UNITED STATES

DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

WATER RESOURCES DIVISION

PRELIMINARY EVALUATION OF AVAILABILITY OF POTABLE WATER ON ELLIOTT KEY, DADE COUNTY, FLORIDA

by

H. Klein

OPEN-FILE REPORT
70010

Prepared by

U.S. GEOLOGICAL SURVEY
in cooperation with
U.S. NATIONAL PARK SERVICE

Tallahassee, Florida
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INTRODUCTION

The National Park Service is presently arranging for the purchase of Elliott Key and adjacent smaller keys in the upper Florida Keys, southeast of Miami (fig. 1), for the proposed Biscayne National

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Figure 1. Belongs near here. Caption on next page.

Monument. Facilities available to the general public will include swimming, boating, fishing, camping, hiking, and other recreational activities. A supply of fresh water will be required. This report describes the results of a reconnaissance on the availability of potable ground water in Elliott Key.

Elliott Key is a 7-mile long island east of Homestead. Its maximum width is about 2,500 feet near the north end and its average width is less than 2,000 feet. The higher elevations on the island range from 6 to 8 feet above sea level and occur generally along an unimproved road that runs longitudinally through the center of the island. The average elevation is about 3 feet above sea level and those areas which exceed 5 feet above sea level are shown in figure 1.

