 7:15 P.M. the Chairman, Professor George W. Hankinson introduced Mr. Edward C. Keane of Fay, Spofford and Thorndike, who gave a highly informative talk entitled "Review of Current Practice in Design of Subgrades for Runways and Highways". With the aid of slides, Mr. Keane discussed the contrasting standards and specifications used in subgrade and pavement design. The speaker developed his subject as a prac-

tical problem in soil mechanics. He described and compared the various methods of soil classification as established by different authorities. The problem of compaction methods and control was also discussed and illustrated.

Fifty-nine members and guests were present at the meeting.

HERMAN J. SHEA, *Clerk*

HYDRAULICS SECTION

NOVEMBER 5, 1947.—A meeting of the Hydraulic Section was held in the Society Rooms, 715 Tremont Temple, following a dinner at the Ambassador Restaurant.

In the absence of Chairman Hooper, the meeting was called to order at 7:10 P.M. by Vice-chairman John G. W. Thomas who introduced the speaker of the evening, Prof. James W. Dailey of the Civil Engineering Department of M.I.T. Dr. Dailey gave us a very interesting paper on "Recent Developments in Cavitation." He described the work done in California during the war with particular reference to torpedoes. Slides and high speed photographs were used to illustrate the paper.

A discussion period followed the paper and the meeting was adjourned at 8:50. Thirty-eight members and guests were present at the meeting.

JAMES F. BRITTAIN, *Clerk*

FEBRUARY 4, 1948.—A meeting of the Hydraulic Section was held at the Society Rooms, 715 Tremont Temple following dinner at the Ambassador Restaurant.

The meeting was called to order by Chairman Hooper at 7:10 P.M. The Chairman was empowered to appoint a Nominating Committee. The committee appointed consisting of Harold A. Thomas, Jr., Stanley M. Dore and Allen J. Burdoin reported the following nominations for the coming year: Chairman, John G. W. Thomas; Vice-Chairman, James F. Brittain; Clerk, Gardner K. Wood; Members of Executive Committee, Elliot F. Childs, Byron O. McCoy, Lincoln W. Ryder.

It was voted that the Clerk cast one ballot for the above slate.

The Chairman then introduced the speaker of the evening, George R. Rich, member of the firm of Chas. T. Main, Inc., who gave a very illuminating paper on Basic Hydraulic Transients. The talk covered water hammer, surge tanks, surge tank stability, and the stability of governing systems. Numerous slides were shown to illustrate the paper. A question period followed and a rising vote of thanks was extended by the 78 members and guests present.

The meeting adjourned at 8:45 P.M. and was followed by a short meeting of the Executive Committee.

JAMES F. BRITTAIN, *Clerk*

Surveying and Mapping Section

NOVEMBER 19, 1947.—The second meeting of the Surveying and Mapping Section was held in Richards Hall at Northeastern University jointly with the regular monthly meeting of the parent Boston Society and another of its children, the Northeastern University Section. It was preceded by dinner at the University Commons. About 170 persons attended the dinner and about 210 persons attended the meeting.

President Kinnison presided during the Society's business meeting and introduced the two speakers of the evening. "The Engineering Aspects of the Land Court" was discussed by Charles M. Anderson, an Assistant Engineer at the Court, and "The Legal Aspect of the Land Court" was presented by Edward P. Shaw, 3rd, Esquire, a lawyer with many years of practice before the Court. The talks were followed by a short discussion period.

The meeting adjourned at 9:15 P.M.

CHARLES M. ANDERSON, *Clerk*

JANUARY 21, 1948.—A meeting of the Surveying and Mapping Section was held in the Society Rooms with twenty-five members and friends in attendance. Louis A. Chase, the Vice-Chairman, called for order at 7:03 P.M. The Clerk's reading of the minutes disclosed the fact that this was the first regular meeting of this section, since the Executive Committee, at its meeting of November 19, 1947, fixed the Section's regular dates as the fourth Wednesday of October, the third Wednesday of January, and the first Wednesday of April.

The Clerk moved that the Chair appoint a nominating committee to submit a slate of officers for the ensuing year. The motion was carried and the Chair appointed Llewellyn T. Schofield, Ernest L. Spencer and George W. Hankinson, who presently submitted the following nominations: Chairman, Charles M. Anderson; Vice-Chairman, Hyman B. Ullian; Clerk, Hugh P. Duffill; Executive Committee, Herman J. Shea, Louis A. Chase, Frank L. Cheney.

Mr. Edwin B. Cobb then moved that the nominations be closed and that the Clerk cast one ballot for the election of these officers. The motion was carried and the ballot so cast.

Mr. Cobb moved that the Chairman appoint a committee of five members to investigate the advisability of requiring that surveys and plans submitted to the Land Court be prepared by "Registered Land Surveyors" and to submit its conclusions to the section, together with a suggestion as to what form of action to take, if any, upon the report. This motion was also carried.

The speaker of the evening was Mr. Louis H. Berger, whose talk was entitled "Simplicity of Design, Materials Suitable for Construction, and the Proper Care of Engineering and Surveying Instruments". Auxiliary portions of his subject were presented by readings by others, viz.: by Herman J. Shea, a discussion of the Zeiss Theodolite Model IV; by Ernest L. Spencer, a discussion of coated lenses; by George W. Hankinson, Anthony Fiala's "At Close Quarters with a Polar Bear"; and by William C. White, a discussion of the United States Army's "Museum" of Surveying Equipment at Fort Belvoir, Virginia.

Four instruments were set up for inspection before and after the meeting.

Much informal discussion followed the adjournment which came at 9:15 P.M.

HUGH P. DUFFILL, *Clerk*

FEBRUARY 25, 1948.—A joint meeting of the Surveying and Mapping Section and the Transportation Section was held at the Society Rooms at 7:30 P.M., Wednesday, February 25, 1948.

Approximately sixty members of both sections and guests were present.

Chairman George W. Hankinson of the Transportation Section presided.

Chairman Charles M. Anderson of this Section announced the date of the next regular meeting of this Section for April 7, 1948 with Mr. Frank L. Cheney presenting a paper on the problems encountered by a Town Engineer.

The speaker of the evening, Mr. Elmer C. Houdlette of the Massachusetts Department of Public Works, presented an excellent paper on the use of aerial topographical maps in the preparation of highway layouts. The paper dealt with the methods used in locating possible lines through difficult terrain and showed the relative economy of this method in comparison to the conventional reconnoissance methods.

He also gave a very interesting description of the several land forms encountered in Massachusetts, how to recognize them on aerial photographs

and how to locate highways to take advantage of the best soil conditions.

A long question and answer period followed with many members taking part, which demonstrated the unusual interest in the speaker's paper.

Mr. Houdlette was accorded a rising vote of thanks at the conclusion of the meeting.

Meeting adjourned at 10:00 P.M.

HUGH P. DUFFILL, *Clerk*

APRIL 7, 1948.—A meeting of the Surveying and Mapping Section was held at the Society Rooms at 7:30 P.M., Wednesday, April 7, 1948.

Approximately sixty members and guests were present.

The meeting was called to order by Chairman Charles M. Anderson. The minutes of the February 25th meeting were read by the Clerk and approved. Chairman Anderson announced that he had appointed a Committee of five to study the proposal to introduce a bill in the Legislature which would require that plans to be filed with the Land Registration Office be made by a Registered Land Surveyor. This Committee consists of Louis A. Chase, Chairman, Hyman B. Ullian, Thomas A. Appleton, Russell H. Whiting and Charles O. Baird, Jr. Mr. Chase reported for this committee that they had held a meeting but could make no report of progress at this time.

The speaker of the evening was Mr. Frank L. Cheney, Superintendent, Engineering Division, P.W.D., Town of Needham, whose subject was, "Municipal Engineering Surveys". He gave a very interesting account of the work done by his office in Needham in establishing a triangulation network in conjunction with the State Geodetic Survey and the preparation of town maps and assessor's plans. His discussion was very well received and a long discussion followed in which a great many members took part.

Chairman Anderson brought to the attention of the members present, the work being done by the Cape Cod Society of Professional Engineers and Land Surveyors, who are attempting to set up standards both for the quality of work and fees to be charged in the Cape Cod area. Mr. H. T. Schofield reported that he had visited a meeting of the Cape Cod Society and that they seemed to be a very active organization of some forty or fifty engineers. Some of the literature which they have prepared in connection with their standardization work was shown to the members for their consideration. It was brought out by Mr. Schofield that the Cape Cod Society claimed to be the only group of engineers who appeared at the State House for or against legislation affecting the engineers of the State and the matter of appointing a legislative committee representing this section was considered.

The meeting adjourned at 9:00 P.M.

HUGH P. DUFFILL, *Clerk*

ADDITIONS

Members

Arnold C. Blake, 329 Stackpole Street, Lowell, Mass.

William C. Goodwin, 70 Fenway, Boston 15, Mass.

Alfred A. Lockerbie, 18 Darling Street, Marblehead, Mass.

DEATHS

Greely S. Curtis, December 15, 1947.

Samuel L. Connor, February 18, 1948.

Oren E. Parks, July 4, 1947.

Henry E. Warren, March 21, 1948.

