5. Assessment of the National Pier of Puntarenas Port

The steel piles of the National Pier at the Port of Puntarenas are in a state of advanced corrosion, and there are many steel pipe piles whose entire external surface has been eaten away due to extreme corrosion at the low water level ; there are still more piles which are partially corroded. As these piles receive no corrosion prevention treatment at all, the corrosion is continuing to advance. If the piles corrode completely, they will no longer withstand horizontal forces such as seismic force and the tractive force of ships as well as surcharge and dead load, and accidents during operation may occur.

MOPT has made an investigation of the state of corrosion of this pier, and on the basis of the investigation, they designed a maintenance and repair plan for the pier in March 1984 aimed at extending its use for 10 more years. Following this plan, INCOP has started repair work beginning with piles which are particularly corroded. This repair operation is considered urgent. However, even if the operation is carried out, the useful lifetime of the pier will not be extended by many years.

If Puntarenas Port continues its cargo handling activities in the future, the pier will have to be completely rebuilt or a new pier will have to be constructed. If the existing pier were rebuilt, it is difficult to expect that the existing structural members would be sufficiently strong. Therefore, the costs of rebuilding the existing pier would almost equal the costs of building a new structure. However, a new pier would be structually more sound.

Furthermore, the repair work would have to take place while no cargo is being handled. Thus, the work period would be quite long, and this would also contribute to high costs.

Consequently, the National Pier of the port of Puntarenas cannot be expected continue to function beyond the immediate future due to its superannuation. The estimated cost for constructing a new pier is about US$ 13,400,000.

CHAPTER XI ECONOMIC ANALYSIS

1. Purpose and Methodology of the Economic Analysis

1.1 Purpose

The purpose of the economic analysis is to appraise the economic feasibility of the maintenance project for the Port of Caldera presented in the previous chapters. The evaluation of a project should show whether the project is feasible from the economic point of view by assessing its contribution to the national economy.

Therefore, the purpose of this chapter is to investigate the economic benefits as well as the economic costs which will arise from the project, and to evaluate whether the net benefits exceed those which could be derived from other investment opportunities (the opportunity cost of capital) in Costa Rica.

1.2 Methodology

The economic return is evaluated in terms of the economic internal rate of return (EIRR) based on cost benefit analysis using the Discount Cash Flow Method.

The EIRR is a discount rate which makes the costs and benefits of a project equal, and it is calculated using the following formula :

$$\sum_{i=0}^{n} \frac{B_i - C_i}{(1+r)^i} = 0$$

n : Calculation period
B_i : Benefit in i-th year
C_i : Cost in i-th year
r : Discount rate

For this project, costs have been calculated based upon international prices.

2. Prerequisites of the Economic Analysis

2. 1 Objects of the Analysis

The following items are defined as the objects of the economic analysis for the project.

(a) Countermeasures against sand sedimentation :

i) Extension of the existing breakwater

ii) Primary and maintenance dredging

(b) Enlargement of the cargo handling capacity by :

i) Shifting of the breakwater foot

ii) Construction of the −3.0 m quaywall

iii) Construction of the mooring dolphin and gangway

iv) Pavement of the open yeads

v) Reinforcement of cargo handling equipment

vi) Reinforcement of maintenance equipment

(c) Construction of a grain cargo terminal (20,000 ton storage capacity)

i) Construction of a grain silo

ii) Construction of cargo handling facilities for grain

2. 2 Alternative Case

In order to determine the return on the project, a cost benefit analysis is conducted. That is, the costs which will be incurred from carrying out the project are subtracted from the benefits which will be gained.

To calculate the benefits of the project in economic terms, an alternative case is used. The case when an investment is made, the With Case, is compared with the case when no investment is made, the Without Case.

In this study, the following conditions are adopted as the Without Case :

(a) The breakwater is not extended.

(b) Annual dredging is carried out in order to maintain the design depth of the existing berths.

(c) Additional equipment and facilities for enlargement of cargo handling capacity are not provided.

(d) The same grain terminal is constructed as under the With Case.

2. 3 Retirement of the Existing Puntarenas Pier

The existing Puntarenas Pier will be retired in 1992 when the construction of this project is completed due to its superannuation. Although the costs of replacing this pier are not considered in this economic analysis, the pier is closely related to this project. After the pier is retired, the following two options may be considered ;

(a) Construction of a grain silo and cargo handling facilities near the Ports of Limón and Moín

In this case, in addition to the construction costs of the grain terminal the transportation costs between this location and the location of grain storage silos in Barranca which is the hinterland of Puntarenas would also have to be considered.

(b) Construction of a new pier of the same scale near the existing Puntarenas Pier

However, there is no space where the grain cargo terminal could be constructed close to the existing Pier. The construction costs for the new pier are described in CHAPTER X.

Considering this situation, we have decided to include the costs of constructing the grain terminal in both the With and the Without Cases as this terminal, or equivalent facilities, will have to be built whether or not the Port of Caldera is improved as proposed in this feasibility study.

2.4 Project Life

The period of economic calculation (project life) is assumed as 30 years from the beginning of the construction (i.e. from 1988).

2.5 Exchange Rate

The foreign currency exchange rate used in this study is

1 US dollar = 53.15 colones

1 Colon = 3.770 Japanese yen

3. Benefits

3. 1 Benefit Items

The benefits brought about by the project include :

(a) Reduction of staying costs, that is, the costs associated with waiting for unoccupied berths and waiting while cargo is being loaded and unloaded after docking

(b) Reduction of dredging costs by the extension of the breakwater

(c) Improvement of the calmness in the port by the extension of the breakwater

(d) Improvement of cargo handling

Many of the expected benefits cannot be evaluated in strictly monetary terms. However, the two benefits which can be evaluated monetarily and are considered in the statistical analysis are :

(a) Reduction of staying costs

(b) Reduction of dredging costs

The other benefits are intangible or difficult to quantify, so only a qualitative analysis is undertaken.

3. 2 Reduction of Ships' Staying Costs

The volume of cargo handled at the Ports of Caldera and Puntarenas is increasing. Investment in improved port facilities and equipment will reduce the waiting period for berth space and the period for loading and unloading cargo. The staying period of ships will be reduced, and this cost reduction is one major benefit of the project.

The benefit that will accrue to Costa Rica from the reduced staying period due to improved facilities and equipment at the Port of Caldera can be calculated by comparing the With Case versus the Without Case. The calculation formula is presented below.

Reduction of Ships' Staying Costs(Benefit)	=	Difference in Ships' Staying Period between With and Without Cases	×	Staying Costs (per Unit Time)	×	Share of Benefits Accruing to Costa Rica

3. 2. 1 Difference in Ships' Staying Period

The average waiting period is estimated in sub-paragraph 2.2.1 of CHAPTER VII from the results of the simulation using Queuing Theory. The difference of the total staying period including ships' berthing period between the With Case in 1992 and the Without Case in 1991 is shown in Table XI−1. To grasp the actual development effects in terms of preventing port congestion, we should compare the With Case with the Without Case in the same year.

However, using the projected figures for the Without Case in 1992 is unrealistic because the port congestion is projected as being abnormally high judging from the calculated berth occupancy ratio as shown in Fig. VII—24. Therefore, in this study the With Case in 1992 is compared with the Without Case in 1991. This results in a conservative estimation of the benefits of the project.

Table XI-1 Total Ships' Staying Period

Unit : Hours

Cargo Type	Without Case (1991)	With Case (1992)	Difference
General Cargoes	24,113	14,644	9,469
Automobiles	6,073	2,684	3,389
Containers	8,443	5,031	3,412
Grain	1,323	886	437
Fertilizer	368	268	100
Total	40,320	23,513	16,807

3. 2. 2 Calculation of Ships' Staying Costs

"Staying Costs" are the costs incurred while a vessel is within the port. There are two main methods for calculating staying costs, i.e. (1) calculating staying costs from various ship costs including depreciation costs and other expenses such as labour and fuel costs, and (2) calculating staying costs based on the time charterage of cargo vessels.

(1) Ship costs

Based upon ship cost data gathered by a Japanese research institute, the following correlation is prepared. Data sources are shown in APPENDIX 12 :

$$Y = 6624.97 - 1134.29 \cdot \ln(X) \quad (R = 0.959)$$

where, X : Ship size ('000 DWT)

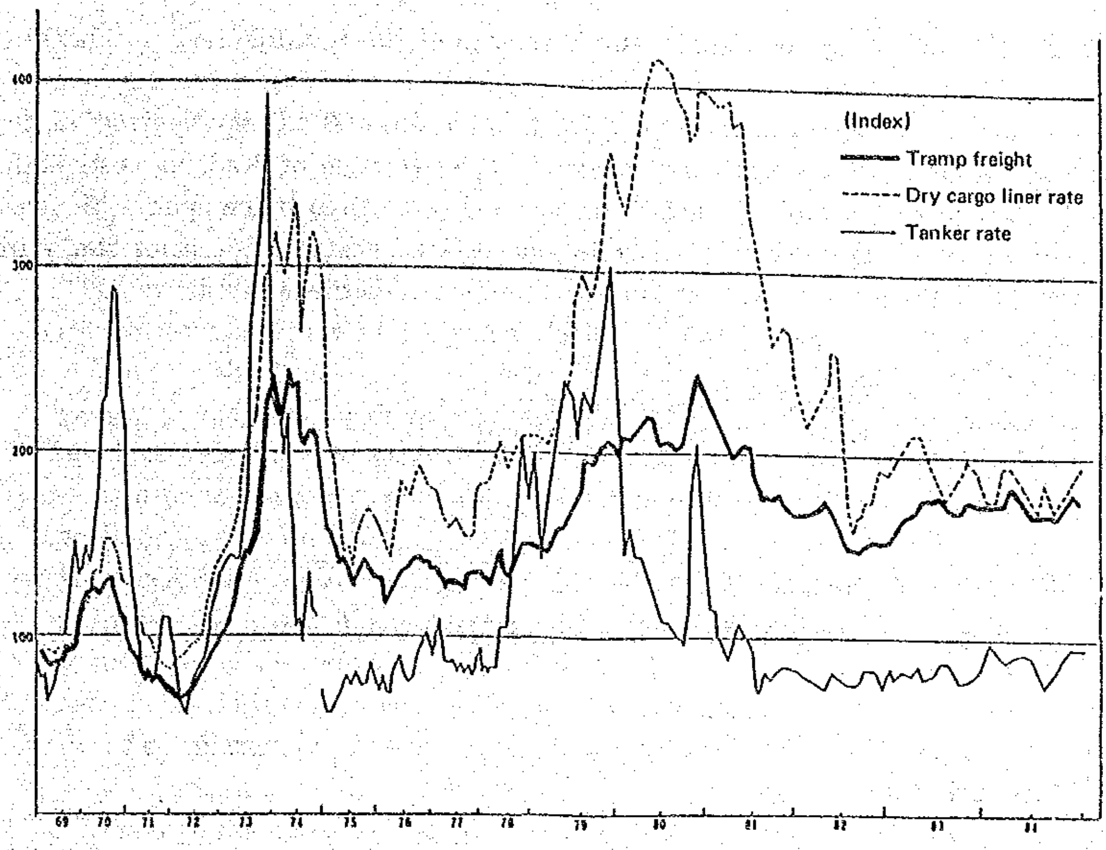
Y : Ship cost (Japanese Yen/DWT/Month)

ln : Natural logarithm

R : Correlation coefficient

(2) Time charterage of cargo vessels

As shown in Fig. XI—1, charter rates fluctuate by a large margin, and acoording to the staffs of Japanese shipping companies, the charter rates (market rates) in 1973 and 1980 were adequate for them, that is the shipping companies were able to realize a reasonable profit at these rates.



Note: The scale of the index presented in this figure is not constant, but changes as follows: 1) from 1966, the index value of 100 is equal to the average rate from July 1965 through June 1966; 2) however, from 1972 for liner vessels only the index value of 100 is equal to the average rate of 1971.
For tankers, the index is based on the single navigation flat rate. From 1975, the index is based on the rates for small size (30-60 thousand D/T) oil tankers.
Source: Norwegian Shipping News

Fig. XI-1 Charter Rate Index (Monthly Average)

Based on item (1) and (2) above, 70% of the calculation costs from the correlation presented in item (1) are adopted as the staying costs for this study. For example, 807 ¢ (15.2 $)/DWT/Month for 7,500 DWT vessels, 662 ¢ (12.5 $)/DWT/Month for 15,000 DWT vessels, and 554 ¢ (10.4 $)/DWT/Month for 25,000 DWT vessels are sample adopted rates using this calculation method.

3. 2. 3 Share of the Benefits Accruing to Costa Rica

The savings in ships' staying costs are primarily realized by shipping companies. For foreign ships, therefore, the benefits accrue to foreign countries. However, some portion of these benefits should be returned to Costa Rica. In this study, it is assumed that 50% of the costs saved by foreign ships accrue to Costa Rica.

