Potential Freshwater Reservoir in the New York Area

Abstract. *Estimates of the water budget of Long Island Sound suggest that it could become the largest reservoir in the United States, with a freshwater surplus equal to 12 times the present needs of New York City. The engineering aspects of this undertaking are within the scope of present technology. The dam structures required to isolate this area from the sea could serve as important highway links in place of highway-bridge projects presently under study.*

A serious water shortage in parts of the United States and the prospect of enlarged future water needs have prompted publication of a recent report calling for increased water resources research, including "research on far-out ideas" (*1*). With this incentive the physical oceanographer is drawn to examine the potential for freshwater capture and storage in coastal regions.

Calculations from river runoff values for the eastern coast of the United States (*2*) reveal that water from this source, if enclosed at the 100-fathom (182.9-m) depth contour, would raise the level of water on the continental shelf area by about 76 cm per year. To utilize some of this surplus it is of interest to examine those coastal areas where natural and engineering factors are favorable for the creation of freshwater reservoirs.

One such area is Long Island Sound, a 160-km-long arm of the sea, lying between Long Island, New York, and the mainland coast of New York, Connecticut, and Rhode Island. Although connected to the Atlantic Ocean through Block Island Sound, the salinity of central Long Island Sound remains low, between 24 and 29 per mille, varying with the seasonal fluctuations of river discharge (*3*). This discharge into Long Island Sound is dominated by the outflow from the Connecticut (*4*) and Housatonic (*5*) rivers, which together average 614 m^3 (21,700 ft^3) per second. Additional contributions from ungaged streams and ground-water discharge are roughly estimated at 42.4 m^3 (1500 ft^3) per second. The excess of precipitation (*6*) over evaporation (*7*) on the 2585-km^2 area of Long Island Sound accounts for another 16.4 m^3 (583 ft^3) per second. All of these contributions (Table 1) produce a total freshwater input of 673 m^3 (23,783 ft^3) per second, or 21 billion m^3 (750 billion ft^3) per year. The total freshwater input derived from these measurements and estimates amounts to 40 percent of the volume of Long Island Sound in 1 year.

The water budget indicates that Long Island Sound, if isolated from the sea, could become a freshwater lake. Once established, this reservoir could supply water to the surrounding area at a rate of 58 million m^3 (2 billion ft^3) per day.

What is the likelihood that such a project could be carried out? Recent reports (*8, 9*) to the New York State Department of Public Works have discussed construction of highway-bridges across Long Island Sound to link the New York and New England express-highway systems. The location of the most feasible of the proposed crossings at the eastern end of Long Island Sound is shown in Fig. 1. Maximum water depths along this transect reach 43 m, while the average depth is 18 m. If this important highway link were shifted a few miles farther east (east of the mouth of the Connecticut River) and constructed instead as part of a dam, the major job of enclosing Long Island Sound would be accomplished. Construction of a shorter bridge-dam to complete the enclosure at the western end would be a relatively minor undertaking and would provide a needed traffic crossing.

The time required after enclosure for the reservoir salinity to reach 415 parts per million, the accepted level for potability, would depend greatly upon the hydraulic works and practices employed. One estimate, based on input values (Table 1), and assuming rapid fresh water–salt water mixing, suggests 7.5 years. However, strong salinity-density stratification, if present, would inhibit mixing and extend this period.

The magnitude of the proposed construction compares favorably with other large-scale hydraulic projects. The major dam would be about 12.8 km long, twice the length of Fort Peck Dam on the Missouri River (presently the longest in the United States), but shorter than two Russian dams, Dneprodzerzhinsk (36.2 km) and Kiev (40.8 km), under construction on the Dnieper River. Mention of these large earth-fill dams is for scale comparison only and does not necessarily imply similar construction; conceivably, a structure on the principle of an impermeable membrane that would separate the fresh- and salt-water bodies could be constructed.

The resulting reservoir would be the largest in the United States (tenth largest in the world) with a capacity of 51 billion m^3 (41.8 million acre-feet). Lake Mead on the Colorado River is presently the nation's largest man-made lake, having a capacity of 40 billion m^3 (29.8 million acre-feet) (*10*).

Perhaps the most meaningful comparison of structures can be made with projects in the Netherlands. The enclosure in 1932 of the Zuider Zee