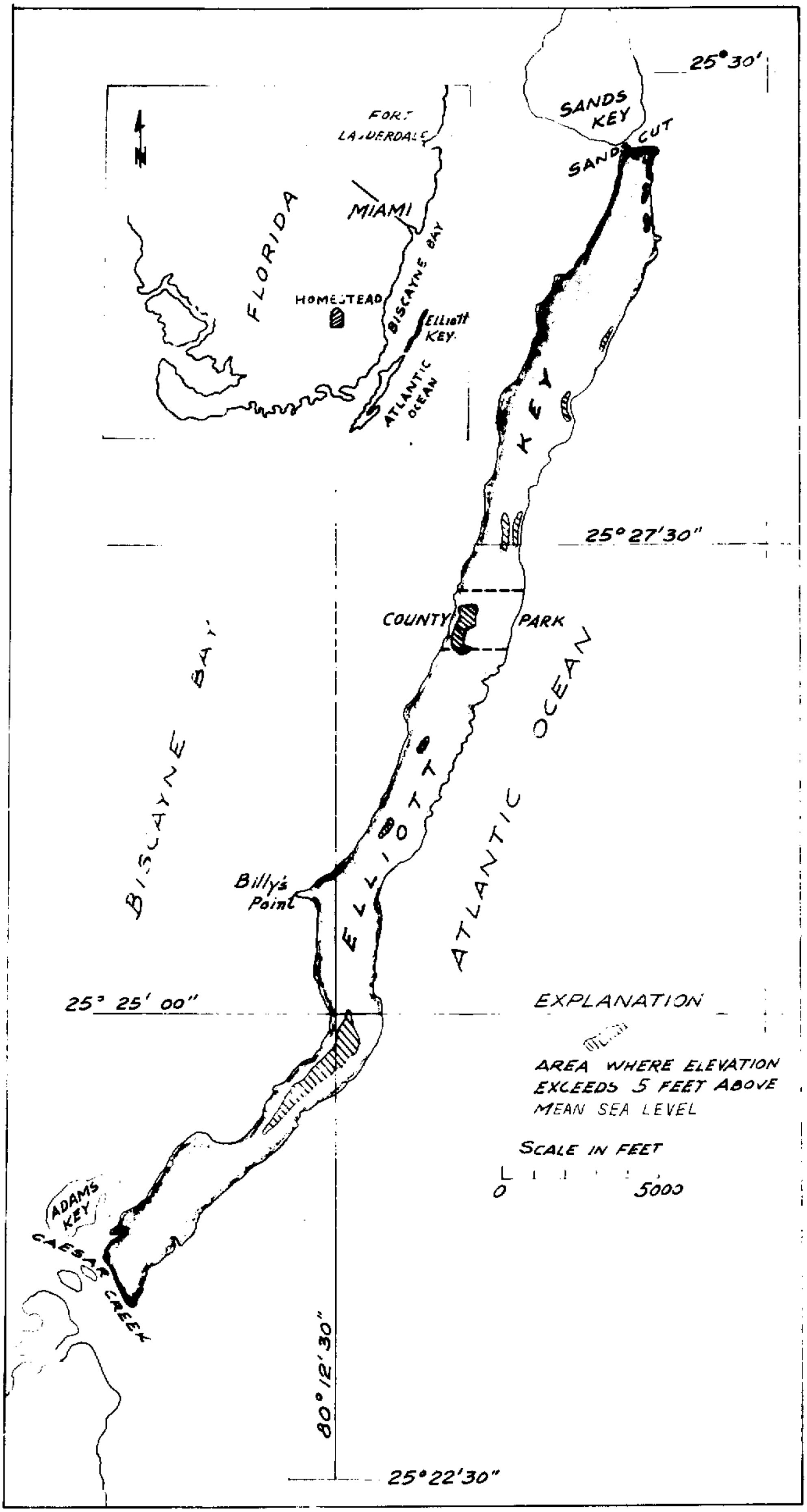

Figure 1.--Map showing the location and configuration of Elliott Key

Rainfall records for Elliott Key are not available but the distribution and amount of rainfall should be similar to those recorded on Miami Beach rather than those recorded on the mainland. A comparison of the average monthly rainfall for Miami Beach and Homestead (mainland) is shown in table 1. Nearly 20 inches more rainfall per year occurs on the mainland than offshore on Miami Beach. Sixty-three percent of the annual rainfall at Miami Beach occurs during June through October.

Table 1. Average monthly rainfall at Miami Beach and Homestead Experiment Station.

RAINFALL, IN INCHES

	Miami Beach 1/	Homestead Exp. Sta. 2/
Jan.	1.68	1.75
Feb.	1.65	1.71
Mar.	1.95	2.38
Apr.	2.92	3.69
May	4.54	6.46
June	5.63	9.77
July	4.45	8.81
Aug.	5.06	8.29
Sept.	7.36	10.61
Oct.	6.71	8.72
Nov.	2.53	2.28
Dec.	1.78	1.22
Total	46.26	64.69

1/ 29 years of record

2/ 59 years of record

GEOLOGY AND SHALLOW GROUND WATER

Elliott Key is composed of the Key Largo Limestone, a coral reef that formed during Pleistocene time (Parker, 1955, p. 155). Corals make up about 30 percent of the Key Largo Limestone; the remainder is a matrix of calcarenite, a mixture of sand-sized debris (Hoffmeister and Multer, 1968 p. 1490-1491). The formation is generally highly permeable providing a good hydraulic connection with the Atlantic Ocean and Biscayne Bay. The permeability of the upper part of the Key Largo Limestone is lower than the rest of the formation; however, rainfall readily infiltrates through the many vertical solution holes on the surface.

Parker and others (1955, p. 176) indicated that fresh ground water in the Florida Keys occurs only as lenses of varying thickness floating on the underlying salt water. Because the sole source of fresh-water replenishment is rainfall, the lenses increase in size during the rainy season (June through October) and decrease in size during the dry season. Although the quantity and frequency of rainfall are important factors in the size and duration of fresh-water lenses on islands, of equal importance are factors such as: (1) permeability of water-bearing materials; (2) size of the island and proximity to salt water; and (3) elevation of the island above sea level. Application of the above factors to the available hydrologic data suggests that potable ground water is not perennially available on Elliott Key.

Because the Key Largo Limestone is generally very permeable, rainfall infiltrates rapidly to the water table and moves laterally toward points of discharge to the ocean and Biscayne Bay. Ground-water levels in Elliott Key fluctuate in response to ocean tides but within a smaller tidal range. During heavy rain storms, rises in the water table are superposed upon the normal cyclic tidal fluctuation, indicating an increase in fresh ground water in the shallow sediments. The maximum thickness of the fresh-water lens would be expected to occur in the center of the island. After heavy rainfall the lens would begin to decay because of seepage and evapotranspiration losses. Only during the rainy season would replenishment by rainfall exceed evapotranspiration losses. Where permeability is locally low, the lens will persist for a longer period than where the permeability is high. Because of Elliott Key's low elevation and the general high permeability of the limestone, thick lenses will not be formed.