3. 3 Reduction of Dredging Costs by the Extension of the Breakwater

As mentioned in CHAPTER VI, if the existing breakwater is extended by 200 m, the sand sediment volume will be drastically reduced. The reduction of dredging costs is the other major benefit of the project. This benefit can be calculated by comparing the case where the extension of the breakwater is carried out with the case where it is not—the With Case versus the Without Case. The calculation formula is described as follows :

$$\boxed{\begin{array}{l}\text{Reduction of}\\ \text{Dredging Costs}\\ \text{(net benefit)}\end{array}} = \boxed{\begin{array}{l}\text{Dredging}\\ \text{Volume}\end{array}} \times \boxed{\begin{array}{l}\text{Dredging Cost}\\ \text{(per Unit Volume)}\end{array}}$$

— under the "Without" Case —

$$- \left(\boxed{\begin{array}{l}\text{Dredging}\\ \text{Volume}\end{array}} \times \boxed{\begin{array}{l}\text{Dredging Cost}\\ \text{(per Unit Volume)}\end{array}} + \boxed{\begin{array}{l}\text{Construction Cost of}\\ \text{the Breakwater Extension}\end{array}} \right)$$

— under the "With" Case —

3. 4 Other Intangible Benefits

3. 4. 1 Improvement of Calmness in the Port by the Extension of the Breakwater

The wave height distribution in the harbour is calculated using a computer simulation. The details are shown in APPENDIX 8. The results show that the occurrence probability of significant wave heights less than 30 cm at the No. 1 and No. 2 berths increases and that the calmness in the harbour is improved to some extent by extending the breakwater. This should decrease the ship movement at berth. Consequently, it may bring about an increase in cargo handling efficiency.

3. 4. 2 Improvement of Cargo Handling

From the rationalization of the cargo handling system, the following benefits are expected :

(a) The progress of containerization will significantly reduce the cargo damage.

(b) The cargo turnover will increase and consequently the warehouses and open yards will be used more efficiently.

(c) The pavement of the open yards will reduce the cargo damage within these yards.

4. Costs

4.1 Costs under the With Case

Table XI-2 shows the total costs under the With Case throughout the project life, i.e. from 1988 to 2017. The prerequisites of the calculation are as follows :

(1) The costs are calculated based on the costs shown in Table X-18. For calculation of the construction cost of individual facilities such as the breakwater extension, the shifting of the breakwater foot and the construction of the mooring dolphin and gangway, and also for dredging costs, the concept of monthly rental fees against the purchase costs of the grab dredger fleet and construction machinery are applied. Generally, in economic analyses, the concept of salvage value is adopted when some equipment or facility can be used for other projects after the subject project is finished. However, in this case, the fleet and the construction machinery will be used for various purposes, and the equipment costs have to be allocated to each construction item in proportion to the estimated number of months the eqipment will be used to construct each item. This is the reason why the concept of monthly rental fees is applied herein. In the calculation of the rental fees, the lives of fleet and repair facilities are estimated as 15 years, and the life of the construction machinery is estimated as 7 years.

(2) The construction cost of the grain terminal is not listed in Table XI-2 because the cost under both the With and the Without Cases remains the same.

(3) Dredging costs are calculated based on the dredging volume in Fig. VI-26(a).

(4) The life of the cargo handling equipment except for maintenance tools is estimated as 10 years, and the life of maintenance tools is estimated as 15 years.

(5) Maintenance costs for the breakwater extension per annum are estimated as 0.5% of the construction costs, and annual maintenance costs for the enlargement of the mooring facility capacity are estimated as 1% of the construction costs. Maintenance costs for the cargo handling equipment and the pavement of the yards are estimated as 5% of the construction costs per annum.

(6) Maintenance costs for the cargo handling equipment are not estimated for the years when equipment is replaced.

(7) The salvage values of the cargo handling equipment and maintenance tools in 2017 are considered.

(8) The cargo handling equipment cost in 1991 includes training fees for INCOP personnel, but in the costs for renewal in 2001 and 2011, training fees are not included.

4.2 Costs under the Without Case

Table XI-3 shows the total costs under the Without Case throughout the project life, i.e. from 1988 to 2017.

The prerequisites of the calculation are as follows :

(1) If the breakwater were not extended, sediment sand would have to be dredged by a contractor with an appropriate dredger fleet. However, taking into consideration the

Table XI-2 Costs under the With Case

Cost Item / Year	Extension of the Breakwater: Cost*1)	Extension of the Breakwater: Maintenance Cost*2)	Dredging Cost	Mooring Facility*3): Cost	Mooring Facility*3): Maintenance Cost	Pavement of the Yards: Cost	Pavement of the Yards: Maintenance Cost	Cargo Handling Equipment: Cost	Cargo Handling Equipment: Maintenance Cost	Total
1988	84,455									84,455
1989	263,332	422								263,754
1990	43,892	1,739	15,400	141,771		92,181				294,983
1991		1,958	12,106		1,418		4,609	86,605		106,696
1992		1,958			1,418		4,609		3,647	11,632
1993		1,958			1,418		4,609		3,647	11,632
1994		1,958			1,418		4,609		3,647	11,632
1995		1,958			1,418		4,609		3,647	11,632
1996		1,958	10,088		1,418		4,609		3,647	21,720
1997		1,958			1,418		4,609		3,647	11,632
1998		1,958			1,418		4,609		3,647	11,632
1999		1,958			1,418		4,609		3,647	11,632
2000		1,958			1,418		4,609		3,647	11,632
2001		1,958	10,088		1,418		4,609	72,949		91,022
2002		1,958			1,418		4,609		3,647	11,632
2003		1,958			1,418		4,609		3,647	11,632
2004		1,958			1,418		4,609		3,647	11,632
2005		1,958			1,418		4,609		3,647	11,632
2006		1,958	10,088		1,418		4,609	1,884	3,647	23,604
2007		1,958			1,418		4,609		3,647	11,632
2008		1,958			1,418		4,609		3,647	11,632
2009		1,958			1,418		4,609		3,647	11,632
2010		1,958			1,418		4,609		3,647	11,632
2011		1,958	10,088		1,418		4,609	72,949		91,022
2012		1,958			1,418		4,609		3,647	11,632
2013		1,958			1,418		4,609		3,647	11,632
2014		1,958			1,418		4,609		3,647	11,632
2015		1,958			1,418		4,609		3,647	11,632
2016		1,958	16,652		1,418		4,609		3,647	28,284
2017		1,958			1,418		4,609	△ 377		
							4,609	△21,885		△10,630
Total	391,679	55,027	84,510	141,771	38,286	92,181	124,443	212,125	87,528	1,227,550

Note : *1) Cost is the primary construction cost.
*2) Maintenance cost is the annual maintenance cost.
*3) Cost items of mooring facility capacity consist of construction costs for shifting the breakwater foot, the -3m quaywall and the mooring dolphin and gangway.

past results, i. e. sudden sand sediment in the harbour within a few days caused by extraordinary waves, it is assumed that the grab dredger fleet is purchased by MOPT and should solely be engaged in the maintenance dredging at the Port of Caldera.

(2) Dredging costs are calculated based on the dredging volume in Fig. VI—26(a).

(3) The life of the grab dredger fleet is estimated as 15 years, and the salvage values of the fleet in 2017 are considered.

(4) In Table XI—3 the maintenance costs of the fleet are included in the dredging costs.

Table XI-3 Costs under the Without Case

Unit : '000 colones

Cost Item \ year	1989	1990	1991	1992	1993	1994
Purchase of the Fleet	263,685					
Dredging	13,090	4,420	4,998	16,898	6,613	7,565
Total	276,775	4,420	4,998	16,898	6,613	7,565

Cost Item \ year	1995	1996	1997	1998	1999	2000
Purchase of the Fleet						
Dredging	8,330	8,891	17,459	9,843	10,132	10,421
Total	8,330	8,891	17,459	9,843	10,132	10,421

Cost Item \ year	2001	2002	2003	2004	2005	2006
Purchase of the Fleet				263,685		
Dredging	10,710	18,989	11,186	11,373	11,458	11,662
Total	10,710	18,989	11,186	275,058	11,458	11,662

Cost Item \ year	2007	2008	2009	2010	2011	2012
Purchase of the Fleet						
Dredging	19,941	12,036	12,223	12,410	12,699	20,791
Total	19,941	12,036	12,223	12,410	12,699	20,791

Cost Item \ year	2013	2014	2015	2016	2017	Total
Purchase of the Fleet					△17,579	509,791
Drdeging	12,699	12,699	12,699	12,699	20,791	355,725
Total	12,699	12,699	12,699	12,699	3,212	865,516

5. Shadow Pricing

5. 1 Calculating Shadow Prices

The costs and benefits considered in previous paragraphs are calculated based on market prices (international prices and domestic prices). However, the values of goods quoted in a given marketplace do not always represent the true value of those goods to the nation. Thus, "shadow pricing" is often used to examine the costs of labour, capital, and imported goods, as well as the benefits of development, to evaluate a project from the economic viewpoint. There are several ways of applying the concept of shadow pricing, but in this study, the prices of domestic goods and services are revised.to shadow prices in order to determine a more rational valuation. These shadow prices are intended to represent the international market prices of these goods and services.

5. 1. 1 Exclusion of Transfer Items

The costs in Table XI—2 and XI—3 should be divided into local currency and foreign currency portions for shadow pricing. The foreign currency portion of the imported equipment and services do not include import duties or sales tax. Thus, these figures are a reasonable statement of the economic value of these goods and services.

On the other hand, the local currency portion of the construction costs include both sales tax and import duties. These are merely transfer items, which do not actually reflect the consumption of any national resources. Therefore, these transfer costs should be excluded from the economic analysis of the value of the project.

5. 1. 2 Method of Applying Conversion Factors

Generally, all benefits and costs are divided into labour, traded goods and non-traded goods. Labour is further divided into skilled labour and unskilled labour. The cost of skilled labour is obtained by multiplying its market price by the conversion factor for consumption (CFC), and the cost of unskilled labour is calculated by multiplying its market price by a ratio of the shadow wage rate and the CFC. Traded goods are expressed by the CIF value for imports and by the FOB value for exports. As world prices cannot be directly applied in the case of non-traded goods, a second level analysis is made of the items required for the production of non-traded goods. These items are, in turn, divided into the categories of labour, traded goods and non-traded goods. The standard conversion factor (SCF) is then applied to the remaining value of non-traded goods.

5. 2 Calculation of the Conversion Factors

5. 2. 1 The Standard Conversion Factor (SCF)

Import duties and export subsidies create a price differential between the domestic market and the international market. For the purpose of analysing benefits and costs within the domestic market, the standard conversion factor is applied in order to convert domestic prices to international market prices.

The standard conversion factor is obtained using the following formula :

$$SCF = \frac{I + E}{I + D_i + E - D_e}$$

where, I : Total Amount of Imports
E : Total Amount of Exports
D_i : Total Amount of Import Duties
D_e : Total Amount of Export Duties

The standard conversion factors in 1984 and 1985 are listed in Table XI—4. In this study, the mean value for the two year period is used. Thus, the standard conversion factor has a value of 0.983.

Table XI-4 Standard Conversion Factors (SCF)

Unit: '000,000 colones

Item	1984	1985	Total
Imports (CIF)	48,560	56,282	104,842
Exports (FOB)	44,684	48,678	93,362
Import Duties	4,165	5,360	9,525
Export Duties	3,165	2,970	6,135
SCF	0.989	0.978	0.983

Note : 1) The source of data for import and export volumes (US$ basis) is BCCR. Exchange rates between US$ and colones are as follows :
1 US$ = 44.40 colones in 1984
= 50.55 colones in 1985
2) The source of data for import and export duties is the Intermodel Commission of Cargo consisting of the Ministry of Finance and the Board of Audit.
3) Import and export figures for 1985 are preliminary.

5. 2. 2 Conversion Factor for Consumption (CFC)

This factor is used for converting the prices of consumer goods from domestic to international prices. This is particularly required to convert domestic labour costs to the corresponding international prices. The conversion factor for consumption is usually calculated in the same manner as the standard conversion factor, replacing total imports and total exports by imports and exports of consumer goods only. However in this case, due to a lack of the required data such as duty revenue figures, the conversion factor for consumption could not be calculated.

In this study, taking into consideration the low share of consumer goods in imports as shown in Table I—10, it is assumed that the CFC is equal to the SCF.

5. 2. 3 Shadow Wage Rate

(1) Evaluation of skilled labour

For economic analysis, labour costs are usually measured in terms of their opportunity costs, that is the value of lost marginal product for other purposes arising from additional employment of labourers for a given project.

In this project, the cost of skilled labour is calculated based on actual market wages, assuming that the market mechanism is functioning properly. However, as these are domestic costs, they are converted to international prices by multiplying the local wage by the conversion factor for consumption.

Thus, the conversion factor for skilled labour

= (nominal wage rate) × (CFC)

= 1 × 0.983

= 0.983

(2) Evaluation of unskilled labour

For unskilled labour, the economic costs are calculated based on a simplified measure of the opportunity cost. Generally, as the wages paid to unskilled labourers by a project are usually far above the opportunity cost, these market wages should not be used for calculating the economic value of the unskilled labourers.

The opportunity cost is estimated by calculating the per-capita-GDP of workers in the agriculture, forestry, hunting and fishery sectors. The total GDP of these sectors is estimated as 38,296 million colones by multiplying the 33,014 million colones value in the sectors in 1984 by the increase rate of the total GDP in 1985 over 1984. The number of workers in the sectors in March, 1985 was 226,765 according to the national employment survey carried out by the Ministry of Labour and National Security. By division, the per capita daily GDP comes to 563 colones, assuming 25 working days in a month.

On the other hand, the nominal daily wage in this project for unskilled labourers including social benefits paid by the employer was 560 colones. As the result of the calculation, it can be said that the opportunity cost estimated from the per capita agricultural GDP is almost the same as the nominal wage for unskilled labour. This is probably because the Costa Rican unemployment rate in 1985 was about 6%, much less than the very high unemployment rate in most other developing countries. It is considered, therefore, that the nominal wage for unskilled labour in Costa Rica approximately represents its economic value.