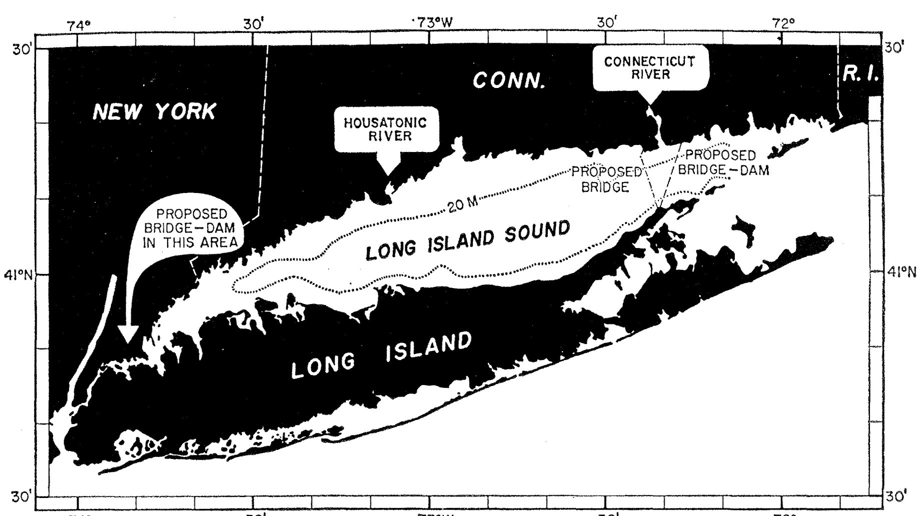

Fig. 1. Features of proposed Long Island Sound Reservoir. The general location of the proposed bridge-dam at the eastern end of Long Island Sound is indicated. The position of the bridge-dam at the shallow western end is not specified; its location would be based primarily upon engineering and highway traffic considerations. The 20-m depth contour is shown by the dotted line.

Table 1. Principal freshwater sources of Long Island Sound.

Source	Equivalent discharge rate	
	(m^3/sec)	(ft^3/sec)
Connecticut River (*4*)	523.5	18,500
Housatonic River (*5*)	90.5	3,200
Ungaged streams and ground water discharge	42.4	1,500
Excess of precipitation (*6*) over evaporation (*7*) on Long Island Sound	16.4	583
Total	673*	23,783*

* The total annual discharge is 21 billion m^3 (750 billion ft^3).

was made possible by construction of the Afsluitdijk, a dam which also serves as an important highway connection and is twice the length of the proposed dam. One of the most challenging hydraulic engineering schemes ever attempted is presently being undertaken in the southwestern delta region of the Netherlands. This project, known as the Delta Plan, will construct more than 20 km of dams across the mouths of the major Zeeland estuaries (Haringvleit, Krammer, Ooster Scheldt), with the exception of the Wester Scheldt. Its purpose is to impound the waters of the Rhine, Maas, and Scheldt in order to reverse the salt intrusion into agricultural land and to shorten and strengthen coastline defenses against damaging North Sea storms (*11*). The storm and sea conditions in the Long Island area are far less severe than in the North Sea. Analysis of sea conditions in eastern Long Island Sound led to design criteria for the proposed highway bridge, based upon wave heights of 6 to 7 m (*8*, p. 8).

The construction of dams, as proposed here, would require sea-level locks to provide access for shipping. Shipping tonnage at Long Island Sound ports amounted to 22 million tons in 1964, consisting largely of shallow-draft barges (*12*). Such traffic presents no problem to a modern lock system; for example, the Port of Amsterdam, isolated by locks from the sea, annually handles 14.5 million tons of ocean freight (*13*).

One of the major problems in the proposed scheme is the control of pollution in this heavily populated and industralized area. For purposes of the present report, it is assumed that control can be achieved through federal, state, and local efforts over the next decade and that maintaining potable water in the proposed reservoir is a realistic goal.

It is of interest to consider the impact of such a reservoir on the surrounding area and some of the economies likely to be derived:

1) A unique situation is presented in having the largest reservoir in the nation located partly within its largest metropolitan center.

2) Water available for use (the excess of average stream and groundwater discharge plus precipitation on Long Island Sound less computed evaporation) would be equal to twelve times the normal daily New York City requirements of 4.7 million m^3 (1.25 billion gallons).

3) The average daily discharge from minor sources (ungaged streams, ground water, and precipitation over evaporation), equal to 5 million m^3 (1.3 billion gallons), would be greater than the New York metropolitan need.

4) The proposed reservoir volume of 51 billion m^3 (41.8 million acre-feet) is three orders of magnitude larger than the present New York City storage system.

5) Populated areas of southern Long Island, dependent on well water, find that the water table has dropped 6 m in 50 years, and salt-water encroachment has become serious (*14*). These communities could be supplied and the aquifers recharged from the proposed reservoir.

6) Water now brought to New York through deep rock tunnels from as far as 200 km away could be diverted (and sold) to other areas.

7) An authority set up to run the project could do the most efficient job of pollution control throughout the whole drainage area.

8) Highway tolls across the two dams would produce a gross revenue estimated at $40 million per year (*9*, p. 11).

9) New York City might save an estimated $50 to $100 million by avoiding installation of water meters, suggested during the present water shortage.

10) The reservoir could be created without the loss of a single acre of land.

11) Benefits to yachtsmen would be numerous, including reduction of corrosion, perpetual "high tide," and the absence of tidal currents.

12) Although present fishing and shellfish industries would be discontinued, the prospects of commercial and sport fishing activity, free from pollution, is an attractive alternative.

It is, however, toward the provision of an essential water supply for large numbers of people that this scheme recommends itself, rather than for the lesser economies involved.

This proposal for the Long Island Sound area is presented as an example of the coastal reservoir concept. There are no doubt many estuaries and other water bodies where these hydrologic and oceanographic principles can be applied to control and use large parts of the normal runoff.

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References and Notes

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15. Supported by AEC contract AT(30-1)2663. I thank Dr. Arnold Gordon of Lamont Geological Observatory for making available his adjusted runoff data for the U.S. East Coast, Lamont Geological Observatory Contribution No. 940.

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