ANNUAL REPORTS

REPORT OF THE BOARD OF GOVERNMENT FOR YEAR 1947-1948

Boston, Mass., March 31, 1948

To the Boston Society of Civil Engineers:

Pursuant to the requirements of Section 6 of the By-Laws the Board of Government presents its report for the year ending March 31, 1948:

(A) *The following is a statement of the status of membership in the Society.*

	March 1947	March 1948
Honorary	8	8
Members	643	658
Associates	3	3
Juniors	43	39
Students	23	76
Total	720	784
Summary of Additions		
New Members	17	41
New Juniors		1
New Students	13	85
Reinstatements		
Members	6	3
Juniors	4	2
Students	5	20
Total	45	152
Summary of Transfers		
Juniors to Members	19	4
Students to Members	1	1
Students to Juniors	3	3
Total	23	8

Summary of Loss of Members

	March 1947	March 1948
Deaths	8	16
Resigned	7	11
Dropped for non-payment of dues	4	12
Juniors who failed to transfer	2	3
Students who failed to transfer	7	46
Total	28	88
Members exempt from dues	82	72

Applications pending on March 31, 1948 48

The Honorary Membership List is as follows:

Dr. Karl T. Compton, elected, February 17, 1932
Prof. C. Frank Allen, elected, March 16, 1932
Prof. Charles M. Allen, elected, January 14, 1942
Arthur W. Dean, elected, January 14, 1942
Charles R. Gow, elected, January 14, 1942
Arthur T. Safford, elected, January 26, 1943
Charles M. Spofford, elected, December 19, 1945
Charles W. Sherman, elected, February 19, 1947

The following members have been lost through death:

Arthur A. Forbes, January 7, 1946
Adin M. Custance, June 22, 1946
Alfred O. Doane, December 17, 1946
Wilfred A. Clapp, February 10, 1947
Henry E. Warren, March 21, 1947
James L. Tighe, April 6, 1947
Frank A. Barbour, May 27, 1947
Oren E. Parks, July 4, 1947
Chester W. Smith, July 22, 1947
Dana M. Pratt, August 19, 1947
Robert R. Evans, August 19, 1947
Charles A. Mixer, October 24, 1947
Arthur G. Robbins, October 26, 1947
Greely S. Curtis, December 15, 1947
Harry M. Steward, January 3, 1948
Samuel L. Connor, February 18, 1948

(B) *Remission of Dues*

Members in Armed Services	9
Others	2

(C) *Funds of the Society*

	Value 1947	Value 1948	Used During 1947-48	
Permanent Fund	$67,228	$67,532	Income	$2,778.28
			Prin.	182.51
John R. Freeman Fund	30,803	31,960		—
Edmund K. Turner Fund	1,015	1,037	New Books	16.20
Desmond FitzGerald Fund	1,999	2,075		—
Alexis H. French Fund	1,072	1,096	New Books	17.00
Edward A. Howe Fund	1,015	1,001	Tripods	51.50
Clemens Herschel Fund	1,248	1,203	Prizes	92.42
William P. Morse Fund	2,000	2,000		—
Samuel E. Tinkham Fund	2,499	2,492	Scholarship at M.I.T.	100.00

(D) *Meetings of the Society*

March 19, 1947—Annual Meeting. "Civil Engineering—A Profession", George A. Sampson.

April 16, 1947—"Extension of Metropolitan District Works; What's Accomplished and What's Ahead", Karl R. Kennison. Joint Meeting with American Society of Civil Engineers, Northeastern Section.

May 21, 1947—"Engineering in the North"—A Symposium. Carroll A. Farwell, William L. Hyland, Howard J. Williams, Edward C. Keane, Murray H. Mellish.

September 27, 1947—Joint Excursion of Boston Society of Civil Engineers and Transportation Section, consisting of a bus trip over the Maine Turnpike Project.

October 15, 1947—"Paricutin Volcano in Mexico", Preston E. Cloud. Student Night. Joint Meeting with American Society of Civil Engineers, Northeastern Section and Student Chapters of Northeastern Section.

November 19, 1947—"Engineering Aspects of the Land Court", Charles M. Anderson; "Legal Aspects of Land Court as an Attorney and Examiner", Edward P. Shaw, 3rd. Joint Meeting with Surveying and Mapping Section.

December 17, 1947—"Intersociety Cooperation for Professional Recognition", William F. Ryan; "Recent Developments in Engineering Registration", Prof. Albert Haertlein; "Evening Education in the Greater Boston Area", William C. White.

January 28, 1948—"The Merrimack River Valley Sewerage District Project". Thomas R. Camp; Discussion, Thomas C. Berrigan.

February 18, 1948—"Carbonic Acidosis of Concrete", Dr. Ruth Terzaghi.

(E) *Attendance at Meetings*

Date	Place	Dinner	Meeting
March 19, 1947	Hotel Vendome	188	75
April 16, 1947	N. E. University	138	170
May 21, 1947	Chipman Hall	97	97
September 21, 1947	Excursion Maine Turnpike	70	70
October 15, 1947	Chipman Hall	265	290
November 19, 1947	N. E. University	153	210
December 17, 1947	Chipman Hall	88	123
January 28, 1948	American Academy of Arts & Sciences	*	125
February 18, 1948	American Academy of Arts & Sciences	*	89
	Totals	999	1249

*Collation served in Lounge after meeting.

(F) *Prize Awards*

Award	Recipient	Paper
Desmond FitzGerald Medal	Jack E. McKee	"Loss of Sanitary Sewage Through Storm Water Overflows".
Clemens Herschel Award	Henry L. Kennedy	"Recent Development in Concrete Durability".
Structural Section Award	Arthur Casagrande	"The Pile Foundation for the New John Hancock Building in Boston".
Transportation Section Award	Alexander J. Bone	"Planning the Airport Site".
Hydraulics Section Award	Howard M. Turner	"Repairs to Dam, South Barre".
Northeastern University Award	Leonard B. Loitherstein	"Ship Surveying".

(G) *Sections*

The Annual Reports of the Various Sections will be presented at the Annual Meeting and will be published as a part of the Annual Report.

(H) *Committees*

The usual special committees dealing with the activities and conduct of the Society were appointed. The membership of these committees was published in the April, 1947, issue of the JOURNAL.

The following additional special committees were also appointed:

"Committee on Competitive Bidding for Engineering Services"—Ralph W. Horne, Chairman, John P. Wentworth, George W. Coffin, George G. Bogren, Herman G. Dresser.

"Committee on Safety"—Herman G. Protze, Chairman, John R. Nichols, Henry I. Wyner.

"Committee on Publicity"—Stephen Haseltine, Chairman, Jack E. McKee, Llewellyn T. Schofield, James C. Tillinghast, Gardner K. Wood, Robert P. Burden, Ernest L. Spencer.

"Committee on Change in By-Laws"—Frederic N. Weaver, Chairman, Thomas R. Camp, Carroll A. Farwell.

"Committee on Advertising"—Leonard J. A. Fenocketti, Chairman, Charles E. Knox, Edwin B. Cobb.

"Committee on Canon of Ethics"—Arthur L. Shaw, Chairman, Oliver G. Julian, George A. Sampson.

"Committee on Membership"—Frank M. Gunby, Chairman, Frank L. Lincoln, Chester A. Moore, Francis H. Kingsbury, James F. Brittain, Edwin B. Cobb, ex-officio.

"Committee on Honorary Membership"—George A. Sampson, Chairman, Harry P. Burden, Carroll A. Farwell.

The reports of the various Committees will be presented at the Annual Meeting and will be published as a part of the Annual Report.

(I) *Activities of Board of Government*

In addition to the routine business of the Society the Board of Government during the year transacted the following items of business:

Meeting of April 8, 1947

Accepted a bequest of $2000 from the late William P. Morse and established the "William P. Morse Fund". It was voted that no restrictions be placed on the use of this fund but that the income be used for the benefit of the Society or its members.

Approved the recommendations made by the 1946-47 Library Committee and directed that they be carried out. The report of the Library Committee indicates the accomplishments to date.

Established the Central Membership Committee to conduct an energetic drive for new members. The accomplishments of this Committee are obvious in the statement of membership.

Established the Surveying and Mapping Section of the Boston Society of Civil Engineers. The interest in and activity of this Section during its first year has justified the expectations of its sponsors.

Established a committee to study the tendency of municipalities to request bids for engineering services.

Meeting of May 21, 1947

The Committee on Subsoils of Boston was authorized to prepare for publication the additional boring data which has been accumulated subsequent to 1931.

The Library Committee was authorized to obtain an Institutional Membership in the Special Libraries Association.

Meeting of June 25, 1947

Authorized the republishing in the JOURNAL of a paper entitled "Continuous Frame Analysis of Flat Slabs", by Dean Peabody, Jr.

Authorized a canvass of the members of the Society to determine the membership of the various sections.

Established a Committee on Safety.

Meeting of September 24, 1947

Voted that it would not be in the interest of the Society to purchase the property at 97 Beacon Street for a new Society Headquarters.

The Treasurer was authorized to enter into a "Supervised Custodian Account Agreement" with the Boston Safe Deposit and Trust Company for the latter to handle the details of the Society's investments.

Authorized the engaging of Miss Ethel H. Bailey as a part-time librarian.

Donated one copy of "Contributions to Soil Mechanics" to Lord Rea Maharashtra Industrial Museum of Poona, India.

Meeting of October 15, 1947

Established a Committee on Publicity. This Committee has obtained recognition in the local newspapers of many of our meetings during the past year.

