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CHANGING TIMES DEMAND NEW ASSESSMENT METHODS FOR M.D.C. SEWERAGE SYSTEM

BY A. E. SULESKY,* Member

(Presented at a meeting of the Sanitary Section, B.S.C.E., held on March 2, 1960.)

AFTER 64 years of operation of the Metropolitan Sewerage Districts the Massachusetts Legislature in 1959 enacted a bill which revised the basis for apportionment of costs of construction and operation of the system. The reasons for the change; the assessment methods studied with a description of the demand-capacity ratio adopted for assessments is our subject.

In order that you may better understand the discussion that follows, I propose to briefly outline the history of the Metropolitan Sewerage Districts, its administration and financing, and how new members were admitted to the system. Mr. Sterling will discuss the methods of assessment that were studied and describe the demand-capacity ratio basis that was adopted.

The problem of sewerage and sewage disposal in an area of 645 sq. miles which drains like a funnel into Boston Harbor through the Mystic, Charles and Neponset Rivers with a population of 2,000,000 has been dealt with in a long series of legislative and technical studies and a long series of acts of successive Legislatures. This has led to the existence of three major sewerage systems in the area; (1) The Boston Main Drainage System built and maintained by the City of Boston and (2) the North and (3) the South Metropolitan Sewerage Systems which are under the jurisdiction of the M. D. C.

BOSTON MAIN DRAINAGE SYSTEM

The Boston Main Drainage System was built by the City of Boston from 1879 to 1884 with additions until 1899 at a cost of

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$6,500,000. It consists of intercepting sewers along the water fronts of the city proper and South Boston, connected with and taking all waste other than heavy storm flow from the old sewers which formally had discharged directly into the tide water all along these water fronts. This intercepting sewer system was the first undertaking of its kind in the country. It delivered the Boston sewage to storage tanks on Moon Island and was then discharged to the harbor on the outgoing tides.

North and South Metropolitan Sewerage Districts

As a result of studies by the Mass. Drainage Commission in 1884 and the State Board of Health in 1887, the legislature created the Metropolitan Sewerage Commission by Chap. 439 of the Acts of 1889, and established the North Metropolitan Sewerage District. This was a trunk system north of the Charles River with an outlet off Deer Island 40 ft. below mean low water. Construction started in 1890 and the original system of trunk sewers was put in operation in 1895.

Successive legislatures have added other districts to the original area and by Chap. 424 of the Acts of 1899 created the South Metropolitan System with outlets off Nut Island 30 ft. below mean low tides. This act stated "Nothing herein shall be construed to vest any rights which cannot be extended to cities and towns or parts thereof other than those herein named, upon such terms and conditions as may hereafter be imposed by legislative enactment."

Metropolitan System Today

At the present time there are 40 cities and towns in the Metropolitan Sewerage Districts which maintain and operate their own sewer systems, subject to rules and regulations of the Metropolitan District Commission. Of these, all but Framingham and Natick are in the drainage basin tributary to Boston Harbor.

The original North Metropolitan System consisted of approximately 51 miles of trunk sewers and 8 miles for the Charles River System, and was designed to reach its capacity in approximately 40 years, by 1930. The present North and South Districts have 180 miles of trunk sewer in operation and an additional 38½ miles are either under construction or are proposed. This enlargement provided outlets for new cities and towns entering the system and relief lines to augment the capacity of inadequate lines.

Over 3,000 miles of local sewers discharge into the Metropolitan Trunk Systems through 1,869 connections, with over 283,000 house connections. There are 14 pumping stations and one treatment plant in the North and South Systems, with 41 pumps ranging in capacity from 2 to 100 mgd.

In addition to the Metropolitan Systems, the city-operated Boston Main Drainage System services a substantial portion of the city, and also disposes of a comparatively small volume of the sewage from some of the communities in the South Metropolitan Sewerage District.

The greater part of the sewage from the entire area is discharged without treatment into Boston Harbor, the two principal points of discharge of untreated sewage being the Metropolitan outlet at Deer Island and the Boston Main Drainage outlet at Moon Island. As a result of population growth, combined with industrial expansion, the volume of sewage produced finally reached a point where its discharge in untreated form resulted in a serious degree of pollution in the waters of the harbor.

Following years of study of this problem, a general program of improvement has been adopted. An Act of 1945 provided for the construction of a treatment plant at Nut Island, together with appurtenance facilities, and authorized a bond issue of $15,000,000 to finance this work. This plant, which has been in operation since 1952, has reduced substantially the former pollution in Quincy Bay and nearby waters. The Legislature, in 1951, provided for the inclusion in the Metropolitan System of the Boston Main Drainage District, and authorized the expenditure of an additional $50,000,000 for the enlarged program.

Principal features of the improvement program include additional relief trunk sewers, two deep rock tunnels extending from East Boston and from Roxbury to Deer Island, and construction of a treatment plant at Deer Island with a daily capacity of 848 mgd. Construction of much of this program is at present in progress and the remaining projects are now under design. Completion of this program will eliminate the discharge of raw sewage into Boston Harbor from both the Metropolitan and the Boston Systems. It will also substantially reduce the present excessive overflows of sewage and storm water into the lower portions of the Charles and other rivers in the Metropolitan area.

Since 1945 the Legislature has authorized bond issues totaling approximately $76 million for various additions to the system.

Expenditure of the funds authorized to finance these improvements will increase substantially the annual assessments of the cities and towns in the Metropolitan Sewerage District for the purpose of meeting debt charges and to operate the new Deer Island Treatment Plant. The full impact of the expenditure of this $76 million is just beginning to be felt by the member communities of the Metropolitan District Sewerage System, and it will affect local tax rates to a marked degree. At the present time the Legislature has a bill before it for an additional $40 million to complete the projects authorized.

Administration and Financing of Metropolitan Sewers

The Metropolitan Sewerage System is administered by the Metropolitan District Commission, a state agency, and is financed by the cities and towns which are served. This arrangement is one evolved to meet the problems of services of concern to the densely populated area in and around Boston which no city or town can cope with alone.

The Metropolitan District Commission is an agency of the Commonwealth. It has the status of a "department" within the scope of the amendment of the Constitution which requires that the work of the Commonwealth be organized in not more than twenty departments. The Commission is composed of a commissioner and four associate commissioners appointed by the Governor.

The Legislature is the only governmental body with power to make policy decisions, extend the area served, and make appropriations for maintenance or construction. As an agency of the Commonwealth, as distinct from a political subdivision, the District has no governing body. The Commissioners have only administrative authority to conduct the operations delineated and authorized by the Legislature.

The financial operations of the Metropolitan Sewer Districts are handled in exactly the same manner as the operations of every other department of the Commonwealth, with one exception, namely, that all of the cost is eventually reimbursed to the Commonwealth by the cities and towns in the district. Appropriations are voted by the

Legislature and expenditures are processed through the office of the State Comptroller and State Treasurer. When expenditures for construction are to be financed through loans, the State Treasurer sells the bonds and thereafter makes the required payments of interest and principal, collecting the amount necessary for that purpose from the cities and towns. Expenditures for maintenance are shared by the several cities and towns in proportion to population. Expenditures for principal and interest were shared in proportion to valuation, until this year when the new demand-capacity ratio method of assessment goes in effect.

Financing Maintenance Costs

The cost of maintaining the several sewerage systems has always been apportioned among the cities and towns benefited in proportion to population. Since 1906 this basis has been fixed in law (Acts of 1906, chapter 369), and the present provision appears in section 6 of chapter 92 of the General Laws. Prior to 1906, the determination was made by commissioners appointed in accordance with the provisions of laws establishing the several systems. The following excerpt from the Massachusetts Drainage Commission report of 1886 shows the reasoning which led to apportionment on the basis of population.

"It would seem as if the proper basis for such an apportionment should be that upon which people pay for most other things; that is, value received. But the relative proportion of value received by each town is a matter difficult to determine, for it is evident that all of the following considerations enter into the problem:

1. The number of persons benefited; that is, the population of each town.

2. The amount of sewerage contributed by each town, and disposed of by the works. This often is not in proportion to the population.

3. The area of land which the system benefits by affording sewerage facilities, making the land more valuable for dwellings and manufactories.

4. The valuation of property benefited, which is the common basis of apportionment in the case of other taxes.

5. The estimated cost of that portion of system used in disposing of the sewage in any case. This would vary with each town. The

sewage of Stoneham, for instance, will flow through nearly ten miles of sewer; that of Malden through only three miles, or less.

6. The extent to which the proposed sewers serve each town, by reason of their location within the town boundaries, in facilitating and cheapening the building of the tributary town systems. Stoneham, for instance, is only reached at one point, to which all her sewage must be brought; in Malden, on the other hand, the main sewer itself takes the place of a common sewer, three miles long, intersecting the town in such a way as to be conveniently and cheaply reached from all parts of it.

All of these considerations might be introduced as factors in calculating the relative amounts to be paid, giving to each factor a certain numerical weight. Some of the factors, however, are indeterminate at present and could only be guessed at, which makes their use unsatisfactory. The simplest, most practicable, and, on the whole, fairest principle of apportionment in this case would be based on population."

This reasoning has seemingly been accepted during the intervening seventy years by successive commissions which have studied the operation and financing of the sewer systems, and maintenance has been apportioned on the basis of population.

Financing Sewer Construction

All sewer construction by the Metropolitan District Commission, upon authorization by the Legislature is undertaken on behalf of the cities and towns which are served. The State borrows the money and pays the bills. The amount required by the State to meet annual payments of principal and interest on the outstanding debt for sewer construction was apportioned among the cities and towns served in proportion to the valuations adopted periodically by the Legislature for state tax purposes. The assessments are calculated annually by the State Treasurer and are published in Public Document No. 92.

Assessments for Metropolitan sewerage construction cost based on state tax apportionment were instituted in 1906 automatically. So long as those apportionments were regularly and frequently revised they provided a seemingly acceptable basis for apportionment of cost on the basis of ability to pay. A new apportionment was enacted every three years, and occasionally more frequently from 1901 to

1943, and again in 1945. Since then the General Court has not enacted a new apportionment; the 1945 figures are still being used.

The growth of suburban towns has rendered the 1945 state tax apportionment figures obsolete and inequitable as a basis for apportioning costs.

Studies by the special Commission created under Chapter 129, of the Resolves of 1956 to study the Metropolitan Sewerage Districts, utilizing the valuations recommended by the Special Commission on Equalization and Apportionment (House, No. 3286 of 1956) indicate that the older cities and towns at the core of the Metropolitan Districts are presently bearing a larger proportion of annual assessments, and the growing suburban towns on the outer fringe of the Metropolitan Districts are bearing a smaller proportion than would be the case if the apportionments were made on the basis of present-day valuations.

The very fact that, though the inequities resulting from its continued use were well known, the Legislature has not been willing to replace the 1945 valuation basis for apportionment indicates that important considerations are involved. The fact is that the 1945 valuations are also used for such diverse purposes as the apportionment of county taxes as well as numerous state-local financial relationships.

The complexity of the situation is suggested by a mere statement of the opposing points of view which may be taken by a city or town, depending on whether the subject under discussion is apportionment of costs or distribution of state aid.

1. The use of the 1945 figures works to the disadvantage of Boston and other older cities at the core of the Metropolitan area in the apportionment of sewer construction costs, but much to their advantage in the distribution of income and corporation taxes.

2. For the growing suburban towns it works the other way. They are not being assessed as heavily as present-day valuations would warrant for sewer construction costs, but at the same time they are getting a proportionately smaller share of the annual distribution of income and and corporation taxes.

The conflicts of interest are so diverse and the changes which would result for individual cities and towns after a lapse of more than fifteen years are now so large and complex that there seems little prospect of a new apportionment in the near future.

It was the considered opinion of the Special Commission created in 1956 to study the M.D.C., Sewerage Division, that the achievement of equity in the apportionment of sewerage construction costs within the Metropolitan Sewerage Districts should not be left contingent upon the adoption of a new basis for state tax apportionment.

Consideration was given to the possibility of basing apportionment of sewerage construction costs on legislatively determined equalized valuations for those cities and towns in the Metropolitan Sewerage Districts, independent of the state tax apportionment, and with the proviso that such tabulations should be used solely for the apportionment of sewerage costs.

This possibility was discarded for a variety of reasons, not the least of which was that periodic legislative revisions, with all the attendant difficulties, would be necessary to maintain equitable treatment between the relatively static core cities and towns and the growing suburbs.

Since there were no available and acceptable property valuations to use as measures of ability to pay, The Special Commission deemed it had no alternative but to look for a different basis for apportionment.

Mr. Sterling and his staff made special studies for the Special Commission analyzing the impact of several possible methods of apportionment which resulted in the adoption of the demand-capacity ratio method.

Financial Arrangements for Admission of New Cities and Towns

Additional cities and towns have been admitted to the districts by legislative action and the formula for assessment has been, in general, composed of three charges as follows:

1. An entrance charge, based on the ratio of valuation of the city or town to the district, applied to the total paid-off debt of the North or South System as of April 1st of the year of entrance.
2. A yearly charge, based on the ratio of valuations as in (1) to cover the cost of interest and sinking fund.
3. A yearly charge based on the ratio of the population of the city or town to the district, applied to the cost of maintenance and operation of the North and South System.

In only three instances prior to the admission of Randolph in 1955 has the Legislature departed from this simple procedure.

1. The Town of Braintree (1910) was required to pay in addition to the usual entrance fee the sum of $1,000.

2. The Town of Reading (1916) was charged a lump sum of $35,000 as an entrance fee.

3. The Towns of Canton, Norwood, Stoughton and Walpole (1928) were assessed an entrance fee of $500,000, divided among them in proportion to their respective state valuations.

Since 1945, there has been an increased migration of population and industry from the cities in the center of the metropolitan districts to the suburbs. This has increased the loads on the sewers serving the fringe areas and has also increased the demand from cities and towns bordering the District for admission into the system. As the distance from the main trunk lines increased, the cost of providing an outlet also increased and the usual formula for entrance charges placed an unequal burden on the District to provide a connection for outlying cities and towns.

As a result in 1957, when Randolph sought admission to the Metropolitan District, the legislature, in addition to the usual entrance fee, imposed a special assessment of $30,000 per year for twenty years, or until a new basis for apportionment of capital charges was adopted.

The Town of Westwood was also required to pay a special assessment of $22,500 per year for 20 years or until a new basis for apportionment was adopted.

As a result of the studies made by the Special Commission, the legislature enacted Chapter 612 of the Acts of 1959.

This act made the following four major changes relative to the financing of the M.D.C. Sewerage System:

1. It combined the North and South Sewerage Districts into one Metropolitan Sewerage District. This was necessary because with the completion of the Deer Island Treatment Plant, certain cities and towns in the South District would be serviced in part through the North System Treatment Plant, and it would be difficult to apportion costs under the two districts.

2. It changed the method of proportioning serial bond and in-

terest charges on the funded debt of the system from the 1945 valuation basis to a "Demand-capacity" ratio basis.

3. It provided that all future construction charges for new or relief sewers shall be charged directly to the cities and towns in proportion to the benefit received.

4. It established a "Sewerage Users" committee similar to the "Water Users" Committee in the M.D.C. Water Division composed of officials of the cities and towns in the Metropolitan Sewerage District for the purpose of keeping them informed of costs and what the M.D.C. is doing.

ALLOCATION OF COSTS FOR THE METROPOLITAN SEWERAGE SYSTEM

By Clarence I. Sterling, Jr.*

(Presented at a meeting of the Sanitary Section, B.S.C.E., held on March 2, 1960.)

With the adoption of a program of improving the sewage disposal methods for the Metropolitan Sewerage District serving the Boston Metropolitan Area, it was felt that there needed to be a reexamination of the methods of assessing the cost of these improvements. These improvements include the Nut Island Sewage Treatment Plant to serve the South Metropolitan Sewerage District, the proposed construction of the Deer Island Sewage Treatment Plant to serve the North Metropolitan Sewerage District, the inclusion of the Main Drainage System of the City of Boston into the Metropolitan Sewerage System, and the extension of the Metropolitan trunk sewers to serve the growing suburban communities.

