6.5 Electric power and chemical consumption

The electric power and chemicals to be consumed by this plant are shown in Table 6.2 below.

Table 6.2 Consuption of Electricity and Chemicals

Item	Unit	Consumption
1. Electricity	kWH/day	21,200
2. Chemicals		
1) Ferric chloride	kg/day	22.3
2) Sulfuric acid	kg/day	441
3) Caustic soda	kg/day	28.8
4) Citric acid	kg/day	11.4
5) Aqueous ammonia	kg/day	2.3

6.6 The organization and its manpower plannings for operation of the plant

6.6.1 The organization

The organization for the newly installed sea water desalination plant will serve only for operation itself planning and control of operation. So this new organization is to be positioned under EMPOISLAS's administrative office at the same level as the group of San Andres water works for attaining rationalization of the total organization scale of EMPOISLA's and the minimum addition of new employees.

6.6.2 Manpower planning

The manning, shcedule for the plant it San Andres has been planned by taking account of the following views.

- The sea water desalination plant applying a reverse osmosis process is based on advanced technologies.
- The plant has been planned to attain full automatic operation and central monitoring.
- Some parts of the plant such as raw sea water intake and waste water discharge are apart from the central control room.

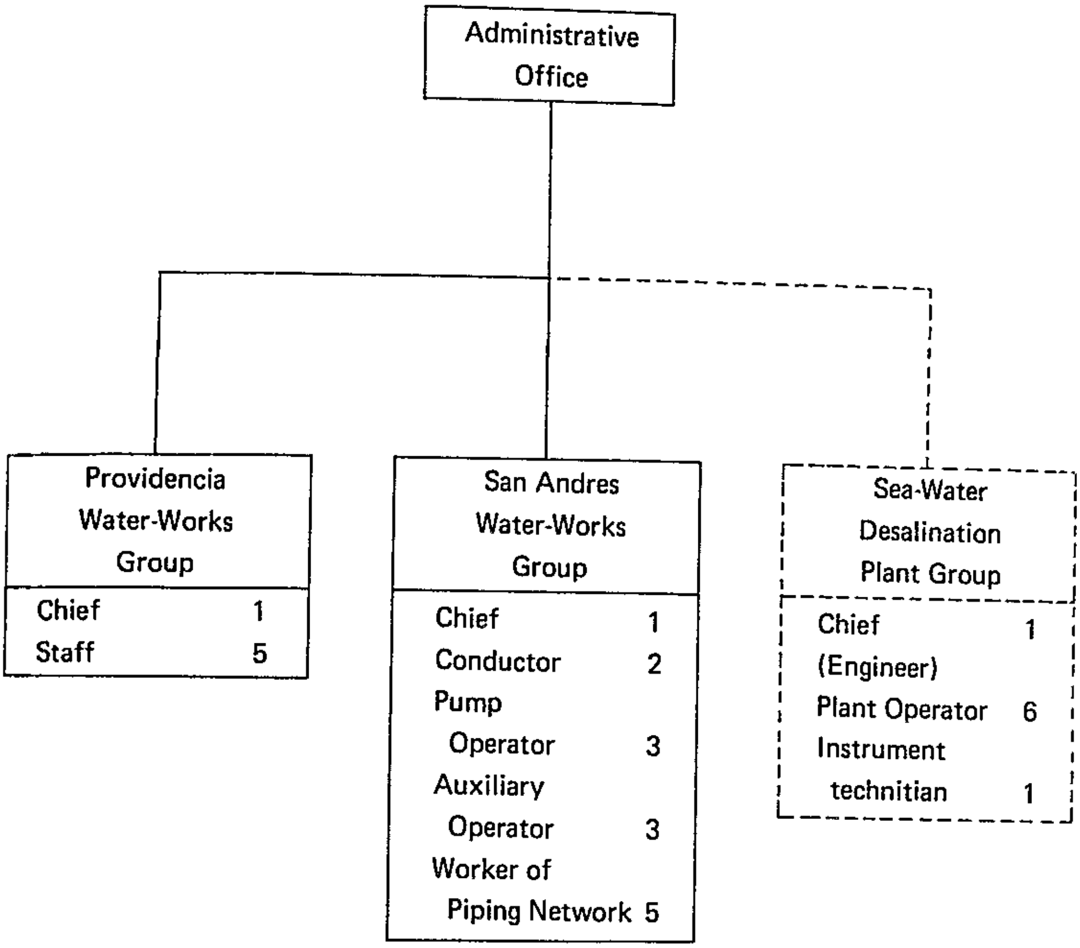
From the above standpoint, the following categories of personnel are required.

Category	Number
Chemical engineer (and concurrently operating supervisor)	1
Plant operator	6 (2/one shift x 3)
Instrument technician	1

Job description and qualifications for each category are assumed as follows:

Chemical engineer	a) Dialy operation control – Production control – Qualilty control	1) College graduate
	b) Maintenance planning	2) Having experience on similar plants more than 5 years.
	c) Operator supervising	
Operator	a) Plant operation	1) Junior high school or vocational school graduate.
	b) Small scale repairing	
Instrument technician	a) Monitoring instrument system	1) Technical high school or vocational school graduate
	b) Identification of troubled instruments	2) Having experience of more than 5 years
	c) Replacing troubled instruments with new ones	

The organization defined for the operation of the plant is shown below.



6.6.3 Operator training

After the mechanical completion of the plant, operator training will be carried out on the following contents during its test run of about one month under the supervision of the engineer from the contractor.

The contents of training

- Start-up and stop procedure of the plant
- Exchange of the module
- Back-washing of the dual media filter
- All of operation procedure other than indicated above.

Furthermore, as for important procedures such as module exchange, filter back-washing, checklist will be prepared for daily monitering and operation details.

6.7 Project schedule

6.7.1 Project schedule

After reviewing this study and deciding this project's realization by Colombian governmental organization, the following steps will be taken to the mechanical completion of the plant. And for attaining smooth project proceeding and protecting Owner's benefits it is recommendable to use a competitive consultant.

First step Bid package preparation and contract policy establishment

As the plant specifications are established and then comes the following:

- Confirm purchasing specifications
- Determine the contents and type of contract
- Establish the mode of contract

2nd step Contractor selection and contract

The contractor for construction of the plant will be selected by a suitable method such as bid invitation and others. Then the contract will be agreed upon.

It is necessary to select a competitive contractor for plant construction because this plant is based on highly advanced technologies.

3rd step Design and construction of the plant.

After contracting, the contractor will execute the job under the control of the Owner.

6.7.2 Estimated construction period

According to Direction Nacional de Planeacion, it will need about 5 months to select the contractor after the decision making, and the construction period has been estimated to be 23 months in total.

- 5 months for contractor selection and others.
- 17 months for design, procurement and construction after contracting till mechanical completion.
- One month for test run till commissioning of the plant.

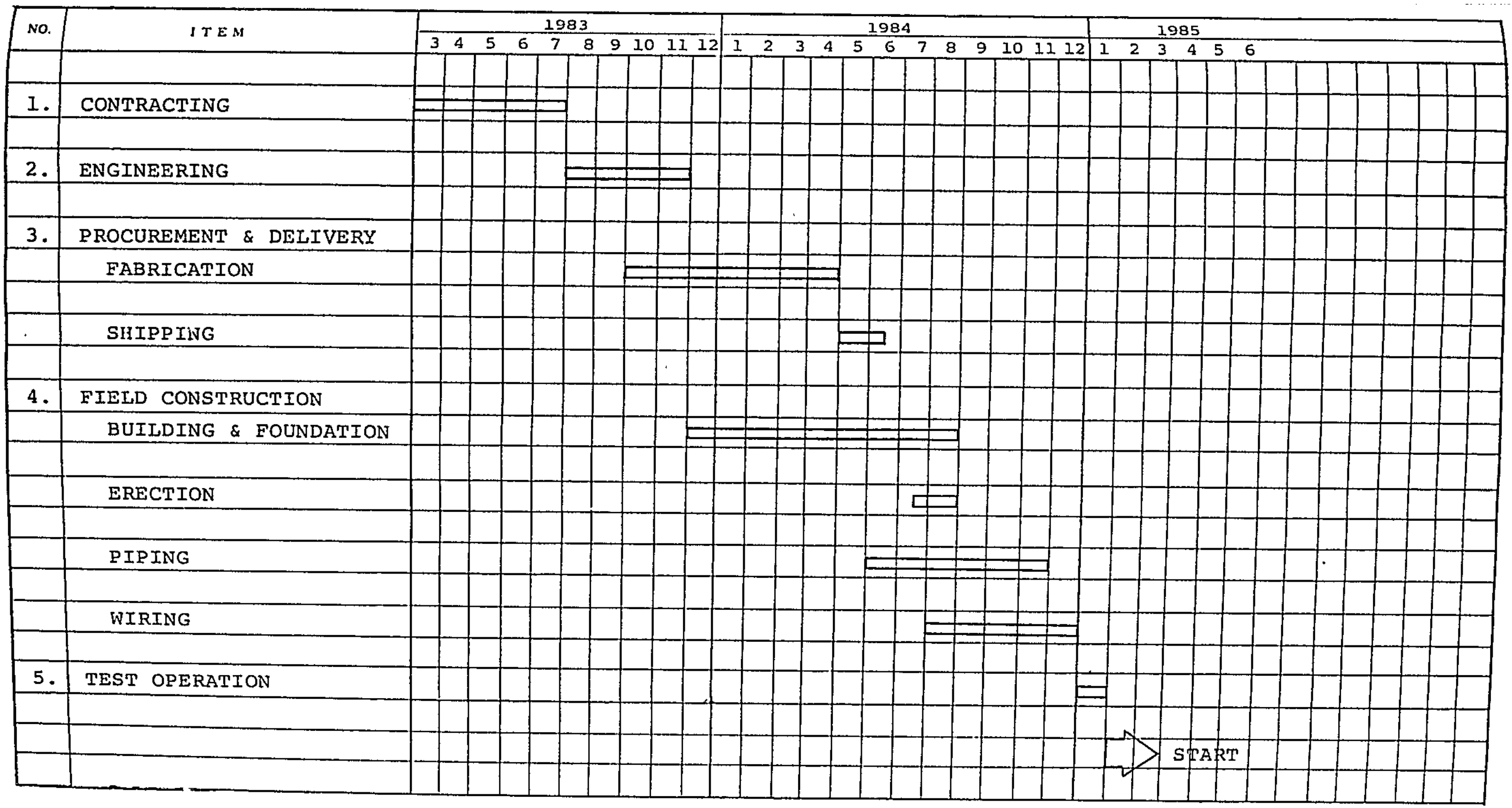


FIG. 6.5 PROJECT SCHEDULE

Chapter 7 Total Capital Requirements and Operating Cost

This chapter describes the total capital requirements and operating cost (for each constituent item) which will become the basis for the financial analysis to be made in Chapter 8.

7.1 Total capital requirements

The term "total capital requirements", as used here, refers to the total capital invested until commercial operation of the projected plant is started. The required total investment includes the following items:

. Plant construction cost
. Preoperation expenses
. Interest during construction

Table 7.1 below gives the results of calculation for each item, the sum of which is US$7,481,000.

Table 7.1 Summary of Total Capital Requirements

(US$ 1,000)

Item	Foreign Exchange	Local Currency	Total
Plant Construction Cost	4,678	2,189	6,867
Preoperation Cost	71	175	246
Initial Working Capital	–	272	272
Interest During Construction	33	–	33
Total Capital	4,782	2,636	7,418

7.1.1 Plant construction cost

Table 7.2 below gives the plant construction cost (as of 1982) estimated on the basis of the specifications given in Chapter 6.

Table 7.2 Plant Construction Cost

(US$1,000)

Item	Foreign Exchange	Local Currency	Total
Desalination Facility	3,469	1,419	4,888
Auxiliary Facility	1,209	770	1,979
1) Seawater Intake Unit	(436)	(101)	(537)
2) Product Transfer Unit	(292)	(214)	(506)
3) Waste Discharge Unit	(323)	(239)	(562)
4) Wiring of Power Supply Cable	(158)	(216)	(374)
Total Plant Construction Cost	4,678	2,189	6,867

The basis used in the above calculation are as described below.

1) Equipment and materials

All equipment and materials will be purchased in foreign exchange.

2) Ocean transportation and insurance

Ocean freight and marine insurance for imported items (machinery, equipment, and materials for plant construction and operation) will be paid in foreign exchange.

3) Construction cost

Construction costs for civil foundation, building, erection, electrical, and instrumentation work will be paid in local currency.

4) Materials for civil and architectural work

Materials for civil (equipment foundation, concrete water reserviors, etc.) and architectural work will be procured within the Republic of Colombia.

5) Import duty

Since San Andres Island is a free port, all imported equipment and materials will be exempted from the payment of import duties.

7.1.2 Preoperation expenses

Table 7.3 gives the expenses required until plant operation is started.

Table 7.3 Preoperation Expenses

(US$1,000)

Item	Foreign Exchange	Local Currency	Total
Training Expenses	71	42	113
Administrative Expenses	–	78	78
Trial Operation Cost	–	55	55
Total	71	175	246

1) Training expenses

The term "training expenses" means salary (to be paid to trainees during training) and expenses necessary for training. Operating personnel will be employed for (4) months before the commencement of commercial operation. Training will be performed at the plant site during a period of one (1) month.

2) Administrative expenses

As administrative expenses, salaries to be paid (before the commencement of operation) to the superintendent and administrative staff (consisting of the following members) involved in project management as well as associated overhead cost have been appropriated.

Class	Required Numbers	Period
Chief engineer	1	1.5 years
Engineer	1	1.5 years

Administrative expenses have been calculated based on the assumption that a consulting firm is employed for plant construction. The fee thereof, however, is not included in the calculations.

3) Trial operation cost

Trial operation cost includes chemical and utility costs.

7.1.3 Initial working capital

At the time of plant construction, funds necessary for satisfactory commencement of plant operation must be prepared. Such funds, therefore, have been allocated as initial working capital (which consists generally of the cost for inventories such as raw materials). However, since the raw material to be used for this plant is sea water which is inexhausible, the inventory cost for raw materials has not been included in the calculations. Consequently, as the initial working capital to be prepared before the commencement of plant operation, the sum of US$272,000 (a balance of accounts of current assets and current liabilities as described in the following Chapter 8) has been allocated in cash. Funds necessary for the purchase spare parts for the plant equipment as well as spare membranes have been included in the plant construction cost.

7.1.4 Interest during construction

Interest during plant construction has been calculated based on the repayment schedule of bank loans taken out for plant construction. The expenditure schedule of total capital requirements during plant construction is shown in Table 7.4.

The plant construction cost is assumed for the construction period of 18 months. Initial working capital is paid totally at the end of 1984. The above yearly capital expenditures are paid by the governmental subsidy and long-term loans which are described in the next chapter.

The interest payments during construction were calculated by computer with interest rate of 7.5% p.a. and added into the fixed capital as shown in Table 7.4.

Table 7.4 Expenditure Schedule

(US$1,000)

Item \ Year	– 2 ('83)	–1 ('84)
Plant Construction Cost	597	6,270
Preoperation Expenses	26	220
Interest During Construction Period	–	33
Initial Working Capital	–	272
Total	623	6,795

7.1.5 Land cost

On the assumption that land can be used without any compensation, land cost has not been allocated.

7.2 Operating cost

This section refers to items necessary for plant operation, and the estimated costs thereof. The cost items for plant operation are as follows:

- Utility and chemical costs
- Operation labor cost
- Maintenance cost
- General expenses

Of the above items, utility and chemical costs are variable operating costs which vary with plant operating rate. Labor cost, maintenance cost and general expenses constitute the fixed operating cost (which has no connection with plant operating rate). The operating cost has been calculated on the basis of the following assumptions.

1) On stream factor: 100% from the first operating year. (see 3.1 of Chapter 3)
   Annual number of operating days: 350 days
2) Use of prices as of 1982 for the calculation of various expenses, without, however, incorporating price escalation.

Tables 7.5 and 7.6 give the operating cost calculated based on the above assumptions.

Table 7.5 Variable Operating Cost

(US$1,000)

Item	Annual Cost
Utility	685
Chemicals	97
Total	782

Table 7.6 Fixed Operating Cost

(US$1,000)

Item	Annual Cost
Operation Labor Cost	62
Maintenance Cost	206
General Expenses	38
Total	306

The above individual cost items are detailed below.

7.2.1 Utility and chemical costs

Utility (electricity) and chemical costs are allocated as plant operating cost. The unit prices and consumptions thereof are summarized in Table 7.7 below. (see Chapters 3 and 6)

Table 7.7 Unit Consumption and Cost of Utility and Chemicals

Utility/Chemicals	Unit Consumption	Unit Price	Cost
Electricity	7.06 kWH/m^3	0.092 US$/kWH	0.650 US$/$m^3$
Chemical			
. Ferric Chloride	0.0091 kg/m^3	0.930 US$/kg	0.008 US$/$m^3$
. Sulfuric Acid	0.147 kg/m^3	0.408 US$/kg	0.060 US$/$m^3$
. Caustic Soda	0.0096 kg/m^3	1.306 US$/kg	0.013 US$/$m^3$
. Citric Acid	0.0038 kg/m^3	2.547 US$/kg	0 010 US$/$m^3$
. Aqueous Ammonia	0.00077 kg/m^3	1.665 US$/kg	0.001 US$/$m^3$
Total	–	–	0.742 US$/$m^3$

7.2.2 Operation labor cost

With respect to personnel expenses, the direct labor cost has been calculated based on Chapter 6, 6.6 Table 7.8 below gives the annual direct labor cost calculated on the basis of the wage rate table (for each type of occupation) given by EMPOISLAS.

Table 7.8 Operation Labor Cost

(US$1,000)

Class	Required Numbers	Unit Cost at 1982	Annual Labor Cost
Chief	1	12.5	12.5
Operator I	3	9.1	27.3
Operator II	3	4.4	13.1
Instrument	1	9.1	9.1
Total	8	–	62.0

7.2.3 Maintenance cost

As expenses necessary for yearly maintenance (consumables, spare parts, and replacement of membranes), US$206,000, which is equivalent to 3% of the plant construction cost, has been allocated.

7.2.4 General expenses

The term "general expenses" means indirect expenses as given below, and other miscellaneous expenses.

. Indirect personnel expenses
. Office expenses and other miscellaneous expenses
. Insurance

1) As annual indirect personnel, office, and other miscellaneous expenses, the sum of US$31,000 (equivalent to 50% of direct labor cost) has been allocated.

2) Insurance
As annual fire and casuality insurance cost, the sum of US$7,000 (equivalent to 0.1% of plant construction cost) has been allocated.

Annual general expenses are summarized below.