Thus, the conversion factor for unskilled labour

= (nominal wage rate) × (CFC)

= 1 × 0.983

= 0.983

5.3 Shadow Prices of Benefit Items

5.3.1 Reduction in Staying Costs

The calculation of the reduction in ships' staying costs is quoted at international prices. Thus, this figure does not have to be converted for economic analysis.

5.4 Shadow Prices of Cost Items

Table XI—5 and Table XI—6 show the breakdown of construction costs divided into the foreign portion and the local portion on a market price basis.

As imported equipment for the project is exempt from import duties, the foreign portion is quoted at CIF prices. Also, almost all of the equipment and tools listed as trade goods in Table XI—5 and Table XI—6 purchased by MOPT without any tax are quoted at CIF prices. For the other items (the local portion except for traded goods), the conversion factor coefficients are calculated. Table XI—7 and Table XI—8 show the calculated conversion coefficients of the costs.

Table XI-5 Construction Costs from 1988 to 1991

Unit: '000 colones

Item	Total	Foreign Portion	Local Portion				
			Sub Total	Traded Goods	Non Traded Goods	Skilled Labour	Unskilled Labour
Extension of the Breakwater	386,854	274,199	112,655	44,379	10,386	34,979	22,911
Primary Dredging	15,400	13,010	2,390	1,190	0	730	470
Maintenance Dredging in 1991	12,106	10,339	1,767	961	0	488	318
Enlargement of the Mooring Facility	140,432	98,441	41,991	15,883	5,960	12,821	7,327
Pavement of the Yards	88,793	10,041	78,752	31,112	6,712	22,051	18,877
Cargo Handling Equipment	86,605	86,605	0	0	0	0	0
Total	730,190	492,635	237,555	93,525	23,058	71,069	49,903

Note: 1) Sales tax in the local portion is excluded.

Table XI-6 Costs under the Without Case from 1989 to 2017

Unit: '000 colones

Item	Total	Foreign Portion	Local Portion				
			Sub Total	Traded Goods	Non Traded Goods	Skilled Labour	Unskilled Labour
Purchase of the Fleet	509,791	509,791	0	0	0	0	0
Dredging	355,725	241,475	114,250	38,127	0	60,236	15,887
Total	865,516	751,266	114,250	38,127	0	60,236	15,887

Table XI-7 Conversion Coefficients of Construction Costs

Item	Foreign Portion	Local Portion					
		Traded Goods	Non Traded Goods	Skilled Labour	Unskilled Labour	Sub Total	Total Conversion Factor
Conversion Factor	1.000	1.000	0.983	0.983	0.983	–	
Extension of the Breakwater	(70.9%) 0.709	(11.5%) 0.115	(2.7%) 0.027	(9.0%) 0.088	(5.9%) 0.058	(29.1%) 0.288	(100.0%) 0.997
Primary Dredging	(84.5%) 0.845	(7.7%) 0.077	– –	(4.7%) 0.046	(3.1%) 0.030	(15.5%) 0.153	(100.0%) 0.998
Maintenance Dredging in 1991	(85.4%) 0.854	(8.0%) 0.080	– –	(4.0%) 0.039	(2.6%) 0.026	(14.6%) 0.145	(100.0%) 0.999
Enlargement of the Mooring Facility	(70.1%) 0.701	(11.4%) 0.114	(4.2%) 0.041	(9.1%) 0.089	(5.2%) 0.051	(29.9%) 0.295	(100.0%) 0.996
Pavement of the Yards	(11.3%) 0.113	(35.0%) 0.350	(7.6%) 0.075	(24.8%) 0.244	(21.3%) 0.209	(88.7%) 0.878	(100.0%) 0.991
Cargo Handling Equipment	(100.0%) 1.000	– –	– –	– –	– –	– –	(100.0%) 1.000

Table XI-8 Conversion Coefficients of Costs under the Without Case

Item	Foreign Portion	Local Portion					
		Traded Goods	Non Traded Goods	Skilled Labour	Unskilled Labour	Sub Total	Total Conversion Factor
Conversion Factor	1.000	1.000	0.983	0.983	0.983	–	
Purchase of the Fleet	(100.0%) 1.000	– –	– –	– –	– –	– –	(100.0%) 1.000
Dredging	(67.9%) 0.679	(10.7%) 0.107	– –	(16.9%) 0.166	(4.5%) 0.044	(32.1%) 0.317	(100.0%) 0.996

6. Economic Profitability

As mentioned above, the economic profitability of the project is evaluated based on the EIRR. The EIRR of the project is 23.7% as shown in Table XI−9.

There are various views concerning the evaluation of the EIRR to guide the judgement as to whether a project is feasible or not. The leading view is that the project is feasible if the EIRR exceeds the local opportunity cost of capital. In port investment projects, EIRRs usually range from 10% to 20%. It is generally considered that a project with an EIRR of more than around 10% is economically feasible. In this case, only taking into consideration the two items which are easily quantified, the EIRR of the project is 23.7%. Therefore, the project is considered to be feasible.

Table XI-9 EIRR Calculation

EIRR=23.7%

Unit: '000 Colones

Year	Benefits	Costs			Benefits –Costs	Present Value in 1988		
		With Case	Without Case	Net Cost		Benefits	Net Costs	Benefits –Net Costs
1988	–	83,163	–	83,163	-83,163	–	83,163	-83,163
89	–	259,725	276,723	-16,998	16,998	–	-13,745	13,745
90	–	288,167	4,402	283,765	-283,765	–	185,555	-185,555
91	61,846	106,426	4,978	101,448	-39,602	32,703	53,643	-20,941
92	123,693	11,374	16,830	-5,456	129,149	52,890	-2,333	55,223
93	123,693	11,374	6,587	4,787	118,906	42,769	1,655	41,114
94	123,693	11,374	7,535	3,839	119,854	34,585	1,073	33,511
95	123,693	11,374	8,297	3,077	120,616	27,967	696	27,271
96	123,693	21,452	8,855	12,597	111,096	22,615	2,303	20,312
97	123,693	11,374	17,389	-6,015	129,708	18,288	-889	19,177
98	123,693	11,374	9,804	1,570	122,123	14,788	188	14,600
99	123,693	11,374	10,091	1,283	122,410	11,958	124	11,834
2000	123,693	11,374	10,379	995	122,698	9,670	78	9,592
1	123,693	90,753	10,667	80,087	43,606	7,820	5,063	2,757
2	123,693	11,374	18,913	-7,539	131,232	6,323	-383	6,709
3	123,693	11,374	11,141	233	123,460	5,113	10	5,104
4	123,693	11,374	275,013	-263,639	387,332	4,135	-8,813	12,948
5	123,693	11,374	11,412	-38	123,731	3,344	-1	3,345
6	123,693	23,336	11,615	11,721	111,972	2,704	256	2,448
7	123,693	11,374	19,861	-8,487	132,180	2,186	-150	2,336
8	123,693	11,374	11,988	-614	124,307	1,768	-9	1,777
9	123,693	11,374	12,174	-800	124,493	1,430	-9	1,439
2010	123,693	11,374	12,360	-986	124,679	1,156	-9	1,165
11	123,693	90,754	12,648	78,106	45,587	935	590	345
12	123,693	11,374	20,708	-9,334	133,027	756	-57	813
13	123,693	11,374	12,648	-1,274	124,967	611	-6	618
14	123,693	11,374	12,648	-1,274	124,967	494	-5	499
15	123,693	11,374	12,648	-1,274	124,967	400	-4	404
16	123,693	28,009	12,648	15,361	108,332	323	40	283
17	123,693	-10,888	3,129	-14,017	137,710	261	-30	291
Total	3,277,864	1,208,378	864,091	344,287	2,933,577	307,991	307,991	0

7. Sensitivity Analysis

7.1 Assumption of Cases

Sensitivity analysis is made for three cases as follows :

(1) Case EA : The construction costs other than the costs of dredging and the purchase costs of the dredging fleet and cargo handling equipment increase by 10%. In other words, the construction costs of the extended and shifted breakwater, the gangway and the small craft basin as well as the pavement cost of the open yards increase by 10%.

(2) Case EB : The forecast port cargo volume decreases by 10%.

(3) Case EC : The ship costs decrease by 29%. The ship costs decrease by 50% of the figure calculated in APPENDIX 13. The comparison with the base case, the decrease rate is 29%.

7.2 Results

The EIRR is calculated for each of the three simulation cases. The results are shown in Fig. XI—2. Every EIRR exceeds 10%. The results of the sensitivity analysis thus prove that each case would be feasible.

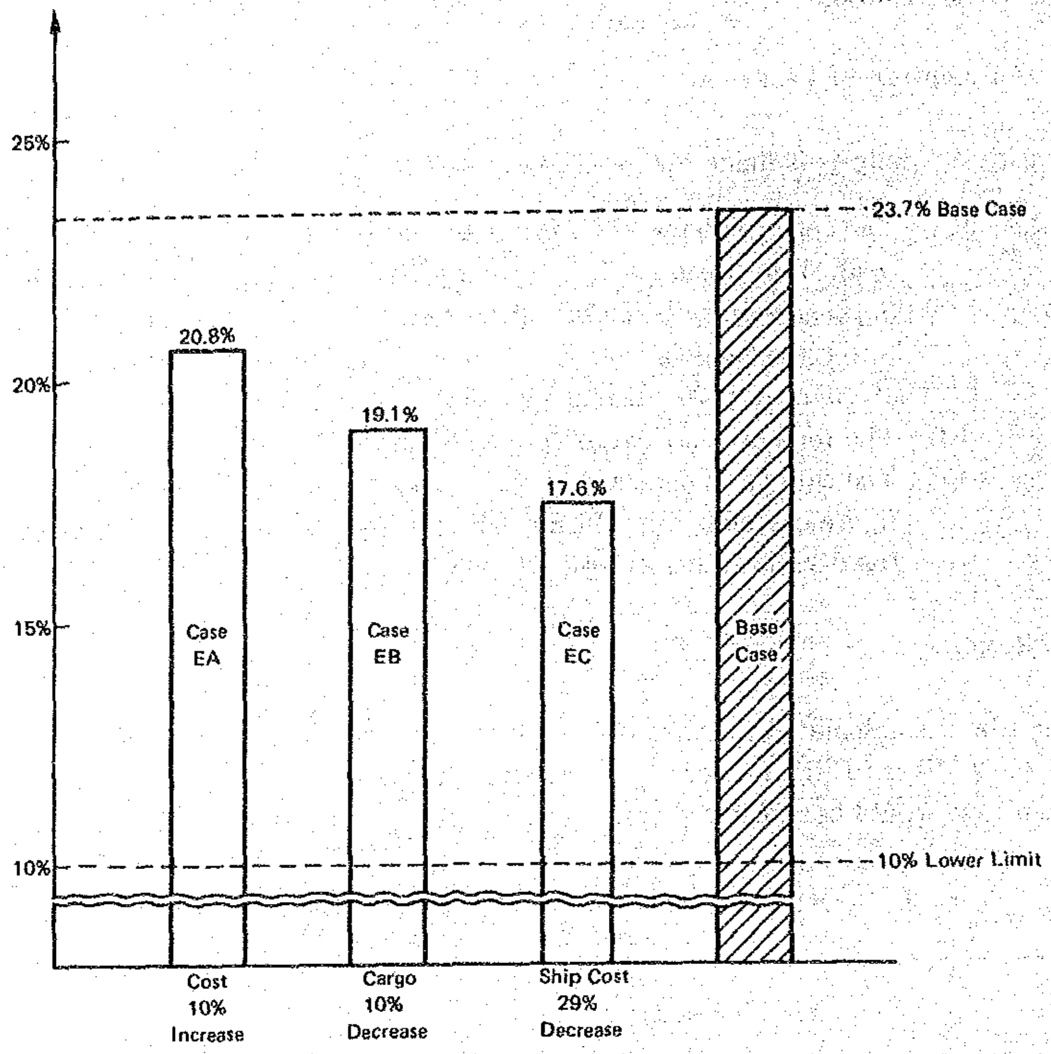


Fig. XI-2 Sensitivity Analysis

8. Conclusion

From the viewpoint of the economic analysis, that is the benefit of the project to the nation, this project can be regarded as feasible.

CHAPTER XII FINANCIAL ANALYSIS

1. Purpose and Methodology of the Financial Analysis

1. 1 Purpose

In the preceding CHAPTER XI, the economic effectiveness of the investment is studied from the viewpoint of the national economy. The purpose of the financial analysis is to ascertain the financial viability of the project itself.

1. 2 Methodology

The investment effects of this project are analysed by the financial internal rate of return (FIRR) using the Discount Cash Flow Method. The FIRR is a discount rate which makes the net present value of the cash flow (revenue minus cost) equal to zero.

2. Prerequisites of the Financial Analysis

2. 1 Objects of the Financial Analysis

The objects of this analysis are limited to the revenues and costs related to this project.

2. 1. 1 Revenues

For this financial analysis, the revenues which will be considered as arising from this project are the port tariffs on the incremental cargo volume, that is the difference in cargo volume between the Without Case in 1991 and the With Case in 1992, and all the port tariffs which will be collected from the handling of grain cargo.

2. 1. 2 Costs

Costs considered in this study are limited to the construction costs for enlargement of the cargo handling capacity listed below. Labour costs are not considered as the cargo volume estimated under the With Case can be handled using the existing number of INCOP personnel.

