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THE WATER SUPPLY SYSTEM OF METROPOLITAN BOSTON 1845-1947

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METROPOLITAN DISTRICT COMMISSION
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I. INTRODUCTION

This report presents the results of a historic sites survey of the water supply system of metropolitan Boston from its beginning in 1845 to the year 1947. The system is operated by the Metropolitan District Commission, Boston, which currently supplies water to thirty-five cities and towns in the greater Boston area. As of July 1, 1985, the system will be administered by the Water Resources Authority. The project was conducted during 1983-85 under two contracts with the MDC, and has been funded in part through grants from the Massachusetts Historical Commission. The purpose of this study has been to:

- compile an inventory of buildings, structures, sites and areas that are significant in the history and development of the metropolitan water supply system;

- establish a historical and developmental context within which cultural resources associated with the Metropolitan Water System can be interpreted and evaluated according to the criteria of the National Register of Historic Places; and

- develop recommendations which may serve as a guide to future cultural resource planning, interpretation, and conservation.

Products of this study include the following report, completed MDC resource inventory forms, USGS maps showing all resources recorded during the survey effort, and a thematic nomination to the National Register of Historic Places for significant features of the Metropolitan Water Supply System built prior to 1926.

The Metropolitan Water Supply System has three principal functions: collection, conveyance and distribution. Water is collected from upland watersheds by construction of dams and reservoirs. It is conveyed from reservoirs to the Boston metropolitan area in gravity aqueducts and pressure conduits. Once in the metropolitan area, water is distributed to member cities and towns through large pressure mains or from small receiving reservoirs and pumping stations. In effect, the Metropolitan Water System is a "wholesale" operation, supplying water in bulk to individual communities which then distribute it to residences, businesses and industries on the "retail" level.

The history of the Metropolitan Water Supply System has been characterized by a constant search for, and development of, new sources of pure water. Each phase in the development of the system has occurred on a scale greater than the one preceding it. The first major water supply for Boston was Lake Cochituate, developed in 1845-48 with a capacity of 16,000,000 gallons. The second supply, located on the Sudbury River and developed in relatively small increments between 1875 and 1894, had a total capacity of 80,000,000 gallons. Sudbury Reservoir (No. 5), completed in 1898, was substantially larger, its 7.2 billion gallon capacity greater than the other seven reservoirs in the Sudbury watershed combined. The 65-billion-gallon capacity of Wachusett Reservoir, completed in 1907, was not only the greatest by far in the system but one of the largest in the world at that time. Quabbin Reservoir, completed in 1940 with a capacity of 412 billion gallons, still qualifies as among the largest artificial bodies of water ever created, and today is the principal source of supply in the Water Supply System.

As new sources of supply have been developed, older portions of the water system have gradually been bypassed, or in other ways removed from service. To a significant degree, however, the unused facilities remain largely intact, although subject to irregular maintenance and, in some cases, increasing vandalism. As a result the Water Resources Authority and Metropolitan District Commission bear a complex responsibility to conserve and protect a valuable historical, architectural and technological legacy while at the same time meeting the rightful needs of their Boston-area constituency for ample supplies of pure water. It is hoped that this historic site survey will provide a concrete basis from which constructive planning for the future of the Metropolitan Water Supply System may proceed in a manner satisfactory to all concerned.

II. HISTORICAL AND ADMINISTRATIVE CONTEXT

The evolution of a public water supply system for Boston and the metropolitan area has proceeded in four well-defined stages. The initial stage (1825-1848) resulted in development of Boston's first public water supply, brought by aqueduct from Lake Cochituate in Natick to the Brookline Reservoir, in Brookline. The second (1871-1895) saw the extension of Boston's system to reservoirs on the Sudbury River and construction of another aqueduct. The third stage (1895-1926) resulted in creation of the Metropolitan Water District and further expansion of the system to the Nashua River at Clinton. The fourth (1926-47) was dominated by construction of Quabbin Reservoir on the Swift River, supplemented by diversion from the Ware River.

Each stage progressed through a cycle of investigation, recommendation, legislation, and implementation. Responding to public and/or professional concern about existing water resources, local or state government commissioned a study by a special board and/or expert consultant. The study projected future population statistics for the area, and estimated per capita consumption from those figures. Projection of anticipated demands were then considered in the context of existing supplies, and if the demand threatened the upper limits of available capacity (which it invariably did), the study then recommended development of an additional supply (Harbridge House 1972:I-1,2). The general recommendations in each study were accompanied by proposals for development of specific sources, including description of construction programs required to carry them out. The study became the basis for legislation authorizing construction of new works, which were duly completed and put into service. Within 30 years of each piece of enabling legislation, the cycle began again.

DEVELOPMENT OF A WATER SUPPLY FOR BOSTON

Prior to initiation of the first cycle, Boston-area inhabitants obtained water from springs, wells, ponds and small streams. The few limited supply and distribution systems were developed as private business ventures by individuals or by corporations chartered for that purpose. In 1652, the Water Works Company was organized to collect spring water in a "conduit," actually a small covered reservoir near the present site of Faneuil Hall, from which residents drew their own supply in buckets for domestic use or fire fighting. This venture was short-lived, and no other attempt to create a water supply in Boston was made until 1795-6, when the Boston Aqueduct Company was chartered to distribute spring water from Jamaica Pond in Roxbury. The company built a modest system of four pine log mains, supplemented by smaller wooden distribution mains, which supplied users on a fee basis. This venture proved quite successful, and by 1825 the system had grown to serve some 1,500 households through 15-18 miles of mains (Primack 1981:5-6; Baker 1889:28; LaNier 1976:174-175). There were only a few other Boston-area communities served by corporate owned water supply systems in this early period. Among them were Peabody, first supplied by Daniel Frye in 1796; and Salem, which with Peabody was supplied by the Salem & Danvers Aqueduct Company beginning in 1799 (Baker 1889:54, 57).

Although convenient for its subscribers, the Jamaica Pond supply was neither large enough to provide water throughout Boston, nor fully reliable in an emergency. As the city grew, so did the demand for clean water; but so also did the degree of pollution in many wells, due to lack of proper sewage disposal. The threat of fire, too, increased public concern about the available water supply. In April, 1825 a major conflagration, and the difficulties encountered in fighting it, brought the water supply issue to the forefront of public thinking. In response, the city appointed a committee to look into the matter, thereby embarking upon a decade of investigation and debate (Primack 1981:6).

The first study, conducted in 1825 by Dr. Daniel Treadwell at the behest of the committee, proposed development of Spot Pond in Stoneham and also utilization of the Charles River above Watertown to create a new water supply for the city (Treadwell 1825). Treadwell's recommendations, however, were soon lost in debates over a related issue, that of who -- the city or private enterprise -- was best qualified to supply water from any source.

In 1834, the water question remaining unresolved, the city began a second investigation. The committee charged with the study turned to Loammi Baldwin, a noted civil engineer from Charlestown, for advice. Baldwin examined four categories of potential water sources (cisterns, common wells, artesian wells, and aqueducts and pumping systems). Selecting aqueducts and pumping systems as most feasible for Boston, Baldwin then presented a historical and technological overview of systems in Rome, Lyons, Constantinople, Paris, Richmond (Va.), Glasgow and Edinburgh. Returning to the immediate issue of Boston, Baldwin examined sources from five to 15 miles outside the city, and ultimately settled on Long Pond in Natick as the only source meeting the twin criteria of water quality and elevation sufficient for delivery of the supply by means of a gravity aqueduct (Baldwin 1835:10-44, 58-59). Interestingly enough, Baldwin was hired, at the same time that he was writing his report for the

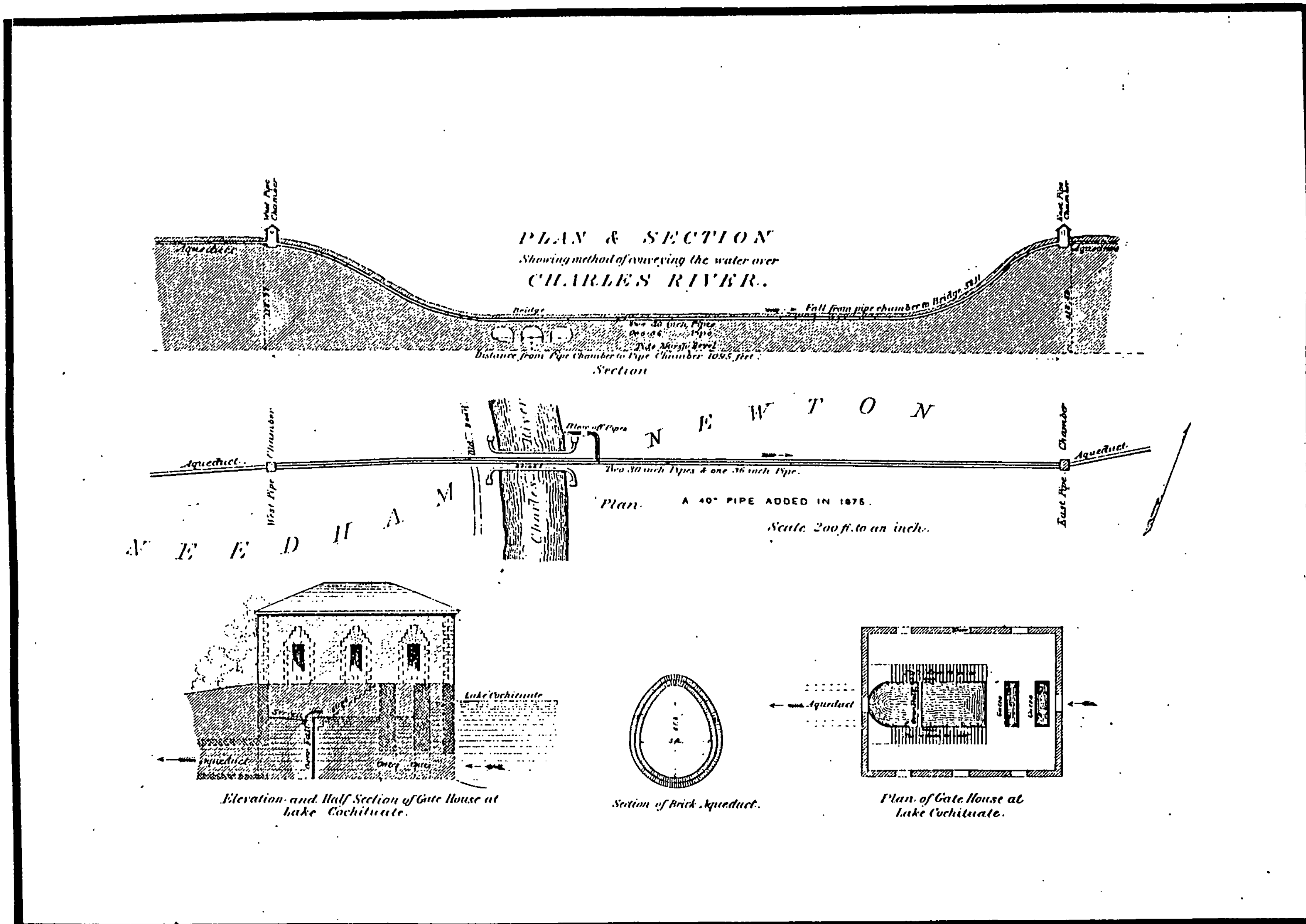
City, by the directors of the Boston Aqueduct Corporation to "...examine their whole scheme of water works, and report upon the best method of extending their establishment...(Baldwin 1835: 10-44, 58-59). He enclosed his report to the aqueduct company in his report to the city council (he suggested the company should upgrade its system and plan for expansion) and then concluded that "This establishment (Boston Aqueduct) will not interfere with any plan the city may have in view as the corporation will be perfectly ready to surrender their franchise to the City upon equitable and fair terms, to be determined by disinterested and intelligent persons, if the corporation and the City authorities cannot adjust it themselves" (Baldwin 1835: 10-44, 58-59).

Although Baldwin's recommendations generated much interest among Boston residents and in the city council, the projected cost of his proposed system was of no little concern. As a result, the city commissioned yet another study, from civil engineer R. H. Eddy (Eddy 1836). Eddy, in reviewing past studies, decided in favor of Mystic Lake and Spot Pond, their water to be conveyed to a reservoir on Beacon Hill by steam pumps.

Eddy's proposals fared no better than had previous recommendations. In 1837, a commission consisting of Daniel Treadwell, James Baldwin (brother of Loammi) and Boston publisher Nathan Hale reviewed all three studies. Treadwell and Hale recommended utilization of dual sources (Spot Pond and Mystic Lake) and a pumping system, while Baldwin, not surprisingly, favored his brother's proposed aqueduct from Long Pond (Report of the Commissioners...1837: 35, 48-51). This disagreement among experts over sources and methods of supply was complicated by the continuing controversy over the merits of public versus private funding, and as a result, no decisions were reached on any of the issues.

Public interest, however, gradually came round to the support of Loammi Baldwin's Long Pond proposal, a support vindicated by yet another commission which in 1844 recommended development of Long Pond after visiting New York's Croton system, then under construction (Report of the Commissioners...1844). Resistance from private water companies and from those who preferred development of Spot Pond, however, remained strong. Ultimately, the whole issue was brought before the state legislature, which commissioned still another investigation, this time by "unbiased" experts, Croton's Chief Engineer John B. Jervis and Professor Walter Johnson, a Philadelphia chemist.

The Jervis-Johnson report strongly supported Loammi Baldwin's proposals for development of Long Pond, and in addition proposed certain changes in the aqueduct's route and in the design of the conduit itself (Report of the Commission...1845). The document, after another round of discussion, became the basis for legislation in 1846 authorizing the City of Boston to "take, hold and convey into and through the said City the water of Long Pond, so called...". To design and build the new system, the City of Boston



Structures on the Cochituate Aqueduct. From <u>A History of the Boston Water Works for the Years 1868 - 1876</u>.

called upon Jervis' services as a consultant, with E. Sylvester Chesebrough and William S. Whitwell as Division Engineers.

Work was begun in 1846 and completed, with due public rejoicing, in 1848 (Celebration of the Introduction of the Water...1848). The centerpiece of the new system was the 14.5 mile brick aqueduct between Long Pond (renamed Lake Cochituate) and Brookline reservoir, with handsome gray granite chambers in the then-still fashionable Greek Revival style.

Despite the success of the new public water supply, within six years the Cochituate Water Board began to forsee an increasing demand for water which Lake Cochituate would, in the not so distant future, be unable to meet. The Cochituate delivered 16,000,000 gallons of water a day to a population of 93,383 but Boston grew at a far greater rate than Jervis had calculated in the 1840s. By 1850 the population had jumped to 136,881 and by 1865 it was almost 192,318 (U.S. Census).

In 1869, the Cochituate Water Board was forced to contract with the City of Charlestown for additional water from the latter's Mystic Lakes supply, developed in 1864. The inadequacy of this measure, however, was demonstrated in 1870-71, when a drought resulted in an "unusual drawing down" of Lake Cochituate. Exacerbating the situation was a devastating fire in 1872, which destroyed 63 acres of Boston, including the city's downtown (King 1878). Alarmed, the Water Board hastily constructed temporary works that linked the Sudbury River to Lake Cochituate. In service during 1872 and from 1875 to 1878, the system included a dam on the Sudbury River near Farm Pond, a smaller dam on a connecting ditch between the river and Farm Pond; and a connecting ditch between Farm Pond and Beaver Dam Brook, a tributary of Lake Cochituate through which water would flow into the depleted lake (<u>Boston Water Works</u>...1882).

The second cycle in the development of the Boston water supply system proceeded more swiftly than the first, not least because the precedents of public financing and utilization of gravity systems to convey water from distant sources had been established and proven successful by construction of the Cochituate works.

In 1871, the Cochituate Water Board retained Joseph P. Davis, a civil engineer who had worked on designs for Boston's sewer system, to investigate potential sources of an additional supply within a 50-mile radius of the city. Davis recommended development on the Sudbury River due to its quantity and consistency of supply. Although he felt that the Sudbury water was not always of the highest quality, Davis believed this could be ameliorated with a series of large settling and storage reservoirs that would allow natural cleansing of the water by pooling it and letting heavier foreign material fall to the bottom. Mains in the dams would be placed so that water could be taken at higher levels to avoid pollution (<u>Boston Water Works</u>...1882:7).

In April 1872, the Sudbury River Act, authorizing use of the river as a water source for Boston, was signed into law. Davis was appointed City Engineer, and in 1873 he presented his final report, which outlined in detail the system of storage reservoirs, conduits and chambers that would constitute Boston's "Additional Supply" (Boston Water Works...1882:7-8; Acts of 1882, Ch. 177).

Construction was underway when, in October 1873, the city council was informed that the Water Board had not obtained proper authority to take land in pursuance of the Sudbury River project. Discussion of that particular problem led to general questioning of the appropriateness of the whole project. For the next 15 months, the city ordered a variety of studies on water quality and alternative sources of supply, most of which simply covered, in varying detail, Davis' original investigations. In December 1874 the city council, at last convinced of the merits of the Sudbury project, authorized resumption of planning and construction (Boston Water Works...1882:9, 28-29). Under Davis as Chief Engineer, and Alphonse Fteley as Resident Engineer, the city constructed an aqueduct from Farm Pond in Framingham to Chestnut Hill Reservoir in Brighton, three settling and storage reservoirs on the north branch of the Sudbury in Framingham, and a conduit from the dam at Framingham Reservoir No. 1 to Farm Pond. A fourth reservoir was added in 1885, a fifth in 1894, and a sixth begun in 1895. In addition, the Sudbury Aqueduct in 1886 was extended from its original beginning at Farm Pond, to Framingham Reservoir No. 1 (Fitzgerald 1898:1).

ORIGINS OF THE METROPOLITAN CONCEPT

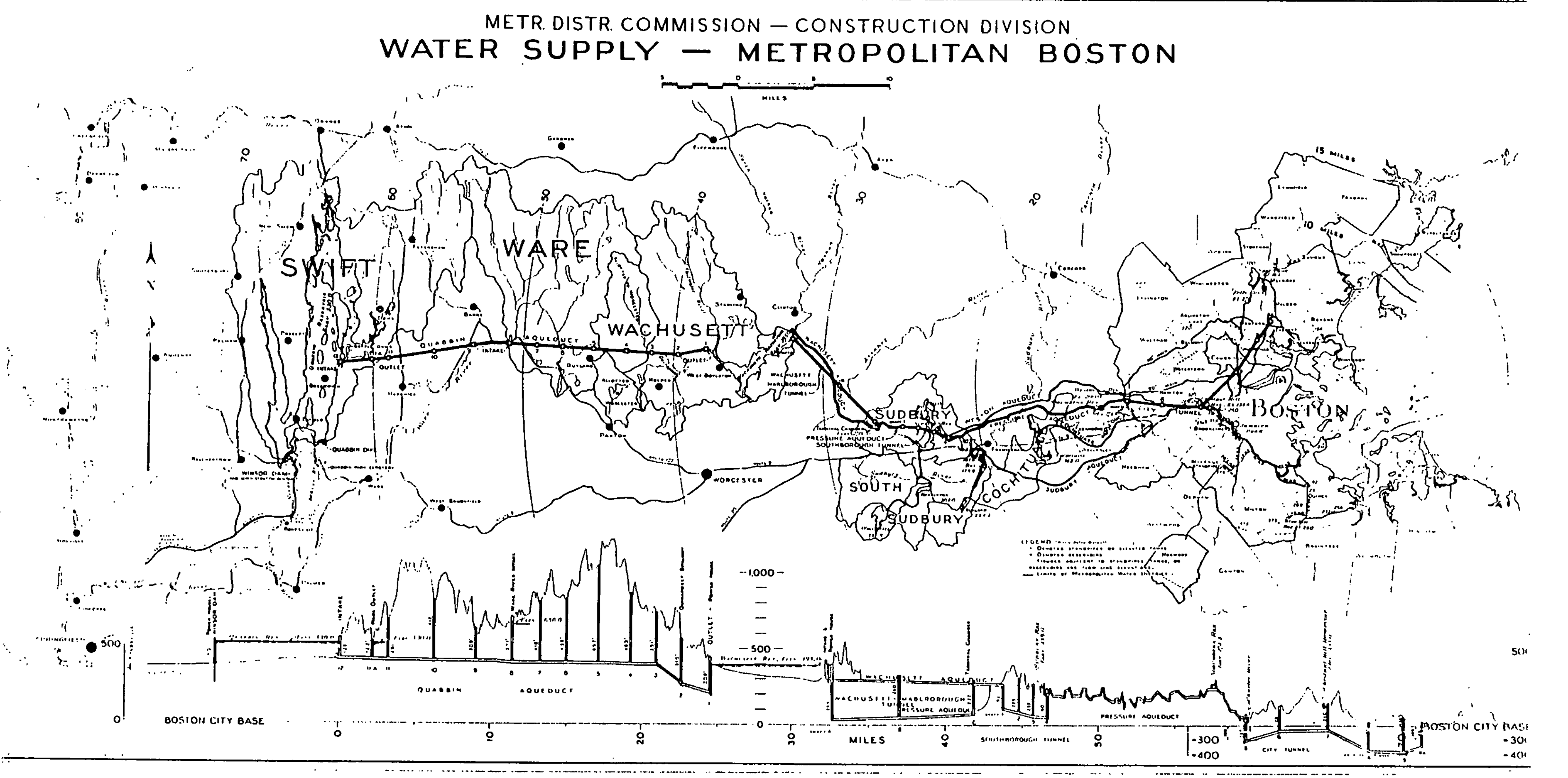
Initiation of this second cycle in the early 1870's coincided with the emergence of issues that were to have a significant bearing on the third cycle in the history of the Boston area's water supply system. One issue was the physical growth of Boston and its consequent impact on neighboring communities; the other was public health.

Until the late 18th century, the city of Boston was largely able to accommodate development and population growth within the confines of the Shawmut Peninsula. From about 1790 to 1860, however, the city's population grew 870 percent, from 18,320 to 177,840 (Wakstein 1972:286). Intensive development and redevelopment within Boston's existing boundaries proved only a temporary solution to ever-increasing demands for housing, commercial space and industrial facilities (Potter 1873:15). In the face of a growing need for more land, the city began a program of reclamation, filling in coves and extending the shoreline along the sea. The landfill project in the Back Bay created nearly three square miles of additional land, but even this proved insufficient (Wakstein 1972:287).

The failure of reclamation to solve Boston's long-term land problems led to proposals for the annexation of adjacent, less populated communities -- a precedent established in 1804 with the annexation of South Boston. During the early 1870's a variety of annexation schemes were advanced, among them Sylvester Baxter's proposal for a "County of Boston" which would include all communities within a 10 mile radius of the State House (Beale 1932:121). Another advocate of annexation was Joseph Potter, a state senator from Arlington, who proposed annexation of fifteen communities around the city (Potter 1873). Such ambitious schemes did not come to fruition, but between 1867 and 1874 Roxbury, Dorchester, Charlestown (along with its Mystic Water Works), Brighton and West Roxbury were brought within the Boston city limits by legislative fiat (Beale 1932:118).

Arguments in favor of annexation included the need to "present a prestigious statistical position" in relation to other cities; to acquire greater representation, and therefore influence, in the state legislature and in Congress; and to counterbalance the growing proportion of foreign-born who were arriving in the central city in large numbers (Wakstein 1972: 287-88). No less important in the view of annexationists, however, was provision of public sevices. Boston's growth between 1790 and 1860 had been paralleled by population increases, although on a smaller scale, in neighboring communities (Wakstein 1972:276). Among the results of these increases was escalating competition among cities and towns for the means to provide public services, particularly water supply and sewage disposal.

In the early 1870's, when the issue of an additional water supply for Boston from either the Sudbury or Charles River was raised in the legislature, communities bordering these watercourses registered strong objections. Among them was Framingham, which declared the "right of inhabitants of the town to use their own water for domestic and manufacturing purposes" (Boston Journal, 15 March 1872). In addition to debating Boston's needs, legislators in the 1872 session confronted petitions from no fewer than 27 other cities and towns for authority to take water from rivers and ponds, often from the same sources (Boston Daily Advertiser, 7 March 1872). Such controversy appeared to Joseph Potter and Sylvester Baxter ample justification for annexation, which they believed would end competition among communities and permit economies of scale to provide quality public services at minimal cost to the users. Others, however, saw a less drastic, but equally effective solution in the creation of special agencies operating on the metropolitan scale, to develop and maintain particular services for communities that would retain their corporate identities. An editorial in the Boston Daily Advertiser stated the concept most clearly: "It deserves to be considered whether the interests of the metropolitan community....would not be better served....for the purpose of water supply and drainage if it were treated as one district, and were placed under the


METR. DISTR. COMMISSION — CONSTRUCTION DIVISION
WATER SUPPLY — METROPOLITAN BOSTON
MILES
SWIFT
WARE
WACHUSETT
SUDBURY
SOUTH SUDBURY
COCHITUATE
BOSTON
QUABBIN AQUEDUCT
WORCESTER
WACHUSETT AQUEDUCT
WACHUSETT MARLBOROUGH TUNNEL
PRESSURE AQUEDUCT
SOUTHBOROUGH TUNNEL
SUDBURY AQUEDUCT
WESTON AQUEDUCT
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care of a single board, aided by the best engineering skill available" (Boston Daily Advertiser, 7 March 1872). With regard to water supply, however, such proposals at the time found few advocates. From 1873 to 1876, at least eight communities around Boston built their own water systems, and two more purchased existing systems from private corporations (Baker 1889).

The appearance of water supply and sewerage as major issues in the annexation debate paralleled a rising concern for public health at the state level. In 1869, the legislature created a State Board charged with taking "cognizance of the interests of health and life among the citizens of this Commonwealth" (Mass. Board of Health Annual Report, 1871). This was one of the earliest state Health Boards in the country. Three years later, in 1873, the Board of Health conducted an investigation of "the questions of sewage, sewerage, and water supply," and in particular the "increasing joint use of water courses for sewers and as a source of supply for domestic use" (Mass. Board of Health Annual Report, 1874:63). This concern can be seen as a direct response to mid-19th century scientific discoveries that germs carried disease, and that waterborne germs, in particular, were responsible for such dread diseases as typhoid and cholera (LaNier 1976:174).

The report issued by the Board of Health in January, 1873, found that only Boston and Worcester had "anything like a comprehensive sewerage system" and that most cities and towns (other than those on the coast) discharged sewage directly into the nearest river, stream or pond. "What becomes of this refuse lower down the stream [was] a matter of little concern" -- at least to the disposing communities (Mass. Board of Health Annual Report, 1873: 61, 40). Lack of proper sewerage also contributed to pollution of waters set aside for consumption. Natural drainage from the growing City of Natick led directly to Lake Cochituate; and Woburn and Winchester were allowing sewage to drain into the Mystic Lakes (Ibid: 106). As a general conclusion, the Board predicted that unless legislation against the pollution of watercourses was more effectively enforced, "the spoiling of our rivers as sources of water supply is a question of time, of density of population, and of their size" (Ibid.:100).

Thus the early 1870's saw serious public discussion of two important ideas -- the concept of a metropolitan approach to certain kinds of services; and the belief that pollution of watercourses would increasingly render them unfit for domestic use, and of no less concern, would continue to present potentially serious hazards to public health.

Not until the 1880's, however, were these two issues directly connected. In 1886, the Board of Health was reorganized to include an engineering division, headed by former Water Board engineer Frederic Stearns. That same year, the state legislature published a "Report of a Commission Appointed to Consider a General System of Drainage for the Valleys of the Mystic, Blackstone and Charles Rivers." The study, in which the Board of Health played a prominent role, addressed the increasing problems of sewage disposal along these watercourses, and determined that a system to collect sewage from many communities and carry it away to safe disposal should be designed and constructed as soon as possible. The system proposed was the construction of two main sewers, for the Charles and Mystic Valleys, to be operated by "a central agency and authority, which can for this special purpose override town boundaries and disregard local susceptibilities." Establishment of such an agency was crucial to the success of the projects, which "are neither of them of local or municipal character. They partake, on the contrary, preeminently of the nature of great arterial channels for the benefit of wide metropolitan districts" (Report...1886:liv).

A second study, completed in 1889, focused particularly on the specific programs and construction needed for sewage disposal in the Charles and Mystic river valleys (Mass. Board of Health 1889). This document became the basis for legislation enacted in June of that year establishing a Metropolitan Sewerage Board (Acts of 1889, Chapter 439). The three-man Board, appointed by the Governor, was authorized to "construct, maintain and operate...such main sewers and other works as shall be required for a system of sewage disposal" for eight cities and ten towns, and to contract with other towns to supply sewerage services in the future.

THE METROPOLITAN WATER ACT

With creation of the Metropolitan Sewerage Board and a solution to the Boston area's sewage problems in hand, the third cycle in the development of Boston's water supply began. Chapter 495 of the Legislative Acts for 1893 ordered the Board of Health to conduct an inquiry into the matter:

> Section 1. The state board of health is hereby authorized and directed to investigate, consider and report upon the question of a water supply for the City of Boston and its suburbs within a radius of ten miles from the state house, and for such other cities and towns as in its opinion should be included in connection therewith.
>
> Section 2. The said board shall forthwith proceed to investigate and consider this subject, including all questions relating to the quantity of water to be obtained from available sources, its quality, the best methods of protecting the purity of the water, the construction, operation and maintenance of works for

storing, conveying or purifying the water, the cost of the same, the damages to property, and all other matters pertaining to the subject.

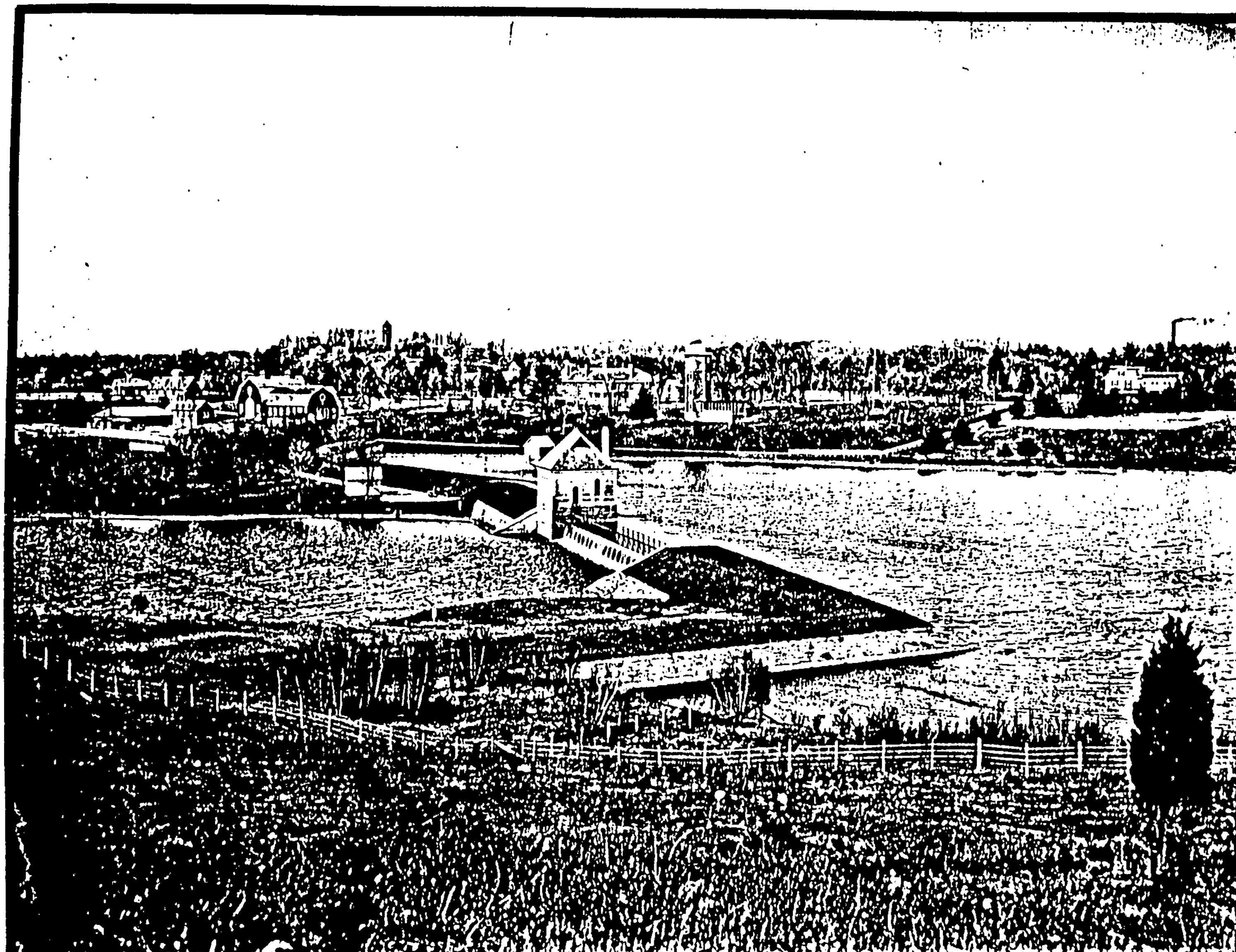
Section 3. The said board shall have power to employ such engineering and other assistance and to incur such expenses as may be necessary for carrying out the provisions of this act.

With the assistance of Chief Engineer Frederic Stearns, Joseph P. Davis (Former City Engineer and Architect of the Sudbury System), Dexter Brackett (of the Water Board's Distribution Department), and Desmond Fitzgerald (Superintendent of the Sudbury System), the Board of Health in 1895 issued a landmark report that in effect became the blueprint for development of a metropolitan water supply system.

In the opening sections of the report, the Board forthrightly stated that it was guided in the study by justifications it had developed previously in support of a metropolitan sewerage system (Massachusetts Board of Health 1895:ix). The Board cited the "familiar experience in this part of the world" of the "failure of sources originally supposed to be abundant to properly meet the wants of their respective communities for any considerable length of time," a situation directly attributable to increasing demands for pure water by "the householder of to-day" (Ibid: x). Protection and improvement of the commonwealth required "protection of the purity of waters," thereby leading to "greater cleanliness of person, clothing and all surroundings..." Ibid:xi). Another factor in the need for adequate water supplies was the growth of population in and around Boston, an "insoluble problem" with which the Board "have not deemed it necessary or advisable to busy ourselves" except as it directly concerned the question of water quality, demand, and supply.

Having established the need for pure water, not only in Boston, but in many neighboring communities, the Board went on to consider a wide range of possible solutions. One was filtration of existing supplies, plus development of additional supplies in the metropolitan area that would also require filtration. Filtration facilities, however, were found to "require continuous care on the part of well-trained attendants," and were subject to constant danger from "inefficient administration or inherent defects of construction" that could result in the introduction of germs into the public water supply (Massachusetts Board of Health, 1895:xv). In light of these considerations, and the fact that as of 1895 the use of filter beds had "not been tried upon a large scale in this country" (Ibid:13), the Board largely rejected a large-scale filtration program in favor of the procurement of new, clean sources of supply.

Possible sources dismissed out of hand included the Neponset, Blackstone, Taunton, Concord, Quaboag, and Connecticut Rivers, due to their polluted condition or to the expectation that


GATE HOUSE AND DAM FRAMINGHAM RES. NO. 2. APR. 28, 1910. 6489

From the Metropolitan District Commission Photograph Collection.

increasing population and development would render them polluted in the near future (Ibid:122-3). Another group of potential sources included Lake Winnepesaukee and Sebago Lake, and the Merrimack, Shawsheen, Ipswich, and Charles Rivers. The two lakes were ultimately rejected because they lay outside Massachusetts. The Merrimack was determined to require extensive filtration, and thus also rejected (Ibid:103-8). The Charles River above South Natick was dismissed due to probable construction cost and inherently poor quality, the Shawsheen due to rising population and to increased market gardening in the Lexington area, and the Ipswich due to difficulty in creating storage reservoirs and to the relatively small available yield. In addition, five ponds in Lakeville were considered and rejected due to small yield and the fact that the water would have to be pumped (Ibid:111-116).