. Indirect personnel expenses . Office expenses . Other miscellaneous epxenses	US$31,000
. Insurance	US$ 7,000
Total	US$38,000

Chapter 8 Financial Analysis

8.1 General

This chapter covers the financial analysis of the Project. The implementation of the Project (aiming at the improvement of sanitary facilities and living environment for the inhabitants) is based on the assumption that the Project is subsidized by the government and exempted from various taxation such as income taxes. Accordingly, the economic advantages of the Project must be studied from standpoints different from those of general industrial projects, with due consideration to the specific features of the Project. However, the Project must be deemed to be a business entity for financial analyses, and like a business firm, income statements, cash flow statements, sales price of product water, etc., are obtained by carrying out profit/loss calculations while comparing the aggregate of construction/operating costs, and revenues from the sale of product water. Further, the profitability of the Project will be assessed on the basis of the Financial Internal Rate of Return (FIRR) and payout period, using the Discounted Cashflow (DCF) Method. The calculation and assessment of the Economic Internal Rate of Return (EIRR) is also described in Chapter 9 with due consideration to the economic assessment from a national standpoint.

8.2 Major premises

8.2.1 Basic premises

Described hereunder are the basic premises for the Project which are generally applied to financial analysis.

1) Project life
   - Construction period: from July 1983 to December 1984
   - Operating period: 16 years from 1985 to 2000
2) Plant capacity: 3,000 m^3/day (annual number of operating days: 350)
3) On stream factor: 100% from the first year (350 days/year)
4) Price calculation basis
   a. Basis

      Prices as of 1982 apply to the calculation of both plant construction cost and operating costs such as labor cost, and utility and chemical costs, without, however, taking into account price and cost escalations.

   b. Exchange rate

      US$ 1 = 61.26 Pesos

      US$ 1 = ¥243

5) Total capital requirements

Total capital requirements (see Chapter 7) for the Project will be obtained on the basis of the following assumptions:

a. Total capital requirements

30%: governmental subsidy

70%: long-term loans

b. Conditions of long-term loans

. Annual interest rate: 7.5%

. Repayment: 5 times for 5 years (repayment of principal: straight line)

. Grace period of repayment of principal: 1 year after from start-up operation

c. Conditions of short-term loans

. Annual interest rate: 18.0%

. Repayment: The full amount will be repaied in the year subsequent to the year when loans are made.

6) Taxation

The project is exempt from payment of all taxes (income and property taxes, import duties, etc.)

7) Depreciation

	Mode	Residual value
. Machinery/equipment:	16 years (straight-line method)	0
. Civil/building:	25 years (– ditto –)	0
. Preoperation expenses and interest during construction:	5 years (– ditto –)	0

Note: Since the Project is exempt from the payment of income taxes, it is not necessary to consider the effect of conditions of depreciation on the IRR of the Project.

8) Working capital

. Initial working capital: Cash US$ 272,000

. Working capital (during plant operation)

– Current assets:

. Cash: amount equivalent to labor cost for one month.

. Accounts receivable: amount equivalent to 1/12 of annual sales revenues.

. Inventory of product: – ditto –

. Inventories (spare parts, e.g. chemicals): amount equivalent to inventories for one (1) month.

– Current liabilities:

. Accounts payable: amount equivalent to utility and chemicals costs for one (1) month.

9) Sale of product water

The whole quantity of product water will be supplied to the inhabitants through the existing survice reservoir. It is estimated that the whole amount of product water will be consumed (see Chapter 3). In other words, it is assumed that the projected plant can be operated at a constant on stream factor of 100% from the first operating year.

10) Profitability of the Project

The supply of potable water in San Andres Island is in a bad condition. First priority, therefore, should be given to the implementation of the Project. It is estimated, however, that water produced by the projected plant will become much more costly than water taken from the existing wells. In other words, no general market prices will be applicable to the water produced under such circumstances. It should be considered that the price of water as a product of public works depends greatly on a political standpoint. The D.N.P. and survey team, therefore, agreed that the financial analysis of the Project should be carried out based on the criteria for profitability established by the Colombian government for each project and that various financial problems involved with project execution should be grasped by calculating a suitable sales price of product water at which such criteria for profitability can be maintained.

The following is the criterion (IRR) to be applied to this Project.

IRR: 15%

In this financial analysis, empahsis is laid on whether or not the sales price of product water calculated based on the above IRR is feasible in view of water supply work.

8.2.2 Total capital requirements

1) The total capital requirements for the Project is US$7,418,000 (see Chapter 7, Table 7.1).

2) Expenditure schedule

The expenditure shcedule of the total capital requirements is summarized below. For details, see Chapter 7, Table 7.4.

. For the first construction year: US$623,000

. For the second construction year: US$6,795,000

8.2.3 Operating cost

1) Variable operating costs

Variable operating costs are summarized below. (see Chapter 7, Table 7.5)

Utility	US$ 685,000/year
Chemicals	US$ 97,000/year
Total	US$ 782,000/year

2) Fixed operating costs

Fixed operating costs are summarized below. (see Chapter 7, Table 7.6)

Operation labor cost	US$ 62,000/year
Maintenance cost	US$ 206,000/year
General expenses	US$ 38,000/year
Total	US$ 306,000/year

3) Total operating cost

Total operating cost is given in Table 8.1 below.

Table 8.1 Summary of Operating Cost

(US$ 1,000)

Item		Year 1 – 16
Variable OP. Cost	Utility (Electricity)	685
	Chemicals	97
	Sub-total	782
Fixed OP. Cost	Labor Cost	62
	Maintenance Cost	206
	General Expenses	38
	Sub-total	306
Total		1,088

8.3 Method of financial analysis

8.3.1 Establishment of calculation basis for IRR:

The product of the Project is not a trading material but potable water domestically supplied, the extent of supply of which is considerably limited. There are no standard on market prices availble. In many cases, the water rates are determined with due consideration to specific regional features as well as from a political standpoint. In general, the profitability of a project is calculated on the basis of the estimated sales price of the product. Such approach, however, even if applied to this Project, will render the establishment of a proper sales price difficult because no general market prices are applicable to the product water. In this financial analysis, therefore, the profitability of the Project has been determined to be 15% in terms of IRR. On the basis of such profit standard, the needed level of sales price, i.e., the feasibility or otherwise of sales price of the product water necessary for maintaining the desired profitability (IRR = 15%) will be studied.

8.3.2 Indexes associated with IRR

Indexes associated with IRR to be applied to the financial analysis of the Project are explained below. In general, the following two indexes are available for financial analysis.

1) IRROI (Internal Rate of Return on Investment)

"IRROI" means the internal rate of return versus total investment(total capital requirements) consisting of owned and borrowed funds. IRROI is used to calculate the profitability of the project concerned and the capacity of payout of invested funds. In the IRROI, however, the specific conditions of the project such as conditions of debts, and fluctuations in the ratio of owned funds to total investment are not taken into account. In other words, IRROI can be used to indicate the profitability of the project per se.

2) IRROE (Internal Rate of Return on Equity)

"IRROE" indicates the IRR of the project, on the basis of invested owned funds (equity), in which financing conditions specified to the project are incorporated. IRROE, therefore, can be used to indicate the capacity of payout of equity invested for the project concerned.

8.3.3 Applied indicators for financial analysis

1) IRROI

In general, IRROI is used to calculate profitability (IRR) to total investment. In this Project, however, from the viewpoint of the specified characteristic of the Project, IRROI will be calculated by regarding subsidy from the government as an earning.

2) IRROE

Since EMPOISLAS, who is responsible for project execution, does not invest any funds, it is not necessary to calculate IRROE. (An equity portion of the Project cost is subsidized by the government.) For the following reasons, however, it has been decided to calculate, for reference, IRROE (where, the subsidy is deemed to be quity for IRROEcalculation).

a. Since bank loans are made in the Project, it is necessary to grasp the effect of repayment of the principal and payment of interests on the financial status of the Project.

b. From a national standpoint, any governmental subsidy should be deemed to be equity.

From the above, the following equision is applied for IRR calculation in this study.

$$\sum_{i=1}^{n} \frac{(CFE)_i}{(1+R)^{i-1}} + \frac{W}{(1+R)^{n-1}} = 0$$

(Legend)

R : Rate of return

i : i-th year on the project including construction period

n : Years from initial cash outlay to the end of the project

W : Working capital plus non-depreciable investment

Where, CFE (Cash Flow Element) means the cash flow from the each operation year, and CFEs for IRROI and IRROE are calculated from the following items, respectively.

IRROI	IRROE
(CFE) = (–) Total investment excluding IDC (+) Subsidy (+) Revenue (–) Operating Cost	(CFE) = (–) Subsidy (+) Revenue (–) Operating Cost (–) Repayment of debt (–) Interest

Note: IDC ... Interest during construction

8.3.4 Financial Statements

1) Financial statements

The results of this financial analysis are detailed on the computer output sheets attached to the end of this Chapter.

- Results of Calculations/Basic Premises (Summary Sheet)
- Income Statements
- Cash Flow Statements
- Balance Sheet
- Details of Working Capital
- Detailed Operating Costs
- Financial Performance Indicators

When preparing a balance sheet, on estimated balance sheet has been prepared, as an example, as dividends are not appropriated.

2) Summary of financial analysis

The results of the above financial analysis are summarized in Table 8.2 below.

Table 8.2 Summary of Financial Analyses

(Base Case)

Item \ Case		IRROI	IRROE
Total Investment	(US$ 1,000)	7,418	7,418
Project Funding			
Subsidy	(US$ 1,000)	2,225	2,225
Debt	(US$ 1,000)	5,193	5,193
Product Water Price	(US$/m^3)	1.85	1.85
Annual Revenues			
Average Annual	(US$ 1,000)	1,942	1,942
Net Production Costs			
Average Annual	(US$ 1,000)	1,469	1,677
Unit – (US$/m^3)		1.40	1.60
Net Profit			
Average Annual	(US$ 1,000)	473	265
Unit – (US$/m^3)		0.45	0.25
Cash Flow			
Average Annual	(US$ 1,000)	612	265
IRR	(%)	15.0 (Basis)	8.08
Payout Period	(Years)	6.0	12.5

3) Financial analysis on IRROE Case

In order to grasp the financial status of the Project, the results of financial analysis regarding Case IRROE are summarized below.

a. Analysis of production cost

The term "production cost", as used here, refers to the cost obtained by adding the depreciationa and interests of loans to operating cost. Table 8.3 below gives estimated production costs for each operating year.

Table 8.3 Production Cost

(IRROE)

(US$ 1,000)

Year	Break-Down of Production Cost			Production Cost	
	Operating Cost	Depreciation	Interest	Annual	Unit (US$/m³)
1	1,088	421	389	1,898	1.81
2	1,088	421	389	1,898	1.81
3	1,088	421	331	1,840	1.75
4	1,088	421	346	1,855	1.77
5	1,088	421	363	1,872	1.78
6	1,088	366	384	1,838	1.75
7	1,088	366	408	1,862	1.77
8	1,088	366	328	1,782	1.70
9	1,088	366	234	1,688	1.61
10	1,088	366	122	1,576	1.50
11	1,088	366	0	1,454	1.38
12	1,088	366	0	1,454	1.38
13	1,088	366	0	1,454	1.38
14	1,088	366	0	1,454	1.38
15	1,088	366	0	1,454	1.38
16	1,088	366	0	1,454	1.38
Average	1,088	383	206	1,677	1.60

b. Breakdown of production cost

The production cost calculated in terms of IRROI = 15% amounts to US$ 1.85/m³ (price basis as of 1982). In this case, IRROE becomes 8.08%. The breakdown of the average annual production cost is as shown in Fig. 8.1 below.

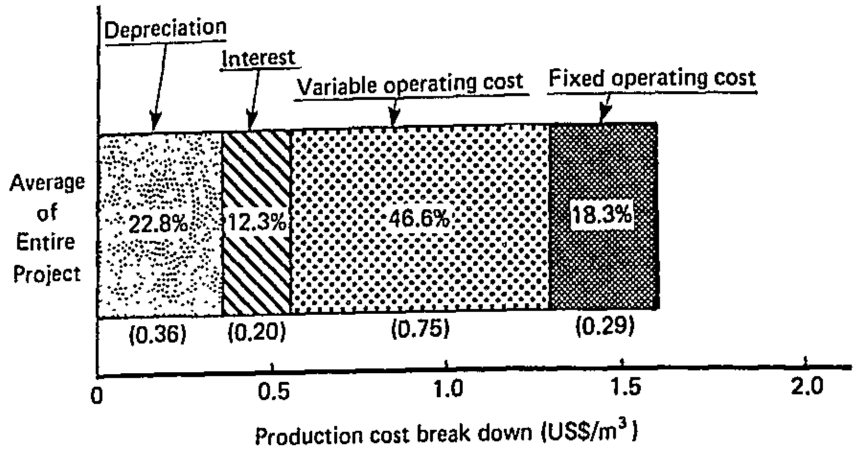


Fig. 8.1 Production Cost Break Down (IRROE Case)

From the above figures, it can be seen that the ratio of variable operating cost accounting for the total production cost is relatively large comparing with fixed costs. Despite the fact that the interest rate of long-term loans is low, the ratio of interest payable accounting for the production cost is large. This is because short-term loans have been introduced in order to make up for the shortage of cash during operation.

4) Financial performance indicators

Table 8.4 gives the major financial performance indicators (for each operating year) in Case IRROE. The individual indicators have been obtained using the following formulas.

i) Profit on Equity (Subsidy):

Profit/Equity (Subsidy)

ii) Profit on Sales Revenue:

Profit (Net income)/Sales Revenue

iii) Debt Service Coverage Ratio:

(Net income + Depreciation + Interest)/(Repayment + Interest)

iv) Profit B.E.P. (Break Even Point) ..... Capacity utilization:

$$\frac{f}{(r_0 - v_0)}$$

v) Cash B.E.P. (Break Even Point) ...... Sales price

$$[v + f + (R - D)] \times \frac{1}{P}$$

where,

f	:	Fixed Op. Cost + Depreciation + Interest
r_0	:	Sales Revenue at full capacity
v_0	:	Variable Op. Cost at full capacity
v	:	Variable Op. Cost at each project year
R	:	Repayment of long term debt
D	:	Depreciation
P	:	Production Volume at each project year

Table 8.4 Major Financial Index

(IRROE)

Project Year	Profit on Equity %	Profit on Sales Revenue %	Debt Service Coverage Ratio	Profit B.E.P. (Cap. Utilization) %	Cash B.E.P. (Sales Price) US$/$m^3$
1	2.0	2.3	2.19	96.25	1.41
2	2.0	2.3	0.60	96.25	2.40
3	4.6	5.3	0.58	89.54	2.32
4	3.9	4.5	0.43	82.82	2.25
5	3.1	3.6	0.33	76.11	2.17
6	4.7	5.4	0.27	64.60	2.10
7	3.6	4.1	0.32	57.88	1.04
8	7.2	8.2	0.40	57.88	1.04
9	11.5	13.1	0.56	57.88	1.04
10	16.5	18.9	1.07	57.88	1.04
11	22.0	25.2	–	57.88	1.04
12	22.0	25.2	–	57.88	1.04
13	22.0	25.2	–	57.88	1.04
14	22.0	25.2	–	57.88	1.04
15	22.0	25.2	–	57.88	1.04
16	22.0	25.2	–	57.88	1.04
Average	11.9	13.7	0.42	67.77	1.44

8.3.5 Sensitivity analysis

With due consideration to changes in Basic Premises established for this financial analysis, a sensitivity analysis has been made regarding the effect of such changes on the sales prices and profitability of the Project.

1) Establishment of varibale factors and parameters

The following variable factors and parameters have been established.

a. Profitability of project (IRR)

The sales price of product water is obtained by assuming a fluctuation of ±5% for the Base Case (IRR = 15%).

b. Plant construction cost

A range of fluctuation of ± 20% is assumed for the plant construction cost of US$6,867,000 (Base Case).

c. Interest rate on long-term loans

The annual interest rate is increased from 7.5% (Base Case) to 10.0% and 12% on the assumption that the period of repayment is 8 and 10 years respectively, and that the grace period in both cases is 1 year.

d. Debt/Equity (Subsidy)

50/50 versus the Base Case (70/30)

e. Range of fluctuation of variable operating cost

± 20% versus the Base Case

f. On stream factor (Base Case: 100% from the first year)

1st year: 80%

2nd year: 90%

3rd year or after: 100%

g. Exchange rate

US$ 1 = 67.39 Pesos, a devaluation of 10% from the Base Case (US$ 1 = 61.26 Pesos).

In this case, the foreign exchange portion will be increased by virtually 10%. The total capital requirements and operating cost calculated in terms of a devaluation of 10% are as given in Tables 8.5 and 8.6 below.

Table 8.5 Total Capital Requirements (Sensitivity Case)

(US$1,000)

Item	Cost
Plant Construction Cost	6,867
Preoperation Expenses	246
Interest During Construction	33
Initial Working Capital	272
Total	7,418

Table 8.6 Operating Cost (Sensitivity Case)

(US$1,000)

Item	Annual Cost
Utility (Electricity)	685
Chemicals	97
Labor Cost	62
Maintenance Cost	206
General Expenses	38
Total	1,088

2) Results of sensitivity analysis

The results of a sensitivity analysis are shown in Tables 8.7 and 8.8.

Table 8.7 Summary of Sensitivity Analyses (No.1)

Financial Parameter and Variation	Sales Price (US$/m^3)	Payout Period (years)	Net Profit (Average Annual) (US$ 1,000)	Cash Flow (Average Annual) (US$ 1,000)
1. IRROI (%)				
. 10	1.70	7.3	317	296
. 15 (Base)	1.85	6.0	473	612
. 20	2.08	4.7	717	859
2. Plant Cost (1,000 US$)				
. 5,740 (– 20%)	1.70	6.0	382	497
. 6,867 (Base)	1.85	6.0	473	612
. 8,486 (+ 20%)	2.00	6.0	560	727
3. Debt/Subsidy Ratio				
. 70/30 (Base)	1.85	6.0	473	612
. 50/50	1.61	6.1	217	449
4. Variable Operating Cost (1,000 US$/Year)				
. 625 (– 20%)	1.70	6.0	470	610
. 782 (Base)	1.85	6.0	473	612
. 939 (+ 20%)	2.00	6.0	472	614
5. On Stream Factor (%)				
. 1st Yr. 80, 2nd Yr. 90, 3rd Yr. ~ 100	1.90	6.1	500	641
. 1st Yr. ~ 100 (Base)	1.85	6.0	473	612
6. Exchange Rate				
. US$ = 61.26 pesos (Base)	1.85	6.0	473	612
. US$ = 67.39 pesos (10% down)	1.92	6.0	501	651

Note: Items 2 to 6 are calculated based on IRROI of 15%

Table 8.8 Summary of Sensitivity Analysis (No.2)

Financial Parameter and Variation	IRROE (%)	Payout Period (Years)	Net Profit (Average Annual) (US$ 1,000)	Cash Flow (Average Annual) (US$ 1,000)
Interest of L.T. Loan (%)				
. 7.5 (Base)	8.08	12.5	265	265
. 10.0 (2.5% up)	7.05	13.3	226	226
. 12.0 (4.5% up)	4.16	15.1	119	81

Note: IRROE is calculated based on sales price of 1.85 US$/m^3

8.4 Evaluation of financial analysis

The profitability and financial status of the Project are evaluated below.

8.4.1 IRR, sales price of product water

In order to discuss the profibtability of this Project, consideration must be first given to the terms and conditions of long-term loans to be taken out to make up the total capital requirements. A comparison between Case IRROI and IRROE shows that the anual interest rate of 7.5%, though relatively low, has a large effect on cash flow during the first half of the projected operating years because of short repayment and grace periods (5 years and 1 year, respectively).