(a) Shifting of the breakwater foot
(b) Construction of the −3.0 m quaywall
(c) Construction of the mooring dolphin and gangway
(d) Pavement of open yards
(e) Purchase of additional cargo handling equipment
(f) Construction of grain cargo handling facilities

According to Costa Rican law, all of the fixed assets in ports on the ocean side of an imaginary line running 30 m behind the face line of quaywalls including channels, basins, breakwaters and the quays themselves are national property, not the property of the local port authority. Thus, based on this law items (a) through (c) above are national property. Nevertheless, herein these items are also considered as objects of the financial analysis in order to consider the relation between the revenues and the costs arising from the enlargement of the cargo handling capacity.

2. 2 Period of Financial Analysis

The financial analysis covers the 30 years from 1988 to 2017.

2. 3 Necessary Funds

The funds necessary to execute the construction works are to be raised as follows ;

(a) Local currency portion : Self finance

(b) Foreign currency portion : Loans from a foreign country under the following conditions

1) Interest rate : 4.75% per annum

2) Repayment terms : 25 years (including a 7 year grace period)

3. Revenues

The revenues are calculated using the port tariff rates set by INCOP. The types of dues and charges are described in Table XII—1. As a result of the calculation, port tariff revenues arising from grain cargo in 1992 will total 51,306 thousand colones and those from other cargo will total 23,585 thousand colones.

The revenues in 1991 are estimated to equal one-half of the projected revenues in 1992 because the construction works to enlarge the cargo handling capacity will all be completed by the end of 1991, and many of these works will be completed earlier in 1991, effecfively expanding the cargo handling capacity during that year.

Table XII-1 Outline of Port Tariffs

Unit : Colones

Revenue Item	Unit Charge
(a) Pilotage, charges for usage of navigation aids, towing service and mooring or untying	21.00/Gross Registered Tonnage
(b) Charge for use of quaywall	290.00/meter length of ship/day
(c) Charge for cleaning wharves	7.00/MT of cargo
(d) Charge for use of wharves	
i) General cargo	472.40/MT of cargo
ii) Bulk cargo	107.40/MT of cargo
(e) Loading/unloading charges	(Colones/MT of cargo)
i) Importation	
o Grain cargo	120.00
o General cargo	150.00
o Vehicles	150.00
o Cargo larger than $6m^3$	200.00
o Cargo longer than 5m	150.00
ii) Exportation	(Colones/MT of cargo)
o General cargo	100.00
o Cargo brought alongside	50.00
(f) Port dues	(Colones/MT of cargo)
i) Importation	
o Cargo to be divided (LCL cargo)	33.00
o Containerized cargo	46.00
o Bulk cargo	50.00
ii) Exportation	
o Cargo to be divided (LCL cargo)	30.00
o Containerized cargo	46.00

Note: Grain is currently being handled at Puntarenas Pier by INCOP personnel together with CNP personnel in charge of loading grain into boxcars with low rate payment of unloading charges to INCOP. After the grain cargo handling is transferred to Caldera, CNP will pay unloading charges of grain to INCOP based on the construction costs of the cargo handling facilities and the labour costs incurred by INCOP.

4. Costs

Total costs arising from 1990 to 2017 are listed in Table XII−2. The prerequisites of the calculation are as follows :

(1) The life of the cargo handling equipment except for maintenance tools is estimated as 10 years, and the life of the maintenance tools as 15 years.
(2) The lives of pneumatic unloaders, the bucket elevator and the movable belt conveyor are estimated as 20 years, and the life of the fixed belt conveyor is estimated as 30 years.
(3) Cost items listed under the column "Breakwater etc" in Table XII−2 are cost items (a) Shifting of the breakwater foot, (b) Construction of the −3.0 m quaywall and (c) Construction of the mooring dolphin and gangway.
(4) The maintenance costs for the breakwater, etc per annum are estimated as 1% of the construction costs, and the maintenance costs for the other cost items are estimated as 5% of the construction cost per year.
(5) Maintenance costs are not estimated for these years when equipment or facilities are renewed totally or partially.
(6) The salvage values in 2017 are considered.
(7) The cargo handling cost in 1991 includes training fees for INCOP personnel, but in the costs for renewal in 2001 and 2011 training fees are not included.

Table XII-2 Costs for the Study

Unit:'000 colones

Year \ Cost Item	Breakwater Foot and Others		Pavement of the Yards		Cargo Handling Equipment		Grain Cargo Handling Equipment		Total
	Cost*)	Mt. Cost*)	Cost	Mt. Cost	Cost	Mt. Cost	Cost	Mt. Cost	
1990	141,771		92,181						233,952
1991		1,418		4,609	86,605		208,088		300,720
1992						3,647		10,404	20,078
1993									
1994									
1995									
1996									
1997									
1998									
1999									
2000									
2001					72,949				89,380
2002						3,647			20,078
2003									
2004									
2005									
2006					1,884				21,962
2007									20,078
2008									
2009									
2010									
2011					72,949		177,571	1,526	258,073
2012						3,647		10,404	20,078
2013									
2014									
2015									
2016									
2017					-22,262		-118,473		-120,657
Total	141,771	38,286	92,181	124,443	212,125	87,528	267,186	261,626	1,225,146

* "Cost" is the primary construction cost. "Mt. Cost" is the annual maintenance cost.

5. FIRR

The FIRR of the project is calculated as 8.26% as shown in Table XII—3. The desirable level of FIRR varies depending on the time and place, and the expectations of the lender and the borrower. For borrowers, the average interest rate paid on borrowed funds is the lower limit.

In this project, 76.3% of the overall construction cost is the foreign portion as shown in Table XII—4, and the foreign portion is assumed to be raised through loans with a 4.75% interest rate. Therefore, the FIRR is required to exceed 3.62%, which is the weighted average interest rate for all the project funds. Judging from this point of view, this project can be regarded as feasible, since the FIRR is 8.26%, well above the weighted average interest rate.

6. Sensitivity Analysis

6.1 Assumption of Cases

Sensitivity analysis is made for three cases where (1) the port tariff revenues will decrease by 10%, (2) the construction costs will increase by 10%, and (3) the revenues will decrease by 10% and the costs will increase by 10% simultaneously. These different assumptions for the sensitivity tests are outlined as follows :

(a) Case FA : revenues decrease by 10%
(b) Case FB : costs increase by 10%
(c) Case FC : revenues decrease by 10% and costs increase by 10% at the same time.

6.2 Results

The FIRR is calculated for each of the three simulation cases. The results are shown in Fig. XII—1. Every FIRR exceeds the lower limit of 3.62%. The results of the sensitivity analysis thus prove that each case would be feasible.

7. Conclusion

From the viewpoint of the financial analysis, that is the profitability of the project itself, this project can be regarded as feasible.

Table XII-3 FIRR Calculation

FIRR=8.26%

Unit: '000 colones

Item / Year	Cost	Benefit	Benefit-Cost	Present Value in 1988		
				Cost	Benefit	Benefit-Cost
1988						
1989						
1990	233,952		−233,952	199,609		−199,609
1991	300,720	37,445	−263,275	236,996	29,510	−207,486
1992	20,078	74,891	54,813	14,616	54,517	39,901
1993				13,501	50,357	36,857
1994				12,470	46,514	34,044
1995				11,519	42,965	31,446
1996				10,640	39,686	29,047
1997				9,828	36,658	26,830
1998				9,078	33,860	24,783
1999				8,385	31,277	22,891
2000				7,745	28,890	21,145
2001	89,380		−14,489	31,848	26,685	−5,163
2002	20,078		54,813	6,608	24,649	18,041
2003				6,104	22,768	16,664
2004				5,638	21,031	15,392
2005				5,208	19,426	14,218
2006	21,962		52,929	5,262	17,943	12,681
2007	20,078		54,813	4,443	16,574	12,131
2008				4,104	15,309	11,205
2009				3,791	14,141	10,350
2010				3,502	13,062	9,560
2011	258,073		−183,182	41,577	12,065	−29,511
2012	20,078		54,813	2,988	11,145	8,157
2013				2,760	10,294	7,534
2014				2,549	9,509	6,959
2015				2,355	8,783	6,428
2016				2,175	8,113	5,938
2017	−120,657		195,548	−12,073	7,494	19,567
Total	1,225,146	1,984,611	759,465	653,226	653,226	0

Table XII-4 Costs for Financial Analysis

Unit : '000 colones

	Foreign Portion	Local Portion	Total
Breakwater, etc.	98,441	43,330	141,771
Pavement of the yards	10,041	82,140	92,181
Cargo handling equipment	86,605	0	86,605
Grain cargo handling equipment	208,088	0	208,088
Total	(76.3%) 403,175	(23.7%) 125,470	(100.0%) 528,645

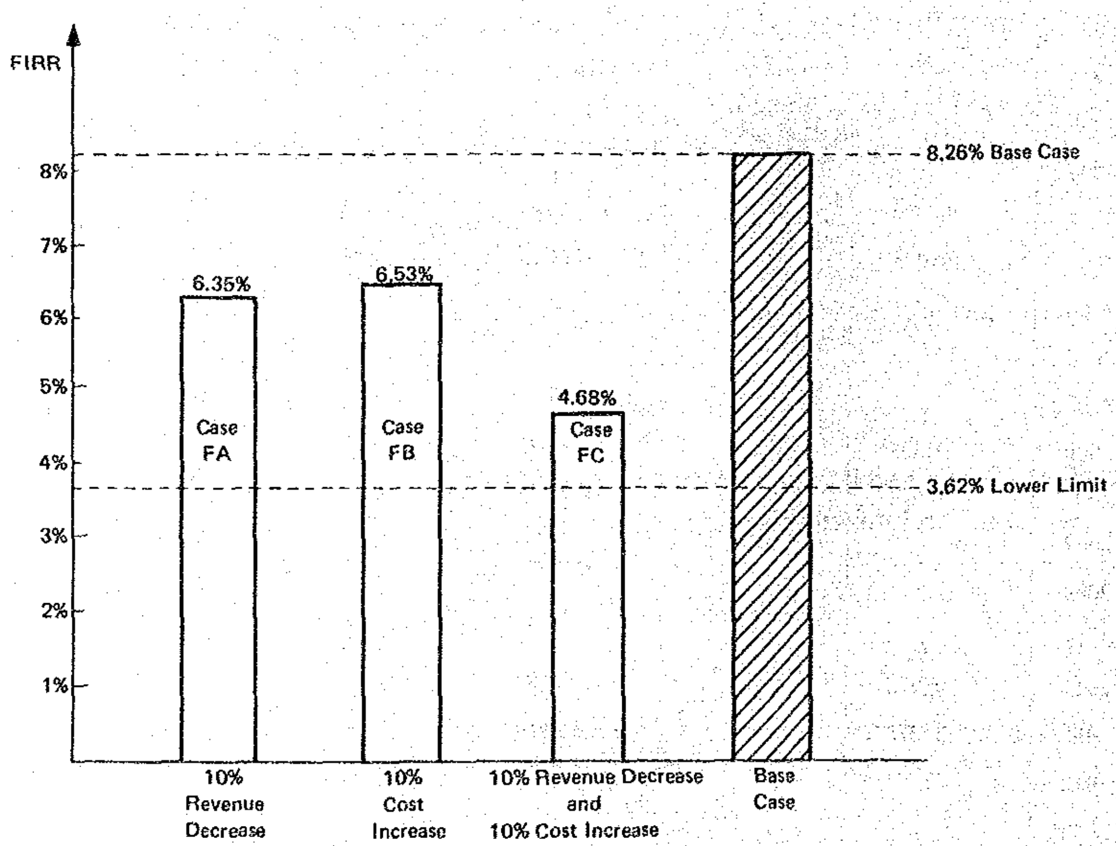


Fig. XII-1 Sensitivity Analysis

APPENDICES

APPENDIX 1 REFRACTION CHARTS OF THE PORT OF CALDERA AREA

The refraction charts[1] executed in the 1981 Feasibility Study on the Second Expansion Project of the Port of Caldera for the purpose of calculating the direction of wave incidence and the refraction coefficients at the Port are shown in Fig. M−1(1)〜M−(42) and Fig. M−2(1)〜M−2(6).

The breakwater extension plan for these charts is different from the plan mentioned in CHAPTER IV and CHAPTER VII. However, the wave directions in these charts are not different. Therefore, we adopted the results of these refraction charts for the study calculations.

Refraction calculations were first performed north of lat. 9°36′N. in a rectangular sea region with a north-south dimension of 40 km and an east-west dimension of 50 km. Then, a greatly reduced refraction chart was prepared for an area to the north side of the parallel passing through the southern edge of Icaco Beach south of Cape Corralillo. The refraction calculations were performed using the orthogonal method, and as stated in CHAPTER IV, the waves in this region are estimated to exhibit behavior similar to regular waves, hence for calculation purposes the waves were assumed to be regular waves. A first step calculation was performed on the 42 combinations of the six wave directions SSE, S, N 191.3° SSW, N 213.8° and SW, and the seven wave periods, 8, 10, 12, 14, 16, 18, and 20 s (refer to Fig. M−1(1)〜M−1(42)). A second step calculation was performed on the 6 combinations of wave directions and periods which tend to concentrate waves in the area of the Port of Caldera. These are wave directions N 191.3° and SSW, and wave periods 12, 16, and 18 s (refer to Fig. M−2(1)〜M−2(6)).

---

1) Japan International Cooperation Agency ; The Feasibilty Study on the Second Stage Expansion Project of the Port of Caldera, Republic of Costa Rica, Dec. 1981, 343 p.