Meeting of November 19, 1947

Authorized a contract with a professional solicitor to obtain advertising for the JOURNAL.

Authorized an increase in advertising rates in the JOURNAL.

Approved the change in name of the Designers' Section to the Structural Section.

Voted to exchange publications with the State River and Water Supply Commission of Victoria, Australia, and to donate copies of the reports of the Committees on Floods to the Commission.

Formed a committee to make recommendations regarding the "Canons of Ethics" sponsored by the Engineering Council for Professional Development.

Your Board in conclusion, wishes to express its appreciation of the excellent work done by the officers of the Sections and by the Committees of the Society.

HARVEY B. KINNISON, *President*

REPORT OF THE TREASURER

Boston, Mass., March 17, 1948

To the Boston Society of Civil Engineers:

The financial standing of the Society on March 8, 1948, at the end of the accounting period, is shown in the following tables:

Table I—Distribution of Funds—Receipts and Expenditures.

Table II—Record of Investments.

The receipts from dues during this year amounted to $5188.50 compared with $4851.00 paid in as dues during the previous year. These receipts were $600 more than the average amount received from this source during the past five years. Dues of members in the Armed Forces, to the extent of $44, were remitted during the year. The payment of dues by the active members has been very satisfactory.

Throughout the year an effort was made to increase the effectiveness of many phases of the Society's interests, and numerous services and changes in procedure have been instituted in order to broaden the work of the Society. Partly as a result of these changes the cost of operation has increased considerably, however, the cost of goods and services is at a peak at the present time and this has contributed to the increased budget. Expenses to the Current Fund amounted to $12,113 as compared to an expense budget of $9551 for the previous year.

The income to the Current Fund, $9152.55, is $2960.79 less than the Current Fund expense with the result that it has been necessary to transfer money from the Permanent Fund income and Permanent Fund to meet current expenses.

The income to the Permanent Fund totaled $2778.28. This money was transferred to pay current expenses by authority of the Board of Government. The additional amount needed, $182.51, was transferred from the Permanent Fund following the approval of such action given by vote of the Society at the regular meetings of December 17, 1947 and January 28, 1948, whereby the Board of Government was authorized to use an amount not to exceed $2000 from the principal of the Permanent Fund for current expenses.

At the above mentioned meetings the Society also voted to authorize the Board of Government to increase the Current Fund to $3000 by a transfer of $1500 from the Permanent Fund to the Current Fund. This vote was requested in order to establish more working capital for the coming year in view of the general higher cost of operating the Society. The transfer to increase the Current Fund to $3000 has not been made as yet as the working capital at present is adequate and it will be sometime next year, if at all, before such a transfer is needed.

The amounts transferred from the Permanent Fund to the Current Fund during the last five years are shown in the following:

	1943-44	1944-45	1945-46	1946-47	1947-48
Receipts to Current Fund					
Dues	$4676	$4317	$4444	$4851	$5188
Other than dues	3161	3518	3216	3560	3964
Total Receipts to Current Fund	$7837	$4835	$7660	$9411	$9152
Current Fund Expenditure	9246	9239	8496	9551	12113
Deficit: Transferred from Permanent Fund	$1409	$1404	$836	$1140	$2960

There were numerous changes in the securities held and one additional fund established. A fund of $2000 was received under the will of the late William P. Morse, who was a member of the Society from May 17, 1893 to February 21, 1946, and by vote of the Board of Government the "William P. Morse Fund" was established. The income will be used for the benefit of the Society or its members.

Sales, transfers and purchases were made as follows:

Sales

4 Rights issues by Pacific Gas and Electric Co.
2 Shares, Consolidated Natural Gas Co.
12 Optional warrants, Commonwealth and Southern Corp.
52 Rights issues by American Tel. & Tel. Co.
20 Shares, National Fire Insurance Co.

Purchases

6 Shares, Pacific Gas & Electric Co.
35 Shares, Texas Co.
30 Shares, Consolidated Edison Co. of New York.
20 Shares, Standard Oil Co. (New Jersey).
20 Shares, Owens Illinois Insurance Co.
15 Shares, Continental Insurance Co.

Transfers

New England Power Association shares exchanged for New England Electric System.
Toledo Edison, $2000 bonds called July 25, 1947.
2 Shares, Trimount Dredging Co. pfd. removed from list as they are valueless.

Transactions authorized but not completed at close of period were as follows:

Sale of—15 Shares, Erie Railroad Co. Series A pfd. 5%; 15 Shares, Timken Roller Bearing Co.; 25 Shares, Commonwealth & Southern Corp.; 225 Shares, United Trust Co., Boston, Common; 20 Rights, Consolidated Edison Co. of New York.

Purchase—7 Shares, Pacific Gas & Electric Co. Common; 20 Shares, Central Hanover Bank & Trust Co.

After due consideration the Board of Government approved the recommendation that the Boston Safe Deposit and Trust Company be engaged to manage the financial affairs of the Society with respect to the securities held by the Society and a Custodian Agreement with the Boston Safe Deposit and Trust Company was signed on October 23, 1947. At that time all of the securities, stocks, bonds and Cooperative Bank Certificates were transferred to the custody of the Boston Safe Deposit and Trust Company and credited to the account of the Society. All sales, and purchases have been made on the recommendation of the Boston Safe Deposit and Trust Company and with the approval of the Board of Government.

The total book value of all securities, plus cash on hand now stands at $110,004.50 an increase of $3,612.62 in assets during the year.

The following table shows the comparative book values of the two principal funds at the close of last five years and the ratio of market value to book value.

	Mar. 6, 1944	Mar. 8, 1945	Mar. 8, 1946	Mar. 7, 1947	Mar. 8, 1948
Permanent Fund	$62,546	$63,690	$65,618	$67,228	$67,533
John R. Freeman Fund	27,470	28,497	29,654	30,803	31,960
Market value in percent of book value	96.47%	101.7%	114%	103.5%	95.5%

The growth of the Permanent Fund is affected not only by the percentage of return on investments but also by the amount it has been necessary to transfer from the income of this fund in order to meet current expenses. The value of the Freeman Fund depends largely upon the expenditures made from the fund during the year and as no expenditures were made from the fund during the past year the only charge to the fund has been the allocation of book loss incurred through the sale of depreciated securities amounting to $115.93 as shown in Table I.

The following table shows the book value of securities and bank deposits and the total value of all holdings not including the value of the library and physical property for the past five years.

	Mar. 6, 1944	Mar. 8, 1945	Mar. 8, 1946	Mar. 7, 1947	Mar. 8, 1948
Bonds	$38,763.93	$35,816.10	$34,318.15	$38,340.01	$36,307.51
Cooperative	10,942.02	11,535.19	12,068.89	12,613.26	13,150.97
Stocks	45,186.63	50,708.44	51,809.15	51,809.15	56,767.69
Cash	2,981.57	2.121.57	5,139.69	1,929.46	3,078.33
	$97,874.15	$100,181.30	$103,335.88	$104,691.88	$109,304.50
		Publication Fund		1,700.00	700.00
				$106,391.88	$110,004.50

The Treasurer's cash balance $3078.33 includes $44.00 withholding taxes of the office secretary for the months of January and February, 1948, which is payable to the Collector of Internal Revenue in April, 1948. The Secretary's "change fund" $30 is not included in the cash balance shown above.

Respectfully submitted,

CHESTER J. GINDER, *Treasurer*

TABLE I.—DISTRIBUTION OF FUNDS—RECEIPTS AND EXPENDITURES

	March 7, 1947 Book Value	Interest and Dividends Cash	Interest and Dividends Credit	Net Profit or Loss at Sale or Maturity +	Net Profit or Loss at Sale or Maturity —	Transfer of Funds Purchased +	Transfer of Funds Sold —	Book Value March 8, 1948
Bonds	$38,340.01	$1,042.88	$60.00		$7.50		$2,092.50	$36,307.51
Cooperative Banks	12,613.26	68.75	207.71			$330.00		13,150.97
Stocks	51,809.15	2,838.78		$95.62	383.86	8,063.41	3,104.87	56,767.69
Cash available for Investment	—79.23				1.50	1,060.72		979.99
Publication Fund Loan	1,700.00						1,000.00	700.00
Total (except Current Fund)	$104,383.19	$3,950.41	$267.71	$95.62	$392.86	$9,454.13	$6,197.37	$107,906.16

	March 7, 1947 Book Value	Allocation of the above Income, Profit and Loss 4.13%	.37%	Misc. Receipts	Misc. Expenditures	Book Value March 8, 1948
Permanent Fund	$67,228.33	$2,778.28	$253.02	$740.00	$2,960.79	$67,532.80
John R. Freeman Fund	30,802.94	1,272.96	115.93			31,959.97
Edmund K. Turner Fund	1,015.60	41.97	3.82		16.20	1,037.55
Desmond FitzGerald Fund	1,999.76	82.64	7.53			2,074.87
Alexis H. French Fund	1,072.93	44.34	4.04		17.00	1,096.23
Clemens Herschel Fund	1,248.57	51.60	4.70		92.42	1,203.05
Edward A. Howe Fund	1,015.06	41.95	3.82		51.50	1,001.69
William P. Morse Fund				2,000.00		2,000.00
	$104,383.19	$4,313.74	$392.86	$2,740.00	$3,137.91	$107,906.16
Current Fund Cash	1,500.00	*2,960.79		9,152.55	12,113.34	1,500.00
Publication Fund Cash	508.69			1,169.65	1,080.00	598.34
Totals	$106,391.88	$7,274.53	$392.86	$13,062.20	$16,331.25	$110,004.50

Secretary's change fund of $30.00 should be added to show total cash.
*Transfer of $2,778.28 from income of Permanent Fund and $182.51 from the Permanent Fund.