As a matter of fact, short-term loans are introduced from the second year to the ninth year in the Project years and shortages of cash during the years are covered as shown in the computer output sheets.

	IRROI	IRROE
IRR:	15% (Basis)	8.08 %
Payout period:	6.0	12.5
Average annual cash flow:	612	265

Sales price of product water is needed to be 1.85 US$/m^3 on the basis of IRROI = 15%.

8.4.2 Break-even point (IRROE case)

The indicated operating rates at the profit break even point are higher (96.25%) during at the first operating year though they gradually fall off from the second year.

Though sales price at the cash break even point (C.B.E.P.) is 1.41 US$/m^3 at the first operation year, it increases up to 2.40 US$/m^3 at second year which is the starting year of the principal repayment of long-term loans. Sales prices at C.B.E.P. are all above a level of 1.85 US$/m³ during the following five years.

8.4.3 Capacity of repayment of debt

DSR (Debt Service Coverage Ratio) which indicates the capacity of repayment of debt is 0.60 at the year 1986 when repayment starts. This means that very unfavorable financial conditions will be encountered at the second operation year due to the repayment of long-term loans. Accordingly, the introduction of short-term loans will be continued over a considerable period (eight years) from the second operating year.

8.4.4 Evaluation of sensitivity analyses

1) Profitability of project

In order to ensure high profitability of the Project, it is necessary to maintain the sales price of the product water at a higher level. Fig. 8.2 shows sales prices to IRROI variations.

For instant, in order to obtain an IRROI of 20%, the sales price of product water must be raised by US$ 0.23/m³ as shown in Fig. 8.2. It seems that the figure of 15% at IRROI is appropiate level for a basic premise in ths study, since the subsidy is deemed to be earnings. However, the financial status of the Project is not so favorable at the given sales price of product water at the rate of 15% on IRROI, and the operation and management of the project will be virtually difficult in the case of 10% on IRROI.

2) Plant construction cost

There is a possibility that the construction cost may exceed the projected cost due to a delay in the construction schedule, large changes in economic environment as well as other unexpected accidents during construction. The relationship of plant cost variations and sales prices is shown in Fig. 8.3. Where the plant construction cost exceeds the projected amount by 20%, the sales price of product water must be maintained at US$2.00/m³ on an IRROI basis. In other words, such an increase in total investment will exert a large influence on the sales price.

3) Interest rate on long-term loans

The interest rate on long-term loans is one of the factors that will greatly affect the financial status of the Project. Table 8.9 gives the required IRROE for each assumed interest rate.

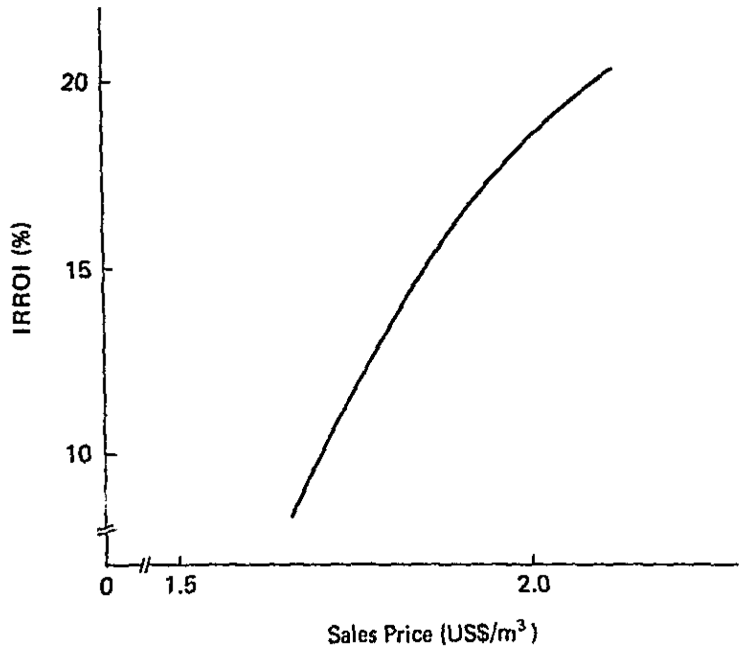


Fig. 8.2 IRROI vs. Sales Price

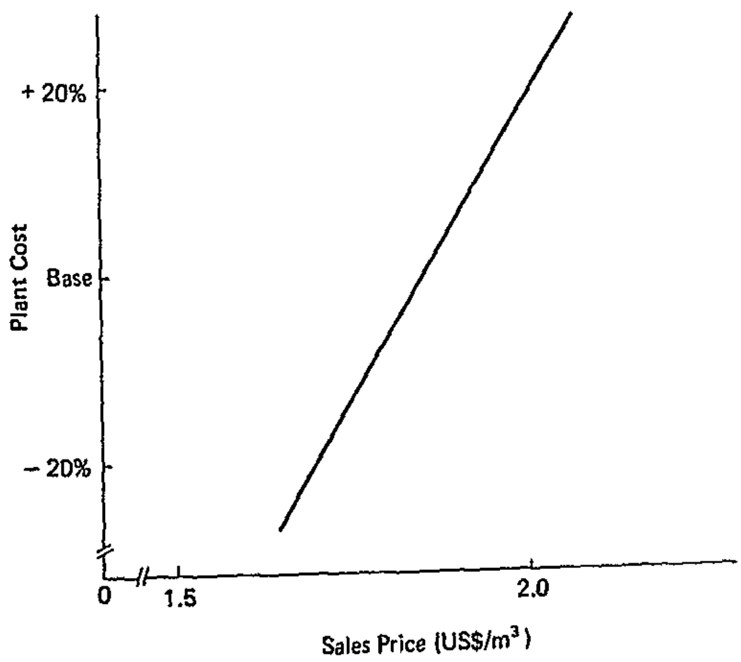


Fig. 8.3 Plant Cost vs. Sales Price

Table 8.9 Interest Rate of Long Term Debt vs. IRROE

Interest Rate	7.5% p.a. (Base)	10% p.a.	12% p.a.
IRROE (%)	8.08	7.05	4.16

From the above table, it can be seen that with increasing interest rate, IRROE values fall rapidly. Accordingly, the use of bank loans at high rates of interest should be avoided as much as possible.

4) Equity (Subsidy)

It is intended that the fund equivalent to equity be covered by governmental subsidy. In the case of IRROI, the increase of subsidy (equity) will immediately lead to a lowering of the sales price of product water (from US$1.85/m^3 to US$1.61/m^3). In order to achieve a supply less-expensive potable water, it is desirable that the amount of subsidy be increased.

5) Variable operating cost

As shown in the before mentioned production cost break down, variable operating cost accounts for the largest portion. This means that the increase or decrease of variable operating costs leads immediately to a rise or fall of the sales price of product water (Table 8.10 below).

Table 8.10 Variable Operating Cost vs. Sales Price

Variable Op. Cost	– 20%	Base	+ 20%
Sales Price (US$/m^3)	1.70	1.85	2.00

Of the operating cost for this Project, electricity cost accounts for the largest portion. It is considered, however, that electric power will be supplied in the future at a stable price by a public enterprise, ELECTROSAN. There is little possibility that operating cost will rise at a large rate.

6) On stream factor

A lowering on stream factor should be avoided because it will result in a decrease of sales revenue. The effect on sales revenues of lowering the on stream factor can be minimized unless it extends over a long period.

7) Exchange rate

Devaluation of the Peso will result in the same effect as an increase in plant construction cost. Table 8.11 shows the rise in sales price in terms of a devaluation of 10%.

Table 8.11 Effect of Exchange Rate

Exchange Rate	1US$ = 61.28 Pesos (Base)	1 US$ = 67.39 Pesos (10% Devaluation)
Sales Price (US$/m^3)	1.85	1.92

8.4.5 Overall evaluation

The purpose of this Project (public work) is to supply potable water to households at a lowest possible price in San Andres Island. Base Case should be made to IRROI in which a subsidy has been deemed to be an earning. In this case, the sales price of product water becomes US$1.85/m^3 (IRROI: 15%) which, however, is considerably higher than the current average water price in US$ 0.3/m^3 (see Chapter 2, 2.1). It should be noted, however, that due to shortage of water supply in San Andres Island, a considerable amount of potable water is being sold using water supply wagons at a very high rate of US$3.3/m^3, in addition to the existing water service system.

It is intended to raise the present potable water rates in the future. There are no possibilities of supplying any other water less costly than the water produced by the projected plant. For the above reasons, the sales price of US$ 1.85/m^3 is considered to be fully acceptable to the inhabitants.

As observed from IRROE, however, the sale of product water at a rate of US$ 1.85/m^3 will render the financial status of the Project considerably unfavorable. This will also result in the introduction of short-term loans for the first half of the projected operating years, during which the repayment of long-term loans will be concentrated. In spite of such unfaovrable financial conditions, it is desirable that the sales price of product water be maintained at a lower level as far as management of the system is possible, with due consideration to the characteristics of waterworks. In order to improve such unfavorable financial status of the Project and thereby enhance the IRR, the repayment period of long-term loans should be extended and the amount of subsidy increased to the maximum possible extent. These measures, if adopted, will serve to minimize the use of short-term loans with high interests.

As mentioned earlier, due to an extreme shortage of water supply within the Island, the earlier implementation of this Project should be fully recognized by the authorities concerned. Measures such as tax exemptions, granting of subsidies, and provision of land without any compensation are being taken by the government. It appears possible to deduce, therefore, that if such measures are taken, the Project will become fully feasible and serve to greatly upgrade the infrastructure of the Island.

Table 8.12

```
11/16/82                    * * *    COLOMBIA SEA WATER DESALINATION PROJECT    * * *                PAGE.  1
                              (      BASE CASE (IRROI 15%)                      )

                                          ... SUMMARY SHEET ...

 1.INTERNAL RATE OF RETURN

   1) IRROI              =  15.0  (%)

 2.SALES PRICE           =  1.45  (USD/M**3)

 3.MAJOR PREMISES

   1) METHODOLOGY          DETERMINE S.PRICE BASED ON IRR(%) INPUT

   2) PRODUCTION CAPACITY

        PRODUCT WATER : 3000 M**3/DAY          (ANNUAL OPERATION DAYS ... 350)

   3) ONSTREAM FACTOR (%)

          YR: 1     YR: 2     YR: 3     YR: 4     YR: 5     YR: 6     YR: 7     YR: 8     YR: 9     YR:10
          100.00    100.00    100.00    100.00    100.00    100.00    100.00    100.00    100.00    100.00

          YR:11     YR:12     YR:13     YR:14     YR:15     YR:16
          100.00    100.00    100.00    100.00    100.00    100.00

   4) TOTAL INVESTMENT       73[illegible]5.  ( 1000USD)

   5) FINANCING STRUCTURE    DEBT    0.00 (%),    EQUITY  100.00 (%)     ( SUBSIDIES ...  30.00 % )

   6) DEBT CONDITION

        DEBT (A)  :  INTEREST   7.50 (%),       ANNUAL     5 INSTALMENTS

   7) DEPRECIATION/AMORTIZATION

        EQUIPMENT & FACILITY             STRAIGHT   ,   16 YEARS,   0.00 % SALVAGE
        CIVIL & BUILDING                 STRAIGHT   ,   25 YEARS,   0.00 % SALVAGE
        PRE-OPERATION COSTS,I.D.C        STRAIGHT   ,    5 YEARS

   8) TAX

        RATE  0.00 % ON TAXABLE INCOME
        GRACE PERIOD :  0 YEARS
        LOSS CARRY FORWARD :  0 YEARS
```

... SUMMARY SHEET ...

4.SALES REVENUE

1) PRODUCT WATER

	YR: 1	YR: 2	YR: 3	YR: 4	YR: 5	YR: 6	YR: 7	YR: 8	YR: 9	YR:10
PRODUCTION (M M**3/Y)	1050.	1050.	1050.	1050.	1050.	1050.	1050.	1050.	1050.	1050.
SALES PRICE (USD/M**3)	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85
SALES REVENUE(1000USD)	1942.	1942.	1942.	1942.	1942.	1942.	1942.	1942.	1942.	1942.

	YR:11	YR:12	YR:13	YR:14	YR:15	YR:16
PRODUCTION (M M**3/Y)	1050.	1050.	1050.	1050.	1050.	1050.
SALES PRICE (USD/M**3)	1.85	1.85	1.55	1.85	1.85	1.85
SALES REVENUE(1000USD)	1942.	1942.	1942.	1942.	1942.	1942.

... SUMMARY SHEET ...

5.OPERATING COSTS

SEE 'DETAILED OPERATING COSTS'

(NOTE) TOTAL OPERATING COSTS ARE SUMMARIZED IN TABLES TITLED (DETAILED OPERATING COSTS).

(BASE CASE (IRRUI 15%))

... INCOME STATEMENTS ...

(1000USD)

YEAR YEAR	(1983) (-2)	(1984) (-1)	(1985) (1)	(1986) (2)	(1987) (3)	(1988) (4)	(1989) (5)	(1990) (6)	(1991) (7)	(1992) (8)
1.SALES REVENUE	0.	0.	1942.	1942.	1942.	1942.	1942.	1942.	1942.	1942.
2.OPERATING COSTS	0.	0.	1088.	1088.	1088.	1088.	1088.	1088.	1088.	1088.
3. VARIABLE OP. COSTS	0.	0.	782.	782.	782.	782.	782.	782.	782.	782.
4. FIXED OP. COSTS	0.	0.	306.	306.	306.	306.	306.	306.	306.	306.
5.CASH INC. B/INT.,DEPR.,TAX	0.	0.	854.	854.	854.	854.	854.	854.	854.	854.
6.DEPRECIATION/AMORTIZATION	0.	0.	415.	415.	415.	415.	415.	366.	366.	366.
7.INTEREST	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
8. ON LONG-TERM DEBT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
9. ON SHORT-TERM DEBT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
10.NET INCOME B/TAX	0.	0.	440.	440.	440.	440.	440.	489.	489.	489.
11.INCOME TAX	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
12.NET INCOME A/TAX	0.	0.	440.	440.	440.	440.	440.	489.	489.	489.

YEAR YEAR	(1993) (9)	(1994) (10)	(1995) (11)	(1996) (12)	(1997) (13)	(1998) (14)	(1999) (15)	(2000) (16)	TOTAL
1.SALES REVENUE	1942.	1942.	1942.	1942.	1942.	1942.	1942.	1942.	31075.
2.OPERATING COSTS	1088.	1088.	1088.	1088.	1088.	1088.	1088.	1088.	17408.
3. VARIABLE OP. COSTS	782.	782.	782.	782.	782.	782.	782.	782.	12512.
4. FIXED OP. COSTS	306.	306.	306.	306.	306.	306.	306.	306.	4896.
5.CASH INC. B/INT.,DEPR.,TAX	854.	854.	854.	854.	854.	854.	854.	854.	13670.
6.DEPRECIATION/AMORTIZATION	366.	366.	366.	366.	366.	366.	366.	366.	6097.
7.INTEREST	0.	0.	0.	0.	0.	0.	0.	0.	0.
8. ON LONG-TERM DEBT	0.	0.	0.	0.	0.	0.	0.	0.	0.
9. ON SHORT-TERM DEBT	0.	0.	0.	0.	0.	0.	0.	0.	0.
10.NET INCOME B/TAX	489.	489.	489.	489.	489.	489.	489.	489.	7573.
11.INCOME TAX	0.	0.	0.	0.	0.	0.	0.	0.	0.

... CASH FLOW STATEMENTS ...

(1000USD)

YEAR	(-2)	(-1)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.SOURCE OF FUNDS										
2. CASH INC. B/INT,DEPR,TAX	0.	0.	854.	854.	854.	854.	854.	854.	854.	854.
3. PAID-IN SHARE CAPITAL	436.	4733.	0.	0.	0.	0.	0.	0.	0.	0.
4. DEBT (LONG-TERM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
5. DEBT (A)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
6. DEBT (SHORT-TERM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
7. SUBSIDIES	187.	2029.	0.	0.	0.	0.	0.	0.	0.	0.
8. =TOTAL SOURCE OF FUNDS=	623.	6762.	854.	854.	854.	854.	854.	854.	854.	854.
9.APPLICATION OF FUNDS										
10. CAPITAL INVESTMENT	623.	6762.	0.	0.	0.	0.	0.	0.	0.	0.
11. FIXED INVESTMENT	597.	6270.	0.	0.	0.	0.	0.	0.	0.	0.
12. PRE-OPERATION COSTS	26.	220.	0.	0.	0.	0.	0.	0.	0.	0.
13. INT. DUR. CONSTRUCTION	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
14. INI. WORKING CAPITAL	0.	272.	0.	0.	0.	0.	0.	0.	0.	0.
15. DEBT SERVICE PAYMENT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
16. REPAYMENT (L-T A)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
17. INTEREST (L-T A)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
18. REPAYMENT (S-T)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
19. INTEREST (S-T)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
20. INC. WORKING CAPITAL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
21. INCOME TAX PAYMENT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
22. DIVIDEND	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
23. =TOTAL APPLICAT. OF FUND=	623.	6762.	0.	0.	0.	0.	0.	0.	0.	0.
24.CASH INCREASE(OR DECREASE)	0.	0.	854.	854.	854.	854.	854.	854.	854.	854.
25.ABOVE CUMULATIVE	0.	0.	854.	1709.	2563.	3418.	4272.	5126.	5981.	6835.
26.W.CAPITAL RETURN, OTHERS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
27.CASH FLOW ON IRROI										
28. CASH FLOW	-436.	-4733.	854.	854.	854.	854.	854.	854.	854.	854.
29. DISCOUNT FACTOR	1.00000	0.86984	0.75662	0.65813	0.57247	0.49795	0.43314	0.37676	0.32772	0.28506
30. DISCOUNTED CASH FLOW	-436.	-4117.	646.	562.	489.	425.	370.	322.	280.	244.

Note: In this calculation, Interest during Construction is excluded from the Total Capital Requirements.

... CASH FLOW STATEMENTS ...

