



UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

MEMORANUM CONCERNING HYDROLOGIC STUDIES
NEEDED IN THE VIRGIN ISLANDS
WITH AN ADDENDUM ON PUERTO RICO

By C. L. McGuinness

April 26, 1951

Introduction

Water is scarce and expensive to develop in the Virgin Islands, particularly on the two smaller islands, St. Thomas and St. John. Therefore, it is necessary to make the best use of the water that is available. To do so requires hydrologic research that is more comprehensive and costly than would be justified for areas of comparable size, population, and water requirements in the continental United States.

Under natural conditions there are no large supplies of ground or surface water on St. Thomas and St. John. For uses requiring large amounts of water, therefore, rainfall catchment has proved to be the principal method of development so far. Small supplies of water are available from wells and from a few springs in favorable areas, but except in wet years--when the need is the least--these are adequate only for modest domestic use. Consideration was given to impounding the flow of Turpentine Run, which has the largest drainage area on St. Thomas, for Charlotte Amalie. However, the consulting firm that made the study, that of Malcolm Pirnie, concluded that, in the driest years, the minimum supply obtainable by impounding would be smaller than that obtainable from rainfall catchments at a given total cost.

Virgin Island and Puerto Rico - 2.

St. Croix is a larger island having larger drainage areas, and larger and more productive water-bearing formations, than have St. Thomas and St. John. There is, therefore, a moderate supply of ground water in certain areas under natural conditions, even in dry years. These supplies have been developed in three areas to meet the needs, respectively, of Christiansted, Frederiksted, and the Virgin Islands Company and the airport. Those three areas probably are the best ground-water areas on the island. The dependable water supplies of the areas developed at present for Christiansted and Frederiksted probably are no larger than necessary to meet the future demands of those towns and may prove to be inadequate even for that. The valley near the airport appears to have a supply somewhat larger than now needed for the Virgin Islands Company and the airport. The excess constitutes a reserve, the amount and future use of which remain to be determined. If water supplies are developed for other than public uses in the three areas, the amounts must be deducted from the total quantities available.

There are a few other areas on St. Croix that appear to have some promise and should be investigated.

Previous Studies

Considerable information on water in the Virgin Islands has been gathered in recent years. The coverage, however, is spotty, and unfortunately much of the latest information has not been published. The studies and resulting data can be summarized briefly.

Geologic studies in the Virgin Islands go back into the 1800's, but systematic studies were first begun about the time of the first World War, as a "Scientific Survey of Porto Rico and the Virgin Islands" sponsored by the New York Academy of Sciences. The program was not carried through to completion, and though a considerable number of papers on physiography, paleontology, and other phases of geology were published there were no comprehensive reports or maps covering the geology.

The first completed reconnaissance of the geology and ground-water resources of one of the Virgin Islands was that of D. J. Cederstrom on St. Croix, the results of which have been published as Water-Supply Paper 1067 of the Geological Survey, "Geology and ground-water resources of St. Croix, Virgin Islands." The reconnaissance was made in the period December 1938 - April 1939 in connection with a program of test drilling, paid for by the Public Works Administration, to locate an adequate water supply for the Virgin Islands Company. The test drilling resulted in the location of the well near the airport (in what may be the best of the three productive ground-water areas mentioned previously) that now supplies the sugar mill at Bethlehem and the distillery near Christiansted.

In 1940 and 1941 the National Park Service and Civilian Conservation Corps drilled 29 test wells, several of which were productive, including three drilled for the airport near the successful well located by Cederstrom. The records of the 29 wells are incorporated in Water-Supply Paper 1067.

In January 1945 the firm of Malcolm Pirnie made its "Report on water supply and sanitary facilities for Charlotte Amalie, St. Thomas, Virgin Islands," to the Federal Works Agency. As stated previously, that report concluded that catchment areas were a more practical source of water for Charlotte Amalie than Turpentine Run would be.

