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Progress report on studies of
salt-water encroachment in Long Island, New York, 1953

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Prepared in cooperation
with the
Nassau County Department of Public Works
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Suffolk County Board of Supervisors
and the
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PROGRESS REPORT ON STUDIES OF
SALT-WATER ENCROACHMENT ON LONG ISLAND, NEW YORK, 1953

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INTRODUCTION

Nearly all the water used on Long Island, N. Y., is derived by wells from the thick and extensive water-bearing formations that underlie and compose the entire island. The unconsolidated deposits, consisting of sand, gravel, and clay, range in thickness from a few feet in northern Queens County to more than 2,000 feet in southern Suffolk County. Four main and relatively distinct aquifers, all interconnected hydraulically to a greater or lesser degree, have been recognized and delineated at least in a general way. They are, from younger to older, the upper Pleistocene deposits, in which the ground water is mainly unconfined, and three formations in which the water is generally confined - the Jamaica gravel, of Pleistocene age, and the Magothy (?) formation and the Lloyd sand member of the Varitan formation, both of Late Cretaceous age. Except for some artificial recharge, these aquifers are replenished entirely by infiltration of precipitation. Under natural conditions, the fresh water moves into and through the formations, discharging into the sea.

With the growth of population on Long Island and the continuously increasing use of water over the years, not only has the infiltration of precipitation been seriously impeded at places, but the withdrawals from the ground-water reservoir have increased markedly. These factors have upset the natural balance between the fresh surface and ground water of the island and the surrounding sea water, and with increased use of water will do so more and more, thus leading to salt-water encroachment. In a sense, the whole problem of utilization of ground water on Long Island is one of determining how much ground water can be withdrawn without serious salt-water encroachment.

THE CURRENT SITUATION

The accompanying map (fig. 1) portrays the current situation with respect to salt-water encroachment on Long Island. In Kings County (Brooklyn), overpumping for years lowered water levels throughout the borough and salt water was drawn in. In 1947 the total withdrawals were reduced by about half and during the next 6 years water levels recovered as much as 25 feet. The ground water is still saline, but the rate of increase of salinity seems to have slowed down. In northern Queens and Nassau Counties, salt-water encroachment apparently has taken place locally and constitutes a continuing danger along the shore, principally in the Lloyd sand member which there is thin and open to the sea. In southern Queens and Nassau Counties, withdrawals chiefly for public supply have increased and, although saline water has been detected locally, the demand for water is high and is increasing and the threat of salt-water encroachment is real. In addition to the steady and increasing demand, the withdrawals of water near the south shore are or may be intensified occasionally by heavy pumping to supplement water supplies from upstate reservoirs. In the extreme southwestern portion of Suffolk County the conditions are similar to those in southern Nassau County, but in nearly all of Suffolk, as well as in the northeastern part of Nassau County, the rate of increase in pumpage is only moderate and the possibility of salt-water encroachment is relatively remote under present conditions. Seasonal pumpage for supplemental irrigation has been increasing steadily in the agricultural areas of Suffolk County, principally in the North Fork. Some increase in chloride concentrations has been noted in water from wells in low-lying areas adjacent to salt-water marshes; and seasonal encroachment has been detected near the eastern tip of the North Fork.

THE INVESTIGATIVE PROGRAM

The study of salt-water encroachment involves much more than the simple application of the Ghyben-Hersberg principle (Brown). The problem has been considered in connection with the investigation of ground-water resources on Long Island that has been under way for the past 21 years. These investigations are made in cooperation with the Nassau County Department of Public Works, Suffolk County Board of Supervisors, Suffolk County Water Authority, and the New York State Water Power and Control Commission. The collection and analysis of data on chemical quality of water constitute one of the basic elements of these studies, but the realization has grown that an adequate study of the problem involves many elements - geologic, hydrologic, and geochemical. The geologic details of the formations in which the water occurs and through which it moves must be known. Factors that influence the hydrodynamic balance between fresh ground water and sea water must be determined. This determination involves not only the permeability of the containing formations, but also the changes in the equipotential and flow-line patterns brought about by variations in pumping and recharged. In addition not only the salinity, but also changes in the temperature and the chemical composition of the saline water as it moves landward, which affect its density, must be measured. Thus, in some degree all the data gathered in connection with the Long Island investigation bear on the problem. At the end of this paper is given a list of some of the specific pertinent projects and reports that have been completed or of others that are expected to be completed soon.