(1000USD)

YEAR	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	TOTAL
1.SOURCE OF FUNDS									
2. CASH INC. B/INT.DEPR,TAX	854.	854.	854.	854.	854.	854.	854.	854.	13670.
3. PAID-IN SHARE CAPITAL	0.	0.	0.	0.	0.	0.	0.	0.	5169.
4. DEBT (LONG-TERM)	0.	0.	0.	0.	0.	0.	0.	0.	0.
5. DEBT (A)	0.	0.	0.	0.	0.	0.	0.	0.	0.
6. DEBT (SHORT-TERM)	0.	0.	0.	0.	0.	0.	0.	0.	0.
7. SUBSIDIES	0.	0.	0.	0.	0.	0.	0.	0.	2215.
8. =TOTAL SOURCE OF FUNDS=	854.	854.	854.	854.	854.	854.	854.	854.	21055.
9.APPLICATION OF FUNDS									
10. CAPITAL INVESTMENT	0.	0.	0.	0.	0.	0.	0.	0.	7385.
11. FIXED INVESTMENT	0.	0.	0.	0.	0.	0.	0.	0.	6867.
12. PRE-OPERATION COSTS	0.	0.	0.	0.	0.	0.	0.	0.	246.
13. INT. DUR. CONSTRUCTION	0.	0.	0.	0.	0.	0.	0.	0.	0.
14. INI. WORKING CAPITAL	0.	0.	0.	0.	0.	0.	0.	0.	272.
15. DEBT SERVICE PAYMENT	0.	0.	0.	0.	0.	0.	0.	0.	0.
16. REPAYMENT (L-T A)	0.	0.	0.	0.	0.	0.	0.	0.	0.
17. INTEREST (L-T A)	0.	0.	0.	0.	0.	0.	0.	0.	0.
18. REPAYMENT (S-T)	0.	0.	0.	0.	0.	0.	0.	0.	0.
19. INTEREST (S-T)	0.	0.	0.	0.	0.	0.	0.	0.	0.
20. INC. WORKING CAPITAL	0.	0.	0.	0.	0.	0.	0.	0.	0.
21. INCOME TAX PAYMENT	0.	0.	0.	0.	0.	0.	0.	0.	0.
22. DIVIDEND	0.	0.	0.	0.	0.	0.	0.	0.	0.
23. =TOTAL APPLICAT. OF FUND=	0.	0.	0.	0.	0.	0.	0.	0.	7385.
24.CASH INCREASE(OR DECREASE)	854.	854.	854.	854.	854.	854.	854.	854.	13670.
25.ABOVE CUMULATIVE	7689.	8544.	9398.	10253.	11107.	11961.	12816.	13670.	0.
26.W.CAPITAL RETURN, OTHERS	0.	0.	0.	0.	0.	0.	0.	1288.	1288.
27.CASH FLOW ON IRROI									
28. CASH FLOW	854.	854.	854.	854.	854.	854.	854.	2142.	9789.
29. DISCOUNT FACTOR	0.24796	0.21565	0.18761	0.16319	0.14195	0.12347	0.10740	0.09342	0.00000
30. DISCOUNTED CASH FLOW	212.	184.	160.	139.	121.	105.	92.	200.	0.

... BALANCE SHEET ...

(1000USD)

YEAR	(-2)	(-1)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.ASSETS	623.	7385.	7889.	8329.	8768.	9208.	9646.	10136.	10625.	11114.
2. CASH FROM OPERATION	0.	0.	854.	1709.	2563.	3418.	4272.	5126.	5981.	6835.
3. CURRENT ASSETS	0.	272.	337.	337.	337.	337.	337.	337.	337.	337.
4. NET FIXED ASSETS	623.	7113.	6698.	6283.	5868.	5454.	5039.	4673.	4307.	3942.
5. INVESTMENTS	623.	7113.	7113.	7113.	7113.	7113.	7113.	7113.	7113.	7113.
6. LESS ACCM. DEPR.(AMORT)	0.	0.	415.	830.	1245.	1659.	2074.	2440.	2806.	3171.
7.LIABILITIES	0.	0.	65.	65.	65.	65.	65.	65.	65.	65.
8. CURRENT LIABILITIES	0.	0.	65.	65.	65.	65.	65.	65.	65.	65.
9. FIXED LIABILITIES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
10. LONG-TERM DEBT (A)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
11.EQUITY	623.	7385.	7824.	8264.	8703.	9143.	9582.	10071.	10560.	11048.
12. SHARE CAPITAL (IN. SUB.)	623.	7385.	7385.	7385.	7385.	7385.	7385.	7385.	7385.	7385.
13. RETAINED EARNING	0.	0.	440.	879.	1319.	1758.	2198.	2686.	3175.	3664.

... WORKING CAPITAL ...

(1000USD)

YEAR	(-2)	(-1)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.CURRENT ASSETS	0.	272.	337.	337.	337.	337.	337.	337.	337.	337.
2. CASH	0.	272.	5.	5.	5.	5.	5.	5.	5.	5.
3. ACCOUNTS RECEIVABLE	0.	0.	162.	162.	162.	162.	162.	162.	162.	162.
4. SPARE PARTS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
5. INVENTORY	0.	0.	170.	170.	170.	170.	170.	170.	170.	170.
6. PRODUCTS	0.	0.	162.	162.	162.	162.	162.	162.	162.	162.
7. MATERIALS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
8. CHEMICALS	0.	0.	8.	8.	8.	8.	8.	8.	8.	8.
9.CURRENT LIABILITIES	0.	0.	65.	65.	65.	65.	65.	65.	65.	65.
10. ACCOUNTS PAYABLE	0.	0.	65.	65.	65.	65.	65.	65.	65.	65.
11. CURRENT PORTION OF DEBT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
12. LONG-TERM DEBT (A)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
13. SHORT-TERM DEBT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
14.W.C.(EX. CURR. PORT. DEBT)	0.	272.	272.	272.	272.	272.	272.	272.	272.	272.
15.INCREASE WORKING CAPITAL	0.	272.	0.	0.	0.	0.	0.	0.	0.	0.

... BALANCE SHEET ...

(1000USD)

YEAR	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1.ASSETS	11602.	12091.	12580.	13068.	13557.	14046.	14535.	15023.
2. CASH FROM OPERATION	7689.	8544.	9398.	10253.	11107.	11961.	12816.	13670.
3. CURRENT ASSETS	337.	337.	337.	337.	337.	337.	337.	337.
4. NET FIXED ASSETS	3576.	3210.	2845.	2479.	2113.	1748.	1382.	1016.
5. INVESTMENTS	7113.	7113.	7113.	7113.	7113.	7113.	7113.	7113.
6. LESS ACCM. DEPR.+AMORT	3537.	3903.	4268.	4634.	5000.	5365.	5731.	6097.
7.LIABILITIES	65.	65.	65.	65.	65.	65.	65.	65.
8. CURRENT LIABILITIES	65.	65.	65.	65.	65.	65.	65.	65.
9. FIXED LIABILITIES	0.	0.	0.	0.	0.	0.	0.	0.
10. LONG-TERM DEBT (A)	0.	0.	0.	0.	0.	0.	0.	0.
11.EQUITY	11537.	12026.	12515.	13003.	13492.	13981.	14469.	14958.
12. SHARE CAPITAL (IN. SUB.)	7385.	7385.	7385.	7385.	7385.	7385.	7385.	7385.
13. RETAINED EARNING	4152.	4641.	5130.	5618.	6107.	6596.	7085.	7573.

... WORKING CAPITAL ...

(1000USD)

YEAR	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1.CURRENT ASSETS	337.	337.	337.	337.	337.	337.	337.	337.
2. CASH	5.	5.	5.	5.	5.	5.	5.	5.
3. ACCOUNTS RECEIVABLE	162.	162.	162.	162.	162.	162.	162.	162.
4. SPARE PARTS	0.	0.	0.	0.	0.	0.	0.	0.
5. INVENTORY	170.	170.	170.	170.	170.	170.	170.	170.
6. PRODUCTS	162.	162.	162.	162.	162.	162.	162.	162.
7. MATERIALS	0.	0.	0.	0.	0.	0.	0.	0.
8. CHEMICALS	8.	8.	8.	8.	8.	8.	8.	8.
9.CURRENT LIABILITIES	65.	65.	65.	65.	65.	65.	65.	65.
10. ACCOUNTS PAYABLE	65.	65.	65.	65.	65.	65.	65.	65.
11. CURRENT PORTION OF DEBT	0.	0.	0.	0.	0.	0.	0.	0.
12. LONG-TERM DEBT (A)	0.	0.	0.	0.	0.	0.	0.	0.
13. SHORT-TERM DEBT	0.	0.	0.	0.	0.	0.	0.	0.
14.W.C.(EX. CURR. PORT. DEBT)	272.	272.	272.	272.	272.	272.	272.	272.
15.INCREASE WORKING CAPITAL	0.	0.	0.	0.	0.	0.	0.	0.

... DETAILED OPERATING COSTS ...

(1000USD)

YEAR	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1.VARIABLE OPERATING COSTS	782.	782.	782.	782.	782.	782.	782.	782.	782.	782.
2. ELECTRICITY	685.	685.	685.	685.	685.	685.	685.	685.	685.	685.
3. FERRIC CHLORIDE	9.	9.	9.	9.	9.	9.	9.	9.	9.	9.
4. SULFURIC ACID	63.	63.	63.	63.	63.	63.	63.	63.	63.	63.
5. CAUSTIC SODA	13.	13.	13.	13.	13.	13.	13.	13.	13.	13.
6. CITRIC ACID	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.
7. AQUEOUS AMMONIA	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.
8.FIXED OPERATING COSTS	306.	306.	306.	306.	306.	306.	306.	306.	306.	306.
9. OPERATION LABOR COST	62.	62.	62.	62.	62.	62.	62.	62.	62.	62.
10. MAINTENANCE COST	206.	206.	206.	206.	206.	206.	206.	206.	206.	206.
11. GENERAL EXPENSE	38.	38.	38.	38.	38.	38.	38.	38.	38.	38.
12.TOTAL OPERATING COSTS	1088.	1088.	1088.	1088.	1088.	1088.	1088.	1088.	1088.	1088.
13.UNIT OPERATING COSTS(W.AV)	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04

YEAR	(11)	(12)	(13)	(14)	(15)	(16)	TOTAL
1.VARIABLE OPERATING COSTS	782.	782.	782.	782.	782.	782.	12512.
2. ELECTRICITY	685.	685.	685.	685.	685.	685.	10960.
3. FERRIC CHLORIDE	9.	9.	9.	9.	9.	9.	144.
4. SULFURIC ACID	63.	63.	63.	63.	63.	63.	1008.
5. CAUSTIC SODA	13.	13.	13.	13.	13.	13.	208.
6. CITRIC ACID	10.	10.	10.	10.	10.	10.	160.
7. AQUEOUS AMMONIA	2.	2.	2.	2.	2.	2.	32.
8.FIXED OPERATING COSTS	306.	306.	306.	306.	306.	306.	4896.
9. OPERATION LABOR COST	62.	62.	62.	62.	62.	62.	992.
10. MAINTENANCE COST	206.	206.	206.	206.	206.	206.	3296.
11. GENERAL EXPENSE	38.	38.	38.	38.	38.	38.	608.
12.TOTAL OPERATING COSTS	1088.	1088.	1088.	1088.	1088.	1088.	17408.
13.UNIT OPERATING COSTS(W.AV)	1.04	1.04	1.04	1.04	1.04	1.04	1.04

... FINANCIAL PERFORMANCE INDICATORS ...

(1000USD)

YEAR	(-2)	(-1)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.LONG-TERM DEBT/EQUITY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.CURRENT RATIO	0.00	0.00	18.28	31.39	44.50	57.61	70.72	83.83	96.95	110.06
3.QUICK RATIO	0.00	0.00	15.67	28.78	41.89	55.01	68.12	81.23	94.34	107.45
4.DEBT SERVICE COVERAGE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.RETURN B/TAX ON EQUITY (%)	0.00	0.00	5.95	5.95	5.95	5.95	5.95	6.62	6.62	6.62
6.RETURN A/TAX ON EQUITY (%)	0.00	0.00	5.95	5.95	5.95	5.95	5.95	6.62	6.62	6.62
7.RETURN A/TAX ON SALES (%)	0.00	0.00	22.63	22.63	22.63	22.53	22.63	25.16	25.16	25.16
8.PAYOUT PERIOD	[illegible]	-5169.	-4315.	-3461.	-2606.	-1752.	-897.	-43.	811.	1666.
9.PROFIT B.E.P. CAP. UTIL(%)	0.00	0.00	62.12	62.12	62.12	62.12	62.12	57.88	57.88	57.88
10.CASH B.E.P. SALES PRICE($)	0.00	0.00	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04

YEAR	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1.LONG-TERM DEBT/EQUITY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.CURRENT RATIO	123.17	136.28	149.39	162.50	175.61	188.72	201.83	214.94
3.QUICK RATIO	120.56	133.67	146.78	159.89	173.00	186.11	199.22	212.33
4.DEBT SERVICE COVERAGE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.RETURN B/TAX ON EQUITY (%)	6.62	6.62	6.62	6.62	6.62	6.62	6.62	6.62
6.RETURN A/TAX ON EQUITY (%)	6.62	6.62	6.62	6.62	6.62	6.62	6.62	6.62
7.RETURN A/TAX ON SALES (%)	25.16	25.16	25.16	25.16	25.16	25.16	25.16	25.16
8.PAYOUT PERIOD	2520.	3374.	4229.	5083.	5938.	6792.	7646.	9789.
9.PROFIT B.E.P. CAP. UTIL(%)	57.88	57.88	57.88	57.88	57.88	57.88	57.88	57.88

... SUMMARY SHEET ...

1.INTERNAL RATE OF RETURN

1) IRROE = 8.05 (%)

2.SALES PRICE = 1.45 (USD/M**3)

3.MAJOR PREMISES

1) METHODOLOGY DETERMINE IRR(Y) BASED ON S.PRICE INPUT

2) PRODUCTION CAPACITY

PRODUCT WATER : 3000 M**3/DAY (ANNUAL OPERATION DAYS ... 350)

3) ONSTREAM FACTOR (%)

YR: 1	YR: 2	YR: 3	YR: 4	YR: 5	YR: 6	YR: 7	YR: 8	YR: 9	YR:10
100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
YR:11	YR:12	YR:13	YR:14	YR:15	YR:16				
100.00	100.00	100.00	100.00	100.00	100.00				

4) TOTAL INVESTMENT 7415. (1000USD)

5) FINANCING STRUCTURE DEBT 70.00 (%), EQUITY 30.00 (%)

6) DEBT CONDITION

DEBT (A) : INTEREST 7.50 %, ANNUAL 5 INSTALMENTS

7) DEPRECIATION/AMORTIZATION

EQUIPMENT & FACILITY	STRAIGHT ,	16 YEARS,	0.00 % SALVAGE
CIVIL & BUILDING	STRAIGHT ,	25 YEARS,	0.00 % SALVAGE
PRE-OPERATION COSTS,I.D.C	STRAIGHT ,	5 YEARS	

8) TAX

RATE 0.00 % ON TAXABLE INCOME
GRACE PERIOD : 0 YEARS
LOSS CARRY FORWARD : 0 YEARS

... SUMMARY SHEET ...

4.SALES REVENUE

1) PRODUCT WATER

	YR: 1	YR: 2	YR: 3	YR: 4	YR: 5	YR: 6	YR: 7	YR: 8	YR: 9	YR:10
PRODUCTION (M M**3/Y)	1050.	1050.	1050.	1050.	1050.	1050.	1050.	1050.	1050.	1050.
SALES PRICE (USD/M**3)	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85
SALES REVENUE(1000USD)	1942.	1942.	1942.	1942.	1942.	1942.	1942.	1942.	1942.	1942.

	YR:11	YR:12	YR:13	YR:14	YR:15	YR:16
PRODUCTION (M M**3/Y)	1050.	1050.	1050.	1050.	1050.	1050.
SALES PRICE (USD/M**3)	1.85	1.85	1.85	1.85	1.85	1.85
SALES REVENUE(1000USD)	1942.	1942.	1942.	1942.	1942.	1942.

... SUMMARY SHEET ...

5.OPERATING COSTS

SEE 'DETAILED OPERATING COSTS'

(NOTE) TOTAL OPERATING COSTS ARE SUMMARIZED IN TABLES TITLED (DETAILED OPERATING COSTS).

... INCOME STATEMENTS ...

(1000USD)

YEAR YEAR	(1983) (-2)	(1984) (-1)	(1985) (1)	(1986) (2)	(1987) (3)	(1988) (4)	(1989) (5)	(1990) (6)	(1991) (7)	(1992) (8)
1.SALES REVENU-	0.	0.	1942.	1942.	1942.	1942.	1942.	1942.	1942.	1942.
2.OPERATING COSTS	0.	0.	1088.	1088.	1088.	1088.	1088.	1088.	1088.	1088.
3. VARIABLE OP. COSTS	0.	0.	782.	782.	782.	782.	782.	782.	782.	782.
4. FIXED OP. COSTS	0.	0.	306.	306.	306.	306.	306.	306.	306.	306.
5.CASH INC. B/INT.,DEPR.,TAX	0.	0.	854.	854.	854.	854.	854.	854.	854.	854.
6.DEPRECIATION/AMORTIZATION	0.	0.	421.	421.	421.	421.	421.	366.	366.	366.
7.INTEREST	0.	0.	389.	389.	331.	346.	363.	384.	408.	328.
8. ON LONG-TERM DEBT	0.	0.	389.	389.	312.	234.	156.	78.	0.	0.
9. ON SHORT-TERM DEBT	0.	0.	0.	0.	20.	112.	208.	305.	408.	328.
10.NET INCOME B/TAX	0.	0.	44.	44.	102.	87.	70.	105.	80.	160.
11.INCOME TAX	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
12.NET INCOME A/TAX	0.	0.	44.	44.	102.	87.	70.	105.	80.	160.

YEAR YEAR	(1993) (9)	(1994) (10)	(1995) (11)	(1996) (12)	(1997) (13)	(1998) (14)	(1999) (15)	(2000) (16)	TOTAL
1.SALES REVENUE	1942.	1942.	1942.	1942.	1942.	1942.	1942.	1942.	31078.
2.OPERATING COSTS	1088.	1088.	1088.	1088.	1088.	1088.	1088.	1088.	17408.
3. VARIABLE OP. COSTS	782.	782.	782.	782.	782.	782.	782.	782.	12512.
4. FIXED OP. COSTS	306.	306.	306.	306.	306.	306.	306.	306.	4896.
5.CASH INC. B/INT.,DEPR.,TAX	854.	854.	854.	854.	854.	854.	854.	854.	13670.
6.DEPRECIATION/AMORTIZATION	366.	366.	366.	366.	366.	366.	366.	366.	6129.
7.INTEREST	234.	122.	0.	0.	0.	0.	0.	0.	3295.
8. ON LONG-TERM DEBT	0.	0.	0.	0.	0.	0.	0.	0.	1556.
9. ON SHORT-TERM DEBT	234.	122.	0.	0.	0.	0.	0.	0.	1738.
10.NET INCOME B/TAX	255.	367.	489.	489.	489.	489.	489.	489.	4245.
11.INCOME TAX	0.	0.	0.	0.	0.	0.	0.	0.	0.
12.NET INCOME A/TAX	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

... CASH FLOW STATEMENTS ...

