Environmental Concerns Imposed by Boston Area Geology

The geologic conditions that have affected settlement and expansion have had a significant effect on the area's environmental management system.

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Many environmental concerns arose with the growth of the Boston area. The expansion of the City of Boston into a large metropolitan area during the 19th century made Boston a leader in the development of a city-wide water and sewerage system. Boston also led the nation in developing a structured solid waste program that was built in conjunction with the water and sewage system. In recent years, a host of new laws regulating the operation of these environmental management systems have resulted in a need for enlarging them further. In addition, new state and federal regulatory statutes have had a significant impact on the treatment of the environmental problems in the metropolitan Boston area.

Water Supply

Boston owes its founding to its abundant fresh water springs that attracted John Winthrop and his Puritan followers (see "The History of Boston: The Impact of Geology" on pp. 33-38). They had abandoned their settlement across the Charles River in Charlestown because of the sickness that was caused by drinking water from a spring that was exposed only at low tide. The settlers soon learned that the drumlin till that composes most of Charlestown consisted of a material that was not likely to provide a good source of fresh water.

The colonists living on the Shawmut Peninsula derived their water from shallow dug wells that produced water of good quality under artesian pressure.[1] Some households in colonial Boston drew water from the town well located at what is now called Washington Mall and the town spring in Spring Lane downhill from Washington Street. Wells in the lower part of Boston tended to be somewhat brackish since they were close to sea level and were influenced by salt water intrusion.

The early colonial wells were lined with slabs of local rock, later ones progressing to cobbles retained by wooden sheathing and then to loosely mortared brick. Pumps consisting of hollow log pipes with a moving wooden