The source finally selected by the Board of Health as the principal water supply for the Boston metropolitan area was the south branch of the Nashua directly above the city of Clinton, due to its 108-square-mile watershed, high quality, and relatively low population (Massachusetts Board of Health, 1895:xvi). The Board proposed construction of a very large reservoir above Clinton, "its area and depth...so great that it will contain, at nearly all stages...a full year's supply when double the quantity now used in the metropolitan district is drawn from it and the Sudbury and Cochituate areas" (Ibid:xvii). This reservoir would be connected to Sudbury Reservoir #5, then under construction by the City of Boston, by a 12-mile aqueduct; and from there water could be conveyed through the Sudbury Aqueduct to the main distribution facilities at Chestnut Hill in Brookline (Ibid:xvi,xvii). Anticipating a rising demand for water in communities north of Boston, the Board also found that another aqueduct, directly from Sudbury Reservoir, would be required within a decade, and to that end outlined the specifics of a 13-mile conduit from the reservoir to the town of Weston (Ibid:xviii).

The program thus outlined was expected to provide a sufficient supply of pure water to the Boston metropolitan area for about 20 years. Assuming continued increases in population and in demand during that time, the Board proposed future expansion of the water supply system by the addition of tributaries of the Assabet River, or by extension of the works to the Ware River. Beyond the Ware, the Board identified further sources of supply from the Swift, Westfield and Deerfield Rivers. "The very great merit of the plan now submitted is to be found in the fact that this extension of the chain of the metropolitan water supplies to the valley of the Nashua will settle forever the future water policy of the district, for a comparatively inexpensive conduit can be constructed through to the valley of the Ware River, and beyond the Ware River lies the valley of the Swift; and, in a future so far distant that we do not venture to give a date to it, are portions of the Westfield and Deerfield Rivers, capable, when united, of furnishing a supply of the best water for a municipality larger than any now found in the world" (Mass. Board of Health 1895: xvi-xvii).

The Board of Health report was issued in February, 1895, and within the year the legislature passed the Metropolitan Water Act (Acts of 1895, Ch. 488). The Metropolitan Water Board, "acting for the Commonwealth, shall construct, maintain, and operate a system of metropolitan water works substantially in accordance with the plans and recommendations of the state board of health..." for seven cities and six towns in the Boston metropolitan area, to be called the Metropolitan Water District (the number to be increased as other communities within a 10 mile radius of the State House wished to join). The Metropolitan Water Board was authorized to take, on or before January 1, 1898, "all lands and all the ponds, basins, reservoirs, filter beds, dams, aqueducts, conduits, pumping stations, pipes, pumps and other property held by the City of Boston" for water supply and distribution west of, and including, Chestnut Hill Reservoir, and also Spot Pond, originally developed by the communities of Malden, Melrose and Medford. In addition to acquisition of these existing facilities and systems, the Water Board was authorized to complete Sudbury Reservoir and, its largest task, to take "by purchase or otherwise" the waters of the south branch of the Nashua River through construction of a reservoir and the appropriate systems for conveying the water to the metropolitan area.

The Metropolitan Water Board, consisting of Henry R. Sprague, Wilmot R. Evans, and John R. Freeman, selected Frederic Stearns as chief engineer, to be assisted by Dexter Brackett (Distribution) and Thomas F. Richardson (Aqueduct Department). Within six months, the Board embarked upon a twenty-year-long program of construction and improvements in five general categories: supply, relocation of existing transportation routes, distribution, water quality, and hydropower.

Largest and most costly was the tapping of new water supplies from the north branch of the Sudbury and south branch of the Nashua through construction of reservoirs and dams, and the building of aqueducts to carry the increased supply to distribution. The Metropolitan Water Board's first task in this program was completion, in 1898, of Sudbury Reservoir, which had been initiated by the City of Boston and was underway at the time the Board took over in 1896. Simultaneously, the Wachusett Aqueduct was built west from Clinton to Sudbury Reservoir, and its completion in March, 1898 marked the first taking of water from the Nashua River. In 1897 stripping and filling, and construction of two huge earthen dikes, at Wachusett Reservoir were begun, to be completed in 1905. Wachusett Dam, begun in 1900, was finished in 1906, and the reservoir raised to full level in May 1908. In the meantime (1901-03), the Weston Aqueduct, like the Wachusett having a capacity of 300 mgd, was completed to augment the old Sudbury conduit in the conveyance of water from the Sudbury watershed to the Boston metropolitan area.

Construction of Sudbury and Wachusett reservoirs required relocation of many roads and several rail lines. As part of the relocation effort, the Metropolitan Water Board built numerous causeways and bridges on roads, both public and private, and for segments of the Central Massachusetts, and the New York, New Haven and Hartford railroads. For the CMRR, the Board also built a 1,080-foot tunnel and 921-foot steel viaduct over the Nashua River below Wachusett Dam.

The creation of additional water supplies necessarily required both renovation of existing facilities and construction of new works at the distribution end of the system. At Chestnut Hill in Brighton, the high-service pumping station was enlarged and equipped with another engine; and a new low-service station was added to the complex. A new pumping station was built at Spot Pond, in Stoneham; the existing reservoir was enlarged and two built in Middlesex Fells. New pumping stations were also constructed in Arlington and Hyde Park. In addition, existing standpipes were replaced on Bellevue Hill, Forbes Hill, and in Arlington. The distribution system was also expanded with miles of new mains throughout the Metropolitan Water District.

Construction under the Metropolitan Water Act included not only supply and distribution facilities, but also works that were intended to preserve the quality of water in the reservoirs. In 1898, the Metropolitan Water Board initiated a program of swamp drainage in areas near the Wachusett Aqueduct open channel in Southborough. Stone-lined ditches were constructed along the edges of these swamps, to collect water and channel it to small settling basins before it entered the reservoir. A similar program was begun in selected areas around Wachusett Reservoir and Lake Cochituate soon thereafter.

Four larger water quality projects involved construction and improvements of systems to filter sewage and other impurities from streams flowing into the reservoirs. The Pegan Brook Filter Beds were constructed by the City of Boston in 1893 to filter water from Pegan Brook, which ran through the center of Natick, before the brook water reached Lake Cochituate. This system was considerably upgraded in 1901. On the northwest side of Sudbury Reservoir, water from Marlborough and Walker Brooks was collected in a settling reservoir, from which it was channeled into a series of filter beds before passing into the reservoir. In 1907, a series of filter beds were constructed near Sterling, to clean water flowing through that town into Wachusett Reservoir.

The largest of the Water Board's water quality works was located at Clinton. Prior to construction of Wachusett Reservoir, the city discharged sewage directly into the Nashua River. In order to compensate Clinton for the loss of its traditional sewage disposal methods, and because of local governmental pressure, the Metropolitan Water Board built intercepting sewers, a covered receiving reservoir, filter beds and a pumping station during 1898-99. Although this facility is no longer in service, the MDC continues to process Clinton's sewage to this day.

Among provisions of the 1895 Metropolitan Water Act, one gave the Water Board authority to exploit the hydropower potential at any

Pipe Arch on the Sudbury River Siphon, Weston Aqueduct, Framingham and Wayland. Built 1902-1903.

of the facilities under its control. Between 1910 and 1916 this potential was realized through installation of hydroelectric power generating equipment at both Wachusett and Sudbury Dams. At Wachusett, this was easily accomplished, because the lower gate chamber had been designed, and built, in anticipation of hydro-power production. At Sudbury, however, installation of three turbines required extensive alterations and addition of special gates and tanks to control hydraulic surges.

Transmission of electricity from Wachusett in August 1911 marked the first known instance of hydroelectric power generation from a domestic water supply (Thayer and Allardice 1914). The Sudbury plant was put in operation in early 1916, and the following year a transmission line was completed along the Wachusett Aqueduct right-of-way to connect the two facilities.

BEYOND WACHUSETT

"The Metropolitan Water Act...called for construction of certain works within the first ten years following the passage of the Act, and certain other works within the succeeding ten years. The works contemplated for the first decade have been completed, as well as the larger part of those which were proposed for the second decade, which is now half completed" (Metropolitan Water and Sewerage Board 1909:11). This statement was made two years after completion of the largest single project in the metropolitan water system, Wachusett Reservoir and Dam. In the following decade, construction of new works tapered off, and activity gradually centered on operation and maintenance of the existing water supply system. Continuing the trend toward centralization of metropolitan administrative functions, which began in 1901 with creation of the Metropolitan Water and Sewerage Board, the legislature in 1919 established the Metropolitan District Commission, which took over not only the water supply and sewerage systems, but also the Metropolitan Parks Commission. Also that year, mindful of the 20-year timetable projected in the Board of Health's 1895 report, the legislature initiated the fourth cycle in the development of the water supply system by ordering a joint board to review the system as it then stood and to develop recommendations for the future (Resolves of 1919, Ch. 49). The Board was composed of members of the MDC Water Division and the Board of Health, and included X.H. Goodnough, who had succeeded Frederic Stearns as the latter's Chief Engineer in 1895.

The Joint Board issued its report in 1922. The Board found that not only was the population of metropolitan Boston steadily increasing, but that rising living standards, plus business and industrial growth, fostered an increase in per capita consumption as well (Goodnough 1922:189,206). It was therefore estimated that by 1930 the demand for water would exceed the safe yield of existing sources of supply by nearly 10 mgd. This estimate considered only communities then members of the Metropolitan Water

District, and did not take into account the demands of other towns within the district's 10-mile radius from the State House that might wish to join by 1930 (Goodnough 1922:220).

Having concluded that the existing system would prove inadequate within a decade, the Joint Board referred to the 1895 report, which had guided development of the Metropolitan Water System for over 25 years. The Board recommended first the diversion of water from the Ware River through a tunnel to Wachusett Reservoir. It also recommended development of a large-scale reservoir at Enfield, which would collect only the flood flows of the Swift River, yet have a capacity of 400 billion gallons. Construction of this reservoir would require removal and/or relocation of a significant number of homes and families, with Enfield, Dana, and Greenwich subject to the greatest impact. In connection with this reservoir, the Ware-Wachusett Tunnel would be extended to the Swift. This portion of the conduit could then convey water either west from the Ware to the Swift Reservoir, or east from the Swift to Wachusett Reservoir (Report of the Joint Board 1922: 16,18,20). The Joint Board recommended that the Ware-Wachusett tunnel be constructed as soon as possible, as portions of water so obtained were badly needed in the City of Worcester. Somewhat unexpectedly, however, the Board "did not presume to say" when the Swift River reservoir would in fact be needed (Report of the Joint Board 1922:20).

The report of the Joint Board was not entirely well-received, either in the legislature or, most certainly, in towns facing possible inundation by the proposed Swift river development. Two years after publication of the Joint Board's report, the legislature called for a new committee to "study further" the question of metropolitan Boston's water supply (Acts of 1924, Ch. 491). Among the issues to be examined were the Joint Board's recommendations for the Ware and Swift Rivers, and just how soon an additional supply, from whatever source, would in fact be required. The new commission, called the Metropolitan Water Supply Investigating Commission, was to draw upon the advice and recommendations of an expert in the field of water supply engineering. However, the legislature, as it had in 1844, specifically demanded the services of a "disinterested engineer," in other words, an engineer from outside the system.

The second report was issued in December 1925, with major contributions from New York engineer Allen Hazen and Boston engineer Leonard Metcalf. The document offered a program substantially at variance with that of the Joint Board. The latter's proposed Swift and Ware river diversions were rejected on the grounds that those projects would require great expenditures in the very near future for a supply that might not be needed for a very long time, "or possibly never." Another factor in the Investigating Committee's decision to reject the Swift River development was the strong objection from communities in that area to "what is deemed to be an unnecessary encroachment upon existing local rights..." The alternative proposed was development on the upper Ware with a dam and reservoir at Barre Falls, chiefly to supply the city of Worcester, with the remaining water being available for metropolitan Boston. For additional supply, the Committee recommended diversion of branches of the Assabet River into Wachusett Aqueduct by construction of intake dams, aqueducts and small pumping stations. The Committee also recommended eventual utilization of the Ipswich River and Hobbs Brook Reservoir in Cambridge, the latter by raising the level of the existing dam approximately 30 feet. Water from both these sources, however, would require filtration before it could be available as a supply. Filtration was also proposed for the south Sudbury system, by construction of "suitable purification works," thereby reactivating a source which had been relegated to emergency use due to a decline in water quality (Report of the Metropolitan Water Supply Investigating Committee 1925:12-17).

Despite the efforts expended in the "further study," the state legislature in the end adopted the recommendations presented by the Joint Board in 1922. Certainly the political influence of the Board of Health and the MDC was a factor in this decision. Also, the weight of tradition lay behind the Joint Board's proposal, in the form of the 1895 study that had proved so successful a basis for the initial development of the metropolitan water supply system. Another likely factor was the Investigating Committee's reliance on filtration of both existing and new sources, which was likely to be unpopular among a citizenry by now well accustomed to the enjoyment of pure, unfiltered water.

THE METROPOLITAN DISTRICT WATER SUPPLY COMMISSION

Chapter 375 of the Acts of 1926 provided authorization for the first phase in the extension of the Metropolitan Water Supply System to the Ware and Swift Rivers, the diversion of Ware River water to Wachusett Reservoir. However, the MDC's Water Division, whose members had participated in the Joint Board recommending the work, was left out of the new venture. Instead, the legislature created a new agency, the Metropolitan District Water Supply Commission, to oversee design, contracting and construction of the Ware-Wachusett tunnel. The only connection with the MDC lay in the fact that the MDC's Commissioner, at the time Davis B. Keniston, was designated chairman of the Water Supply Commission. Otherwise, the Water Supply Commission was given its own budget, administrative organization and staff, and was permitted to operate outside of civil service regulations concerning hiring, promotion and salaries. Frank E. Winsor, who had been an engineer with the Metropolitan Water Board from 1895 to 1902, supervising construction of Wachusett Reservoir and Dam and the Weston Aqueduct, was appointed Chief Engineer of the Water Supply Commission, with Karl Kennison, formerly an associate of John R. Freeman on the Colorado River Project as Designing Engineer (Metropolitan District Water Supply Commission 1926:2,3).

The Metropolitan District Water Supply Commission existed for twenty-one years, operating despite the Depression, World War II, and periodic calls for its abolition. The Commission's first task was the Ware River diversion, which was accomplished in 1931 upon completion of the Ware-Wachusett tunnel and its extraordinarily sophisticated intake works. In 1927, the state legislature authorized construction (Chapter 321) of the Swift-Ware segment of the tunnel, and also construction of the reservoir on the Swift River.

In January of 1928, however, the State of Connecticut filed before the U.S. Supreme Court a bill of complaint against Massachusetts. Connecticut claimed that the Ware-Swift project would adversely affect navigation on the Connecticut River, and also injure the state's agriculture by diverting sediment-laden floodwaters that had historically contributed to the fertility of the Connecticut Valley. In addition, Connecticut claimed that ample sources of water supply could readily be developed in eastern Massachusetts (the "Fifteen Watersheds" plan, which incorporated many of the recommendations of the 1925 Metropolitan Water Supply Investigating Committee report); and that if such sources required filtration because they were polluted, it was the Commonwealth's fault for allowing pollution to occur in the first place (Kennison 1947:156; Winsor 1931:279, 282).

The Supreme Court appointed a Special Master, Charles W. Bunn of Minneapolis, to take evidence and to report findings of fact, plus his conclusions, concerning the case. The Special Master found no hard evidence that Connecticut would suffer loss of navigation, and that actual amount of injury to agriculture from diminished flooding could not be "predicted or proven." Concerning the alternative watershed issue, Bunn concluded that Massachusetts could not legitimately be "punished" for pollution of eastern sources of supply by denying it the right to divert water from the cleaner Swift and Ware. He pointed out that Massachusetts and its communities, in not adequately controlling pollution, were simply following a "practice which has been almost universal in the United States" (Winsor 1931:280, 285).

The Supreme Court rendered its opinion in February 1931, just as the Ware-Wachusett tunnel reached completion. The court, based on the Special Master's report, found nothing to "justify inference of real or substantial injury or damage." Connecticut's complaint was thereby dismissed, although the state was permitted to retain standing to sue "if it shall appear" that its interests were indeed demonstrably injured by the Ware and Swift developments (Kennison 1947:157).

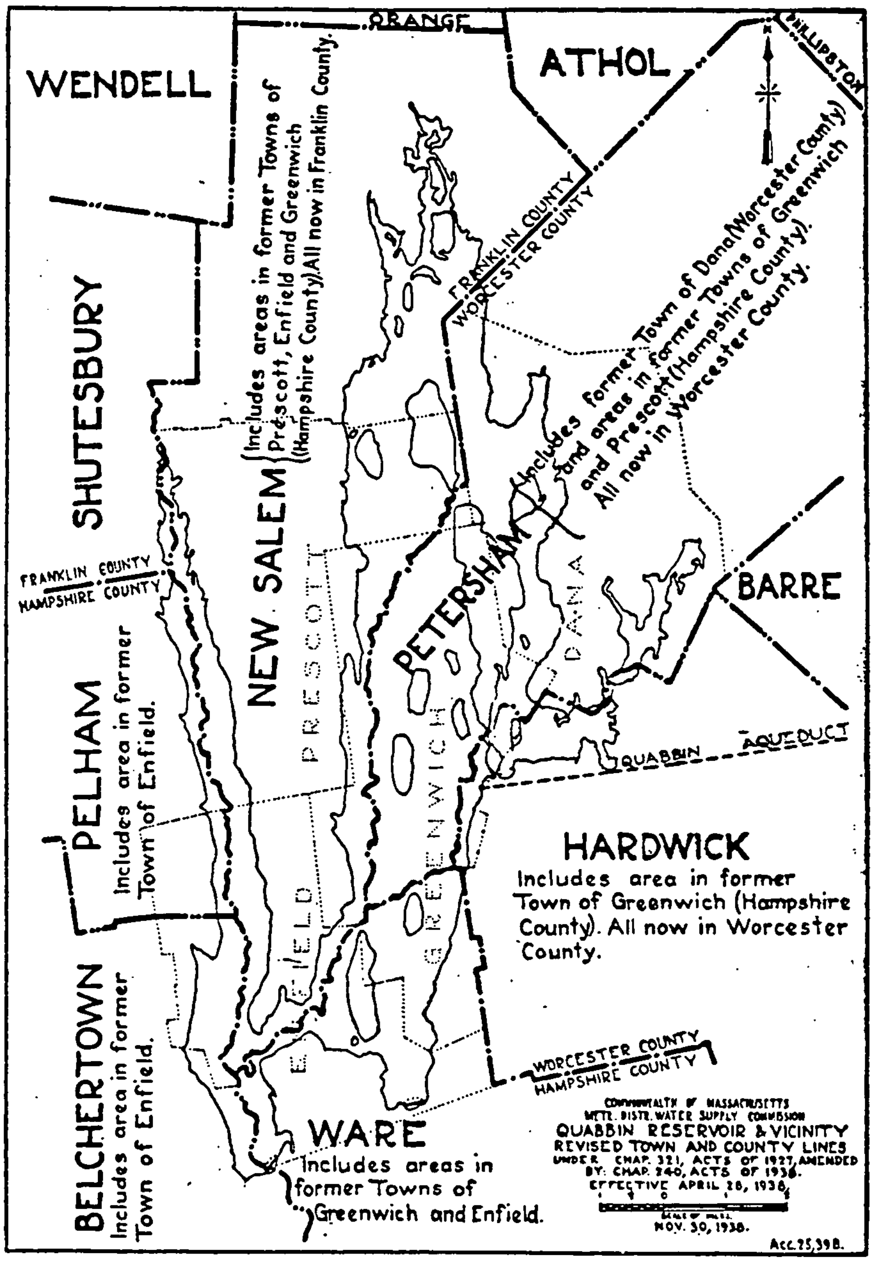
With the lawsuit settled, contracts were let in 1932 for the Swift-Ware segment of the aqueduct, then renamed Quabbin, through which water could be diverted west from the Ware or east from the Swift, effected by means of one-way shutters or "tidegates" at Shafts 11A and 12. This portion of the tunnel was completed on October 1, 1935, allowing the first diversion of water from the Swift.

Meanwhile, construction of Quabbin Reservoir had begun soon after resolution of the Supreme Court case. The land takings required to ensure a large enough area for pure water containment and for watershed protection were on a scale previously unheard of in the state of Massachusetts and the United States. When completed, Quabbin Reservoir would have a watershed of 186 square miles and a reservoir area of 38.6 square miles, or 80,949 acres, with a capacity of 412 billion gallons.

Surveys begun in 1921 confirmed the desirability of the proposed reservoir site; although it covered an extremely large area, the number of people to be affected was less than might have been expected. The four towns (Dana, Enfield, Greenwich and Prescott) in which the reservoir was to be located had a small, decreasing population and only a few small, local industries, with most of the land used for farming.

In 1880 the total population of the four towns was 4,355; by 1920 the total had fallen to 3,039, and the immediate areas to be acquired had at that time a population of only 2,048 people (Report of the Joint Board 1922:198). The average population density was 41 persons per square mile, quite low when compared to the density of lands acquired for Wachusett Reservoir, which had 264 persons per square mile. Surveys also indicated that only 1,040 buildings would have to be bought, moved or demolished within the watershed boundaries. The four towns, however, would have to be legally dissolved. As written, in retrospect, by Karl Kennison, who succeeded Frank Winsor as chief engineer in 1939, "The liquidation of entire townships was one of the unprecedented features of the Commission's work. It introduced many unique problems, not only on account of the legal necessity for maintaining the rights of the individual citizens of these towns, but also on account of the great area covered. As a result the Commission had to assume many roles: of school teachers, welfare agents, fire marshalls, undertakers, and many others, in the liquidated towns..." (Kennison 1947:151-214).

Under the direction of Water Supply Commission Secretary R. Nelson Molt, land acquisitions began in 1926. An exacting procedure of record keeping and implementation was followed, beginning with an aerial survey that was used to develop original locality and progress maps (Christenson 1940:205). Land was acquired as needed for commencement of construction projects, such as dams, dikes and intakes. For obvious legal and emotional reasons (families would be relocated, sometimes from farms they had lived on for generations), every transaction was methodically recorded, cataloged and filed and every structure photographed. By late 1926, seventy owners had offered to sell their properties and by 1927 11,000 acres had been acquired (Metropolitan District Water Supply Commission 1926:4, 1927:1-2). The purchase of real estate was a relatively large item in the overall budget for the reservoir, comprising fully 24 percent of the project cost. It should be noted that the sum of $9,587,198 was not the result of inflated prices, but was due to the large acreage needed



Quabbin Reservoir—Revised Town and County Lines

From the Files of the Metropolitan District Commission.

(Christenson 1940:194). Most purchases of real estate resulted from voluntary offers by individual owners. A few exceptions were acquired through court orders or findings of a Board of Referees and a small remaining number of acres through eminent domain (Christenson 1940:206; By order of the Legislature Acts of 1932, Ch. 30). In addition to private homes, stores and farms, a number of small industries were also purchased, including two textile mills, a sawmill and a grist mill (Christenson 1940:221-22).

In 1928 the Water Supply Commission assumed direction of the town government of Prescott for "the remainder of the town's corporate existence" (Metropolitan District Water Supply Commission 1928: 1). By 1930 almost all land located within one-half mile of the reservoir boundaries had been surveyed and tables compiled showing ownership areas and valuations of properties not yet offered for sale by the owners (Metropolitan District Water Supply Commission 1930:25). Many of the buildings acquired by the Water Supply Commission were moved and/or sold to individuals who moved them. Most structures were moved to neighboring towns. An 1811 match manufacturing shop in Greenwich was moved to the Dearborn Museum Village, Michigan; a house from Dana was taken apart and reassembled in Vermont. The Boston and Albany Railroad in north Dana was moved and rebuilt as a private residence (Howe and Lincoln 1951:511-2). Interestingly enough, the majority of the people who were displaced chose to remain in the area and move to nearby towns.

One of the largest tasks, and certainly one equal to, if not more emotionally charged than, moving homes and entire towns, was that of moving the contents of thirty-four cemeteries located in the project area, thirteen of which were within the reservoir boundaries. With a total of 7,500 burials, the cemeteries ranged in size from old family plots with one burial to the Greenwich Cemetery which contained 1,680 bodies (Metropolitan District Water Supply Commission 1939:1; see also plot maps on file in MDC Water Division, Boston). Public cemeteries were acquired by the Commission through release from individual owners; private cemeteries were acquired through the purchases of the land they were located on (Christenson 1940:224). In its usual understated style, the Commission noted that "In accomplishing this work many problems had to be faced, most of them of a personal nature which required a high degree of tact and communication" (Christenson 1940:235). Under the direction of William W. Polter, a Commission engineer, 82.22 acres located south of and between Winsor Dam and Goodnough Dike were set aside for a new cemetery, Quabbin Park. It was open to any person "with a close interest in valley cemeteries and to Water Supply Commission and Metropolitan District Commission employees," a policy still in effect today (Christenson 1940:234-35; Lori Peterson, MDC Water Divison, personal communication, February 1985). Development of the new cemetery began in 1931. It was landscaped according to a design by Arthur A. Shurcliff, who as a former disciple of Frederick Law Olmsted, preserved and enchanced many of the existing natural features. The cemetery was laid out with space for 11,920 burials, a section for unknown graves and a memorial area, at the entrance to the cemetery, that now contains public war monuments from abandoned towns. Additionally a receiving vault and a utility building were constructed (Christenson 1940: 233-34).

By 1932 the cemetery was ready to receive burials, although some landscaping still was needed. Upon this level of completion, no further interments were allowed in the other valley cemeteries (Metropolitan District Water Supply Commission 1932:14). All bodies were relocated at Commission expense. Although several alternative cemeteries were available, most of the bodies were reinterred in Quabbin Park Cemetery at the request of concerned relatives or representatives. Before any of this work was begun, advertisements were placed in local newspapers to alert residents, and no removals were made without giving a representative interested in the remains an opportunity to be present while the grave was opened (Christenson 1940:229).

As with the real estate acquisitions, an elaborate recording process was employed to keep track of removals. Each grave was numbered and given an index card in addition to being entered in a taking book which essentially reproduced the information cards. Plans were made of each cemetery using existing headstones since often there were no interment records. When a body was removed it was noted on the card, in the taking book, and marked in red on the plans with the date moved, the date reinterred, and where in Quabbin Park Cemetery the remains were placed. The portions of the cemetery reserved for "unknown or unrepresented" bodies were those discovered in cemeteries and unclaimed by anyone, those with no markers or those that were found accidentally while excavating other graves.

Excavation was tedious work since most graves were very old and there was, in general, a complete deterioration of coffin, clothing and physical frame, although skulls were usually intact. Remains were put in a wooden box with "great care being used to discover and save every remaining element of the skeletal structure" (Ibid.). The remains were mixed with soil from the immediate area and the box sealed. While cemeteries could not be duplicated as to plot plans, every effort was made to have remains placed "in the same relative positions" as those of the cemeteries from which they were removed (Metropolitan District Water Supply Commission 1933:16). By 1938 all landscaping and other work on the cemetery had been completed and it was turned over to the MDC (Metropolitan District Water Supply Commission 1938:7). The final removals and reinterments were completed on 4 October 1944 (Metropolitan District Water Supply Commission 1940-45:38).

In addition to dwellings and cemeteries, many miles of roads were affected by construction of the reservoir: 242 miles of roadway were abandoned and 36 miles of new highway, including segments of Routes 2 and 122, were constructed to create a large loop near the perimeter of the watershed (Christenson 1940:197; Metropolitan District Water Supply Commission 1931:1). The New England Power Company high tension line was also relocated in 1933, by reusing transmission towers and rerouting the line south of the reservoir (Metropolitan District Water Supply Commission 1933:16).

By 1936 a "general clearing program" was begun to strip the reservoir floor. It was done as a WPA project and due to requirements of that program, it was begun two years earlier than the Water Supply Commission would have preferred. The work, which consisted of cutting all softwood trees and removing stumps and brush, employed over 4,000 men. Hardwoods suitable for timber sale were left for harvesting by commerical operations (Metropolitan District Water Supply Commission 1936:12-13). Young pines, spruce, hemlock, laurel and azaleas in areas that would eventually be inundated by water were carefully transplanted to higher ground. In only a year, stripping of the land had commenced enough to warrant the Commission's issuing an order prohibiting any more farming on Commission land in order to preserve the purity of water on the Quabbin Watershed (Metropolitan District Water Supply Commission 1937:1-2).

In 1936, ten years after land acquisition had begun, 83,548 acres had been purchased. As noted in the Commission's Annual Report: "... as a comparison it is of interest to note that the land area of Boston is only 28,000 acres and of the 20 cities and towns making up the MWA only about 117,000 acres" (Ibid.:4). By the time land acquisitions were completed, a total of $9,587,198 was spent for a total of 90,185 acres at the average rate of $106.41 per acre. (Christenson 1940:217). By an act of the state legislature, at midnight 27 April 1938, the towns of Dana, Enfield, Greenwich and Prescott ceased to exist and portions of those towns not flooded were annexed to adjacent Petersham (Chap. 240 and 455 of 1938 ammended Chapters 321 of Acts of 1922; Metropolitan District Water Supply Commission 1938:1; Christenson 1940:197). Town records and management of town affairs were turned over to the Superintendent of Quabbin Reservoir at the Quabbin Administration Building (Metropolitan District Water Supply Commission 1947:10) and to this day that is where all birth, death, and marriage certificates are issued and town records kept. In 1939 all roads leading into the reservoir were blocked and passes issued only to "former residents, employees of the Commission and its contractors, men seeking employment on the clearing project and others having necessary business in the area" (Metropolitan District Water Supply Commission 1939:2) One can only imagine the eerie quality of the setting: houses dismantled, miles of earth stripped bare and only the occasional passerby.

The Swift River diversion tunnel was sealed in August 1939 and water flowed for the first time into Quabbin Reservoir (Metropolitan District Water Supply Commission 1939:1). In only six years the reservoir was at elevation 591.92, only 8 feet

Quabbin Reservoir from Administration Road, with Goodnough Dike at Center.

below the crest of the spillway. It held 341 billion gallons of water, and 34 of a total of 39 square miles were flooded (Metropolitan Water Supply Commission 1940-1945:2). On 22 June 1946 the first water went over the spillway, and a celebration attended "by several hundred people" was marked by the lifting of the stop logs on the spillway at 2:30 PM (Metropolitan District Water Supply Commission 1946:1, 2, 14). The same day, the lookout tower and hiking trails on Quabbin Hill were opened to the public.

In its annual report for 1935, the Metropolitan District Commission had observed that due to increasing population "and the resulting activities," it had become difficult to protect Sudbury Reservoir from pollution "by enforcement of the Sanitary Rules and Regulations alone." The MDC suggested that consideration be given to a plan, originally proposed in the 1925 report of the Metropolitan Water Supply Investigating Commission, to bypass Sudbury Reservoir with a deep-rock pressure tunnel that, extended into the Metropolitan Water District, would also avoid the need to build extensive new pipelines from the Weston Terminal Chamber (Metropolitan District Commission 1935:25; Metropolitan Water Supply Investigating Committee 1925:17, 53).

The legislature in response created, the following year, a special committee to study "improvements to distribution" and "adequate prevention of pollution" in the Metropolitan Water District. As had been customary since the 19th century, the committee included members of the state's Department of Public Health. The other members, however, were drawn not from the MDC, the agency responsible for operating and maintaining the system, but from the Metropolitan District Water Supply Commission, including the latter's chief engineer, Frank Winsor.

The committee concurred with the MDC's observation concerning pollution threats to Sudbury Reservoir. It also identified the Wachusett open channel as a major contributor to the contamination problem since its water passed through an increasingly industrial and "intensively developed farming" region before entering the reservoir. The Cochituate and South Sudbury systems were also found to be polluted, and groundwater leakage into the Sudbury Aqueduct contributed further to the decline in that segment of the water supply (Hultman 1938:160, 163, 165-66).

To ameliorate the situation, the committee supported construction of a pollution-resistant pressure aqueduct, which, running from the Wachusett terminal chamber to the Weston head chamber at Sudbury Dam, would allow a complete bypass of Sudbury Reservoir. From Sudbury Dam, another segment was proposed to a point west of the Charles River, near the Weston terminal chamber, from which it could then be extended to Chestnut Hill and, eventually, all the way into Boston as a "tunnel loop" (Special Report... 1937:49). The added dividend of this proposal was that water conveyed through a pressure conduit could be distributed without the need for pumping, thereby permitting elimination of low-service pumping from Chestnut Hill and Spot Pond (Special Report... 1937:12).

In considering the nature of the new conduit, the committee had initially leaned toward a deep-rock pressure tunnel, but found that the cost of construction in suburban areas would be much greater than for cut and cover. It found an alternative in the recently completed Colorado River Aqueduct, which had successfully demonstrated the "feasibility and economy" of a cut and cover pressure conduit, constructed of steel cylinder reinforced concrete pipe (Dore 1941:316). To expand the capacity of the Weston Aqueduct, which was to receive water from the "new pressure aqueduct" at a shaft below Sudbury Dam, the committee also recommended addition of pipes to the Weston siphons, which had been designed to carry three each, but had been built with only one (Special Report 1937:12). Financing the new aqueduct was found to be little problem, as substantial funds were available due to "economies effected" in construction of the Ware and Swift developments (Ibid:14).

Not surprisingly, given the composition of the committee, the Metropolitan District Water Supply Commission was recommended as the appropriate agency to oversee the proposed new construction. With legislative authorization of the project (Ch. 501, Acts of 1938), the dominant role of the Water Supply Commission in development of the water supply system was extended beyond its original mandate to build the Swift-Ware system, and its future seemingly ensured.

The Water Supply Commission was not universally admired, however, a prominent critic being the Special Commission on Taxation and Public Expenditures. In Part 13 of a series of reports on public agencies in the Commonwealth, the Special Commission discussed the problems and progress of the MDC, and in addition devoted a section to the Water Supply Commission. In general remarks, the Special Commission criticized the lack of apparent cooperation and coordination among the operating and engineering divisions within the MDC, and recommended establishment of an office of Chief Engineer to coordinate engineering activities (Report of the Special Commission...1938:28-30).

The Special Commission went on to question "the necessity and desirability of creating separate organizations" to handle planning and construction of large scale works, and also the "increasing tendency to regard large scale construction as outside the proper function of the several engineering divisions under the MDC." The Special Commission felt that the MDC's Water Division staff, "suitably augmented" by appropriate technical staff and "assisted by capable consulting engineers" should have been able to handle the Quabbin development, and that creating the Water Supply Commission had been quite unnecessary. The Special Commission did recognize that the civil service system under which the MDC operated tended to discourage, if not prohibit, the hiring of specialized individuals, and that civil service pay grades provided only limited financial incentive to engineers "capable of large scale design and construction", not to mention the fact that internal promotion tended to result in staff with little experience outside the agency. Nonetheless, the Special Commission felt that with engineering staffs as large as those of the MDC, "it should seldom be necessary to turn over to outside consultants the actual designing, and never the supervision of construction." Seeing no merit in perpetuation of the existing situation, the Special Commission concluded by recommending that the Water Supply Commission be merged into the MDC's water division "by the close of the next fiscal year," and that, as a cost saving measure, the new pressure aqueduct be postponed and construction at Quabbin be "retarded," since diversion from the Ware appeared to make Quabbin's completion less important (Ibid:61-3, 67).

The Metropolitan District Water Supply Commission appears to have had sufficient political influence to withstand this direct assault on its existence. Proceeding with its most recent mandate, the Water Supply Commission initiated the first contracts for construction of the "new pressure aqueduct," including over 14 miles of cut and cover pressure conduit plus a three-mile deep-rock tunnel beneath Sudbury Reservoir. Completed in October 1940, the conduit was subsequently named for Eugene Hultman, a former chairman of the Water Supply Commission and commissioner of the MDC. The Water Supply Commission also pressed ahead with completion of work at Quabbin. The years 1940 and 1941 saw such extensive activity that by the time of the Pearl Harbor attack the reservoir was being filled and all its major buildings and structures were in place and largely operational.

With the United States entry into World War II, construction in the metropolitan water system was halted, including the planned extension of the Hultman from the Charles River to Chestnut Hill, that had been determined inessential to the war effort. Beginning in 1946, however, the Water Supply Commission began to gather data and generate studies to aid a Special Legislative Commission convened to investigate water supply needs of communities in the valley of the Connecticut and its tributaries. This investigation, completed in December 1946, recommended that the Water Supply Commission initiate construction of a pressure aqueduct from Quabbin Reservoir to the Chicopee city line, from which Quabbin water would be distributed to Chicopee, South Hadley's Fire District #1, and Wilbraham. That same year, the Water Supply Commission let a contract for construction of a siphon to replace that section of the Wachusett Aqueduct carried by the Assabet River Bridge. In addition, with the war over, the legislature authorized the Commission to move ahead with sinking of two shafts preliminary to construction of the City Tunnel extension of the Hultman Aqueduct.