(1000USD)

YEAR	(-2)	(-1)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.SOURCE OF FUNDS										
2. CASH INC. B/INT,DEPR,TAX	0.	0.	854.	854.	854.	854.	854.	854.	854.	854.
3. SUBSIDIES	187.	2035.	0.	0.	0.	0.	0.	0.	0.	0.
4. DEBT (LONG-TERM)	435.	4755.	0.	0.	0.	0.	0.	0.	0.	0.
5. DEBT (A)	436.	4756.	0.	0.	0.	0.	0.	0.	0.	0.
6. DEBT (SHORT-TERM)	0.	0.	0.	109.	624.	1154.	1701.	2269.	1823.	1297.
7. =TOTAL SOURCE OF FUNDS=	623.	6795.	854.	963.	1473.	2003.	2556.	3124.	2673.	2152.
8.APPLICATION OF FUNDS										
9. CAPITAL INVESTMENT	623.	6795.	0.	0.	0.	0.	0.	0.	0.	0.
10. FIXED INVESTMENT	597.	6270.	0.	0.	0.	0.	0.	0.	0.	0.
11. PRE-OPERATION COSTS	25.	220.	0.	0.	0.	0.	0.	0.	0.	0.
12. INT. DUR. CONSTRUCTION	0.	33.	0.	0.	0.	0.	0.	0.	0.	0.
13. INI. WORKING CAPITAL	0.	272.	0.	0.	0.	0.	0.	0.	0.	0.
14. DEBT SERVICE PAYMENT	0.	0.	389.	1428.	1473.	2003.	2556.	3124.	2673.	2152.
15. REPAYMENT (L-T A)	0.	0.	0.	1033.	1033.	1033.	1033.	1033.	0.	0.
16. INTEREST (L-T A)	0.	0.	359.	395.	312.	234.	156.	78.	0.	0.
17. REPAYMENT (S-T)	0.	0.	0.	0.	109.	624.	1154.	1701.	2269.	1823.
18. INTEREST (S-T)	0.	0.	0.	0.	20.	112.	208.	305.	403.	329.
19. INC. WORKING CAPITAL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
20. INCOME TAX PAYMENT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
21. DIVIDEND	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
22. =TOTAL APPLICAT. OF FUNDS=	623.	6795.	389.	1428.	1473.	2003.	2556.	3124.	2673.	2152.
23.CASH INCREASE(OR DECREASE)	0.	0.	465.	-465.	0.	0.	0.	0.	0.	0.
24.ABOVE CUMULATIVE	0.	0.	465.	0.	0.	0.	0.	0.	0.	0.
25.W.CAPITAL RETURN, OTHERS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
26.CASH FLOW ON IRROE										
27. CASH FLOW	-187.	-2035.	465.	-465.	0.	0.	0.	0.	0.	0.
28. DISCOUNT FACTOR	1.00000	0.92522	0.85603	0.79201	0.73279	0.67799	0.62729	0.58038	0.53697	0.49682
29. DISCOUNTED CASH FLOW	-187.	-1886.	398.	-368.	0.	0.	0.	0.	0.	0.

... CASH FLOW STATEMENTS ...

(1000USD)

YEAR	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	TOTAL
1.SOURCE OF FUNDS									
2. CASH INC. B/INT,DEPR,TAX	854.	854.	854.	854.	854.	854.	854.	854.	13670.
3. SUBSIDIES	0.	0.	0.	0.	0.	0.	0.	0.	2225.
4. DEBT (LONG-TERM)	0.	0.	0.	0.	0.	0.	0.	0.	5192.
5. DEBT (A)	0.	0.	0.	0.	0.	0.	0.	0.	5192.
6. DEBT (SHORT-TERM)	676.	0.	0.	0.	0.	0.	0.	0.	9654.
7. =TOTAL SOURCE OF FUNDS=	1531.	854.	854.	854.	854.	854.	854.	854.	30741.
8.APPLICATION OF FUNDS									
9. CAPITAL INVESTMENT	0.	0.	0.	0.	0.	0.	0.	0.	7418.
10. FIXED INVESTMENT	0.	0.	0.	0.	0.	0.	0.	0.	6867.
11. PRE-OPERATION COSTS	0.	0.	0.	0.	0.	0.	0.	0.	246.
12. INT. DUR. CONSTRUCTION	0.	0.	0.	0.	0.	0.	0.	0.	33.
13. INI. WORKING CAPITAL	0.	0.	0.	0.	0.	0.	0.	0.	272.
14. DEBT SERVICE PAYMENT	1531.	798.	0.	0.	0.	0.	0.	0.	18141.
15. REPAYMENT (L-T A)	0.	0.	0.	0.	0.	0.	0.	0.	5192.
16. INTEREST (L-T A)	0.	0.	0.	0.	0.	0.	0.	0.	1558.
17. REPAYMENT (S-T)	1297.	675.	0.	0.	0.	0.	0.	0.	9654.
18. INTEREST (S-T)	234.	122.	0.	0.	0.	0.	0.	0.	1738.
19. INC. WORKING CAPITAL	0.	0.	0.	0.	0.	0.	0.	0.	0.
20. INCOME TAX PAYMENT	0.	0.	0.	0.	0.	0.	0.	0.	0.
21. DIVIDEND	0.	0.	0.	0.	0.	0.	0.	0.	0.
22. =TOTAL APPLICAT. OF FUND=	1531.	798.	0.	0.	0.	0.	0.	0.	25559.
23.CASH INCREASE(OR DECREASE)	0.	56.	854.	854.	854.	854.	854.	854.	5182.
24.ABOVE CUMULATIVE	0.	56.	910.	1765.	2619.	3474.	4328.	5182.	0.
25.W.CAPITAL RETURN, OTHERS	0.	0.	0.	0.	0.	0.	0.	1288.	1288.
25.CASH FLOW ON IRROE									
27. CASH FLOW	0.	56.	854.	854.	854.	854.	854.	2142.	4245.
29. DISCOUNT FACTOR	0.45967	0.42529	0.39349	0.36406	0.33684	0.31165	0.28834	0.26678	0.00000
25. DISCOUNTED CASH FLOW	0.	24.	336.	311.	288.	266.	246.	572.	0.

*** BALANCE SHEET ***

(1000USD)

YEAR	(-2)	(-1)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1. ASSETS	523.	7418.	7525.	6640.	6218.	5797.	5376.	5010.	4644.	4279.
2. CASH FROM OPERATION	0.	0.	465.	-0.	-0.	-0.	-0.	-0.	-0.	-0.
3. CURRENT ASSETS	0.	272.	337.	337.	337.	337.	337.	337.	337.	337.
4. NET FIXED ASSETS	623.	7146.	6724.	6303.	5881.	5460.	5039.	4673.	4307.	3942.
5. INVESTMENTS	623.	7146.	7146.	7146.	7145.	7146.	7146.	7146.	7146.	7146.
6. LESS ACCM. DEPR.&AMORT	0.	0.	421.	843.	1264.	1686.	2107.	2473.	2838.	3204.
7. LIABILITIES	436.	5192.	5257.	4328.	3804.	3296.	2805.	2335.	1889.	1363.
8. CURRENT LIABILITIES	0.	0.	1104.	1212.	1727.	2257.	2805.	2335.	1889.	1363.
9. FIXED LIABILITIES	436.	5192.	4154.	3115.	2077.	1038.	0.	0.	0.	0.
10. LONG-TERM DEBT (A)	436.	5192.	4154.	3115.	2077.	1038.	0.	0.	0.	0.
11. EQUITY	187.	2225.	2269.	2312.	2414.	2501.	2571.	2675.	2756.	2916.
12. SUBSIDIES	187.	2225.	2225.	2225.	2225.	2225.	2225.	2225.	2225.	2225.
13. RETAINED EARNING	0.	0.	44.	87.	189.	276.	346.	450.	530.	691.

*** WORKING CAPITAL ***

(1000USD)

YEAR	(-2)	(-1)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1. CURRENT ASSETS	0.	272.	337.	337.	337.	337.	337.	337.	337.	337.
2. CASH	0.	272.	5.	5.	5.	5.	5.	5.	5.	5.
3. ACCOUNTS RECEIVABLE	0.	0.	162.	162.	162.	162.	162.	162.	162.	162.
4. SPARE PARTS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
5. INVENTORY	0.	0.	170.	170.	170.	170.	170.	170.	170.	170.
6. PRODUCTS	0.	0.	162.	162.	162.	162.	162.	162.	162.	162.
7. MATERIALS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
8. CHEMICALS	0.	0.	8.	8.	8.	8.	8.	8.	8.	8.
9. CURRENT LIABILITIES	0.	0.	1104.	1212.	1727.	2257.	2805.	2335.	1889.	1363.
10. ACCOUNTS PAYABLE	0.	0.	65.	65.	65.	65.	65.	65.	65.	65.
11. CURRENT PORTION OF DEBT	0.	0.	1038.	1147.	1662.	2192.	2740.	2269.	1823.	1297.
12. LONG-TERM DEBT (A)	0.	0.	1039.	1038.	1038.	1038.	1038.	0.	0.	0.
13. SHORT-TERM DEBT	0.	0.	0.	109.	624.	1154.	1701.	2269.	1823.	1297.
14. W.C.(EX. CURR. PORT. DEBT)	0.	272.	272.	272.	272.	272.	272.	272.	272.	272.
15. INCREASE WORKING CAPITAL	0.	272.	0.	0.	0.	0.	0.	0.	0.	0.

... BALANCE SHEET ...

(1000USD)

YEAR	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1.ASSETS	3913.	3603.	4092.	4581.	5070.	5558.	6047.	6536.
2. CASH FROM OPERATION	-0.	56.	910.	1765.	2619.	3474.	4326.	5182.
3. CURRENT ASSETS	337.	337.	337.	337.	337.	337.	337.	337.
4. NET FIXED ASSETS	3576.	3210.	2845.	2479.	2113.	1748.	1382.	1016.
5. INVESTMENTS	7146.	7146.	7146.	7146.	7146.	7146.	7146.	7146.
6. LESS ACC. DEPR.&AMORT	3570.	3935.	4301.	4667.	5033.	5398.	5764.	6129.
7.LIABILITIES	742.	65.	65.	65.	65.	65.	65.	65.
8. CURRENT LIABILITIES	742.	65.	65.	65.	65.	65.	65.	65.
9. FIXED LIABILITIES	0.	0.	0.	0.	0.	0.	0.	0.
10. LONG-TERM DEBT (A)	0.	0.	0.	0.	0.	0.	0.	0.
11.EQUITY	3171.	3538.	4027.	4516.	5004.	5493.	5982.	6470.
12. SUBSIDIES	2225.	2225.	2225.	2225.	2225.	2225.	2225.	2225.
13. RETAINED EARNING	946.	1313.	1802.	2290.	2779.	3268.	3757.	4245.

... WORKING CAPITAL ...

(1000USD)

YEAR	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1.CURRENT ASSETS	337.	337.	337.	337.	337.	337.	337.	337.
2. CASH	5.	5.	5.	5.	5.	5.	5.	5.
3. ACCOUNTS RECEIVABLE	162.	162.	162.	162.	162.	162.	162.	162.
4. SPARE PARTS	0.	0.	0.	0.	0.	0.	0.	0.
5. INVENTORY	170.	170.	170.	170.	170.	170.	170.	170.
6. PRODUCTS	162.	162.	162.	162.	162.	162.	162.	162.
7. MATERIALS	0.	0.	0.	0.	0.	0.	0.	0.
8. CHEMICALS	8.	8.	8.	8.	9.	8.	8.	8.
9.CURRENT LIABILITIES	742.	65.	65.	65.	65.	65.	65.	65.
10. ACCOUNTS PAYABLE	65.	65.	65.	65.	65.	65.	65.	65.
11. CURRENT PORTION OF DEBT	676.	0.	0.	0.	0.	0.	0.	0.
12. LONG-TERM DEBT (A)	0.	0.	0.	0.	0.	0.	0.	0.
13. SHORT-TERM DEBT	576.	0.	0.	0.	0.	0.	0.	0.
14.W.C.(EX. CURR. PORT. DEBT)	272.	272.	272.	272.	272.	272.	272.	272.
15.INCREASE WORKING CAPITAL	0.	0.	0.	0.	0.	0.	0.	0.

... DETAILED OPERATING COSTS ...

(1000USD)

YEAR	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1.VARIABLE OPERATING COSTS	782.	782.	782.	782.	782.	782.	782.	782.	782.	782.
2. ELECTRICITY	685.	685.	685.	685.	685.	685.	685.	685.	685.	685.
3. FERRIC CHLORIDE	9.	9.	9.	9.	9.	9.	9.	9.	9.	9.
4. SULFURIC ACID	63.	63.	63.	63.	63.	63.	63.	63.	63.	63.
5. CAUSTIC SODA	13.	13.	13.	13.	13.	13.	13.	13.	13.	13.
6. CITRIC ACID	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.
7. AQUEOUS AMMONIA	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.
8.FIXED OPERATING COSTS	306.	306.	306.	306.	306.	306.	306.	306.	306.	306.
9. OPERATION LABOR COST	62.	62.	62.	62.	62.	62.	62.	62.	62.	62.
10. MAINTENANCE COST	206.	206.	206.	206.	206.	206.	206.	206.	206.	206.
11. GENERAL EXPENSE	38.	38.	38.	38.	38.	38.	38.	38.	38.	38.
12.TOTAL OPERATING COSTS	1088.	1088.	1088.	1088.	1088.	1088.	1088.	1088.	1088.	1088.
13.UNIT OPERATING COSTS(W.AV)	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04

YEAR	(11)	(12)	(13)	(14)	(15)	(16)	TOTAL
1.VARIABLE OPERATING COSTS	782.	782.	782.	782.	782.	782.	12512.
2. ELECTRICITY	685.	685.	685.	685.	685.	685.	10960.
3. FERRIC CHLORIDE	9.	9.	9.	9.	9.	9.	144.
4. SULFURIC ACID	63.	63.	63.	63.	63.	63.	1008.
5. CAUSTIC SODA	13.	13.	13.	13.	13.	13.	208.
6. CITRIC ACID	10.	10.	10.	10.	10.	10.	160.
7. AQUEOUS AMMONIA	2.	2.	2.	2.	2.	2.	32.
8.FIXED OPERATING COSTS	306.	306.	306.	306.	306.	306.	4896.
9. OPERATION LABOR COST	62.	62.	62.	62.	62.	62.	992.
10. MAINTENANCE COST	206.	206.	206.	206.	206.	206.	3295.
11. GENERAL EXPENSE	38.	38.	38.	38.	38.	38.	608.
12.TOTAL OPERATING COSTS	1088.	1088.	1088.	1088.	1088.	1088.	17402.
13.UNIT OPERATING COSTS(W.AV)	1.04	1.04	1.04	1.04	1.04	1.04	1.04

... FINANCIAL PERFORMANCE INDICATORS ...

(1000USD)

YEAR	(-2)	(-1)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.LONG-TERM DEBT/EQUITY	2.33	2.33	1.83	1.35	0.86	0.42	0.00	0.00	0.00	0.00
2.CURRENT RATIO	0.00	0.00	0.73	0.28	0.20	0.15	0.12	0.14	0.18	0.25
3.QUICK RATIO	0.00	0.00	0.57	0.14	0.10	0.07	0.06	0.07	0.09	0.12
4.DEBT SERVICE COVERAGE	0.00	0.00	2.19	0.50	3.58	0.43	0.33	0.27	0.32	0.40
5.RETURN B/TAX ON EQUITY (%)	0.00	0.00	1.96	1.76	4.58	3.91	3.12	4.70	3.60	7.21
6.RETURN A/TAX ON EQUITY (%)	0.00	0.00	1.96	1.96	4.58	3.91	3.12	4.70	3.60	7.21
7.RETURN A/TAX ON SALES (%)	0.00	0.00	2.24	2.24	5.25	4.48	3.58	5.39	4.13	8.26
8.PAYOUT PERIOD	-197.	-2225.	-1760.	-2225.	-2225.	-2225.	-2225.	-2225.	-2225.	-2225.
9.PROFIT B.E.P. CAP. UTIL(%)	0.00	0.00	95.25	96.25	89.54	82.82	76.11	64.60	57.33	57.88
10.CASH B.E.P. SALES PRICE(D)	0.00	0.00	1.41	2.40	2.32	2.25	2.17	2.10	1.04	1.04

YEAR	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1.LONG-TERM DEBT/EQUITY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.CURRENT RATIO	0.45	6.03	19.14	32.25	45.36	58.47	71.59	84.70
3.QUICK RATIO	0.23	3.42	15.53	29.65	42.76	55.87	68.98	52.09
4.DEBT SERVICE COVERAGE	0.66	1.07	0.00	0.00	0.00	0.00	0.00	0.00
5.RETURN B/TAX ON EQUITY (%)	11.47	16.49	21.96	21.96	21.96	21.96	21.96	21.96
6.RETURN A/TAX ON EQUITY (%)	11.47	16.49	21.96	21.96	21.96	21.96	21.96	21.96
7.RETURN A/TAX ON SALES (%)	13.14	18.89	25.16	25.16	25.16	25.16	25.16	25.16
8.PAYOUT PERIOD	-2225.	-2169.	-1315.	-460.	394.	1249.	2103.	4245.
9.PROFIT B.E.P. CAP. UTIL(%)	57.38	57.48	57.98	57.89	57.48	57.89	57.88	57.88
10.CASH B.E.P. SALES PRICE(D)	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04

Chapter 9 Effect on San Andres's Economy

9.1 General

The objective of this Project is to improve the standard of living of the inhabitants of San Andres Island by improving the infrastructure, which may serve to facilitate the economic development and stability of the Island. In other words, as mentioned in Cahpter 2, there is a shortage of potable water in the Island and this is an obstacle for the welfare of the inhabitants as well as the development of tourism (the main industry on the Island), etc. Accordingly, it is imperative to develop new sources of potable water.

However, since the product of this Project is a non-trading material, direct benefits (e.g. saving of foreign currency) can not be expected from the sale of the product. A small number of operators are needed to operate this compact desalination plant, which means that the Project cannot serve to increase the opportunity of employment.

It should be noted, however, that from a viewpoint of social welfare, the Project will give considerably large benefits since the living standard in the Island will be thereby improved. It is not easy, however, to quantitatively evaluate these types of benefits.

Accordingly, the economic benefits of the Project will be discussed here by quantitative assessment (with emphasis on the measurable effect of the subsidization policy) coupled with qualitative assessment (with due regard to the above mentioned characteristics of the Project).

9.2 Calculation of EIRR (Economic Internal Rate of Return)

This project should be understood as a project for improving the conditions of the basic infrastructure. Projects of this nature generally involve much difficulty in calculating EIRRs. Meanwhile, it is intended to introduce various subsidization policies to this Project. It appears that such subsidization policies will exert the largest effect on the economic assessment of the Project. Accordingly, the EIRR of this Project will be calculated with due regard to such subsidization policies.

9.2.1 Premises for calculation of EIRR

The following premises have been established to calculate the EIRR of the Project.

1) Labor resources

The unemployment rate on the Island is quite low. Accordingly, the economic premium of labor resources is not evaluated.

2) Land cost

The projected plant site (where there are currently no structures) is land owned by public organizations (Intendencia and tourism corporation). So, the economic cost of the land is deemed to be zero.

3) Other items

Other items such as insurance are excluded from economic costs.

Note: 1) In view of the fact that this project involves public waterworks, it is exempt from taxation. Accordingly, it is not necessary to consider taxes as a transfer item.

2) In financial analysis, subsidies have been deemed to be earnings, whereas in economic assessment, they are deemed to be an economic cost.

Thus the EIRR of this Project is obtained from total capital requirements, and cash flows calculated by deducting operating cost* from sales revenue.

*after transfer items have been deducted.

9.2.2 Results of calculation

The EIRR calculated based on the above assumptions is summarized in Table 9.1 below.

