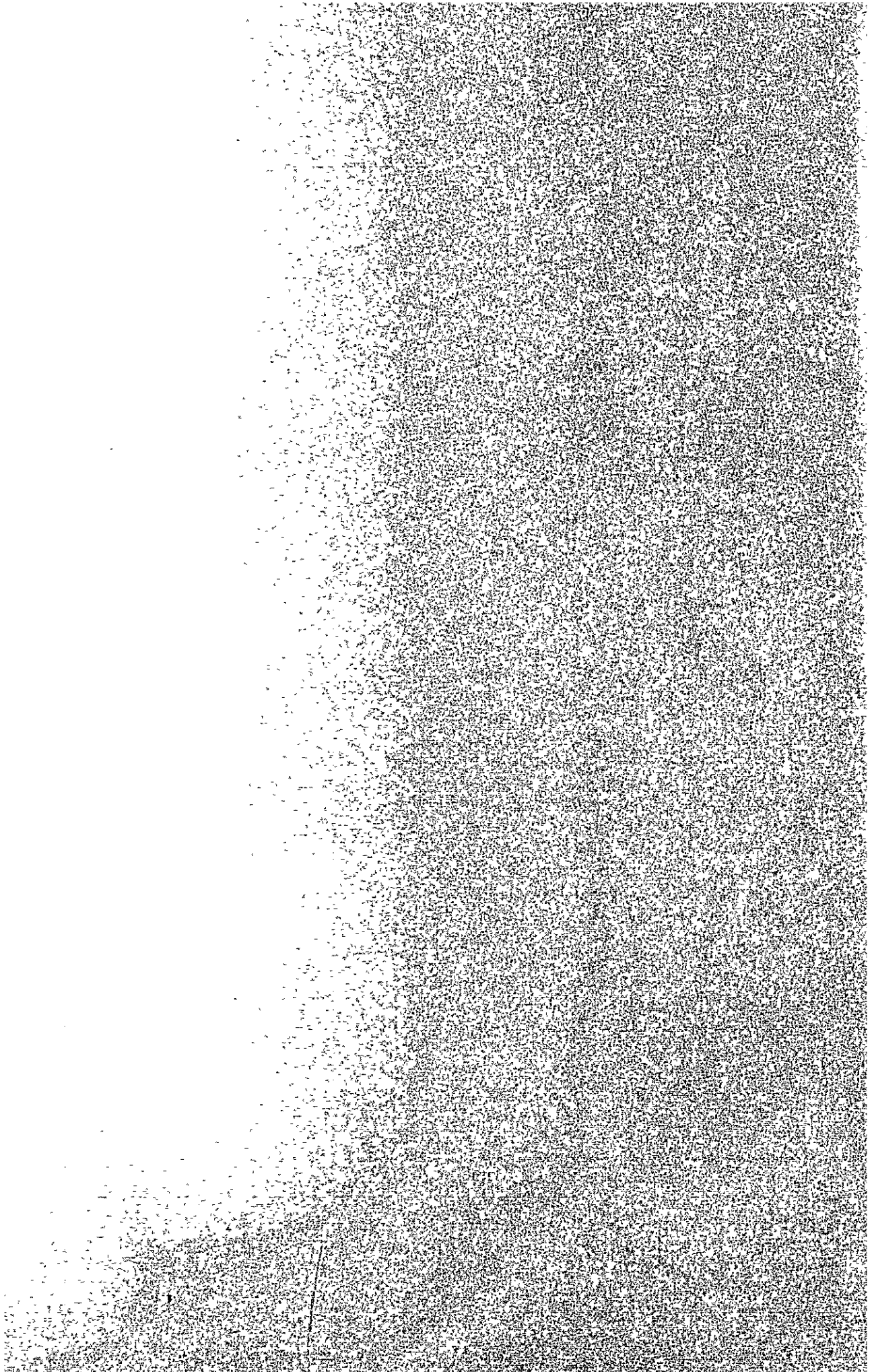


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INTERIM REPORT
ON
FEASIBILITY STUDY
OF
SEA-WATER DESALINATION PROJECT
FOR
THE REPUBLIC OF COLOMBIA

JULY, 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

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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 forecast of water work.**
 - a) Current status of water work**
 - b) Demand forecast**
- (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 electro dialysis 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 |
| Caroheen Watson A. | Secretary |
| Efraín 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 |
|-----------------------|--------------|

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	Navy Office
	(BGT -- SAI)	
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)
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 m³/D by 1985, 2,000 m³/D of which will be supplemented by means of additional wells development and 3,000 m³/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 Sardinias, 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 diffusion 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 m³, 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 m³/d in the view point that the production capacity actually required in 1982 was estimated to be 340 m³/d by EMPOISLAS and that the amount of 500 m³/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.

JICA