Cash Balance

Investment Fund	$979.99
Publcation Fund	598.34
Current Account	1,500.00
Total	$3,078.33

TABLE II.—RECORD OF INVESTMENTS

	Date of Maturity or Classification	Fixed or Current Interest Rate	During the Year March 7, 1947 to March 8, 1948				March 8, 1948		
			Interest Received	Additional Amount Invested	Sold or Matured Cost	Sold or Matured Profit + (or Loss —)	Par Value	Book Value	Market Value
BONDS									
American Telephone & Telegraph Co.	Dec. 15, 1961	2¾%	27.50	....	....	....	1,000.00	$1,014.75	$1,040.00
Canadian Pacific R.R.	July 2, 1949	4%	168.21	....	....	....	5,000.00	5,342.50	4,300.00
The Pennsylvania Railroad Company	June 1, 1965	4½%	45.00	....	....	....	1,000.00	1,017.74	1,010.00
Puget Sound Power & Light Co.	Dec. 1, 1972	4¼%	42.50	....	....	....	1,000.00	1,058.44	1,050.00
Southern Pacific Oregon	Mar. 1, 1977	4½%	180.00	....	....	....	4,000.00	4,191.30	3,760.00
The Toledo Edison Co.	July 1, 1968	3½%	39.67	....	2,092.50	—7.50	....	....	....
Western Maryland R.R. Co.	Oct. 1, 1952	4%	40.00	....	....	....	1,000.00	982.78	980.00
United States Savings Bonds, Series D	Jan. 1, 1950	....	60.00	....	....	....	3,000.00	2,700.00	2,250.00
United States Savings Bonds, Series G	June 1, 1953	2½%	200.00	....	....	....	8,000.00	8,000.00	8,000.00
United States Bonds, Series G	July 1, 1954	2½%	175.00	....	....	....	7,000.00	7,000.00	7,000.00
United States Savings Bonds, Series G	Nov. 1, 1956	2½%	25.00	....	....	....	1,000.00	1,000.00	1,000.00
United States Savings Bonds, Series G	May 1, 1958	2½%	100.00	....	....	....	4,000.00	4,000.00	4,000.00
TOTALS			$1,102.88		$2,092.50	—$7.50	$36,000.00	$36,307.51	$34,390.00

TABLE II.—RECORD OF INVESTMENTS—*Continued*

	Date of Maturity or Classification	Fixed or Current Dividend Rate	During the Year March 7, 1947 to March 8, 1948				March 8, 1948		
			Dividends Received	Additional Amount Invested	Sold or Matured Amount Received	Profit + (or Loss —)	Number of Shares	Book Value	Market Value
CO-OPERATIVE BANKS									
Codman Co-Operative Bank	Matured Certificate	2¼%	$47.50	....	....	....	10	$2,000.00	$2,000.00
Suffolk Co-Operative Federal Savings & Loan Assoc.	Matured Certificate	2%	21.25	....	....	....	5	1,000.00	1,000.00
Suffolk Co-Operative Federal Savings & Loan Assoc.	Series 134	....	207.71	$330.00	....	....	30	10,150.97	10,150.97
TOTALS			$276.46	$330.00	....	....		$13,150.97	$13,150.97

TABLE II.—RECORD OF INVESTMENTS—*Continued*

	Date of Maturity or Classification	Fixed or Current Dividend Rate	During the Year March 7, 1947 to March 8, 1948				March 8, 1948		
			Dividends Received	Additional Amount Invested	Sold or Matured Cost	Profit + (or Loss —)	Number of Shares	Book Value	Market Value
STOCKS									
American Tel. & Tel. Co.	Common	$9.00	$468.00	....	....	+58.03	52	$6,189.04	$7,800.00
Bankers Trust Co., N. Y.	Common	1.80	64.80	....	....	....	36	1,590.00	1,404.00
Central Hanover Bank & Trust Co. of N. Y.	Common	4.00	120.00	....	....	....	30	3,210.00	2,640.00
Commonwealth and Southern Corp.	Cum. Pfd.	....	96.00	....	....	....	8	....	816.00
Commonwealth and Southern Corp.	Common	....	....	....	....	....	25	1,019.89	50.00
Commonwealth and Southern Corp.	Opt. Warrants		....	....	....	+ .08	12	....	....
Consolidated Natural Gas Company	Capital	2.00	2.00	....	49.87	+33.04	2	....	....
Consolidated Edison (Gas) Co. of N. Y.	Common	1.60	32.00	649.62	....	....	50	2,556.12	1,050.00
Continental Insurance Co.	Capital	2.00	50.00	819.77	....	....	40	2,026.21	1,960.00
Erie Railway 5%	Pref.	5.00	75.00	....	....	....	15	1,133.05	765.00
General Electric Co. of N. Y.	Common	1.60	80.00	....	....	....	50	2,341.47	1,600.00
Great Northern Railway	Pref.	3.00	45.00	....	....	....	15	778.67	570.00
Hartford Fire Insurance Co.	Common	2.50	25.00	....	....	....	10	761.25	1,050.00
Minnesota Power & Light Co., Minn.	Pref.	5.00	50.00	....	....	....	10	882.00	960.00
National Dairy Products Corp.	Common	1.65	90.00	....	....	....	50	1,154.74	1,250.00
National Fire Insurance Co. of Hartford	Common	2.00	40.00	....	1,240.00	—383.86	20	....	....

TABLE II.—RECORD OF INVESTMENTS—*Continued*

	Date of Maturity or Classification	Fixed or Current Dividend Rate	During the Year March 7, 1947 to March 8, 1948				March 8, 1948		
			Dividends Received	Additional Amount Invested	Sold or Matured Cost	Profit + (or Loss —)	Number of Shares	Book Value	Market Value
STOCKS									
New England Power Assoc.	Pref.	6.00	30.00	....	1,815.00	....	20	....	....
New England Electric System	Common	1.06	99.72	1,815.00	....	....	108	1,815.00	1,296.00
North American Trust Shares	July 15, 1955	17.6¢	264.00	....	....	....	1500	5,342.00	4.500.00
Owens Illinois Glass Co.	Common	....	....	1,187.75	....	....	20	1,187.75	1,160.00
Pacific Gas & Elec. Co.	Cum. 1st Pfd.	$1.50	$90.00	....	....	....	60	....)	$1,980.00
Pacific Gas & Elec. Co.	Cum. 1st Pfd.	1.37	27.51	....	....	....	20	$1,922.02)	600.00
Pacific Gas & Elec. Co.	Common	2.00	134.00	150.00	....	+ 4.47	70	1,958.79	2,170.00
Radio Corp. of America	1st Pfd.	3.50	70.00	....	....	....	20	1,720.75	1,320.00
Southern California Edison Co. Ltd.	Cum. Orig. Pfd.	1.50	60.00	....	....	....	40	1,161.22	1,480.00
Southern California Edison	Common	1.50	30.00	....	....	....	20	539.75	520.00
Southern Railway	Pref.	5.00	75.00	....	....	....	15	1,136.80	885.00
Standard Oil Co. of N. J.	Capital	4.00	80.00	1,475.57	....	....	40	2,486.67	2,880.00
Tampa Electric Co.	Common	1.90	57.00	....	....	....	30	1,151.25	870.00
Texas Co.	Common	3.00	26.25	1,965.70	....	....	35	1,965.70	1,855.00
Timken Roller Bearing Co.	Common	2.50	37.50	....	....	....	15	1,018.97	690.00
Union Carbide & Carbon	Capital	3.00	120.00	....	....	....	30	2,407.79	2,940.00
Union Pacific Railroad	Common	10.00	220.00	....	....	....	22	2,473.29	3.498.00
United States Trust Co.	Common	.80	180.00	....	....	....	225	4,837.50	3,375.00
TOTALS			$2,838.78	$8,063.41	$3,104.87	—288.24		$56,767.69	$53,934.00

REPORT OF THE SECRETARY

Boston, Mass., March 17, 1948.

To the Boston Society of Civil Engineers:

Attached herewith is a statement of the money received by the Secretary and the expenditures approved by the President. For your information also included is a comparison of the average expenditures and receipts for the various items since 1936-37.

The following amounts were received from entrance fees and were added to the Permanent Fund and the 1946-47 amounts are shown in comparison:

	1947-48	1946-47
Entrance fees for new memberships	$640.00	$199.00
Allocated from transfers of grade in 1946-47 according to By-Laws, paragraph 8	100.00	10.00
	$740.00	$209.00

Three new members during the year were exempt from payment of entrance fees under Section 8 of the By-Laws, which exempts Federal Employees from payment of Entrance Fees.

On October 28, 1946 the Board of Government authorized an amount not to exceed $1800 to provide for cost of printing 1500 copies of "Contributions to Soil Mechanics". This fund has been termed the "Publication Fund". The status of this fund to date is as follows:

Year	Expenditures	Copies Sold	Receipts
1946-47	$1767.96	273	$576.65
1947-48	80.00	542	1169.65
	$1847.96	815	$1746.30

The Secretary holds $30 as a "change fund" which money does not appear in any of the amounts above.

