FEASIBILITY

of

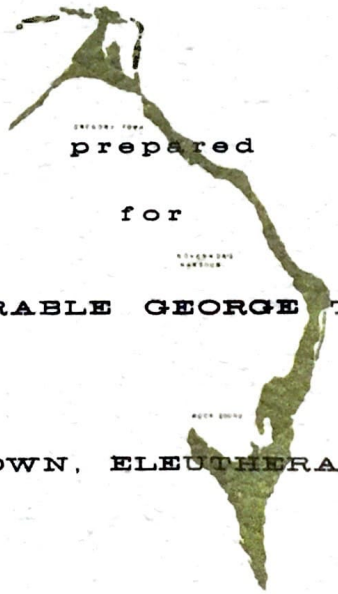
SALT WATER CONVERSION

and

ELECTRIC GENERATION

for

ELEUTHERA ISLAND, BAHAMAS



prepared

for

THE HONORABLE GEORGE THOMPSON

GREGORY TOWN, ELEUTHERA, BAHAMAS

by

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and

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MIAMI · FLORIDA

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CHAPTER VIII

THE PROPOSED SYSTEM

Layout:

The proposed water distillation-electric generation system for Eleuthera Island will consist of supply works situated near Governor's Harbour with an aqueduct and a power transmission line running nearly the length of the Island from Gregory Town to Rock Sound. The water and electricity will be sold wholesale to the existing local distribution companies, who will retail it to the customers. The water will be delivered to existing or new reservoirs situated where possible at sufficient elevation to supply the local system by gravity. If the ground elevations are too low for this arrangement, the necessary pumping will be the responsibility of the local water system operator. Small taps from the supply main not connect to adequate local storage reservoirs will not be permitted. A diagrammatic plan of the system is shown in Figure 2.

Conversion - Generation Plant:

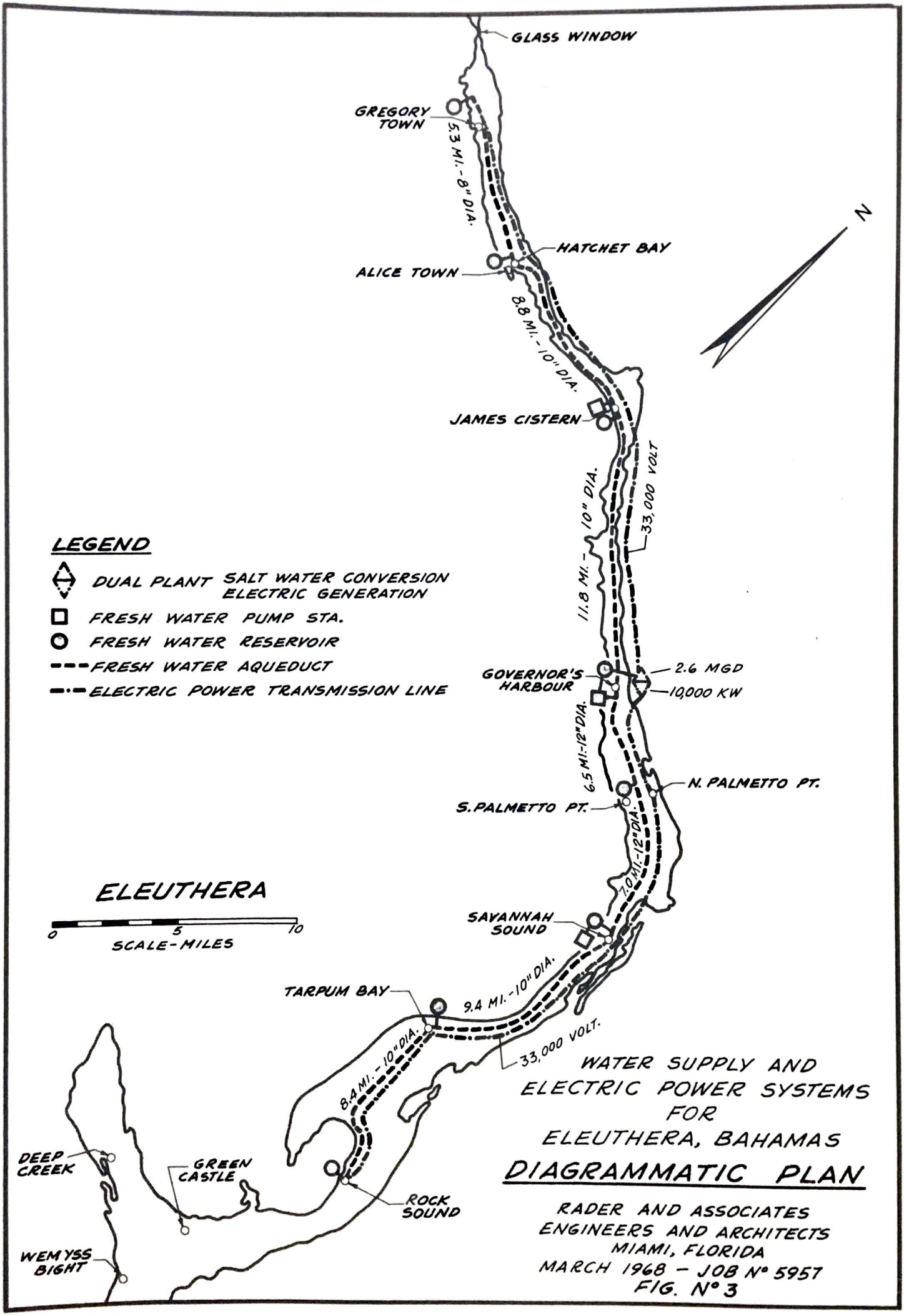
The proposed system will include conversion - generation plants situated near Governor's Harbour, with the following features:

(1) Two oil fired boilers with chimney, controls and auxiliaries.

(2) Two 5,000 KW turbo-generators.

(3) Two 1.3 mgd water distillation plants with supply works, waste brine disposal and auxiliaries.

(4) Oil storage facilities adequate to supply the operation for 60 days or more.


GLASS WINDOW
GREGORY TOWN
5.3 MI.-8" DIA.
HATCHET BAY
ALICE TOWN
8.8 MI.-10" DIA.
JAMES CISTERN
11.8 MI.-10" DIA.
33,000 VOLT
N
LEGEND
DUAL PLANT SALT WATER CONVERSION ELECTRIC GENERATION
FRESH WATER PUMP STA.
FRESH WATER RESERVOIR
FRESH WATER AQUEDUCT
ELECTRIC POWER TRANSMISSION LINE
GOVERNOR'S HARBOUR
2.6 MGD
10,000 KW
6.5 MI.-12" DIA.
N. PALMETTO PT.
S. PALMETTO PT.
7.0 MI.-12" DIA.
ELEUTHERA
0
5
10
SCALE-MILES
SAVANNAH SOUND
TARPUM BAY
9.4 MI.-10" DIA.
8.4 MI.-10" DIA.
33,000 VOLT.
DEEP CREEK
GREEN CASTLE
ROCK SOUND
WEMYSS BIGHT
WATER SUPPLY AND ELECTRIC POWER SYSTEMS FOR ELEUTHERA, BAHAMAS
DIAGRAMMATIC PLAN
RADER AND ASSOCIATES
ENGINEERS AND ARCHITECTS
MIAMI, FLORIDA
MARCH 1968 - JOB N° 5957
FIG. N° 3

(5) Ground level water storage reservoirs having a total capacity of 2,000,000 U. S. gallons.

(6) A two part pumping station situated at the conversion-generation plant, one part designed to deliver water both north and south on the Island, and the other part to deliver water to the local Governor's Harbor water distribution system.