At the instigation of the officials of the older cities and towns in the Metropolitan District, a special commission was established by the Legislature in 1956 to study the entire financing program. Members of the special commission consisted of two State Senators, three Representatives, the Chairman of the Metropolitan District Commission, the Mayor of one of the cities, a public works official, and a member of the Massachusetts Federation of Taxpayers Association. The writer was engaged as the Engineering Consultant to the Commission to study the problem.

This paper will not attempt to describe all of the details of the various studies that were made but will summarize the problem and the conclusions that were reached.

Present Method of Assessing Costs

There are two systems,—the North Metropolitan Sewerage District and the South Metropolitan Sewerage District. The costs of construction and maintenance for the operation of each district are kept separately. The present method of making assessments was

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established by Chapter 369 of the Acts of 1906, which is included at the present time in Section 6 of Chapter 92 of the General Laws. Under the existing procedures the amount required to meet annual payments of principal and interest on outstanding indebtedness of each district for construction purposes is apportioned among the cities and towns served by each district, based upon the valuations established by the Legislature. The most recent valuation was made in 1945. The cost of maintaining and operating the two systems is apportioned among the cities and towns in the two districts on the basis of population as determined by a census made at five-year intervals.

Problems Resulting From Use of Present Method

The present methods worked in a generally satisfactory manner until recently. The migration of population from the older center core cities of the districts to the suburban areas made necessary the construction of long sewer extensions. These extensions are urgently needed by the outlying municipalities but are of little or no value to the older members of the district.

In addition, the expansion of the sewerage systems has made some of the older trunk sewers inadequate, thus necessitating the construction of relief sewers. Furthermore, the necessity for treating the sewage from the two Metropolitan Sewerage Districts is resulting in new expenditures that will be several times in excess of all of the money that has been invested in the Metropolitan Sewerage Systems since their inception.

Finally, the passage of Chapter 645 of the Acts of 1951 authorized a program of sewage treatment which provided that the Boston Main Drainage System, heretofore an independent sewerage system, be considered a part of the South Metropolitan Sewerage System, but that the sewage would be treated at the proposed Deer Island Sewage Treatment Plant which would serve the North Metropolitan Sewerage District. All of the sewage which was tributary to the Ward Street Pumping Station and heretofore pumped into the South Metropolitan Sewerage System would be discharged by gravity in a tunnel under Boston Harbor, together with the sewage from the Boston Main Drainage System, to the proposed Deer Island Treatment Plant. With the completion of this program for sewage treatment, the present methods of determining assessments will become so complicated that all kinds of inequities appear inevitable.

ASSESSMENT METHODS STUDIED

A number of methods were reviewed that could be used for apportioning the assessments of construction costs. Many of the methods were quickly discarded because they were impracticable or did not compensate for the service rendered. The methods that were studied in detail included:

(1) The continued use of municipal valuations.

(2) The number of persons benefited.

(3) The volume of sewage from each municipality. We believe this method is impracticable because of the number of interconnections between the various trunk sewers in the Metropolitan District; and further, because of the large number of municipal connections, approximately 770, to the Metropolitan Systems. In addition, some of the Metropolitan sewers serve as trunk sewers within individual communities. This conclusion was reached after extensive surveys by the engineering consultant and intensive study by the Commission. However, it was only one of the methods under examination.

(4) Measuring the volume of sewage on the basis of the water consumption records of individual municipalities is a yardstick frequently used because of its simplicity. Water consumption is measured in all the municipalities in the Metropolitan sewerage areas.

(5) Apportioning the costs on the relationship between the availability of the Metropolitan District Sewerage System to the capacity of the municipal systems discharging into the main system. This approach is comparable to that often used by public utilities in determining rates.

In making this study, data for the year 1955 were used, as it was a census year, and as the data were readily available it was felt that the results would be representative. From the best information available, the amount of construction work to be financed under the present authorized program totaled $68,394,000.

The above figure was used in making this study. However, these sums were authorized in legislation passed a number of years ago, so detailed engineering studies plus the continuous increase in construction costs will undoubtedly place the cost of the program about 50 per cent higher.

It was felt that no matter which method of assessment is ultimately adopted, the two sewerage districts should be combined into a single district, or there must be a more realistic realignment of the membership of the North and South Districts. When the program is completed, sewage from the cities of Boston and Newton and the towns of Milton and Brookline will be treated at both sewage treatment plants, thus making it necessary to arbitrarily divide up these municipalities in order to determine the correct assessments.

The engineering study was directed primarily to developing a method to measure the proportionate service that is rendered by the Metropolitan Sewerage Districts to each member municipality.

Continued Use of Valuations Adopted by the Legislature for State Tax Purposes

The valuations now in use for state tax purposes were adopted by the Legislature in 1945. They are not representative of the present valuations of properties in the Metropolitan area, as the fringe areas of the Metropolitan District have greatly increased in valuation with the outflow of population from the older densely populated urban areas. This is readily recognized by any one familiar with the tax problem, and as a result a Special Commission appointed by the Legislature, on Equalization and Apportionment, in a report published as House Document No. 3286 and dated July, 1956, proposed new valuations for all cities and towns in the Commonwealth. The new valuations have not been adopted by the Legislature, and at the moment it looks very doubtful that they will be, due to the fact that so many assistance programs are now dependent upon the state valuations. Table I shows what the assessments would be to the individual cities and towns to finance the present construction program if the 1945 valuations were used. Computations have been made for continuing separate South and North Sewerage Systems as now established by existing legislation or using the valuation method for a combined Metropolitan System.

Further studies were made of the use of valuation figures, with the idea that there would be a new alignment of the members of the North and South Metropolitan Sewerage Districts in that if sewage from a municipality were treated at the Deer Island Treatment Plant it would be considered in the North Metropolitan Sewerage District, and if it were treated at the Nut Island Sewage Treatment Plant it would be considered in the South Metropolitan Sewerage District. Table II shows what the effect would be, again using the 1945 valuations, maintaining separate North and South Districts or a combined Metropolitan Sewerage District.

Determination of Assessments by Sewage Flows

There are some Metropolitan areas or sewer districts in the United States which have been able to apportion the cost of construction upon the volume of sewage to be treated from each municipality. However, in the case of the Metropolitan Sewerage Systems, this method is impracticable because of the number of interconnections between the various trunk sewers in the Metropolitan System, plus the fact that some of the large diameter sewers are used as storage basins under certain tidal conditions. Furthermore, many of the Metropolitan sewers serve as trunk sewers within the individual municipalities. There are approximately 770 such municipal connections, which would make the problem of measuring sewage flows extremely difficult, if not impossible.

Determination of Assessments by Utilizing Water Consumption

In many metropolitan sewerage systems, or in individual municipalities where it is impracticable to measure sewage flows, the apportionment of costs is frequently based upon the water consumption of the individual municipalities. The water consumption is measured in all of the municipalities in the Metropolitan Sewerage Districts and records are readily available.

A study was made of the relationship between the volume of sewage treated at the Nut Island Sewage Treatment Plant serving the South Metropolitan Sewerage District and the water consumption for the member municipalities of the district contributing sewage to that plant for the year 1955. This relationship is shown in Table III and is illustrated in Figure No. 1.

Table IV shows what the assessments would be if there was a new alignment in the towns of the North and South Sewerage Districts, basings these assessments either upon water consumption, popu-

TABLE I.—MDC STUDY BASED ON PRESENT METHOD OF ASSESSMENT AND EXISTING ENABLING LEGISLATION

	1945 Valuations						
	South Metropolitan		North Metropolitan			Combined Metropolitan	
Municipality	Per Cent	Amt.[1]	Per Cent	Amt.[1]	Total Amt.[1]	Per Cent	Amt.[1]
Arlington	—	—	5.87	$1,041	$1,041	1.85	$1,265
Belmont	—	—	5.38	955	955	1.69	1,156
Boston	57.31	$29,029	7.93	1,407	30,436	41.82	28,602
Braintree	1.36	689	—	—	689	.93	636
Brookline	6.98	3,536	—	—	3,536	4.80	3,283
Cambridge	—	—	17.48	3,101	3,101	5.48	3,748
Canton	.43	218	—	—	218	.29	198
Chelsea	—	—	4.31	765	765	1.36	930
Dedham	1.24	628	—	—	628	.84	575
Everett	—	—	8.18	1,451	1,451	2.57	1,758
Framingham	1.70	861	—	—	861	1.16	793
Hingham (North District)	.38	192	—	—	192	.26	178
Lexington	—	—	2.44	433	433	.76	520
Malden	—	—	7.15	1,269	1,269	2.25	1,539
Medford	—	—	8.04	1,426	1,426	2.52	1,724
Melrose	—	—	4.07	722	722	1.28	875
Milton	1.90	962	—	—	962	1.31	896
Natick	.96	486	—	—	486	.65	445
Needham	1.29	653	—	—	653	.88	602
Newton	7.71	3,905	—	—	3,905	5.29	3,618
Norwood	1.31	664	—	—	664	.89	609
Quincy	6.15	3,115	—	—	3,115	4.23	2,893
Randolph	.36	182	—	—	182	.24	164
Reading	—	—	1.84	326	326	.58	397
Revere	—	—	3.90	692	692	1.22	834
Somerville	—	—	11.39	2,021	2,021	3.57	2,442
Stoneham	—	—	1.52	270	270	.48	328
Stoughton	.44	223	—	—	223	.30	205
Wakefield	—	—	2.32	412	412	.72	492
Walpole	.82	415	—	—	415	.56	383
Waltham	2.63	1,332	—	—	1,332	1.81	1,238
Watertown	2.51	1,271	—	—	1,271	1.73	1,183
Wellesley	2.10	1,064	—	—	1,064	1.45	992
Weymouth	2.42	1,226	—	—	1,226	1.67	1,142
Winchester	—	—	3.51	623	623	1.10	752
Winthrop	—	—	2.47	438	438	.77	527
Woburn	—	—	2.20	390	390	.69	472
Totals	—	$50,652	—	$17,742	$68,394	—	$68,394

[1] Amounts shown are in thousands of dollars.

TABLE II.—MDC STUDY, NEW ALIGNMENT OF NORTH AND SOUTH DISTRICTS

	Based on 1945 Assessed Valuations						
	South Metropolitan		North Metropolitan			Combined Metropolitan	
Municipality	Per Cent	Amt.[1]	Per Cent	Amt.[1]	Total Amt.[1]	Per Cent	Amt.[1]
Arlington	—	—	2.58	$1,367	$1,367	1.85	$1,265
Belmont	—	—	2.34	1,240	1,240	1.69	1,156
Boston	20.21	$3,115	50.26	26,629	29,744	41.82	28,602
Braintree	3.31	510	—	—	510	.93	636
Brookline	14.53	2,239	1.00	530	2,769	4.80	3,283
Cambridge	—	—	7.62	4,037	4,037	5.48	3,748
Canton	1.05	162	—	—	162	.29	198
Chelsea	—	—	1.87	991	991	1.36	930
Dedham	3.02	465	—	—	465	.84	575
Everett	—	—	3.57	1,891	1,891	2.57	1,758
Framingham	4.15	640	—	—	640	1.16	793
Hingham (North District)	.93	143	—	—	143	.26	178
Lexington	—	—	1.06	562	562	.76	520
Malden	—	—	3.12	1,653	1,653	2.25	1,539
Medford	—	—	3.51	1,860	1,860	2.52	1,724
Melrose	—	—	1.77	938	938	1.28	875
Milton	4.63	714	—	—	714	1.31	896
Natick	2.33	359	—	—	359	.65	445
Needham	3.14	484	—	—	484	.88	602
Newton	9.43	1,453	3.68	1,950	3,403	5.29	3,618
Norwood	3.20	493	—	—	493	.89	609
Quincy	15.03	2,316	—	—	2,316	4.23	2,893
Randolph	.87	134	—	—	134	.24	164
Reading	—	—	.80	424	424	.58	397
Revere	—	—	1.70	901	901	1.22	834
Somerville	—	—	4.97	2,633	2,633	3.57	2,442
Stoneham	—	—	.66	350	350	.48	328
Stoughton	1.09	168	—	—	168	.30	205
Wakefield	—	—	1.01	535	535	.72	492
Walpole	2.02	311	—	—	311	.56	383
Waltham	—	—	2.52	1,335	1,335	1.81	1,238
Watertown	—	—	2.39	1,266	1,266	1.73	1,183
Wellesley	5.13	791	—	—	791	1.45	992
Weymouth	5.93	914	—	—	914	1.67	1,142
Winchester	—	—	1.53	811	811	1.10	752
Winthrop	—	—	1.08	572	572	.77	527
Woburn	—	—	.96	509	509	.69	472
Totals	—	$15,411	—	$52,983	$68,394	—	$68,394

[1] Amounts shown are in thousands of dollars.

TABLE III.—RELATIONSHIP BETWEEN WATER AND SEWAGE FLOWS FOR THE SOUTH METROPOLITAN SEWERAGE DISTRICT, YEAR 1955
(Figures in parentheses give the relationship to the average daily flow)

	Water M.G.D.	Sewage M.G.D.	Ratio of Water to Sewage Flows
Average daily	88.586	120.91	1: 1.36
Daily flow for maximum week	121.389 (1.37)	186.76 (1.54)	1: 1.54
Daily flow for maximum month	105.241 (1.19)	151.77 (1.25)	1: 1.43
Average daily for June, July & Aug.	99.325 (1.12)	104.24 (0.86)	1: 1.05

lation or a combination of 50 per cent population and 50 per cent water consumption.

BASING ASSESSMENTS UPON ABILITY OF THE METROPOLITAN DISTRICT SEWERAGE SYSTEM TO SERVE MEMBER MUNICIPALITIES

This method apportions the construction costs on the relationship between the adequacy of the Metropolitan Sewerage System to serve the capacity of the municipal sewer connections discharging into the Metropolitan System. This method is comparative to that often used by public utilities in determining rates, for it is predicated on the ability to serve. Before a municipal connection can be made to the Metropolitan Sewerage System, the size, capacity and other engineering details must be approved by the Metropolitan District Commission. Thus it is possible to determine the capacity of the municipal connections. In a similar manner, the capacity of the metropolitan trunk sewers can be determined reasonably accurately by engineering studies. If the Metropolitan Sewerage System could take care of the entire capacity of the municipal connections, the municipality would pay for the total capacity of its connections. In the event that the Metropolitan Sewerage System is not capable of handling the full capacity from the municipal connections, the municipality would then be required to pay for only that portion that could be handled by the Metropolitan Sewerage System.

In order to use this method there must be a realignment of the present North and South Sewerage Districts on the basis that if the sewage from a municipality is flowing to the Nut Island Sewage Treatment Plant the city or town would be considered in the South District, and if the sewage is discharged to the Deer Island Sewage Treatment Plant it would be considered in the North District. In cases where a municipality has sewage discharging into both plants, the amount discharged to each plant would be determined and the assessment proportioned to each district.