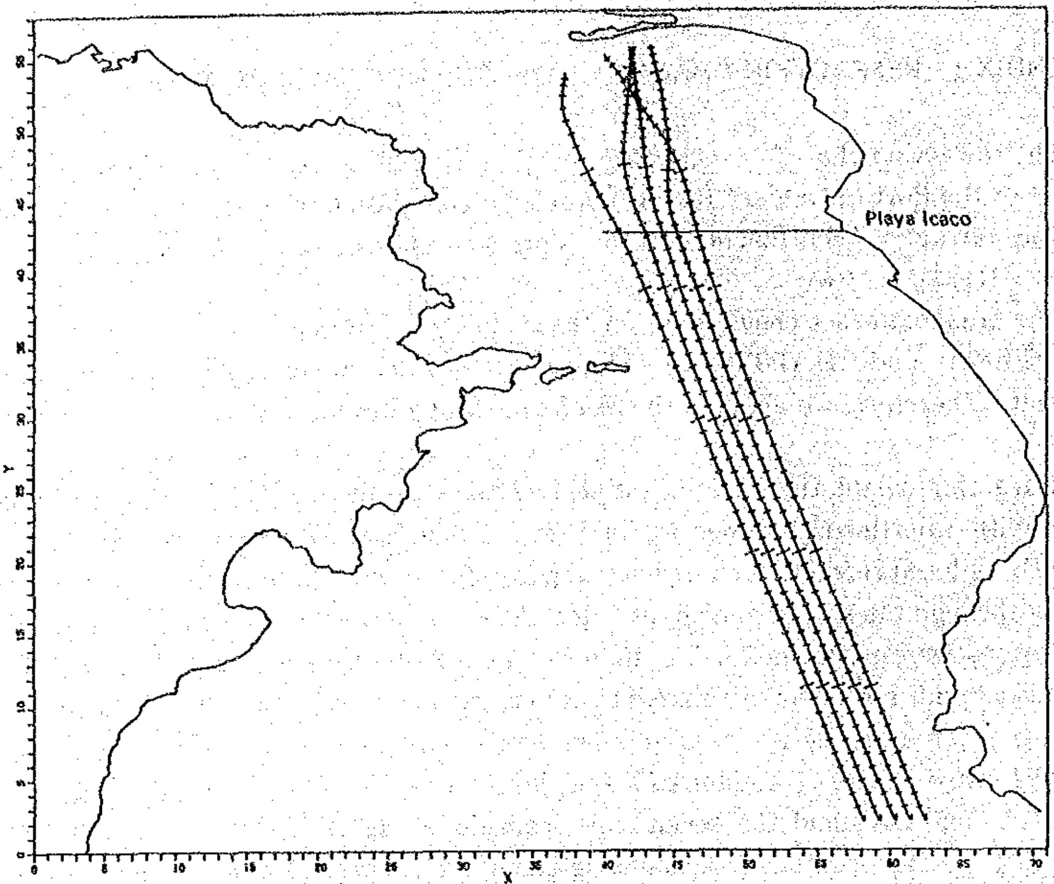


Fig. M-1 (1) Wave Refraction Chart of the Mouth of the Gulf of Nicoya
(Wave Direction: SSE, $T_{1/3}$ = 8s)

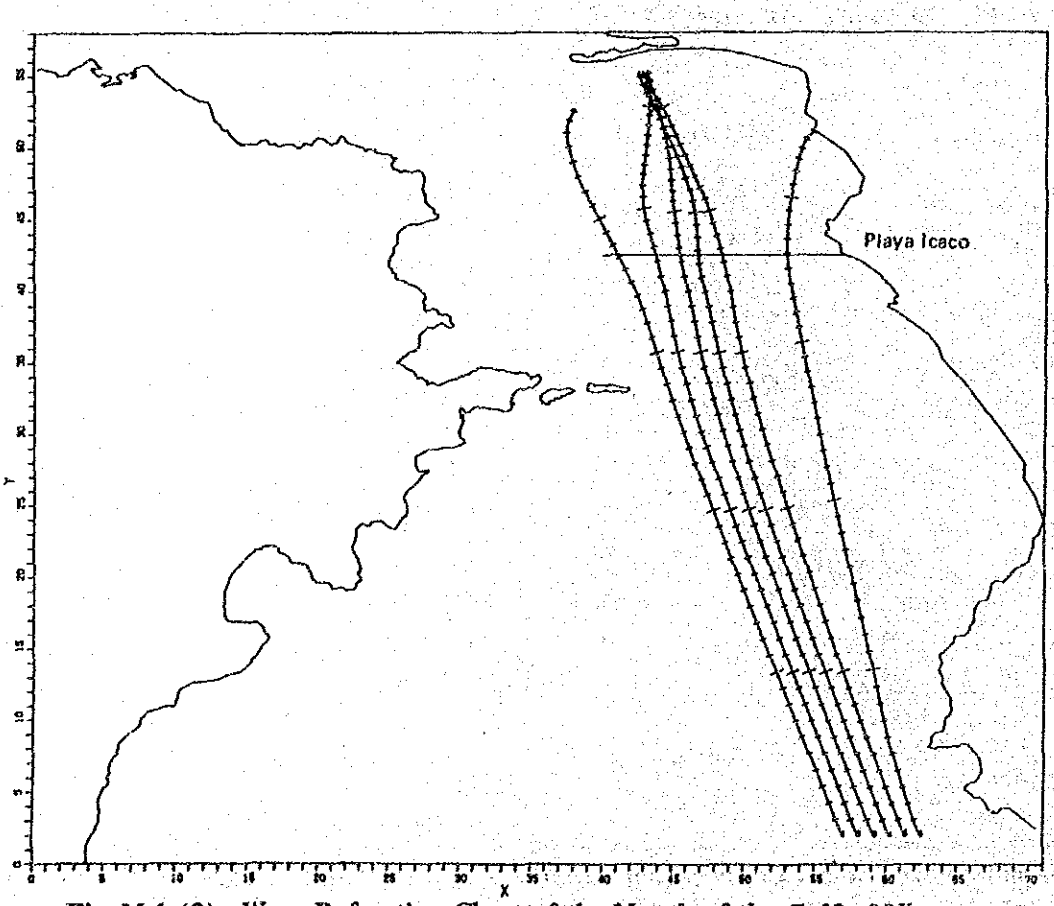


Fig. M-1 (2) Wave Refraction Chart of the Mouth of the Gulf of Nicoya
(Wave Direction: SSE, $T_{1/3}$ = 10s)

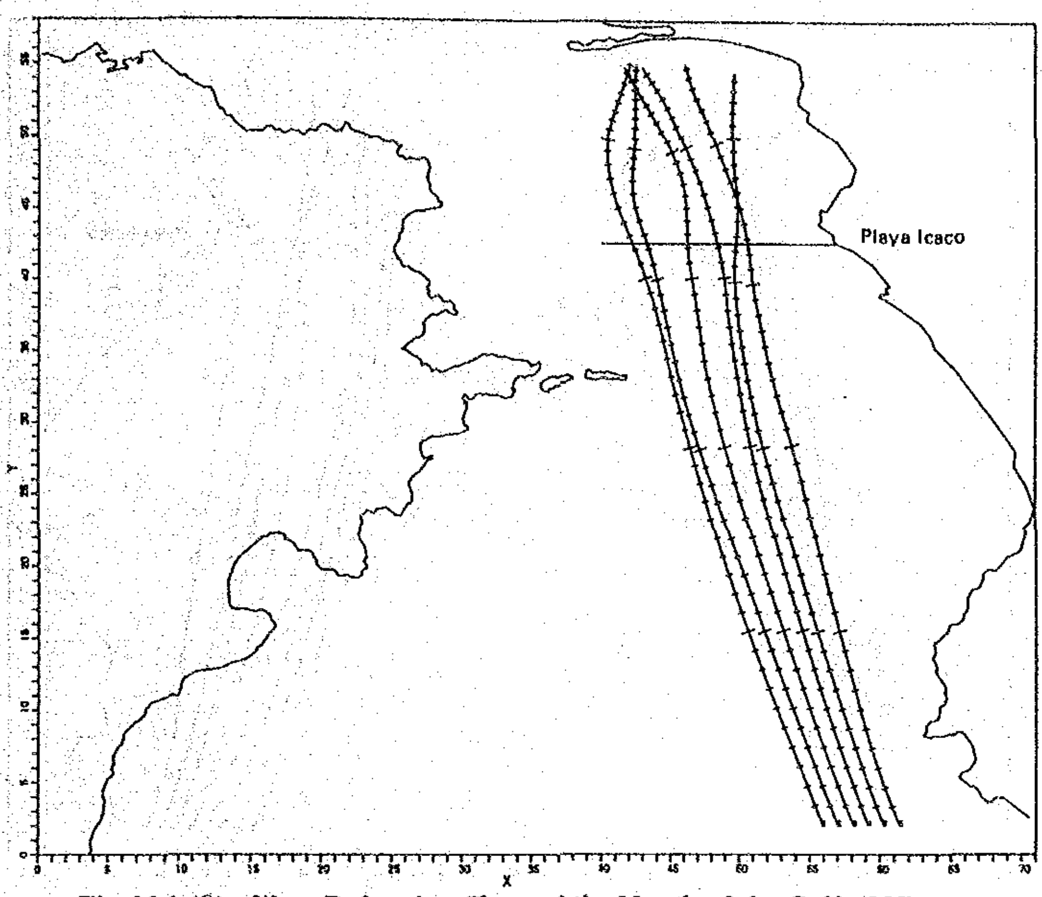


Fig. M-1 (3) Wave Refraction Chart of the Mouth of the Gulf of Nicoya
(Wave Direction: SSE, $T_{1/3}$ = 12s)

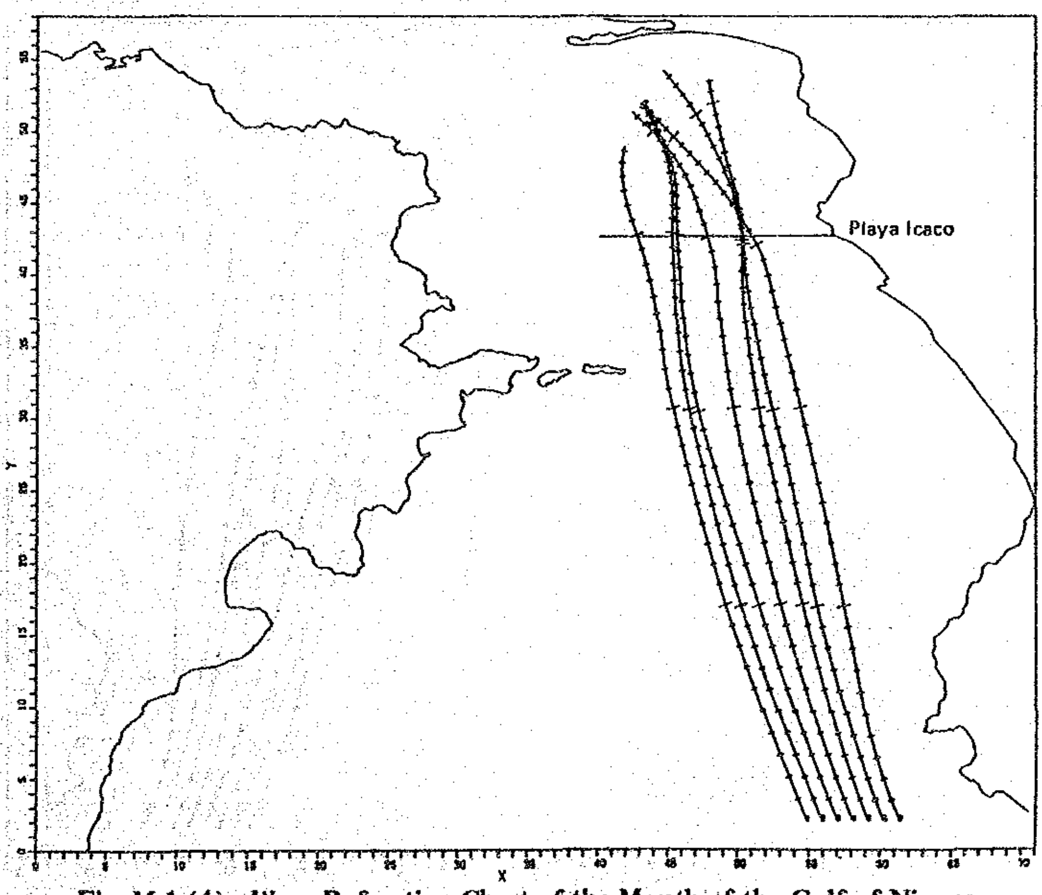


Fig. M-1 (4) Wave Refraction Chart of the Mouth of the Gulf of Nicoya
(Wave Direction: SSE, $T_{1/3}$ = 14s)