Distribution Systems:

(1) A water supply aqueduct running nearly the length of the Island from Governor's Harbor to Gregory Town, and from Governor's Harbor to Rock Sound.

(2) A system of ground level water storage reservoirs situated as follows:

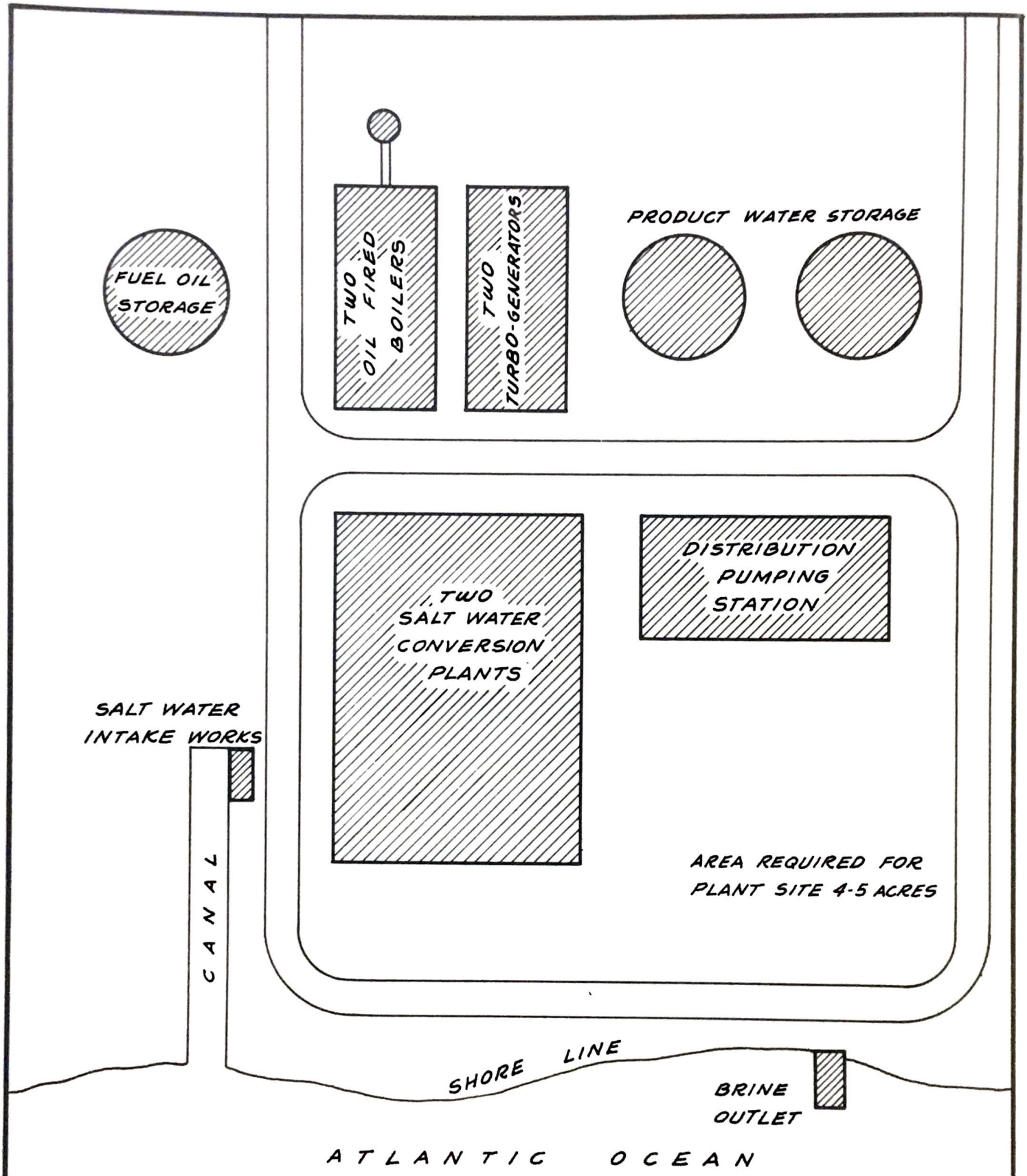
	Million Gallons of Water
Gregory Town	1.0
Hatchet Bay	1.0
James Cistern	0.5
Governor's Harbor	2.0
Palmetto Point	0.5
Savannah Sound 2 Units Total	1.5
Tarpon Bay	0.5
Rock Sound - 2 Units Total	2.0
Total	9.0

(3) Booster Pumping Stations:

(a) At Hatchet Bay to deliver water to Gregory Town.