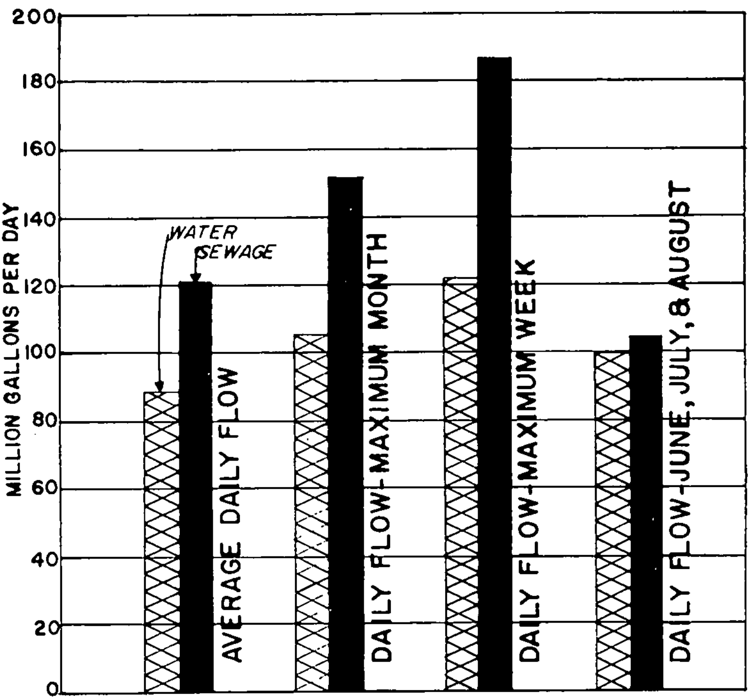

FIGURE 1.—COMPARISON OF SEWAGE FLOWS AND WATER CONSUMPTION. SOUTH METROPOLITAN SEWERAGE SYSTEM YEAR ENDING DECEMBER 31, 1955.

It was not possible in the course of this study to make detailed engineering studies of the capacities of the Metropolitan sewers or of the capacity of each of the municipal connections. However, for the purpose of the study to determine the practicability of the method, the capacity of the municipal connections was based upon the assumption that the sewage in the sewer was flowing at a velocity of two feet per second when flowing full. In some cases individual houses

TABLE IV.—MDC STUDY, NEW ALIGNMENT OF NORTH AND SOUTH DISTRICTS

Municipality	Based on 1955 Population			Based on Water Consumption			Based on Fifty Per Cent Population and Fifty Per Cent Water Consumption		
	South Metropolitan (Per Cent)	North Metropolitan (Per Cent)	Combined Metropolitan (Per Cent)	South Metropolitan (Per Cent)	North Metropolitan (Per Cent)	Combined Metropolitan (Per Cent)	South Metropolitan (Per Cent)	North Metropolitan (Per Cent)	Combined Metropolitan (Per Cent)
Arlington	—	3.39	2.33	—	1.94	1.40	—	2.67	1.87
Belmont	—	2.07	1.43	—	1.14	.82	—	1.61	1.13
Boston	25.77	40.46	35.88	38.12	50.16	46.79	31.95	45.31	41.34
Braintree	4.24	—	1.32	3.02	—	.84	3.63	—	1.08
Brookline	7.68	.61	2.82	6.74	.46	2.22	7.21	.54	2.52
Cambridge	—	7.12	4.90	—	10.20	7.35	—	8.66	6.13
Canton	1.61	—	.50	1.59	—	.44	1.60	—	.47
Chelsea	—	2.65	1.82	—	2.08	1.50	—	2.37	1.66
Dedham	3.41	—	1.06	1.55	—	.43	2.48	—	.75
Everett	—	3.24	2.23	—	4.53	3.26	—	3.89	2.75
Framingham	5.02	—	1.57	5.10	—	1.43	5.06	—	1.50
Hingham (North District)	.88	—	.27	1.14	—	.32	1.01	—	.30
Lexington	—	1.60	1.10	—	1.52	1.09	—	1.56	1.10
Malden	—	4.28	2.95	—	3.06	2.20	—	3.67	2.58
Medford	—	4.70	3.24	—	2.93	2.11	—	3.82	2.68
Melrose	—	2.10	1.45	—	1.10	.79	—	1.60	1.12
Milton	3.82	—	1.19	2.40	—	.67	3.11	—	.93
Natick	4.16	—	1.30	4.11	—	1.15	4.14	—	1.23

TABLE IV (*Continued*)

Municipality	Based on 1955 Population			Based on Water Consumption			Based on Fifty Per Cent Population and Fifty Per Cent Water Consumption		
	South Metro-politan (Per Cent)	North Metro-politan (Per Cent)	Combined Metro-politan (Per Cent)	South Metro-politan (Per Cent)	North Metro-politan (Per Cent)	Combined Metro-politan (Per Cent)	South Metro-politan (Per Cent)	North Metro-politan (Per Cent)	Combined Metro-politan (Per Cent)
Needham	3.42	—	1.07	2.99	—	.84	3.21	—	.96
Newton	6.87	3.11	4.28	6.25	2.43	3.50	6.56	2.7	3.89
Norwood	3.34	—	1.04	3.54	—	.99	3.44	—	1.02
Quincy	13.42	—	4.18	10.74	—	3.00	12.08	—	3.59
Randolph	2.15	—	.67	1.38	—	.39	1.77	—	.53
Reading	—	1.18	.81	—	.65	.47	—	.92	.64
Revere	—	2.85	1.96	—	1.78	1.28	—	2.32	1.62
Somerville	—	6.98	4.80	—	5.61	4.04	—	6.30	4.42
Stoneham	—	1.14	.78	—	.91	.66	—	1.03	.72
Stoughton	2.18	—	.68	1.72	—	.48	1.95	—	.58
Wakefield	—	1.59	1.09	—	.87	.63	—	1.23	.86
Walpole	1.79	—	.56	2.38	—	.67	2.09	—	.62
Waltham	—	3.61	2.48	—	3.02	2.18	—	3.32	2.33
Watertown	—	2.80	1.93	—	2.00	1.44	—	2.40	1.69
Wellesley	3.45	—	1.08	3.26	—	.91	3.36	—	1.00
Weymouth	6.79	—	2.12	3.96	—	1.11	5.38	—	1.62
Winchester	—	1.30	.89	—	.92	.66	—	1.11	.78
Winthrop	—	1.35	.93	—	1.08	.78	—	1.22	.86
Woburn	—	1.86	1.28	—	1.63	1.17	—	1.75	1.23

had been connected directly to the Metropolitan trunk sewers. These were not considered in this study as their effect would be minute.

The capacity of the trunk sewers and the capacity of the municipal connections to these trunk sewers would be determined by the Metropolitan District Commission. The Metropolitan District Commission would then compute the proportionate share that each member has in the capacity of the Metropolitan District Sewerage System, thus determining the member's assessment. After the initial determination of the proporionate share of each member, the assessment would be recomputed after any change in the capacity of the Metropolitan District Sewerage System, or in the capacity of the municipal sewer connections to the Metropolitan District Commission System. The redetermination of assessments should be made at least once in every five years if any changes occur in that period, but not oftener than once in a fiscal year.

The principle involved for this method would be that the annual assessments to meet the cost of Metropolitan District sewer construction which is a benefit to the system as a whole should be figured in proportion to the adequacy of the Metropolitan Sewerage System to serve the capacity of the municipal sewer connections.

If the Metropolitan sewer is large enough to take the full flow of the city or town sewer, the city or town would be charged for the full capacity of its sewer connections. If, on the other hand, the Metropolitan sewer were not adequate, the city or town would be charged only for the proportionate capacity available. Thus, as we have pointed out, payment would be based solely on the basis of service rendered.

A Simple Example of How the Method Works

To illustrate how this principle might be applied, assume that at the end of a Metropolitan District sewer farthest from the treatment plant there are four towns—A, B, C and D—each with one connection to the Metropolitan District sewer, as illustrated in Figure No. 2.

Town A has a municipal connection capable of delivering 20 M.G.D. (million gallons daily); and towns B, C and D have connections which are capable of delivering 10 M.G.D.

At the point where town A is connected to the Metropolitan sewer, the capacity of the latter sewer is 20 M.G.D. or just large enough to meet the requirements of the town connection.

At the point where town B is connected to the Metropolitan sewer, the capacity of the latter sewer is 30 M.G.D., hence large enough to meet the needs of both towns A and B.

At the point where town C connects with the Metropolitan sewer, the latter sewer has a capacity of only 30 M.G.D.—and the total of the three town connections is 40 M.G.D.

It is clear that if we are considering towns A and B alone, we would base our calculations on the size of the individual connections, since the Metropolitan sewer is large enough to accommodate the full discharge of both town connections. If we were apportioning costs at this point, according to the principle recommended by the Com-

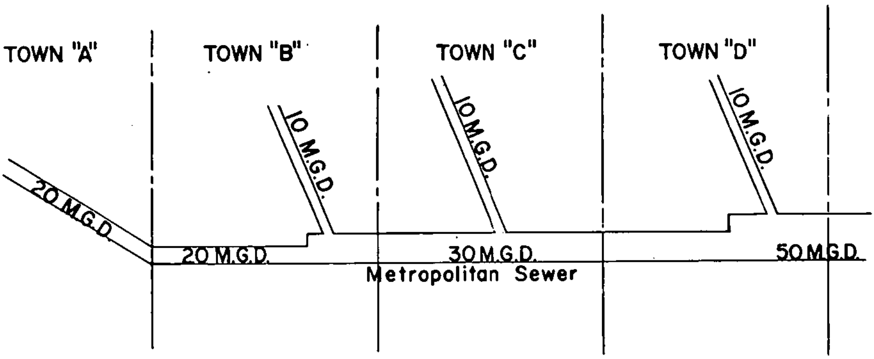

FIGURE 2.—SKETCH SHOWING MUNICIPAL CONNECTIONS TO METROPOLITAN SEWER.

mission, the cost would be divided into thirds and town A would pay two thirds and town B one third.

There is a problem, however, at the point where town C connects with the Metropolitan sewer. The capacity of the Metropolitan sewer is only 30 M.G.D., theoretically completely utilized by the capacities of towns A and B. Obviously, the Metropolitan sewer cannot take 30 M.G.D. from towns A and B, plus 10 M.G.D. from town C, a total of 40 M.G.D., or 33-1/3 per cent more than the rated capacity of the Metropolitan sewer.

Since it is not practicable to assume that no sewage can flow into the Metropolitan sewer from town C, the only alternative is to assume that the Metropolitan sewer can carry 30 M.G.D. divided among the three towns in proportion to the capacities of their connections.

On this basis it is calculated (see Table V) that the Metropolitan sewer can take only 15 M.G.D. from town A (three quarters of 20 M.G.D.) and 7.5 M.G.D. from towns B and C, respectively. Hence, in apportioning costs for the three town connections, town A would be charged with 15 M.G.D. instead of 20 M.G.D., and towns B and C charged with 7.5 M.G.D. instead of 10 M.G.D.

TABLE V.—APPORTIONMENT OF SEWER CAPACITY (HYPOTHETICAL ILLUSTRATION)

	Capacity of Sewers (Million Gallons Daily)		Apportionment on Basis of Available MDC Capacity	
	Local	MDC	Per Cent	M.G.D.
Point 1:				
Town A	20	20	100	20
Point 2:				
Town A	20		66.67	20
Town B	10		33.33	10
Sub-total	30	30	100.00	
Point 3:				
Town A	20		50	15.00
Town B	10		25	7.50
Town C	10		25	7.50
Sub-total	40	30	100	30.00
Point 4:				
Town A	15.00[1]		37.50	15.00
Town B	7.50[1]		18.75	7.50
Town C	7.50[1]		18.75	7.50
Town D	10.00		25.00	10.00
Total	40.00	50	100.00	40.00

[1] Adjusted capacity from previous compilation.

At this point where town D is connected to the Metropolitan sewer the capacity of the latter is 50 M.G.D. Analysis shows that at this point there is a potential flow (see Table V) of 30 M.G.D. from towns A, B and C, plus 10 M.G.D. from town D, or a total of 40 M.G.D. Town D would be charged for its 10 M.G.D. which, at that point, the Metropolitan sewer has capacity to handle.

Advantages of Method of Using Sewer Capacities for Assessment Purposes

As detailed studies were made using this method of making assessments for construction cost, many inequalities that have cropped up using the present method of making assessments were automatically compensated for. The advantages could be summarized as follows:

1. A downstream municipality would not be required to pay for the upstream extensions or relief sewers which would not benefit them.
2. Each municipality would pay in proportion to the ability of the Metropolitan District Commission to serve them.
3. The basis of assessment would be determined technically instead of arbitrarily or politically as at present under the present valuation methods.
4. Municipalities having combined sewers (designed to carry domestic sewage and surface drainage) would rightfully pay a larger share because of greater flows requiring treatment.
5. Municipalities using the Metropolitan District Commission trunk sewers as local collecting sewers instead of maintaining their own sewers would inevitably pay a larger share.

Example of How Method Works

When the Metropolitan Sewerage System was extended to serve Natick and Framingham it was planned that a so-called Neponset Relief Sewer would be constructed. This was needed in order to prevent the discharge of sewage into the Charles River.

In order to determine how this "Capacity Method" would work in the construction of the relief sewer, a study was made of the effect that the proposed so-called Neponset Relief sewer would have upon the determination of assessments under this method and who would pay for the sewer.

Figure No. 3 shows how the Metropolitan District sewers are presently serving the towns of Framingham, Natick, Dedham, Needham and portions of Brookline and Newton, and portions of the Hyde Park and West Roxbury sections of the city of Boston, as well as the effect of the construction of the so-called Neponset Relief sewer upon these same areas.

Table VI is a comparison of how the Neponset Relief sewer affects these communities and the amount that would be assessed against each of these communities for the construction of this relief sewer.

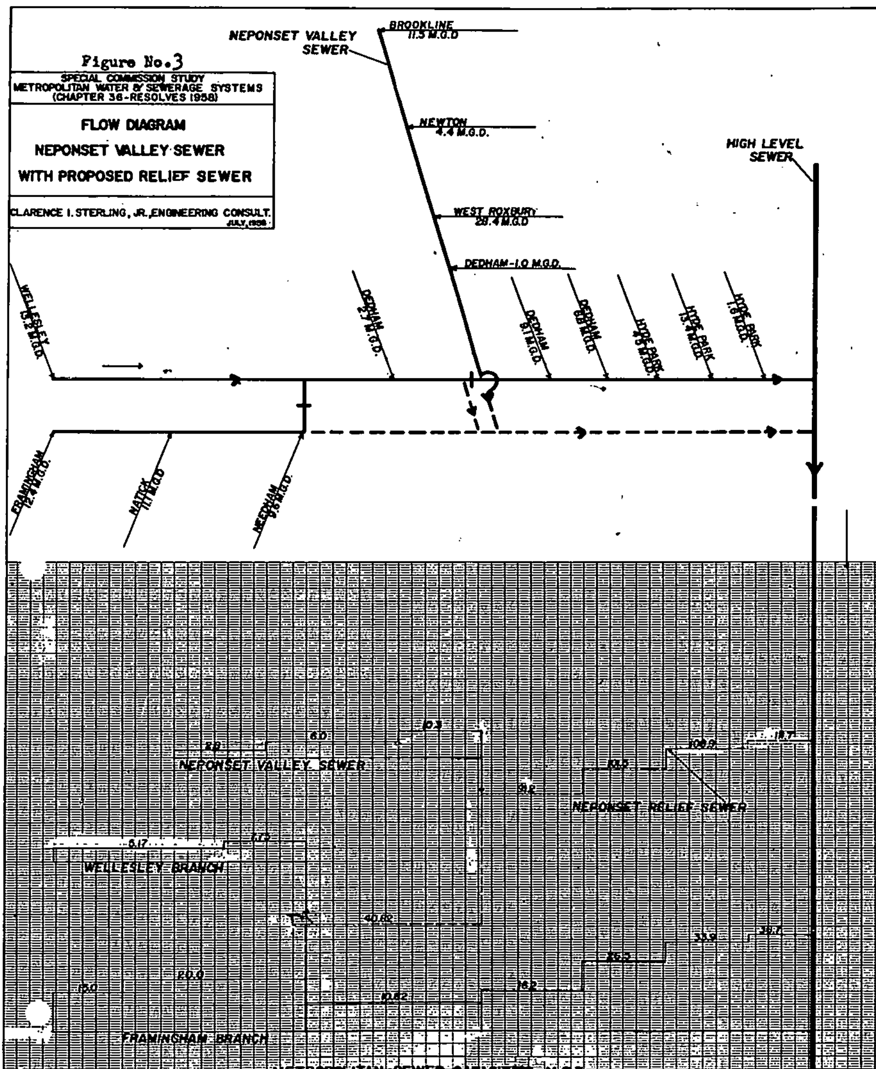

FIGURE 3.