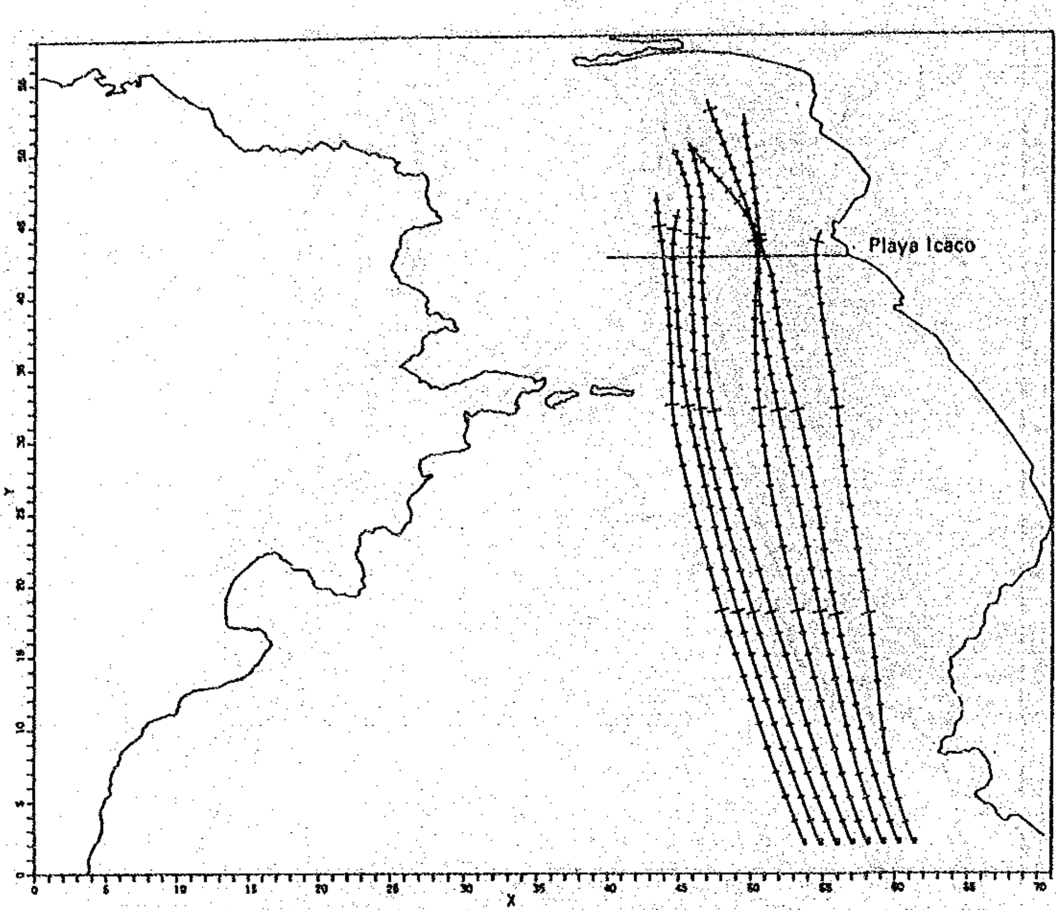


Fig. M-1 (5) Wave Refraction Chart of the Mouth of the Gulf of Nicoya
(Wave Direction: SSE, $T_{1/3}$ = 16s)

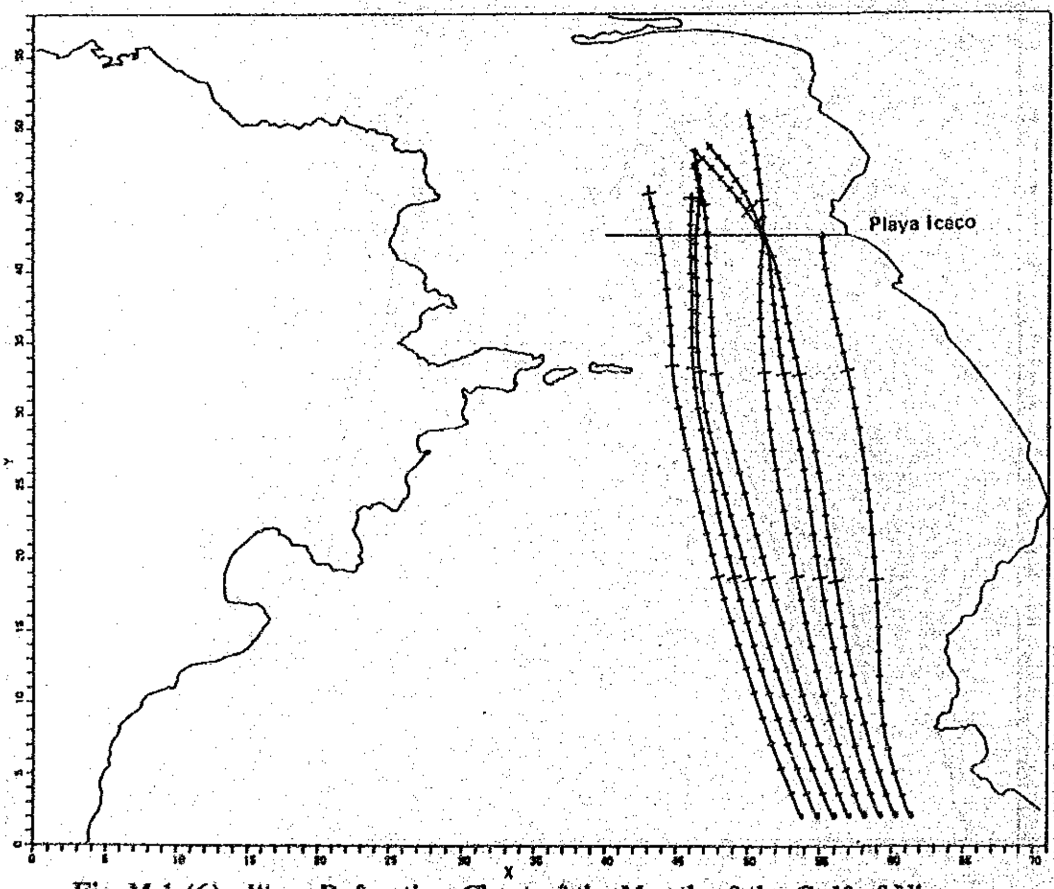


Fig. M-1 (6) Wave Refraction Chart of the Mouth of the Gulf of Nicoya
(Wave Direction: SSE, $T_{1/3}$ = 18s)

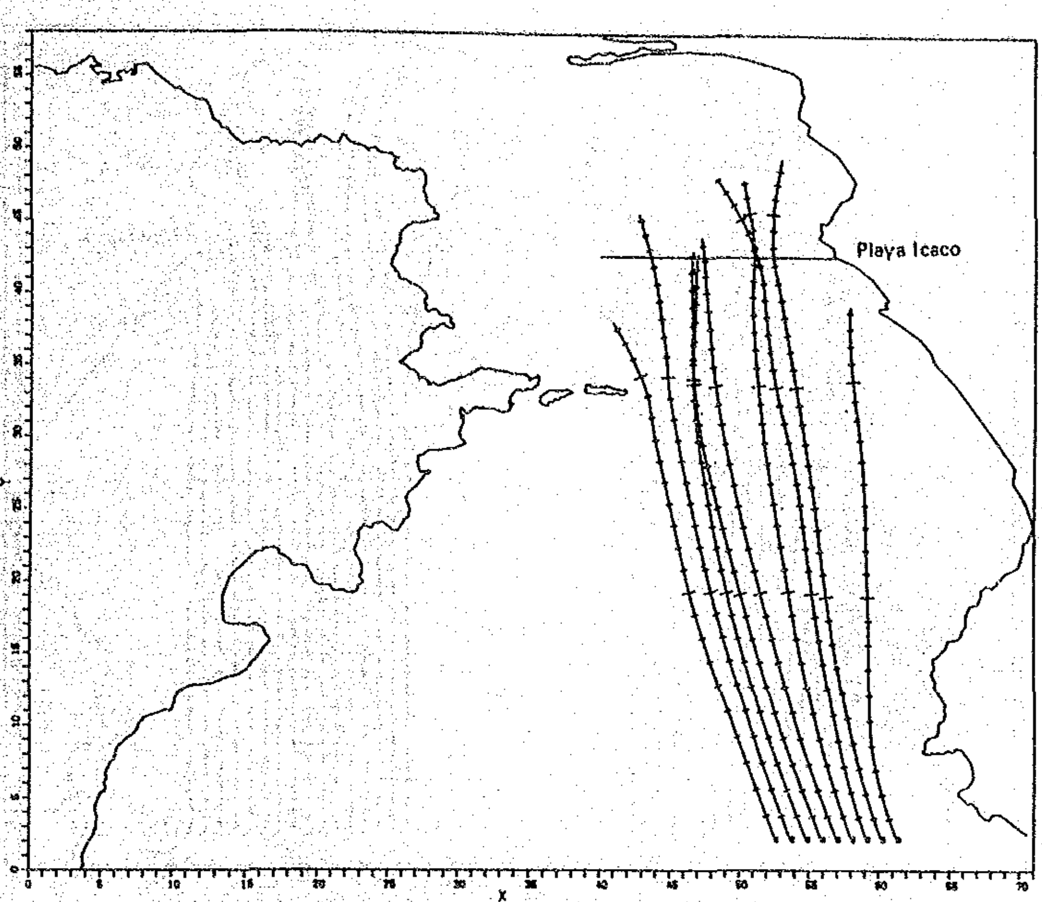


Fig. M-1 (7) Wave Refraction Chart of the Mouth of the Gulf of Nicoya (Wave Direction: SSE, $T_{1/3}$ = 20s)

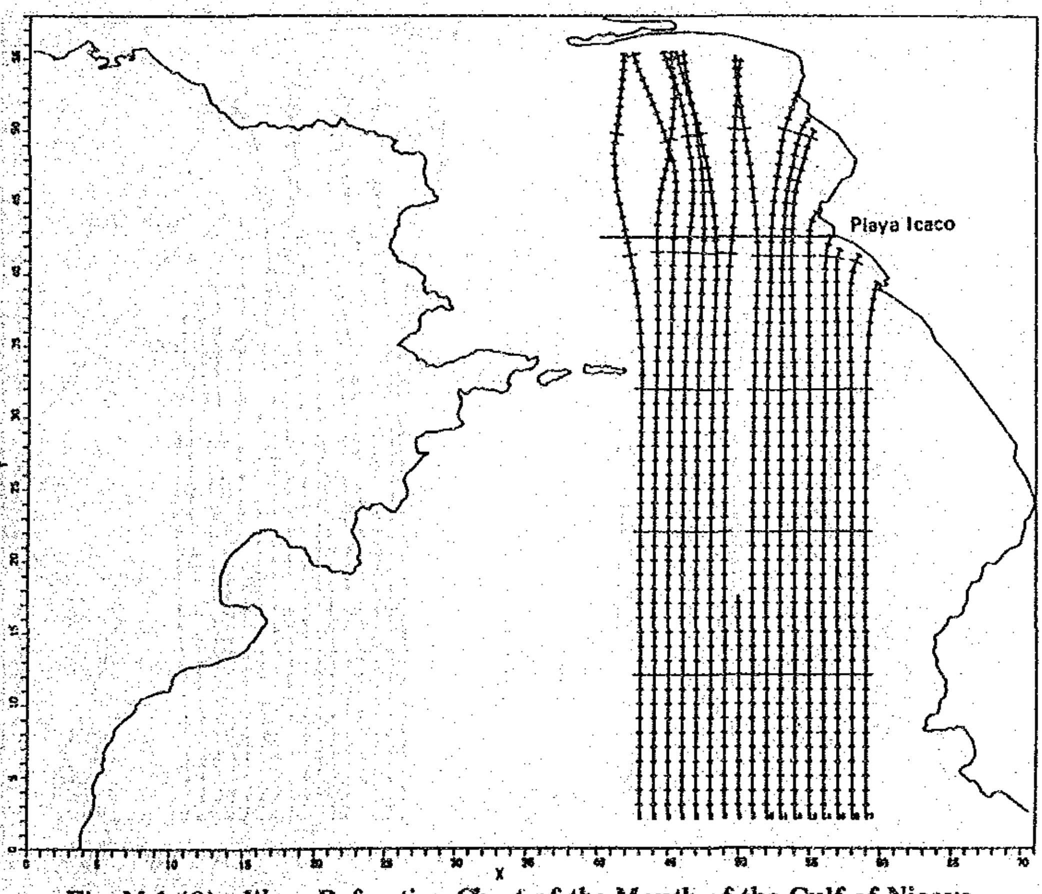


Fig. M-1 (8) Wave Refraction Chart of the Mouth of the Gulf of Nicoya (Wave Direction: S, $T_{1/3}$ = 8s)