In October 1945 the writer, at the request of and in cooperation with T. G. Mooney of the Federal Works Agency, made a reconnaissance of St. John. The purpose of the study was to determine where ground water might be available on that island, both to meet its own needs and perhaps to supply Charlotte Amalie if it should prove to be cheaper to pipe water across to St. Thomas than to develop it there. The reconnaissance, and wells dug later and tested in January 1946, showed the availability of small supplies in the valleys entering Reef Bay, at the south-central side of the island, and Coral Bay, at the east end, and still smaller supplies in numerous other areas. It was shown, however, that sufficient water would not be available for St. Thomas, and it was later concluded that even the small supply needed for the Cruz Bay area could be developed more practicably by means other than piping it all the way from the valley near Reef Bay.

A brief report by the writer, "Ground-water reconnaissance of St. John, Virgin Islands," was released in typewritten form in May 1946.

In 1947 the Geological Survey, again at the request of the Federal Works Agency, and in cooperation with the consulting firm of R. L. Kenan and Associates, made studies to determine the practicability of using the St. Thomas airport, which was to be resurfaced, as a catchment area, re-charging a part of the water into the ground for recovery during the dry season. It was desired to store for later recovery as much as 20 million gallons each wet season, so that as much as 200,000 gallons per day could be pumped during a 100-day dry season. The studies showed that 20 million gallons

probably could not be stored but that not less than 5 million, could be.

The present gallery system was installed on that basis, inasmuch as the cost of the gallery system was ly a fraction of that of a tank of comparable storage capacity. So far, however, the system has not been used as designed, for the only water that has been put into the ground through it was a small quantity recharged during the final stages of construction.

In 1948 and 1949 the Geological Survey located and supervised the drilling and testing of 19 test wells on St. Croix. Three of the successful wells were reconstructed for use for public supply for Christiansted and two of them for Frederiksted. The present demand is small and no difficulty has been encountered. However, as the demand rises it will be necessary to gather and to study critically data on rainfall, quantities pumped, ground-water levels, and mineral content of the water, to determine the amounts that can be pumped safely, especially in dry years.

The writer, because of the pressure of his regular work, has not been able to prepare reports on the recent work on St. Thomas and St. Croix. However, he is drafting a brief summary report in order to get the principal conclusions and recommendations of the Geological Survey on record.

Studies Needed

1. Additional reconnaissance work is needed on St. John and St. Thomas, comparable to that done on St. Croix by Cederstrom, to determine all the places where small supplies of ground water may be developed and to determine whether there are criteria, such as topography or rock type, that can be used to increase the chances for successful location of domestic wells. Several months of work by an experienced ground-water geologist would be required.

2. There is still considerable interest in Turpentine Run as a potential source of an impounded supply of surface water. The writer believes that the report of Malcolm Pirnie is conclusive in that regard. The small runoff in dry years, the high rate of evaporation to be expected (roughly 6 feet per year), and the high silt content of the water are factors unfavorable to the development of surface-water supplies anywhere in the Virgin Islands.

However, there is one possibility in the valley of Turpentine Run that may be worth considering. Successful wells were located for Frederiksted, St. Croix, in the consolidated bedrock that forms the basement of St. Croix and all of St. Thomas and St. John. The only drilled well on St. Thomas, on the slope behind Charlotte Amalie, was a failure; it obtained only a little water and that water was very salty. However, the experience at Frederiksted shows that where favorable rocks and a sizable drainage area coincide there may be some water. Several test wells in the Turpentine Run valley, therefore, may be justified, the locations to be selected by an experienced ground-water geologist.

That Turpentine Run has no flow in dry weather argues against the presence of any large amount of ground water in its valley. However, there may be considerable water that is used by vegetation when it reaches the

surface, and thus never appears as surface flow. Also, under conditions of development the lowering of the water table may create additional storage space in the rocks, and may lead both to a higher rate of recharge than under natural conditions and to the salvage of water now used by vegetations.

Nine test wells were required near Frederiksted to locate three successful wells. It should not be assumed, therefore, that one or two wells would be adequate to test the valley of Turpentine Run adequately.