Table VII shows what the cost of the Neponset Relief sewer would be to the various municipalities using two different methods:

1. Based upon the benefits that each municipality received from increased sewer capacity.

2. Based upon the 1945 valuations with the existing South Metropolitan District grouping and under existing laws.

TABLE VI.—ESTIMATED ASSESSMENTS FOR NEPONSET RELIEF SEWER

Municipality	Adjusted Capacity Before Relief Sewer (M.G.D.)	Adjusted Capacity With Relief Sewer (M.G.D.)	Benefits M.G.D.	Benefits Per Cent	Assessed Amount
Framingham	1.6	10.55	8.95	20.18	$1,413,000
Natick	1.4	9.45	8.05	18.14	1,270,000
Wellesley	.4	5.17	4.77	10.75	752,000
Needham	.8	9.6	8.8	19.83	1,388,000
Dedham	11.6	19.6	8.0	18.03	1,262,000
Brookline	.2	.4	.2	.45	31,000
Newton	.3	.6	.3	.68	48,000
West Roxbury	2.5	5.0	2.5	5.63	394,000
Hyde Park	16.7	19.5	2.8	6.31	442,000
Totals	35.5	79.87	44.37	100.00	$7,000,000

The Special Commission, after a number of meetings, then recommended the adoption of legislation for a single district and apportioning the cost of bond and interest payments for capital expenditures upon available sewer capacities. These assessments are shown in Table VIII.

This recommendation was adopted by the Legislature with the passage of Chapter 612 of the Acts of 1959. The act provides that:

(1) There will be a single metropolitan sewerage district.

(2) The assessment for capital expenditures will be based on metropolitan sewer capacities available to each member community with the initial apportionment being the same as shown in Table VIII. These assessments shall be revised whenever there is a major change in the metropolitan sewerage system and reviewed at least every five years by the district.

(3) Maintenance and operation costs would be apportioned in accordance with population of the member municipalities.

TABLE VII.—MDC STUDY—COMPARISON OF VARIOUS METHODS FOR APPORTIONING ASSESSMENTS FOR NEPONSET RELIEF SEWER. ESTIMATED COST, $7,000,000 (Chapter 36, Resolves of 1958)

Municipality	Based on Sewer Capacity		Based on Assessed Valuations Present South Metropolitan District Grouping 1945 Valuations	
	Per Cent	Amount	Per Cent	Amount
Boston	11.94	$836,000	57.31	$4,011,700
Braintree	—	—	1.36	95,200
Brookline	.45	31,000	6.98	488,600
Canton	—	—	.43	30,100
Dedham	18.03	1,262,000	1.24	86,800
Framingham	20.18	1,413,000	1.70	119,000
Hingham (North District)	—	—	.38	26,600
Milton	—	—	1.90	133,000
Natick	18.14	1,270,000	.96	67,200
Needham	19.83	1,388,000	1.29	90,300
Newton	.68	48,000	7.71	539,700
Norwood	—	—	1.31	91,700
Quincy	—	—	6.15	430,500
Randolph	—	—	.36	25,200
Stoughton	—	—	.44	30,800
Walpole	—	—	.82	57,400
Waltham	—	—	2.63	184,100
Watertown	—	—	2.51	175,700
Wellesley	10.75	752,000	2.10	147,000
Weymouth	—	—	2.42	169,400
Totals	100.00	$7,000,000	100.00	$7,000,000

(4) Principal and interest payments on new construction after January 1, 1960, shall be apportioned among the benefited municipalities in proportion to the additional capacity made available to them.

(5) On or before October 1st of each year the Metropolitan District Commission shall notify the officers of the member communities as to the financial status of the District and the proposals for the next fiscal year in regard to improvements and new construction.

(6) On or before November 1st, the Metropolitan District Commission shall hold a public hearing on the subject of proposed improvements for the sewerage system.

TABLE VIII.—RECOMMENDED APPORTIONMENT OF CHARGES FOR DEBT SERVICE Based on Available M.D.C. Sewer Capacities for Single Metropolitan District

Cities and Towns	Per Cent	Cities and Towns	Per Cent
Arlington	1.85	Norwood	0.81
Belmont	1.18	Quincy	5.47
Boston	36.18	Randolph	0.62
Braintree	1.59	Reading	0.47
Brookline	3.42	Revere	1.16
Cambridge	8.71	Somerville	2.51
Canton	0.42	Stoneham	0.91
Chelsea	2.91	Stoughton	0.17
Dedham	1.42	Wakefield	0.40
Everett	1.14	Walpole	0.26
Framingham	0.16	Waltham	1.33
Hingham (No. Dist.)	0.43	Watertown	1.21
Lexington	0.23	Wellesley	0.04
Malden	1.26	Westwood	0.78
Medford	4.38	Weymouth	1.22
Melrose	0.46	Wilmington	0.56
Milton	4.74	Winchester	2.99
Natick	0.14	Winthrop	0.99
Needham	0.08	Woburn	1.66
Newton	5.74		
		Total	100.00

(7) No change in the rates of apportionment for debt service and interest costs shall be approved by the Commission until the schedule has been submitted to the member municipalities and the Commission has held a public hearing.

(8) The assessments upon the towns of Westwood and Wilmington and the Boston Main Drainage District would be deferred until such time as the Metropolitan Sewerage System is made available to serve those areas.

SUMMARY

This is an attempt to equitably apportion the cost of the expansion of the Metropolitan Sewerage System to fit in with the changing pattern in the development of the Boston Metropolitan area. It is also an attempt to determine assessments by engineering methods. It is realized that it is practically impossible to devise the perfect method of making assessments. This method, however, does have an added advantage of minimizing the political factors in the determination of assessments.

DESIGN PLANNING FOR THE THIN SHELL CONCRETE ROOF OF THE INTELEX POST OFFICE

By Robert L. Pare*

(Presented at a meeting of the Structural Section, B.S.C.E., held on February 10, 1960.)

The thin shell roof of the Intelex Systems Post Office in Providence, Rhode Island was developed to produce a functional structure of striking architectural appearance. The building is to house the nation's first fully mechanized post office. It was the desire of Intelex Systems Incorporated to express this revolutionary concept of mail handling by enclosing the electronically controlled equipment in a building as completely modern as the equipment itself.

Functional requirements determined that the building must provide:

1. A floor area 420 feet long by 300 feet wide with a minimum of obstructions,
2. Minimum clear height of 26 feet except for an area over the control tower where 50 or more feet is required,
3. Areas above the 26-foot level to be free of obstructions for the installation of conveyors,
4. Areas around the exterior of the building to be clear for truck and rail docks,
5. The cost of the structure must be economically justifiable.

The late Frederick H. Paulson, partner in the firm of Charles A. Maguire & Associates, met the challenge of these requirements by planning a building with a roof of intersecting barrels of thin shell concrete. This plan called for two longitudinal barrels each 150 feet wide by 420 feet in length and three transverse barrels each 140 feet wide by 300 feet in length. The inspiration for this design came from The Mulhouse Hall of Sports Building which Mr. Paulson observed in Europe. However, the Hall of Sports Building consisted of only two intersecting barrels. Another example of a design in many ways similar to the Post Office roof is the St. Louis Terminal Building.

* Associate, Charles A. Maguire & Associates, Engineers, Providence, R. I.

Upon completion of the basic sketches, a feasibility study was prepared. In this the ASCE pamphlet No. 31 on thin shells was found to be invaluable. A very idealized section of the shell was taken for study. From this study it was apparent that the structure was practical both from a construction and cost point of view. It was decided therefore that this structure should be proposed to Intelex Systems Incorporated.

A rendering was prepared and submitted, together with supporting data. The design was approved by both Intelex Systems Incorporated and the Post Office Department, and Mr. Paulson was instructed to proceed with the final design.

At this time, time itself became one of the biggest problems facing the designers. The construction schedule imposed by Intelex Systems Incorporated called for the design to be started in late January 1959, piles to be driven for the foundations starting in February, the design of the roof to be complete in June, erection of the roof forms to start in May, and the building to be complete by June 1960.

From the data accumulated in making the feasibility study, it was possible to generally size the shell and estimate loads to the foundations. This was a tremendous asset in that it meant the foundations could be designed with an added factor of safety for unknowns and the pile driving start on schedule. The analysis of the roof in such a short time was quite another problem, however, and some means other than a pure mathematical analysis had to be employed.

The solution to the analysis problem was proposed by the consulting group of Professors Hanson, Holley and Biggs of M.I.T., who were approached to assist in the design of the roof. It was suggested that the shell be analyzed partially by a mathematical approach and partially through model studies. This suggestion was accepted and design conferences immediately instituted.

It was decided at an early conference on the roof design with the M.I.T. consultants that simplification of design and construction could be achieved and the overall progress accelerated if the roof could be divided into six equal parts. This was done by introducing a 2-inch expansion joint longitudinally down the center of the roof and transversely at third points. The six segments were then made independent by placing a column at the corners of each shell. The only connection of the separated segments is at the base of the columns.

When first considering a shell roof it was thought that the thrusts at the corners of the shell could be resisted by flying buttresses or by developing resistance within the building walls. However, due to the location of truck docks and openings in the walls for conveyors, it became apparent that this was impractical. Ties, therefore, became a necessity. To keep movement due to shrinkage, expansion, snow and live load within reasonable limits, a tie section of sufficient size to limit tie stresses to a maximum of 12,000 pounds per square inch was developed.

The columns were designed to carry the vertical loads axially and to resist horizontal and side sway loads as cantilevers fixed at the base. An attempt was made to design the columns fixed both to the shell and the foundation, but was abandoned as the interaction of shell and column was found to cause excessive stresses in the columns. It was determined that an allowable horizontal movement at the tops of the columns of one inch would be permissible without undue stress in the columns. This permitted a tie cross section of 52 square inches. If the columns had been fixed at the shell and base, the ties would have had to be nearly four times as large. Due to the length of the ties in comparison to the length of the columns, the economic solution was to have heavy columns and relatively light ties.

The supporting structure at the top of the columns presented a very interesting problem. The St. Louis Terminal Building was studied to determine if the solution used there would be applicable to the Post Office shell. At St. Louis a floor framed into the columns immediately below the intersection of thrust line of the shell with the thrust line of the column, figure 1. This provided a built-in tie with very little stretch. As the bays were square, it was permissible to establish a pin through the intersection of the thrust lines on the line of the diagonals. All that remained was to tie the columns into the intersecting floor and design the column for the resulting shears and moments.

This was an excellent solution for the St. Louis shell, but was not applicable to the Post Office roof (figure 2) for two reasons; (1) the bays were rectangular, inducing rotations on a vertical plane or planes not necessarily concurrent with the diagonals, and (2) the thrusts from the shell were so large that a tie placed on the columns would induce excessively large amounts in the columns. The solution to this problem appeared to be, to so locate the ties and col-

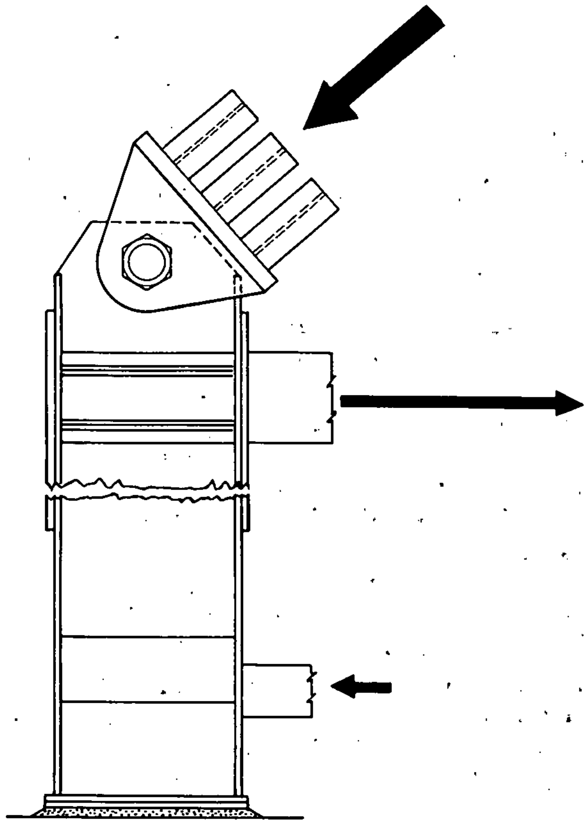

FIGURE 1.

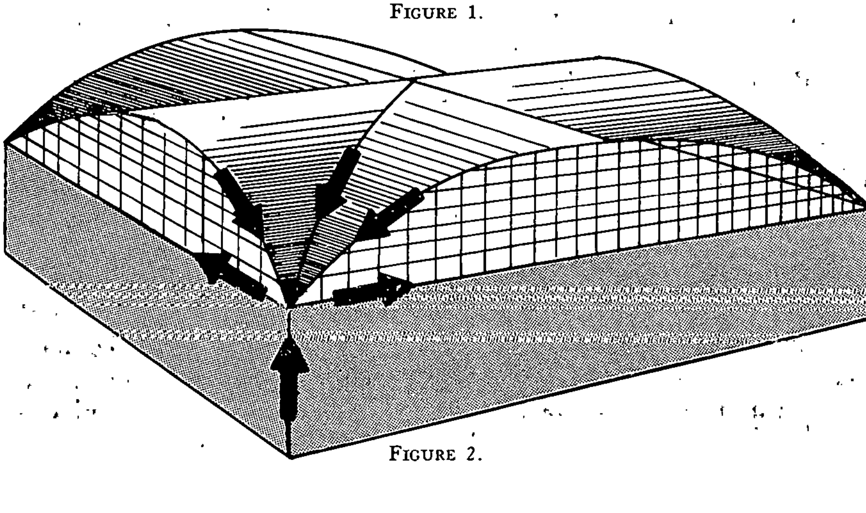

FIGURE 2.

umns that all thrust lines must pass through a theoretical point thus producing a concurrent force system.

The implementation of this simple idea was full of complications. The columns were designed with rounded tops to eliminate any resistance to shell rotation and to fix the vertical thrust line to within one inch of the center line of the columns. The thrust line from the shell was determined as accurately as possible, using both the mathematical

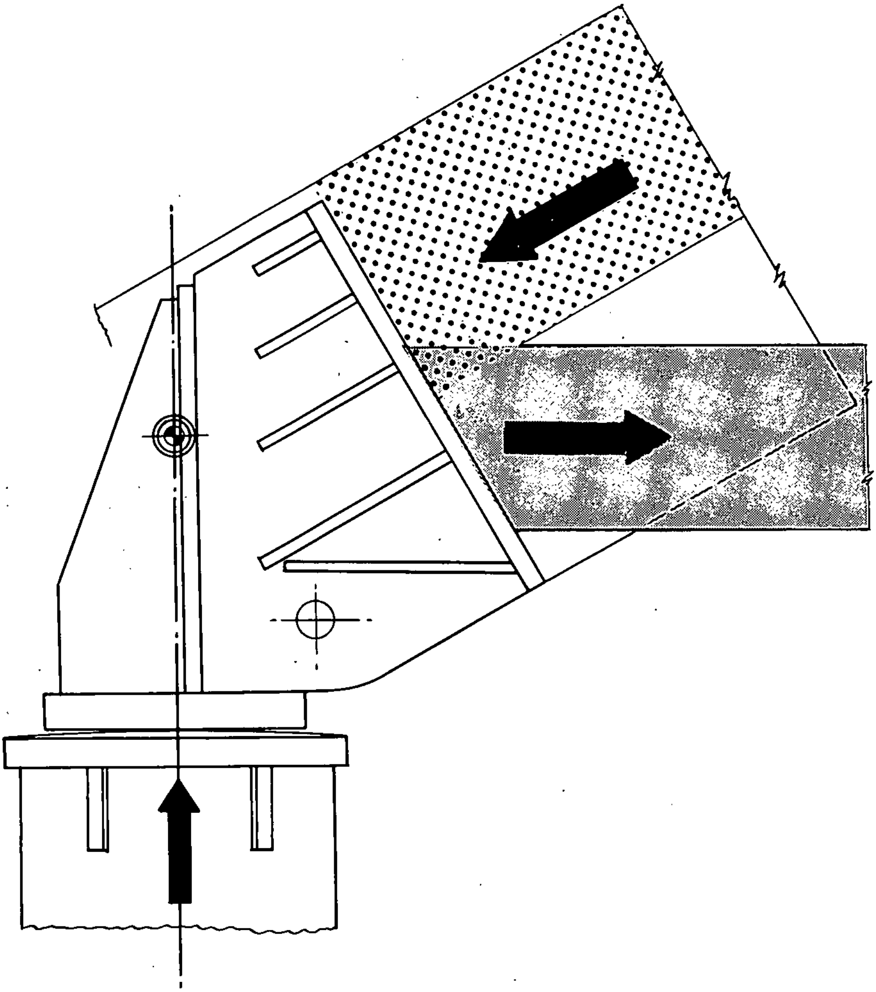

FIGURE 3.

and model approach and the ties established in elevation at the intersection of the column and shell thrust lines, figure 3.