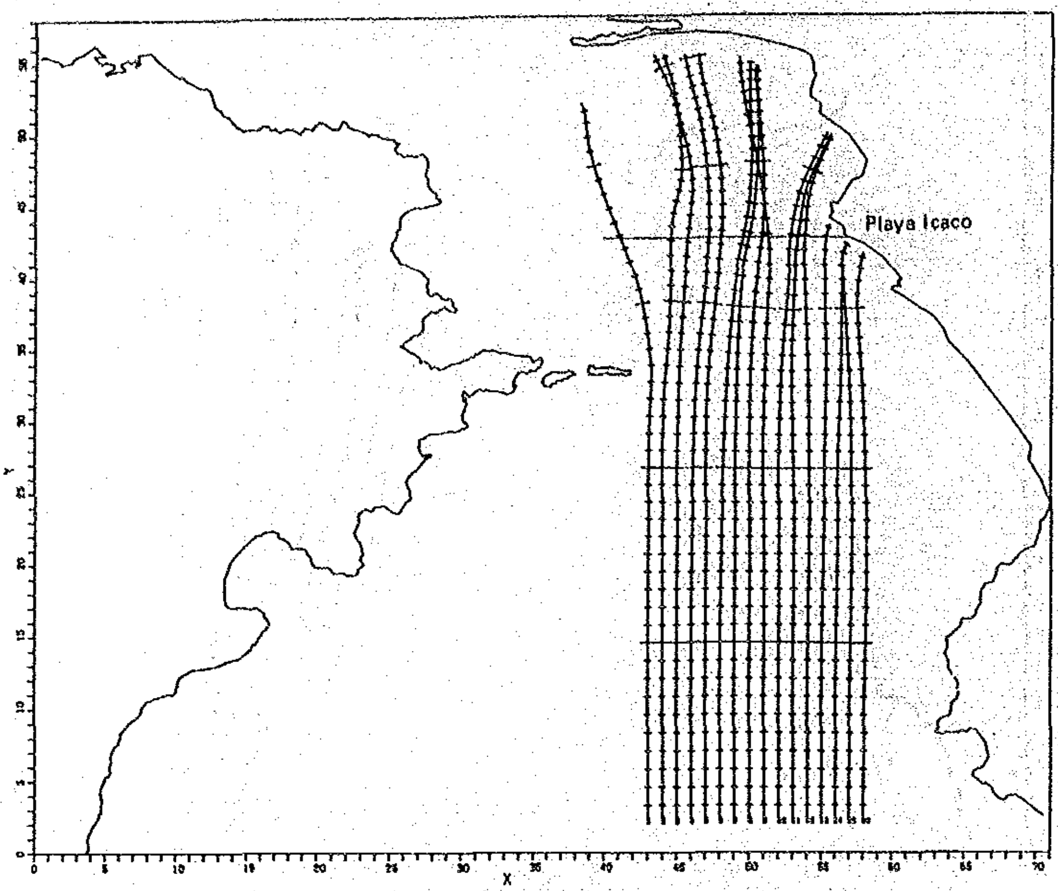


Fig. M-1 (9) Wave Refraction Chart of the Mouth of the Gulf of Nicoya
(Wave Direction: S, $T_{1/3}$ = 10s)

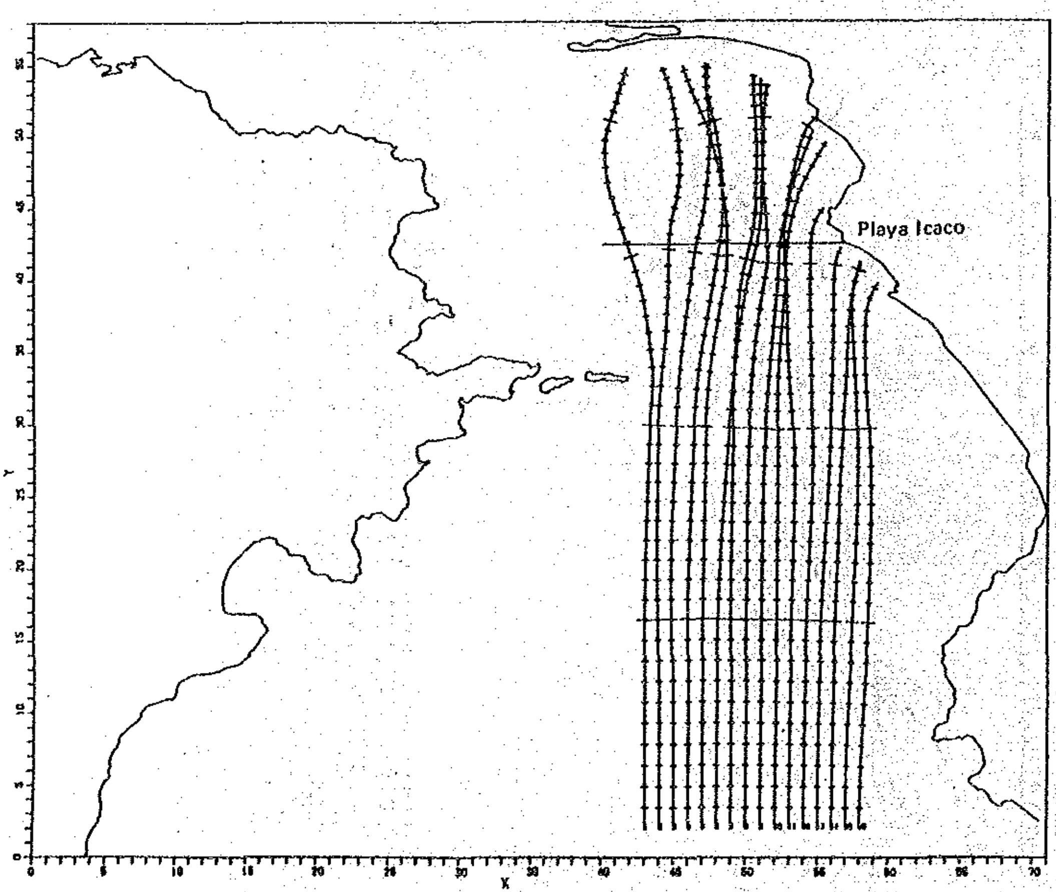


Fig. M-1 (10) Wave Refraction Chart of the Mouth of the Gulf of Nicoya
(Wave Direction: S, $T_{1/3}$ = 12s)

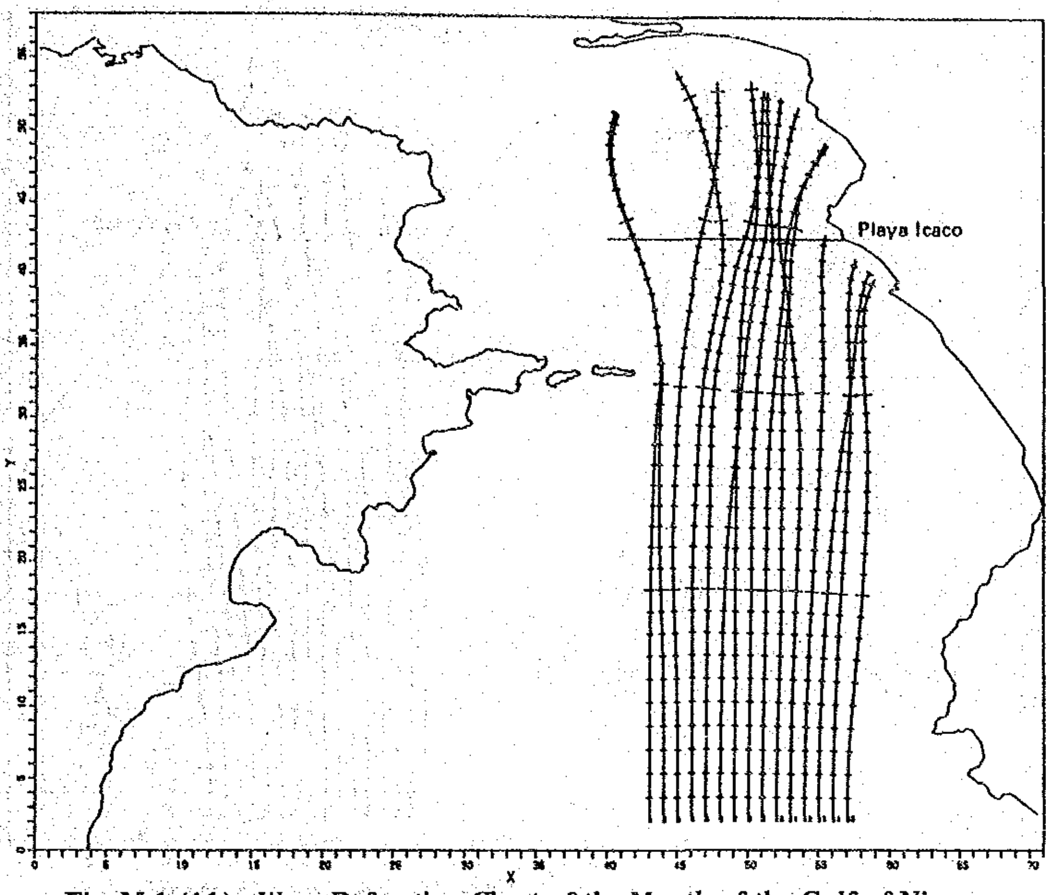


Fig. M-1 (11) Wave Refraction Chart of the Mouth of the Gulf of Nicoya (Wave Direction: S, $T_{1/3}$ = 14s)

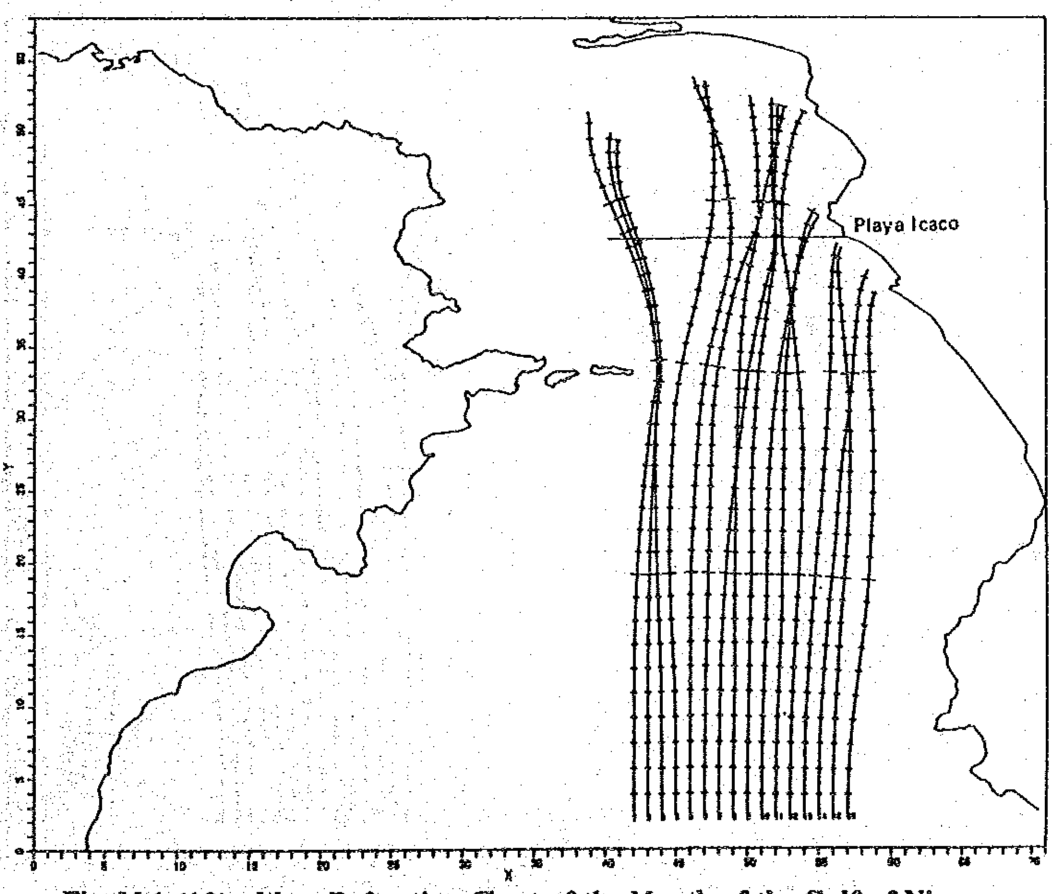


Fig. M-1 (12) Wave Refraction Chart of the Mouth of the Gulf of Nicoya (Wave Direction: S, $T_{1/3}$ = 16s)

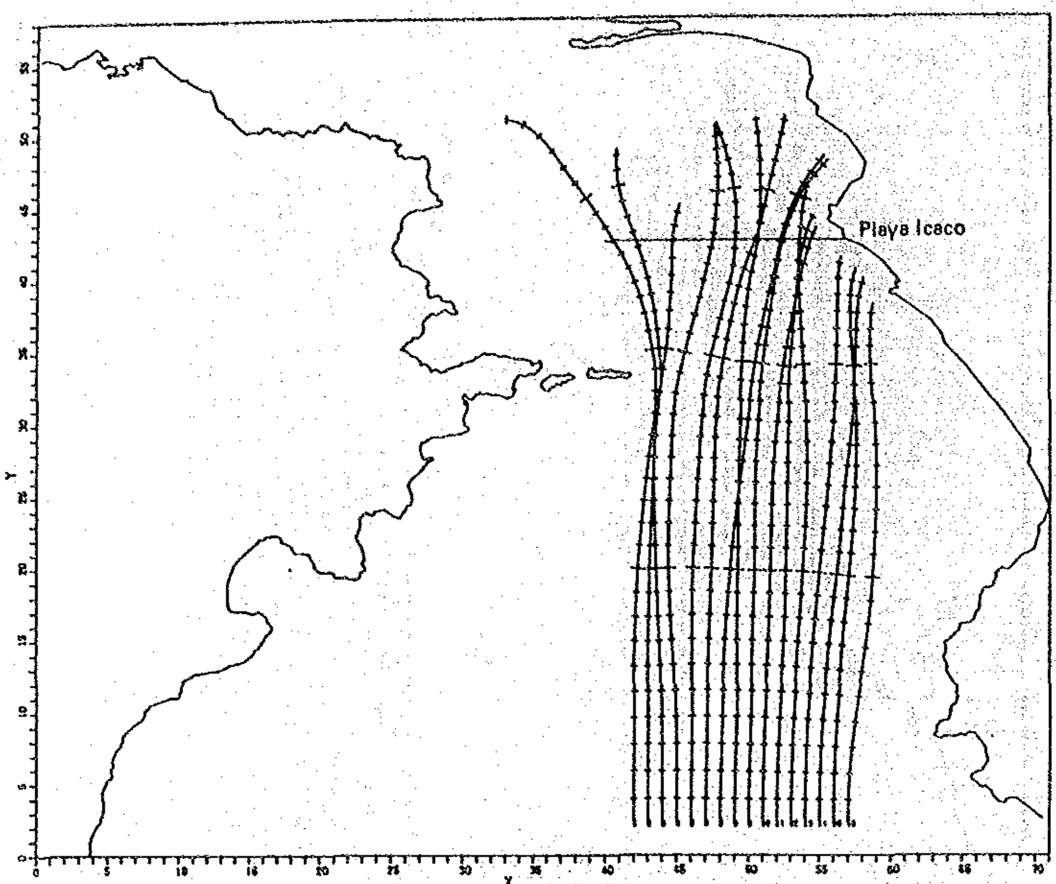


Fig. M-1 (13) Wave Refraction Chart of the Mouth of the Gulf of Nicoya
(Wave Direction: S, $T_{1/3}$ = 18s)