In January of 1947, however, the newly selected Republican Governor, Robert F. Bradford, in his inaugural address to the legislature called for abolition of the Metropolitan District

Water Supply Commission as "an example of the kind of duplication in government which it is our responsibility to end." He noted that, although the Commission's original mandate had been fulfilled "some years ago," the Commission had in 1938, and again in 1945 and 1946 been "armed with new authority and given new funds" to branch out in new directions and on new projects which could be extended far into the future." Echoing a criticism expressed in 1938 by the Special Committee on Taxation, the Governor also noted that the Commission's personnel were employed outside state civil service to perform functions parallel to those of the water and sewerage divisions of the Metropolitan District Commission, a situation both unnecessary and undesirable.

The Governor's recommendation was soon enacted into law. The Metropolitan District Water Supply Commission ceased to exist as a separate agency, and many of its staff were transferred to a newly-created Construction Division in the Metropolitan District Commission. The fourth cycle in the development of the water supply system came to an end with publication of the Water Supply Commission's last annual report on 30 June 1947.

THE METROPOLITAN DISTRICT COMMISSION 1926-1947

During the two decades in which major construction was dominated by the Water Supply Commission, the Metropolitan District Commission concentrated its own energies toward parks development. Many of the parks and parkways that grace the metropolitan area today were constructed during this period, among them the Charles River Basin, the Fellsway, and the Blue Hill and Revere Parkways. Meanwhile, the MDC's water division focused on general maintenance of the existing system and on a few small building projects. In 1936, for example, the MDC built a supplemental standpipe in Arlington and a pumping station in Belmont. In conjunction, distribution pipes were laid for northern high service, as well as southern low service, and a second basin was constructed at Bear Hill Reservoir in the early 1940s. Also, several steam driven pumps in the system were replaced with oil-fired or electric engines, including the large Leavitt engines at Spot Pond, and engines at Arlington and Chestnut Hill pumping stations.

This period also saw an increase in chlorination due to expanding population and industrial growth, both of which contributed to pollution. The MDC modified several pumping stations to include chlorination systems, and built chlorination facilities at Weston Reservoir and at Framingham Reservoir #1. Sources of pollution, however, remained a continuing problem, even in the Wachusett Reservoir. Although a trunk sewer had been built in 1935 from Rutland through Holden to a connection with the Worcester sewer system, the MDC found itself in confrontation with watershed polluters such as "piggeries, [which] continue to be a menace," because many owners "continue to be defiant and have little thought of the necessity of complying with the Sanitary Rules." (Metropolitan District Commission 1939:28).

Portions of the system were removed from service, beginning with the by now throughly polluted Cochituate Reservoir and Aqueduct in the 1930s. The reservoirs of the South Sudbury System (Ashland, Hopkinton and Whitehall) joined Lake Cochituate in the state's park system in 1947.

During the 1940s questions were raised concerning membership in the Metropolitan Water District and the costs thereof. The original Water District comprised 13 member communities within a 10-mile radius of the statehouse, and seven more joined between 1897 and 1911. In the next 33 years, however, the Metropolitan Water District gained only one new member, apparently due to the cost of joining, which presented a "deep-seated obstacle" for many municipalities (Report of the Special Commission...1943).

The original 10-mile limit was extended to 15 miles in 1942, and in 1947 the MDC was authorized to sell and deliver water to communities outside this limit, beginning with several in the Chicopee Valley. Fees were limited to a "fair share" of connection costs, with no other fee charged if the new member agreed to take its entire supply from the Metropolitan Water District (Acts 1945 Ch. 587; Acts 1947 Ch. 575).

Upon abolition of the Metropolitan District Water Supply Commission, the Metropolitan District Commission took over all the former's "functions, duties, obligations, and properties," and its newly organized Construction Division went on to complete City Tunnel and to build the Chicopee Valley Aqueduct in the 1950s. In the following decades, the City Tunnel extension from Chestnut Hill was completed to Malden (1962), the Wachusett-Marlboro (Cosgrove) tunnel built in 1965, and another tunnel from Chestnut Hill to Dorchester was put in operation (1974). Quabbin Reservoir, metropolitan Boston's principal source of pure water, and Wachusett Reservoir are today the only supplies in active use, although Sudbury Reservoir is maintained for possible emergency use. Of the old gravity conduits, only the Weston remains in active service; the Sudbury and Wachusett are unused, but do receive periodic maintenance. One section of the Cochituate in Newton serves as a utilidor and another carries sewage for the Town of Wellesley. Following completion of City Tunnel, the pumping stations at Chestnut Hill were gradually removed from service, as was Fisher Hill Reservoir.

III. BUILDING THE WATER SUPPLY SYSTEM, 1845-1947

THE COCHITUATE SYSTEM

Boston's first public water supply, built between 1845 and 1848, consisted of two reservoirs linked by a masonry aqueduct. The source, or supply, reservoir was developed in the natural basins of Lake Cochituate. Brookline Reservoir, at the east end of the system, was an artifical basin that was used to store water until it was required for local distribution.

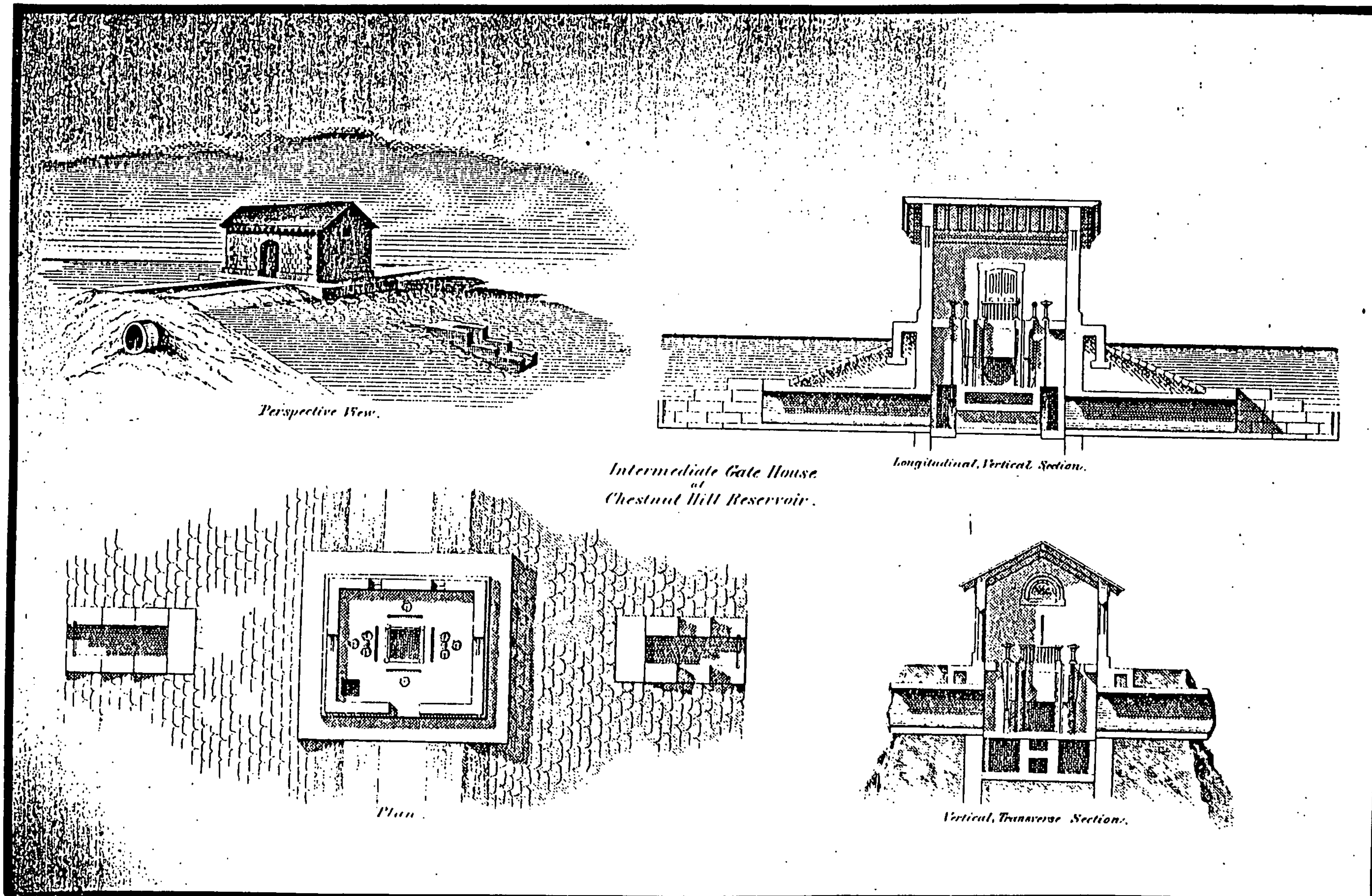
Lake Cochituate is actually a chain of three natural ponds of roughly equal sizes totaling approximately 776 acres, with a combined length of 3.5 miles. The Cochituate watershed also included Dudley, Dug, and Waushakum Ponds, plus the feeder streams Beaver Dam, Course, Pegan and Snake Brooks. Between the lakes ran three roads, and two railroad lines, the Boston and Worchester and the Saxonville (now Conrail).

There were three low peat meadows within the boundaries of the reservoir. During the summer months these areas were often left without water, and therefore subject to pollution. A circular dam was built in 1879 to keep the southernmost meadow flooded. In 1901 the dam was upgraded and the wooden flume replaced with a concrete one. In 1887 the meadow was further deepened and the following year Pegan Meadow was also dredged. The lake itself was cleaned and improved in 1901.

In 1857, due to gradual failure of the original dam, a second dam was built 500 feet downstream. Two years later the latter was raised two feet, which then required raising the headhouse four feet, eight inches.

By 1890 both these dams were replaced with a sturdier structure consisting of an earthen embankment with a concrete core and granite-faced overflow.

In 1893-94 the Pegan filter beds were added to the system. The beds were built to clean the water of Pegan Brook, which ran through the center of Natick, carrying industrial and human



From A History of the Boston Water Works for the Years 1868 - 1876.

wastes into Lake Cochituate. When the beds, consisting of a dam across the brook, a small pumping station, and three circular, granite beds, were built, Engineering News described them as "probably the first works constructed for the purification of a small feeder to a lake" (Engineering News Vol. 31, 1894, June 28, p.532)

All of the architectural elements in this system were constructed of gray granite (often three different shades of gray) in ashlar and rough cut stones. Generally designed in a handsome classical style with gabled roofs, arched openings with stone surrounds, and quoins, the structures range from austere waste weirs to the more stylized gatehouses to the full blown Palladian distribution house at Brookline Reservoir.

The only water and valley crossing and the only use of iron pipe in the aqueduct is the Charles River siphon and bridge in Newton. This siphon, because it crossed a river, was supported by a granite bridge with three ellipitical arches. The siphon originally contained two 30-inch pipes; in 1874 a 36-inch pipe was added and in 1890 a 40-inch pipe was laid on top of the others. Long out of service, the terminal chambers, similar in design to the waste weirs, have been demolished.

Brookline Reservoir was the terminus of the aqueduct and the beginning of the Boston distribution system. The reservoir is a natural basin lined with rubble granite, with depths ranging from 14 to 24 feet and a capacity of 120,000,000 gallons of water. At the west end of the reservoir is the aqueduct terminal chamber. At the east end is the distribution house, which marks the terminus of the Cochituate Aqueduct. This is a striking building, set on an angle to the street intersection, boldly and confidently facing Boston and its task: to supply the citizens with water.

Lake Cochituate is today a state park; the Pegan Brook Filter Beds are barely discernable as a result of a flood in 1955. The beds south of the railroad track have been filled in, through repeated dumping over the years. The circular dam, which kept part of the lake flooded during periods of low water, is in ruins.

The Cochituate Aqueduct is only partially used today, although most of the original elements including the conduit itself, are in existence.

The only active section of the aqueduct is from the lake to Morse's waste weir in Wellesley. Under an agreement between the MDC and the City of Boston this section is used to dump water into the Charles River when the river falls below acceptable levels. The City of Newton has owned the portion of the aqueduct that runs through that community since 1955 and uses it as a sewer. The Wellesley section, owned by that town since 1962, is employed as a utilidor. Brookline Reservoir has been taken out of service and is a park owned by the City of Brookline. The distribution house is now headquarters for the Brookline Sportsmen's Club.

THE SUDBURY SYSTEM

The first, and largest, phase in development of the Sudbury River supply began in 1873 and was completed in 1878. This involved construction of three reservoirs, Framingham #1, 2 and 3, their dams and gatehouses; Farm Pond and its gatehouse; two masonry conduits, four waste weirs, an inverted siphon and two chambers, two bridges and a terminal chamber (Boston Water Board, 3rd Annual Report, 30 April 1879). Ultimately the system would include four more reservoirs: Ashland (1884-1886), Whitehall (1848, 1892) Hopkinton (1895), and the much larger Sudbury Reservoir (1894-1898).

Of the earliest reservoirs, Farm Pond proved the least satisfactory. Its waters were muddy to begin with, and were continually fouled by industrial and residential waste from nearby Framingham. In 1884-1885 a conduit was built across Farm Pond to link the head of the aqueduct and the conduit from Dam #1, thus effectively bypassing the pond completely (10th Annual Report, Boston Water Board, December 25, 1885). Additionally, the Farm Pond Gate House had to be moved 100 feet away from the Boston and Albany Railroad line due to an agreement between the railroad and the Water Board which allowed the railroad access to Farm Pond and the use of the Pond's water for steam engines. For unexplained reasons the gatehouse was originally built too near this access point.

The capacity of the Sudbury Aqueduct was 80 MGD, 64 MGD greater than that of the Cochituate Aqueduct and thus a significant addition to Boston's water supply. The route of the Sudbury was primarily determined by the need to keep a consistent grade sloping toward Boston at the rate of 2 inches to the mile, by land contours, and by the need to avoid inconvenience to property owners. The aqueduct was built with a horseshoe-shaped section, averaging 8.5 feet in diameter. The brick conduit was generally laid on a foundation of cement and concrete; in wet or sandy places, however, it was built on a wood platform. The embankments were built up in layers, then left to settle for a winter before the aqueduct was laid in them. Along the route there are three particularly high embankments with the aqueduct set in deep cuts (Hurd's, Waban, and Hunnewell's), each between 30 and 50 feet high. The aqueduct foundations in these were made slightly thicker and in Hurd's embankment reinforcing rods were inserted to keep the embankment tied in.

The aqueduct crosses three valleys on its route to Chestnut Hill; two different solutions were used to make the valley crossings because of grade levels and the necessity of keeping the aqueduct gradient constant.

At Rosemary Brook, in Wellesley, a cast iron inverted siphon, similar to that used on the Cochituate Aqueduct, was built. The

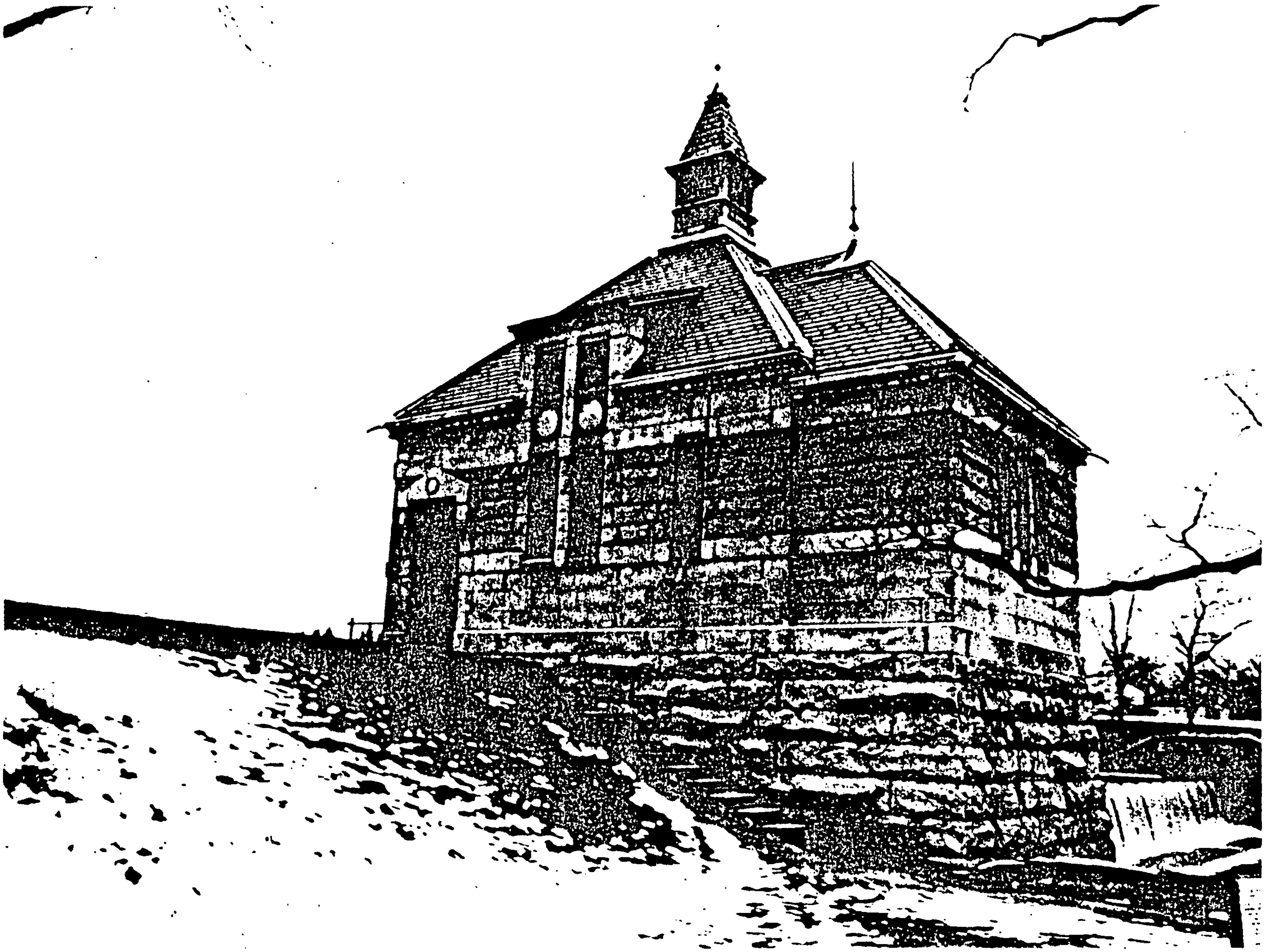
1,800 foot siphon contained two 48-inch pipes, with provisions for a third which was added in 1898. The siphon chambers at each end are fanciful brick and brownstone structures in a medieval style. The west chamber features a corner tower with a viewing platform accessible from a circular stair. The substructure of each chamber is basically an open well, without gates, in which water makes the transition from masonry aqueduct to iron pipe.

At two other points, the Sudbury is carried over a watercourse on a masonry bridge. Echo Bridge was described by engineer Desmond Fitzgerald as "the principal structure to be seen on the line of the aqueduct" (Fitzgerald: 1898:30). However, Waban Bridge (on the National Register of Historic Places) and Echo Bridge are similar structures, with multiple arches, concrete and brick interiors faced with granite, and brick parapets between which the aqueduct rests.

The aqueduct ends at Chestnut Hill in an architecturally striking terminal chamber. The chamber was originally constructed with five distribution connections although only three were ever put into use.

Framingham Reservoirs #1,2 and 3, their dams, and gatehouses are all essentially the same. The floors of the reservoirs were clear-cut, with top soil and stumps left in place. However, by 1883-86 the reservoirs needed to be drained and stripped of organic matter due to poor water quality. Although of different lengths, the dams were constructed to the same design. Each features a granite rubble masonry core laid in cement, and overfalls of granite rubble laid in cement and faced with cut granite. The gatehouses, with slight variation in position and number of gates, were all built of granite with hipped roofs and for the most part with rectangular plans. Reservoirs #2 and 3 were connected to #1 (but not to each other) by 48-inch mains which were then connected to the conduit, Farm Pond and the Aqueduct (Fitzgerald 1898; Boston Water Board Annual Reports, 1878, 1879 and 1880). The 4,162-foot conduit from Farm Pond to Dam #1, like the main Sudbury, is of brick construction on a concrete base, with a horseshoe shaped-section.

Reservoirs #4 and #6 (Ashland and Hopkinton) are located on tributaries entering the Sudbury River from the south. Ashland Reservoir, completed in 1885, was the first in the water supply system to be stripped of organic matter during construction, a policy that was subsequently followed through construction of Wachusett Reservoir. Both Ashland and Hopkinton Dams are earth embankments with concrete core walls. At one end of each is a 30 foot wide granite spillway, over which waste water flows into a long waste channel with granite sidewalls and steps. Every gatechamber surveyed in the Metropolitan system has a superstructure with the exception of the chambers at Hopkinton Dam. Evidence suggests that a superstructure was never built on either chamber. (Metropolitan Waterworks, Sudbury Dept. 1907-1920).



Gatehouse at Framingham Reservoir #1 (Sudbury System), Framingham. Built 1876-1879. George Clough, Architect.

Reservoir #8, Whitehall Pond, was originally developed by the City of Boston as a compensating reservoir during construction of the Cochituate works (1846-1848). It was subsequently sold, but then reacquired in 1892. Four years later the Boston Water Board built a wood dam and short dike above the original dam. In the 1920's a low concrete and earth dam was built, along with a square brick and granite gatehouse.

The designs for chambers along the Sudbury, and the Framingham reservoir gatehouses, were developed in the office of the Boston City Architect, at that time headed by George A. Clough. Four chambers (the Framingham gatehouses and the aqueduct's terminal chamber) were built of granite. The remaining seven (Farm Pond Gatehouse, four waste weirs and two siphon chambers) utilized red brick and sandstone. Use of brick for aqueduct chambers marked a significant departure from the tradition established by the Cochituate. However, with the exception of the Glenwood Pipe Yard (1911), Hyde Park Pumping Station (1913), and Arlington Pumping Station (1907), brick was largely abandoned for exterior use after its employment on the Sudbury.

The brick and granite structures of the Sudbury system have little in common beyond a vaguely medieval theme and a preference for narrow, vertical windows. The brick structures are rectangular in plan with articulated parapet gables, quarryfaced stone quoins and small windows. Farm Pond Gatehouse has a double gabled roof with a gabled entrance pavilion. The waste weirs and siphon chambers have single gables, but with the exception of the tower on the west siphon chamber, are similar to Farm Pond Gatehouse. The structures are safely Victorian, and have none of the almost agressive presence that characterizes the granite structures in the Sudbury System. In contrast, the latter are complex, carefully thought out structures with hipped roofs, featuring as many as three different colors and textures of granite for walls, foundations and trim. While all are strongly individualistic structures, the most interesting is the startlingly handsome, yet paradoxical Sudbury Terminal Chamber at Chestnut Hill. This is a complicated but stark "object"-like building, which appears to have been heavily influenced by the work of Philadelphia architect Frank Furness. It is arranged as a central block with short end pavilions, and the walls are laid up in both smooth and rough granite. Framing the arched doorway are corner cut-outs that suggest a pyramidal shape reflecting the structure's gabled dormers and hipped roofs. A row of five arched windows face the reservoir; directly beneath them are five stone discs symbolizing the openings for five pipe connections. A disc is also centered in the dormer gable over the entrance. This disc motif is seen on the Framingham Reservoir gatehouses and on the high service pumping station at Chestnut Hill designed by Arthur Vinal (1886-1887).

SUDBURY RESERVOIR

Sudbury Reservoir (originally known as Reservoir #5) was the largest of the reservoirs on the Sudbury watershed, its 7.2

billion gallon capacity greater than all the other reservoirs in that system combined. Stony Brook, which ran through Southborough from the west, was dammed at the village of Fayville. The dam is an earthen embankment with concrete core wall over 1,800 feet long. At the center is a 300 foot spillway, of concrete with granite exterior facing. Nine gate chamber inlets at three levels were originally operated from a granite gatehouse located at the north end of the spillway. Waste water from the reservoir was drawn through the inlets and down to three 48-inch pipes laid through the base of the dam. Water was either conveyed into Weston Aqueduct, or discharged into a fountain and pool and then into the stone-lined open channel leading into Framingham Reservoir #3. In 1915-16, the gatehouse and spillway were modified for the production of hydroelectric power. With construction of the Hultman Aqueduct in 1940, the gatehouse and pipes leading from the dam to the Weston Head Chamber were discontinued. The Weston Aqueduct is now supplied directly from Shaft 4 of the Hultman.

The Boston Water Board began construction of Sudbury Reservoir in 1894. The following year, the Metropolitan Water Board assumed control of the work, completing the reservoir in 1898 in conjunction with the Wachusett Aqueduct. In addition to construction of the dam, development of the reservoir required stripping organic matter from the bottom, filling in depressions to create a uniform ground surface, and protecting the shore with sand, gravel and stone riprap. To enable local traffic to cross the reservoir, several roads and a rail line were relocated on earthen embankments in which were built concrete arch "bridges" or culverts, faced with granite, through which water in the reservoir could pass. At Middle Road, a stone circular dam with a 150 foot overfall was built in order to maintain an 8-foot level of water in the narrow segment of reservoir between Middle and Flagg Roads. Near Marlborough Center, a filtration system was developed, consisting of a stone weir, 1.5 acre settling reservoir, 8.63 acres of natural and 5.36 acres of artifical filter beds. This facility was built to purify water from Marlborough and Walker Brooks, both of which ran through densely settled areas of the town, before they discharged into the reservoir.

WACHUSETT AQUEDUCT

Wachusett Aqueduct, the first aqueduct built by the Metropolitan Water Board, was begun in 1896 and completed in 1898. It carried water from the Nashua River to Sudbury Reservoir until bypassed with the Wachusett-Marlborough Tunnel in 1965. The aqueduct is approximately 12 miles long, consisting of two miles of tunnel, seven miles of masonry conduit in trench or earth embankment, and three miles of open channel. The covered portions of the aqueduct average 11 feet wide and 10 feet 5 inches high. For about half its length, the tunnel section is unlined, the remainder being lined with concrete faced with three to six rings of brick. Construction of the tunnel required sinking four shafts, down which equipment and crews passed to reach the work sites. At

Shaft 4, a large air compressor plant was erected to operate the drills, pumps and hoists. Here, the contractor, E.D. Smith & Co. of Philadelphia, erected a circular brick superstructure with conical roof, to protect the shaft entrance.

The masonry portion of the Wachusett Aqueduct is constructed of concrete and brick, with a horseshoe-shaped section. The bottom and side walls of the conduit are of natural cement concrete, lined with one or more rings of brick. The arch itself is of Portland cement concrete. Near the village of West Berlin, a metering chamber was built on the aqueduct. The square gray granite structure provided access to a manhole on the aqueduct through which the level and rate of flow within could be measured. At Woodside, in the town of Northborough, the aqueduct is carried across the Assabet River on a 359-foot-long bridge. The seven round arches, each with a 29.5-foot span, are of mass concrete covered with light gray quarryfaced granite. The aqueduct, as it crosses the bridge, has eight inches of brick lining, backed by sheet lead. In 1946, a siphon was built under the Assabet River, and the bridge removed from service.

The seven-mile masonry conduit terminates in Marlborough. Marking the transition from covered aqueduct to open channel is a terminal chamber with wooden stop planks. The concrete substructure is enclosed with a hipped-roofed, gray granite superstructure.

Below the terminal chamber, the three mile open channel follows the original course of Stony Brook, winding through farmland and forest to Parkerville Road, where it empties into Sudbury Reservoir. To build this channel, the stream bed was stripped of organic material, dug out to a width of approximately 20 feet, and lined with sand and gravel on the slope. Stone riprap was not used along the channel, because two small control dams were built to maintain a depth of five to six feet and thus retard the flow of water along the channel. These stone dams were built with indented spillways in order to provide an overfall greater than would have been possible with straight structures. At intervals along the channel are six small bridges connecting portions of local private and public roads. All consist of single concrete arches faced with random granite ashlar to retard weathering. Much of the shore along the channel is lined with conifers or arborvitae.

A few hundred yards above the upper control dam is a stone circular dam, constructed in 1940. This dam raises the water level behind it sufficiently high to supply the Hultman Aqueduct, which begins at this point and is marked with a square granite head chamber on the north bank of the channel. With construction of the Wachusett-Marlborough Tunnel in 1965-67, the Wachusett Aqueduct was removed from service. The Hultman is now directly supplied from the tunnel via pressure reducing valves enclosed within a granite-faced building with glass block windows, located a few feet away from the Hultman Head Chamber.

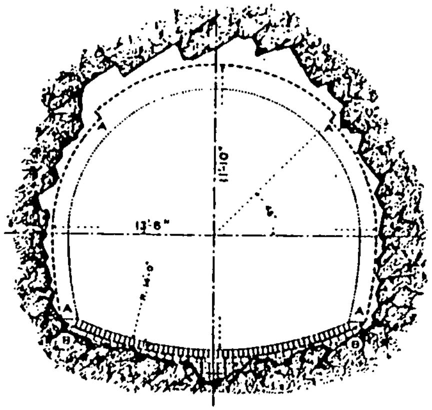
From the Metropolitan District Commission Drawing Files

COMMONWEALTH OF MASSACHUSETTS

METROPOLITAN WATER BOARD

AQUEDUCT SECTIONS AND ASSABET BRIDGE.

DECEMBER 1, 1896.



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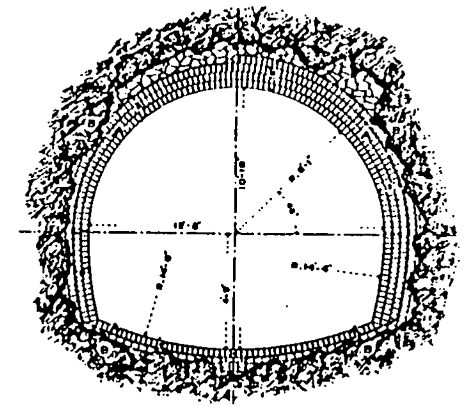

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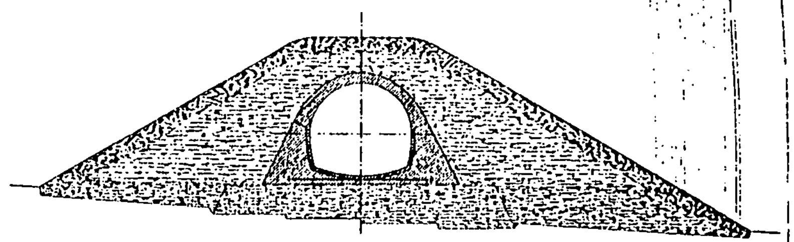
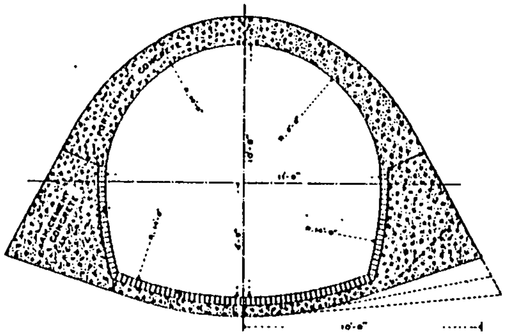


AQUEDUCT ON EMBANKMENT



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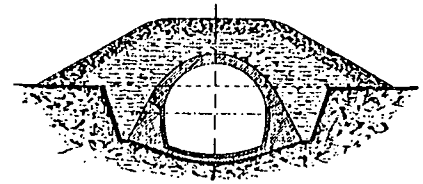
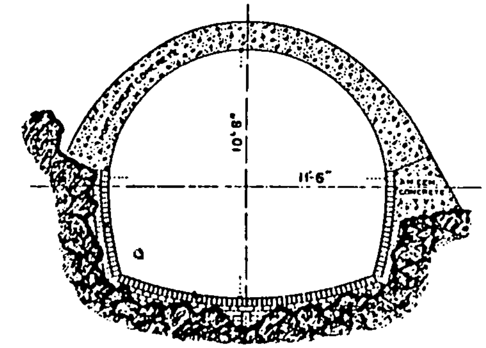
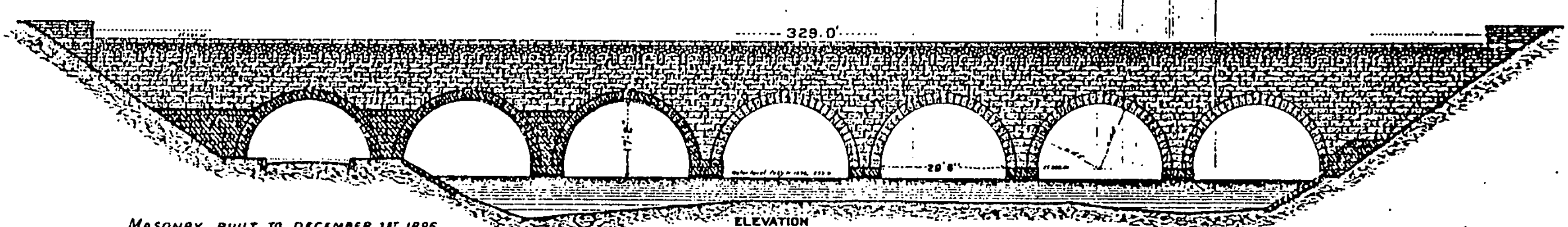


AQUEDUCT IN EXCAVATION

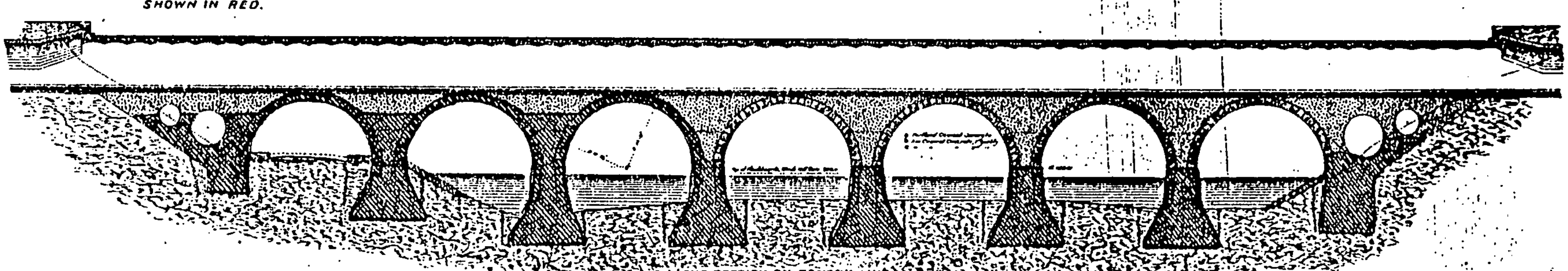


AQUEDUCT IN ROCK

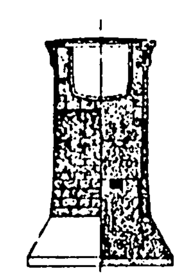


ELEVATION

MASONRY BUILT TO DECEMBER 1ST 1896 SHOWN IN RED.



LONG. SECTION ON CENTRE LINE



CROSS SECTION

WESTON AQUEDUCT

Between 1901 and 1903 the Metropolitan Water and Sewerage Board constructed an aqueduct to carry water from Sudbury Reservoir to a point on the east side of Weston, from which it supplied distribution mains and also Spot Pond in Stoneham. The aqueduct is 13.5 miles long, with a horseshoe shaped section similar to that of the Wachusett aqueduct. It is approximately 13 feet wide and 12 feet high, and has a capacity of 300 mgd. The aqueduct begins at Sudbury Dam, from which pipes extend to a gray granite head chamber, where water from this reservoir enters the closed conduit.

The Weston Aqueduct features a variety of conduit types. There are five tunnel sections, totaling 2.30 miles, and 9.14 miles of masonry aqueduct (cut and cover, or on embankments). Most of these sections were built with natural concrete bases and side walls lined with a single ring of brick, and with unlined arches of Portland cement concrete. Certain tunnel portions, however, are fully lined with three rings of brickwork.