The remainder of the structural design of the Intelex Post Office roof presented only normal problems which were handled in a routine manner.

Design planning embodies, however, much more than how the building will be framed and how to go about analyzing the structure visualized. For the Intelex Post Office roof it was necessary to plan construction procedures and controls concurrently with the structural design. As an example, the ties were designed with adjustable connections and jacking devices to facilitate tensioning. A detailed procedure was prepared to direct the Contractor in the exact manner and sequence in which the ties were to be tensioned.

Another field that required special design studies was the analysis and selection of materials for the roof construction. As an example, sand haydite concrete was selected for the shell proper with a design strength of 4,000 psi at 7 days and a maximum wet weight of 110 pounds per cubic foot. Type 3 cement was required with special restrictions on the tricalcium aluminate content. The maximum slump permitted, except near the corners of the shell over the columns, was 2 inches.

The design of a structure of a type such as the Providence Post Office leads the designer far afield from the ordinary analysis of stresses and strains. New methods of analysis, investigation of materials about which not nearly enough is known, construction problems and controls, fabrication difficulties, all must be evaluated and brought together to form an integrated and complete design.

RECONSTRUCTION — CHARLES RIVER DAM LOCK GATES

By Paul S. Crandall*, Member

(Presented at a meeting of the Structural Section, B.S.C.E., held on April 6, 1960.)

This discussion of the reconstruction of the structural, mechanical and electrical equipment at the Charles River Dam Locks is actually a comparison of the engineering of 1906 with that of 1958. Considerable credit should be given to the original designers who were required to create an unusual lock design with very limited experience and with very little equipment available to choose from. A careful examination of the original construction cannot but cause admiration for the remarkable ingenuity which was applied to the problem.

In 1903 the Charles River Basin Commission was established by the General Court of Massachusetts to study and prepare plans for a dam across the Charles River to create a pleasant and attractive basin between Boston and Cambridge.

Because of the 10 to 14 foot tide range in Boston Harbor, the estuary of the Charles River up as far as Watertown was always a series of mud flats at low tide which were flooded at high tide, resulting in obnoxious odors and the necessity of constructing buildings, roads and drainage systems well above the spring tide level.

The Commission decided that the best compromise elevation for the new river basin would be at +8.0 feet above low tide so that the natural river discharge could be sluiced off during the two normal low-tide periods of the day. Since high tides were generally about 2 to 4 feet higher than the established basin level of +8.0 feet, this meant that about 6 to 8 hours would be available at each tide for sluicing.

The Charles River Dam was designed with a navigation lock 300′ long, 45′ wide and 20′ deep at low tide, equipped with two rolling gates which would retract into recesses on the Boston side of the lock. Since it would be necessary that the gates resist water pressure in both directions, the conventional twin leaf gates could not be used, and a box caisson design, 6 feet between exterior plates,

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was planned. The equalization of water levels on each side of a gate was accomplished by six motor operated sluice gates in each lock gate, which were controlled by switch gear in the control tower. In addition to serving for water level equalization, the sluice gates also are used for allowing river water to be discharged into the harbor at low tide when no navigation interfered. On the Cambridge side of the dam a sluice gate house was built for discharging river water while the locks were being used for the passage of vessels and for providing a means of large volume sluicing after periods of heavy rain.

The entire original installation was operated by direct current power furnished by the Boston Elevated Railway Company which is today the Metropolitan Transit Authority. In recent years the M.T.A. has been plagued with frequent power failures, resulting in power failure at the Charles River Dam. Since it is far easier for the M.T.A. to substitute bus transportation to relieve the situation, quite often the delays in restoring power have been prolonged. It was only logical therefore to recommend a complete conversion to alternating current power from the Boston Edison Company supply which was close at hand. This conversion was carried out simultaneously with the replacement of the gates themselves.

Each lock gate was driven by two 50 HP motors by means of two heavy roller chains arranged on an endless system on each side of the gate recess. An equalizing beam pin connected to the gate at the center served to transmit the thrust of the chains to the gate. This original equipment had performed so well and was in such good working condition that only the gears and motors needed replacement.

In 1958 the Metropolitan District Commission engaged Crandall Dry Dock Engineers to design new gates which would be more durable than the old ones had been and with an improved rolling system which would eliminate the difficulties previously experienced of broken rails and high friction. Also the new design was to have 165 square feet of sluicing openings in the upper gate instead of the 92 square feet originally provided.

The lock at the Charles River Dam is provided with two pumps for dewatering. The largest of these is a 150 horsepower pump made by Worthington with a capacity for dewatering both the lock and the lower gate recess in about 48 hours. In the upper gate house, a smaller 50 horsepower pump exists which dewaters the lock gate recess only. When it was decided that the electrical power in the entire installation was to be converted from direct current to alternating current, the problem arose whether to renew the entire pumps or just the motors. An examination was made of both pumps and we found that the original cast iron impellers and scroll cases were in excellent condition, in spite of having been exposed to salt and brackish water for 50 years. As a result, only the motors were renewed. The operation of these pumps is rather infrequent, so that they would not have had occasion to wear out, but we were astonished at the durability of the metal in the salt water, particularly since no cathodic protection was provided.

The seal between the lock gates and the recess for these was originally made with live oak, carefully fitted and bolted to either the gate itself or to the concrete of the lock recess. Since this untreated oak, exposed to marine borer attack, was found in poor condition, new sealing timbers of greenheart were substituted. The new sealing timbers were bolted to the gate and to the lock recess with wrought iron bolts.

The original wheel system for the travel of the lock gates resulted in approximately 6 to 8% effective friction and, in cases where any additional resistance to movement of the gates occurred, the truck wheels at one end or the other were subjected to excessively high loads. The original installation presented an important maintenance problem since it was necessary to jack the gates up six feet in order to reach the truck wheels. Also the cost of wheel replacement itself was very expensive and the time required to place the gate in its recess, install stop planks across the lock gate recess, dewater the recess, jack the gate up, perform the replacement and then return the gate back into service would interrupt navigation for a good many days. In designing the new gates, it was felt that a free roller system, similar to that used on large railway dry docks, would provide lower friction, simple replacement at low cost, and greater reliability in operation. In order to make the installation simple, a single track of greenheart, measuring 8 x 24″ with a flat rail plate 20″ wide and 2″ thick, was positioned along the centerline of the gate, bearing on the concrete base of the lock. This track was held in place by wrought iron bolts held with cinch anchors to the concrete and clamped to the edge of the timber with malleable iron clamps. With this system it was possible to replace all of the roller frames without any dewatering and with a minimum of interruption of service. Since three of the roller frames of each gate do not uncover as the gate travels, an access well was built into the gate itself, permitting a diver to disconnect the frames and lift them out. The new roller system requires no lubrication. The rollers are made of alloy cast iron, 5″ in diameter and 22″ between flanges. They are capable of resisting a great overload, should it actually occur. The gate itself is equipped with two heavy shoe plates, 20″ wide and 3″ thick, which ride on the top of the roller treads. This low friction design is being driven by a single 30 horsepower motor instead of the two 50 horsepower motors originally used. The open-gear machinery which showed considerable wear in the high speed gears was simplified by the installation of a Westinghouse speed reducer, direct coupled to the 30 horsepower motor.

Since salt water presented a basic corrosion problem, it was decided that the new gates should be made of wrought iron instead of steel. The cost of the raw material is about twice that of mild steel, but its resistance to corrosion is estimated to be 4 to 5 times greater than steel. By designing the new gates as a continuous box structure, we were able to keep the weight of wrought iron approximately equal to that used previously with riveted steel fabrication. Since the working strength of wrought iron is only 12,000 psi as against 20,000 psi for steel, it was essential that we take full advantage of continuity in the structural design. All bolt fastenings to either cast iron or to the concrete or to the wrought iron gates themselves were made of wrought iron. Some steel was used in the top of the gate where it is not immersed in sea water. The supply of wrought iron presents certain limitations in selection of plate and angles; therefore we had to standardize on a single 5 x 3 x ⅜ angle as a principle rolled section. The welding was done with ordinary mild steel welding rod, fusing with the wrought iron base metal at 2900° F instead of the 2700° F usually used for mild steel, and produced a welding bead essentially of wrought iron. There was no question but that the welding of wrought iron is more difficult than mild steel and requires greater skill and care in the workmanship.

Since it was essential that the locks not be out of service longer than necessary, the project was planned so that as much fabrication as possible would be done prior to the dewatering of the lock. This meant that the new lock gates would be prefabricated, each in two pieces, to be launched overboard and floated into position. The top girders for the gates would be prefabricated and placed over the main body of the gates after they were positioned on their new roller track. In order to avoid delays, all material for the track, including rail plates, roller system and greenheart timber, were purchased in advance and delivered to the site prior to field construction. The sluice gates, motor operators and shafts were also available at the site. The electric motor and speed reducers for conversion from open gearing with direct current power to alternating current were purchased and delivered several months before construction began. All of the new guide wheel system for the top girder of each gate was fabricated and available prior to construction.

Once the four lock gate sections had been floated into the lock and positioned vertically in the lock, stop planks were installed at both ends of the lock and the lock subsequently dewatered. The contractor then proceeded to dismantle the old steel gates by cutting them up with torches and transporting the scrap steel by truck from the site. After the gates themselves were removed, the old crane rails and chair castings were removed. These chair castings had been imbedded in the concrete and required chipping out with compressed air tools. Then the contractor proceeded to place his greenheart timber way along the centerline of the gate recess and to anchor this timber way with cinch anchors and malleable iron clips. Once the timber was graded and grouted, the steel rail plate was positioned exactly on centerline and fastened down with special countersunk head wrought iron bolts drifted into the greenheart. As soon as both tracks were completed, the rollers were placed over the rails and the lock was then flooded so that the new gate sections could be floated into position and grounded on their rollers. Once grounded on the rollers, the lock was then dewatered again so that the field welding of the centerline splice could be accomplished and so that the top girder could be welded on in the dry. At the same time the heavy sluice gates were installed and the shafting, motor operators and electric wiring were installed.

While the new track was under construction, the old sealing timbers were removed and new greenheart sealing timbers were attached with wrought iron bolts and cinch anchors. The lock gate sections were already equipped with their greenheart sealing timbers upon delivery to the lock with the exception of spliced pieces which were to be attached in the field. While the gate assembly was being carried out, the old guide buttons which simply rubbed against the wear plate of the girder were removed and new guide wheels of cast steel with Lubrite bushings turning on a fixed pin were installed at the six support points of each gate. These new guide wheels reduced

Lower Gate Being Installed.

the friction to a small fraction of the original friction and provided a means of guidance which would not wear out as rapidly.

Bridge

During the period of installation of the lock gates, it was also necessary to install new motors and brakes together with electric controls for the two leaves of the adjacent draw bridge. Since one leaf of the draw bridge had to be available at all times for road traffic, it was necessary to operate one leaf on direct current while the second leaf was being converted to alternating current. Temporary power hookups had to be made to accomplish this. The electrical conversion to alternating current included the conversion of two electric capstans, two electric hoists, a machine shop, including milling machine, lathe and drill press as well as lighting and other minor conversions.

HEATING

Since the Charles River is a fresh water river which freezes in the winter, it was necessary to provide a heating system for the gates which would insure operation throughout the winter. The old system consisted of a steam line direct connected to radiators in the gates with condensate traps to catch the condensing water. This solution had the disadvantage that, once in operation with freezing conditions, it had to continue operation to avoid freezing of the condensate.

The new gates were designed with an antifreeze type heating system with a gravity feed from a reservoir in each gate house which would function from tower control. The antifreeze solution was heated by a heat exchanger from the existing steam supply. A small circulating pump would discharge the heated antifreeze solution at 100° into the high level funnel of the gate and it would flow by gravity through orifices which would control the rate of flow through the various sections of the gate and then discharge into a lower funnel back into the reservoir. Two sets of heating funnels were provided, one for the closed position of the gate and one for the open position. A three way valve controlled by limit switches on the hauling chains of the gate provides for flow to the proper funnels of the feeding system.

The gates themselves have a series of wrought iron pans welded to the skin plate of the gate with a one inch space between for the antifreeze solution of water and ethylene glycol.

The advantages of the new system are that heat only needs to be provided during the coldest winter days when the river water might freeze, and that no physical pipe connection is required between the gate and the heat supply.

The new lock gates were designed by Crandall Dry Dock Engineers and the conversion of the power system from direct current to alternating current and the design of the heating system were done by Kerr Atkinson. The writer wishes to acknowledge the assistance of Mr. Benjamin Fink of the Parks Division of the Metropolitan

District Commission and Mr. Arthur Southwick, superintendent of locks and bridges for the Metropolitan District Commission in obtaining information on the history of the old gates. The contract for furnishing the wrought iron gates and the general installation of them was done by Builders Iron Works of Somerville. The resident engineer for Crandall Dry Dock Engineers was Donald T. Fairburn. The cost of the entire project was approximately \$550,000 and the lock was closed to navigation for a period of 65 days.

DESIGN AND CONSTRUCTION OF CHASE MANHATTAN BANK'S NEW HEAD OFFICE BUILDING

By Morton H. Eligator*

(Presented at a meeting of the Structural Section. B.S.C.E., held on May 11, 1960.)

In the heart of New York City's downtown financial district, the Chase Manhattan Bank is busy constructing their new Head Office Building, on a site covering 2½ acres. Started in early 1957, the building will be ready for part-occupancy in late fall of this year.

The building consists of a 100 ft. x 300 ft. tower rising without setbacks for 60 floors, 820 feet above street level. There is a plaza and 6 basements below, covering the entire site. (See Fig. 1.)

Special consideration had to be given to the design and construction of the foundation walls and basement floors because of the great depth of excavation. A cost study was made which revealed it was more economical to use the permanent floor steel as a horizontal strut system, or crosslot bracing, rather than the usual temporary bracing of cofferdam walls. Under design loads from the horizontal earth pressure, the elastic shortening of these beams amounted to about one inch, which meant that the cofferdams being braced, if not somehow restrained, would have been subject to cracking or movement. To overcome this problem, the crosslot beams were prestressed after erection by jacking against the walls.

The basement floor beams, designed to take the permanent vertical floor loads and the horizontal earth pressures, were located in pairs straddling the permanent columns. Ends of all beams were milled for bearing, as columns.