Respectfully submitted,

EDWIN B. COBB, *Secretary*

SECRETARY'S FINAL BUDGET REPORT
MARCH 8, 1948

Account Office		Actual to date Exp.	Actual to date Rec.	Average 1936-37 1946-47 Exp.	Average 1936-37 1946-47 Rec.
1.	Sec. Sal.	$240.00	....	$240.00	....
2.	Sta. Pr. Post.	488.59	....	292.00	....
3.	Petty Cash	135.87	....	179.00	....
4.	Ins. Bond	87.50	....	51.00	....
5.	Deposit Box	12.00	....	12.00	....
7.	Rent & Tel.	1,803.09	600.00	1,778.00	609.00
8.	Salary	1,979.26	....	1,447.00	....
9.	Audit & Inv.	250.00	....	206.00	....

*Difference between Exp. & Rec.

Account	Actual to date		Average 1936-37 1946-47	
Meetings	Exp.	Rec.	Exp.	Rec.
11. Rent of Halls	150.00	....	194.00	....
12. Notices	46.75	....	43.00	....
13. Soc. Act.	1,156.11	948.22	*144.00	....
15. Stereopticon	18.50	....	....	....
16. Annual (1947)	863.60	484.75	92.00	....
Sections				
21. Sanitary	15.67	....	17.00	....
22. Structural	40.60	....	24.00	....
23. Transportation	6.00	....	7.00	....
24. N. E. Univ.	8.00	....	7.00	....
25. Hydraulics	14.63	....	....	....
26. Surv. & Map.	6.00	....	....	....
Journal				
31. Editor & Sal.	308.00	....	308.00	....
32. Pr. and Post	3,193.16	**300.00	2,001.00	....
33. Reprints	....	31.18	89.00	....
34. Advts.	....	863.00	246.00	951.00
35. Sale of Jour.	....	595.20	....	677.00
Library				
36. Fines	....	3.33	....	5.00
41. Librarian	384.00	....	....	....
43. Periodicals	63.52	....	89.00	....
44. Binding	39.71	....	36.00	....
Miscellaneous				
51. Badges	18.30	18.30	38.00	38.00
52. Bind. Jour. Mem.	12.68	7.57	18.00	21.00
53. Bank Charges	.50	....	10.00	....
54. Misc.	161.01	112.50	....	....
59. Dues to ESNE	610.29	....	595.00	....
70. Dues of Mem.	....	5,188.50	....	4,795.00
	$12,113.34	$9,152.55	$8,163.00	$7,096.00
Transferred from income of Permanent Fund		2,778.28		
‡Transferred from Principal of Permanent Fund		182.51		
		$12,113.34		

**Credit from 1946-47 (Jan. '47 Journal).
‡Authorized by vote of Society Jan 28, 1948.

REPORT OF THE AUDITING COMMITTEE

Boston, Mass., March 31, 1948.

To the Boston Society of Civil Engineers:

We have reviewed the records and accounts of the Secretary and Treasurer of the Boston Society of Civil Engineers and we have compared the bank statement of securities held by the Boston Safe Deposit and Trust Company, with the enumeration submitted by the Treasurer. We have also reviewed the report of William J. Hyde, certified Public Accountant, who has examined said records and accounts.

We have accepted and present herewith with our approval the signed report of the accountant.

DONALD W. TAYLOR
GEORGE W. COFFIN
Auditing Committee of the Directors of the Boston Society of Civil Engineers

March 29, 1948.

PROF. DONALD W. TAYLOR
Chairman of the Auditing Committee
Boston Society of Civil Engineers

DEAR SIR:

In accordance with instructions, I have completed the annual audit of the financial records of the Society for the fiscal year ended March 8, 1948 and report as follows.

All changes in securities owned were found properly recorded in the accounts. All receipts of income, including entrance fees as recorded in the records of the Secretary, together with interest and dividends were found correctly recorded in the Treasurer's accounts and to have been deposited in the bank.

Cooperative Bank earnings were verified and found correct.

All paid bills were found to have been duly approved by the President and Secretary and payment of the same was substantiated by comparison with paid checks returned by the bank.

A certified list of the Society's securities, held by the Boston Safe Deposit and Trust Company as custodian, as of March 8, 1948, was in agreement with the Treasurer's record.

Withheld taxes from employee's wages for the months of January and February amount to $44.00 and will be remitted to the Collector of Internal Revenue in the first quarterly payment, due in April.

In accordance with past practice the Secretary's change fund $30.00 is not included in the assets reported by the Treasurer.

One thousand dollars of the original Publication Fund, $1,700.00 has been returned to cash available for investment. The difference between the $700.00 remaining and Publication Fund Cash, $598.35, amounting to $101.66 represents the remaining cost of books on hand.

A verified copy of the Treasurer's report is attached hereto and summaries of his ledger accounts are shown in detail. I found the records for the fiscal year ended March 8, 1948 in good condition and, in my opinion, they are correct.

Respectfully submitted,
WILLIAM J. HYDE, *Certified Public Accountant*

REPORT OF THE EDITOR

February 12, 1948.

To the Board of Government
Boston Society of Civil Engineers:

The JOURNAL for the calendar year 1947 (volume XXXIV) was issued quarterly, in the months of January, April, July and October, as authorized by the Board of Government on December 20, 1935.

During the year 1947 there have been published ten papers presented at meetings of the Society and Sections. The Table of Contents and Index for the year are included in the October, 1947, issue.

The four issues of the JOURNAL contained 344 pages of papers, discussions, and proceedings, 6 pages of Index, and 32 pages of advertising, a total of 382 pages. An average of 1150 copies per issue were printed. The net cost was $1,350.07 as compared with $801.28 for the preceding year.

The cost of printing the JOURNAL was as follows:

Expenditures		
Composition and printing	$1,910.55	
Cuts	524.07	
Wrapping, mailing and postage	63.17	
Editor	300.00	
Copyright	8.00	
		$2,805.79
Receipts		
Receipts from sale of JOURNALS and Reprints	$ 624.72	
Receipts from Advertising	831.00	
		$1,455.72
Net cost of JOURNAL to be paid from Current Fund		$1,350.07

Respectfully submitted,

CHARLES E. KNOX, *Editor*

REPORT OF THE HOSPITALITY COMMITTEE

Boston, March 31, 1948.

To the Boston Society of Civil Engineers:

The Hospitality Committee submits the following report for the year 1947-1948.

Six regular meetings, a Student Night meeting, an Annual Dinner and an Excursion were held during the year. The Annual Meeting was at the Hotel Vendome, the April and November meetings were at Northeastern University, the May and October meetings at Chipman Hall, the January and February meetings

were held at the American Academy of Arts and Sciences and the Excursion covered the new Maine Turnpike.

The Annual Dinner attendance was 188 or ten less than the previous year. The Student Night meeting attracted a total of 290 with 265 present at the preceding dinner.

The January and February meeting involved a change of policy in that there was no dinner but a collation was served after the meeting. These meetings proved to be quite successful.

The total attendance at the six regular meetings was 864 or an average of 144 per meeting. This average is greater by 38 than for the previous year.

The summary of meetings and attendance follows:

Date	Place	Attendance at Dinner	Attendance at Meeting
3-19-47	Hotel Vendome	188	188
4-17-47	N. E. University	138	170
5-21-47	Chipman Hall	97	97
9-21-47	Excursion Maine Turnpike	70	70
10-15-47	Chipman Hall	265	290
11-19-47	N. E. University	153	210
12-17-47	Chipman Hall	88	123
1-28-48	American Academy of Arts & Sciences	*	125
2-18-48	American Academy of Arts & Sciences	*	89
		999	*1362

*Collation served in Lounge after meeting.

The average attendance at all nine meetings were 151 or eleven more than for the year 1946-1947.

Respectfully submitted,

JOHN H. HARDING, *Chairman*

REPORT OF THE LIBRARY COMMITTEE

Boston, Mass., March 17, 1948.

To the Board of Government
Boston Society of Civil Engineers:

A year ago the Library Committee, headed by Mr. A. B. Edwards, presented a very detailed report on the status of the library, formulated a policy and made specific recommendations for the future conduct of the library. This report was approved at an early date by the Board of Government. This year's committee dedicated itself to carrying out those recommendations and submits the following progress report.

Miss Ethel H. Bailey was employed early in October, 1947 as a part-time librarian to renovate the library, and her services have been continued to the present. Engineering organizatioins throughout the city were visited to ascertain how the library can best serve the members. Card indices of all requests for material have been kept and indicate that a wide range of subjects were covered. It is expected that these cards will serve as a convenient guide as to the type of material to be added to the library in the future.

Binding of material which is to be a permanent part of the library has continued.

Many of the publications of Engineering Societies listed for discard in Table V of the 1946-47 committee report have been donated to various universities. Negotiations for disposal of the remainder continue.

Most of the periodicals listed for discard in Table VII of the 1946-47 committee report have been donated to various universities. The disposal of the remainder will be accomplished in the near future.

In continual anticipation that the Committee on Quarters, who have been very active this past year, would meet with success in locating other quarters before the 100th Anniversary the committee has concentrated on reducing the vast bulk of unbound material to facilitate moving if it became necessary and to materially decrease the cost of the same. For this reason, relatively few books have been added.