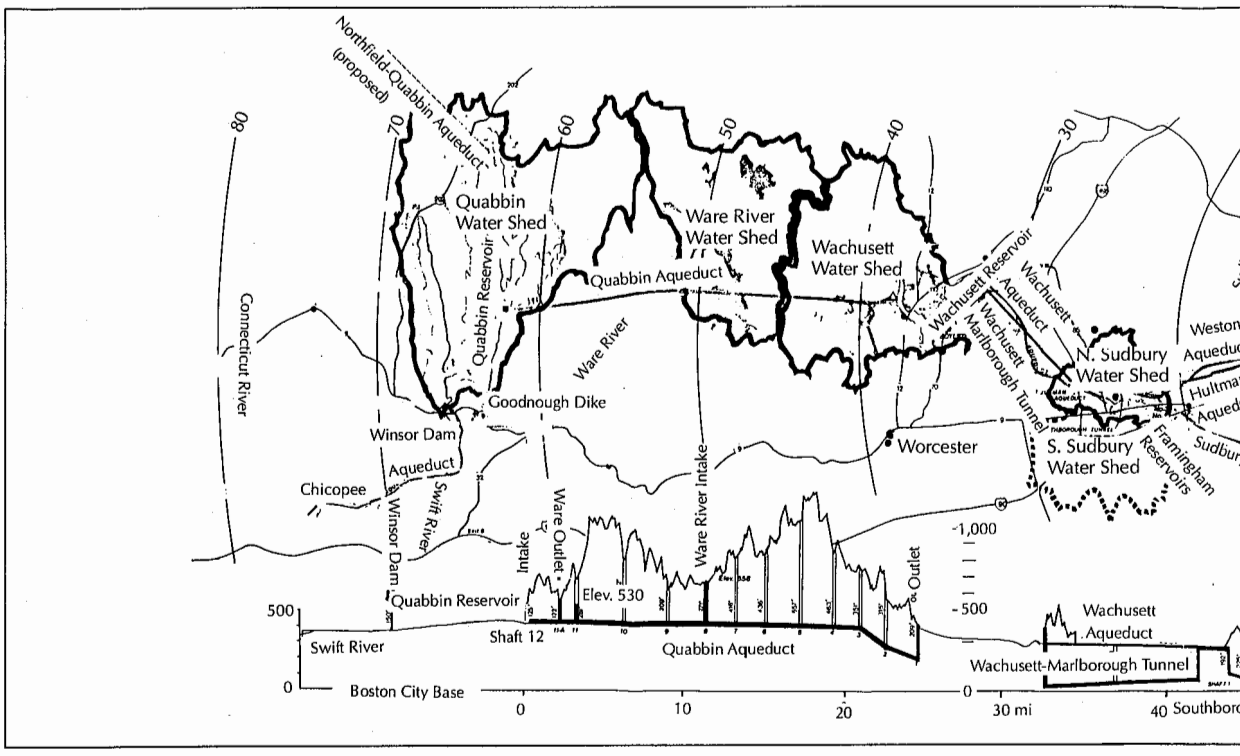


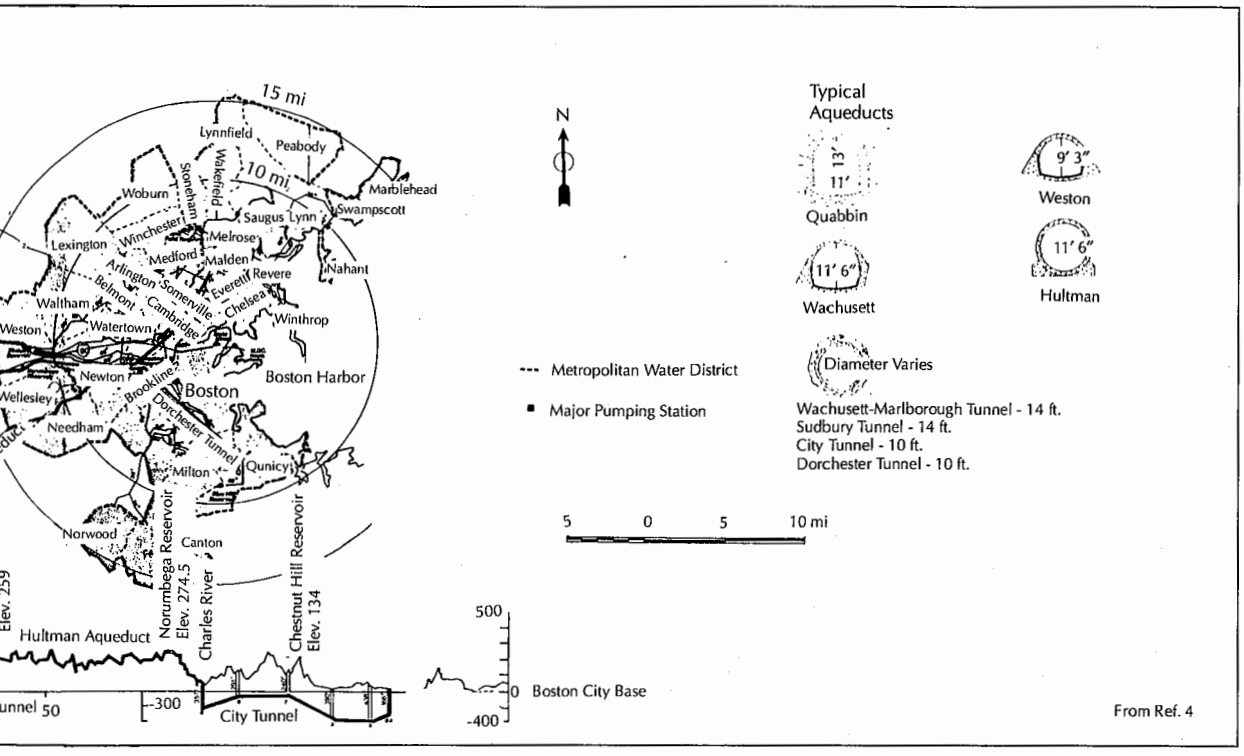
FIGURE 1. Map of eastern Massachusetts showing the aqueduct tunnels and the reservoirs of the Metropolitan District Commission water system.

piston and flap-valve have been found in the deep wells. Thin lift-rods were attached to the valved piston and activated by a pump handle at the surface. Log pipes were used for water until the mid-19th century.