At the start, after clearing the site, two lines of sheet piling 5 to 7 ft. apart, were driven around the perimeter of the site. The sheeting was cross-braced, the space between excavated, and the cofferdam walls poured to their full debt. Excavation proceeded then to slightly below the 1st Basement. Temporary H-piles were driven to hardpan (generally just below the 3rd Basement), and horizontal

* Partner, Weiskopf & Pickworth.

framing erected to pairs of piles, providing a series of pile bents. The permanent framing of the 1st Basement was then erected using the pile bents for support. When the floor system was completed, jacking proceeded. 300-Ton jacks, mounted in pairs at the end of each member, were forced against a large billet plate on the cofferdam wall and a bracket fitting on the beam to a predetermined stress. Steel wedges

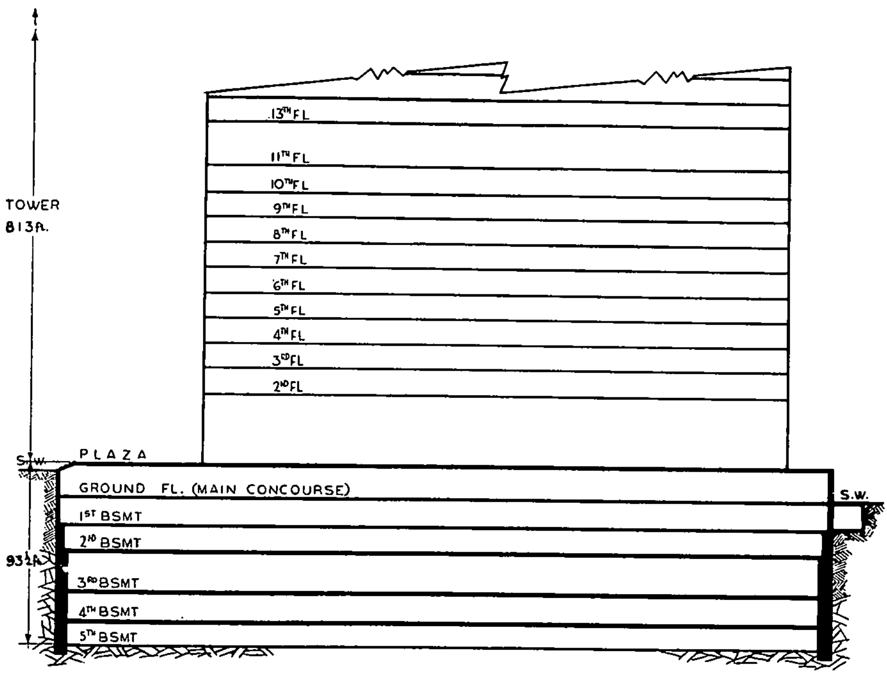


FIGURE 1.

were driven to hold the stress, and excavation proceeded to just below the 2nd Basement, where again horizontal framing was erected to the temporary pile "columns" to support this level of steel, and the jacking procedure repeated. This entire procedure was again repeated at the 3rd Basement level. (See Fig. 2.)

As each subsequent lower level was installed, 2-way diagonal and vertical bracing angles were welded between levels. This was done not only to stabilize the crosslot framing system, which covered an area about 200 ft. by 400 ft., but to allow for removal of any one line of pile bent supports so that excavation could continue below the hard-pan bottom of the piles, the steel framing itself acting as a 3-level 2-story truss between remaining pile bents.

At the 4th Basement level, crosslot bracing was not used, since this floor was to be the roof of the main bank vault, constructed of a concrete slab generally 30 inches thick, for security purposes. Instead, spur bracing to the bottom of the hole (the 5th Basement) was

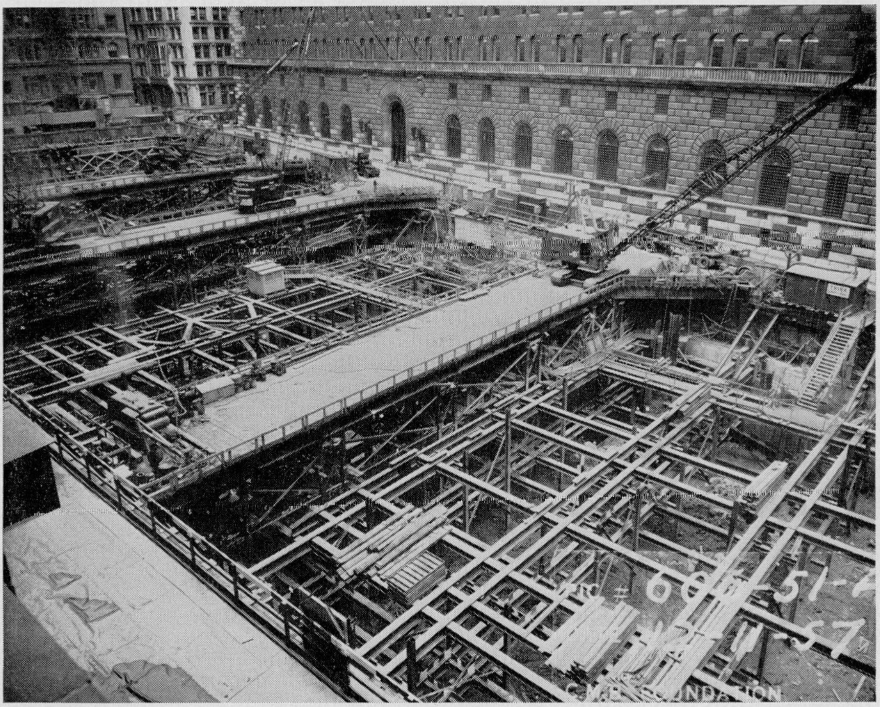


FIGURE 2.—LOT JUST PRIOR TO PLACING THE 3RD BASEMENT STEEL. SHACK IN LEFT CENTER IS CONTROL STATION FOR JACKING OPERATION. NOTE TRUCK AND CRAWLER CRANES ON ACCESS TRESTLES.

utilized to take the earth pressures. The 4th Basement, then, was the only point where a transfer of stress from the temporary to permanent construction was necessary. At the 5th Basement level, of course, the cofferdam was keyed into the rock.

When general excavation was completed, grillage pits were dug, grillages set in place, and columns erected.

The large bays and long spans (up to 45′-5″) resulted in heavy column loads, perhaps the heaviest encountered in tier building construction. Approximately half the steel weight of over 50,000 tons is in the built up columns.

One of the first and most important studies necessary was to determine the general shape of the column. Capacity to carry the large direct loads due to gravity, and bending moments due to wind, would have to be reached in such a fashion as to fit in with the style of architecture. Fabrication had to be considered also; you can't specify a column that is impossible to rivet or weld together. The

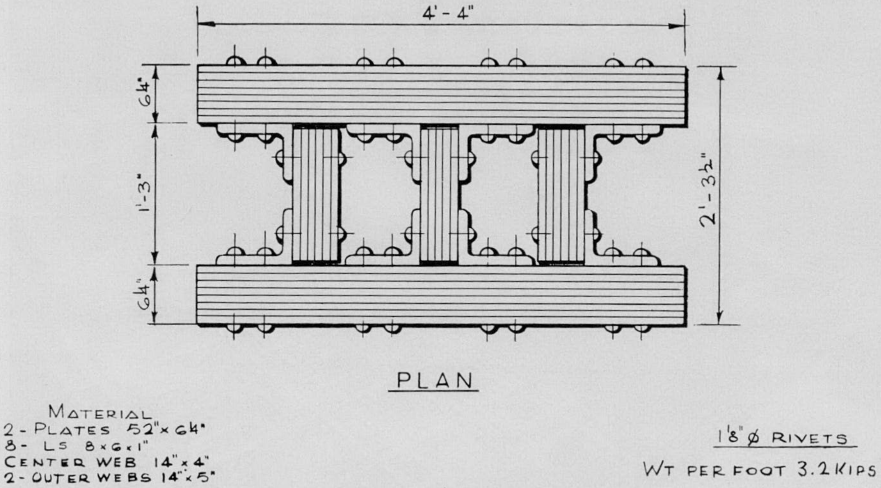


FIGURE 3.—PLAN OF LARGEST COLUMN USED ON THE JOB.

shape finally arrived at satisfied the architectural requirements, and the fabricating necessities.

Not only must a column carry the forces and stresses just mentioned, but some method must be devised to transmit these stresses to the column; in other words, a suitable connection must be made. By extending part-thickness of the cover plates out between wind-girder flange angles, no extra fitting material was required, thus eliminating the "weak link" in the connection.

The shape of the column, about twice as deep as wide (in the critical wind direction of the building, at least), proved to be economical in two respects. First, the slenderness ratio is so small that the design stress is just about the maximum the column formula allows, and 2nd, except for a few isolated instances, the columns designed for gravity loads satisfied gravity wind moment requirements with no increase in column size, due mainly to the very great bending strength of the column section. (See Fig. 3.)

The maximum load reached 15,820 Kips, for which the grillage consisted of two tiers of 33″ and 36″ stiffened and cover-plated beams,

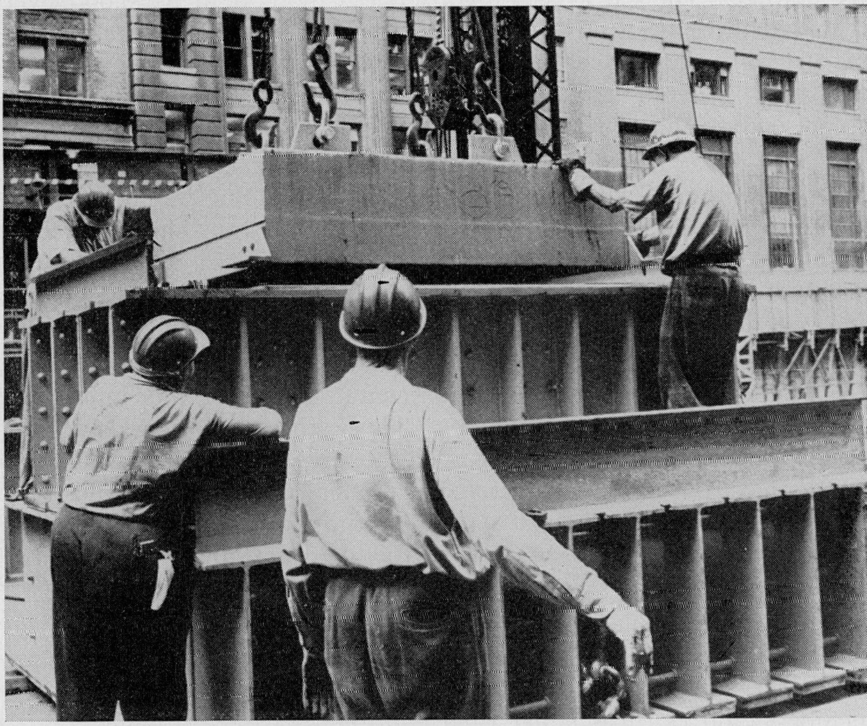


FIGURE. 4.—TWO TIERS OF THE GRILLAGE, AND THE BILLET, BEING ASSEMBLED PRIOR TO BEING LOWERED INTO PLACE. THE SMALLER BEAMS ON TOP OF EACH GRILLAGE TIER WERE USED TO HOLD THE INDIVIDUAL BEAMS SECURELY IN PLACE AND FLUSH DURING ASSEMBLY, SHIPPING AND ERECTION.

topped by a 20″ thick, 14 ton billet. (See Fig. 4.) Rock bearing was 40 tons per square foot.

Erection of the columns was done from the Ground Floor (between the 1st Basement and Plaza), truck ramps having been built projecting into the site. The columns were "threaded" down through the slots between the intersection of 2 pairs of crosslot beams, and the beams connected to them by means of seated support assemblies. The Ground Floor framing was then erected, the building "topped out" flush at this particular level, close to street grade, so that an accessible working platform for trucking and storage of building materials could be available. This Ground Floor was designed to take the heaviest concrete and steel delivery trucks, or a 500 psf. load for storage. The extra cost involved was more than $100,000 over that had there been no special loading requirements, but was necessary in this area since there was absolutely no other storage area available. Where surrounding streets are narrow and congested, off-street loading and delivery facilities are essential.

The tower construction, in general, consists of a cellular steel sub floor with 2½" of concrete topping. Fireproofing was effected by spraying a fiber asbestos material with an inorganic binder directly to the underside of the metal deck, and by Vermiculite and lath cages around the beams. Three floors, used only for mechanical equipment, and the floors directly above them, have reinforced concrete arches and concrete beam fireproofing.

In the wind analysis, total horizontal deflection was limited to .0015 of the height of the building. This rather conservative restriction was applied due to the complete absence of masonry walls and for the most part lack of concrete encasement of the tower wind-girders, both of which, although never quantitatively taken into account where they do occur, stiffen a structure and act to reduce the calculated deflections.

The actual deflections, in fact, are expected to be less than the calculated, since the wind system material in the upper quarter of the tower is determined by the gravity load, or by minimum size members, and hence is stiffer than required.

The basic wind system in the short direction consists of double plate girders over the office space, and double channel inverted V-trusses in the core, between stairs and elevator shafts. All ten column lines are utilized for this purpose. Girder to column connections were simplified by holding a constant dimension between inside of cover plates, and extending the cover plates out to provide a built-in "gusset." In the long direction, the two interior lines of columns are braced by double-angle knees at the sides of the elevator shafts. The wind system is carried down to the 2nd Basement, the wind shears then transmitted through the 8″ thick concrete floor arch to the cofferdam walls and into the earth.

In order to satisfy the service requirements for a fully air-conditioned building without inordinately increasing the floor-to-floor height, all duct work passes through the wind-girders, the hung ceiling being directly below the girder fireproofing.

Large slots were designed in the girder webs, up to 2 ft. deep and 7 ft. long, for passage of horizontal ductwork. Supplementary angle reinforcing was provided to transmit the stresses around the weakened sections.

Desirous of an unbroken surface along the inside of the building wall, the architects placed the exterior columns outside the building, resulting in a column braced only on its strong axis, by the heavy double wind-girders. In the other direction, the spandrel beam is three feet from the centerline of the column. Weak axis bracing was accomplished by welding a 1″ thick plate to the top flange of the girders to act as a horizontal stiffening web to prevent buckling. This plate carries from the first interior beam to the first web of the column, to which it is welded. Additional plate diaphragms are welded between the three webs to continue the action of this stiffener. (See Fig. 5.)

In addition to causing bracing problems, the exposure of the exterior columns created a vulnerability to temperature differentials that exist between a more or less constant temperature building interior and the variation of the outside. The general effect is a relative change in length between the interior and exterior columns, inducing bending stresses in the columns and girders of the frame. Since the differential lengthening or shortening is cumulative toward the top of the building, it was decided to insulate the upper half of the exterior columns where the bending stresses would otherwise have necessitated an increase in column and girder sizes, even using an increase in the working stresses for this analysis when combined with gravity and wind stresses. The stresses in the lower half of the building were within this working figure. The effect of the insulation (rigid foamglass) is to reduce the total temperature differential so that the exterior columns will approach more closely the building temperature.