In addition to the tunnel and masonry sections, there are two lengths of inverted siphon, in which the water is conveyed in 7-1/2 foot steel pipes across valleys. The longest siphon extends 3,505.5 feet across the Sudbury River Valley. At each end is a concrete siphon chamber containing special steel castings and gates that control the flow of water from the masonry to pipe sections of the conduit. The chambers are enclosed in square granite superstructures that shelter floorstands and the openings leading to the aqueduct. Over the Sudbury River, the siphon is "reinverted" in the form of a pipe arch of 80 foot span with granite abutments. The second, shorter inverted siphon crosses Happy Hollow (Route 126 in Wayland) and like the Sudbury River siphon, features concrete and granite chambers at each end. Both siphons were designed to carry three parallel lengths of pipe, but were built with only one. In the late 1930's a second pipe was added to the Happy Hollow siphon. At the same time, an inverted siphon was built under Sudbury River near the pipe bridge.

At two places on the aqueduct are small metering chambers, with concrete substructures and granite superstructures. Each permits the measurement of water at a different gradient. The fall of the aqueduct is four inches in 5,000 feet at the first chamber, and one inch in 5,000 feet at the second.

In Weston, just east of Wellesley Street, a tunnel section terminates at a 1,500-foot open channel leading to a holding and equalizing reservoir. At the end of the tunnel is a channel chamber equipped with stop planks. Below this chamber, the open channel extends in a straight line to the reservoir. The channel is approximately 20 feet wide, and is lined with stone riprap and ornamented with rows of arborvitae and conifers. At Ash Street, over the end of the open channel is a single arch concrete bridge faced with granite. Below the bridge, the channel empties into

Weston Reservoir, which covers approximately 66 acres and has a maximum depth of 28 feet. The approximately 150 acres surrounding the reservoir were developed to maintain a naturalistic setting of rocky promontories and tree-lined shores by the Olmsted firm of Brookline. The naturalistic planning was carried through at the dam on the east end of the reservoir, which is a 900-foot curved earthen embankment with a concrete core wall, largely undistinguishable from other slopes around the reservoir. On the dam is a screen chamber, which contains wood and metal screens to catch debris in water entering the final tunnel segment of the Weston Aqueduct. This segment ends at a terminal chamber, which in effect is a large concrete well from which distribution mains lead to Chestnut Hill, and to the northern distribution works of Spot Pond.

In planning the Weston Aqueduct, the Metropolitan Water and Sewerage Board contracted the Boston architectural firm of Shepley, Rutan and Coolidge to design the superstructures of all ten chambers. The design chosen for all but one of these structures was a simplified Renaissance Revival, similar to that used in the Middlesex Fells works, executed in orange-tan random ashlar granite, with pink granite trim (quoins, foundations, and rectangular window and door surrounds), and red Spanish clay roof tile. The superstructures were either rectangular or square, one story high with hipped roofs. Each chamber or pair of chambers (i.e. siphon chambers and metering chambers) represented a variation, simpler or more elaborate, on the basic theme, with the terminal chamber being the most decorative. The exception was the head chamber, located below Sudbury Dam in Southborough. In order to compliment the earlier Sudbury Dam gate chamber designed by Wheelwright and Haven, Shepley, Rutan and Coolidge employed gray granite and round-arched openings.

The Weston is the oldest of the Metropolitan Water Supply's aqueducts still in active service. Since 1940, it has been supplied directly from Shaft 4 of the Hultman Aqueduct.

WACHUSETT RESERVOIR

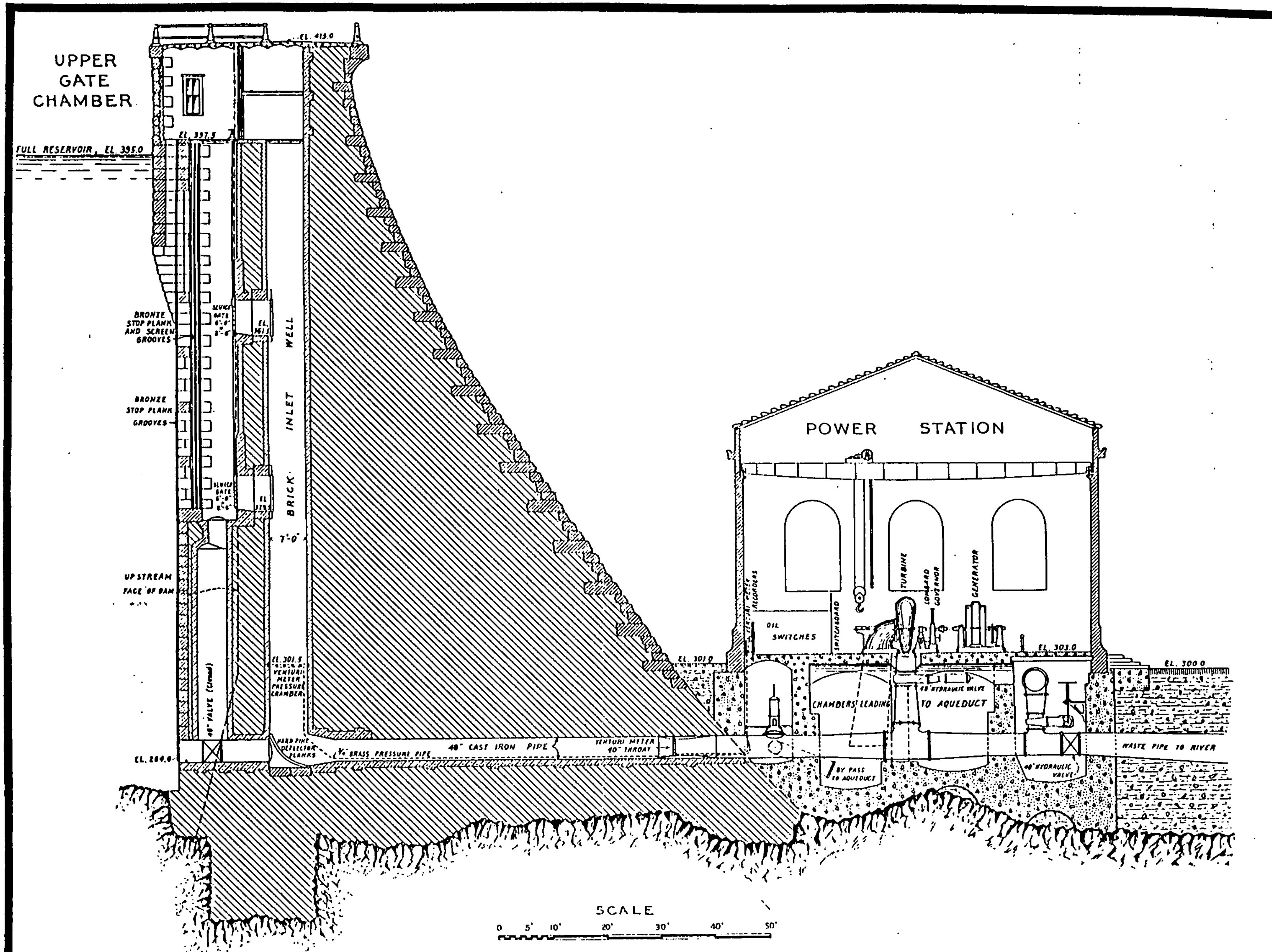
Wachusett Reservoir was the principal water supply for metropolitan Boston from 1907 until completion of Quabbin Reservoir in 1940. Wachusett Reservoir was created by damming the south branch of the Nashua River at Clinton, and is also fed by the Stillwater and Quinepoxet Rivers. Surveys and soil borings were begun by the Metropolitan Water Board in 1896. The first contracts for the reservoir were let in 1897. The contract for the dam proper was let in 1900, and the structure was completed in 1906.

Wachusett Reservoir has a surface area of approximately 6.5-square miles, is supplied by a 108-square mile watershed, and holds 65 billion gallons. At the time it was built, it was one of the largest reservoirs in the world (Massachusetts Board of Health 1895:129). The natural topography of the valley was utilized all around the reservoir except at the east end, where in two places the level of the ground required construction of large earthen dikes to prevent loss of water when the reservoir was filled nearly to capacity.

The north dike is the largest of the two, built in two segments for an overall length of 8,550 feet. A trench 30 feet wide and 30 to 60 feet deep was cut through gravel and coarse sand down to nearly impervious sand. Along portions of the trench, the sand was determined to be at least partially permeable. To prevent loss of water by percolation under the dike, 5,245 feet of wooden sheet pilings were driven along the bottom of the trench, before the trench was filled with compacted, "almost absolutely water-tight" soil. The sheet piles were driven by a 50 foot pile driver. To facilitate their placement, a pump was installed in the trench and water forced to the bottom of the piles through 6 inch pipe and 2-1/2 to 3-1/2 inch hoses in a "powerful jet of water" to soften the soil in which the piles were driven. Utilization of this hydraulic jet technique was so successful that it was closely examined by members of the International Board of Consulting Engineers for the Panama Canal, who visited Wachusett Reservoir in 1905 (Boston Herald 28 September 1905:6; Clinton Daily Item, 23 September 1905:1; Metropolitan Water Board, 4th Annual Report, 1849:73-4; 5th Annual Report, 1900:81-82).

The Wachusett Dam spans the Nashua Valley above a millpond developed in the 1840's to provide water power for the Lancaster Mills. The main dam structure is approximately 850 feet long between abutments, and over 200 feet high at the deepest part of the gorge. It is constructed of rubble rock faced with quarry faced and cut granite. A 450-foot waste weir is angled to the northwest off the north end of the main dam; the flow of water is controlled by wooden flashboards mounted on steel stanchions along the crest. Waste water flows over the weir into a curved channel, excavated in bedrock, that opens into Lancaster Millpond below the dam. Crossing the channel are two concrete arch bridges faced with granite. The upper bridge was originally built during relocation of the Central Massachusetts Railroad line. The line was extended from West Berlin, through a 1,080 foot rock tunnel on the south side of the millpond, over the millpond on a 921 foot plate girder viaduct, then over the arched channel bridge to a connection with a Boston and Maine line. The lower bridge carries auto traffic on Grove Street, which passes between two concrete maintenance structures and then onto the grounds below the dam.

Wachusett Dam has both upper and lower gate chambers. The upper chamber is built into the upstream face of the dam. From it, water is introduced through sluice gates into a wet well that leads to four 48 inch pipes extending through the base of the dam to the lower gate chamber. At the lower chamber, water was originally conveyed into the Wachusett Aqueduct (the dam's lower gate chamber functioning as the head chamber for this conduit), first passing through inlet tubes to four, S. Morgan Smith hori-



WACHUSETT DAM — SECTION THROUGH GATE CHAMBERS AND POWER STATION

From Metropolitan Water and Sewerage Board Annual Report, 1911.

zontal water turbines. These turbines in turn powered four horizontal Westinghouse generators, with floor-mounted Lombard governors. Once leaving the turbine wells, the water was conveyed through the draft tubes directly into Wachusett Aqueduct, which thus functioned as a tailrace. Waste water is also discharged into a circular pool and fountain below the gatehouse, and then into the millpond.

The grounds below Wachusett Dam were landscaped under recommendations from Arthur Shurcliff, a partner in the firm of the Olmsted Brothers. Major features of the grounds include the rows of conifers along the access drive to the lower gatehouse, the long flight of stone steps from the south end of the spillway to the base of the dam, and the construction of the waste channel through bedrock in a naturalistic manner. Shurcliff also provided "general designs" for the two bridges over the waste channel, and for the pool, fountain and mulberry plantings below the lower gatehouse. The latter was designed by Shepley Rutan & Coolidge in a neo-classical style with tall round-arched windows illuminating the main generating room. The exterior, clad in coursed lightly-rusticated gray granite, complements the two channel bridges and the great rising wall of the dam itself.

In West Boylston, the Metropolitan Water Board built three concrete arch bridges, faced with granite, to carry local traffic across portions of the reservoir. At the point where the Quinepoxet River enters a channel leading to the reservoir is a concrete and granite circular dam. This structure slows the river current, and prevents sand and gravel from being carried into the reservoir. Shaft 1 of Quabbin Aqueduct is located here as well. The granite-faced headhouse contains hydroelectric power generating apparatus.

QUABBIN RESERVOIR AND AQUEDUCT

Quabbin Reservoir was completed in 1939 and raised to full level in 1946. Surveys and soil borings, originally begun in 1921, were carried forward by the Metropolitan District Water Supply Commission in 1926; and the first construction contracts were let in 1931.

The reservoir has a surface area of 38.6 square miles. It extends 18 miles north from just above Route 9 in Belchertown to just below Route 122 in New Salem. Maximum water depth, behind Winsor Dam, is 150 feet, with an average depth of 90 feet some eight miles above the dam. The reservoir's 412-billion-gallon capacity is supplied by two watersheds, the Swift (186 square miles) and the Ware (98 square miles) above Coldbrook in Barre.

Quabbin Reservoir was created by construction of Winsor Dam and Goodnough Dike, immense earthen dams which were built across the Swift and Beaver Brook valleys, respectively. The bedrock in both valleys was found to be covered with a thick layer of permeable glacial overburden. In order to make each dam impermeable, a core wall was constructed by excavating an open cut trench, and sinking reinforced concrete caissons, 9 feet long and 45 feet in diameter, to rock ledge. These caissons were piled on top of one another, sealed together with concrete, and the wells filled with impermeable soils. Then, approximately 15 feet of fine sand was piled on top of the caissons in the trench, and a pool of water was created at what would be the top of each dam. With pumps and a "mixing box," soil was introduced in measured amounts into the pool. Water and soil mixture flowed over the top of each dam, with the finest (most watertight) soils settling in the center. Subsequently, earthen embankments or shoulders were raised on either side of the core wall, planted in grass on the landward side and faced with riprap on the water side. The Reservoir itself was prepared by removing all structures, filling in cellar holes, and removing or transplanting most vegetation.

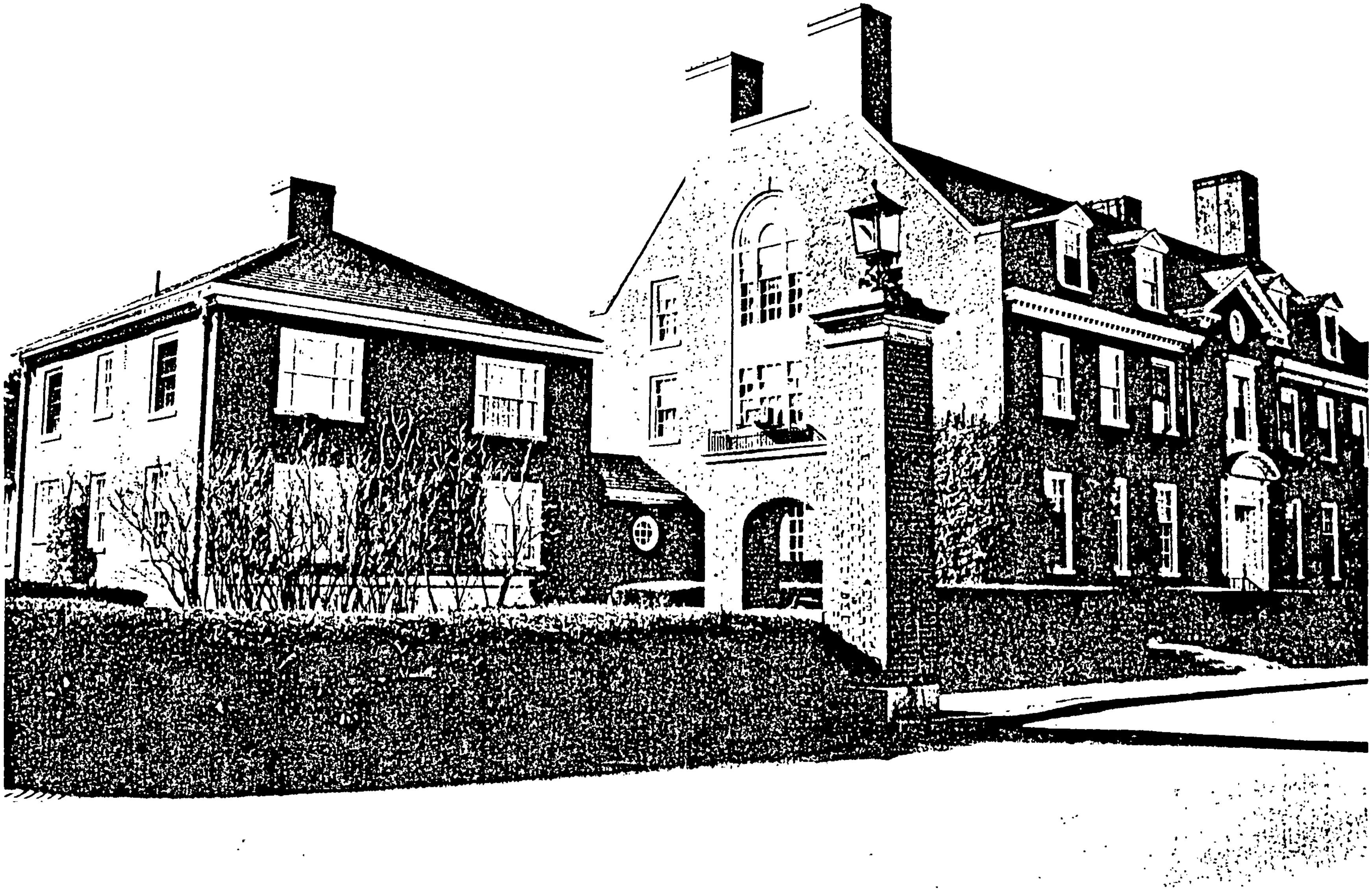
In the northern reaches of the reservoir are two regulating dams consisting of earthen embankments with circular concrete spillways. These structures maintain a minimum level of water in shallow portions of the reservoir during periods of drawdown or whenever the overall reservoir level is low.

There are two spillways associated with Winsor Dam. The auxiliary spillway is a curved concrete wall with quarryfaced granite crest, approximately 200 feet across, located southwest of the dam. The main spillway, located northeast of the dam, is used to release excess water from the reservoir into the Swift River below Winsor Dam. The structure is built of concrete with cut granite facing and hammered stone crest. The main section of the spillway is approximately 370 feet long, ranging in height from four to eight feet above rock ledge. At the north end is a 30-foot, angled section that is furnished with stop planks set in metal stanchions. A plank walkway above the crest provides access to the stop planks, which are operated manually.

Water flowing over the spillway enters a long narrow pool, two sides of which are formed by the spillway, the third by solid rock. From this pool water enters a channel cut in rock that extends approximately 2200 feet to the Swift River. A reinforced concrete arch bridge, faced with quarryfaced granite, spans this channel some 400 feet below the spillway to carry an access road to the east end of Winsor Dam.

A concrete and granite intake structure at the west end of Winsor Dam supplies water from the reservoir to a hydroelectric power generating facility a short distance to the southeast, constructed of brick and concrete. Since the early 1950's it has also supplied the Chicopee Valley Aqueduct, the connections for which were included in the powerhouse's original designs of some 15 years earlier.

The Quabbin system's administrative complex was built in 1937-38 just west of Winsor Dam. It consists of a group of red brick, Colonial Revival structures, arranged in a strict symmetrical



Quabbin Administration Buildings, Quabbin Reservoir, Belchertown. Built 1938-39. Densmore, LeClear & Robbins, Architects.

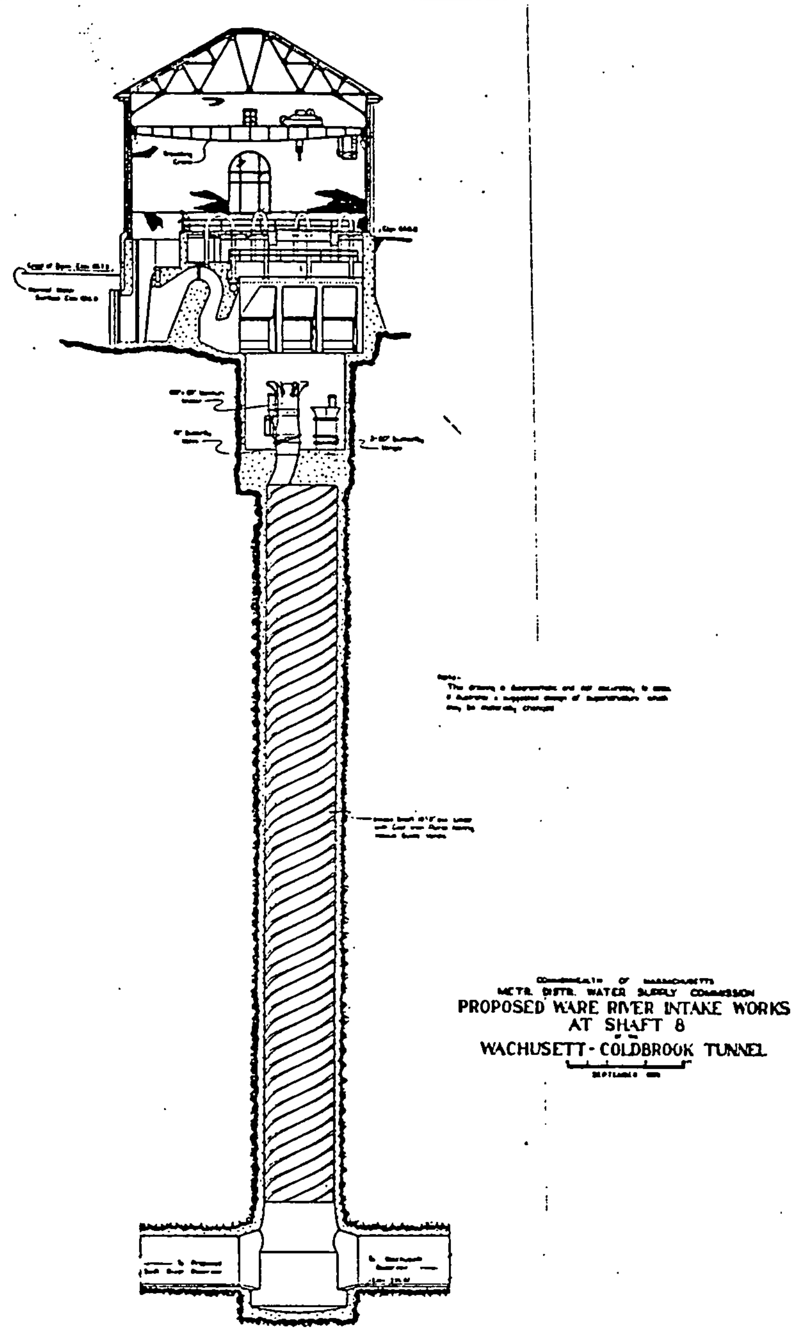
formation, inspired by southern colonial buildings of the late 18th century and also by the reconstruction of Williamsburg, Va. in the 1930's. The arrangement is focused around a 2-1/2-story gabled-roofed office block flanked by 2-story, hipped-roofed square dependencies (originally both used as residences) connected to the main block by enclosed brick walkways. Behind this group are two long rectangular garages which stand opposite one another and perpendicular to the office/house complex, thus forming a U-shaped courtyard. The complex was designed by Densmore, LeClear and Robbins, with the axial planning and siting by Arthur Shurcliff.

The structures, set back on a high point of land, face north toward the reservoir. A landscape plan consisting of driveways, oval planted areas, a brick wall and arched false gates of brick was designed by Shurcliff, the gates themselves by Frederick Kingsbury. Beneath this area is a hydroplane hangar and boat ramp. The hangar, with large garage doors of metal and glass, is constructed of concrete faced with random ashlar similar to that used on the Quabbin Aqueduct structures.

West of the administration complex, on Blue Meadow Road, is a collection of residential and maintenance buildings. The latter consist chiefly of rectangular, wood framed structures built in the 1940's for storage and utility purposes. There are also three wood frame dwellings, used by MDC employees. One is of recent construction, while the other two were acquired by the Water Supply Commission during the land-takings for the reservoir, dismantled, and reassembled on Blue Meadow Road.

Quabbin Park Cemetery, located southeast of Winsor Dam, was built in 1931-1933 to accommodate the over 7,500 burials in 34 cemeteries that had to be relocated during construction of Quabbin Reservoir. The 82-acre cemetery was designed by Arthur Shurcliff with a utility building (1941) designed by Frederick Kingsbury. The cemetery was laid out with space for 11,920 burials, an area for unknown graves and memorial area, near the cemetery entrance, which contains public war monuments from the abandoned towns. There is also a receiving vault near the cemetery entrance. Although the original cemetery plot plans could not be duplicated, every effort was made to have remains placed in the same relative positions they had occupied in cemeteries from which they were removed.

Additional built structures at Quabbin include a network of roads linking Blue Meadow Road, the administration buildings, Winsor Dam, Quabbin Hill and the Lookout Tower. Adjacent to the Quabbin Hill Road, on the way up to the tower, is a granite and bronze memorial (1939) dedicated to the memory of Chief Engineer, Frank Winsor. The Lookout Tower on Quabbin Hill consists of one story hipped roof section originally used for storage of radio equipment, and an 84-foot, six story, fire, radio and observation tower. At the bottom of the hill is one story rectangular structure housing public toilets. Both structures, designed by



Plan of Proposed Ware River Intake Works at Shaft 8.

From the Metropolitan District Water Supply Commission Annual Report, 1929.

Densmore, LeClear and Robbins, are built of concrete faced with field stone.

Quabbin Aqueduct is the conduit through which water is conveyed from the Ware River to Quabbin Reservior, and from Quabbin Reservoir to Wachusett Reservoir. Approximately 24-1/2 miles long, the aqueduct was built in two phases. The Ware-Wachusett segment, approximately 13-1/2 miles long, was constructed in 1927-31. The Quabbin-Ware segment, over 10 miles long, was completed in 1935. The conduit is a deep-rock tunnel lined with unreinforced concrete, with a cross-section roughly equivalent to a 12-foot 9 inch circle. It has a circular section in areas of "poor quality" rock, and a horseshoe-shaped section elsewhere. Thirteen shafts, ranging in depth from 122 feet to 657 feet, and numbered from east to west, are found along the aqueduct. Two of the shafts (8 and 12) are intakes, and two (11A and 1) are outlets.

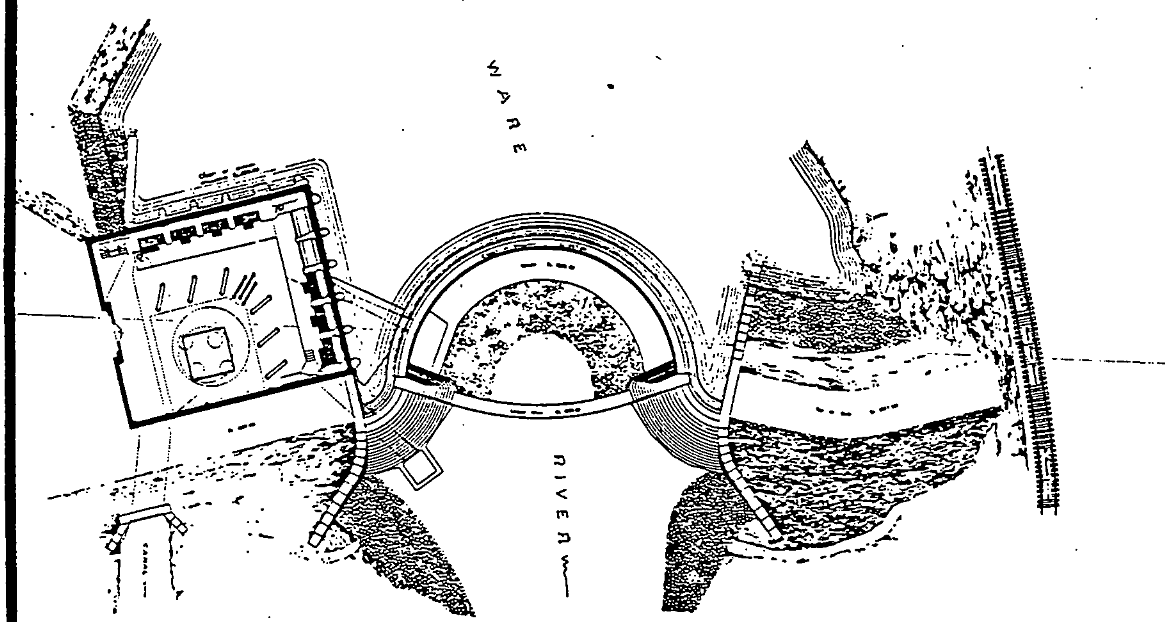
Shaft 8 is the intake facility for drawing water from the Ware River into the Aqueduct. The facility consists of a diversion dam, intake substructure, shaft, and superstructure. The dam is a thin semi-circular concrete arch, faced with granite, that has a 52-foot radius. The 174-foot spillway includes 34 feet atop the abutments, which are stepped on the downstream side to provide additional overflow length. From the pool behind the dam, water is diverted through nine siphon spillways, controlled by break pipes, the crests of which are one foot lower than that of the dam in order to ensure, automatically, that diversion will occur only when the river is above 85 MGD. The siphons discharge into a square pit, at the bottom of which are four butterfly valves. From these valves, water in the pit is discharged through a nozzle tangentially (approx. 30° from the horizontal) against the shaft lining. The shaft is lined with cast-iron helical vanes that guide the water, flowing in a thin sheet created by centrifugal force, down to the aqueduct. At the bottom of the shaft, the water is forced west by closure of gates at Shaft 1, to emerge at Quabbin Reservoir from Shaft 11A. From Shaft 11A, Ware River water is circulated in a carefully-contrived path through the reservoir, created by construction of two earthen baffle dams at strategic points. After nearly 4 years, Ware water, by then well mingled with water entering the reservoir directly from the Swift watershed and cleansed by the long period of storage, is drawn back into the Quabbin Aqueduct at the granite headchamber above Shaft 12 (only 3 miles from Shaft 11A), and from there is conveyed east to the Wachusett Reservoir on the first leg of the journey to distribution. At the outlet (Shaft 1) on the Quinepoxet River, water may be directly discharged into Wachusett Reservoir, or first channeled through a hydraulic turbine for the production of electricity. To ensure that water pressure does not exceed the turbine's capacity, a spillway was built at the top of Shaft 2, approximately two miles to the west.

The Shaft 2 spillway is approximately 16 feet high. The shaft opening, approximately 14 feet in diameter, is surrounded by an octagonal concrete inner ring covered with an applied concrete facing reinforced with 3/4-inch circular bars, for a total diameter of approximately 22 feet. The shaft is capped with a concrete plug, 4 feet thick, in which are built four air vents and four 4-foot-diameter openings fitted with heavy hinged steel covers. A relatively small head of water can lift these covers to relieve water pressure as needed. The spillway is surmounted by an 8-1/2-foot steel fence. A narrow channel lined with stone riprap conveys water released from the spillway to the Quinepoxet River, approximately 200 feet away.

Other structures associated with the operation of Quabbin Aqueduct include the Winsor Dam intake, powerhouse/outlet, and headhouses at Shafts 1, 4, 8, 9, and 12. There are also service buildings at Shafts 1, 8, and 12. Designs for all these buildings were developed by the Boston firm of Densmore, LeClear and Robbins under contract with the Metropolitan District Water Supply Commission. The architects developed a utilitarian, but attractive, design theme that appears to have been adopted from the neo-Renaissance Revival idiom that characterized architecture in earlier segments of the Metropolitan Water Supply System. Principal features included an upright, rectilinear form; hipped roof; symmetrical arrangement of openings; and central placement of the entrance within a tall round arch in either a long or short side. Exteriors, with one exception, were clad in quarry-faced random ashlar granite; but structural systems commonly employed steel I-beams and roof trusses, and inner walls of tan facebrick over a common brick core.

HULTMAN AQUEDUCT

The Hultman Aqueduct was built in 1938-40 to bypass Sudbury Reservoir, which by then was threatened by pollution; and to bring clean water from Wachusett Reservoir directly into the Metropolitan Water District under sufficient pressure to eliminate the need for low-service pumping. The 18-mile pressure conduit extends from near the Wachusett Aqueduct Terminal Chamber in Marlborough to a point near the Charles River in Weston. It includes a 9700-foot segment of cut and cover with 12-foot 6-inch steel cylinder reinforced concrete pipe; a three-mile rock tunnel beneath Sudbury Reservoir; thirteen miles of 11-foot 6-inch steel cylinder reinforced concrete pipe; and a 170-foot twin-tube segment below Norumbega Reservoir in Weston. Contractors for the work included West Construction Co., Boston; B.A. Gardetto, Boston; the American Concrete and Steel Pipe Co., Los Angeles; and Carlo Biachi, Framingham. The pipe used in the Hultman was manufactured by the Lock Joint Pipe Co., of Ampere, New Jersey, which built a large plant on Speen Street, Natick, for fabrication of the steel cages and casting of all but the largest pipe segments. A second plant was established in Southborough, where the largest cylinders were cast. Fabrication of the steel cylinder and cage assemblies was subcontracted to the American Concrete and Steel Pipe Co. which had produced similar elements for the Metropolitan Water District of Southern California.



COMMONWEALTH OF MASSACHUSETTS
METR DISTR WATER SUPPLY COMMISSION
PROPOSED WARE RIVER INTAKE WORKS AT SHAFT 8
OF THE
WACHUSETT-COLDBROOK TUNNEL

From the Metropolitan District Water Supply Commission Annual Report, 1929.

Structures associated with the Hultman are a semicircular diversion dam on the Wachusett open channel, an intake structure near that dam, a headhouse at Shaft 4 below Sudbury Dam, and a gatehouse and chlorine storage structure at Norumbega Reservoir. Consulting architect for the Shaft 4 headhouse and Norumbega Reservoir gatehouse was the Boston firm of Densmore, LeClear & Robbins, which based the designs for the Hultman structures on those developed earlier for Quabbin Aqueduct. Both structures have rectilinear forms, hipped roofs, and tall round-arched openings fitted with hollow bronze doors. The exteriors are clad in quarryfaced random ashlar granite.

The original plan for the "new pressure aqueduct" called for its extension all the way to Chestnut Hill Reservoir and for construction of a "tunnel loop" within the immediate Boston area. The segments from Southborough to Weston were completed in 1940. With the nation's entry in World War II, however, the "city tunnel" section to Chestnut Hill was delayed, Federal authorization having been denied on grounds that it was not essential to the war effort, despite intensive lobbying by the state legislature. Construction resumed in 1947, and the city tunnel extension was completed in 1950. Subsequently, the tunnel extension to Malden (1962) and Dorchester Tunnel (1974) extended the pressure system into the heart of Metropolitan Boston. The Cosgrove Tunnel, bypassing the Wachusett Aqueduct, was completed in 1965.

MYSTIC WATER WORKS

The Mystic Water Works were built by the City of Charlestown in 1862-1865 to supply water to that community and to neighboring Somerville and Everett. This small system contained all the elements necessary to make Charlestown self-sufficient in its water supply. Chief Engineer for the works was C.L. Stevenson; Consulting Engineer, George R. Baldwin.

Water was drawn from two natural glacial kettle tidal ponds known as the Mystic Lakes. To keep out the salt water, a dam was built at a small natural channel between the lakes and in fact part of the earthen embankment of the dam rests on the spit of land that forms the channel. The dam has a 100-foot overfall, with 5 granite piers surrounded by a wooden walkway. The piers are grooved to accomodate stop logs, and the area directly below the dam is paved with stone and cement to prevent washouts. There was also a wooden fish ladder on the east side of the south face of the dam. A brick gate house is located east of the dam where an oviform brick conduit began. This carried water 7,463 feet along the east side of the Mystic River to a pipe chamber; the water then passed beneath the river in a cast iron pipe to the Mystic Pumping Station.

The Second Empire-style pumping station was built as a 1-1/2 story brick structure on a granite foundation, with arched windows and doorways. Directly behind this building was a 100-foot brick chimney and retaining wall. The chimney had an underground flue that led to the pumping station. The retaining wall stabilized a hill through which mains passed to Walnut Hill Reservoir.