Water samples were collected from a shallow well used for sanitary facilities within 500 feet of the bay side of Elliott Key in the County Park area during April 1970. Analyses of the water showed that the chloride content exceeded 8200 milligrams per liter, indicating that a perennial source of potable ground water is not available on the key. However, some fresh water might be obtained by skimming from the water table through the use of infiltration galleries or shallow wells along the center line of the key. Recovery would have to be at a low rate and carried out immediately after heavy showers. Storage facilities would be required. The quantity available would be determined by careful testing and pumping in selected areas at selected intervals during and after the rainy season. Parker and others (1955, p. 177) indicated that water samples collected from wells in the Florida Keys during the 1940's showed different amounts of contamination by sea water even after periods of heavy rainfall. They suggested further that Key West and Big Pine Key (lower chain of keys) have the greatest potential supplies of any of the Keys, but that those supplies are limited, and pumpage of several thousand gallons per day during the rainy season would rapidly exhaust the fresh water.

Consideration should also be given to the frequency of hurricanes which cause abnormal tides along the Keys. Tidal inundation would temporarily eliminate the fresh ground water on Elliott Key. The Corps of Engineers (1956, Table 2) lists 13 major hurricanes during the interval 1900-55 that have affected the upper Keys and Miami Beach, or a frequency of once every 4.2 years. Eight of the storms caused tidal water levels that exceeded 3 feet above sea level. Thus, there is a distinct probability of recurring tidal inundation of Elliott Key.

OTHER METHODS OF FURNISHING POTABLE WATER

One method of obtaining potable water in water-short areas such as the Florida Keys, a method formerly used in Key West and presently used in certain islands in the Bahamas, is by collection of roof runoff into cisterns. A related method used by the Air Force in its missile tracking stations in the Bahamas, was to pave several acres for catchment areas and after each rainfall, pump the water to storage tanks.

Probably the most practical method of obtaining a dependable potable water supply for the Biscayne Monument facilities is through desalination of brackish water from the Floridan aquifer. Information on an artesian well in the Floridan aquifer drilled to a depth of 1330 feet at the Pennekamp State Park in middle Key Largo shows the 6-inch well yields water containing less than 2500 milligrams per liter of chloride at a rate of 460 gallons per minute by natural flow. The dissolved solids content is less than 5000 milligrams per liter. The static water level in the well in 1969 was 38 feet above sea level or 35 feet above the land surface. The water is used nearly continuously to replenish a wading pool in the park. The well has been in use since 1965 and the water quality has not changed significantly. A chemical analysis of water from the Pennekamp Park well is given in Table 1.

Table 2. Analysis of water from well at Pennekamp Park collected in 1968 (Results are in milligrams per liter except those for color, pH, and specific conductance)

Silica	15
Calcium	90
Magnesium	130
Sodium	1200
Potassium	44
Carbonate	0
Bicarbonate	224
Sulfate	426
Chloride	2000
Fluoride	2.4
Nitrate	0
Dissolved Solids	4060
Hardness (Carbonate)	813
Hardness (Noncarbonate)	630
Color	0
pH	7.9
Specific conductance (micromhos at 25°C)	7200.
Temperature (degrees C)	26

Remarks - Odor of hydrogen sulfide

An alternate source of brackish water is shallow ground water in the center of the island. However the salinity of the water might approach that of sea water during prolonged dry periods.

Meyer (1970) has indicated that the estimated cost of converting water similar in quality to that from the Pennekamp Park well to fresh water by the reverse osmosis process has declined to 50 cents per thousand gallons in 1968, as compared to 85 cents per thousand gallons at the distillation plant at Key West, where sea water is converted to fresh water.

Consideration might be given to the possibility of blending water from different sources to obtain the required quantity of acceptable water. For example, rainfall collected from catchments or cisterns can be blended with artesian water or with water pumped from the shallow ground water lens during the rainy seasons. However these quantities would represent supplemental water only, and could not be depended upon for year-round supplies.

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