No culling has been done from the collection of textbooks in the library. It is deemed inadvisable to remove any books from the shelves until certain persons, said to have an intimate knowledge of what constitutes the valuable and historical books in the collection, have had an opportunity to advise the committee in this respect and until the committee has further studied the establishment of a historical collection.

In line with the recommendations of last year's committee only the following reports will be kept in our library:

U.S.G.S. Water Supply Papers
U.S.G.S. Topographical Maps
U.S. Census Reports
Reports of the Chief of Weather Bureau

Incidentally, two new reports of the Weather Service are currently being received. They are the monthly Meteorological Summary and the Annual Condensed Report. Countless reports of various departments of the Commonwealth, currently available at other nearby libraries have been donated to the State House Library. Reports of sundry U. S. Government and Canadian departments and bureaus have been requested by local technical schools to fill gaps in their collections. Many bulletins on Canadian mineral resources have been similarly requested. A great number of U. S. Coast and Geodetic Bulletins are to be returned to that department for shipment to Washington. The remainder, for which there seems to be no demand, will be disposed of as waste paper. Card indices of all materials donated to other libraries and educational institutions will be kept for reference purposes.

The map file, recommended to be purchased by last year's committee and approved by the Board of Government in April has been ordered but delivery has not yet been made. The approximate cost of this map file is $190.00.

Certain material for which there has been no demand was sold to the J. S. Canner Co., and the sum of $79.50 was realized thereby. This money was credited to the General Fund.

No material has been, or shall be, disposed of without the prior approval of the Board of Government.

A recent survey by our part-time librarian indicated a great need for, and considerable interest in, the establishment of a central reference collection of standard specifications in our library. The committee has therefore appointed a seven-man sub-committee, under the Chairmanship of J. F. Brittain, to make

a study of what standard specifications should be purchased and to advise the committee in this respect.

It is the ambition of the committee to also establish a section on Building Codes and Zoning Ordinances but to date our efforts to organize a sub-committee for a study of these matters has been unavailing. We urgently request that members of the Society who have a well-rounded knowledge thereof, or who are interested therein, volunteer their services to the committee.

The Board of Government, on May 21, 1947, authorized the committee to join the Special Libraries Association, at a cost of $15.00 annually. The membership has been renewed for 1948.

The following expenditures have been made during the past year:

For hire of part-time librarian	$384.00
For cleaning books and shelves	81.81
For subscriptions to periodicals	63.52
For binding	39.71
Replacing missing NEWWA journals	2.50
New Books	33.20
Membership in Special Libraries Assoc.	30.00

There were 180 books loaned during the year, and $3.33 was collected in fines.

The following books were purchased and added to the library:

Index to Engineering News Record 1923-1927
Index to Engineering News Record 1928-1943
Index to Proceedings, Journal and other publications of American Water Works Association.
Steelways of New England, Alvin F. Harlow.
Advanced Mathematics for Engineers, 2nd Ed., H. W. Reddick and F. H. Miller.
Standard Methods for the Examination of Water and Sewage, 9th Ed. (A.P.H.A. & A.W.W.A.).
Engineering Applications of Fluid Mechanics, J. C. Hunsaker and B. G. Rightmire, 1st Ed.

The following books were received as gifts:

Bridges—Charles S. Whitney. Gift of Clude M. Durgin.
Historical Reports of Chief Engr., Engr. Dept. A.E.F. 1917-1919. Gift of Edwin B. Cobb.
Report of the Joint Board—Sewage Disposal in the Merrimack River Valley. Gift of Camp, Dresser and McKee.

The following books have been ordered but shipment has been delayed and were not received in time for this report:

Hydraulics for Engineers, Robert W. Angus, 3rd Ed.
The Middlesex Canal, 1793-1860, Christopher Roberts.
Hydraulic Measurements, Herbert Addison, 2nd Ed.
Applied Mathematics for Engineers and Physicists, Louis A. Pipes.

Respectfully submitted,

ROBERT W. MOIR, *Chairman*

Discard from Library approved by Board of Government:

May 21, 1947

To Northeastern University

Power		1916-1940	1941-1942
Iron Age		1920-1940	1941-1942

To Georgia Tech.

American Society of Municipal Improvements			1901-1932
Concrete			1914-1939
Engineering and Contracting			1908-1930
Engineering and Mining Journal	1875-1878	1893-1902	1921-1932
Journal of Municipal Engineers			1916-1921
Proceedings of Western Soc. of Eng.			1880-1881
Report of Chief Engineer U. S. Army		1874-1906	1913-1931

June 25, 1947

To Mass. Institute of Technology

Architectural Forum	1922-1945
American City	1914-1932

To Railroad Enthusiasts, Inc.

Railway Age	1876-1941-1942

To New England Electric Railway Historical Society, Inc.

Electric Railway Journal	1920-1943

Books sold to J. S. Canner Company

Amer. Soc. Heating & Ventilating Engrs.	1895-1897-1925
Amer. Inst. Mining & Met. Engrs. Trans.	1871-1925
Engineering (London)	1872-1932
Sanitary Engineer	1881-1884
Eng. News Record (duplicates)	1893-1901-1917

September 24, 1947

To Mass. State Library

Railroad Commissioners Annual Reports, 1847, 1943, 1946, 1947.
Gas and Light Commissioners Report, 1890, 1902, 1915.
State Board of Health Reports, 1871, 1872, 1875, 1876, 1878, 1921.
(1872-1914 Miscellaneous Reports)
Abolition of Grade Crossing, 1889.
Mass. Railroad and Telephone Laws, 1914.
Railroad and Railway Laws, 1904-1909.
Mass. Street Railway Investigation, 1918.
Docks & Terminal Facilities, 1897.
Chief of District Police Reports, 1889, 1891, 1901.
Prison Commissioners Reports, 1881, 1883.
Metropolitan Water and Sewerage Board, 1902, 1903, 1905, 1910, 1912, 1922.
Attorney General's Report, 1906.
Salem, Beverly, Peabody and Ipswich River, 1911.
Agriculture of Mass., 1858, 1860, 1870, 1871, 1872, 1874, 1877, 1879, 1880, 1941.
Report of Topographical Survey, 1897-1900.
Boundary Line—Between Mass., and New Hampshire, Rhode Island, New York and Vermont.
Cochituate Water Board, 1870-1876.
Digest of Health Laws, 1904.

State Bulletin. Industrial Review, Mar. 1920.
Public Employment Officers, 1919.
Statistics of Manufactures, 1918.
Time-Rate of Wages and Hours of Labor, Oct. 1, 1911.
Changes in Rates of Wages and Hours of Labor, 1910.
Labor Bulletin of Mass. July-Aug. 1907, June, Apr., Mar., Jan. 1907. Dec. 1906, June, 1905.
Metropolitan District Commission, 1921-1927.
Metropolitan Improvements Commission, 1909-1911.
Metropolitan Park Commission, 1895-1919.
Directors Port of Boston, 1912-1915.
Harbor and Land Commission, 1893-1919.
Commission on Waterways & Public Lands, 1919.
Interstate Commerce Commission, 1888, 1820, 1922, 1923.
Statistics of Railways in U. S., 1888-1924.
Mass. Highway Commission, 1893-1909.
Spon's Dictionary of Engineering. Vol. 1-8.
Public Service Commission, 1913-1919.
Reclamation Service, 1907-1920.
Cities of Malden, Medford, Melrose
Petitioners — V. — Mass. 1904-1905.
Nashua River Paper Company—Petitioners—V. Mass. 1900-1902.
New Groton Aqueduct of New York, 1887-1895.
Atlas to Accompany; The Tertinary History of that Grand Canyon District.
2 Books Geology of the Comstock Lode and the Warhow District.
2 Vols. Electrical World, 1932.
American Society for Testing Materials, 1930-1931.
(duplicates)

To American Society of Civil Engineers

Duplicate Transactions ASCE	1893-1911
Duplicate Proceedings ASCE	1896-1912

December 17, 1947

To the University of New Hampshire

American Architect and Building News	1900-1930 (bound)
2 Volumes of Plates	
The Engineer (London) Bound	1886-1932
Unbound	1933-1940

REPORT OF COMMITTEE ON RELATIONS OF SECTIONS TO MAIN SOCIETY

Boston, Mass., March 12, 1948.

To the Boston Society of Civil Engineers:

There follows the report of the Committee on Relations of Sections to Main Society. This committee has held no formal meetings during the present year. It is the opinion of this committee that the policy laid down in the Report on Sections of March 21, 1945 should be continued. This policy was summarized as follows:

"Funds should be made available to the Sections to permit them to carry out their respective Section activities in a proper manner, limited of course to the general financial condition of the Society. For the present, to accomplish this purpose, there should be budgeted to each Section, except the Northeastern University Section, an amount of $10 per scheduled Section meeting (excluding joint meetings with the main Society) to a maximum of $50 per season. On application by the Officers of a Section, the Board should give consideration to an appropriation of additional funds for a special program.

"In order to coordinate the programs of the Sections with that of the Society, the special Committee on Programs should consist of at least nine members and should include the Chairman of the Sanitary, Structural, Highway, Hydraulics, Surveying & Mapping Section and N. E. University Section, or members designated by the respective Chairmen."

Respectively submitted,

LESLIE J. HOOPER, *Chairman*

REPORT OF THE JOHN R. FREEMAN FUND COMMITTEE

Boston, Mass., March 31, 1948.