3. Additional systematic ground-water studies and test drilling are needed on St. Croix to outline better the possibilities there. Studies are needed, as mentioned previously, to determine the safe yield of the three areas now developed for public water: that north of Frederiksted, the Salt River valley west of Christiansted, and the valley near the airport. Test drilling and pumping tests are needed in the several other areas that may have some promise for future development. The early stages of this work could be done by the same ground-water geologist who would be working on St. Thomas and St. John. Later, as test drilling and pumping got under way on St. Croix, additional geologists might be necessary, and one or more experienced ground-water engineers would be needed to supervise the pumping tests and to analyze the data mathematically in reaching quantitative conclusions concerning the safe yield of various areas.

The studies on St. Croix, the most comprehensive ones needed in the Virgin Islands, could and probably would require the services of several ground-water specialists for a period of several years.

4. Additional research, including the study of data obtained in research projects elsewhere, is needed to determine the best and cheapest methods for developing water where natural supplies of ground water prove to be unavailable. Research is needed on engineering methods of building catchment areas and storage reservoirs cheaply and on distillation

or other treatment of sea water. The so-called Telkas system of solar distillation was tried on St. John and has been unsuccessful so far, but study of methods (1) to improve, if possible, the insulation of the evaporation-trough bottoms, (2) to develop transparent cover material having greater heat transmissibility, to increase condensation, and (3) to increase heat absorption by the water, all have some promise.

- - - - -

Assuming the availability of funds and of experienced personnel, the part of the studies outlined above that could be undertaken in the 1952 fiscal year would include a part of the reconnaissance work on St. Thomas and St. John, a beginning on the test-drilling program on St. Thomas, and a beginning on the comprehensive studies and the test drilling on St. Croix. Personnel required would include an experienced ground-water geologist for the whole year, an experience ground-water engineer for the last half of the fiscal year, and one or more field assistants for the full year. The cost of the work in the 1952 fiscal year, including salaries, subsistence, transportation, and the drilling of five or six test wells, would be about \$30,000.

- - - - -

In conclusion: Water is scarce and expensive in the Virgin Islands, and the islands are poor. If the people are ever to attain a standard of living comparable to that in the continental United States, it must be through the tourist industry or others which require substantial supplies of water. The key to development of the islands, therefore, must be the intelligent and economical development of at least the minimum water supplies needed.

Addendum on Puerto Rico

Additional ground-water studies are needed also in Puerto Rico. The Geological Survey, the only agency that has made any systematic studies there, has done a total of less than 1 man-year of work. The principal project was a 6-month reconnaissance made by the writer at the request of the Puerto Rico Aqueduct and Sewer Authority in the latter part of 1945 and early part of 1946. Previously, in 1945, a 2-week study of the San Juan area was made by A. G. Unklesbay of the Geological Survey at the request of the Puerto Rico Industrial Development Company. Since the reconnaissance the writer has made five brief follow-up visits to Puerto Rico, each one lasting only about a week. Also, a geologist of the Engineering Geologic Branch assigned to work on engineering-geology problems for the Water Resources Authority, Aqueduct and Sewer Authority, Industrial Development Company, and Insular Department of the Interior has done several brief ground-water jobs for the Aqueduct and Sewer Authority.

Because of previous geologic studies, and of the excellent records kept by the largest well-drilling firm in Puerto Rico, the reconnaissance resulted in a more substantial report than otherwise would have been possible. Nevertheless, additional work is critically needed. Puerto Rico, with an area of less than 3,500 square miles, constitutes an important ground-water area. In only about a third of the States of the United States is the pumpage greater than it is in Puerto Rico. The pumpage there is roughly the same as that on Long Island, N.Y., one of the most productive and heavily pumped areas of the Nation. The amount of ground-water study in Puerto Rico, less than 1 man-year, contrasts strongly with that on Long Island, which has totaled perhaps considerably more than 100 man-years. More than four-fifths of the pumping in Puerto Rico is on the south coastal plain, an area of only a few hundred square miles. Depletion and salt-water encroachment have already occurred

locally, and with increasing development it is inevitable that serious trouble will develop unless a comprehensive ground-water study is made and the pumping is regulated in accordance with its findings.

For the 1952 fiscal year, a start on the additional studies needed in Puerto Rico should be made by assigning an experienced ground-water geologist, with necessary technical and clerical assistance. The cost of the work would be about \$15,000.