Table 9.1 Economic Internal Rate of Return

(US$1,000)

Year	Economic Cost			Economic Benefit	Economic Cash Flow
	Capital Cost	Operating Cost	Total		
– 2 ('83)	623	–	623	–	– 623
– 1 ('84)	6,762	–	6,762	–	– 6,762
1 ~ 15 ('85) ('99)	–	1,081	1,081	1,942	861
16 (2,000)	– 1,288 *	1,081	– 207	1,942	2,149

* Working capital return and nondepreciable value of investment

Economic internal rate of return: 9.08% at Sales Price 1.85 US$/$m^3$

The EIRR (9.08 %) thus obtained is far below FIRR (15%).

This means that the implementation or otherwise of this Project depends on producing any direct benefits such as an increase of foreign currency. However, it is too early to conclude that the implementation of this Project will not bring a social economic benefit. Rather, it should be noted that the implementation of this Project will bring about great and immeasurable benefits (as described below).

9.3 Benefits arising from implementation of the Project

1) Upgrading of social welfare condition:

Due to the shortage of potable water, water supply is being limited on the Island, and this is interfering greatly with the welfare of the inhabitants. It is considered, however, that the projected desalination plant, if completed, can meet the increased demand for potable water. This will lead to a large improvement of the social welfare condition of the Island, resulting in the upgrading of the standard of living.

2) Resulting effect on industries:

As mentioned earlier, the shortage of potable water is greatly retarding the development of tourism (which can be said to be the sole industry on the Island). Accordingly, the implementation of this Project will immediately lead to the preparation of the industrial infrastructure (i.e., the development of tourism) of the Island.

9.4 Overall assessment

In this Project, the EIRR is less than the FIRR. It should be noted, however, that this Project is a public program aimed at upgrading the social welfare condition of the inhabitants. From such a viewpoint, this Project can fully satisfy its obective. Accordingly, the immeasurable social and economic benefits of this Project can fully compensate for such a low EIRR. As mentioned in Chapter 8, this Project is fully feasible from a financial standpoint. It is concluded therefore, that this Project should be implemented at the earliest opportunity.

Chapter 10 Recommendations

10.1 Recommendation for smooth realization of this project

For the smooth execution of the seawater desalination plant project in San Andres Island, it is recommended that the following measures be taken.

1) Use of consultant
The EMPOISLAS has only staff members for managing the current water works. It is desirable, therefore, that a consulting firm be employed in order to properly determine the plant equipment specifications as well as to satisfactorily manage the construction work.

2) For the enhancement of profitability of the project
- The amount of subsidies should be increased since this Project plays a vital role in the regional industrial promotion program.
- The interest rate of long-term loans should be maintained at a minimal possible rate, and the repayment period of the loans should be extended.

10.2 Idea for improving the profitability of portable water supply business

It should be noted that the increase of water supply capacity will not necessarily lead to the enhancement of profitability of water works. It is recommended, therefore, that the following measures be also taken for the rationalization of water works in the Island.

1) In order to minimize loss due to leakage in the water distribution piping systems, the water distribution piping systems should be inspected. On the basis of such inpsections, any faulty pipes should be reinforced or renovated.
2) The water metering system is to be improved and in addition, measures for preventing theft of water are to be established.
3) It is favorable for improving the profitability of potable water supply business that a system of increasing water rate should be adopted for large water consumers such as hotels.

VOLUME II

PROVIDENCIA ISLAND

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Summary

(Seawater Desalination Plan for Providencia Island)

Summary of proposed Project:

1. Name of Project:	Seawater Desalination Plant
2. Production capacity:	500 m^3/day
3. Applicable process	Reverse osmosis process
4. Construction site:	Western part of old town
5. Expected date of commercial operation:	At the beginning of 1985
6. Major facility:	
1) Seawater intake unit:	
Method:	pipe method
Capacity:	1,500 m^3/day
2) Pretreatment unit:	Dual media pressure filter
3) Reverse osmosis unit:	Cellulose-triacetate hollow fiber module for single stage desalination
4) Product water transfer unit:	
5) Waste water discharge unit:	
7. Product water quality:	
Chloride ion (Cl):	250 mg/l or less
Calcium (Ca):	75 mg/l or less
Magnesium (Mg):	125 mg/l or less
Total dissolved solids:	500 mg/l or less
pH:	6.5–8.5
8. Water balance:	
Seawater intake:	1,500 m^3/day
Production:	5000 m^3/day
Waste water	1,000 m^3/day
9. Utility consumption:	
Electricity:	4,020 KWH/day
10. Chemical consumption:	
Ferric chloride:	4.55 kg/day
Sulfuric acid (98%):	71.5 kg/day
Caustic soda (flake):	4.8 kg/day
11. Construction cost:	US$2,250,000
12. Unit production cost:	US$2.46/$m^3$

Chapter 1. Outline of Providencia Island

Natural condition:

Providencia Island is a small island lying about 160 km northeast of San Andres Island. The average annual temperature is 27.5°C and the annual rainfall is 1,895 mm.

Social environment:

Providencia Island has a population of about 3,000 (1982). However, unlike San Andres Island, there is no large concentration of population. The chief industries are agriculture, fishing, and stock raising. There are virtually no secondary or tertiary industries. In addition, since the port has not yet been completely provided with necessary facilities, traffic and transportation of goods rely mostly on one dialy regular flight from San Andres Island.

Chapter 2: Current status and supply-demand forecasts concerning water supply on Providencia

Current status of waterworks:

In 1981, a total of 230 households, representing 750 persons, was supplied with water at a rate of 86 m^3/day (1 ℓ/sec), and the water is supplied to individual households through the distribution piping network which is devided three blocks (northern, western or southern block). The source of water consists of springs scattered around the mountain area. Spring water collected by means of troughs is first stored in service reservoirs (located at 50 or 60 meters above sea level) having a capacity between 50 and 100 m^3, and is then distributed by gravity to the individual households via an undergrounded piping network.

Supply-demand forecast:

The population in 2000 is estimated to be 3,922 and water supply-demand is estimated to be 588 m^3/day.

Chapter 3: Planning of seawater desalination plant

Plant capacity:

The capacity of the seawater desalination plant has been determined to be 500 m^3/day on the assumption that the amount (502 m^3/day) equvalent to the difference between the projected amount of water supply in 2000 (588 m^3/day) and the current capacity of water supply using springs (86 m^3/day) will be made up by the desalination plant.

Water intake and discharge:

With due consideration to the specific regional features of the Island, the following systems have been employed:

1)	Raw seawater intake:	Pipe method
2)	Waste water discharge:	Discharge points will be located 100 meters from the intake points.

Chapter 4: Process Selection

For the same reasons as mentioned in Vol. I "San Andres Island", a reverse osmosis process has been employed.

Chapter 5: Site selection

For the selection of a plant site, following two candidate sites have been studied.

1) Western part of old town
2) Southern part of airport

As a result of the comparative study, the western part of the old town was selected as the plant site, because of the following advantages.

1) It is situated near the port, and there are suitable access roads. This will assure ease of construction work.
2) It lies on the peninsula. This will ensure convenient water intake and wastewater discharge.
3) It is situated near the existing service reservoir.

Chapter 6: Outline of proposed plant

This seawater desalination plant consists of the same facilities as those of the seawater desalination plant to be installed at San Andres Island. In other words:

1) Seawater intake unit:
2) Pretreatment unit:
3) Reverse osmosis unit (including a power recovery turbine):
4) Product water transfer unit:
5) Waste discharge unit:

Chapter 7: Construction, operating, and product water cost

1. Construction cost

   Total: US$2,346,000

2. Operating cost

   Total: US$276,300/year

3. Unit production cost: US$2.46/$m^3$

Chapter 1 Outline of Providencia Island

1.1 Location

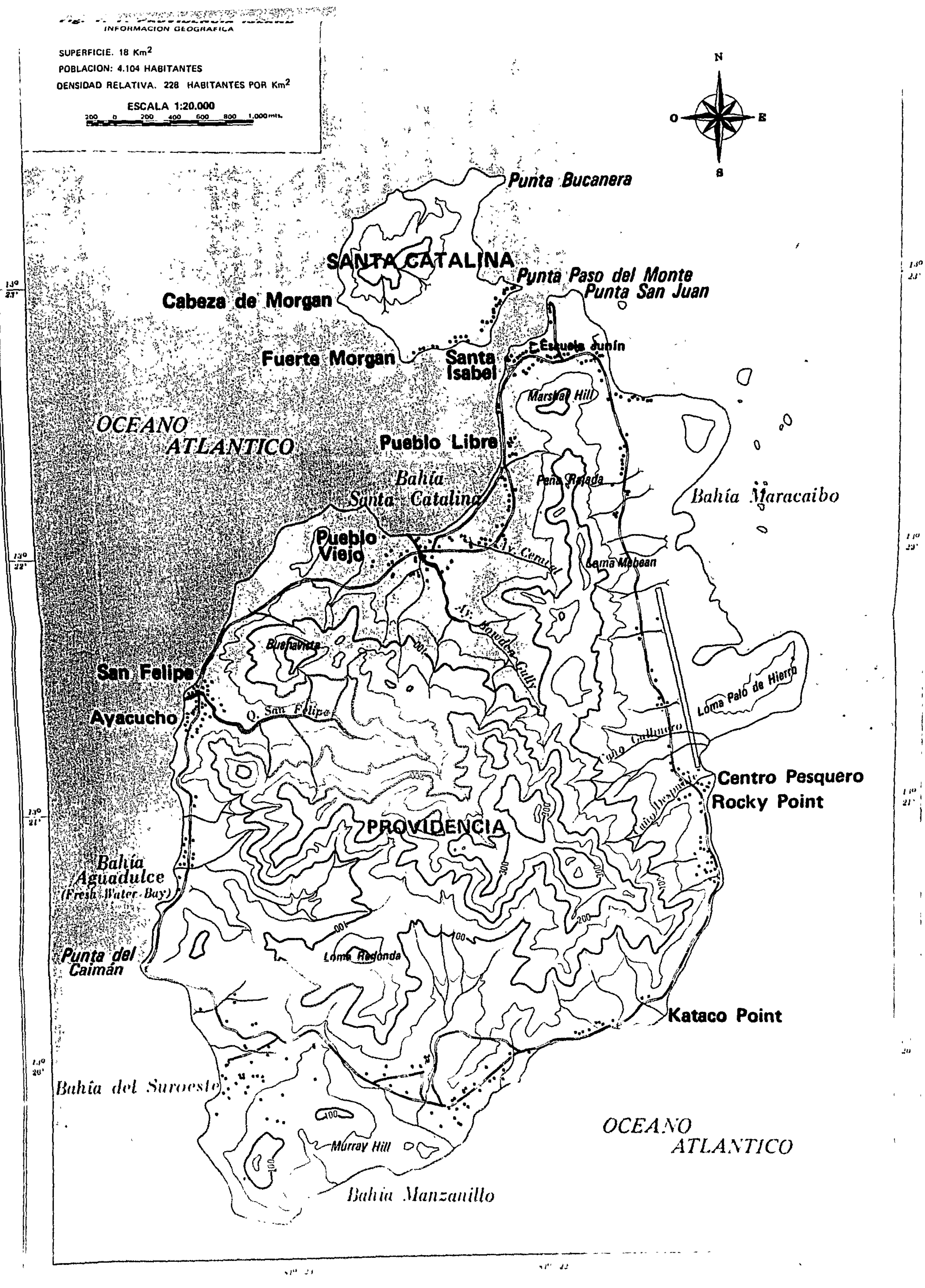
Providencia Island (hereinafter called "Island") is a small island in the Caribbean sea situated at 13°10′ north latitude and 81°30′ east longitude, about 160 km off the northeastern coast of San Andres Island, and extends about 6 km in both the north-south and east-west directions. The Island lies about 800 km off the mainland of the Republic of Colombia and about 250 km off the east coast of the Republic of Nicaragua.

1.2 Natural condition

Unlike San Andres Island, most of the Island is mountaneous (Fig. 1.1). Mountains, some reaching a maximum height of 300 meters above sea level, exist right up to the shores of the Island. The Island has a very similar climate to that of San Andres Island. According to statistics for 1980, the average annual temperature is 27.5°C and annual rainfall 1,895 mm. The Island, however, has the following specific features compared with San Andres Island. The central region, constituting a mountaneous area, has a poor water retaining capacity. In spite of a relatively heavy rainfall, most rainwater is drained rapidly into the ocean through the mountaneous slope. This can be seen from several small rivers (consisting of basins of 2 to 5 meters in width) where there are no constant streams. At the bottom of the rivers, rocks lie open to view. It appears that the ground is composed mostly of rock beds. The sea around the Island is relatively deep and there are few coral reefs.

1.3 Social environment

The Island has a population of about 3,000 (1982). There is no large concentration of population within the Island, though a slight concentration in new and old towns can be observed. Most roads remain unpaved but a trunk road runs around the Island, connecting villages scattered along the coast to each other. The chief industries are agriculture, stock raising, and fishing. There are virtually no secondary or territary industries. In addition, tourism which exists in San Andres Island remains undeveloped because some restrictions have been imposed on the construction of large-scale hotels. In addition, there is only one daily regular flight service from San Andres Island. Of daily living necessaries, the island is self-sufficient in most foodstuffs. Other items are transported either by the daily regular flight service or through the port (located at the new town) which, however, has not yet been completely equipped with necessary facilities such as private cargo handling equipment. Accordingly for the transportation of daily living necessaries, the daily regular flight is mostly used. Running water is provided by spring water which is stored in service reservoirs located on high ground before being distributed to the individual households through a distribution piping network consisting of three blocks. The east area, however, where the airport is located, is not served by this network due to sparse population. Electric power is supplied from a power plant located on the northeastern side of the Island.


INFORMACION GEOGRAFICA
SUPERFICIE. 18 Km2
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200 0 200 400 600 800 1,000 mts.
N
O
E
S
Punta Bucanera
SANTA CATALINA
Punta Paso del Monte
Punta San Juan
Cabeza de Morgan
Fuerte Morgan
Santa Isabel
Escuela Junín
Marshal Hill
OCEANO ATLANTICO
Pueblo Libre
Bahía Santa Catalina
Peña Rajada
Bahía Maracaibo
Pueblo Viejo
Av. Central
Loma Mabean
Buenavista
Bowden Gully
San Felipe
Q. San Felipe
Ayacucho
Loma Palo de Hierro
Centro Pesquero
Rocky Point
PROVIDENCIA
Bahía Aguadulce
(Fresh Water Bay)
Punta del Caimán
Loma Redonda
Kataco Point
Bahía del Suroeste
Murray Hill
OCEANO ATLANTICO
Bahía Manzanillo

The power generating capacity, however, is presently insufficient.

Chapter 2 Current Status and Supply-demand Forecast Concerning Water Supply on Providencia

2.1 Current status of waterworks

The springs which serve as the source of running water are scattered around the mountain area. The water supply capacity, however, is limited, being only 86 m^3/day (1 ℓ/sec). In 1981, a total of 230 households, representing 750 persons, was supplied with water at the above rate. The water distribution piping network is divided roughly into three unconnected blocks (northern, western, and southern parts), though they are scheduled to be connected to each other in the near future. Meanwhile, in the absence of suitable water sources, the southeastern area of the airport is outside the water distribution piping network. It is planned to supply water to the above area by extending a service mainly from the northern piping network.

The above three blocks employ similar water distribution systems. In other words, spring water collected by means of a trough is first stored in the aforesaid service reservoirs, the capacity of which ranges from 50 to 100 m^3, and then distributed by gravity to individual households. However, in view of the fact that a large amount of rainwater is drained rapidly into the ocean, it cannot be said that the source of water of the Island is effectively utilized. Attempts, therefore, are being made to store rainwater initially in the existing dam and pump it up to the service reservoirs. It appears, however, that since rainwater flowing down the steep slope of the mountains contains surface soil, it is difficult to use it as potable water. Accordingly, a study of obtaining potable water using the dam should be accompanied by a study of a water purification plant consisting of such processes as coagulation/sedimentation, and sand filtration.

2.2 Supply-demand forecast

On the basis of the targeted year 2000, the demand for potable water within the Island has been forecast. The population in 2000 is estimated to be 3,922 based on the population in 1982 (3,000) and an estimated annual rate of population increase of 1.5%. The necessary amount of water in 2000 is estimated to be 470 to 588 m^3/day on the basis of an estimated of per-capita consumption of 120 to 150 liters per day.

3.1 Plant capacity

As previously mentioned, the demand for potable water in 2000 is estimated to be 470 to 588 m^3/day, whereas the supply remains unchanged, i.e., 86 m^3/day (1 ℓ/sec). Accordingly, in 2000, there will be a deficiency of 384 to 502 m^3/day of water. Table 3.1 has been prepared by EMPOISLAS to provide an estimate of the demand for potable water in the Island. The estimate shows that the required per-capita consumption will become 120 to 123 liters/day in 1990.

It is considered, therefore, that the required amount of water in the Island will become closer to that of San Andres Island (177 to 186 ℓ/day/capita, in 1990) in the future. Although the increase of available water with due consideration to the future development of water sources is incorporated in the figures given in the above table, it is estimated that the maximum possible supply amount will reach an upper limit of 86 m^3/day (1 ℓ/sec). For the above reasons, the capacity of the projected desalination plant has been determined to be 500 m^3/day. Meanwhile, with due consideration to the specific features of the existing water distribution piping network, a study has been performed with a view to installing a desalination plant for each block (northern, western, and southern). However, since the division of the plant into several regions will result in the necessity of future rearrangement of distribution piping as well as a rise in construction and water production costs, planning is carried out on the assumption that only one plant will be installed.

3.2 Product water quality

See Vol. I "San Andres Island", Cahpter 3, Table 3.2.

3.3 Characteristics of raw seawater

An analysis of the quality of raw seawater showed that there are no large differences between the Island and San Andres Island (see Table 3.3, Chapter 3, Vol. I). Accordingly, the same design basis as given in Table 3.4 of the said chapter will apply to the design of the projected desalination plant.

Table 3.1 Forecast for Population and Water Supply Plan

Items \ Year		Present	Future Plan						
		1981	1982	1983	1984	1985	1986	1987	1970
Population		2,500	3,000	3,045	3,091	3,137	3,184	3,232	3,379
No. of Houses		669	700	711	721	732	743	754	788
Coverage of water supply %		30	34	50	60	90	90	90	90
Pupulation served water supply		750	1,020	1,523	1,855	2,823	2,857	2,909	3,041
Required Water Supply	ℓ /pop., day	114	120	120	121	121	122	122	123
	ℓ/sec.	0.99	1.42	2,11	2.60	3.95	4.03	4.11	4.33
	m^3 /day	86	122	183	224	342	349	355	374
Subscribers		230	261	355	505	586	594	603	630

3.4 Method of taking raw seawater

Unlike San Andres Island, there are few coral reefs in the vicinity of the Island. There is a depth of water of 5 to 10 meters within the sea area 100 meters off the shore. Accordingly, the necessary amount of water can be drawn by a short intake pipe. In addition, the capacity of this plant is smaller than that of San Andres Island. It is considered, therefore, that, of the water intake methods given in Table 3.5, Chapter 3 of Vol. I, the pipe method (which is widely used for water intake) is the most economical.

3.5 Wastewater discharge method

As in San Andres Island, a pumping method will be employed. The discharge points, however, will be located 100 meters from the intake points in order to avoid mixing wastewater with raw seawater.