Two projects are directly related to salt-water encroachment and are of particular interest. One of these is the collection of data on chloride concentrations in well waters; the other is the exploration of subsurface conditions through test and observation wells drilled for the purpose.

The following table shows the current program of chloride sampling being conducted on Long Island:

Program statistics for well-sampling program in Long Island, N. Y. a/

County	Frequency of sampling	Chloride content and temperature				Partial analyses				Total
		Aquifer <u>b/</u>				Aquifer <u>b/</u>				
		UP	J	M	L	UP	J	M	L	
Kings	Bi-monthly	9								9
	Quarterly	14			1					15
	Semi-annually									0
	Annually	127	5					1		133
	Summers only	12								12
Queens	Bi-monthly									0
	Quarterly									0
	Semi-annually									0
	Annually	91						10		101
Nassau	Monthly		d/4	d/8						12
	Quarterly	25								25
	Semi-annually			13	10			d/8		223
	Annually							40		48
Suffolk	Bi-monthly									0
	Quarterly									0
	Semi-annually									0
	Annually	e/50							2	52
		328	9	21	11	0	0	8	53	430

a/ Conducted by the U. S. Geological Survey in cooperation with State and county agencies. Additional data collected by private water companies, water districts, municipalities, and well drillers also available.

b/ UP, upper Pleistocene deposits; J, Jameco gravel; M sands of the Magothy (?) formation; L, Lloyd sand member of the Raritan formation.

c/ Program reduced from 200 wells to about 50 wells in 1949.

d/ Outpost wells in southwestern and southcentral Nassau County.

For many years, and at a greater rate recently, withdrawals principally for public supply have been increasing in the artesian formations in southeastern Queens and southwestern Nassau Counties. Over and above this, heavy withdrawals are made in these areas and elsewhere by New York City from time to time when the surface-water sources of Upstate New York are insufficient to meet the demand, such as during the water shortage in 1949 and 1950.

Meanwhile, the replenishment from precipitation to the water-bearing formations is being reduced as a result of works of man accompanying population and industrial growth, although the construction of storm-water recharge basins in the central portion of Nassau County counteracts this reduction to some extent. Thus the opportunity for salt-water encroachment is being improved.

In recognition of this danger, a series of so-called outpost wells is being constructed at strategic locations in southwestern and south-central Nassau County. These wells are located between the ocean and public-supply wells, so that water-level and salinity trends can be ascertained in advance and, if necessary, remedial measures can be taken to prevent further encroachment. Ten wells were constructed in 1952 and three more were contracted for in 1953. In all, eight outpost wells are screened in the sands of the Hagothy (?) formation at depths from 300 to 600 feet below sea level, and five (including one supply well) in the overlying Jameco gravel at depths about 200 feet below sea level. One more well is to be constructed in the Lloyd sand member in northwestern Nassau County. Funds for this project were provided by the Geological Survey and two cooperating agencies, the Nassau County Department of Public Works and the New York State Water Power and Control Commission. The deeper wells are being drilled under Federal contract by a private driller; the shallower wells were constructed by the Nassau County Department of Public Works.

Because of this special well-drilling project, many useful hydrologic, geochemical, geologic, and other data are being obtained which when combined and evaluated, together with similar information already available for the area, will help define somewhat better the potentiality and extent of salt-water encroachment. Preliminary information reveals that the greatest threat of salt-water encroachment is in the Magothy (?) formation in southwestern Nassau County. Water levels in the area under investigation are at stages less than 5 feet above mean sea level.

Thorough review, analysis, and appraisal of the various data collected thus far and to be collected in the future are contemplated and will be included in a comprehensive report scheduled for completion in 1954. Drilling of other outpost wells on Long Island will depend on the conclusions and basic principles reached in preparation of that report.

**Progress as of 1953 on reports that include salinity data
and discussions of salt-water encroachment**

1. The recovery of ground-water levels in Brooklyn, N. Y., from June 1947 to 1950. Released as a U. S. Geol. Survey circular in 1953.
2. The recovery of ground-water levels in Brooklyn, N. Y., from 1947 to 1953. To be completed in 1954.
3. Ground water from the Lloyd sand member of the Raritan formation on Long Island, N. Y. Data and illustrations released; final report to be completed in 1954.
4. Detailed progress report on outpost well program in southern Nassau County. To be completed in 1954.
5. Safe withdrawal of ground water in Southold Township, Suffolk County, N. Y. Preliminary draft completed and being revised.
6. Compilation and evaluation of all chemical data particularly chloride content collected since start of investigative program in Long Island in 1932. To be completed in 1955 or 1956.