(b) At Savannah Sound to deliver water to Tarpon Bay and Rock Sound.

(4) An overhead power line running from Governor's Harbor to Gregory Town and from Governor's Harbor to Rock Sound.



DIAGRAMMATIC LAYOUT OF SALT WATER CONVERSION — ELECTRIC GENERATION PLANT ELEUTHERA, BAHAMAS

RADER AND ASSOCIATES
ENGINEERS AND ARCHITECTS
MIAMI, FLORIDA
MARCH 1968 — JOB N° 5957

Figure No. 4

The general layout of the proposed supply works is shown in Figure 3. When detail contract drawings and specifications are prepared, ready for construction, it may be found desirable to change the layout from that shown herewith.

Operation:

The turbo generator will be used to carry the electric load and to supply electricity to the entire island up to its capacity. Steam will be bled off from the turbine to feed the salt water conversion plant, which will be operated at adequate capacity to supply the then existing demand for potable water. Salt water will be pumped from a well or other supply facilities into the conversion plant and the concentrated brine remaining after fresh water has been removed will be discharged into the ocean through a pipeline or ditch.

Electricity, generated at a conventional voltage (say 13,000 V) will be stepped up to a higher voltage (say 33,000 V) for transmission to other parts of the island, where it will be stepped down to the potential used in the local distribution system.

Electricity will be sold to the local distribution company at a wholesale rate to be based on the cost of operation of the supply system.

Likewise, potable water will be sold to the local distributing company at a wholesale rate to be based on the cost of operation of the supply system. The aqueduct will be operated at moderate pressures (100 psi or less) to permit an increase in capacity, if required in the future, by boosting the pressure. Water will be bled from the aqueduct into the local control reservoirs by control valves designed to discharge at a constant 24 hour rate and to conserve sufficient aqueduct capacity to serve customers further down the line. A local distribution system will be fed only through a reservoir of sufficient capacity to permit delivery at a uniform rate throughout the 24 hours. No direct connection to a local system without reservoir will be permitted.

CHAPTER IX

CONSTRUCTION COST

Estimates of construction costs have been prepared on the assumption that the work will be done by a general contractor who will handle the entire project. Bids will be requested and received from a number of contractors, and the award of a contract will be made to the company making the most favorable offer. It has been assumed that the materials, supplies, equipment, and skilled labor not available in the Bahamas will be obtained from the United States.

Storage tanks, both for oil and water, will be made of steel or concrete, erected on stabilized earth foundations. Only the necessary parts of the conversion-generation plant and the pumping stations will be housed.

The aqueduct will be constructed of steel pipe, lined and wrapped with bitumastic material and laid partly above and partly underground, the selection of method depending on the local requirements and the construction costs.

The power transmission line will be of copper or aluminum wire strung on concrete poles having steel cross arms.

The estimated construction cost of the dual plants, and of the distribution facilities is $12,288,000.00, as shown in Tables 10 and 11.

?