Water was pumped from the Mystic station by two Worthington steam engines (one with a capacity of 5,000,000 gals/day; the other 8,000,000 gals/day) up to the 4-1/2 acre Walnut Hill Reservoir located on the Tufts College campus. This rectangular distribution reservoir had a depth of 26 feet and could hold up to 26,244,000 gallons of water. The bottom was concrete and the sides were lined with brick set in hydraulic cement. From here water was fed, by gravity, to consumers.

In 1870, growing demand for water in neighboring Everett resulted in the expansion of the pumping station to hold a third Worthington engine. In 1895, further demand necessitated a fourth engine and another addition to the building. This engine, a Leavitt, was eventually moved to the Spot Pond Pumping Station.

Between these expansions, the Boston Water Board noted that the roof trusses in the pumping station were "old and distorting". In 1887, therefore, most of these trusses were replaced by triangular wood trusses strengthened with iron tie rods. Several of the original trusses, however, remain near the middle of the roof. These interesting arched structures are about one foot in diameter, and are built up from thirteen narrow strips of laminated wood. They are connected to the building's brick bearing walls with tie buckles which can be turned to increase or decrease tension.

When the City of Boston annexed Charlestown in 1874, the Boston Water Board assumed control of the Mystic Water Works and operated the system until the formation of the Metropolitan Water Board in 1895. Soon thereafter, the system was removed from service because the water had become fouled by industrial waste. The reservoir was kept full, however, as an emergency supply and to maintain the pressure necessary for high service pumping. In 1898, the shore areas were turned over to the Metropolitan Parks Department, but the water rights remained with the Water Board.

In 1912, the remaining engines, boilers and other associated equipment were removed from the pumping station and sold for scrap. The station was converted to a shop, original interior partitions removed, new ones added, and a second story loft inserted. During World War I, the building was used by the American Radio and Research Corporation to manufacture materials for the United States government; and Tufts University students also used the building and reservoir for military training. The original mansard slate roof has been covered with asphalt shingles, and decorative iron trim and the central tower removed.

In 1920 the building underwent renovation again and in 1921 the chimney was demolished; additional office space was built in the 1940's on the site.

The reservoir was maintained for emergencies until sometime between 1933 and 1955 when it was filled in and used as a commons for Tufts University.

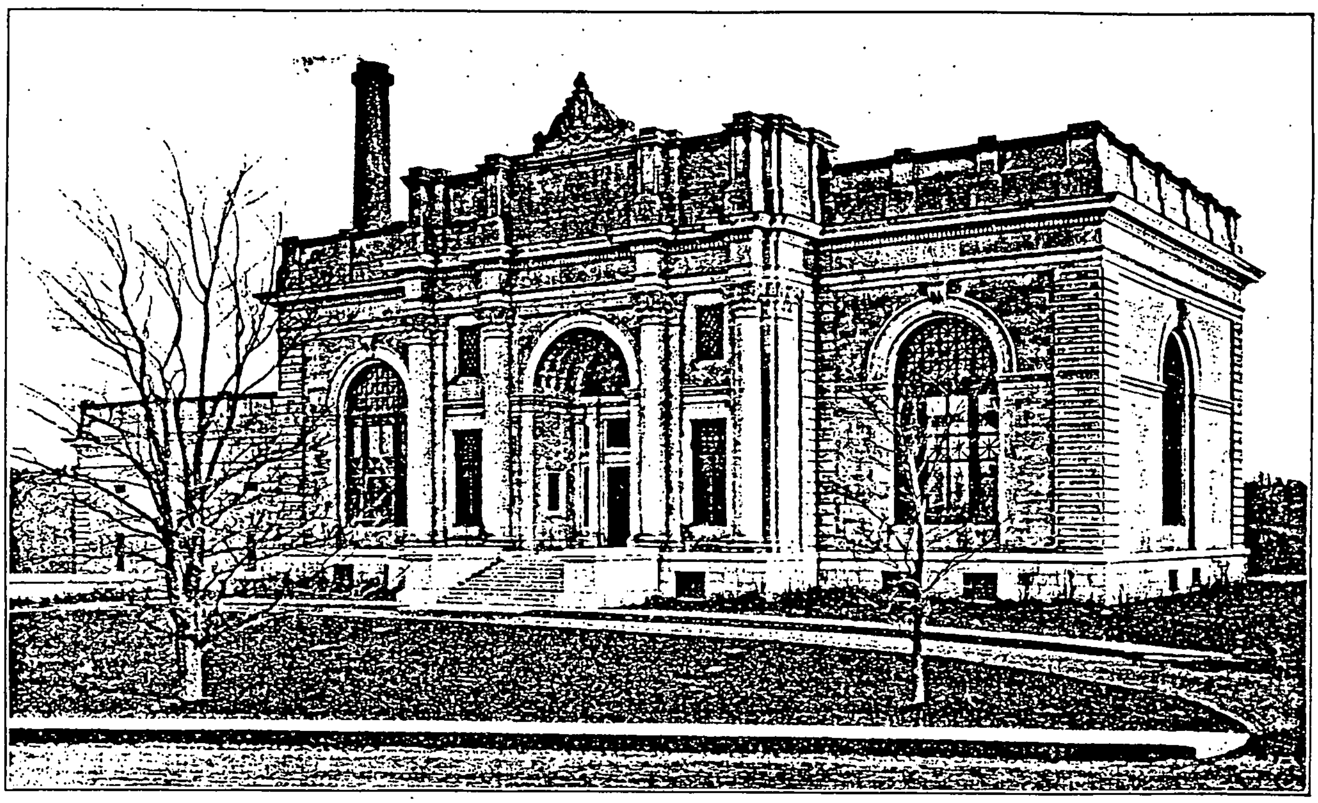
CHESTNUT HILL RESERVOIR

Chestnut Hill Reservoir was developed in 1865-70 as an additional supply and distribution reservoir supplied by the Cochituate Aqueduct, which terminated at the smaller Brookline Reservoir one mile to the southeast. Chestnut Hill originally featured two basins, the Lawrence and the larger Bradlee, which were separated by an impermeable earth and stone dam. The chamber of the small granite intermediate gatehouse on the dam was arranged so that either basin could be emptied as necessary for cleaning or other purposes. An influent gatehouse (no longer extant) was located on the north side of Lawrence basin, and a two-level effluent chamber was built on the east end of Bradlee basin. Originally equipped with manual gates, the effluent chamber was refitted with hydraulic sluice gates in 1873-74.

In 1878, the Sudbury Aqueduct was completed from Farm Pond to Chestnut Hill. The gray granite Sudbury Terminal Chamber was constructed near the south shore of Lawrence Basin, with pipe connections into the reservoir and also into Cochituate Aqueduct.

In the early 1880's, Boston City Engineer Henry Wrightman raised the issue of expanding the high service system beyond the pumping stations then in operation at Brighton and West Roxbury. Wrightman, quoted in the Water Board's 1884 report, noted "...the constant pressure from inhabitants of the districts supplied from low service..." The first stage of the expansion was construction of Fisher Hill Reservoir, south of Chestnut Hill, in 1885. Fisher Hill's granite, brownstone and brick intake chamber was designed by the City Architect's office under Arthur Vinal.

At Chestnut Hill, the Boston Water Board constructed a new high-service pumping station that was completed in 1887. The station was also designed by Vinal, who borrowed freely from the Romanesque idiom of Henry Hobson Richardson's Trinity Church, built in Copley Square in 1872-77. The station's impressive scale was directly attributable to the space requirements of its coal-fired steam engines and pumps. As originally constructed, the high-service station contained two Gaskill compound duplex engines, each with a capacity of 8 mgd. Engine #2 was replaced in 1920-1 with a Worthington horizontal cross compound crank and flywheel engine with a capacity of 15 mgd. In 1894 No. 3, a Leavitt triple expansion engine with a capacity of 20 mgd, was installed. Considered an outstanding example of its type, the Leavitt was designated a National Historic Mechanical Engineering landmark on 14 December 1973 by the American Society of Mechanical Engineers. Though taken out of service the engine was kept in operating condition for some years after, and is for the most part still intact.



CHESTNUT HILL Low-Service PUMPING STATION.

From the Metropolitan Water Board Annual Report, 1901.

Chestnut Hill Reservoir and pumping station were among a number of Boston water supply facilities taken over by the Metropolitan Water Board. In 1897, the Board installed an Allis triple expansion engine with a capacity of 30 mgd (extant today) in a newly built extension off the west end of the pumping station. The addition, designed by the Boston firm of Wheelwright and Haven, was carefully planned to blend with the earlier structure, and was so successfully executed that it appears to be part of the original construction.

The following year, the Metropolitan Water Board initiated further expansion of the capacity of the distribution system by enlarging Spot Pond in Stoneham for high and low service, and by constructing a new low-service pumping station at Chestnut Hill connected to Spot Pond via a 48" main. The latter's three Holly triple-expansion engines, with a combined 35 mgd capacity, were housed in a monumental white Beaux-Arts building designed by Shepley, Rutan and Coolidge. To supply both the low and high service stations, a neoclasical granite gatehouse, designed by Wheelwright and Haven, was built in 1901 on the southeastern shore of Bradlee Basin. It conveyed water, via 60-inch mains, to both the high and low-service facilities.

In addition to the main buildings and structures, several small support buildings were built at Chestnut Hill from c. 1900-1940, along with a pipe yard and a stone stable. The latter, located between the high and low service stations, is now used as a workshop. In 1940, Lawrence Basin was filled in, and the property sold to nearby Boston College. The Chestnut Hill facility was removed from active service following completion of the Dorchester Tunnel in the mid-1970's. Modern gas powered engines and pumps are currently maintained in the low-service station, but only for backup in emergencies.

MIDDLESEX FELLS RESERVATION RESERVOIRS AND PUMPING STATION

The 2,060 acre Middlesex Fells Reservation was an underdeveloped area that became a park in 1894. The Fells was kept in its natural state, but was "designed" by Charles Eliot, an associate in the Olmsted firm, to the extent of locating lookouts, naturalistically landscaped areas, and walks and drives that made the park more inviting and accessible to the public.

Within the reservation is Spot Pond, which had been considered as a possible municipal water source as early as 1825, but was not utilized until 1869, when the town of Malden built a pumping station on the Pond's shore. The following year, 1870, Melrose and Medford also built pumping stations on the pond.

In 1898, under provisions of the Metropolitan Water Act, Spot Pond was taken over by the Metropolitan Water Board for its northern distribution system. Under the direction of Dexter Brackett, Engineer of the Distribution Department, and Frederic Stearns, Chief Engineer, the Water Board began a series of improvements, including expansion of Spot Pond, construction of a pumping station, and development of two smaller reservoirs within the Fells for additional high service distribution.

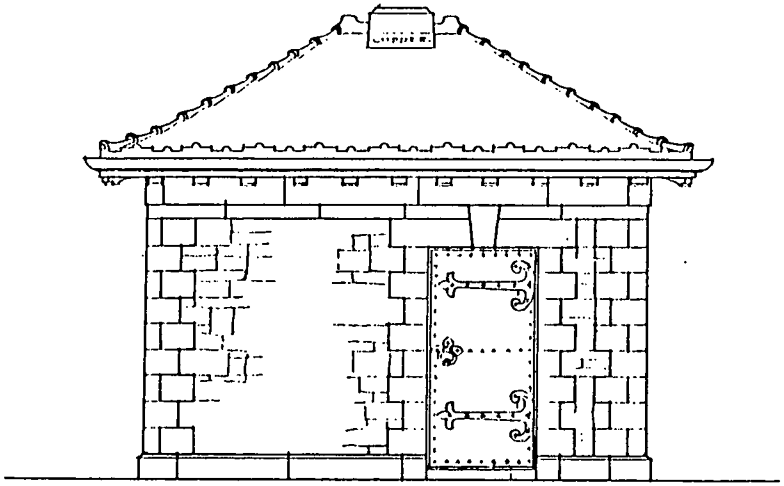
Soon after acquisition, the Melrose, Malden and Medford pumping stations were demolished, and a 50 MGD pumping station was completed at Spot Pond by 1898. Designed with a Renaissance Revival theme by Shepley, Rutan & Coolidge, the building housed three steam engines, including a Leavitt engine which had originally been built for the Mystic Works and a Holly Engine with a 20 MGD capacity. The station was connected to the Chestnut Hill Low Service Pumping Station (built the same year) by a 48-inch main.

The east gatehouse, on the pond northwest of the pumping station, although not documented as such, was probably designed by Shepley, Rutan & Coolidge. The structure is in the same style as the other structures in the Water Board's Fells complex, and Shepley, Rutan & Coolidge was the firm most often associated with Olmsted in the design of structures in the park system. In anticipation of the pond being raised nine feet, the gate chamber was constructed twelve feet higher than the 1897 water level. It has four valve compartments to control the flow of water into and from the pond. A short high connection was made through a 48-inch pipe; a second, longer pipe extended to deep water, terminating in a horseshoe-shaped cement conduit. Two other gates controlled the flow of water into the pumping station.

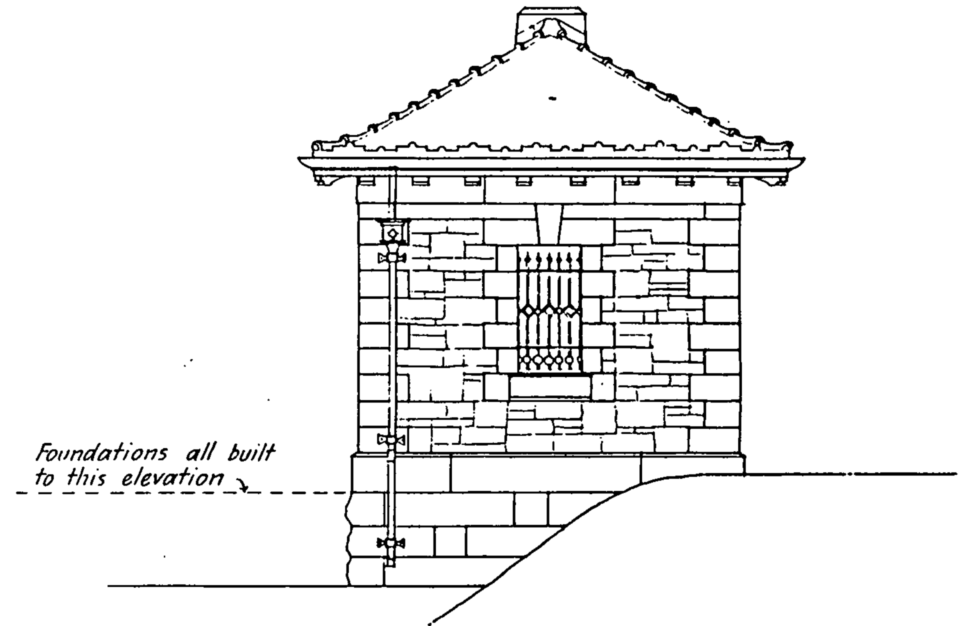
Spot Pond itself was "improved" in 1899-1900 by construction of twelve earthen embankments, and by connecting the waters of Quartermile, Dark Hollow, and Doleful Ponds with conduits and open channels. The embankments were designed and landscaped in a naturalistic manner by the Olmsted Brothers. In 1900, a granite gatehouse, designed by Shepley, Rutan & Coolidge, was constructed at the southern end of Spot Pond. The chamber contains two sluice gates which regulate 60-inch pipes, and two 60-inch gates for controlling the flow of water from different levels of the pond.

Additional structures in the Spot Pond complex include a granite house and barn. The house, built in the mid-19th century by John Bottume as a summer home, was acquired by the Metropolitan Water Board as a residence for the superintendent of the reservoir. The stone barn, located some distance south of the house, was converted to storage, but has since been abandoned.

The Middlesex Fells Reservoir and Gatehouse were built in 1899 as the northern high service distribution facility. The site was a natural basin and swamp; two basins were developed by constructing five small dams and lengthening a natural rock ridge with two concrete walls. The 8-acre reservoir landscaped by the Olmsted Brothers, held 38,500,000 gallons of water. A granite gatehouse, designed by Shepley, Rutan & Coolidge, was completed in 1900. The chamber, containing 36-inch sluice gates, connects with Spot Pond via a 36-inch main and with Bear Hill Reservoir via a 20-inch main.



FRONT ELEVATION.



SIDE ELEVATION

· COMMONWEALTH OF MASSACHUSETTS ·
METROPOLITAN WATER WORKS ·
BEAR HILL RESERVOIR
GATE HOUSE.

· SHEPLEY · RUTAN · & COOLIDGE ·
ARCHITECTS.
· BOSTON · MASS ·

From the Drawing Files of the Metropolitan District Commission.

Bear Hill Reservoir was developed in order to provide water to the town of Stoneham, which was admitted into the Metropolitan Water District in 1901. The 3/4-acre reservoir holds 2,450,000 gallons of water. It was built in a depression on a rocky ridge with concrete dams at either end. A gatehouse was built on the east side of the reservoir, with a 20-inch line from Middlesex Fells to Bear Hill and a 20-inch pipe to Stoneham. A 24-inch main connects the reservoir with Spot Pond.

The buildings and structures of the Middlesex Fells Reservation are, with one exception, basically intact. In 1975, a fire in the pumping station resulted in the removal of the clerestory and replacement of the roof. The building is now nine feet shorter than originally constructed. The three steam engines have been replaced by two Fairbanks and Morse diesel engines, with an electric engine as a back-up.

Increased demand for water resulted in the construction of a third basin for the Middlesex Fells Reservoir in 1940.

PUMPING STATIONS & STANDPIPES FOR LOCAL DISTRIBUTION

Many features associated with the Metropolitan Water Supply are organized as long, linear systems composed of a number of elements. But within the water supply network are also smaller systems with only one or two components. These are generally located within the confines of the City of Boston and were built for the express purpose of local distribution. Components include standpipes, or vertical reservoirs; distribution reservoirs; and pumping stations.

The earliest of these small systems is the West Roxbury Pumping Station and Bellevue Standpipe, built under the direction of engineer Dexter Brackett. This high service supply for the West Roxbury district is higher in elevation than either Parker Hill (Roxbury) or Fisher Hill (Brookline) reservoirs. The brick pumping station, built in 1886, was located at the corner of Washington and Metropolitan Avenues. It contained two duplex, high pressure Blake Manufacturing Company pumps, each with a capacity of 400,000 gallons per day, that pumped water from Fisher Hill Reservoir to the Bellevue Standpipe. The original standpipe, completed in 1888, was a small, picturesque, shingle-style structure which held 125,000 gallons of water. It was located in Muddy Pond Woods, 600 acres of a rocky, hilly ground too rugged for development and used primarily as a woodlot. In 1894, the land was acquired by the newly-formed Metropolitan Parks Commission. Roads and landscaped areas were designed by the Olmsted Brothers and the name changed to Stony Brook Reservation.

In 1912, with the annexation of Hyde Park to Boston, the Metropolitan Water and Sewerage Board built a new pumping station and abandoned -- and eventually demolished -- the West Roxbury station. The Hyde Park station is constructed of red brick, on a raised basement. It was built beside the New York, New Haven, and Hartford Railroad where a small spur, built by the railroad, was used to supply coal. The Hyde Park station conveyed water from Chestnut Hill to Bellevue with two pumping engines, each with a 3 MGD capacity. At the same time this station was built (1916), the original Bellevue standpipe was replaced with a larger capacity (250,000) steel tank surrounded by a Romansque-style granite and concrete masonry tower.

In 1936 the steam engines were replaced by four General Electric electronic engines with Allis-Chalmers pumps, each with an 80 MGD capacity. A diesel engine was used as a backup to the electric engines. The masonry standpipe, though extant, has been functionally replaced by a larger capacity steel tank, completed in 1956.

Forbes Hill Reservoir and Standpipe were constructed in 1901-1902 to supply the City of Quincy after it joined the Water District in 1897. Water supplied from Chestnut Hill was distributed from the reservoir and standpipe to the surrounding community by gravity. The steel standpipe held 338,000 gallons and was built on the perimeter of the rectangular reservoir, which held 5,000,000 gallons of water. The Forbes Hill Standpipe was encased in a granite shell, capped with a crenellated observation platform, that vaguely resembles a castle keep.

Although not a part of the metropolitan water system, the Roxbury Standpipe and Pumping Station are briefly described here because the standpipe was the earliest built in the city and because both facilities were an integral part of Boston's high service distribution system.

Annexation of Roxbury in 1868 brought the former city within the Boston water system. To supply the Roxbury area, the Boston Water Board built a standpipe and a pumping station, a relatively rare combination at the time. The location of the standpipe was one of the highest in Roxbury, and the site of the remains of a Revolutionary War fort. Placement of the structure generated some controversey because citizens felt the hill should be "sacredly preserved as a relic." The Water Board prevailed, however, and the tower was completed in 1870. It consisted of an iron tank enclosed within a Gothic style brick tower, with an octagonal observation deck topped by a spire. The base was a four sided, gabled structure, reminiscent of the shape of fort's remains and perhaps a conciliatory gesture on the part of the city.

A pumping station was also built in Roxbury, at Elmwood and Roxbury Streets; it contained two steam engines with a combined capacity of 2.4 MGD. Though the standpipe remains today, it was taken out of service upon the completion of the high service pumping station at Chestnut Hill in 1887. The pumping station was also taken out of service and eventually demolished.

Arlington had developed a water supply system in 1873, but impurities in the water, which could not be removed, finally led the town to join the Metropolitan Water District in 1898. The Metropolitan Water Board constructed a temporary wooden pumping station in 1899 which was used until completion, in 1907, of a red brick station at Brattle Court, adjacent to the Arlington and Maine Railroad. Two horizontal steam engines, one built by Blake and Knowles, the other by Allis-Chalmers, each pumped 1.5 MGD to the Arlington standpipe which, by gravity, served Arlington and Lexington, through the distribution system remaining from the original Arlington works. The town's standpipe, built in 1894, was replaced by the Metropolitan District Commission in 1923 with a steel tank holding 1,995,000 gallons. The tank was enclosed in a new classical style shell based in part on a plate of a small Grecian tower, from the 4th century on the island of Samothrace found in Russell Sturgis' European Architecture, published in 1896. The masonry structure, ringed at the top with Doric columns, is separated from surrounding houses by open lawn.

In 1982, the Arlington station was remodeled and the old pumps replaced. The interior alterations reflect changing space needs, as engines have grown smaller and personnel requirements have also changed through the years. The only exterior modifications are new metal windows in the same style as the old, and the removal of a small cupola.

The Southern Sudbury Emergency Supply System was constructed in 1927, after a year in which water consumption exceeded supply. In order to "buy time" until water from the Ware and Swift watersheds became available, the Metropolitan District Water Supply Commission constructed a small system to take water from Whitehall, Hopkinton and Ashland Reservoirs. The works included a 24-inch pipe from Ashland to Framingham Reservoir #2; a 20-inch pipe from Whitehall Reservoir to City Brook; a small diversion dam and reservoir and open channel at Whitehall; and a 30-inch pipe from Hopkinton to the Sudbury Reservoir. At Cordaville in Southborough, the water supply commission built a one story, almost square brick pumping station containing a 20-inch Worthington Pump with a General Electric electric motor and a chlorinator pump. By the time the Emergency Supply was complete, however, the water crisis had abated and the system was no longer needed. In 1933 the works were turned over to the Metropolitan District Commission. The system, never used, is in ruins today.

The Belmont Pumping Station, and an associated covered reservoir in Arlington, were built for Intermediate High Service in 1936-37. The one-story, flat-roofed pumping station, with seam-faced granite exterior, was originally furnished with two electric motor centrifugal pumping units, built by the Turbine Equalizer Co. of New England. In 1946 three 6 MGD dynamic head centrifugal pumps were installed, and connected directly to a three-phase, 60 cycle, 2200 volt squirrel cage induction unit for operaton with suction pressure from Weston Aqueduct. Since the construction of Norumbega Reservoir the existing pumps operate at a low efficiency ratio due to higher suction pressure. The station continues to serve Belmont and Arlington.

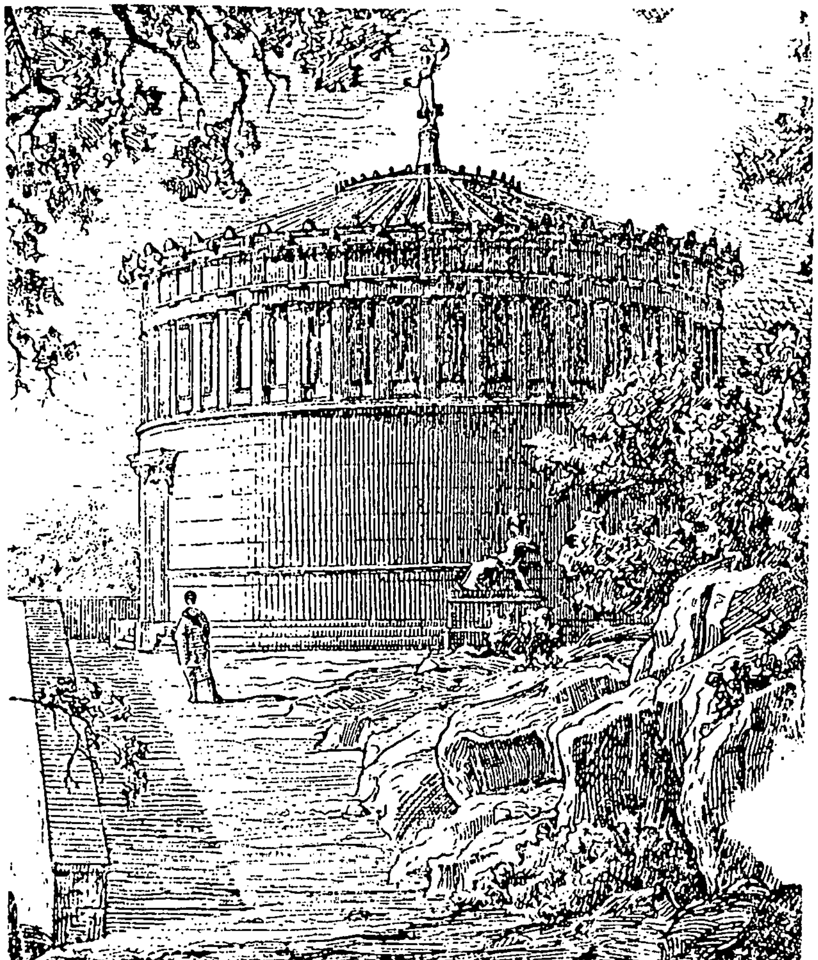
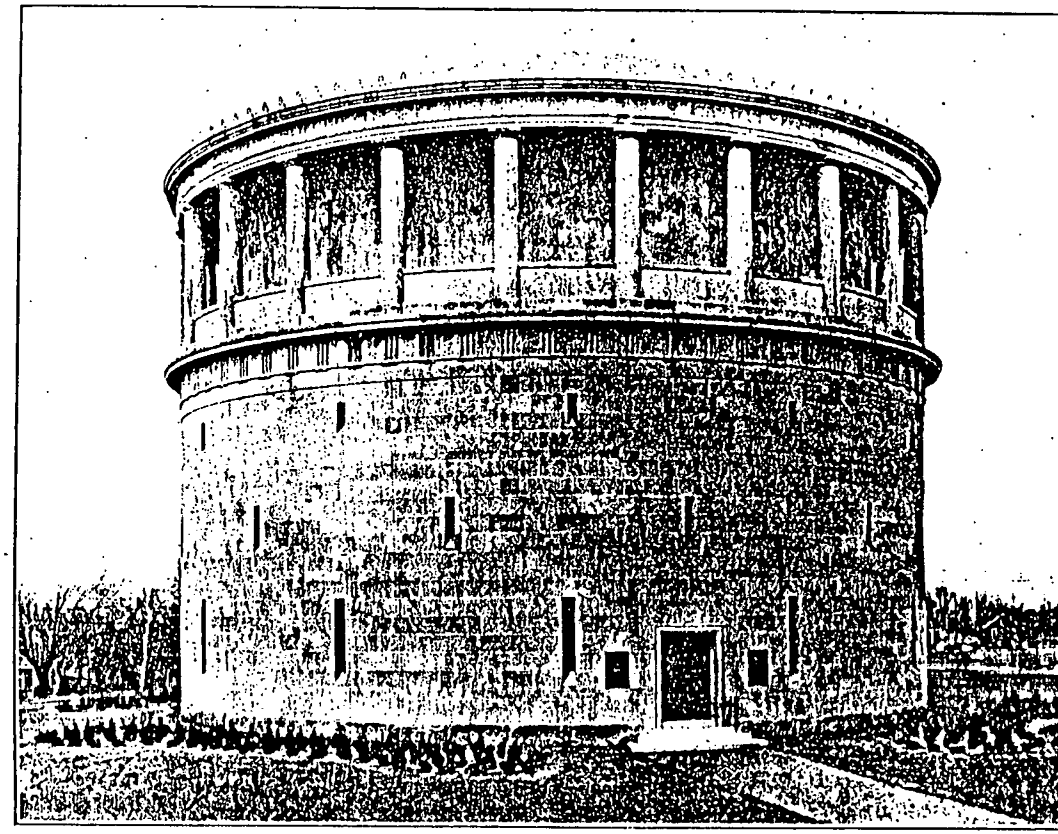


FIG. 24. Island of Samothraki (Samothrace): Restoration of a building of fourth century B.C.



ARLINGTON RESERVOIR

A design sketch in the offices of the Metropolitan District Commission indicate that the design for the Arlington Standpipe was based on "a small Grecian Tower, built sometime B.C.," an illustration of which is found in European Architecture by Russell Sturgis, 1896.

From the Metropolitan District Commission Annual Report, 1924.

IV. ANALYSIS AND RECOMMENDATIONS

The significance of the Metropolitan Water Supply System can be interpreted in many different ways. In terms of level of significance, the system appears to be primarily of statewide importance. Presently, it is difficult to assess the relationship of the system to water supply development nationwide, due to lack of comparable studies of other systems. However, the relatively early date at which this system (and also possibly the sewerage system) was developed, as a metropolitan entity, may prove to be important in terms of development of the metropolitan concept on a national basis. Significance at the local level may be interpreted in terms of the contribution of the water supply system to increased standards of living, the issue of annexation to Boston, and the impact of large-scale construction within small communities, but for the most part the association of particular structures with such topics is rather indirect. Architecturally, various structures of the system may be interpreted as of local importance; however, the context in which they were designed, built and operated bears little relationship to the architectural history of any given community.

All four National Register criteria apply, in various ways, to the Metropolitan Water Supply System. In a very broad sense, Criterion A is applicable because the system is associated with the history of public works in Boston and Massachusetts, the emergence of public health as a major governmental concern, and the beginnings of the metropolitan, as opposed to local, approach to the solution of many problems of urban life. Criterion B is rather more difficult to apply, because development of the water supply system drew upon the collective efforts of many different people whose individual contributions are not easily determined. However, it may be possible to say that aspects of the system are significant for their association with engineers of recognized importance, such as Frank Windsor, Frederic Stearns, Joseph P. Davis, and Desmond Fitzgerald, whose abilities were crucial to the successful design, construction and function of the water supply system.

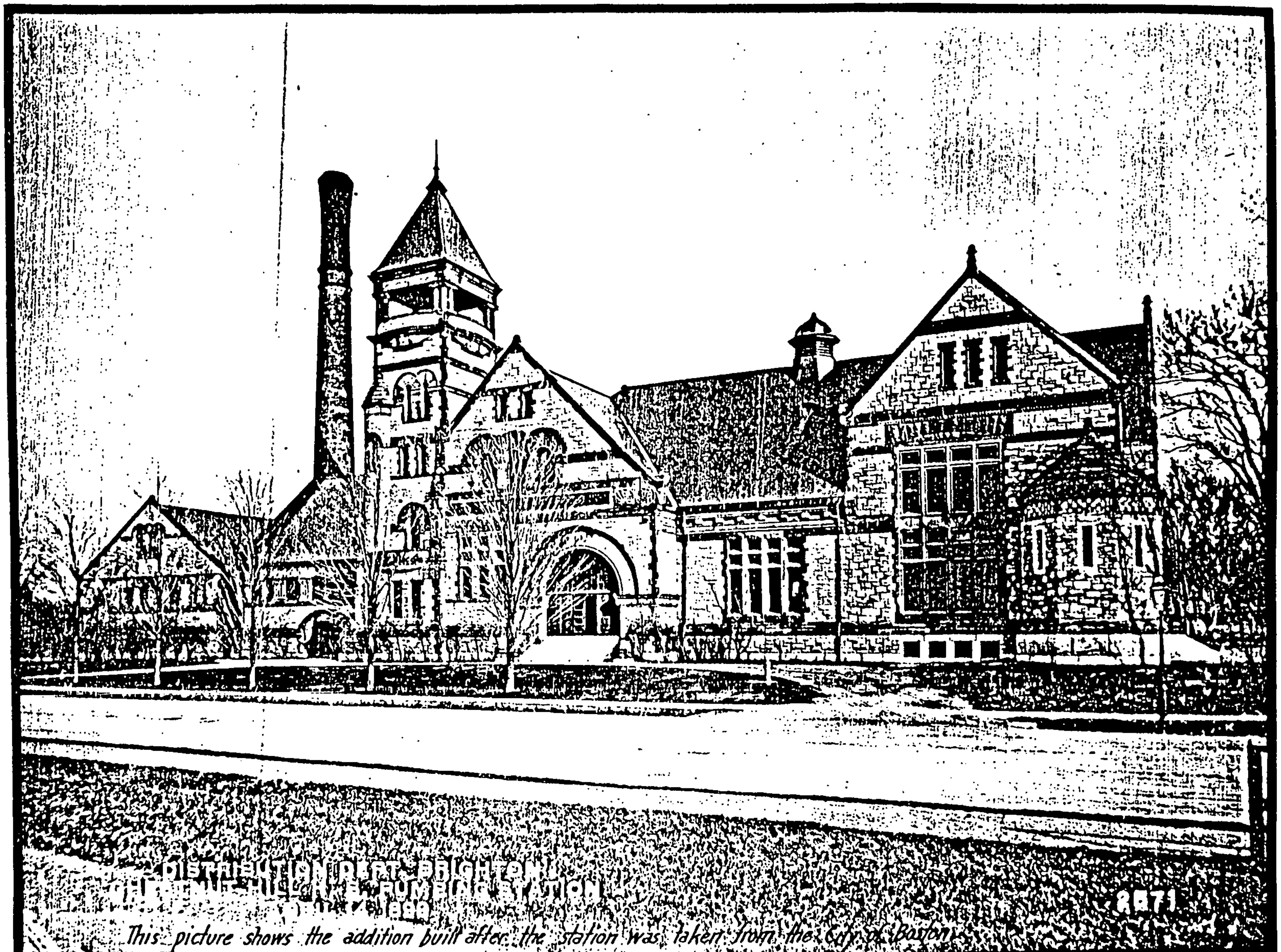
Criterion C is applicable in several aspects. Within the system are represented works by important Boston-area architects (Shepley, Rutan & Coolidge; Wheelwright and Haven; Densmore, LeClear & Robbins) and by the Olmsted Brothers' landscape firm. Many of the chambers and pumping stations represent excellent adaptations of major architectural styles to utilitarian structures. In addition, aqueducts, chambers and pumping stations have considerable importance as well-preserved manifestations of both 19th and 20th century hydraulic engineering and construction techniques, as do many of the dams in the area of civil engineering. Finally, many of these resources may be considered as elements of districts through unity of function and/or design.

Although Criterion D is commonly applied primarily to archaeological resources, a case can be made for its applicability to the Metropolitan Water Supply System. The system has great potential to convey, both to the public and to students of engineering history, information about hydraulic and civil engineering of a given time, and how it was employed to meet various demands of topography, capacity and supply. Although portions of the system are no longer in use, even these retain a surprising degree of integrity; thus, the system presents quite clearly not only the workings of a large scale gravity water supply in its entirety, but also a graphic portrayal of technological evolution over a century.

Over 150 structures, buildings and areas were inventoried in the course of the Metropolitan water survey. Many of these resources have only limited meaning outside the context of the water supply system as a whole. Within that context, however, even the smallest chamber has an intrinsic importance, since every structure was built for a specific purpose and all were considered important to the success of the overall "mission", i.e., the collection, conveyance and distribution of water to Boston and the metropolitan area.