REFERENCE CITED

Brown, John S., 1925, A study of coastal ground water, with special reference to Connecticut: U. S. Geol. Survey Water-Supply Paper 537.

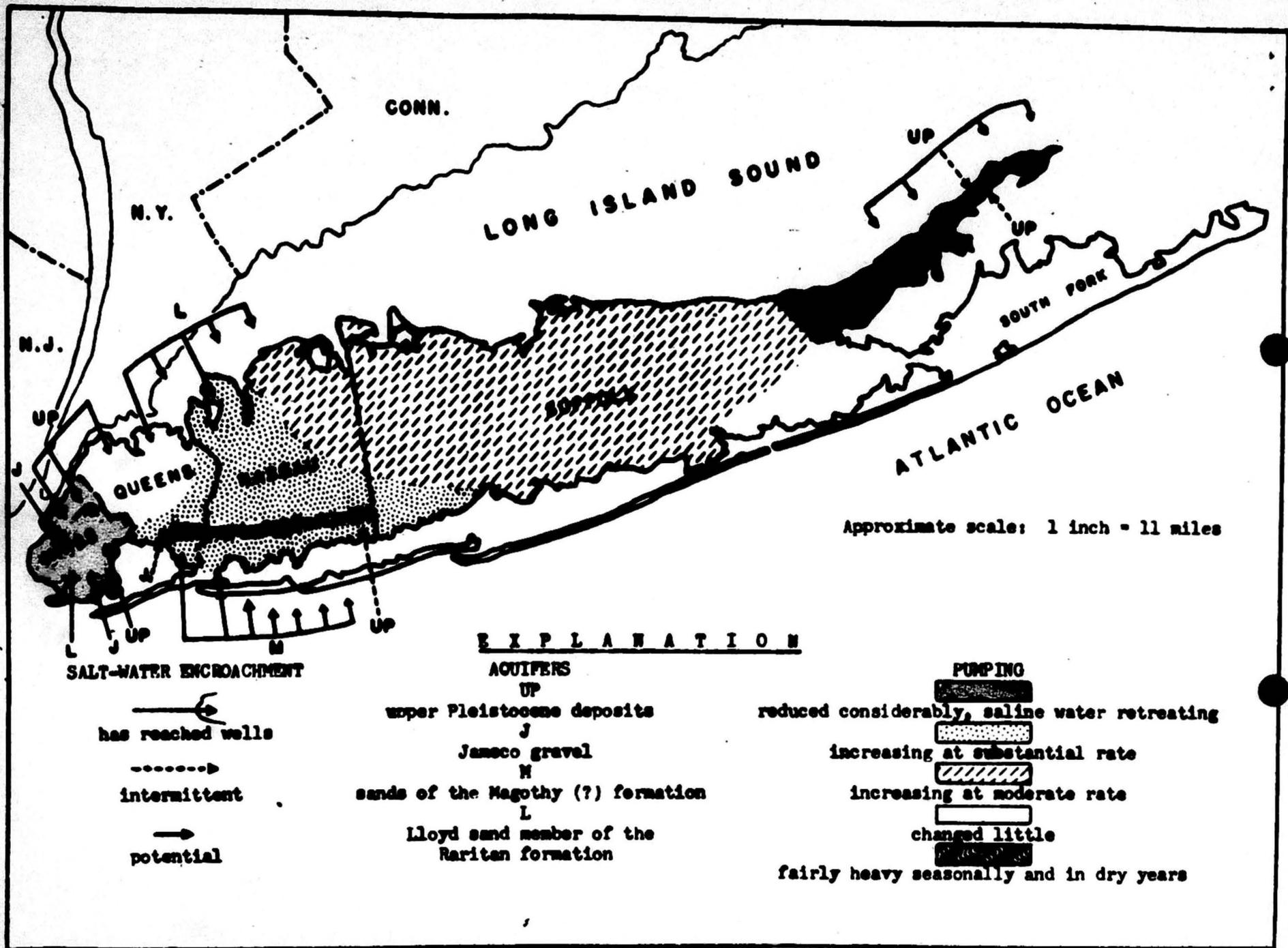


Figure 1.- Salt-water encroachment in Long Island, N. Y.