TABLE 10 - ESTIMATED CONSTRUCTION COST OF SALT WATER CONVERSION - ELECTRIC GENERATION PLANT

Salt Water Conversion - Electric Generation Plant Including:	
2 - 5,000 KW Turbo Generators	
2 - 1.3 mgd seawater desalting plants	
2 - Steam Boilers, oil fired	
All required auxiliaries, including: pumps, motors, controls, control building, chemical feeds, sea water intake, brine discharge and foundations	$ 5,000,000
Fuel Oil Storage Tanks and Piping:	
2 - Reservoirs @ $35,000	70,000
Piping	10,000
	$ 5,080,000
20% Contingencies and Engineering	1,016,000
Sub-Total (Construction Cost)	6,096,000
5% Financing	305,000
Sub-Total	6,301,000
7.5% Interest During Construction	483,000
Total Money Requirements	$ 6,784,000
Say	$ 6,800,000

$860,000 = 13 miles or ?

TABLE II - ESTIMATED CONSTRUCTION COST OF AQUEDUCT, PUMPING STATIONS, POWER LINE AND ACCESSORIES

AQUEDUCT:

Cost?

8" Dia. Steel Pipe - Lined and Coated	5.3 Mi	$30,000/mi.	$ 159,000		
10" Dia. " " " " "	38.4 Mi	38,000	1,459,200		
12" Dia. " " " " "	13.5 Mi	46,000	621,000	$2,239,200	
Total	57.2 Mi				

PUMPING STATIONS:

No. 1 Governor's Harbour (House 75' x 30')		$ 118,300	
4 Pumps - 400 gpm at 110' TDH - 20 HP motors			
3 Pumps - 600 gpm at 170' TDH - 40 HP motors			
No. 2 James Cistern (House 40' x 25')		$ 44,000	
3 Pumps - 300 gpm 115' TDH - 15 HP motors			
No. 3 Savannah Sound (House 40' x 25')		$ 44,600	206,900
3 Pumps - 400 gpm at 150' TDH - 25 HP motors			

WATER STORAGE RESERVOIRS:

18 Reservoirs @ 0.5 MG. Ea.	$ 39,000	702,000
Electric Power Line 57.2 Mi. (33,000V) @ $16,000/Mi		915,200
Sub-Total		$4,063.300
20% Contingencies and Engineering		812,700
Sub-Total (Construction Cost)		4,876,000
5% Financing Costs		243,800
Sub-Total		5,119,800
7.5% Interest During Construction		384,000
Total Money Requirements		$5,503,800
Say		$5,500,000

CHAPTER X

OPERATING COST

The cost of the water and electricity delivered to the local distribution systems will be made up of two principal parts:

(1) The Cost of Operation.

(2) The Cost of Amortization of the Capital Cost.

The principal components of the cost of operations will be:

(a) The fuel component.

(b) The labor component.

(c) The chemical component.

(d) The cost of miscellaneous supplies.

The fuel used will be Bunker "C" oil delivered either from the United States or from Nassau. Bunker "C" fuel oil has a high calorific value, is less expensive than the lighter oils, and can be successfully used in an installation such as that contemplated for Eleuthera if suitable equipment is provided for handling the heavy oil. No Bunker "C" fuel is now used on the Island, and new facilities must be provided for handling the oil, including unloading docks, if present docks cannot be used, oil storage and pipeline facilities to deliver the oil to the water-electric plant. It is obvious that the location of the new fuel docks must be coordinated with the plant location, so as to facilitate the handling of the fuel.

Equipment will be provided to make the operation of the plant as nearly automatic as possible, but 24 hour attendance will be required to handle emergencies and to correct any possible malfunction before the equipment is damaged or the product water contaminated. The routine cleaning and oiling of the equipment will be carried out principally by the day-time shift, reducing the number of men required on the night-time shift. Likewise, cleaning and repairing boiler tubes, conversion plant tubes, and other major repair work will be carried on by the day-time shift. The water conversion plant consisting of two units will be designed to allow for periods of shut down for the repair of the equipment. The total generating plant capacity is divided into 2 parts permitting one unit to be shut down for repairs while service is provided by the second unit.

A preliminary summary of the labor organization required is shown below, with the annual salaries assumed for each group of employees:

(a) For the Conversion-Generating Plant and the Governor's Harbour Pumping Station.