Since the curtain wall has no operating sash, a scaffold will be used for washing and cleaning the glass and aluminum. The scaffold is suspended by cables from a self-propelled roof car riding on tracks circling the perimeter of the building. These tracks are located near the top of the roof screen; which is a continuation of the curtain wall above the roof level. The purpose of this is to conceal the house tanks, cooling towers and elevator bulkheads. The scaffold itself is 58 ft. long (2-29 ft. bays), and straddles two columns in any working position. This length allows for reaching the 10-foot cantilevered ends of the building, and in addition permits more workmen for cleaning,

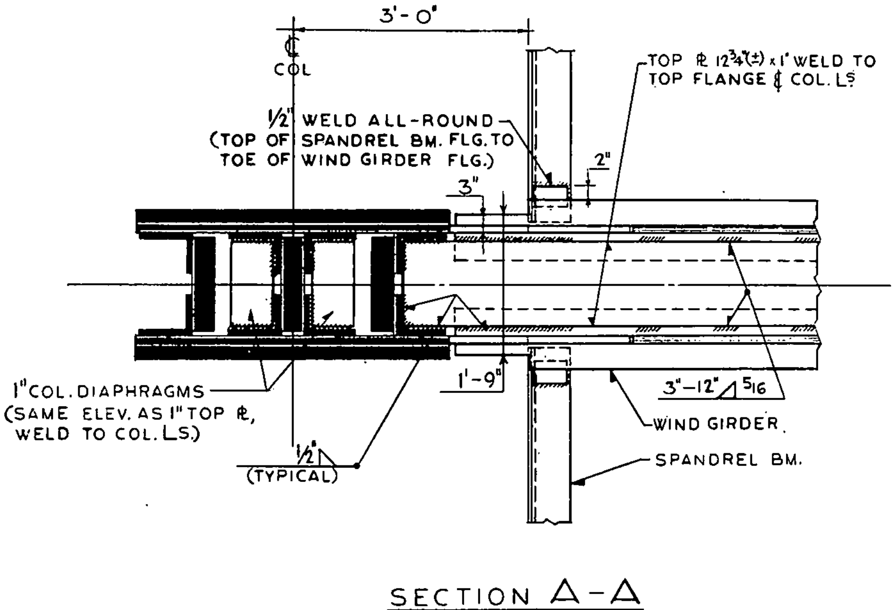


FIGURE 5.—PLAN DETAIL OF GIRDER CONNECTION TO EXTERIOR COLUMN.

reducing the actual time the scaffold will be in view. The scaffold is guided by the mullions to resist wind forces and eccentric gravity loads. Nyon rollers fit in and around the H-section mullions for complete stability and bracing of the scaffold while it is in motion. Only 42 of the 140 mullions guide and provide horizontal support (three for each of the 14 scaffold positions). It was neither economically or architecturally feasible to use larger sections for these 42 "work" mullions. In order to limit deflection of the mullions under the working loads to preclude glass breakage, the vertical span was reduced by the introduction of supplementary support brackets below the floor line, in addition to the floor level supports which alone carry the other mullions.

As mentioned earlier, the main security vault of the bank is located in the 5th Basement, and occupies about 35,000 square feet.

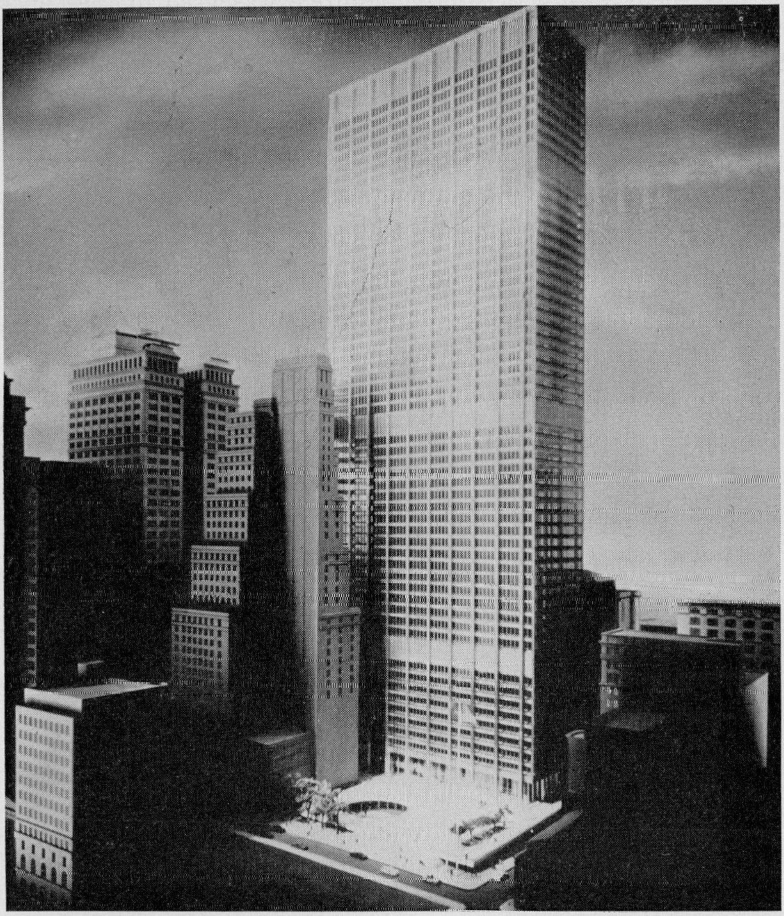


FIGURE 6.

Roof slab, floor slab and walls (which are independent of the foundation cofferdams) are 30 inches thick, and designed to be able to resist total inundation of water from street grade. Vertical loads of the roof slab (4th Basement), are carried to the foundations through a 15″ thick concrete encasement of the steel building columns, the heavy shears being resisted by low-carbon steel 24″ I-beams welded together to form a lattice-type shear-head.

In order to reduce shrinkage in the 30″ thick pours to a minimum, Type II cement with a plasticizer additive was used in the concrete, the maximum slump being specified at 3″. Control strips 5 feet wide, with lapped reinforcing, broke the pours into areas of about 2500 square feet. The concrete in the control strips was placed after the adjoining concrete had been in place for 60 days, a requirement deemed necessary due to the probable slow curing as a result of the lack of air motion and slow evaporation at this low level. (The upper basements were already poured, sealing off this level from the outside.)

When completed, Chase Manhattan will occupy the lower half of the building, other tenants the upper half, in the tallest skyscraper built in the past two decades. (See Fig. 6.)

Architects for the project were Skidmore, Owings and Merrill. Design of the foundations and field supervision of prestressing were handled by Moran, Proctor, Mueser & Ritledge. Bethlehem Steel Company fabricated and erected the structural steel. Structural Engineers were Weiskopf & Pickworth.

SEWAGE OXIDATION PONDS IN NEW HAMPSHIRE

By Darrell A. Root*, Member

(Presented at a joint outing of the Boston Society of Civil Engineers and the Sanitary Section, B.S.C.E., held on June 4, 1960.)

The use of oxidation ponds in this country apparently started at Santa Rosa, California, in 1924 where a seepage area clogged and a sewage pond developed above the seepage area. Later that same year oxidation ponds were built at Vacaville, California, to impound septic tank effluent during the summer. In 1928 at Fessenden, North Dakota, a pothole was dammed up and sewage was discharged into the pothole. Since that time the use of oxidation ponds has grown, slowly, at first, and much more rapidly after the end of World War II. In the ASCE Research Report No. 19 entitled "Sewage Treatment by Lagoons" the following statement is made. "Judging from reports in the literature, it would appear that at least 400 communities are employing lagoons in some capacity in their sewage treatment process."

Basically, a sewage oxidation pond or sewage lagoon utilizes all of the natural processes for the stabilization of sewage that normally occur in a stream, pond, or lake. The principal difference is that the oxidation pond is utilized to confine these natural processes to the location of the pond and to control the discharge. The sewage is retained in the oxidation pond until it is completely stabilized and the BOD reduced to the point where it can easily be assimilated by the receiving stream. The concentration of bacteria is reduced to the point where objectionable numbers do not enter the receiving stream. Oxidation ponds have a unique advantage in New England, where critical stream flows may occur during a long, hot summer and the capacity of the receiving stream is reduced to a minimum. This advantage is that enough storage area can be designed into the operating depth to retain all of the sewage flow from a community in the oxidation pond area for a period of between 45 to 60 days. Thus, 100% removal of sewage, including the liquid volume for a critical period of stream flow or for a period which might interfere with the recreational use of the receiving stream downstream from the discharge point, can be accomplished.

* Partner, Camp, Dresser & McKee, Boston, Massachusetts.

The treatment efficiency which can be expected from oxidation ponds during warm, sunny days is at least equivalent to results obtained from well-operated conventional secondary treatment. Prior to the construction of the pond in Derry, New Hampshire, the only use of oxidation ponds in New Hampshire was for the sewage treatment for a summer camp in the Town of Richmond. The oxidation

Sewage Oxidation Pond at Derry, New Hampshire Showing One Cell in Operation. Photo Courtesy of Stephen Leavenworth, Division of Sanitary Engineering, New Hampshire State Health Department.

pond in Derry has been in operation since January, 1959, and another pond was placed in operation in Jaffrey, New Hampshire, during the spring of 1960.

The conventional design of oxidation ponds requires one acre for 100 to 200 persons. This basic requirement automatically limits the use of oxidation ponds to communities which have sufficient land area available for this type of disposal. As with any other sewage disposal facility, the pond should be located as far from human habitation as possible. The pond for Derry lies exactly one mile from the Town Hall and is 2400 ft. from the intersection of the two main trunk sewers which drain all the sewage from the town.

The total surface area at 5-ft depth provided in the Derry installation is equal to 20 acres. This area is divided into four basins,

Sewage Oxidation Pond at Jaffrey, New Hampshire Taken Just Before the Completion of Construction. Photo Courtesy of Stephen Leavenworth, Division of Sanitary Engineering, New Hampshire State Health Department.

and the piping is so arranged that the flow can be divided into all four of the basins in parallel or can be directed into all four basins in series. It is expected that the normal operation will be to divide the incoming sewage into the two upper basins and the overflow from the two upper basins will be divided into the two lower basins. Piping, however, is such that almost any desired arrangement of flow can be obtained.

The site selected for the Derry oxidation pond was a gravel pit area, and the original layout was adjusted in order not to remove the substantial amount of ledge which was found in the southeasterly basin. Only a small amount of ledge was found in the northeasterly basin; and practically none, in either of the westerly basins. Because of the permeability of the gravel material, no depth of sewage could be maintained during the initial operations in the northwesterly basin. The contractor was instructed, therefore, to place a 3-inch layer of loam on the bottom of the northeasterly basin and to compact this layer of loam with a 10-ton roller.

Concurrent with the construction of the sewage disposal facility, a sewerage system was constructed throughout the village of West Derry. With the exception of a sewer constructed in 1954 on parts of Crystal Avenue and Rollins Street, the only sewer in the village consisted of a sewer along parts of East and West Broadway which ran down a portion of Railroad Avenue, across the railroad tracks, and entered Beaver Brook below South Avenue. Inasmuch as this sewer also collected all of the storm water drainage along East Broadway, all of the sanitary sewage was removed from this sewer and the old sewer left to drain the storm water from the East Broadway area. The construction of the sewer system was started in the spring of 1958, and construction had progressed to the point where sewage could be turned into the system in January of 1959. A new pumping station was started at that time. The construction of the system was completed by the mid-summer of 1959, and house connections to the new system have been made gradually since January of 1959. The sewage from the town flows by gravity to the pumping station located just southerly of Fordway Street. At the pumping station the sewage passes through the barminutor into the suction well and is pumped automatically to the oxidation pond area.

As mentioned before, operation of the oxidation pond was started in January of 1959; during the initial operating period only a few thousand gallons per week were pumped to the pond. Because of the low flow during this period the riser pipe was disconnected so there would be no possibility of its freezing. As the sewage was pumped into the bottom of the pond, it filled the hole above the tee from the distribution pipe and spilled over onto the bed of the pond. Inasmuch as the ground was frozen, the sewage froze; and a laminated iceberg was formed from January until thawing conditions occurred in the spring. Throughout this period the liquid in the hole in the center remained unfrozen. As soon as the ground thawed and the ice melted, all of the liquid percolated into the soil. All of the sewage pumped into the basin from January until the end of June, 1959, percolated into the ground and the depth of the liquid never exceeded an inch or two on the bottom of the basin, which was never completely covered.

On June 25, 1959, after the contractor had completed the placing of loam on the bottom of the northeast basin and had completed all the other work required under his contract, sewage was diverted into the northeast basin. In order to be certain of maintaining a sufficient depth of liquid in this basin, the precaution of diverting some water from Beaver Brook into the sewer was taken. This diversion occurred for about six weeks. Inasmuch as the sewer was below the brook bottom suction hoses were placed in the brook to discharge water into the sewer by siphoning. This worked very well until boys in the neighborhood decided to pull the siphons out or until small turtles got caught on the end of the suction lines and plugged them up. During this period, the flow of brook water and sewage increased the depth in the northeast basin to approximately 18 inches. At this time the siphons were removed from the brook and only sewage was pumped into the basin. During this period the sewage flow varied from 0.8 million gallons per week to 1.8 million gallons per week late in December. About 38 mg of sewage were pumped into the northeast basin from June 25 until December 16, 1959.

During the early part of December, 1959, a period of cloudy, rainy weather occurred, during which time the oxygen content of the liquid in the northeast basin decreased to zero. Some odors developed in the liquid, and these odors were noticeable at the discharge point near the corner of the basin. The concentration of odor was not sufficient to be noticed outside the fence. The total flow was being added to the basin at this time. Officials of the New Hampshire State Board of Health became concerned about the lack of oxygen and the presence of odors. At their suggestion the total flow was diverted from the northeast basin to the northwest basin. Observations of the pond made during this period indicate that on December 16 the pond was completely covered with ice except at the inlet area. The flow was diverted, and the ice cover of the pond increased gradually until about the end of January at which time the ice was 14 inches thick and there were about four inches of snow on top of the ice. With the ice and snow cover no odors escaped from the pond except when holes were cut through the ice for the purpose of sampling. Samples were taken through the ice during January, and the observations indicate that a strong hydrogen sulfite odor was present when the ice cover was broken. Except for the release of odors when samples were taken, no odors escaped through the ice.

The 1959 winter operation of the northwest basin was similar to the operation during the previous winter in the same basin except in 1959 the overflow pipe was left sticking above the bottom and the sewage discharged from the top of the overflow pipe. The sewage spread out over the basin and ice was formed. All during the winter there was an open area immediately around the overflow pipe which contained no ice. No odors were given off from the northwest basin during this period.

The northeast basin was sampled every week and various analyses were run on the samples. There was very little change noted in the samples taken during this period, and at the end of January it was suggested to the State Official that the flow be divided between both basins so that observations could be made of the condition of the ponds during the period in which ice melted. The State Officials agreed to this, and on February 10 the flow was divided equally between the two basins. At the time the sewage flow was again diverted into the northeast basin the ice thickness was about 15 inches, and within a week a hole was melted through the ice in the vicinity of the discharge point. This hole remained ice-free from this time until the ice disappeared from the basin.

The flow has been divided between the two basins ever since February 10, 1960. The reports of the sampling observations during the ice-melting period are as follows:

FEBRUARY 24: "ice was thin and about 50 gallons per minute was overflowing the weir. The appearance of the effluent began to improve and there was no odor."

MARCH 9: "ice cover, return of odor."

MARCH 30: "ice started to crack, no objectionable odor."

APRIL 1: "ice breaking up some H_2S in sample, not in air."

APRIL 4: "ice opened up around the effluent end and the area around the inlet pipe was about 40 feet in diameter."

APRIL 11: "basin was ice free and the depth was 42 inches. Color of liquid in pond was gray and turbid and odor similar to fresh sewage or slightly sour sewage was noticeable in the immediate vicinity of pond, but there was no hydrogen sulfide odor. Condition remained same through rest of April."

MAY 4: "slight greenish color in pond, fresh sewage odor, 2-3 parts per million of DO in center, 8 parts per million of DO in northeast corner, wind blowing towards northeast corner. Dissolved O_2 concentration in Northwest basin was 19.0 parts per million."

MAY 12: "pond was green and no odor—oxygen concentration in northeast basin was 9.8 parts per million at bottom and 22 parts per million at top."

Since then the oxygen has always been present and there has been little or no odor.

The New England Water Pollution Control Commission made arrangements with the University of New Hampshire to conduct an investigation of the operation of this oxidation pond and provided funds for samples from the pond to be analyzed weekly. This testing procedure was under the general supervision of Professor J. Harold Zoller, of the College of Technology of the University of New Hampshire. Tests were made under Professor Zoller's direction for B. coli, BOD, dissolved oxygen, and occasionally other pertinent tests, together with observations made during the sampling procedure. Samples were taken on both the raw sewage and the liquid in the northeast basin.