3.6 Utilities and chemicals

As in San Andres Island, power is supplied by ELECTROSAN using a diesel generator having a capacity of 460 KVA, which, however, cannot satisfy the demand of 650 KVA. Accordingly, nighttime or regional power suspension is effected. In order to resolve such problem in power supply, it is planned to install two more units (ea. 300 KVA, totalling to 600 KVA) within the next few years.

If such measures are taken, the power generation capacity will amount to 1,060 KVA in the near future. It appears that power can be fully supplied to the projected plant when its operation is started. Power will be supplied to the plant based on the conditions given in Table 3.2 below. Incoming cables from the power plant to the projected plant will be newly installed. The power cost of the Island is the same as that of San Andres Island.

Table 3.2 Condition of Electric Power Supply

Item	Specification of Condition
Voltage	440 V
Frequency	60 Hz
Phase	3 ϕ
Tariff	5.66 peso/kWH

3.6.2 Chemical

Table 3.3 gives the unit purchase prices of chemicals, established in consideration of the transportation conditions to the Island.

Table 3.3 Unit Price of Chemicals

Items	Specification	Form	Price
Ferric Chrolide	98 %	Powder	71.8 peso/kg
Sulfuric Acid	98 %	Aqueous Solution	31.5 peso/kg
Caustic Soda	99 %	Flake	100.8 peso/kg
Sodium Hypochlorite	13 %	Aqueous Solution	20.9 peso/kg
Sodium Bisulphate	100 %	Powder	151.2 peso/kg
Citric Acid	100 %	Powder	196.5 peso/kg
Aqueous Ammonia	25 %	Aqueous Solution	128.5 peso/kg

Chapter 4 Process Slection

4.1 Seawater desalination process

The capacity of the projected seawater desalination plant is relatively small, i.e., 500 m^3/day. It is desirable, however, that a process assuring highly efficient demineralization be applied even to such small desalination plant. Accordingly, reverse osmosis and electrodialysis systems have been selected as possible desalination processes, and a comparative study has been carried out regarding the construction and operating costs (including the specifications of the major equipment) for both systems.

4.2 Process comparison and selection

Table 4.1 gives the results of the above comparative study. The table shows that although the construction cost for a reverse osmosis system is the same as that of an electrodialysis system, the reverse osmosis system is much superior in respect of operating costs (electricity, chemicals, and maintenance) to the electrodialysis system. It is proposed, therefore, that a reverse osmosis system be employed as same as in San Andres Island.

Table 4.1 Process Evaluation

Items	Unit	Reverse Osmosis	Electro Dialysis
A. Construction Cost	–	100	100
B. Operating Cost	–	100	161
a) Electricity	–	(74)	(92)
b) Chemicals	–	(12)	(53)
c) Maintenance	–	(14)	(16)
C Major Specification			
a) Required space	m^3	360	312
b) Building space	m^3	216	156
c) Energy consumption	kWH/m^3	8.04	10.1
d) Water intake	m^3/day	1500	1070

5.1 Summary of candidate sites

Plant sites recommended by EMPOISLAS are outlined below.

1) Western part of old town

This plant site is situated in a small peninsula (northwest of the Island) 1 km from the old town and 2 km from new town. There is a relatively swift tidal current near the coast. The depth of water can fully satisfy the requirements for water intake. This site is also situated about 1 km from the water distribution tanks for the new and old towns, where there is a slight concentration of population. Since there are few houses around the site area, it is possible to secure a sufficiently large site area as well as minimize the nuisance of noise, etc., on the inhabitants. It should be noted, however, that this plant site lies about 6 km from the power plant which is situated at the southern part of the airport.

2) Southern part of airport

This plant site is relatively small having a length of 30 m and a width of 10 m. It lies between the main road (running around the Island) and the ocean, and is 1 km from the southern part of the airport, and 500 m from the power plant. Neither water distribution piping networks nor water distribution tanks exist within this area. Produced water will be fed from here to the distribution tank located either on the northern or southern part of the Island (5 or 6 km from the plant site).

5.2 Selection of plant site

There are advantages and disadvantages in the above candidate plant sites in view of the route for distributing product water as well as for obtaining electric power. It is considered, however, that the western part of the old town has more advantages in respect of the construction work than the southern part of airport since the western part of the old town is situated near the port and has well-maintained roads for transportation. In addition, since the western part of the old town lies on the peninsula, it is possible to take raw seawater from the eastern side of the peninsula and to discharge wastewater to the western side. This will ensure effective and easy water intake and discharge. It is proposed, therefore, that the projected plant be located at the western part of the old town.

Chapter 6 Outline of Proposed Plant

Reagarding matters which are not specified in this chapter, see Chapter 6, Vol. I "San Andress Island".

6.1 Establishment of design basis

Table 6.1 has been prepared to provide the major design basis for the projected plant in the Island.

Table 6.1 Design Basis of the Plant

Items	Design Basis
A Water Balance	
1) Sea water intake	1,500 m^3/day
2) Production	500 m^3/day
3) Waste water	1,000 m^3/day
B. Characteristics of Raw Sea Water	
1) Total dissolved solids (TDS)	37,000 mg/ℓ
2) Chloride (Cℓ⁻)	21,000 mg/ℓ
3) PH	8.2
4) Electric conductivity	57,000 μS/cm
5) Temperature Max.	40 °C
Min.	25 °C
C. Materials	SUS316/PE lined pipe/PVC/FRP
D. Applied Standards	Japanese Standards
E. Scope and Condition	
1) Water intake section	Pipe method
2) Pretreatment section	Coagulation and Filtration
3) Reverse osmosis section	Hollow fiber type membrane
4) Product transfer section	From the site to existing reservoir
5) Waste discharge section	From the site to discharge point
6) Power supply section	From power plant to the site
7) Civil and building section	Civil and foundation: RC Building: Prefabricated panel house
8) Erection and Construction	
9) Test run	
10) Training and Instruction	

6.2 Process description

See chapter 6, Vol. I "San Andres Island". For the flow sheet, see Fig. 6.1.

6.3 Major equipments

Table 6.2 gives the specifications of the major facilities. Figs 6.2 and 6.3 show a plot plan and an outline drawing on buildings, respectively.

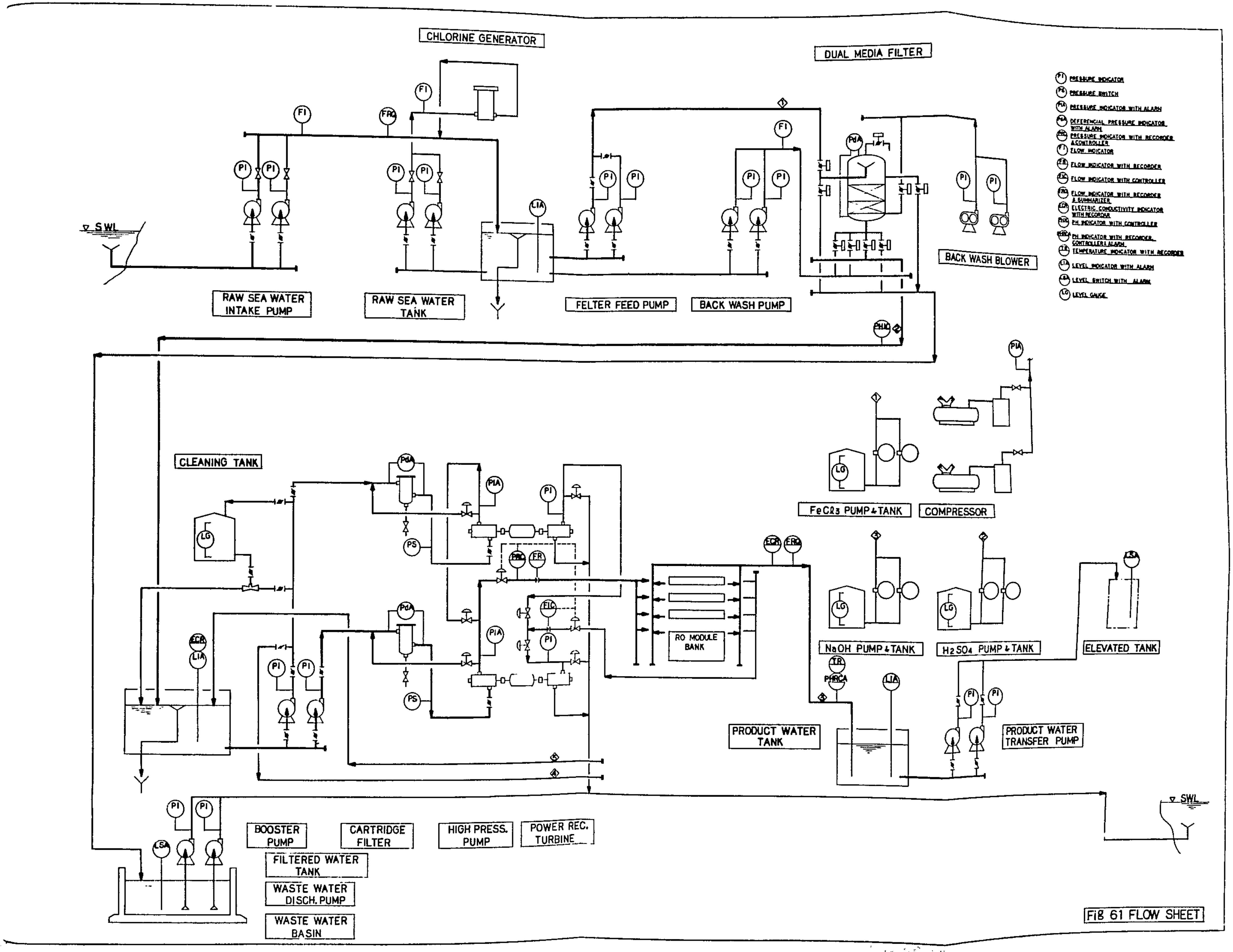

Fig 61 FLOW SHEET

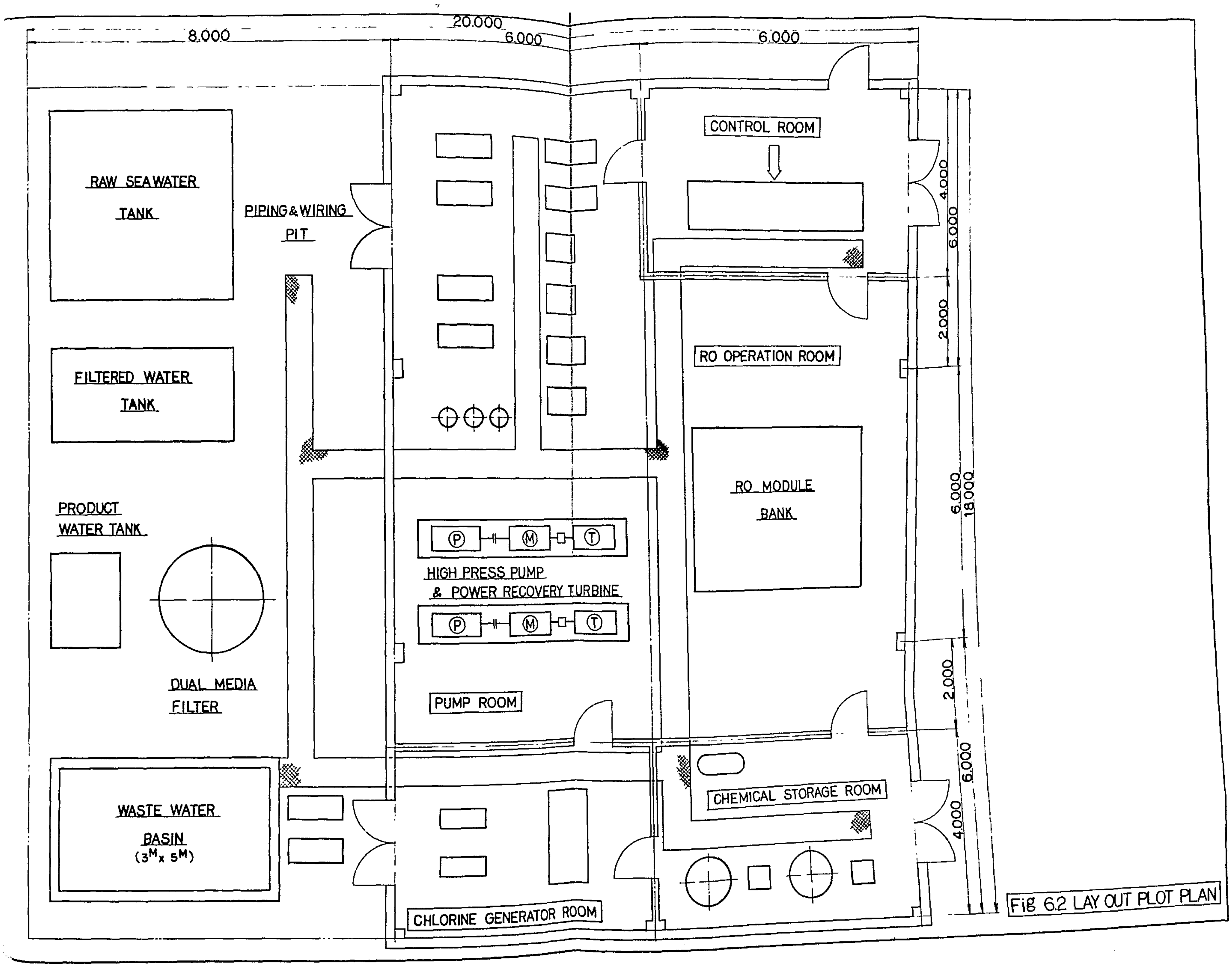

Fig 6.2 LAY OUT PLOT PLAN

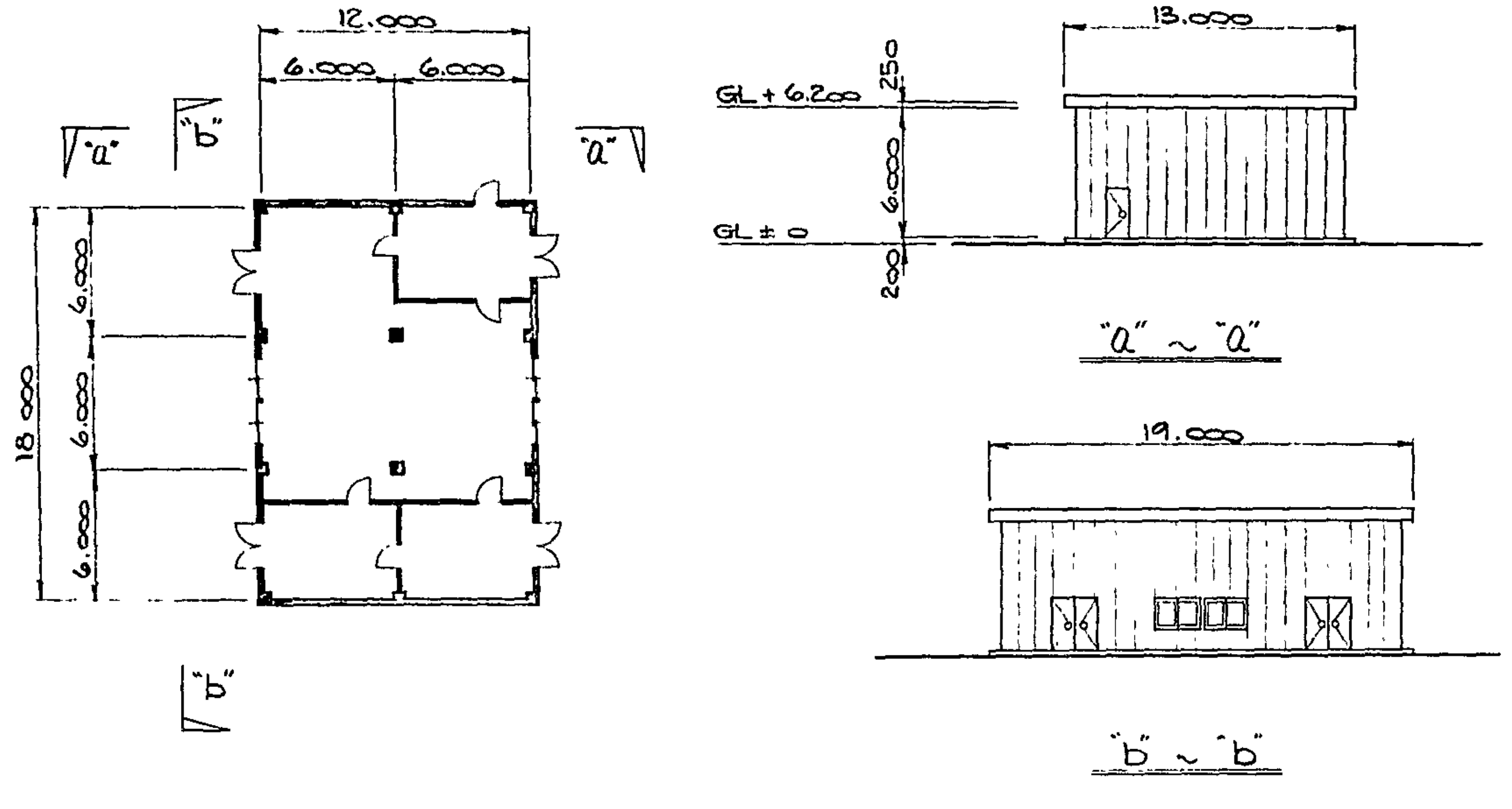

Fig 6.3 BUILDING PLAN

Table 6.2 Major Specification of the Plant

Items	Specification
A. Overall required space	360 m^2 (20m x 18m)
B. Power Requirements	220 KVA (440V, 3ϕ 60Hz)
C. Building	
1) Dimensions	18m x 12m x 6m(H) (216 m^2)
2) Specification	Prefabricated panel house
3) Accessories	a) Illumination b) Geared trolley (1 ton) c) Air conditioner/wall fan
D. Water intake system	a) Type: Pipe method b) Quantity: 1500 m^3/day
E. Pretreatment system	Coagulation and filtration
1) Type of filter	Dual media pressure filter with carbon steel
2) Liner velocity	15 m/hr
3) No. of filters	One
4) Dimensions	2300mmϕ x 3000mmH
F. Reverse Osmosis system	Reverse Osmosis
1) Production capacity	500 m^3/day (500 m^3/day x 1 unit)
2) Applied RO membrane	Cellulose triacetate hollow fiber type membrane for single stage desalination
3) Specification of high press. pump	a) Capacity: 1.0m^3/min x 60 kg/cm^2 x 140kW b) No. : 2 (including one stand-by) c) Material : SUS 316
4) Specification of power recovery turbine	a) Capacity: 0.65 m^3/min x 54 kg/cm^2 b) Recovered power: 32 kW c) Recovered rate: 19 %
5) Operational conditions	a) Press.: 60 kg/cm^2 (max) b) Recovery ratio: 35 % (max)
6) Quality of desalinated water	a) TDS 500ppm or less b) PH 7 – 8
G. Operational Consumables	
1) Electricity	4,020 kWH/day
2) Chemicals	
• Ferric chloride	4.55 kg/day
• Sulfuric acid	71.5 kg/day
• Caustic soda	4.8 kg/day

Chapter 7 Construction, Operating and Water Production Costs

7.1 Construction cost

Table 7.1 gives the plant construction cost computed based on the following assumptions:

1) Commercial operation will be started in early 1985.
2) No import duties will be imposed on the items associated with plant construction.
3) Plant personnel will be trained during a period of about one month at the plant site.