To the Boston Society of Civil Engineers:

Last May the committee again offered a Scholarship for a year's study of research work in connection with hydraulics or an allied science. The scholarship provided $3000 for a single man or $3600 for a married man. Preference was offered to residents of New England and eastern New York north of New York City. The award was to be made to a candidate who presented the best research project and was best qualified to carry it through. The notice was sent out to all the engineering schools in the area, and also published in the engineering bulletins and magazines. No suitable applications were received.

No plan for this year has yet been made, but the committee will probably again offer a scholarship of some form. If any member of the Society has any suggestion regarding the use of this fund the committee will be glad to consider it.

For the John R. Freeman Fund Committee,

HOWARD M. TURNER, *Chairman*

REPORT OF THE COMMITTEE ON QUARTERS

Boston, Mass., March 17, 1948.

To the Board of Government
Boston Society of Civil Engineers:

This committee was continued from the previous year. At the time of the last annual meeting it was engaged with a committee of the E.S.N.E. in the consideration of engineering quarters which would house other engineering societies. The committee felt that until this possibility had been explored it was unadvisable for the Boston Society to be considering other quarters by itself.

On receipt of information that none of the societies of the E.S.N.E. were interested in such a project this committee started further investigation of providing new quarters for the Boston Society alone. Various locations have been considered as described in the following paragraphs.

1. The question of remodeling the present quarters to make them more suitable and attractive has been considered by the committee and still remains a possibility. The difficulty of the fire hazard during meetings still exists to some extent though conditions have been greatly improved in this respect by the work done by the owners of the building this last year.

2. The renting of space in the new John Hancock Life Insurance building was considered. This appeared to present a satisfactory location with ample facilities in the way of meeting rooms. It was finally dropped on account of the expense of rental, approximately $4.50 per sq. ft. which would cost for adequate space between $7,000 and $10,000 a year.

3. The purchase and remodeling of the building at 97 Beacon Street next to the new Engineers' Club was considered. The results of this investigation were presented to the members of the Society in a report dated October 27. It was decided that the expense involved was more than the Society could afford.

4. The American Academy of Arts & Sciences building was considered and a proposition was made to that Society under which the Boston Society would rent sufficient rooms for its library and office and committee meetings and have available the use of the auditorium for its meetings and of the main library after them. This arrangement presented a very attractive prospect for the Society. Unfortunately the American Academy of Arts & Sciences decided that our requirements would conflict with theirs and therefore refused our offer.

5. The committee also looked at some space in an office building on Water Street. This was suitable space and location but it was felt that until some of the other more attractive possibilities were disposed of such a space in an office building should not be considered.

6. New quarters at the Boston City Club are being investigated. The space under consideration consists of three (3) rooms at present used as bedrooms, on the 9th floor near the entrance to the large hall. It is proposed that two of them should be combined for a library and lounge, the third used as an office. The large meeting room on the 9th floor would serve for the meetings of the Society and a smaller room on the 10th floor is available for section meetings. The restaurant facilities of the Club make it convenient for serving meals. This project is still pending. The Club Directors have requested some months more before they reply to the Society's request.

Until the City Club is heard from this committee can make no definite recommendations to the Board. Its term expires with this meeting. It recommends, however, that a Committee on Quarters be appointed to continue further this study of new quarters.

Respectfully submitted,

HOWARD M. TURNER, *Chairman*

REPORT OF THE EXECUTIVE COMMITTEE OF THE SANITARY SECTION

Boston, Mass., March 3, 1948.

To the Sanitary Section,
Boston Society of Civil Engineers:

During the past year four meetings have been held as follows:

March 5, 1947.—Annual Meeting and election of officers, Mr. Jack E. McKee spoke on the subject "Loss of Sanitary Sewage Through Storm Water Overflows". Attendance 75.

June 7, 1947.—Outing and inspection trip to the waste disposal plant of Eastman Gelatin Co., Peabody, and the new grease and grit chamber of the South Essex Sewerage District Board in Peabody and Salem. Attendance 27.

October 1, 1947.—Mr. A. E. Griffin presented a paper titled "Chlorine in Waters and Wastes". Attendance 49.

December 3, 1947.—Prof. W. E. Stanley and J. F. Berberich jointly presented a paper on "B.O.D. Loading of Activated Sludge Plants". Attendance 68.

The average attendance was 55.

Five meetings of the Executive Committee have been held during the year.

Respectfully submitted,

KENNETH F. KNOWLTON, *Clerk*

REPORT OF THE EXECUTIVE COMMITTEE OF THE STRUCTURAL SECTION

Boston, Mass., February 24, 1948.

To the Structural Section,
Boston Society of Civil Engineers:

On November 19, 1947, the Designers' Section, which had been in existence since May 19, 1920, was renamed the Structural Section.

During the past year the following meetings were held:

March 12, 1947.—Annual Meeting and Election of Officers. Mr. Jacob P. Den Hartog spoke on "Vibrations, Their Effects and the Means to Avoid Them". Attendance 45.

April 9, 1947.—Charles S. Whitney spoke on "Applications of the Plastic Theory to the Design of Modern Reinforced Concrete Structures". Attendance 92.

May 14, 1947.—Harrison E. Schock spoke on "Design of One of the Earliest Steel Frame Structures to Be Erected in Boston". Attendance 34.

October 8, 1947.—Joint Meeting with Transportation Section. Mr. A. L. Delaney spoke on "Pressure Grouting". Attendance 34.

November 12. 1947.—William H. Owens spoke on "Structural Aspects of Mechanical Equipment in Modern Office Buildings". Attendance 39.

January 14, 1948.—Albert G. H. Dietz spoke on "Structural Sandwich Materials". Attendance 61.

February 18, 1948.—Joint Meeting with Main Society. Dr. Ruth Terzaghi spoke on "Carbonic Acidosis of Concrete". Attendance 86.

Total attendance was 391.

The Average Attendance was 56.

Respectfully submitted,

ROBERT W. MOIR, *Clerk*

REPORT OF THE EXECUTIVE COMMITTEE OF THE TRANSPORTATION SECTION

Boston, Mass., February 25, 1948.

To the Transportation Section,
Boston Society of Civil Engineers:

During the past year, the following meetings were held:

April 23, 1947.—Mr. Edward C. Keane, Senior Engineer of Fay, Spofford & Thorndike, presented a paper entitled "Review of Current Practice in Design of Subgrades for Runways and Highways". Attendance 59.

September 27, 1947.—Joint Meeting of the Boston Society of Civil Engineers and the Transportation Section. A field trip was conducted to inspect the Maine Turnpike Project. Attendance 70.

October 8, 1947.—A joint meeting of the Structural and Transportation Sections. Mr. A. L. Delaney of the Portland Cement Association presented a paper entitled "Pressure Grouting". Attendance 60.

November 26, 1947.—Mr. Robert Jarrett of the E. W. Wiggins Airways presented a paper entitled "New England Air Transportation". Attendance 12.

February 25, 1948.—A joint meeting of the Surveying and Mapping and the Transportation Sections. Mr. Elmer C. Houdlette presented a paper entitled "Use of Aerial Photography in Highway Locations in Massachusetts". Attendance 65.

The total attendance was 266.

The average attendance was 53.

Respectfully submitted,

HERMAN J. SHEA, *Clerk*

REPORT OF THE EXECUTIVE COMMITTEE OF THE HYDRAULIC SECTION

Boston, Mass., Feb. 19, 1948.

To the Hydraulic Section,
Boston Society of Civil Engineers:

The following meetings were held during the past year:

May 7, 1947.—Mr. Howard M. Turner presented a paper entitled "Repairs of a Dam at South Barre, Mass." Attendance 44.

November 5, 1947.—Dr. James W. Daily presented a paper entitled "Recent Developments in Cavitation". Attendance 38.

February 4, 1948.—Mr. George R. Rich presented a paper entitled "Basic Hydraulic Transients". Attendance 78.

The total attendance was 160.

The average attendance was 53.

Respectfully submitted,

JAMES F. BRITTAIN, *Clerk*

REPORT OF THE EXECUTIVE COMMITTEE OF THE SURVEYING AND MAPPING SECTION

Boston, Mass., February 28, 1948.

To the Surveying and Mapping Section,
Boston Society of Civil Engineers:

The following meetings were held during the past year:

April 30, 1947.—Organization of the Section with the election of officers. Prof. Charles O. Baird presented a paper entitled "A Compilation of Vertical Curve Data". Attendance 37.

November 19, 1947.—Joint Meeting of the Main Society, the Northeastern University Section and the Surveying and Mapping Section. Mr. Edwin P. Shaw, 3rd, spoke on the "Legal Aspects of the Land Court" and Mr. Charles M. Anderson spoke on the "Engineering Aspects of the Land Court". Attendance 210.

January 21, 1948.—Annual Meeting with the election of officers. Mr. Louis H. Berger presented a paper entitled "Simplicity of Design, Materials Suitable for Construction and the Proper Care of Engineering and Surveying Instruments". Attendance 25.

The total attendance was 272.

The average attendance was 81.

Respectfully submitted,

CHARLES M. ANDERSON, *Clerk*

NORTHEASTERN UNIVERSITY SECTION

To the Northeastern University Section,
Boston Society of Civil Engineers:

The following meetings were held during the past year:

March 22, 1947.—The initial meeting of delegates from the fourteen Student Chapters comprising the New England Conference of the A.S.C.E. was held with the N.U.C.E.S. acting as host. Plans for the annual conference to be held at Brown University were made at this meeting. Attendance 16.