Tests were also made during the winter and spring by the staff of the Water Pollution Commission of the State of New Hampshire. The tests made by the state supplemented the tests made by the University and included such items as pH, alkalinity, chlorides, ammonia, phosphate, dissolved oxygen, and algae. Of particular interest in these tests are the algae counts. During December the predominant specie was microactinium which was present in concentrations of approximately 100,000 per milliliter. From this concentration the count gradually fell during December, February, March and reached a low point about the first of April at which time the concentration was 530 per milliliter. After April 4 the count started to increase, and on April 20 the concentration was 15,000 per milliliter. Samples taken on May 4 and May 12 indicated that the predominant algae had changed to chlamydomonas, and the concentration of this specie reached 1,148,000 per milliliter on May 12. On May 19 microactinium was the predominant specie and the concentration at that sampling date was 756,000 per milliliter. On May 25 the predominant specie was golenkenia and the concentration was 317,000 per milliliter.

It must be kept in mind that the basic concept for the operation of this pond is that the flow will be divided into two primary basins and then into two secondary basins. The operation for the first 18 months has been confined to the two primary basins and no flow has been diverted into the secondary basins. During the winter period of 1959 to 1960 there was some overflow from the northeast primary basin which discharged into Beaver Brook. Early in April of 1960 the overflow from the northeast basin was diverted into the northwest basin so that all of the solids in the overflow from the northeast

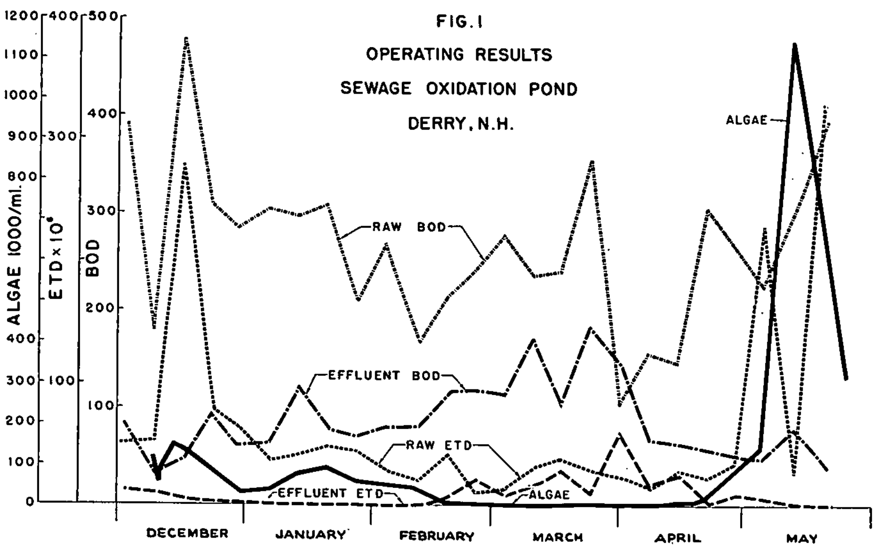
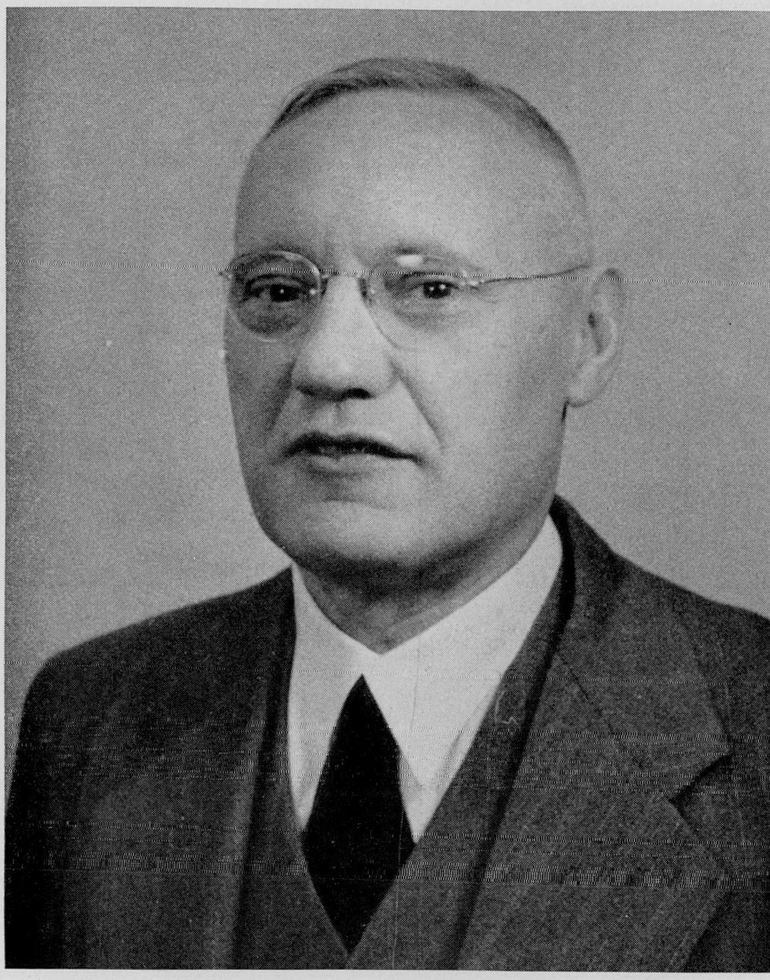


FIG. 1
OPERATING RESULTS
SEWAGE OXIDATION POND
DERRY, N.H.

basin, together with the solids in one half of the raw sewage flow, could be used to seal the northwest basin. With the event of the large algae growth in the spring of 1960, the algae bodies have been used to seal the northwest basin; and it is now possible to maintain a depth of sewage over the whole bottom of the northwest basin. As soon as the northwest basin begins to overflow, the overflow from this basin, together with the overflow from the northeast basin, will be discharged into one of the secondary basins in order to seal this basin in the same manner that was used to seal the northwest basin.

The operating results of the period from December 1959 through May 1960 are best shown on Fig. 1. In this figure the BOD of the raw sewage is represented by a broken dash line, and the estimated total density of unconfired B. coli in the raw sewage is represented by a broken line. The BOD of the effluent is shown as a solid line; the estimated total density of unconfirmed B. coli, also shown as a solid line. Fig. 1 also shows the concentration of algae growth in the northeast basin. These results are for the primary stage only, and additional BOD removal and B. coli removal will be obtained when the secondary basins are placed in operation. The BOD figures for the effluent are unfiltered, and some spot checks of BOD results after filtration indicated that the BOD of the filtered sample was approximately one half the BOD of the unfiltered samples. Some spot-check samples on the confirmation of B. coli were made, and the confirmed B. coli counts were substantially below the total counts indicated on Fig 1.

The sewage disposal project, consisting of the oxidation pond, sewage treatment plant, and the necessary interceptor and collecting sewers, was constructed under the general direction of the Board of Selectmen of the Town of Derry, consisting of Donald Bentley, Frank T. Buckley, and Emile J. Bienvenue. Mr. Harold Bean, Superintendent of the Water Department, has charge of the operation and maintenance of the sewage pumping station and the oxidation pond. We are indebted to Professor Harold J. Zoller and members of his staff and to William A. Healy, Technical Secretary of the New Hampshire Water Pollution Commission and members of his staff for furnishing us the data which was used in this paper.



ALBERT HAERTLEIN

1895–1960

ALBERT HAERTLEIN
1895-1960
An Appreciation

"Nobody," according to Dr. Johnson, "can write a life of a man but those who have eat and drunk and lived in social intercourse with him." If we accept this dictum, I am among those who can write, not a life, but at least a brief account of the life of Albert Haertlein. For years on end I lunched frugally with him here and there about Harvard Square and later, less frugally perhaps but with equal pleasure, at the Faculty Club of Harvard University and supped with him at the monthly meetings of the Boston Society of Civil Engineers.

I first got to know Albert when we were both cub instructors in the Harvard Engineering School. He had just resigned his commission in the Corps of Engineers, U. S. Army, upon his return from France, taken unto himself a wife, and accepted the invitation of George F. Swain—that noble tyrant among teachers of civil engineering and astute leader among engineering consultants—to work with him in his classes and in his engineering practice. Professor Swain, as his many students will remember, was both an exact and an exacting man. Accordingly, his words of praise, that Albert Haertlein was "the most exact assistant" he ever had, mean much.

Albert was, himself, a student of Swain's. Their teacher-pupil relationship which was to mean much to both of them had begun soon after the younger man had come to Harvard from his boyhood home in St. Louis, Mo., with modest funds but with the interest, willingness, and stamina to work his way, first to a Harvard A.B. in 1913 and subsequently to a Harvard-M.I.T. S.B. in Civil Engineering in 1918. In both institutions, he completed his studies with honors. Indeed, he was elected to Phi Beta Kappa at the time of his graduation from Harvard in 1916, after but three years in residence.

In 1923, on the advice of Professor Swain, who was convinced that every engineering teacher should have at least five years of practical experience, Albert became a structural engineer with Dwight P. Robinson, Inc., on loan for a short period of time to Professor

Swain himself in some of his investigations and for a longer stretch to the Duquesne Light Company in Pittsburgh, Pa.

When Swain fell ill in 1928, his former assistant was called back to give his lectures and, as it became evident that the Professor would not return to duty, Albert Haertlein was appointed Associate Professor of Civil Engineering in his place. The teacher-pupil bond, however, remained unbroken, for I remember well how every Saturday afternoon, for many a year, Albert would ride out to the Swains' house in Brookline for a visit with his ailing friend.

In the course of time, Professor Haertlein became known for his contributions to the cause of engineering education in two ways: directly as a teacher of civil engineering, and indirectly as a staunch supporter of the engineering societies to which he belonged and as a member of the Massachusetts Board of Registration of Professional Engineers and Land Surveyors.

As a teacher, he was not only a clear expositor of the material he taught but also a warm friend of students and advisees. To him the needs of the student came before the convenience of the teacher, and the call of the classroom before the lure of practice. He was, you see, one of those rare people who had time for others: young and old, sick and well, casual visitor and firm friend. That the time thus spent had to be made up by work late into the night at home did not deflect him from the path of helpfulness he had chosen to follow. In 1940, he was elected to the Gordon McKay Professorship of Civil Engineering and he became Associate Dean of his division, ultimately the Division of Engineering and Applied Physics, in 1951.

As a defender of the profession, too, Haertlein never spared himself. Four organizations, in particular, benefited by his great capacity for work: The Boston Society of Civil Engineers, the Engineering Societies of New England, the American Society of Civil Engineers, and the Massachusetts Board of Registration of Professional Engineers and Land Surveyors. In each of these he held important posts. He was President of the Boston Society of Civil Engineers in 1941-42; President of the Engineering Societies of New England from 1945 to 1947, Vice-President of the American Society of Civil Engineers in 1950-51, and a member of the Massachusetts Board of Registration of Professional Engineers and Land Surveyors from its inception in 1942 until his death. The Boston Society he joined in 1929 as soon as he knew that Boston would be his permanent home.

The caliber of his work for these organizations can be judged by the honors they were moved to bestow upon him. From the Boston Society of Civil Engineers he received in 1937 the Desmond Fitzgerald Medal for a paper, "The Design of Statically Indeterminate Trusses," and the Chairmanship of the 100th Anniversary Committee of the Society in 1941. The Engineering Societies of New England, in February 1960, presented him with a Paul Revere bowl as a special award in recognition of "his long, faithful, and continuing service as a member of the Massachusetts Board of Registration of Professional Engineers and Land Surveyors." To the enormous task of this Board of examining the careers of more than 10,000 applicants, he had brought the judicious thinking, friendly warmth, and personal integrity that marked his relationship to his profession and indeed to all men throughout his life. During his 18 years of service to the Commonwealth, he was not only a member of the Board but also its Secretary and Chairman.

In 1956, the American Society of Civil Engineers conferred honorary membership on him, explaining that this award was being made to him as a "Dedicated teacher, in recognition of his lifetime of work in the cause of engineering education, his pioneer efforts to advance the profession and uplift its standards, and his long and distinguished service to the Society." Northeastern University, which because of its intimate and fruitful relationship to the regional engineering community has been particularly aware of the importance of outstanding contributions to this community and happily alert to acknowledge them, bestowed on him the honorary degree of Doctor of Engineering in 1949.

Those of us who had the privilege of friendship or close association with Albert Haertlein know that his great sense of duty would have lacked fulfillment had he not been blessed in marriage with an understanding, helpful, and patient wife who merits our own gratitude as well as that of engineers in many other places. No one of Albert's students, and in particular, no one far from home lacked an invitation to share the hospitality of his Watertown home on the holidays in which the unity of the family group is dominant in our American culture.

Death came to Albert Haertlein on June 7, 1960. He is survived by his wife Ethel, his two sons John and James, and eight grandchildren.

May I close with another one of the great lexicographer's opinions: "No man," he is reported to have said, "is obliged to do as much as he can." I shall leave it to the friends of Albert Haertlein to tell whether such was his own belief and doing.

GORDON M. FAIR

OF GENERAL INTEREST

PROCEEDINGS OF THE SOCIETY

MINUTES OF MEETING

Boston Society of Civil Engineers

SEPTEMBER 28, 1960.—A Joint Meeting of the Boston Society of Civil Engineers with the Transportation Section, BSCE was held this evening at the United Community Services Building, 14 Somerset Street, Boston, Mass., and was called to order by President Arthur T. Ippen, at 7:00 P.M.

President Ippen stated that the Minutes of the previous meeting held May 18, 1960 would be published in a forthcoming issue of the JOURNAL and that the reading of those Minutes would be waived unless there was objection.

President Ippen announced the death of the following members:—

Armand W. Benoit, who was elected a member September 16, 1908, and who died May 15, 1960.

Benjamin W. Guppy, who was elected a member December 18, 1889, and who died July 10, 1960.

Albert Haertlein, who was elected a member February 29, 1929, and who died June 6, 1960.

The Secretary announced the names of applicants for membership in the Society and that the following had been elected to membership on May 18, 1960:—

Grade of Member—Alfred W. Hoadley, Warren H. Ringer, Frank B. Rogers, Francis X. Turcotte.

Grade of Junior—Joseph T. McColgan, Jr.

President Ippen stated that this was a Joint Meeting with the Transportation Section and called upon Robert A. Snowber, Chairman of that section to conduct any necessary business.

President Ippen announced that Mayor John F. Collins would be the speaker at the BSCE Dinner meeting to be held at the Statler-Hilton Hotel, Boston, on October 10, 1960, and urged members to attend and get acquainted with ASCE members attending the ASCE Convention.

Mr. Robert A. Snowber, Chairman of the Transportation Section introduced the speaker of the evening, Mr. Thomas J. McLernon, General Manager, Metropolitan Transit Authority, who gave an interesting talk on "M.T.A. and Boston Transportation Problems." Question period and discussion followed the talk.

Fifty-eight members and guests attended the dinner preceding the meeting and ninety members and guests attended the meeting.

The meeting adjourned at 8:45 P.M.

CHARLES O. BAIRD, JR., *Secretary*

OCTOBER 10, 1960.—A Dinner Meeting of the Boston Society of Civil Engineers was held this evening in connection with the National Convention of the American Society of Civil Engineers, at the Statler-Hilton Hotel, Boston, Mass., and was called to order at 8:30 P.M., by President Arthur T. Ippen.

President Ippen stated that the reading of the Minutes of the previous meeting held September 28, 1960 would be published in a forthcoming issue of the JOURNAL and that the reading of those Minutes would be waived unless there was objection.

President Ippen extended a cordial welcome to members of A.S.C.E. on the occasion of their Annual Meeting.

President Ippen then introduced the guest speaker of the evening, the Honorable John F. Collins, Mayor of the City of Boston, who gave a most interesting talk on "Rebuilding a City." Question period and discussion followed the talk.

At the end of the talk President Ippen, on behalf of the Boston Society of Civil Engineers, expressed thanks and appreciation to Mayor Collins for an interesting evening.

One hundred seventy-one members and guests attended the dinner and meeting.

The meeting adjourned at 9:45 P.M.

CHARLES O. BAIRD, JR., *Secretary*

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