7.2 Operating cost

1) On the basis of the conditions given on Table 7-3, Chapter 7, Vol. I "San Andres Island", operations will be carried out by the following number of personnel.

   Superintendent: 1

   Operators: 3
2) Operating rate: 100 %
3) Annual number of operating days: 350 days
4) Maintenance cost: 3 % of plant construction cost

7.3 Water production cost

On the basis of construction and operating costs as well as the following assumptions, the depreciation for facilities and interest thereof have been computed as given in Table 7.3 below.

1)	Depreciation method:	straight-line method	
2)	Period of depreciation:	Machinery/equipment:	16 years
		Civil/architectural:	25 years
3)	Repayment of bank loans:	Uniform repayments of principal	
4)	Period of repayment:	5 years	
5)	Interest rate:	7.5 %/year	
6)	Operating rate:	100 %	
7)	Annual njmber of operating days:	350 days	

Water production cost has been calculated to be US$2.46/$m^3$

Table 7.1 Construction Cost

(US$1,000)

Item	Cost
Equipment, Material and Field Construction	2,250
Operation Training	96
Total	2,346

Table 7.2 Operating Cost

(US$1,000)

Item	Annual Cost
Operating Labor Cost	25.8
Electricity	157
Chemicals	26
Maintenance Cost	67.5
Total	276.3

Table 7.3 Production Cost

Item	Production Cost	
	Per Year (US$ 1000)	Per m^3 Production (US $)
Operating Cost	276.3	1.58
Depreciation	121.1	0.69
Interest	32.8	0.19
Total	430.2	2.46

APPENDIX

INTERIM REPORT

ON

FEASIBILITY STUDY

OF

SEA-WATER DESALINATION PROJECT

FOR

THE REPUBLIC OF COLOMBIA

JULY, 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

CONTENTS

Chapter 1 Introduction

The preliminary survey team sent in February 1982 by The Japan International Cooperation Agency (JICA) and The National Department of Planning of the Government of the Republic of Colombia (DNP) discussed on the basic conditions and the scope of work of the feasibility study to be conducted by JICA for the Sea-Water Desalination Project at San Andrés Island of the Republic of Colombia and reached the conclusion mentioned in the Minutes of Meetings during February 17-26, 1982. On the other hand, in June 1982, DNP requested to JICA to conduct the rough feasibility study of the Sea-Water Desalination Project at Providencia Island in addition to the before-mentioned feasibility study on San Andrés Island, the scope of work of which was established in July 8, 1982 in Bogotá. The feasibility study to consist of two studies, i.e. the feasibility study on San Andrés Island and the rough feasibility study on Providencia Island has commenced by JICA in this back-ground and the Study Team was delegated to the Republic of Colombia to make the site survey and discussions for the sake of obtaining the basic information.

The Study Team headed by Mr. N. Hashimoto has conducted the site survey to study the site condition and several discussions with DNP, Empresa de Obras Sanitarias de San Andrés y Providencia Ltda. (EMPOISLAS) and the other related authorities to collect necessary information and data and to establish the study bases, in Bogotá, San Andrés Island and Providencia Island in the period of July 5 to July 23, 1982.

This interim report presents a summary of the Study Team's findings and observation as well as the conditions of conceptual design agreed upon between DNP (as well as EMPOISLAS and other related authorities) and JICA in respect of major elements to be confirmed as a basis for the subsequent study performed in Japan by JICA.

Chapter 2 Scope of The Feasibility Study

The feasibility study to consist of two studies on San Andrés Island and Providencia Island, respectively, will be conducted covering the following scope of work:

2.1 Feasibility Study on San Andrés Island.

(1) Outline of San Andrés Island.
- a) Location
- b) Natural condition
- c) Social surrounding condition
- d) Development plans

(2) Current status and demand forcast of water work.
- a) Current status of water work
- b) Demand forcast

(3) Plant capacity.

(4) Rough process comparison among evaporation, electrodialysis and reverse osmosis processes

(5) Selection of the most appropriate process.

(6) Raw water (sea-water).
- a) Temperature
- b) Characteristics
- c) Others

(7) Chemicals.

(8) Plant Site.
- a) Candidate sites (Taller, Plaza de Mercado and Campamento)
- b) Selection of plant site

(9) Utilities and infrastructures.

(10) Conceptual design of plant.
- (a) Design bases
- (b) Desalination process
- (c) Plant facilities
- (d) Utility facilities
- (e) Water supply and water storage facilities
- (f) Offsite facilities
- (g) Plant layout

(11) Construction plan.

(12) Operating organization and manning plan.

(13) Total investment and investment plan.

(14) Financial analysis.

   a) Production cost estimate

   b) Financial internal rate of return

(15) Economic evaluation.

   a) Economic benefit

   b) Economical internal rate of return

(16) Conclusion and recommendation.

2.2 Rough Study on Providencia Island

The Study Team will conduct the rough study based on the under-mentioned items and the study result will be combined with the feasibility study report on San Andrés Island:

(1) Selection of the most appropriate process (Reverse osmosis and electrodialysis processes).

(2) Raw water (sea-water).

   a) Condition of water-intake

   b) Temperature, characteristics and others

(3) Selection of plant site.

(4) Conceptual design of plant.

   a) Design bases

   b) Desalination process

   c) Plant facilities

   d) Utility facilities

   e) Water supply and water storage facilities

   f) Offsite facilities

   g) Plant rough layout

(5) Construction plan.

(6) Total investment.

(7) Production cost estimate.

Chapter 3 Member List

3.1 JICA Study Team

Naoto Hashimoto	Team Leader
Yasuo Ohtaka	Sub-Leader, Project Engineer
Harutoshi Nagano	Industrial Engineer
Shintaro Takahashi	Process Engineer
Norio Tsuji	Process Engineer
Masaaki Awamoto	Industrial Economist
Iwao Nagayama	Project Engineer

3.2 DNP

Nohra Bateman Durán	Chief, International Technical Cooperation Division
Luis Mario Barrera H.	Chief, Sanitary Engineering Division
Ligia Rodriguez	International Technical Cooperation Division

3.3 EMPOISLAS

Alvaro Forbes James	Manager
Carlos José Villate S.	Civil Engineer
Rodrigo I. Andrade S.	Civil Engineer
Narco Quimbay	Electric Engineer
Hernando Durán R.	Coordinator Engineer
Carogeen Watson A.	Secretary
Efrain Rojas I.	Administrator (Providencia)

3.4 INSFOPAL (Instituto Nacional de Fomento Municipal)

Luis Alberto Leal Ferro	Sub-Director, Technical

3.5 INTENDENCIA DE SAN ANDRES Y PROVIDENCIA

Alicia Lung	Representative
Bernardo Howard N.	Secretary (Planeación)
Guillermo Luna F.	Chief, Urban Development Division (Architect)
Aldan Jay R.	Administrative and Economic Adviser
Pustano Taylor A.	Civil Engineer (Planeación)

3.6 HIMAT (Instituto Colombiano de Hidrología, Metereología y Adecuación de Tierras)

Eufrasio Bernal Duffo	Sub-Director

3.7 DIVISIONS MARITIMA Y PORTUARIA de la ARMADA NACIONAL

Efrain Angel	Captain

3.8 Other Related Authorities

3.8.1 Electrosan

Antonio Manuel Stephens	Manager
Julio Bedoya	Chief, Wiring
Gustavo Joy Pang	Chief, Generator
Julio Dios	Foreman
Edburn Newball	Manager (Providencia)

3.8.2 Sistemas Hidráulicos y Sanitarios

Ing. Gonzalo Peña O.

3.8.3 Pyne Corpus & Cia. Ltda.

Rino Pyne Chow	Civil Engineer

3.8.4 Agencia Marítima

Carlos Ramos Torreglosa	Trade Service

3.8.5 Importaciones Ramírez

Olecdes Ramírez

3.9 Embassy of Japan/Bogota

Kenichi Ogasawara	Second Secretary
Fusakazu Takahashi	Second Secretary

3.10 JICA-Bogota

Kazuo Ishii	Resident Representative

Chapter 4 Team Activities

Brief record of activities conducted by the Study Team is as follows:

Date	Place	Visit to	
July 4th (Sun)	Arrived at BGT		
July 5th (Mon)	BGT	JICA, Embassy of Japan, DNP	
July 6th (Tue)	BGT	HIMAT, INSFOPAL	
July 7th (Wed)	BGT (BGT -- SAI)	Navy Office	
July 8th (Thu)	SAI	EMPOISLAS	
July 9th (Fri)	SAI	EMPOISLAS. Plant sites	
July 10th (Sat)	SAI	Water supply facilities	
July 12th (Mon)	SAI	EMPOISLAS, Sewerage facilities.	
July 13th (Tue)	SAI	EMPOISLAS, Electrosan	
July 14th (Wed)	SAI	PYNE, INTENDENCIA, Sistemas hidráulicos, Agencia Marítima, Importaciones Ramírez.	
July 15th (Thu)	SAI	EMPOISLAS	
July 16th (Fri)	SAI	EMPOISLAS	
July 17th (Sat)	(SAI -- BGT) (SAI -- PRI)		
		BGT	PRI/SAI
July 18th (Sun)		(Internal Meeting)	Site Survey /Electrosan
July 19th (Mon)		DNP	EMPOISLAS
July 20th (Tue)	(PRI -- SAI)	(Preparing Interim Report)	
July 21th (Wed)		DNP	EMPOISLAS
July 22th (Thu)	(SAI -- BGT)	(Preparing Interim Report)	EMPOISLAS
July 23th (Fri)	BGT	DNP	
July 24th (Sat)	BGT	(Preparing Interim Report)	
July 25th (Sun)	BGT	(Preparing Interim Report)	
July 26th (Mon)	BGT	DNP	
July 27th (Tue)	Leave BGT		

The summary of the works the Study Team has performed in Colombia is described below:

1) Discussions with DNP, EMPOISLAS and other related authorities concerning major elements and factors for the feasibility study of the project.

2) To visit to the candidate plant sites and other related facilities.

3) To select the most appropriate site from the candidate sites in San Andrés Island and Providencia Island respectively, from technical and economical points of view.

4) To select the suitable sea-water intake method from some possible methods taking into consideration the technical and economical aspects.

5) Visits and interviews with firms and companies related to the plant construction.

6) Collection of data and information which are required for conducting the feasibility study, and confirmation of data and information which has been presented by the Study Team.

Chapter 5 Major Items Discussed

5.1 San Andrés Island

5.1.1 Plant capacity.

According to EMPOISLAS, the amount of water shortage will be approximately 5,000 m^3/D by 1985, 2,000 m^3/D of which will be supplemented by means of additional wells development and 3,000 m^3/D of which will be supplemented by the production capacity of the new desalination plant to be constructed.

The above capacity of the new plant is agreeable to the Study Team because of:

* Suitable scale to be managed without much modification of the current organization of EMPOISLAS.
* Necessity of early accomplishment of the full capacity operation in order to acquire and maintain the profitability of the plant.
* Suitable scale as single train capacity to operate the plant with the ability of plant expansion in future.

5.1.2 Plant Site Selection

As the minutes of meetings signed by DNP and the preliminary survey team sent by JICA in February 26, 1982 show, the following sites were nominated as the candidate installation sites of the plant:

(1) Taller

(2) Plaza de Mercado

(3) Campamento

After having carried out site-visit and investigation, the Study Team evaluated these three candidate sites as shown below:

Evaluated Items		Candidate Sites		
		Taller	Plaza de Mercado	Campamento
1)	Area size of site	A	C	A
2)	Availability of site	B	A	C
3)	Sea-water supply	B	C	A
4)	Brine discharge	B	C	A
5)	Product transfer	A	B	B
6)	Power supply	A	A	B
7)	Maintenance	B	B	A

Note: Superiority is indicated in alphabetical order

Being different from other two sites, Plaza de Mercado is fully owned by EMPOISLAS. Though it is superior to other sites judging from the above view points, it has the critical inferiority that the area size would be too small for construction and maintenance of the plant. The above evaluation does not show any effective difference in superiority between Taller and Campamento, but the Study Team has put more weight in superiority to the evaluation items of sea-water intake and brine discharge because of importance of sea-water handling in any desalination processes and has reached the conclusion that Campamento is the most suitable site as the proposed site.

5.1.3 Sea-Water Intake

Three methods have been considered for sea-water intake, namely:

(1) Intake by piping to be installed on the bottom of sea (pipe method).

(2) Open pit at a coast
(Open pit method).

(3) Intake from wells at the site
(Well method).

where the relative features of above mentioned methods are as follows:

Pipe method

* Requiring moderate sea depth at the intake point (preferably more than six meters under the sea level).

* Requiring the construction work in the sea.
* Requiring the pipeline between the plant site and the sea-water intake point.

Open pit method

* Preferring rock beach and moderate sea depth.
* Requiring mechanical equipment (screens and pumps) at the sea side.

Well method

* Requiring test well drilling for the acquirement of well characteristics.
* Requiring the countermeasure to the probable plugging of sea-water vein.

As for the intake point, there can be three candidate coasts near the plant site; Bahia Las Sardinas, Bahia San Andrés and southside coast of Punta Norte. Among these three coasts, former two are inappropriate since those are surrounded by coral reef and accordingly those offshores are shallow, and since those coasts are of precious properties for tourism of the island.

Southside coast of Punta Norte has appropriate depth and is lapped with high waves. Therefore, it is apparently pointed out that the pipe method is not suitable because of costly construction and the open pit method seems to be possible.

The plant site is to be located relatively far from the above coast. When the open pit method is applied, sea-water transfer pipeline is required. On the contrary, in case of the well method that can be omitted. EMPOISLAS, who has many valuable experiences with well drilling and operation, suggested that superiority could be found in the well method.

As a conclusion, the well method has been judged to be the most suitable to intake the sea-water, and the following well specification for study basis has been determined based on EMPOISLAS's experiences:

(1)	Number of well to be drilled	3
(2)	Depth of well	60m
(3)	Distance among wells	150m

It should be noted that this specification should be applied only for the feasibility study, and the careful and precise study of which should be executed when this project is decided to be accomplished.

5.1.4 Brine Discharge.

In order to avoid influences on ecological system of adjacent sea to a brine discharge point, prompt mixing and difusion of brine to the sea are needed. Southside coast of Punta Norte is only a possible point for discharging the brine because of high waves and tidal current there.

5.1.5 Financial and Economic Aspects

1) The desalination project in San Andrés Island shall be planned and managed taking into consideration the stabilization of the people's livelihood and improvement of their living conditions. Being taken the necessity of realization of the project into account, a financial analysis should be focussed to present the financial situation based on the project viabilities, and the main objective of the economic analysis shall be to prepare the information for economic costs and benefits qualitatively on the project.

2) The following work has been performed for the Study Team and Colombian authorities to make the study basis clear with regards to financial and economic aspects.

   (1) Confirmation of the philosophy for proceeding the financial and economic analysis and document preparation on the methodology of financial analysis.

   (2) Clarification of cost factors and major assumptions and/or premises on the basis of financial and economic analyses.

   (3) Establishment of conditions and premises to be applied for financial and economic analyses.

3) Based on the financial plan projected by the Study Team, the Study Team will prepare financial statements and on the basis of the projected financial statements, the Study Team will conduct the analyses on the basis of the assumed Internal Rate of Return (IRR) before tax vs. water charges. The analyses will be made by employing the Discounted Cash Flow Method and sensitivity analyses for major factors.

4) Taking into account economic cost and benefit of the project, the Study Team will assess the economic effect qualitatively on the project.

5) Major assumptions and premises as the study basis to be applied for financial and economic analyses will be as follows:

(1) Capital structure

a) Equity : 30%

Loan : 70%

b) Terms and condition of loan

* Repayment period: 5 yrs. (grace 1 yr)
* Annual Interest Rate: 7.5% per annum

(2) Project life

Project life for IRR calculation: 16 years

(3) Depreciation and amortization

a) Depreciation Period

* Machinery and equipment 16 years
* Civil and structure 25 years

b) Amortization period

preoperation cost 5 years

(4) Tax

All taxes will be exempted in the project.

(5) Utility cost

* Electricity $5,66/KWH

5.1.6 Others.

1) Electric power.

According to Electrosan, the present electric power capacity in the island is enough and relatively stable for this project. In addition, self-generation system is not preferable from economic and technical points of view. Therefore, it is suitable for the plant to purchase the electric power with installation of independent wiring from the generation facility owned by Electrosan on this project and the necessity of emergency generators will be studied on, in the view point of the evaluation on candidate desalination processes.

2) Product transfer and distribution.

The reservoirs, having the total capacity of 1,200 m^3, are located on Cliff, a hill behind the urban area in the island. Product water shall be transferred by the underground piping installed on this project and will distributed by using existing water network.

5.2 Providencia Island.

5.2.1 Plant Capacity.

This Study Team agreed with DNP that the production capacity of the new plant should be 500 m^3/D in the view point that the production capacity actually required in 1982 was estimated to be 340 m^3/D by EMPOISLAS and that the amount of 500 m^3/D could cover the quantity to be required in 2000 because the increasing rate of the population would be very slight.

5.2.2 Plant Site Selection.

The following sites were nominated as candidate installation sites of the plant:

1) The west of Old Town
2) The south of the Airport

After having carried out site-visits and investigation, the Study Team selected the west of Old Town as the plant site from the following reason:

* Very near to the existing elevated tank
* Possible to get clear sea-water
* Possible to intake sea-water and to discharge waste water easily.

5.2.3 Others

1) Water intake and discharge

It was determined that the water intake by piping method at the point of 20 meters far from the shore was possible, and the water discharge could be done at the shore of 200 meters far from the intake point.

2) Scope of work.

Following items shall be included in the scope of work for the plant:

* Water intake piping and equipment
* Desalination plant including erection and commissioning
* Civil and building work
* Waste water discharge piping
* Product water transferring piping and equipment from the site to the nearest existing elevated tank
* Transportation

As for the diesel generator for the plant, it shall not be included in the scope, because existing power plant will be possible to supply the sufficient electricity for the plant by the end of 1982.

Chapter 6 Reporting Schedule

Based on findings, data and information obtained through the foregoing activities, JICA will accomplish the feasibility study on San Andrés Island and the rough study on Providencia Island simultaneously, performed subsequently after the return of the Study Team to Japan.

Draft final report will be prepared and submitted to DNP by the beginning of December, 1982.

The final report will be prepared in accordance with the conclusion of discussions during presentation of the above-mentioned draft final report and submitted to DNP by the end of February, 1983.

Chapter 7 Finally

The Study Team has made efforts and dedication to complete the survey to obtain findings, data and information and successfully performed its duties with the full cooperation of DNP and EMPOISLAS. These informations will be fully used in the performance of the subsequent work to be conducted in Japan after the return to Japan. The Study Team would like to take this opportunity to express its appreciation for the kind cooperation given by DNP and EMPOISLAS.