In assessing the significance of resources in the water supply system, it appears appropriate in some cases to look at assemblages of resources, or districts. One type of district is the linear district represented by an aqueduct system, consisting of the conduit, its associated chambers, and, where appropriate, reservoirs. The other type of district is the grouping of resources within a definable boundary, within which the resources share not only functional, but visual relationships. Between the two is a certain degree of overlap. For example, the Weston Head Chamber is on the Weston Aqueduct, but its location and architectural features require its consideration as well as part of the district at Sudbury Dam. Similarly, the Sudbury Terminal Chamber is an integral part of the Sudbury Aqueduct, but is also properly comprehended within the district at Chestnut Hill Reservoir.

Another interpretation of these resources is in the thematic context. For example, one might interpret the superstructures of



The High Service Pumping Station at Chestnut Hill. From the Metropolitan District Commission Photograph Collection.

aqueduct and reservoir chambers as "the architecture of the Metropolitan Water Supply System," in which utilization of canons of form, proportion, scale, aesthetic treatment, and style is emphasized over function. Or, certain classes of structures, particularly masonry dams, can be considered thematically as examples of an important type of civil engineering structure, as bridges are increasingly considered today. Not all resources, however, can be neatly fitted into a district or thematic group, and thus must be interpreted individually as discrete objects.

If it is assumed that all resources inventoried in the Metropolitan Water Supply System have at least a significance based on their functional association with a system of unquestioned importance, it still remains necessary to organize them into some framework for planning purposes. The system is not a museum piece, but is rather an evolving system that must constantly meet the demands of its constituency. To this end, a series of categories is proposed to which districts and individual resources are assigned according to the relative degree to which they:

- retain physical integrity
- illustrate or represent various features of the water system
- are architecturally significant
- are associated with events or developments of particular importance in the history of the water supply system
- are able to convey information about certain categories of structures, or about particular functions, both to scholars and to the public at large.

Adoption of such categories can provide a tool for developing priorities for programs of conservation, restoration, protection and public interpretation.

GROUP 1: Six potential districts, including three linear districts, are recommended for inclusion in Group 1. All display a high level of integrity and clear architectural distinction. Collectively these six districts illustrate the three major functions of the water supply system: collection (Wachusett Dam and Quabbin Reservoir districts), conveyance (Cochituate, Weston, and Quabbin Aqueduct systems) and distribution (Chestnut Hill and Spot Pond).

Chestnut Hill

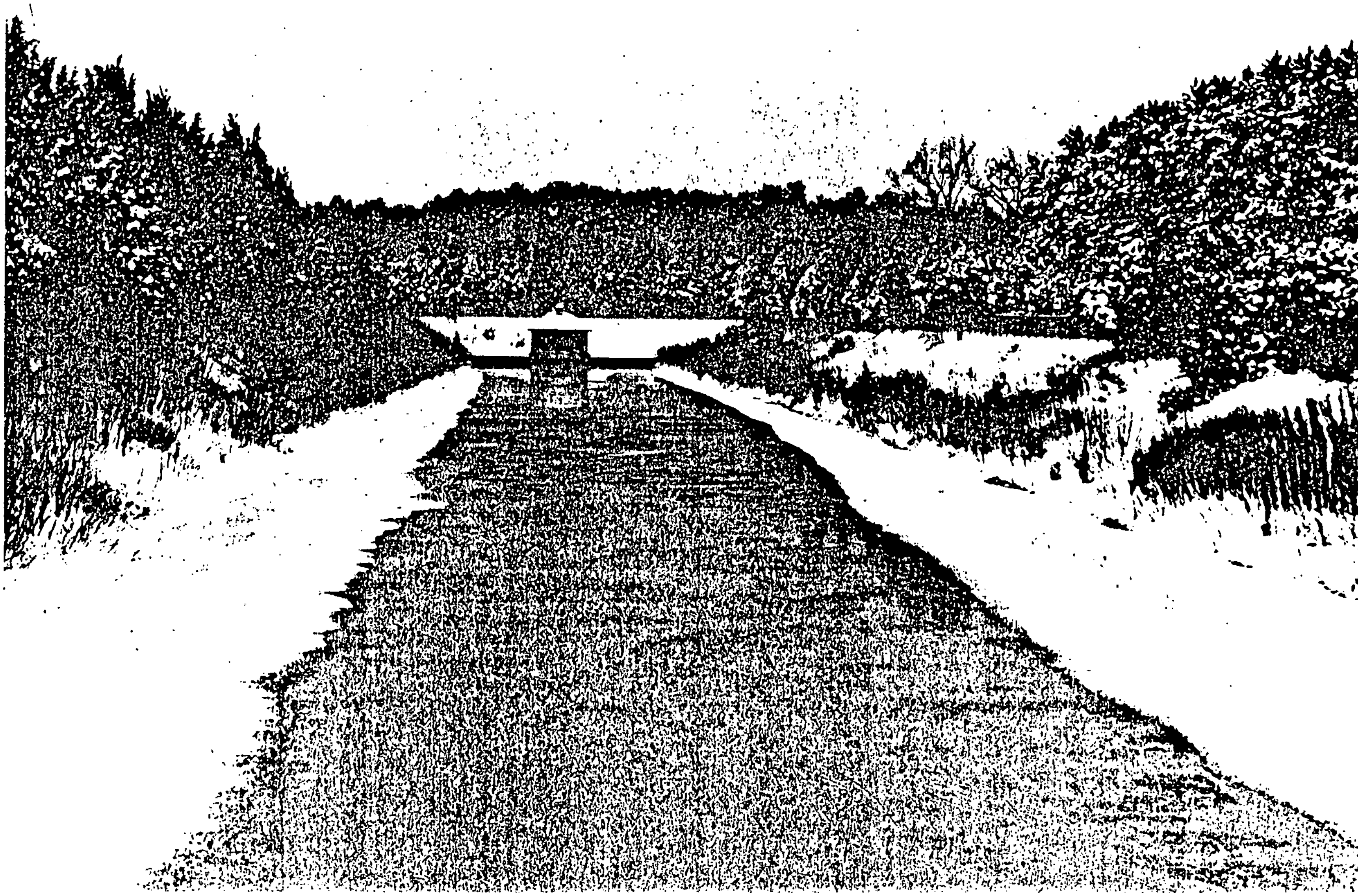
Chestnut Hill is among the most significant, and certainly the most highly visible, complex within the Metropolitan Water Supply System. It marks the connection between supply (Cochituate and Sudbury aqueducts) and distribution (high- and low-service pumping stations) that operated until completion of the City Tunnel and its extension in the mid-20th century. The constant development and expansion of facilities at Chestnut Hill have left a technological legacy of gravity and pressure conduits, manual and hydraulic gates, and a veritable museum of 19th and early 20th century pumping engines, plus their modern gas-powered replacements.

Arranged around Bradlee Basin, the buildings and structures at Chestnut Hill present a compendium of the water system's architectural themes. The Greek Revival, first employed on the Cochituate, is represented in the intermediate and effluent gatehouses built in 1868-70. The picturesque eclecticism associated with the "additional supply" developed in the 1870's is portrayed to great effect in George Clough's Sudbury Terminal Chamber. The high-service station, designed under Arthur Vinal with an addition by Wheelwright and Haven, is an outstanding example of the Richardsonian Romanesque style and, rightly, an area landmark. The turn-of-the-century revival of neoclassical styles is vividly illustrated in Shepley, Rutan & Coolidge's low-service pumping station, a highly successful adaptation of the Beaux Arts style to utilitarian function, and, on a smaller scale, in the complementary low- and high-service gatehouse.

Although the Chestnut Hill facility is largely obsolete, the buildings and landscaped grounds remain well-maintained symbols of the Boston and Metropolitan water supply systems. Combining functional, technological and architectural importance, Chestnut Hill must be considered a pivotal element in the system as a whole, with priority given to its future care and conservation.

Cochituate Aqueduct

Cochituate Aqueduct (1845-48) is of particular importance because it was the first in the development of a water supply system for the Boston area, and as such established several important precedents: first, for utilization of pure sources obtained from wells outside the city; second, for utilization of gravity conduits, rather than pumping facilities, to bring water from source to distribution; and third, for utilization of a common architectural theme, expressed in common materials, in construction of aqueduct and reservoir chambers associated with particular conduits. Selection of form and materials was particularly appropriate on the Cochituate: the simplified Greek Revival style bespoke utility as well as modest fashion, and the native gray granite was eminently durable and reflective of the New England landscape. Much of the architectural vocabulary established here was used throughout the system well into the 20th century. The Cochituate Aqueduct also features the earliest of the masonry arched bridges (over the Charles River) built to carry conduits over river courses.



Open Channel and Channel Chamber, Weston Aqueduct, Weston. Built 1901-1903.
Shepley, Rutan & Coolidge, Architects.

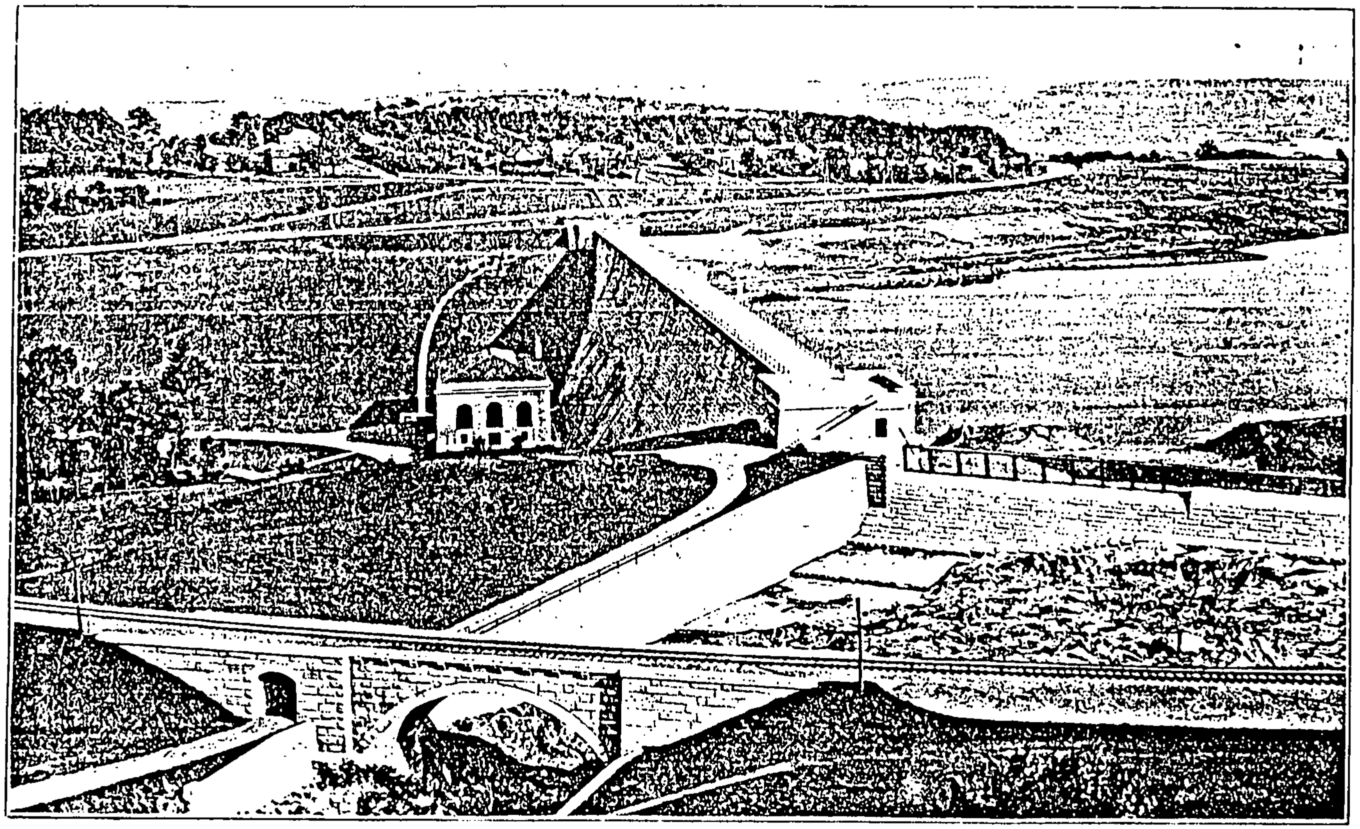
Weston Aqueduct

The Weston Aqueduct (1901-03) displays the greatest variety of conduit and chamber types along a single aqueduct; as such, it presents an excellent illustration of the ways in which gravity aqueducts were designed and built to meet hydraulic grade requirements in a variety of topographical circumstances. In addition, the chambers along the aqueduct display a noteworthy coherence and continuity of design, expressed in their simplified Renaissance Revival forms, attractive polychrome granite exteriors, and measured incorporation of detail. Subtle variations within the overall design theme were developed for each chamber type, thereby reinforcing the feeling of care and creativity exhibited in this work of a major Boston architectural firm, Shepley, Rutan & Coolidge.

Within the Weston system, major features are the terminal chamber, marking the end of the conduit and appropriately given a somewhat more elaborate exterior treatment and site than other chambers; the pipe bridge over the Sudbury River, which is the only true pipe arch in the Metropolitan Water System (at the Medford pipe bridge, the structure is carried on plate girders, while at the Sudbury River the pipe is a self-supporting arch); the Happy Hollow siphon, which due to its short length and siting offers the most readily comprehended example of this kind of hydraulic structure; and the open channel, including channel chamber and Ash Street Bridge, for the classical formality of line and symmetry unique within the Metropolitan Water Supply's arrangement of structures in landscape. The other structures and features associated with the Weston (with the exception of the head chamber, see below) while not of outstanding individual merit, are important for their functional and visual contribution to an appreciation of the Weston system as a whole.

Wachusett Dam Complex

Unlike the Sudbury Dam group (see Group 2, below), which is the result of several construction phases, the complex of structures at Wachusett Dam was developed as a single project, and as such reflects a unified design approach that may be credited in large part to Arthur Shurcliff, at the time a partner in the Olmsted Bros. landscape firm. This unity of concept is well illustrated in the extensive use of quarryfaced granite on the dam, gatehouse, steps, retaining walls and both the Grove Street and Central Mass. Railroad bridges. The complex is dramatically sited, with the dam a great wall across a relatively narrow gorge flanked by steep, wooded hillsides. The Olmsted emphasis on naturalistic treatment is clearly conveyed in the "rusticity" of the two bridges and of the waste channel, which was cut in a sweeping curve through bedrock, its floor and edges left unfinished in natural stone outcrops and projections. In interesting contrast, the lower gatehouse, designed by Shepley, Rutan & Coolidge, presents a rather severe, formal aspect in its symmetrical neoclassicism. This formality is emphasized by the circular pool below the dam, the regular placement of mulberry trees



WACHUSETT DAM WITH RAILROAD ARCH BRIDGE, WASTE WEIR AND BASTION AT NORTHWESTERLY END.

From the Metropolitan Water and Sewerage Board Annual Report, 1907.

around the pool, and by the neat line of conifers along the north side of the access road.

The district at Wachusett Dam displays a very high degree of integrity, as essentially no changes have been made in the structures or landscape treatment. The principal "alteration" has been removal of the Central Mass. Railroad viaduct, which crossed Lancaster Millpond only a few hundred feet below the pool. However, the viaduct, a plate-girder span supported on tall steel bents, was in a visual sense a decidedly intrusive element in the district. While its removal may be a loss in a historical sense, it cleared the way for an unrestricted view of the overall composition of structures in landscape.

Among individual features in this district, two are of some historical interest as well. The lower gatehouse is significant for the incorporation of two functions (head chamber for the Wachusett Aqueduct, and hydroelectric power generation) in its original design and construction. Transmission of electricity in August 1911 marked the first known instance of hydroelectric power production from a water supply created principally for domestic consumption. It set a precedent within the Metropolitan Water System for utilization of the head available at dams and on aqueducts to produce electric power. Although the gatehouse at Sudbury Dam had to be modified for generating equipment, subsequent projects (Quabbin Aqueduct, and Cosgrove Tunnel at Quabbin Reservoir) incorporated hydroelectric power generation facilities at the design stage. In addition to the gate/powerhouse, the Wachusett Dam is also significant as the largest solid masonry dam in the Metropolitan Water System (Winsor Dam, at Quabbin Reservoir, is larger but includes embankment sections). Chief Engineer Frederic Stearns was particularly cited for his contribution to the design of Wachusett Dam, which compensated for upward pressure by methods subsequently standard in structures of this type (Turner 1948:349-50).

Middlesex Fells Reservation

The Middlesex Fells Reservoirs and Pumping Station clearly depict the sweeping changes in Boston's water supply system as a result of the formation of the Metropolitan Water Board in 1895. The Board's mandate, to ".....construct, maintain and operate a system of water works .. in accordance with ... recommendations of the state Board of Health...." resulted, among other things, in construction of several "... pumping stations, to elevate the water so that it may be supplied with sufficient pressure to all portions of the Metropolitan Water district without local pumping." Under this mandate, Spot Pond was built, in conjunction with the pumping station at Chestnut Hill, as the main northern low and high service distribution point.

The reservoirs and pumping station are located in the Middlesex Fells Reservation, an area of natural beauty used principally for logging until developed as a park in 1894. Landscape Architect

Charles Eliot designed roads, lookouts and naturalistic areas within the Fells, and as a result the 1889 Annual Report of the Water Board noted: "...Landscape considerations have considerable weight in determining the outline and general treatment of the work." To the Board's credit, it commissioned the Olmsted firm to oversee the aesthetic aspects of the enlargement of Spot Pond and also the construction and placement of the Middlesex Fells and Bear Hill Reservoirs. In the Olmsted tradition, buildings in parks were intended to harmonize with and even be subordinate to the scenery. Nowhere is this better seen than at the Middlesex Fells Reservoir, an area of the most appealing naturalistic beauty.

Quabbin Reservoir and Aqueduct System

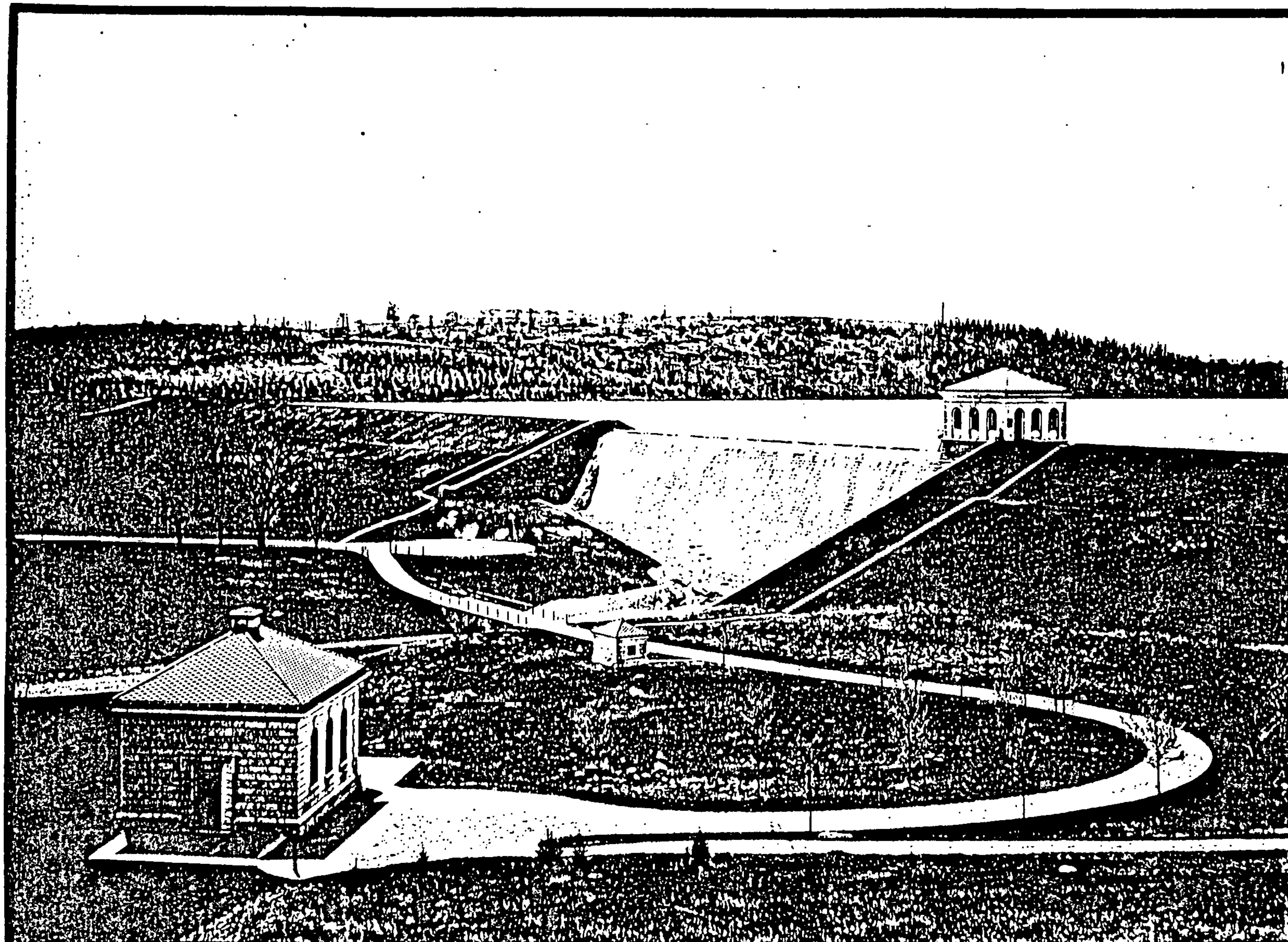
Quabbin Reservoir is the largest reservoir in the Metropolitan Water Supply System, and has been metropolitan Boston's chief source of pure water since the mid-1940's. Its construction had a tremendous local impact that remains vivid to many people after almost half a century. To create the reservoir, four towns were removed from corporate existence, and the boundaries of two counties were rearranged. Hundreds of dwellings, churches, schools, businesses and industries were relocated or demolished, 36 miles of new road were built, and the contents of 34 cemeteries painstakingly relocated.

Construction of Quabbin Reservoir also had a statewide impact, particularly as it provided employment, directly and indirectly, for thousands of Massachusetts residents at the height of the Depression through expenditure of both state and federal (PWA) funds. Since its completion, the reservoir and its watershed have provided not only water and lumber, but also a focus for tourism as a wildlife refuge and prime fishing area.

The Quabbin Reservoir and Aqueduct system also represents a noteworthy feat of civil and hydraulic engineering, combining efficiency of operation with an extraordinary elegance and sophistication of design. Among the most obvious illustrations of these qualities are:

-- the way in which the differences in elevation among the Swift, the Ware and the Wachusett reservoirs were exploited in the design of the Swift-Ware segment of Quabbin Aqueduct so that water could be conveyed either west or east;

-- construction of a separate outlet at Quabbin for Ware River water, and the routing of this water, by careful placement of baffle dams, through the reservoir on a path that ensures long-term storage and concomitant natural purification before introduction to the supply system;



The Sudbury Dam Complex. From the Metropolitan District Commission Photograph Collection.

-- incorporation of a pressure segment at the east end of Quabbin Aqueduct and utilization of the head thus created to generate electricity;

-- design of the spillway at Shaft 2 as an automatic pressure release;

-- design of the Ware River intake, in which diversion occurs only when the volume of water in the Ware River exceeds 85 MGD; and also the way in which centrifugal force is utilized to channel Ware River water 260 feet straight down to the aqueduct.

Like the metropolitan district's other aqueducts, the Quabbin Aqueduct was given its own particular architectural identity through the development of design theme that was used for all structures associated with that conduit. Continuing system tradition, the Boston firm of Densmore, LeClear and Robbins developed the Quabbin theme around simple, rectilinear forms with hipped roofs, granite exteriors and symmetrically-arranged elevations, characteristics which had first appeared on the Cochituate and which were carried through, with appropriate variation, in all of the later aqueduct systems except the Sudbury. At Quabbin Reservoir, however, the architects departed from system tradition in their designs for structures not associated with the aqueduct, turning to architectural themes then in popular fashion. Thus, the Neo-Georgian Administrative Complex suggests the influence of Colonial Williamsburg; and the lookout tower displays the carefully contrived air of rusticity that characterized much park architecture during the 1930's.

GROUP 2: Recommended for Group 2 are a variety of individual resources that are primarily of architectural significance. The Sudbury Dam district is included here as well, because although it has both architectural and functional importance, it lacks the element of landscape design that figures so prominently at Wachusett Dam and contains several instrusive features. Also in this category is a thematic group of dam structures, which could be used as a vehicle to promote public awareness and appreciation of this kind of engineering resource. The Mystic system is included on the grounds of age and its ability to illustrate small-scale supply and distribution functions.

Sudbury Dam Complex

This district represents the intersection of three phases in the development of the Metropolitan Water Supply System: construction of Sudbury Reservoir, the last and largest in the "additional supply system" begun in 1875; the Weston Aqueduct, built to augment the supply from the Sudbury Reservoir to Chestnut Hill, and also to supply the northern distribution facility at Spot Pond; and the Hultman Aqueduct, built in 1939-40 to convey water directly from the Wachusett Aqueduct to the Weston and to distribution, thereby marking the first of a series of bypasses of existing portions of the supply system. Dominating the district is Sudbury Dam, with its 1,800-foot earth embankment and 300-foot spillway, the largest dam structure by far built in the Boston water system to that time. The rising granite face of the overfall presents the theme for other construction at the site, beginning with the gate chamber designed by Wheelwright and Haven. This structure's simple, rectangular form, gray granite exterior and round-arched openings were adopted, with variation, in the Weston head chamber (Shepley Rutan & Coolidge) and the Hultman Shaft 4 Headhouse (Densmore, LeClear and Robbins). Together these structures illustrate the continuity of form and materials that characterized the Metropolitan Water System through completion of the Hultman Aqueduct in 1940. Contributing features in the district include the single-arch span over the waste channel near the dam, and the double-arch span carrying Route 30 over the channel further down. The two most recent buildings (fluoridation facility and office/laboratory), however, are singularly intrusive, their forms, scale and materials assembled here without regard to the architectural tradition and standards so fully demonstrated in the Hultman, Weston and Sudbury dam structures.

Echo, Waban and Assabet Bridges

These structures, two on the Sudbury Aqueduct, the third on the Wachusett, are important examples of masonry bridge construction in Massachusetts, and may be among the largest of this structure type in the state. Their utilization in the aqueduct systems bespeaks not only function but also a not-unconscious homage to the Roman origins of long-distance water supply systems. The "curiosity factor" also contributes to the significance of Echo Bridge, due to the acoustical properties of the channel arch from which the structure deservedly derives its name.

Distribution Standpipes

The Roxbury Standpipe is historically significant as the first standpipe built for high-service distribution in Boston; in addition, it may represent an early use of this structure type. The standpipe is architecturally significant for its Victorian design, which effectively conceals its function, like so much of the design of that time period. The Arlington, Bellevue and Forbes Hill Standpipes vividly illustrate the Metropolitan Water Board's concern for the aesthetics, as well as the utility, of facilities in the water system. Medieval and classical themes are employed in a manner appropriate to the scale of the structures. As a result they appear as interesting and attractive, although rather unusual, features of their environment, rather than as awkward intrusions.

Fisher Hill Reservoir

Like the Chestnut Hill high-service pumping station, the Fisher Hill intake chamber was designed under Boston City Architect Arthur Vinal, and displays the same strong Richardsonian influences. Among the many noteworthy features are variety of materials, colors and textures, and the oversized voussoirs above the very narrow, round-arched window openings. The figured terra cotta panels are an instance of purely decorative detail unusual in the architecture of the Boston and Metropolitan Water Systems.

Mystic System

Although not used as a water source since 1898, the Mystic System has been maintained throughout the years and is, for the most part, intact. The system is significant because it represents a clearly defined, mid-19th century urban distribution system, enabling an observer to clearly see how a city obtains and distributes its water.

Although the pumping station has had two additions and a number of changes, including that of function, it is still representative of municipal architectural standards of the 1860's. The three interior truss systems (1864, 1870, 1890's) clearly depict a chronology of large span construction technology. In addition, the Mystic Dam is the oldest masonry dam remaining in the Metropolitan Water Supply System.

Gatehouses at Framingham Reservoirs 1, 2 and 3

These reservoirs feature three very similar masonry dams that comprised one of six general kinds of dams employed in the Metropolitan Water System. At each dam is a gatehouse, designed under City Architect, George Clough. Executed in gray granite, these structures display a somber, somewhat medieval character. Collectively, they employ various architectural details which are brought together in the Sudbury Aqueduct terminal chamber. The gatehouse at Framingham Reservoir #1 is the most readily visible of the three; the sight of this structure from Route 9 offers a picturesque relief to the seemingly endless strip development that otherwise characterizes much of this road east of Worcester.

Masonry Dams

Masonry dam structures employed in the Metropolitan Water System display noteworthy variety of scale, form and materials, and range in age from the 1860's to the 1940's. Their organization in a thematic group presents an opportunity to promote public appreciation of this particular aspect of civil engineering, which, unlike truss bridges for example, has not yet achieved the public visibility it deserves. Included in this thematic group are the large Wachusett and Sudbury Dams, the dams on Framingham Reservoirs #1, #2 and #3, the dam between upper and lower Mystic lakes, four circular dams (one on the Quinepoxet, two in the Wachusett Aqueduct open channel, and the wood and rubble stone dam in Lake Cochituate), and the two control dams with indented spillways in the Wachusett open channel.

GROUP 3: This group includes Wachusett, Sudbury, and Hultman aqueducts, which are relatively less distinguished, architecturally, than the Cochituate or Weston. However, the first two once played important roles in the water supply system, and the Hultman remains integral to the system today. Several individual resources are put into this category as well. They were not major features of the system, but due to form or construction represent interesting examples of their kind.

Quinepoxet Arch

This triple span bridge is significant for its somewhat unusual construction. Like many other bridges built in the Metropolitan Water Supply System after 1815, the Quinepoxet Arch is constructed of mass concrete faced with granite to retard weathering. To prevent scouring of the reservoir bottom below the arches, however, it is constructed in longitudinal section very like three short segments of masonry aqueduct placed side by side, with concrete bases and sidewalls as well as arches.

Marlboro Filters

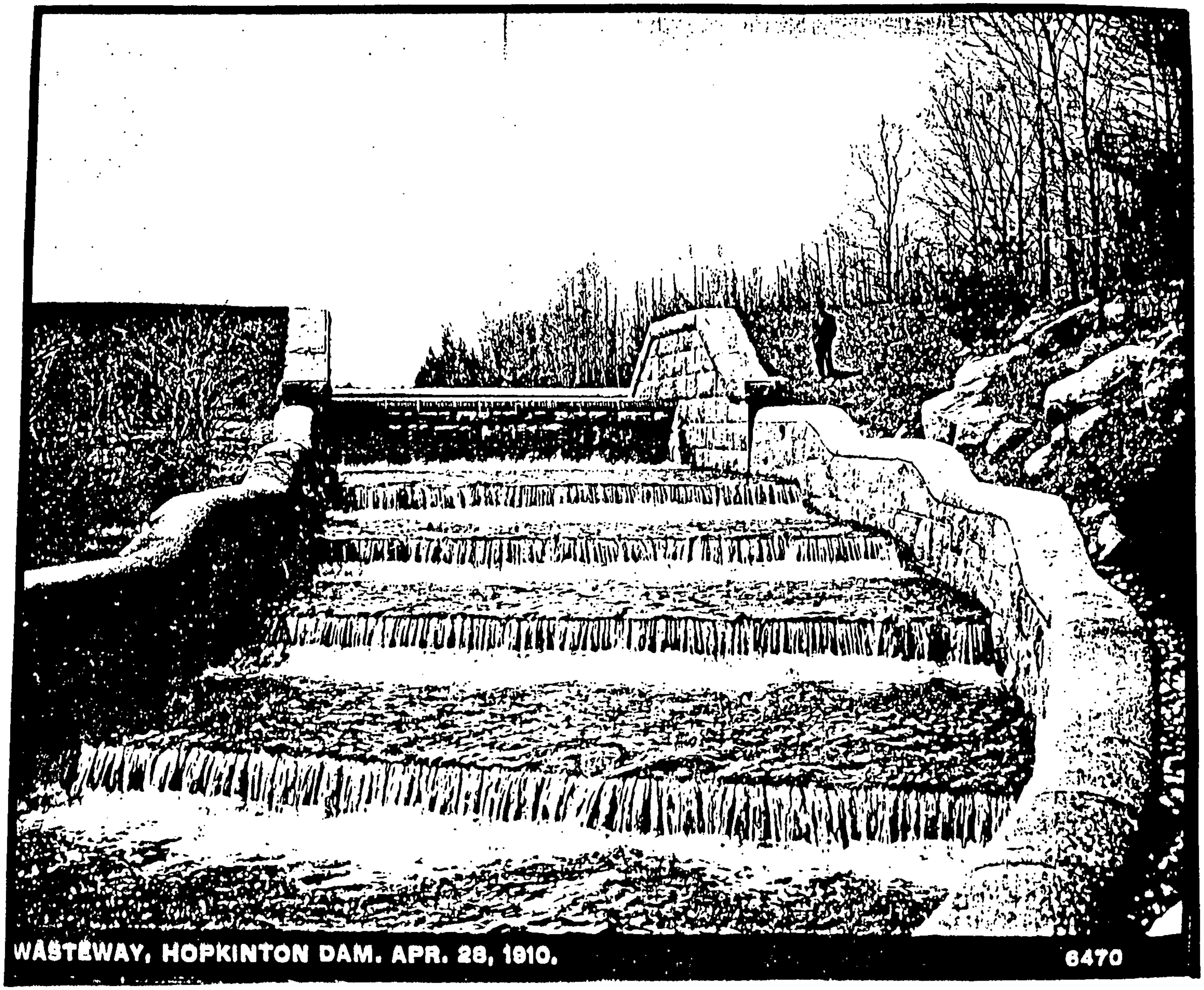
This facility represents one of a variety of ways in which the Metropolitan Water Board maintained the quality of water in reservoirs without imposing excessive hardships on local communities. The filters were built to purify water from Marlborough and Walker Brooks, which flowed through heavily populated areas of Marlborough on the way to Sudbury Reservoir. In addition, the Marlborough Filters are the largest, and by far the best preserved, examples of filter bed construction remaining in the water system. The characteristics and operations of a gravity filter system are excellently illustrated in the arrangement of channels, beds and the small weirs by which water is conveyed to various sections of the facility. Resources such as this have the potential to contribute information about the development of water purification systems, which are themselves an important kind of public works engineering.

Medford Pipe Bridge

This is a picturesque engineering structure which is a good example of a utilitarian object made visually and literally accessible to the public via its use as a pedestrian footbridge on top of the arched conduit) and its handsome decorative iron railing.

Hopkinton and Ashland Reservoir Spillways

These spillways, identical in design, are particularly handsome structures in the environment and are significant examples of the Metropolitan Water Board's concern with design aesthetics and land management.



From the Metropolitan District Commission Photograph Collection.

Sudbury Aqueduct

The Sudbury Aqueduct (1875-78) marked the extension of Boston's water supply system to the Sudbury River watershed. It was the first of the aqueducts to use a horseshoe-shaped section and natural cement concrete, although the arch continued to be built with brick. The principal features of the aqueduct are Waban and Echo Bridges (see group 2). Superstructures along the aqueduct were designed under Boston City Architect, George Clough. He employed brick, sandstone and brownstone in typically Victorian structures of a rather self-conscious, pseudo-medieval character. Although not without architectural interest, these structures lack the imagination and "presence" displayed in Clough's designs for gatehouses at Framingham Reservoirs #1, #2 and #3, and the Sudbury Terminal Chamber at Chestnut Hill.

Wachusett Aqueduct

The Wachusett Aqueduct (1897-98) was the first gravity conduit built specifically for the Metropolitan Water Supply System. Its horseshoe-shaped section was similar to that of the earlier Sudbury, but departed from the latter in the use of Portland cement concrete, rather than brick, for the arch or crown of the masonry conduit segments. The somber gray granite superstructures, few in number and visually rather self-effacing, recall those of the Cochituate Aqueduct, which was also the first conduit in a "new" water supply system.