April 9, 1947.—Mr. T. Alfred Fleming, Director of Conservation at the Underwriters' Laboratories, spoke on "The Human Equation in Fire Prevention". Mr. Fleming told of the destruction of life and property resulting from poor engineering principles. Attendance 60.

April 16, 1947.—At a business meeting of the Society a discussion on the New England Conference was followed by the election of delegates. Attendance 40.

May 27, 1947.—A course in "The Structural Aspects in Fire Prevention" was delivered in six lectures by Mr. Corson of the Factory Mutual Fire Insurance Companies. The lectures were given on the following dates: March 5 and 19, April 22 and 29, and May 13 and 27. These meetings were held jointly with the Student Sections of the A.S.M.E. and S.A.M. Average attendance for the six meetings was 40.

October 9, 1947.—A business meeting was called to discuss a proposed smoker

for new members. A trip to the Highway Exposition was also planned. Attendance 35.

October 15, 1947.—Preston E. Cloud, Assistant Professor of Geology at Harvard, gave an illustrated description of the "Paricutin Volcano". This was a joint meeting of the Boston Society of Civil Engineers and American Society of Civil Engineers, Northeastern Section and Student Chapters of A.S.C.E. Attendance 265.

October 28, 1947.—An informal smoker was given to welcome new members into the society and to interest non-members of the sophomore and middler classes in the benefits of the Society. A tribute was paid to Professor Pugsley, who is retiring from the University. Attendance 67.

November 19, 1947.—The Massachusetts Land Court was the subject of two speakers before a joint meeting of the Surveying and Mapping Section of the B.S.C.E. and the Northeastern University Section. Mr. Charles M. Anderson, of the Massachusetts Land Court spoke on "The Engineering Aspects of Land Court", and Mr. Edward P. Shaw, of Deland & Rockwood, Attorneys at Law, spoke on "The Legal Aspects of Land Court as an Attorney and Examiner". Attendance 235.

December 16, 1947.—Election of officers for the year 1948 were held and the following chosen:

President—William J. Downey, Jr.
Vice-President—Joseph A. Corbisiero
Secretary—Arthur L. Quaglieri
Treasurer—Charles F. Quigley

Attendance 44.

December 23, 1947.—Mr. Leonard B. Loitherstein delivered a student paper entitled "Ship Surveying". Mr. Loitherstein presented interesting and informative facts on the use of surveying in the construction of ships. He pointed out the many differences between land surveying and the surveys carried out in shipyards. Attendance 35.

January 15, 1948.—A business meeting was held at which the new officers disclosed plans for future meetings and informed the new members of the various advantages of the Society. Committees for the following year were chosen. Attendance 30.

February 2, 1948.—The Annual Meeting of the American Society of Civil Engineers, Northeastern Section, was held at Northeastern University. The Students aided the parent Society in making preparations. Mr. Henry Parkma, former Governmental Affairs Advisor in Germany for General Clay, spoke on "Recent Observations in Europe". Attendance 135 of which 23 were students.

The total attendance during the year was 625.

The average attendance during the year was 52.

Respectfully submitted,

ARTHUR L. QUAGLIERI, *Clerk*

PROFESSIONAL SERVICES AND ADVERTISEMENTS

The advertising pages of the JOURNAL aim to acquaint readers with Professional and Contracting Services and Sources of Various Supplies and Materials. You would find it of advantage to be represented here.

Volume XXXV APRIL, 1948 Number 2

BOSTON SOCIETY OF CIVIL ENGINEERS

FOUNDED 1848

PROFESSIONAL SERVICES

PAGE

LISTED ALPHABETICALLY . . . . . iii & iv

INDEX TO ADVERTISERS

ALGONQUIN ENGRAVING CO., INC., 18 Kingston St., Boston v
CHAPMAN VALVE MFG. CO., 165 Congress St. v
CRANDALL DRY DOCK ENGINEERS, 238 Main St., Cambridge v
ELLIS, W. H., & SON CO., East Boston v
HAWKRIDGE BROS., 303 Congress St., Boston vi
HEFFERNAN PRESS, 150 Fremont St., Worcester viii
HUGHES, EDWARD F., COMPANY, 53 State St., Boston viii
MAKEPEACE, B. L., INC., 387 Washington St., Boston . . . . . Back Cover
MULCARE, THOMAS, CORP., 66 Western Ave., Boston vi
NAWN, HUGH, INC., 77 Floydell St., Boston vii
NEW ENGLAND CONCRETE PIPE CORP., Newton Upper Falls, Mass. vii
NEW ENGLAND POWER SERVICE COMPANY, 441 Stuart St., Boston v
NORTHERN STEEL COMPANY, 44 School St., Boston vi
O'CONNOR, THOMAS, & CO., 238 Main St., Cambridge v
OLD COLONY CRUSHED STONE CO., Quincy, Mass. vi
OLD CORNER BOOK STORE, THE, 50 Bromfield St., Boston v
PIPE FOUNDERS SALES CORP., 6 Beacon Street, Boston v
RAYMOND CONCRETE PILE CO., Park Square Building, Boston vii
S. MORGAN SMITH CO., 176 Federal St., Boston v
SPAULDING-MOSS CO., Boston v
STUART, T., & SON COMPANY, 70 Phillips St,, Watertown vi
WARREN FOUNDRY & PIPE COMPANY, 11 Broadway, N. Y. vi

In These Columns Professional Cards are listed alphabetically. Your Card should be among them.

COMMITTEES

1948-1949

NOMINATING COMMITTEE

Past Presidents (Members of the Committee)

Athole B. Edwards
Dean Peabody, Jr.
William P. Hyland
Walter E. Merrill
(Term expires March, 1949)

Howard M. Turner
George F. Brousseau
Frank L. Cheney
William E. Stanley
(Term expires March, 1950)

Harry P. Burden

SPECIAL COMMITTEES

Program

Frederic N. Weaver, *Chairman, ex-officio*

Thomas R. Camp
William E. Stanley
Stanley M. Dore

Robert W. Moir
Charles M. Anderson
Allen J. Burdoin

Oliver G. Julian
R. Newton Mayall
John G. W. Thomas

Publication

Charles E. Knox, *Chairman*

John B. Babcock

Edwin B. Cobb

Leonard J. A. Fenocketti

Library

Robert W. Moir, *Chairman*

James F. Brittain
Elliot F. Childs

Edwin B. Cobb
George W. Hankinson

Ralph M. Soule
Henry I. Wyner

Thomas C. Coleman, *ex-officio*

Hospitality

Edward S. Averill, *Chairman*

Joseph C. Lawler

Charles T. Main, 2nd

James C. M. Tillinghast

Relations of Sections to Main Society

Oliver G. Julian, *Chairman*

Charles M. Anderson
Allen J. Burdoin

William J. Downey, Jr.

R. Newton Mayall
John G. W. Thomas

John R. Freeman Fund

Howard M. Turner, *Chairman*

Charles M. Allen

William F. Uhl

Desmond FitzGerald Award

Byron O. McCoy, *Chariman*

John B. Wilbur

Jack E. McKee

Sanitary Section Award

Jack E. McKee, *Chairman*

Harry P. Burden

George F. Brousseau

Hydraulics Section Award

Byron O. McCoy, *Chairman*

Elliot F. Childs

Harold K. Barrows

Structural Section Award

John B. Wilbur, *Chairman*

Henry Brask

Howard A. Gray

Transportation Section Award

Alexander J. Bone, *Chairman*

Francis T. McAvoy

Ernest L. Spencer

Surveying and Mapping Section Award

Charles O. Baird, *Chairman*

Alexander J. Bone

Chester A. Moore

Subsoils of Boston

Donald W. Taylor, *Chairman*

Miles N. Clair
Irving B. Crosby

Stanley M. Dore
Lawrence G. Ropes

Investment Committee

Herman G. Dresser, *Chairman*

Frederic N. Weaver

Everett N. Hutchins

Auditing Committee

George W. Coffin

Chester J. Ginder

Membership Central Committee

Frank L. Lincoln, *Chairman*

George F. Brousseau
Chester A. Moore

Francis H. Kingsbury
James F. Brittain

Robert W. Moir, *ex-officio*

Quarters Committee

Howard M. Turner, *Chairman*

Herman G. Dresser
Albert Haertlein

E. Sherman Chase
John B. Wilbur

Robert W. Moir, *ex-officio*

Building Laws and Building Construction

John R. Nichols, *Chairman*

Emil A. Gramstorff
Burtis S. Brown

Arthur L. Shaw
Thomas Worcester

Publicity Committee

Stephen Haseltine, Jr., *Chairman*

Jack E. McKee
Ernest L. Spencer

Llewellyn T. Schofield
James C. M. Tillinghast

Gardner K. Wood

Safety Committee

Herman G. Protze, *Chairman*

John R. Nichols

Henry I. Wyner

Insurance Committee

Frank L. Flood, *Chairman*

Donald W. Taylor

George A. Sampson

Competitive Bidding for Engineering Services

Ralph W. Horne, *Chairman*

John P. Wentworth
George W. Coffin

George G. Bogren
Herman G. Dresser

Changes in By-Laws

Frederick N. Weaver, *Chairman*

Thomas R. Camp

Carroll A. Farwell