A privately owned water company was organized in Boston in 1795 that brought water downslope from Jamaica Pond through a 64-km (40-mi) long distribution system of hollow pipes. However, wells continued to be used on the higher elevations such as Beacon Hill because of a lack of pressure. In 1848, the city initiated a new public water supply system from Lake Cochituate, about 24 km (15 mi) west of the city. A reservoir was built on top of Beacon Hill and water was pumped up to it, to flow from there by gravity to all parts of Beacon Hill. Water was also brought in from the Sudbury River, about 40 km (25 mi) west of Boston.

In the 1890s, it was realized that the water supply problem could only be solved on a metropolitan basis. The Metropolitan Water District (MWD) was created in 1895 and work began on a major expansion: the building of the Wachusett Reservoir 64 km (40 mi) west of Boston and an aqueduct to connect the new reservoir to Boston (see Figure 1). The water quality of the Wachusett Reservoir is now endangered because the Metropolitan District Commission (MDC), which now manages the reservoir, owns only eight percent of the watershed. Development is taking place in the watershed at a rate unequaled in any other part of the state. Algal growth in the reservoir recently has given Boston's system an odor.

In 1926, the demand for more water led to a 20-year program for the construction of the Quabbin Reservoir 104 km (65 mi) west of Boston in a valley in central Massachusetts that was occupied by six towns. The water supply for the reservoir was provided by impounding the water of the Swift River, a tributary of the Connecticut River. The impounding of the river was accomplished by the construction of an earth dam referred to as the Winsor Dam and Goodnough Dike. In 1946, when the reservoir was constructed and filled, it had a capacity of 412 billion gallons, and covered a surface area



of 10,000 hectares (39 square miles). Today, it provides water for 44 cities and towns, 34 of which are located within the metropolitan area.

The water is transported to the metropolitan area by a series of aqueducts and tunnels. The tunnels and aqueducts are 3.7 to 4.3 m (12 to 14 ft) in diameter, and local distribution tunnels within Boston are 3 m (10 ft) in diameter (see Figure 1).

Historically, the water quality at the Quabbin Reservoir has been excellent and contains none of the road salt or organic chemicals that plague other water supplies within the state. The reason for the excellent quality is due to the remote location of the reservoir and the superior management of the watershed that feeds the reservoir.

However, recently trace metals such as mercury have been found in the waters of the Quabbin and the Wachusett Reservoirs. The metals are concentrating in fish and has resulted in at least a temporary ban on fishing and consumption of the fish. It is not known whether the metals are originating from materials in the towns inundated by the dammed Swift River or from airborne pollution. The only other water quality problems that have occurred have been related to local distribution systems. Elevated levels of lead occur in Boston and Cambridge where much of the old distribution system consists of lead pipes. Tetrachlorethylene has been detected in some of the most recently installed dead-end sections of the distribution system where pipes with a plastic coating to reduce corrosion were used. Current water treatments include chlorination, ammoniation and fluoridation.

Wastewater Management

Wastewater management in the greater Boston area is not unlike that of other communities of similar age. In concert with the development of the city and its environs, which was complicated by the filling of the mudflats and other tidal areas, a sanitary sewer system evolved. The tidal flats of the Charles River in the Back Bay became so polluted and offensive to the City Fathers that the area was filled in during the latter half of the 19th century. The need for a sewer system to serve the entire area was emphasized in a mid-19th century report from the Consulting Physicians of the City of Boston, which recommended a plan that would "carry the sewerage out so far at sea that point of

discharge will be remote from dwellings, and beyond the possibility of doing harm to the citizenry."

A plan developed in 1875 called for two main drainage systems: one to serve the area north of the Charles River, and one to serve the area south of it. Both systems were to discharge untreated sewage into the ocean on the outgoing tide. The southerly system, termed the Boston Main Drainage System, was constructed first and was placed into operation in 1885, discharging into Boston Harbor at Moon Island. The North Metropolitan Sewer District was created to serve the northern area and was placed into operation in 1895, and it discharged into Broad Sound from Deer Island near the town of Winthrop. In the same year, both districts were united under one administration, called the Metropolitan Sewer District (MSD), which served 18 cities and towns.