Apart from the Assabet River Bridge (see Group 2), the most noteworthy feature of Wachusett Aqueduct is the three-mile open channel, due to the way natural contours of an existing streambed were utilized and only slightly modified for functional purposes, and to the manner in which the banks were landscaped not only for utility but for visual enhancement as well. The channel's four small regulating dams (two circular dams and two with indented overfalls) provide excellent illustrations of two of the more unusual kinds of dam structures found within the Metropolitan Water System. Finally, the arch bridges over the channel, with their granite facing, present an air of rusticity appropriate to their semi-rural environment, and thus may be considered as contributing to the general visual interest of this section of the aqueduct.

Hultman Aqueduct

The Hultman Aqueduct was the Metropolitan Water Supply System's first completely pressure aqueduct, and its construction (1938-40) marked the first in what would be a series of bypasses of older portions of the system. Subsequently extended both west and east, the Hultman remains the chief vehicle for conveying water from supply to local distribution. The aqueduct has only three chambers. The headchamber at Shaft 1 was designed to resemble the nearby terminal chamber of the Wachusett Aqueduct, from which the Hultman was originally supplied. The remaining two

(Shaft 4 Headhouse, and Norumbega Reservoir Gatehouse) were built from designs originally developed by architects Densmore, LeClear & Robbins for Quabbin Aqueduct.

GROUP 4: Most resources in this group have only indirect association with the principal functions of the water supply system. Several small pumping stations are included here because their operational importance is chiefly local and their architectural aspirations relatively modest.

Glenwood Pipe Yards

This facility is architecturally significant within the confines of the Metropolitan Water Supply System. The buildings in the system tend to be Neo-classical and restrained. While the Flemish Revival is not an unusual style in its own right, it is in this instance because the exuberance with which it is employed here is so contradictory to the utilitarian nature of the structures involved.

Pumping Stations

There are two small pumping stations built during the study period that are significant primarily on the local level. Arlington joined the Metropolitan Water Supply System in 1898 after unsuccessful attempts to maintain sanitary water conditions; Hyde Park was annexed in 1912. Arlington and Hyde Park pumping Stations were constructed in conjunction with their standpipes (see Group 2) to meet specific community needs, unlike the larger distribution pumping stations, Chestnut Hill and Spot Pond which each supplied a number of communities.

Clinton Sewage Pumping Station

This facility (pumping station and covered reservoir) is of local historical significance, representing one way in which the Metropolitan Water Board attempted to mitigate the impact of Wachusett Reservoir upon a locality. Prior to development of the reservoir, the City of Clinton used the Nashua River for disposal of sewage. As loss of this traditional disposal method promised hardship to the community, the Metropolitan Water Board agreed to construct and operate a proper sewage treatment facility.

Designed by the Metropolitan Water Board's engineering staff, the pumping station displays a low-key, Romanesque Revival-inspired exterior fully in keeping with popular architecture of its period, but suitably simplified in keeping with its utilitarian function. The adjacent covered reservoir appears to represent a relatively early use of the concrete groin vault in structures of this type, and thus may be considered important in the context of the history of building technology in the United States.

Metropolitan Water Board Field Office

The Metropolitan Water Board's field headquarters at Clinton is significant chiefly for its association with development of the water supply at Wachusett Reservoir. It appears to have been the most elaborate, and longest used, of the various field offices established by the Water Board at various construction sites, at least until construction of Quabbin Reservoir began in the 1930's. Unlike many other field offices, which were rented quarters or buildings acquired during construction, the Clinton office was designed and built by the Metropolitan Water Board, with careful attention to drafting rooms, document vaults, laboratory facilities and administrative space. The building's Shingle-style exterior presented a domestic character appropriate to the residential area in which it was located.

Metropolitan District Commission Administrative Headquarters

The Metropolitan District Commission Building on Somerset Street, Boston, is significant because it is the headquarters of all the divisions of the MDC including the Commissioner's office. The building was designed in a Classical Revival style by Densmore, LeClear and Robbins, architects who also designed a number of structures for Quabbin Reservoir, Quabbin Aqueduct and the Hultman Aqueduct. The building also housed the offices of the Water Supply Commission during its existence (1926-47).

Concrete Arches

Many of the concrete and granite arches built by the Metropolitan Water Board and its successors are included in districts or on aqueducts listed in Groups 1, 2 and 3. The remainder, located at Sudbury and Wachusett Reservoirs, are included in the inventory chiefly because they were built during construction of the reservoirs in order to maintain local traffic routes across these large bodies of water.

V. SELECTED BIOGRAPHIES

Biographical Introduction

The following selected biographical sketches acknowledge some of the many people who worked on the Metropolitan Water Supply System. Since it would be impossible to include every engineer and architect involved, biographies focus on those who were most instrumental in conceptualization, design, and implementation. Availability of biographical material also dictated the selection process with the result that some individuals may not have received here, the treatment they so deserve. The absence of anyone in no way reflects their merit as designers nor does it reflect any bias on the part of the authors.

Spanning a period of just over one hundred years, the wealth of creative talent brought to the system by engineers and architects is impressive. These professionals worked together to create technologically innovative and aesthetically pleasing water systems, that fit so well into the physical landscape as to be almost invisible amidst more obvious civic, commerical, and residential projects.

While the engineers were producing "state of the art" technology such as the filter beds at Pegan Brook and Marlborough; large reservoirs such as the Wachusett and Quabbin; and complex systems such as Shaft 8 on the Quabbin Aqueduct; the architects tended to be, if not restrained, carefully within the bounds of their stylistic time periods. The entire system, from Cochituate in 1845 to Quabbin in 1947, represents periods of architecture in a neat chronological sequence: Cochituate, Greek Revival; Sudbury, Victorian Eclectic; Weston and Wachusett, Classical Revival; and Quabbin, Colonial Revival.

The 19th and early 20th centuries were a time of rapid urban and industrial expansion which is clearly evidenced by the career routes of these civil and hydraulic engineers. What becomes readily apparent after studying the individuals who worked on the systems is how closely defined was the world in which they worked. Almost all of those in the Boston system worked in the public sector and moved easily from other water supply systems in New York City (John Jervis, Aphonse Fteley and J. Waldo Smith), Newark, New Jersey (Smith and Thaddeus Merriman), Providence (Frank Winsor) and on to Boston. Some moved west to work in Chicago (E.S. Chesbrough) and California (Thaddeus Merriman). Inevitably after a long public career most retired and then went on to consult in the private sector.

Water supply was what these engineers were known for, unlike the architects who worked on the systems. Almost never, in an architect's biography, obituary or in articles about an individual architect or architectural firm is there mention of any water system structures. The reason for this remains unknown, although architects, unlike engineers, did not specialize in water supply structures. George Clough, Arthur Vinal and Edmund Wheelwright were all, at varying times, Boston's official city architect, and therefore designed a variety of municipal structures (in addition to water supply buildings) such as schools and courthouses.

Under the influence of Frederick Stearns, landscape architecture played a prominent role in the aesthetic development of the metropolitan system. Stearns, who believed that technology and nature could live and thrive together, was responsible for initiating the participation of the Olmstead Associates, and subsequently Arthur Shurcliff, in the landscape design of several major components of the system, most notably Middlesex Fells and Weston reservoirs, the Wachusett Dam Complex, and Quabbin Reservoir. It is interesting to note that the professional relationship originally established by Henry Hobson Richardson and Frederick Law Olmsted was perpetuated by their sucessor firms (Shepley, Rutan & Coolidge, and Olmsted Associates, respectively) in their projects for the Metropolitan Water Supply System.

Insight into the engineers and architects who designed and built Boston's Water Supply System provides a more fully humanistic view of the system. Often undocumented, but readily observed, is the close working relationship of these architects and engineers and their sensitivity to people and the environment.

Perhaps due to an unspoken, but underlying philosophy, the systems these professionals designed together provide not only water for the people, but also handsome architecture and literally thousands of acres of lush forests, lakes, scenic vistas and abundant wildlife habitats, all in the context of the ultimate goal of pure water.

Ellis Sylvester Chesbrough

E.S. Chesbrough (1813-1886) began his career as an engineer on the construction of the Boston & Providence Railroad. In 1846 he was hired by the City of Boston as Chief Engineer for the Western Division of the Cochituate Aqueduct, becoming Water Commissioner of Boston in 1849, and the first City Engineer of Boston, from 1850 to 1855. Chesbrough left Boston in 1855 for Chicago where he remained for the duration of his career first as an engineer in Chicago's Sewerage Commission, and then as commissioner of Public Works and City Engineer, a position he held until 1879 when he retired. From 1879-1881 he was a planning consultant for the New Croton Aqueduct (National Cyclopaedia of American Biography 1899: 35).

George A. Clough

George A. Clough (1843 - ca. 1916) established an architectural practice in Boston in 1869. He was appointed Boston's first City Architect, a position he held from 1873 to 1883. During this time he designed the Prince School, on Newbury St. (1875); and English High School and Latin High (1877). In 1882, he restored Boston's first statehouse. Clough also designed the Suffolk County Courthouse (1889) and with a partner, designed the Soldiers' Home and St. Patrick's Church, both in Chelsea (Withey 1970: 127, Lyndon 1982: 4,39; Southworth 1984:99,285).

Structures Designed for the Boston Water Board:

Sudbury System:

Farm Pond Gatehouse
Framingham Reservoir & Gatehouses #1, 2, & 3.
4 Waste Weirs
2 Siphon Chambers
Terminal Chamber

Joseph Phineas Davis

Joseph P. Davis (1837-1917) began his career as an engineer on the construction of the Brooklyn, New York, Water Works, with which he was involved from 1856 to 1861. From 1861 until 1865, he was employed by the Peruvian government as a topographical engineer and worked on railroad, bridge and sewer projects. Davis returned to Brooklyn and in 1865 was Assistant Engineer for the Ridgewood Reservoir. From 1866 to 1867 he served as Chief Engineer for construction of Prospect Park, designed by Frederick Law Olmsted.

Davis moved to St. Louis, Mo., where from 1867 to 1870, he was Principal Assistant Engineer for the St. Louis Water Works. Returning east Davis was Chief Engineer of the Lowell, Mass. Water Works from 1870-1871. In 1870 he was commissioned by the

City of Boston to investigate possible sources for an additonal supply of water. His report became the basis for construction of the Sudbury System. From 1872 until 1880 Davis, as Boston City Engineer, supervised all city engineering work including construction of the Sudbury Aqueduct and three storage reservoirs on the Sudbury River in Framingham. He also "...designed and constructed a system of main drainage for the city (of Boston) which was at its completion one of the most elaborate municipal sewers in the United States."

Davis left Boston in 1880 to become a Consulting Engineer for the American Bell Telephone and Telegraph Company and stayed with the firm until his retirement in 1908 (National Cyclopaedia of American Biography 1936:5).

Densmore, LeClear & Robbins

Densmore, LeClear & Robbins, a Boston architectural firm, designed a number of well-known structures in that city including the Salada Tea Company Building of 1919, which has elaborate cast bronze doors that won a silver medal at the Paris Salon of 1927. The Park Square Building, which housed the firm's offices for a number of years, was completed in 1923. This building has a concourse down the middle of the main floor with shops on either side in addition to a lobby and elevators to the floors above. The firm also designed the Art Deco style New England Telephone and Telegraph Company building (1930), as well as a variety of buildings and structures for the Metropolitan District Commission and the Metropolitan District Water Supply Commission. Edward Dana Densmore (1871-1925), senior partner in the firm, was from Somerville, Massachusetts and educated at Harvard and M.I.T. (Withey 1970: 170; Boston Public Library, Architectural File, Densmore, LeClear & Robbins; Southworth 1984: 140; Lyndon 1982: 41, 191).

Structures Designed for the Water Supply System:

MDC Administration Building
Quabbin Administration Buildings
Quabbin Lookout Tower
Quabbin Aqueduct Shaft 1,4,8,9, and 12 Headhouses and Shaft 1,8, and 12 Service Buildings
Winsor Dam Outlet Works Powerhouse
Hultman Aqueduct Shaft 4 Headhouse
Norumbega Reservoir Gatehouse

Desmond Fitzgerald

Desmond Fitzgerald (1846-1926) was born in the Bahamas. At an early age Fitzgerald displayed the talent and inquisitiveness that would be the hallmark of his successful life and career. At the age of twelve, after going to school in Providence, R.I., he studied art in Paris. He then attended Phillips Academy in

Andover, Mass. and graduated in 1864, at which time he studied engineering at Cushing & Dewitt, an engineering firm in Providence, R.I. In 1866, at only 20 years of age he became Deputy Secretary of Rhode Island and Private Secretary to General Burnside, Governor of Rhode Island.

Fitzgerald's first engineering job was in the midwest; this led to his appointment as Chief Engineer, in 1871, of the Boston & Albany Railroad, a position Fitzgerald held until 1873 when he became Superintendent of the Western Division of the Sudbury Aqueduct for the City of Boston. In this capacity he designed Framingham Reservoirs #1, #2, #3, and Ashland and Hopkinton Reservoirs. Fitzgerald remained with the Boston Water Works for 30 years, a time which proved to be the most productive period of his life. He was a pioneer in the sanitary protection of water supplies, and extensively studied the causes, formation and control of algae and bacteria in drinking water. He also was one of the first hydraulic engineers involved in the study of water color and swamp drainage. In connection with this work, he established one of the first biological laboratories. Fitzgerald published a number of articles, including "Evaporation" (Transactions of the American Society of Civil Engineers, 1886) and "Rainfall, Flows of Streams and Storage" (Ibid, 1892). He also wrote The History of the Boston Water Works, a book that was published in 1876.

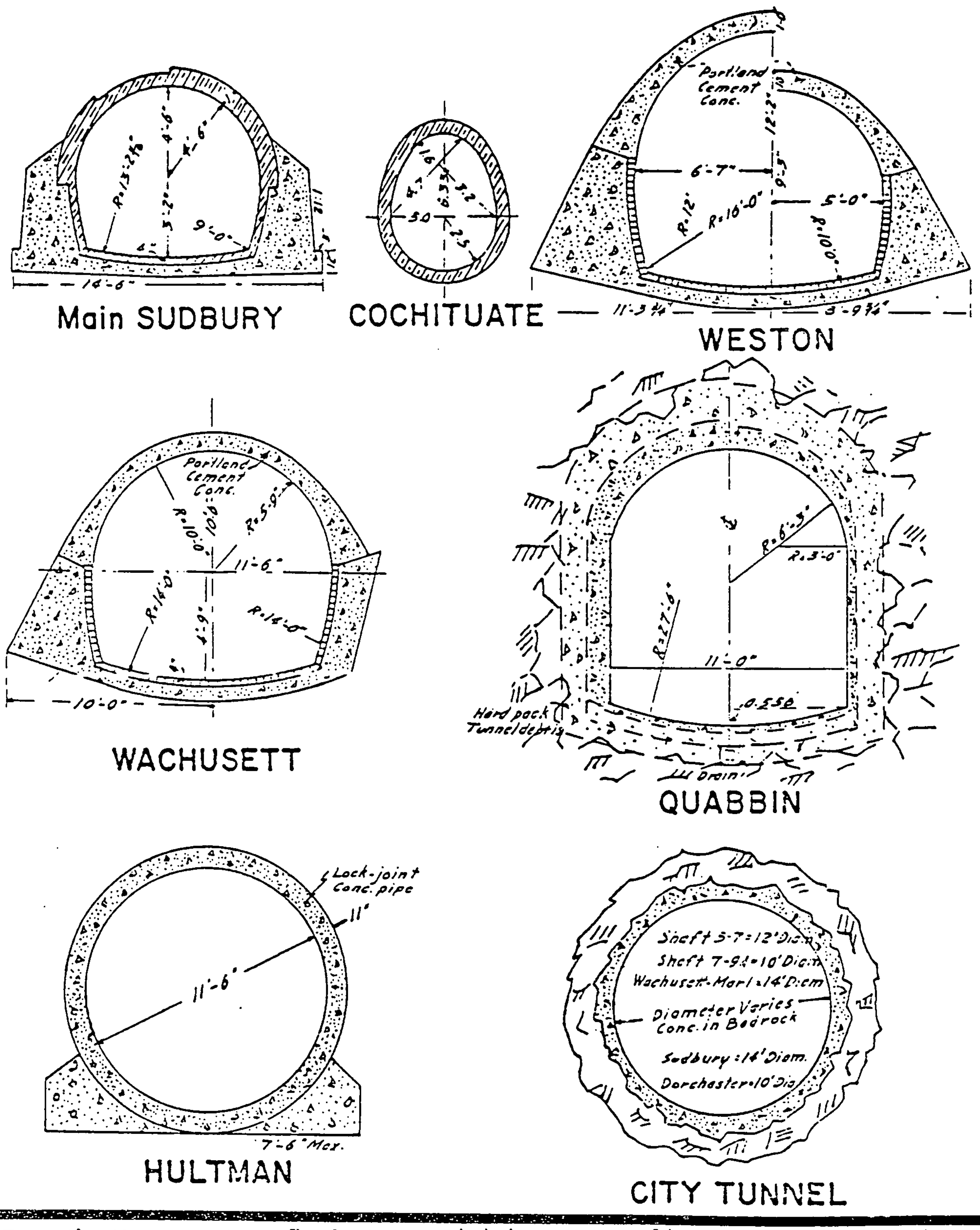
In addition to his scientific activities Fitzgerald was an avid art collector, an avocation he began in 1871. In 1913 he built an art gallery, open to the public, near his home in Brookline, to house a collection of Korean and Chinese pottery and porcelains, his own travel photographs, and works of Monet, Manet, and Pissaro.

After his retirement from the Boston Water Works Fitzgerald was a consultant on water supply to the cities of Chicago, Washington, San Francisco, and Manila. In 1892 He was elected president of the American Society of Civil Engineers (Dictionary of American Biography 1959: Vol. III: 434-435; Boston Evening Globe, 22 September 1926:16).

Alphonse Fteley

Alphonse Fteley (1837-1903) was born in France and came to the United States in 1865. From 1865 to 1870 he worked for William E. Worthern, primarily on hydraulic projects. In 1870 he began his own practice as a civil engineer, and three years later became Resident Engineer of construction of the Sudbury Aqueduct. From 1873 to 1880 Fteley was City Engineer of Boston, which included duties as Superintendent of the water supply. Fteley left Boston in 1884 to become principal assistant engineer of the New Croton Aqueduct Commission in New York City. Two years later he became Consulting Engineer for the Commission and in 1898 Fteley was appointed Chief Engineer of the New Croton Aqueduct. One of his major contributions in this post was the design of the New Croton Dam at Cornell.

CROSS SECTIONS OF AQUEDUCTS



From the Management Handbook, Water Division, Metropolitan District Commission, Harbridge House, 1972.

During his career Fteley also served as a Consulting Engineer to the Metropolitan Water Board, and as Boston's first Rapid Transit Commissioner. During the construction of the Panama Canal, he was a consultant for the Panama Canal Company. Poor health forced him to retire in 1900 and he died in 1903 (National Cyclopaedia of American Biography 1906:561).

Xanthus Henry Goodnough

X.H. Goodnough (1860-1935) was born in Brookline, Mass. He attended Harvard University, from which he graduated in 1882. A sanitary engineer, Goodnough worked for the Commonwealth of Massachusetts from 1886 until 1930, a period of 44 years. He began his career in the State Board of Health's Engineering Division as Assistant to Frederic Stearns. Upon Stearns' appointment as Chief Engineer of the Metropolitan Water Board in 1895, Goodnough was appointed Chief Engineer of the Board of Health, a position he held until 1914. In this capacity he acted as Chief Engineer for the Joint Board created to investigate water supply needs, investigations which eventually led to construction of Quabbin Reservoir and Aqueduct. Other Board of Health projects included improvements of the Sudbury, Concord and Neponset Rivers and expansion of the southern metropolitan sewerage system. A reorganization of the Board of Health resulted in Goodnough's promotion to Chief Engineer and Director of the Division of Sanitary Engineering of the Department of Public Health. During this time, he also served as an advisor to the Metropolitan District Water Supply Commission. In 1930, Goodnough retired from public service and formed a private practice with Bayard F. Snow. Upon his death, in Waterford, Maine, the Water Supply Commission, in its Annual Report of 1935, noted: "By the death of Mr. Goodnough the Commission lost the services of one who was particularly well fitted to advise them on this [Quabbin Reservoir] project" (Metropolitan District Water Supply Commission 1935:1). In his honor the Commission named the Quabbin Reservoir dike, Goodnough Dike (Metropolitan District Water Supply Commission 1935:1; Dictionary of American Biography, Vol. XI: 325).

John Bloomfield Jervis

John B. Jervis (1795-1885) a civil engineer, began his career as a rodman on the Erie Canal, but soon became Engineer in Charge of canal construction from Albany to Amsterdam, New York. In 1825 he became an Assistant Engineer on the Delaware and Hudson Canal and advanced to Chief Engineer in 1827. Jervis was then Chief Engineer of the first railroad constructed in New York State, the Albany and Schenectady, completed in 1830. As was typical of the beginning years of major railroad construction and before the days of "specialization", civil engineers such as Jervis moved easily between a variety of water, rail and transportation projects. In 1833 Jervis, in his capacity as Chief Engineer, completed the Chenago Canal, which was 100 miles long and had

98 locks. Jervis devised an artificial storage reservoir for this project that was used to maintain the water level of the canal. In 1836, Jervis became Chief Engineer of the Croton Aqueduct, the project that made him one of the leading and best-known civil engineers of the 19th century. The 41-mile long aqueduct was essentially completed in 1842. While still Chief Engineer of Croton, a position he held until 1849, Jervis served as Consulting Engineer for Boston's Cochituate Aqueduct (1846-1848) and also as the Chief Engineer of the Hudson River Railroad, which ran from Albany to New York City. From 1851 until 1854 he was Engineer and President of the Chicago and Rock Island Railroad. Jervis retired in 1858, but three years later became Superintendent and Engineer of the Pittsburgh and Ft. Wayne Railroad. In 1868 he organized the Merchant Iron Mill in his hometown, Rome, New York, where he died in 1885 (National Cyclopaedia of American Biography, 1907:35; FitzSimons 1971).

Karl Kennison

Karl Kennison (1886-1977) a graduate of Colby College and M.I.T., had a long career in water related construction projects. Before joining the Metropolitan District Water Supply Commission in 1926, he had been involved with the planning of the San Francisco and Providence water supplies, and also designed some of the first dams for the Mississippi River Power Development. He was also an advisor on a number of shipyard construction projects.

Kennison joined the Water Supply Commission as Designing Engineer; in 1934 was promoted to Assistant Chief Engineer and upon the death of Frank Winsor in 1939, became Chief Engineer on the Quabbin project. Kennison remained with the Water Supply Commission after it merged in 1947, with the Metropolitan District Commission and was renamed the Construction Division. He left the MDC in the 1950's and moved to New York City where he headed the city's Board of Water Supply from 1952 until his retirement in 1962.

Kennison was a past president of a number of professional organizations including the New England Water Works Association and the Boston Society of Civil Engineers. He also served as director of the Municipal Engineers of New York City and of the American Water Works Association. Kennison wrote numerous articles on the Quabbin construction and on sewage treatment in the Boston area. Upon his death he was buried in the Quabbin Park Cemetery. (Boston Globe, 3 May 1977: 12; Metropolitan District Water Supply Commission Annual Reports, 1932:4; 1939:4).

Thaddeus Merriman

Thaddeus Merriman (1876-1939) was, like his father, a hydraulic engineer. Born in New Haven, Connecticut, he was educated at Lehigh University, Penn. After school he worked on the construction of waterworks for New Boston, Connecticut. From 1898-1900 Merriman was an assistant engineer for a survey team in Nicaragua that was trying to build a canal. Returning to the United States he worked with Jonas Waldo Smith, on the Little Falls, New Jersey filtration plant. Continuing in New Jersey, Merriman was Assistant and Division Engineer on the dam at Boonton for the Jersey City Water Supply Company which was the first cyclopean dam, consisting of large stones imbedded in concrete rather than set in mortar.

In 1905, Merriman began "a long and distinguished" association with the New York City Water Supply Board, first working as an Assistant to J. Waldo Smith in preparing general plans and estimates for the Catskill Water Supply. Succeeding Smith (who retired) as Chief Engineer in 1922, Merriman stayed with the New York City Water Board until 1933 when he retired from public service. He began a busy private practice in which, among other activities, he served as Consulting Engineer for Quabbin Reservoir; consulting engineer from 1933 to 1939 to the City of New York's Delaware River Project Dam in Lackawanna, New York; and as Chief of the Engineer Board of Review for the Metropolitan Water District of Southern California.

Merriman maintained an active academic life, lecturing on hydraulics at Yale, M.I.T., Harvard, Princeton and at Lehigh University, where he was awarded an honorary Ph.D in 1903. He also researched the properties and uses of Portland cement for over 25 years and published a number of articles on the subject. In his honor. upon his death in 1939, the Delaware River Project Dam at Lackawanna, N.Y. was renamed the Merriman Dam (National Cyclopaedia of American Biography Vol. 29:95-96).

Frederick Olmsted and Associates

The Olmsted architectural landscaping firm was founded by Frederick Law Olmsted (1822-1903) who began his landscaping career when he and Calvert Vaux submitted a winning design for New York City's Central Park. Previous to this Olmsted traveled throughout China, Europe and the United States and was a farmer, writer, and dry goods clerk. After the completion of his work on Central Park in 1857, Olmsted moved to California where he managed gold mines. He remained in California to design a campus and village for the College of California at Berkeley, the Mountain View Cemetery and a park and parkway plan for San Francisco. During the mid-1860's while in California, Olmsted wrote a report advocating the Yosemite Valley and Mariposa Big Tree Grove as scenic reservations.

Olmsted returned to New York in the fall of 1865 and immediately began, with Vaux, his design for Brooklyn's Prospect Park. Throughout the 1860's and 1870's Olmsted worked in theory and practice on his design for urban parks and parkways and it was during this period that his philosophy became clearly defined. His theories of parks within urban landscaping linking different areas of cities through waterways and landscaped parkways and boulevards was to have an impact on major cities throughout North America including New York City, Boston, Buffalo, Riverside, Ill., Newark, Chicago, Montreal, Detroit, Milwaukee, Rochester, and Louisville.

Vaux and Olmsted's partnership was dissolved in 1872. In 1877, after becoming increasingly disenchanted with New York City Olmsted moved to Brookline, Mass. where he remained for the rest of his life. He was encourage in this move by the architect, H.H. Richardson, who also lived in Brookline. He and Olmsted collaborated on a number of projects including the Ames estate in North Easton, Mass. (1881) and the Crane Memorial Library, Quincy, Mass. (1883), as well as several railroad stations for the Boston and Albany Railroad.

It was in Boston that Olmsted was able to fully realize his vision of an interconnected park system with continuously green open space throughout an urban area. In 1878 he began his work for the Boston Park System which resulted in the "Emerald Necklace", a string of parks and parkways which included the Fenway, the Jamaicaway and Arborway. These were linked with Commonwealth Avenue, the Arnold Arboretum and Franklin Park. In conjunction with Shepley, Rutan and Coolidge, successor firm to Richardson, Olmsted designed the Stanford University (California) campus and the Middlesex Fells in Boston. He also designed a number of private estates including the 2,000 acre Biltmore (1888), the Vanderbilt home in Asheville, N.C. Olmsted, working <u>with</u> the landscape, maximized that natural formations of an area with a result that looks amazingly natural and untouched, although the effect was often achieved through massive earth moving projects.

Olmsted's last major design was the 1893 site plan for the World's Columbian Exposition in Chicago. By 1895 he had retired from the firm and much of the day to day operation was taken over by his stepson, John C. Olmsted, who had joined the firm in 1879 and became a partner in 1884. In addition to his stepson, Olmsted had a number of other partners including Codman from 1889 to 1893 and Charles Eliot from 1893 to 1897. Arthur Shurcliff, active in the Boston Park System, was also a partner in the firm but left in 1907 to begin his own practice. Olmsted's son, Frederick Law, Jr. joined the firm after 1895 and with John C. Olmsted developed "...a practice many times larger than before."

Tragically, Frederick Law Olmsted died, ill and senile, after a creative and productive life, in McLean's Hospital, outside of Boston, for which he had designed the grounds (Placzek 1982: Vol. 3: 319-324 Southworth 1984:X, 435, 442-445).

<u>Landscape Projects for the Metropolitan Water Supply System</u>:

Spot Pond
Middlesex Fells Reservoir
Bear Hill Reservoir
Weston Reservoir

Shepley, Rutan & Coolidge

George Foster Shepley (1860-1903), Charles Hercules Rutan (1851-1914), and Charles Allerton Coolidge (1858-1936) were all members of H.H. Richardson's firm. Upon his death in 1886, they formed a partnership, completed Richardson's unfinished projects and went on to become one of the most successful architectural firms in America.

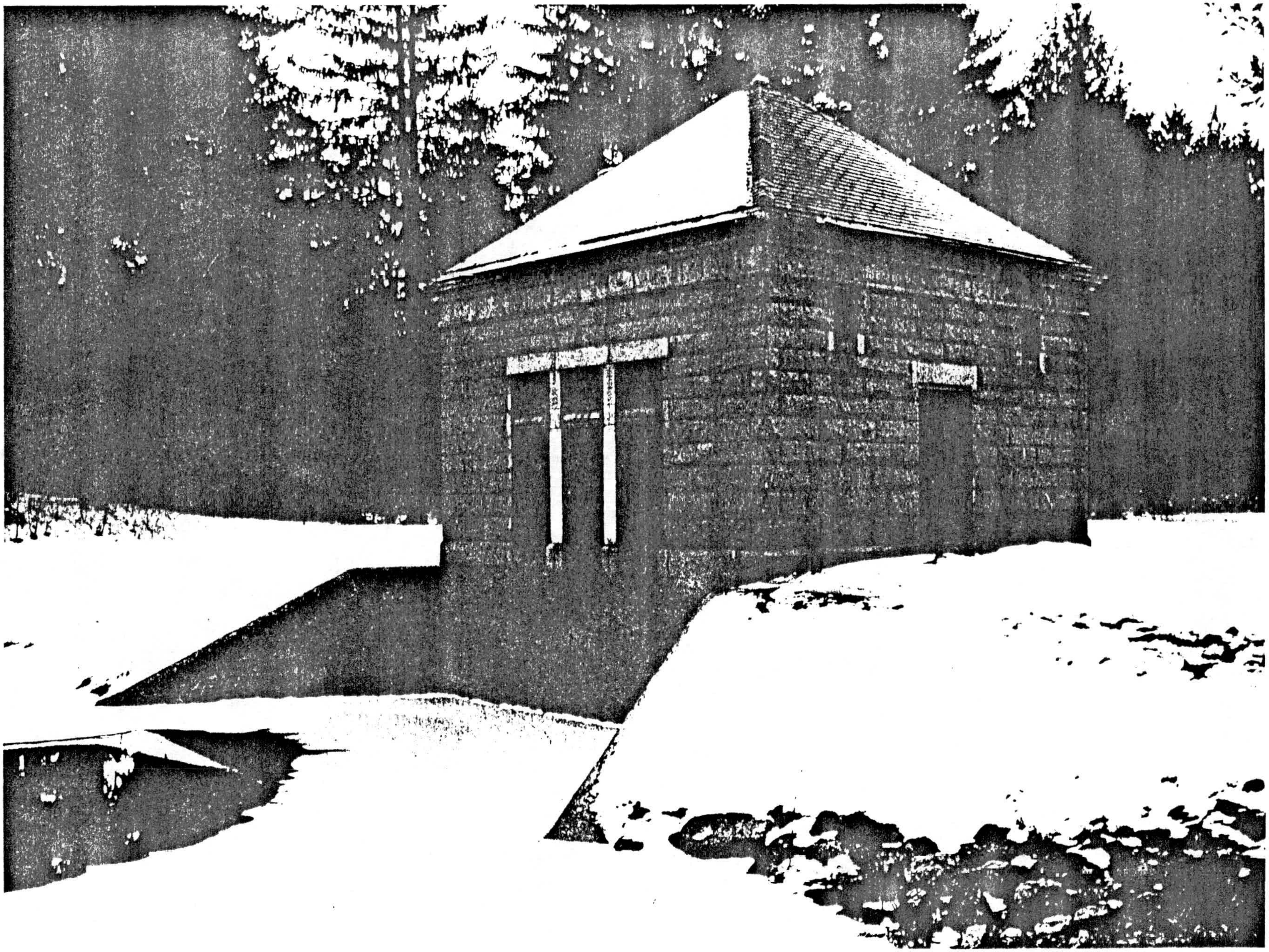
In 1892 the firm completed the Ames building, then the tallest (13 stories) structure in Boston and today still the second highest masonry wall-bearing building in the United States. They designed the campus of Stanford University, Palo Alto, Calif. (1892), Chicago Art Institute (1897) and the John Hay Library at Brown University (1907). In the Boston area, in addition to the Ames Building, the firm also designed the Grain and Flour Exchange (1889-1892), the Chamber of Commerce(1892), the Trinity Church Porch (1897), South Station (1900), and the Harvard University Medical School (1907).

Working in conjunction with the Olmsted firm, Shepley, Rutan & Coolidge designed structures for the Metropolitan Water Supply System at the three reservoirs in the Middlesex Fells (an Olmsted designed park). They also designed the Chestnut Hill Low Service Pumping Station, all the structures on the Weston Aqueduct, and the lower gate house at Wachusett Dam.

Shepley and Coolidge both studied at M.I.T. This and their subsequent relationship with Richardson may well account for the firm's strong grasp of a number of styles including Richardsonian Romanesque, Classical Revival and the Beaux Arts. In 1886, Shepley married Richardson's daughter and their son, Henry R. Shepley, became a partner in the firm, then named Coolidge, Shepley, Bulfinch and Abbott. The partnership continues today in Boston, with offices in the 1892 Ames Building, as Shepley, Bulfinch, Richardson and Abbott (Placzek 1982: Vol. 4: 51-51; Withey 1970: 136-137, 534; 550-551 Southworth (1984:78, 90, 109; Lyndon 1982:13', 163, 274).

Structures Designed for the Metropolitan Water Supply System:

Spot Pond Pumping Station
Spot Pond Southern Gatehouse
Low Service Pumping Station, Chestnut Hill
Weston Aqueduct Structures:
- Head chamber
- 2 gaging chambers
- 4 siphon chambers
- Channel chamber
- Screen chamber
- Terminal chamber
- Wachusett Dam lower gatehouse/powerhouse
- Middlesex Fells Reservoir Gatehouse
- Bear Hill Reservoir Gatehouse



Terminal Chamber, Wachusett Aqueduct, Marlborough. Built 1897.

Arthur Shurcliff

Arthur Shurcliff (1870-1939) was a landscape architect and planner who through good design and a forceful personality had a powerful impact on all his projects. Shurcliff, a graduate of both M.I.T. and Harvard University, began his career in the office of Frederic Law Olmsted. He soon left however, to form his own practice and eventually founded the firm of Shurcliff, Shurcliff and Merrill. Nationally known for recreating the gardens and grounds of Williamsburg, Va. in the 1930's, Shurcliff was best known in his home town of Boston for redesigning Boston Commons in 1918, in which he cleared the area of unneccessary structures, realigned walks to better focus on the State House and advocated removing some of the paving from Tremont Street and returning it to green land.

Shurcliff was for many years a consultant to the MDC water and parks division, and in this capacity was involved in the Charles River Basin/Storrow Drive design in the 1940's, in addition to his work at Wachusett and Quabbin reservoirs. He was also one of the founders of the Harvard School of Landscape Architecture, and was a member and secretary of the Massachusetts State Art Commission for 27 years. In addition to his landscape work Shurcliff designed town plans for over 37 cities in New England and for Ft. Worth, Indiana, and Ft. Worth, Texas.

During the late 1940's Shurcliff wrote his autobiography (published privately by his family in 1981) in which he carefully detailed the projects he had worked on and his role in each. The book conveys a man of enormous energy and talent with a strong willed character. Today, his grandson, Charles Shurcliff, works at the MDC Parks Division as a landscape architect. (New York Times, Nov. 13, 1957: 35; Southworth 1984: 438; Shurcliff 1981).