1	Plant Manager	$6,000.00
5	Shift Superintendents	25,000.00
9	Shift Operators	21,600.00
2	Maintenance Personnel	9,000.00
		$61,600.00

cf. Investment

(b) For the Administrative Office of the Water-Electric Organization.

1	Manager	$ 7,000.00
1	Meter Reader and Billing Clerk	5,000.00
1	Bookkeeper	4,000.00

(c) For Aqueduct and Power Line Maintenance.

2	Foremen	$ 10,000.00
2	Mechanics	9,000.00
6	Laborers	19,000.00

(d) For the Two Pumping Stations (Hatchet Bay and Savannah Sound) (Two Shifts Per Day)

6	Operators	18,000.00
	Total Annual Payroll	$133,600.00

Ten percent has been added to the payroll costs listed above to cover fringe benefits.

A number of chemicals will be required in the operation of the plant. The most important of these from the standpoint of cost is sulphuric acid, which is required to control scaling of the tubes of the salt water conversion plant, and the use of about 2,300 pounds of sulphuric acid per million gallons of water has been included in the estimates of operating costs. Chlorine may be required to control aquatic growths in the salt water intake, and an allowance has been included for this chemical. Other chemicals such as a metaphosphate may be required to condition the water, but the cost of these

will be small.

Miscellaneous supplies such as oil, grease, cleaning rags, etc., have been estimated on the basis of experience in other plants.

The details of the estimate of the cost of operation are shown in Table 12.

TABLE 12
ESTIMATED COST OF OPERATION OF DUAL PLANT AND DELIVERY FACILITIES CONSISTING OF 2.6 MGD SALT WATER CONVERSION PLANT PLUS 10,000 KW STEAM TURBINE GENERATION PLANT

Water Production Rate average MGD	1.95	1.68	1.35	1.05	0.85
Water Sold - MGD	1.85	1.60	1.28	1.00	0.80
Electricity Sold KWH/day (a)	84,500	73,000	58,300	45,500	36,500
Power for Conversion plant KWH/day	25,200	25,200	25,200	25,200	25,200
Power for Distribution pumping (3 pump stn's) KWH/day	2,000	1,300	1,000	400	200
Total Power Generated KWH/day	111,700	99,500	84,500	71,100	61,900
Turbine load average KW	4,650	4,150	3,520	2,960	2,580
Fuel Cost $/Hr	79.80	73.10	64.00	56.20	51.00
COST OF OPERATION, $/Day					
Conversion-Generation Plant					
Fuel Cost $/Day	1,920.00	1,760.00	1,540.00	1,350.00	1,230.00
Labor @ $7.70/hr.	185.00	185.00	185.00	185.00	185.00
Chemicals @ $78/mg.(b)	152.00	131.00	105.00	82.00	67.00
Maintenance & Supplies (c)	121.00	121.00	121.00	121.00	121.00
Sub-Total	2,378.00	2,197.00	1,951.00	1,738.00	1,603.00
Administrative Office (d)	77.00	77.00	77.00	77.00	77.00
Distribution Facilities (d)	257.00	257.00	257.00	257.00	257.00
Total Daily Cost	$ 2,712.00	$ 2,531.00	$ 2,285.00	$ 2,072.00	$ 1,937.00
Total Annual Cost	990,000.00	924,000.00	834,000.00	756,000.00	707,000.00

(a) At 45.5 KWH per 1,000 gallons water consumed.
(b) Sulfuric acid at 2300 lbs per mg and chlorine at 10 ppm
(c) $17,000/year per mgd plant capacity ($46.60/Day)
(d) Details of estimate - daily cost

	Administration Office	Aqueduct, 2 Pump Stations and Power Line
Payroll	$ 43.80	$ 153.00
Fringe benefits	4.38	15.30
Supplies	15.00	50.00
Automotive equipment	10.00	30.00
Sub-Total	73.18	248.30
Contingencies	3.82	8.70
Total	$ 77.00	$ 257.00