By 1904 the MSD had expanded and constructed another flow release point at Nut Island. The Nut Island plant was to serve the additional southern and western towns that were accepted into the system. In 1907, new regulations were formulated that prohibited the combined sewer construction. In 1910, a new treatment plant was constructed at Deer Island for better waste dispersion. In 1919, the Metropolitan District Commission (MDC) was established. It was replaced by the Massachusetts Water Resources Authority (MWRA) in 1986.

Over the years, the MDC upgraded the disposal plants: Nut Island in 1949, Deer Island in 1952, and remote headworks for Deer Island in 1968. The Moon Island plant was phased out with the operation of the new remote headworks. In conjunction with the upgrading of the various treatment plants, new collection, routing and outfalls were constructed (see "Tunnelling Projects in the Boston Area" on pages 100-117 for a summary of the deep tunnels constructed for the MDC). Today, the MWRA is studying and implementing various systems for the upgrading of the treatment and disposal system for compliance with new environmental requirements for tertiary treatment (see "Boston Harbor Cleanup: Use or Abuse of Regulatory Authority?" on pages 25-32 for a critique of the proposed cleanup plan.)

Boston remains the only major city in the United States to still dump raw sewage. This sewage is dumped mainly into Boston Harbor. The treatment plants do not meet Clean Water Act standards since they are antiquated and stressed beyond their capacity. The city also mixes storm water and sewage that is discharged at high tide at many outfalls along the waterfront.

The U.S. Environmental Protection Agency (EPA) has cited the city and the Commonwealth of Massachusetts for non-compliance with federal regulations and the MWRA was formed in 1986 to clean up the harbor in response to a Federal Court Order. The EPA now has approved a plan by the MWRA to pump sewage treated at a new Deer Island Plant into Boston Harbor about 13 km (8 mi) east of the island, maximizing the dispersion of the effluent and minimizing potential adverse water quality and shoreline impacts.

The EPA has approved locations proposed by the MWRA for tunnels to bring sewage from Nut Island to Deer Island and to transport effluent from the Deer Island plant to the outfall pipe in the harbor beyond the Graves, the outermost island in Boston Harbor. The proposed tunnel would be the longest of its kind in the world, about 13 to 16 km (8 to 10 mi) long and 7.6 m (25 ft) in diameter. The invert would be in the bedrock about 30 m (100 ft) below the ocean floor.

The tunnel is expected to discharge 500 million gallons of treated effluent daily and to be operational by 1995. The existing Deer and Nut Island treatment plants currently discharge 450 million gallons of inadequately treated wastewater and 70 tons of dry sludge into the harbor every day. Projected costs for the ocean outfall range from $389 to $468 million.

The MWRA today serves 104,000 hectares (400 square miles) and 43 member communities that make up the Metropolitan Sewer District. The system's 2.1 million inhabitants generate 400 million gallons a day of flow. The MWRA operates 8,900 km (5,578 mi) of interceptors, which provide routing to the Deer Island and Nut Island treatment plants.

Solid Waste Disposal

Throughout its long history, Boston has been

faced with the problem of waste disposal that dates back to colonial times. Solid waste had been dumped in the marshes and tidal flats around Boston. Causeway Street near North Station is built over a fill of street sweepings. Old dumps exist throughout Boston, some of which are still generating methane gas and burning underground. The University of Massachusetts at Boston was built on the old Columbia Point dump with a foundation that was designed to allow for the venting of gas.

During the 20th century up to the enactment of the Clean Air Act, Boston either trucked its wastes for incineration to the dumps situated on the tidal marshes in Lynn and Saugus, north of the city, or to the city incinerator located off Massachusetts Avenue. Boston now trucks its waste, using private contractors, to eleven landfills and transfer stations located in the surrounding suburbs. The city also ships garbage to Spectacle Island in Boston Harbor where it is open-burned since the city chose not to upgrade its incinerator to comply with the Clean Air Act because of costs. A resource (RESCO) recovery plant in Saugus accepts some of the Boston waste, burning it to generate steam for the General Electric Company.