Landscape Projects for the Metropolitan Water Supply System

Quabbin Administration (Administration and Winsor Dam areas).
Wachusett Dam Area
Quabbin Park Cemetery

Jonas Waldo Smith

J. Waldo Smith (1891 - 1933) was born in Lincoln Mass. where he obtained his first engineering job, at the age of 16, in the town water works. He left to go to school at Phillips Academy, and in 1881 continued his education at M.I.T. where he graduated in 1887 with a degree in civil engineering. Between his stays at Phillips and M.I.T., Smith was Assistant Engineer with the Essex Water Power Company, Lawrence, Mass. He continued his career in the water field, working for two years at the Holyoke Water Power Company. From 1890 to 1897, Smith worked for the East Jersey Water Company, where he was First Resident Engineer and then Principal Assistant Engineer. Upon completion of a design of the Newark water supply system, Smith designed the first modern mechanical filtration plant in the United States, at Little Falls, New Jersey, in 1902.

Like many of his colleagues, Smith worked on New York City's Croton System. In 1903 he was Chief Engineer in charge of all construction on the New Croton Supply including the New Croton Dam, then the world's largest masonry dam. In 1905, New York City's additional supply from the Catskills was begun, work that was finally completed in 1922. Smith, who planned and engineered the project, considered this "his triumph." The 92 mile long Catskill Aqueduct was finished under budget and one year ahead of schedule. He retired from public service soon after the completion of the Catskill Project and then consulted on a number of projects, including the Quabbin Aqueduct and Reservoir studies, until his death in 1933 (National Cyclopaedia of American Biography Vol. 24: 108; Metropolitan District Water Supply Commission Annual Report 1933: 1).

Frederic P. Stearns

Frederic Pike Stearns was born in Calais, Maine on 11 November 1851. At the age of 18, he went to Boston and obtained a position in the office of the city surveyor. Three years later, in 1872, Stearns joined the "engineering corps" of Boston's Cochituate Water Board, then under the administration of Joseph P. Davis, and the following year conducted surveys for the Sudbury aqueduct and reservoir project as an Assistant Engineer. When construction began on that system, Stearns was put in charge of completion of a segment of the aqueduct. In 1877-79, Stearns and Alphonse Fteley conducted a series of hydraulic experiments through the Sudbury Aqueduct. Publication of their work in 1883 earned Stearns and Fteley a Norman Medal from the American Society of Civil Engineers (National Cyclopaedia of American Biography 1967, Vol. 14:306).

From 1880 to 1886, Stearns was employed in the construction of the Boston Main Drainage Works, with particular responsibility for the tunnel under Dorchester Bay and the reservoir and outlet works at Squantum and Moon Island. In 1886, with the creation of an engineering department in the Mass. State Board of Health, Stearns was appointed Chief Engineer for that department. In this capacity, he conducted studies and developed plans for main sewers in the Charles and Mystic river valleys, which became the basis for creation of the Metropolitan Sewerage Board in 1889. In addition, Stearns served as engineer to a joint board examining improvements to the Charles River and developed plans for creation of a fresh-water basin by construction of a dam with a tidal lock. During 1893-95, Stearns played a pivotal role in the Board of Health's study for a metropolitan water supply system, which, published in 1895, resulted in the establishment of the Metropolitan Water Board.

With Stearns as Chief Engineer, the Water Board's engineering department oversaw construction of Sudbury and Wachusett

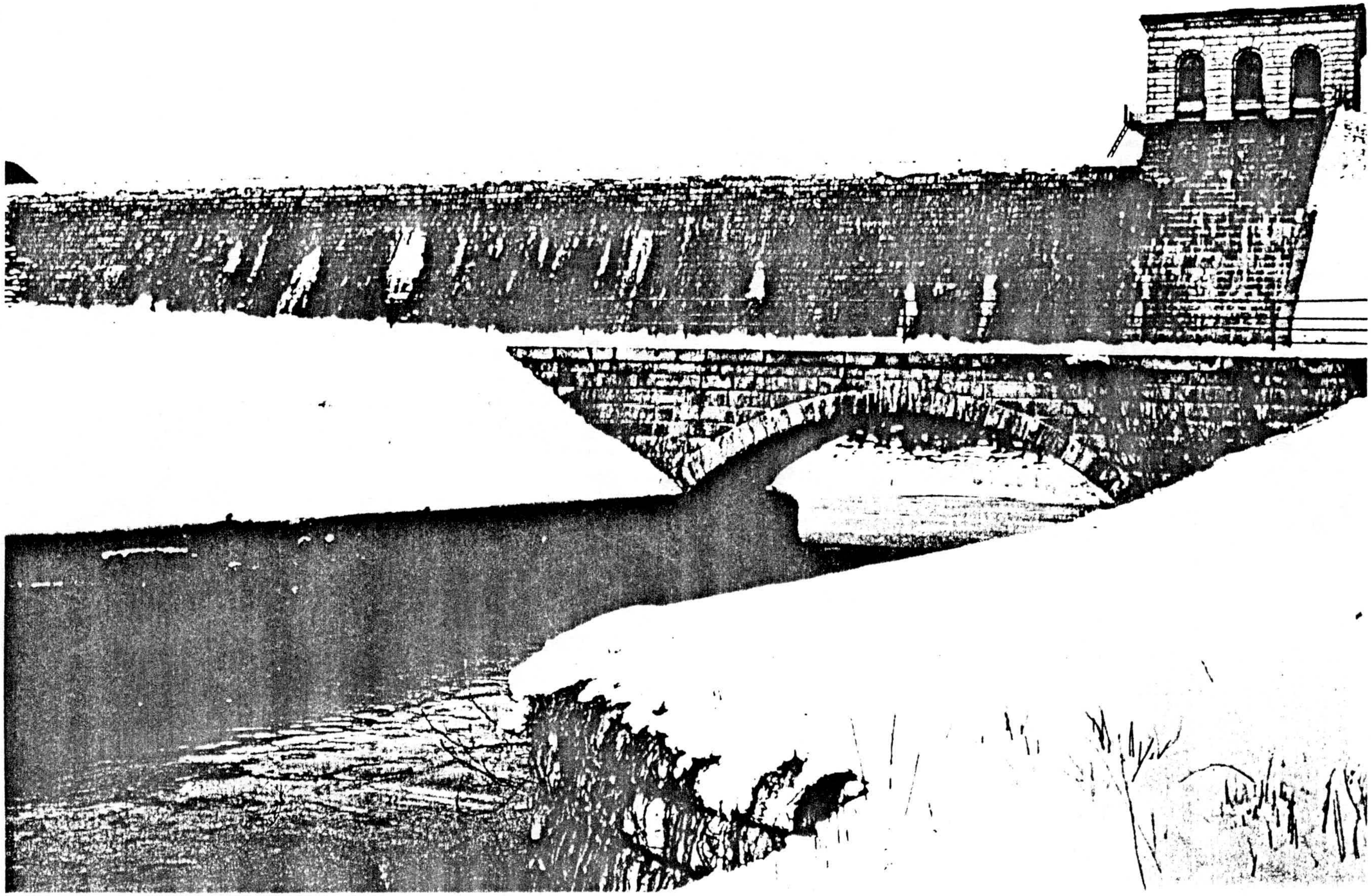
Reservoirs, Wachusett and Weston Aqueducts, and also numerous improvements to the distribution facilities, most notably at Chestnut Hill and Spot Pond. With completion of Wachusett Reservoir and Dam, Stearns retired from public service, but until his death in 1919 maintained an active career as a private consultant.

Frederic Stearns may in many respects be considered the "architect" of the Metropolitan Water Supply System. The 1895 Board of Health study, to which he contributed extensively, became in effect the blueprint for development of the system through construction of Quabbin Reservoir, the completion of which marked the realization of ideas Stearns had developed forty years before. Stearns' reputation as an engineer was perhaps most prominently highlighted in his selection to a 13-member international commission of engineers for the Panama Canal, which functioned in an advisory capacity on that project. The north dike at Wachusett Reservoir, designed by Hiram Miller under Stearns' guidance, was of particular interest to the commission, which made a special trip to the reservoir in November 1905 to discuss its unusual construction methods and to view the results thereof.

A hallmark of Stearns' work in Massachusetts was his concern for the aesthetics as well as the technology of the Metropolitan Water Supply System. The Boston Evening Transcript noted this characteristic by saying Stearns "combined in rare degree both scientific attainment and a love of the beautiful, as the result of which his achievements adorned as well as served in a utilitarian sense the communities for which he worked" (Transcript, 2 December 1919:4). Having worked with Charles Eliot, of the firm Olmsted, Olmsted & Eliot, on the Charles River improvement studies in the 1880's, Stearns remembered that experience and built upon it as Chief Engineer for the Metropolitan Water Board (Journal of the New England Water Works Assn. 34 (1920):30). As a result, landscaping was a prominent feature of reservoirs built under Stearns, in particular Weston Reservoir and Spot Pond, and of the complex of structures at Wachusett Dam. Stearns' contributions were eloquently summarized by the American Society of Civil Engineers, of which he was at one time president, as "at... their construction probably the most noteworthy series of water works structures in the United States; foremost not altogether in size, but in perfection of detail and the embodiment of the best practice in hydraulic engineering...from reservoir to pumping station" (ASCE Transactions 83 (1919-20):2135).

Arthur Vinal

Arthur H. Vinal (1855-1924) was born in Quincy, Massachusetts. He apprenticed in the architectural firm of Peabody & Stearns before beginning his own practice, in Boston, in the 1870's. During his career, Vinal designed a number of single-family dwellings in and around Boston, including houses for family members on Bay State Road. As Boston City Architect, a position Vinal held from 1884



Sudbury Dam, Gatehouse and Channel Bridge, at Sudbury Reservoir, Southborough. Built 1893-1897, 1902.
Wheelwright & Haven, Architects.

to 1888, Mr. Vinal designed schools, and police and fire stations, including Engine and Hose Houses No. 33 and the adjacent Police Station, now the Institute of Contemporary Art. As City Architect, Vinal designed what is perhaps his best known work, the Chestnut Hill High Service Pumping Station, a carefully massed and detailed Richardsonian Romanesque structure. Vinal also designed the Robert B. Brigham Hospital and subsequently did work on the Brigham family estate. He also designed the lodge at the base of the Bunker Hill Monument and was the architect for the Bangor and Augusta, Maine, opera houses. Vinal died suddenly, in West Harpsell, Maine (Boston Transcript, August 25, 1924:5; Boston Public Library, Architectural File, Arthur Vinal; Southworth 1984: 10, 292; Lyndon 1982: 180, 211, 300).

Structures Designed for the Water Supply System:

Fisher Hill Reservoir and Gatehouse
Chestnut Hill High Service Pumping Station

Wheelwright & Haven

Edmund March Wheelwright (1854-1912), a Boston architect, was educated at Harvard, M.I.T. and the Ecole des Beaux Arts, Paris. Before beginning his own practice he worked in the offices of Peabody & Stearns and McKim, Mead, & White. After five years of private practice, Wheelwright in 1889 formed a partnership with Parkman B. Haven (1858-1943). During his practice with Haven, Wheelwright (from 1891 to 1895) was also Boston City Architect and designed a number of municipal buildings including the subway entrance on Boston Common at Park Street (1897); several of the buildings at Boston City Hospital; the Fine Department Headquarters, now the Pine St. Inn, which was based on the Palazzo Vecchio, Florence Italy (1894); and the Massachusetts Historical Society (1899). It was in this capacity that Wheelwright designed some of the structures for the Metropolitan Water Supply System. In 1895 the city architect position was abolished and Wheelwright resumed his partnership with Haven. The firm designed several notable buildings in Boston including Horticultural Hall (1900); New England Conservatory of Music (1903); Longfellow Bridge, inspired by a bridge in St. Petersburg Russia (1907); and the New Opera House (1908) (Placzek 1982: Vol. 4; 389; Withey 1970: 273, 648-649; Lyndon 1982:108, 203, 296, 300; Southworth 1984: 191, 297, 310).

Structures Designed for the Boston Water Board:

Extension of Chestnut Hill High Service Pumping Station
Gatehouse at Chestnut Hill
Glenwood Pipe Yards
Sudbury Dam Gate Chamber

Frank E. Winsor

Frank E. Winsor (1970-1939), born in Providence, Rhode Island, graduated from Boston University with a civil engineering degree and later an honorary Doctor of Science degree. For his entire career Winsor was involved with water related projects. From 1881 to 1895 he worked on the construction of the Boston metropolitan sewerage system. In 1895 he moved to the Metropolitan Water Board where for five years he was an assistant in the Wachusett Dam and Reservoir and Aqueduct Departments. He was then promoted to Assistant Engineer in charge of the Weston Aqueduct Department and from there moved up to Division Engineer for part of the Wachusett Aqueduct.

In 1903-6 Winsor served as Designing and Deputy Chief Engineer for the Boston's Charles River Basin Commission. He left this position to work in New York City for the next 9 years where he was an engineer on the Catskill Water Supply. In this capacity he was in charge of construction of the Kensico and Hillview Reservoirs and 32 miles (out of a total of 92) of the Catskill Aqueduct. Later he served as consulting engineer to the New York City Board Water Supply. Returning to New England, Winsor was Chief Engineer of the Metropolitan Supply of Providence, Rhode Island. In 1926, he was appointed Chief Engineer for the Metropolitan District Water Supply Commission in Boston. In this capacity, Winsor was in charge of construction of the Quabbin Aqueduct and Quabbin Reservoir, one of the largest construction projects ever undertaken at that time in the United States. He was also the highest paid state official in Massachussets, earning $3,500 more a year than the governor of the state. In the most ironic of circumstances for a career public servant, Winsor died while testifying in Boston Muncipal Court, in a contractor's suit against the Water Supply Commission. Upon his death the main dam at Quabbin Reservoir was renamed Winsor Dam and a memorial, cosponsored by the Boston Society of Engineers and the Northeastern Section of the American Society of Civil Engineers was erected on a hill overlooking the reservoir. As recorded in the Water Supply Commission Annual Report for 1939, "He died at the height of a distinguished career and his loss was very keenly felt." (Metropolitan District Water Supply Commission 1939:4-5, New York Times, February 1, 1939).

BIBLIOGRAPHICAL NOTE

The following bibliography lists sources directly used in preparation of this report and historic site forms. It cannot convey, however, the wealth of material, written and graphic, that is available on the physical development of the Boston Metropolitan Water System. Much of this documentation is located in the Water Division offices of the Metropolitan District Commission, Boston. There are, however, additional collections of materials at Chestnut Hill Reservoir, Sudbury Department offices at Sudbury Dam, and at Quabbin Reservoir.

Drawings: The Water Division's vault contains a remarkable collection of plans and other drawings on everything from the Chestnut Hill pumping stations to portable engineers' offices. The drawings (principally record documents) are most complete for works constructed after creation of the Metropolitan Water Board in 1895. In addition, there is a complete set of original architectural renderings (ink and colored wash on paper) for structures of the Cochituate system. For the Weston, there are both record drawings, original inked drawings from the architects, and blueprints colored and labeled according to materials required for construction. The Sudbury system is documented in a large bound volume of record drawings (reproductions) but no superstructures are represented. A set of studies for the Arlington standpipe, built in 1923, is of considerable architectural interest in its presentation of several different design schemes, including the design ultimately chosen and its source.

Except for the Cochituate and Sudbury drawings, which are in volumes, many pre- 1926 drawings are filed roughly according to subject, and also according to sheet size, but there is no particular order within a given drawer. Drawings prepared by the Metropolitan District Water Supply Commission (1926-47) are for the most part filed by contract number. As repairs or other work is done, new drawings are added to the collection. Although some structures are no longer in service, for those still in use, the drawings often provide important information for locating structures, and for planning repairs and alterations.

Photographs: From its inception, the Metropolitan Water Board retained the services of a photographer to record construction of new works; the images were commonly featured in annual reports. In addition, photographic prints, numbering in the thousands, were bound in volumes, and are now shelved in the Water Division director's office. The volumes are organized chronologically and by general subject (for example, "Sudbury Department," "Wachusett Reservoir"), and each has a typewritten table of contents that repeats the captions and dates found on the bottom of each photograph. Several volumes contain photographs of buildings and structures that were on land taken by the Metropolitan Water Board for various reservoir construction projects, Wachusett Reservoir in particular. Others chronicle construction, over days, weeks and even years, of nearly all reservoirs and structures built or remodeled by the Metropolitan Water Board and its successor agencies from 1895 through 1926. The distribution system is similarly recorded in photographs showing construction of pumping stations, pipelines, and standpipes and other storage facilities.

Construction under the Metropolitan District Water Supply Commission (primarily Quabbin Aqueduct and Reservoir) is documented in thousands of images filed in the office of the MDC historian, Captain Albert Swanson. The MDC office at Quabbin Reservoir also holds a large number of photographs, including images of all buildings and structures removed or acquired during construction of that reservoir. Copies of these are also available at the Massachusetts State Archives. Additionally, town records including birth, marriage and death records, for the four communities inundated by Quabbin Reservoir are available at the MDC office at Quabbin.

Of the 1895-c. 1926 photographs, only one set of prints is currently known to exist, and a number of these images are faded or have darkened to the point where they are unintelligible. It appears that the glass plate negatives from which these images were made were housed in wooden cabinets in an unheated upper room of the Chestnut Hill High Service Pumping Station. Perhaps a hundred or so glass plates remain here, uncatalogued and in poor condition. The bulk of the negative collection was turned over to the Smithsonian Institution some years ago, and are stored at the National Museum of American History.

The MDC Water Division offices also house extensive collections of correspondence, plus hundreds of volumes of water records, surveyors' notes, land transactions, and other materials. There are several boxes of glass plate negatives which appear to have been made from drawings. Construction contracts, beginning with the year 1896, are bound in chronological order, often preceded by lists of bidders and bids. There are two scrapbooks of newspaper clippings, chiefly from Boston papers. The smaller of the two contains clippings from the 1870's, primarily about the construction of the Sudbury "additional supply." The second covers 1896-1900, focusing on construction activities at Wachusett Reservoir. Toward the end of the period, the clippings (from Worcester and Clinton, as well as Boston, papers) chronicle events leading to a special legislative inquiry into labor conditions and employment and contracting practices at Wachusett. The complete transcript of the legislative hearings is also available in the Water Division offices.

This extraordinary collection of written and graphic material is the result of many years' accumulation in the course of planning, construction and daily operation of the water supply system. As materials become out of date, obsolete, or otherwise no longer of immediate use, they are simply stored to make room for new documents and drawings. There is no cataloguing system or other organizational framework for the bulk of the materials, and as a result the full extent of the collections is unknown and will certainly remain so, unless a cataloguing program is instituted by the MDC.

Also unknown is the degree of duplication among collections of documents and drawings at the Water Division, the MDC historian's office, Chestnut Hill, and the Sudbury and Quabbin offices.

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APPENDIX A

LIST OF INVENTORIED RESOURCES

BY TOWN

Arlington
Arlington Standpipe (16-3)
Arlington Pumping Station (16-5)

Ashland
Ashland Reservoir and Dam (4-3)
Hopkinton Reservoir and Dam (4-4)

Barre
Quabbin Aqueduct Shaft 8 (17-18)
Shaft 8 Service Building (17-19)
Shaft 8 Diversion Dam (17-20)
Quabbin Aqueduct Shaft 9 (17-17)

Belchertown
Quabbin Administration Complex (17-10)
Blue Meadow Road Maintenance (17-11)
Winsor Dam (17-2)
Windor Dam Intake (17-12)
Winsor Dam Outlet/Power House (17-13)

Belmont
Belmont Pumping Station (16-12)

Berlin
Wachusett Shaft #4 Chamber (8-2)
Wachusett Metering Chamber (8-3)

Boston
M.D.C. Administration Building (16-14)

Boston (Brighton)
Chestnut Hill Reservoir (13-1)
Chestnut Hill Gatehouse (13-2)
Low Service Pumping Station (13-3)
High Service Pumping Station (13-4)
Sudbury Terminal Chamber (13-5)
Connection Chamber (13-6)
Effluent Gatehouse #1 (13-7)
Intermediate Gatehouse (13-8)

Boston (Hyde Park)
Hyde Park Pumping Station (16-6)

Boston (Roxbury)
Roxbury Standpipe (16-2)

Boston (West Roxbury)
Bellevue Standpipe (16-1)

Brookline
Brookline Reservoir (2-1)
Cochituate Distribution Chamber (2-2)
Cochituate Terminal chamber (2-3)
Cochituate Waste Weir (1-10)

Fisher Hill Reservoir and Gatehouse (16-10)
Brookline Booster Station (16-11)

<u>Clinton</u>
Wachusett Dam (9-2)
Central Massachusetts Railroad Bridge (9-3)
Grove Street Bridge (9-4)
Wachusett Lower Gatehouse/Powerhouse (9-5)
Lightning Arrester Chamber (9-6)
Central Massachusetts Railroad Tunnel (10-1)
Metropolitan Water Works Office (10-5)
Clinton Sewage Pumping Station (10-6)

<u>Framingham</u>
Cochituate Reservoir (1-1)
Lake Cochituate (1-2)
Lake Cochituate Dam (1-3)
Farm Pond (3-5)
Farm Pond Gatehouse (3-6)
Framingham Reservoir #1, Dam and Gatehouse (3-2)
Framingham Reservoir #2, Dam and Gatehouse (3-3)
Framingham Reservoir #3, Dam and Gatehouse (3-4)
Gaging Chamber (5-7)
Sudbury River Siphon (12-5)
Weston Metering Chamber #1 (12-9)
Weston Metering Chamber #2 (12-10)
Route 30 Bridge (7-5)
Bullard Place (3-7)

<u>Hardwick</u>
Quabbin Aqueduct Shaft 12 (17-15)
Shaft 12 Service Building (17-16)

<u>Holden</u>
Quabbin Aqueduct Shaft 2 Spillway (17-22)

<u>Hopkinton</u>
Hopkinton Reservoir (4-4)
Whitehall Reservoir and Dam (4-1)
Whitehall Gatehouse (4-2)

<u>Marlborough</u>
Marlborough Filter Beds (6-2)
Wachusett Terminal Chamber (8-4)
Hultman Shaft #1 (8-5)
Hultman Aqueduct Diversion Dam (8-15)
Crane Meadow Road Arch (8-6)

<u>Medford</u>
Medford Pipe Bridge (16-8)
Glenwood Pipe Yards (16-7)
Mystic Lakes (15-1)
Mystic Dam (15-2)
Mystic Gatehouse (15-3)

Natick

Lake Cochituate (1-2)
Cochituate Head House (1-5)
Circular Dam (1-8)
Pegan Brook Filter Beds (1-9)

New Salem

Middle Branch Regulating Dam (17-6)

Newton

Weber's Waste Weir (1-7)
Cochituate Ventilator (1-11)
Waban Hill Reservoir and Gatehouse (16-9)
Charles River (Echo) Bridge (5-3)
Sudbury Waste Weir D (5-6)
Charles River Bridge and Siphon (1-12)

Northborough

Assabet River Bridge (8-9)

Quincy

Forbes Hill Standpipe (16-4)

Rutland

Quabbin Aqueduct Shaft 4 (17-21)

Sherborn

Sudbury Waste Weir A (5-5)

Somerville

Mystic Pumping Station (15-4)

Southborough

Sudbury Dam Complex (7-1)
Sudbury Dam (7-2)
Sudbury Dam Gatehouse (7-3)
Sudbury Dam Storehouse (7-4)
Bridge at Section 1, Weston Aqueduct (7-6)
Weston Head Chamber (7-7)
Hultman Shaft #4 (7-8)
Middle Road Arch (6-3)
Parkervill Road Arch (6-4)
Cordaville Road Arch (6-8)
Circular Dam (6-6)
Old Boston Road Arch (6-7)
White Bagley Road Arch (6-5)
New York, New Haven & Hartford Railroad Arch (6-9)
Upper Dam, Wachusett Open Channel (8-7)
Lower Dam, Wachusett Open Channel (8-8)
Northborough Road Arch #1 (8-10)
Northborough Road Arch #2 (8-11)
Flagg Road Arch (8-12)
Lynbrook Road Arch (8-13)
Chestnut Hill Road Arch (8-14)
Cordaville Pumping Station (16-13)

Stoneham
Middlesex Fells (14-1)
Spot Pond Reservoir (14-2)
Spot Pond Pumping Station (14-3)
Spot Pond East Gatehouse (14-4)
Spot Pond South Gatehouse (14-5)
Middlesex Fells Reservoir and Gatehouse (14-6)
Bear Hill Reservoir and Gatehouse (14-7)
Spot Pond Superintendent's House (14-8)
Spot Pond Stone Barn (14-9)

Ware
Winsor Dam (17-2)
Goodnough Dike (17-3)
Winsor Dam Spillway (17-4)
Spillway Bridge (17-5)
Winsor Memorial (17-8)
Quabbin Lookout Tower (17-9)
Quabbin Park Cemetery (18-1)
Cemetery Receiving Vault (18-2)
Cemetery Maintenance Building (18-3)

Wayland
Lake Cochituate (1-1)
Sudbury River Siphon (12-5)

Wellesley
Rosemary Brook Siphon (5-2)
Waban Bridge (5-4)
Morse's Waste Weir (1-11)

West Boylston
Worcester Street Arch (10-2)
Quinepoxet River Arch (10-3)
Beaman Street Arch (10-4)
Quabbin Aqueduct Outlet Works (11-1)
Quinepoxet River Circular Dam (11-2)
Quabbin Shaft #1 (11-3)

Weston
Weston Aqueduct (12-1)
Weston Reservoir (12-2)
Happy Hollow Siphon (12-3)
Ash Street Bridge (12-4)
Weston Terminal Chamber (12-6)
Weston Screen Chamber (12-7)
Weston Channel Chamber (12-8)
Norumbega Reservoir (19-2)
Norumbega Reservoir Gatehouse (19-3)
Norumbega Reservoir Chlorine Storage (19-4)

Winchester
Mystic Lakes (15-1)
Mystic Dam (15-2)

Resources with Multiple Locations

Cochituate Aqueduct: Boston (Brighton), Brookline, Natick, Needham, Newton, Wayland, West Needham (1-4)

Sudbury Aqueduct: Framingham, Natick, Newton, Sherborn, South Natick, Wellesley, West Natick (5-1)

Wachusett Aqueduct: Berlin, Clinton, Marlborough, Northborough, Southborough (8-1)

Weston Aqueduct: Framingham, Southborough, Wayland, Weston (12-1)

Sudbury Reservoir: Marlborough, Southborough (6-1)

Wachusett Reservoir: Boylston, Clinton, Sterling, West Boylston (9-1)

Quabbin Aqueduct: Hardwick, Barre, Rutland, Holden, West Boylston (17-14)

Quabbin Reservoir: Belchertown, Ware, Shutesbury, Pelham, Petersham, New Salem (17-1)

Hultman Aqueduct: Marlborough, Southborough, Framingham, Wayland Weston (19-1)

APPENDIX B

LIST OF INVENTORIED RESOURCES BY SYSTEM

Cochituate System

1-1 Cochituate Reservoir (Area)
1-2 Lake Cochituate
1-3 Lake Cochituate Dam
1-4 Cochituate Aqueduct
1-5 Cochituate Headhouse
1-6 Morse's Waste Weir
1-7 Weber's Waste Weir
1-8 Circular Dam
1-9 Pegan Filter Beds
1-10 Cochituate Waste Weir
1-11 Cochituate Ventilator
1-12 Charles River Bridge and Siphon
1-13 Cochituate Maintenance Complex (Area)
2-1 Brookline Reservoir (Area)
2-2 Cochituate Distribution Chamber
2-3 Cochituate Terminal Chamber
2-4 Brookline Reservoir

Sudbury Reservoirs and Aqueduct System

3-1 Framingham Reservoirs (Area)
3-2 Framingham Reservoir #1, Dam and Gatehouse
3-3 Framingham Reservoir #2, Dam and Gatehouse
3-4 Framingham Reservoir #3, Dam and Gatehouse
3-5 Farm Pond
3-6 Farm Pond Gatehouse
3-7 Bullard Place
4-1 Whitehall Reservoir and Dam
4-2 Whitehall Gatehouse
4-3 Ashland Reservoir and Dam
4-4 Hopkinton Reservoir and Dam
5-1 Sudbury Aqueduct
5-2 Rosemary Brook Siphon
5-3 Charles River (Echo) Bridge
5-4 Waban Bridge
5-5 Sudbury Waste Weir A
5-6 Sudbury Waste Weir D
5-7 Gaging Chamber

Sudbury Reservoir System

6-1 Sudbury Reservoir (Area)
6-2 Marlborough Filter Beds
6-3 Middle Road Arch
6-4 Parkerville Road Arch
6-5 White Bagley Road Arch
6-6 Circular Dam
6-7 Old Boston Road Arch
6-8 Cordaville Road Arch
6-9 New York, new Haven & Hartford Railroad Arch

Sudbury Dam Group

7-1 Sudbury Dam Complex (Area)
7-2 Sudbury Dam
7-3 Sudbury Dam Gatehouse
7-4 Sudbury Dam Storehouse

7-5 Route 30 Bridge
7-6 Bridge at Section 1, Weston Aqueduct
7-7 Weston Head Chamber
7-8 Hultman Shaft #4

<u>Wachusett Aqueduct System</u>

8-1 Wachusett Aqueduct (Area)
8-2 Wachusett Shaft #4 Chamber
8-3 Wachusett Metering Chamber
8-4 Wachusett Terminal Chamber
8-5 Hultman Shaft #1
8-6 Crane Meadow Road Arch
8-7 Upper Dam, Wachusett Open Channel
8-8 Lower Dam, Wachusett Open Channel
8-9 Assabet River Bridge
8-10 Northborough Road Arch #1
8-11 Northborough Road Arch #2
8-12 Flagg Road Arch
8-13 Lynbrook Road Arch
8-14 Chestnut Hill Road Arch
8-15 Hultman Aqueduct Diversion Dam

<u>Wachusett Reservoir System</u>

9-1 Wachusett Reservoir (Area)
9-2 Wachusett Dam
9-3 Central Massachusetts Railroad Bridge
9-4 Grove Street Bridge
9-5 Wachusett Lower Gate Chamber/Powerhouse
9-6 Lightning Arrester Chamber
10-1 Central Massachusetts Railroad Tunnel
10-2 Worcester Street Arch
10-3 Quinepoxet Arch
10-4 Beaman Street Arch
10-5 Metropolitan Water Works Office
10-6 Clinton Sewage Pumping Station
11-1 Quabbin Aqueduct Outlet Works (Area)
11-2 Quinepoxet River Circular Dam
11-3 Quabbin Shaft #1

<u>Weston Aqueduct System</u>

12-1 Weston Aqueduct (Area)
12-2 Weston Reservoir (Area)
12-3 Happy Hollow Siphon
12-4 Ash Street Bridge
12-5 Sudbury River Siphon
12-6 Weston Terminal Chamber
12-7 Weston Screen Chamber
12-8 Weston Channel Chamber
12-9 Weston Metering Chamber #1
12-10 Weston Metering Chamber #2

<u>Chestnut Hill Reservoir</u>

13-1 Chestnut Hill Reservoir (Area)
13-2 Chestnut Hill Gatehouse
13-3 Low Service Pumping Station

13-4 High Service Pumping Station
13-5 Sudbury Terminal Chamber
13-6 Connection Chamber
13-7 Effluent Gatehouse #1
13-8 Intermediate Gatehouse
13-9 Chestnut Hill Reservoir

Middlesex Fells System

14-1 Middlesex Fells (Area)
14-2 Spot Pond Reservoir
14-3 Spot Pond Pumping Station
14-4 Spot Pond East Gatehouse
14-5 Spot Pond South Gatehouse
14-6 Middlesex Fells Reservoir and Gatehouse
14-7 Bear Hill Reservoir and Gatehouse
14-8 Spot Pond Superintendant's House
14-9 Stone Barn

Miscellaneous Distribution

15-1 Mystic Lakes (Area)
15-2 Mystic Dam
15-3 Mystic Gatehouse
15-4 Mystic Pumping Station
16-1 Bellevue Standpipe
16-2 Roxsbury Standpipe
16-3 Arlington Standpipe
16-4 Forbes Hill Standpipe
16-5 Arlington Pumping Station
16-6 Hyde Park Pumping Station
16-7 Glenwood Pipe Yards
16-8 Medford Pipe Bridge
16-9 Waban Hill Reservoir
16-10 Fisher Hill Reservoir and Gatehouse
16-11 Brookline Booster Station
16-12 Belmont Pumping Station
16-13 Cordaville Pumping Station
16-14 MDC Administration Building

Quabbin Reservoir & Aqueduct System

17-1 Quabbin Reservoir (Area)
17-2 Winsor Dam
17-3 Goodnough Dike
17-4 Winsor Dam Spillway
17-5 Spillway Bridge
17-6 Middle Branch Regulating Dam
17-7 East Branch Regulating Dam
17-8 Winsor Memorial
17-9 Quabbin Lookout Tower/Toilet
17-10 Quabbin Administration Complex
17-11 Blue Meadow Road Maintenance
17-12 Winsor Dam Intake
17-13 Winsor Dam Outlet/Powerhouse
17-14 Quabbin Aqueduct (Area)
17-15 Shaft 12
17-16 Shaft 12 Service Building

17-17 Shaft 9
17-18 Shaft 8
17-19 Shaft 8 Service Building
17-20 Shaft 8 Diversion Dam
17-21 Shaft 4
17-22 Shaft 2 Spillway

Quabbin Park Cemetery
18-1 Quabbin Park Cemetery (Area)
18-2 Receiving Vault
18-3 Service Building

Hultman Aqueduct
19-1 Hultman Aqueduct (Area)
19-2 Norumbega Reservoir (Area)
19-3 Norumbega Reservoir Headhouse
19-4 Norumbega Reservoir Chlorine Storage

CHRONOLOGY OF THE BOSTON AND METROPOLITAN WATER SUPPLY SYSTEM
1845-1947

	1845-50	1850-55	1855-60	1860-65	1865-70	1870-75	1875-80	1880-85	1885-90	1890-95
ADMINISTRATION	← COCHITUATE WATER BOARD (1845–1875) →						← BOSTON WATER BOARD (1875–1895) →			
SUPPLY	LAKE COCHITUATE COCHITUATE AQUEDUCT WHITEHALL RESERVOIR		COCHITUATE DAM #2	MYSTIC LAKES MYSTIC PUMPING STATION	SPOT POND	SUDBURY AQUEDUCT	FARM POND FRAMINGHAM RESERVOIR #1 FRAMINGHAM RESERVOIR #2 FRAMINGHAM RESERVOIR #3	ASHLAND RESERVOIR	COCHITUATE DAM # 3	WHITEHALL RESERVOIR HOPKINTON RESERVOIR PEGAN BROOK FILTER BEDS
DISTRIBUTION	BROOKLINE RESERVOIR			ROXBURY STANDPIPE	CHESTNUT HILL RESERVOIR			FISHER HILL RESERVOIR	WEST ROXBURY PUMPING STATION CHESTNUT HILL HIGH SERVICE	

	1895-1900	1900-05	1905-10	1910-15	1915-20	1920-25	1925-30	1930-35	1935-40	1940-45	1945-50
ADMINISTRATION	METRO-POLITAN WATER BOARD	← METROPOLITAN WATER & SEWERAGE BOARD (1900–1919) →			← METROPOLITAN DISTRICT COMMISSION (1919–) →		← METROPOLITAN DISTRICT WATER SUPPLY COMMISSION (1926–1947) →	20 SOMERSET STREET			
SUPPLY	SUDBURY RESERVOIR #5 MARLBOROUGH FILTERS WACHUSETT AQUEDUCT	WACHUSETT RESERVOIR AND DAM WESTON AQUEDUCT		WACHUSETT HYDRO-ELECTRIC	SUDBURY HYDRO-ELECTRIC WACHUSETT - SUDBURY TRANSMISSION LINE		WARE - WACHUSETT TUNNEL	SWIFT-WARE TUNNEL ← QUABBIN RESERVOIR (1930–1940) →	HULTMAN AQUEDUCT		QUABBIN RESERVOIR FILLED CITY TUNNEL → CHICOPEE VALLEY ← AQUEDUCT
DISTRIBUTION	SPOT POND IMPROVEMENTS AND HIGH SERVICE MIDDLESEX FELLS RESERVOIR CHESTNUT HILL LOW SERVICE	FORBES HILL RESERVOIR BEAR HILL RESERVOIR	ARLINGTON PUMPING STATION	HYDE PARK PUMPING STATION BELLEVUE STANDPIPE		ARLINGTON STANDPIPE	SOUTH SUDBURY EMERGENCY SUPPLY		BEAR HILL RESERVOIR BASIN BELMONT PUMPING STATION		