With many landfills closing because of the new environmental laws, Boston is currently reviewing options to dispose of its solid waste. These options include the construction of a resource recovery plant at a site acceptable to the citizens of Boston, a difficult task to say the least.

Wetlands & Shore Protection

Boston has not had to take any extraordinary measures for shore protection since its geologic setting affords natural protection. Historically, high tides from hurricanes and blizzards have been the only concern other than some flooding and wind damage.

However, the coastal areas north and south of Boston have suffered severe damage from hurricanes and blizzards. The famous blizzard of February 1978 caused considerable erosion and flooding of these shoreline areas. The estimated one-hundred-year storm flood elevations were greatly exceeded. Huge amounts of sand from Plum Island, north of Boston in Newburyport, and from beaches to the south, including Cape Cod, have been removed and re-deposited. The normal rate of erosion on many parts of Cape Cod and nearby islands is about 1 m (3 ft) per year. The erosion rate along the Boston Harbor islands is also high.

New Coastal Wetlands Regulations, General Laws Chapter 30, Section 37, which supplemented the Massachusetts Wetlands Protection Act, Chapter 131, Section 40 and the Coastal Zone Management (CZM) Program now prevent, without special permit, any construction activities on shore and beach areas. Extensive tidal marshes still exist along the Neponset River in Dorchester, a section of Boston bordering Quincy to the south, and in East Boston.

The densely urbanized area of the lower Charles River has been exposed to the threat of serious flood damage in the past. Boston and its neighboring cities such as Cambridge previously experienced intensive flooding in severe storms. The Charles River dam was completed in 1910 by the Commonwealth of Massachusetts to prevent tidal flooding along the lower reach of the river and to create a recreational pool covering unsightly and malodorous tidal flats.[2] The pool, also called the Charles River Basin, was modeled on the Alster River Basin of Hamburg, Germany, and it soon became a major recreational and aesthetic feature of Boston. With the growth of the city, the dam became unsuited to the needs of the community. Its sluice gates were no longer adequate to handle floodwater coursing into the basin and its single navigation lock could not accommodate recreational river traffic growing in volume every year.[3] A new Charles River dam was authorized by Congress in 1968 and construction began in February 1973. The dam was completed in 1978. It cost $59 million and is the single largest flood control project in New England. The project won a Presidential design award.

Hazardous Waste

Outside of the hilly areas of the original Boston Peninsula, much of the city was built on reclaimed tidal marsh. These low areas were filled with granular material from sources in and around Boston until the 19th century. With the advent of the industrial revolution, waste

in the form of ash and cinders was used as a fill. Therefore, these materials will be encountered in many excavations in the filled areas of Boston so that it might seem to be *ubiquitous*. Such fill would likely be classified as hazardous waste under our current environmental laws.

Old dumps exist in every section of Boston, some of which have been reclaimed such as the Columbia Point dump, the current site of the John F. Kennedy Library and the Boston campus of the University of Massachusetts. No old dump or landfill in Boston has yet to be classified as a Superfund site.

Boston is now the home of high-tech rather than the smokestack industries that are common elsewhere in the northeast. Only small hazardous waste generators, for the most part, now operate outside the downtown area. Hazardous waste generators are regulated by the Department of Environmental Quality Engineering (DEQE), 310 CMR 30.0, Hazardous Waste Regulations promulgated under Massachusetts General Laws 21C. Some hazardous waste disposal sites are identified on what is called the *Hazardous Waste Site List A,B,C* published quarterly in compliance with Massachusetts General Laws Chapter 21E, Section 3A(b) as amended by Chapter 554, Acts of 1986. They are identified as requiring cleanup or no action.

Under Chapter 21E, a superlien (one that supersedes all others) may be placed on property that is found to contain hazardous waste. The lien allows the state to recover the costs of state-implemented assessments of cleanups. In order to avoid this liability, properties in Massachusetts that are being sold are subjected to a 21E site assessment required by title insurance companies.

The DEQE has not promulgated any regulations describing the criteria for a 21E site assessment. If hazardous waste is found, each site is evaluated on a case-by-case basis.

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