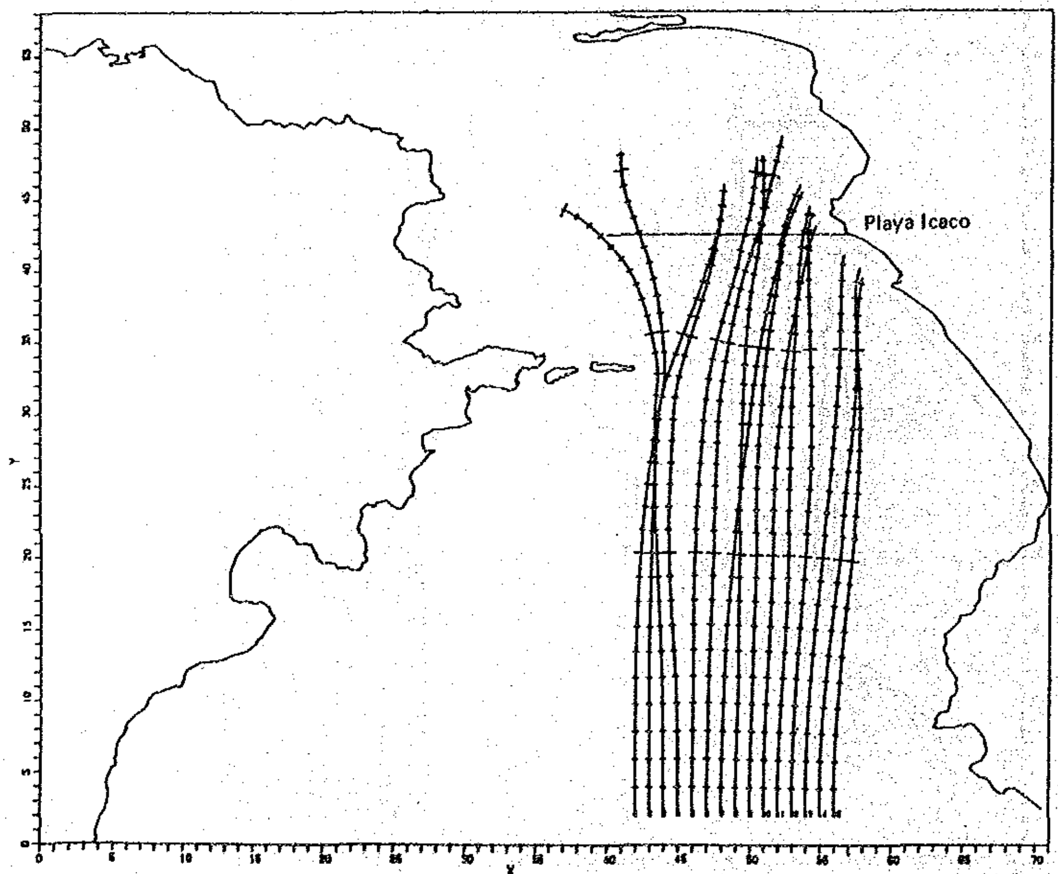


Fig. M-1 (14) Wave Refraction Chart of the Mouth of the Gulf of Nicoya
(Wave Direction: S, $T_{1/3}$ = 20s)

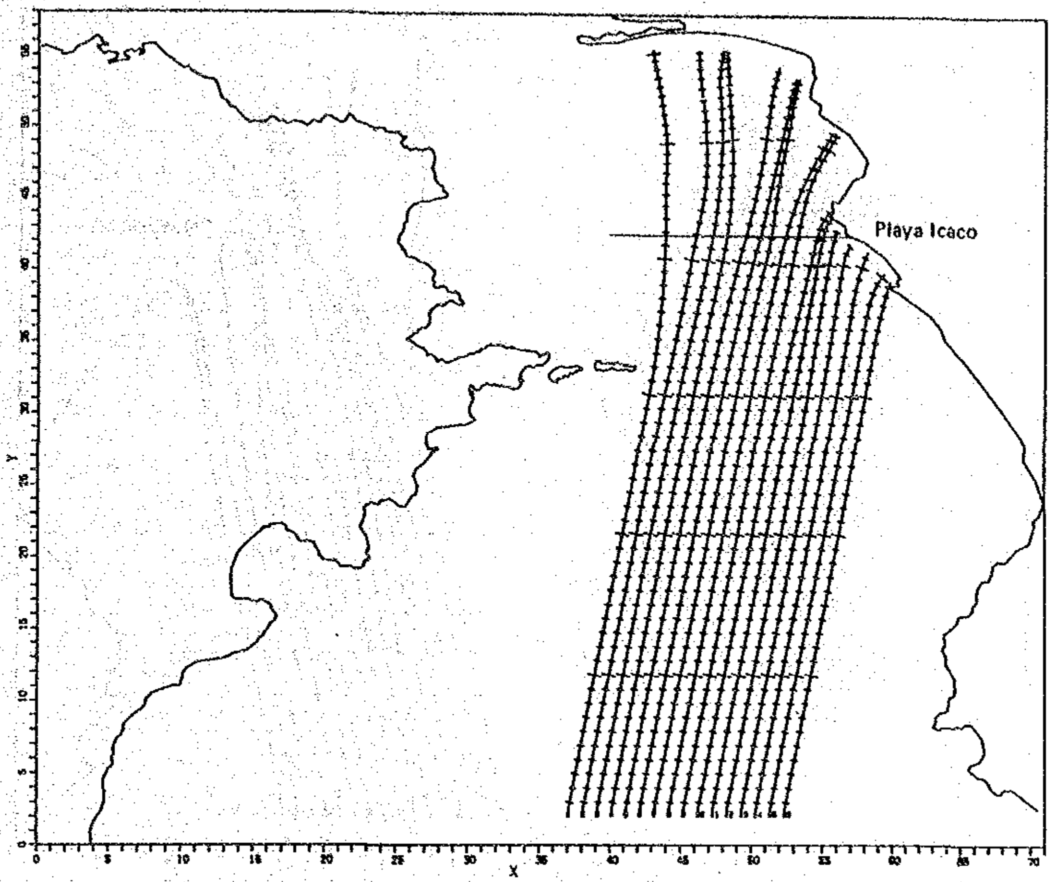


Fig. M-1 (15) Wave Refraction Chart of the Mouth of the Gulf of Nicoya (Wave Direction: N 191.3°, $T_{1/3}$ = 8s)

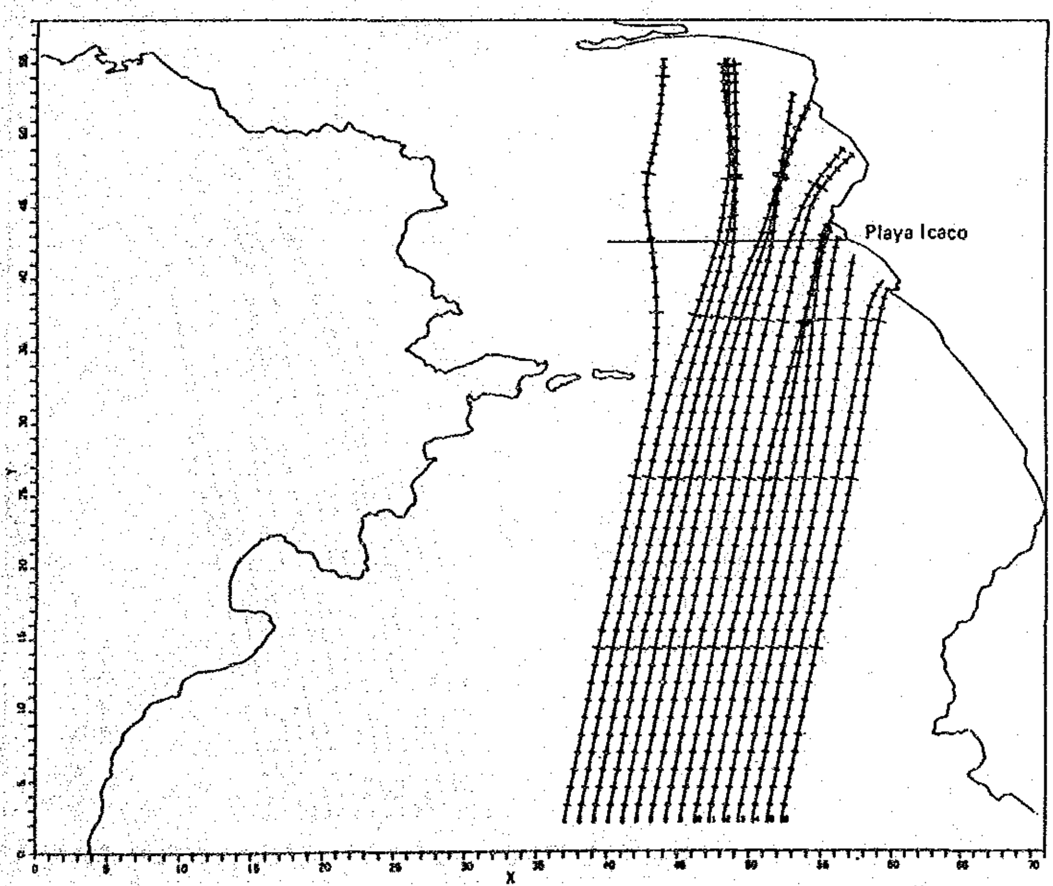


Fig. M-1 (16) Wave Refraction Chart of the Mouth of the Gulf of Nicoya (Wave Direction: N 191.3°, $T_{1/3}$ = 10s)

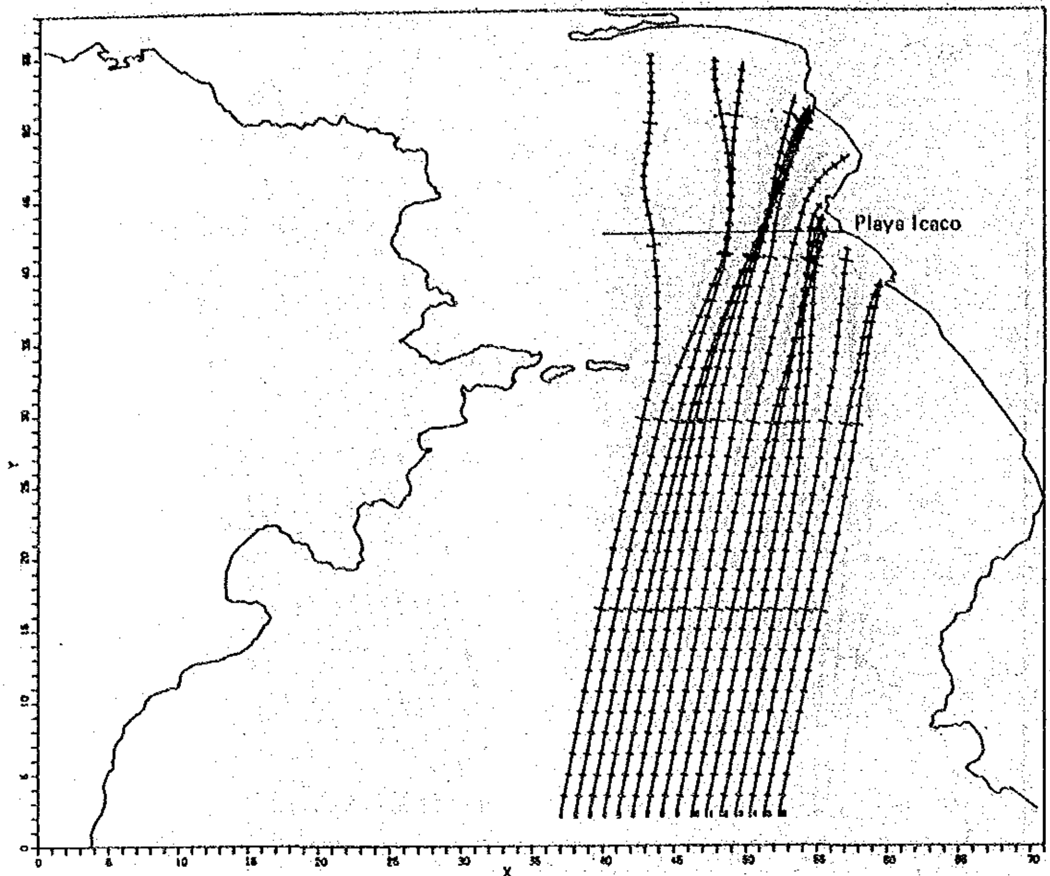


Fig. M-1 (17) Wave Refraction Chart of the Mouth of the Gulf of Nicoya (Wave Direction: N 191.3°, $T_{1/3}$ = 12s)

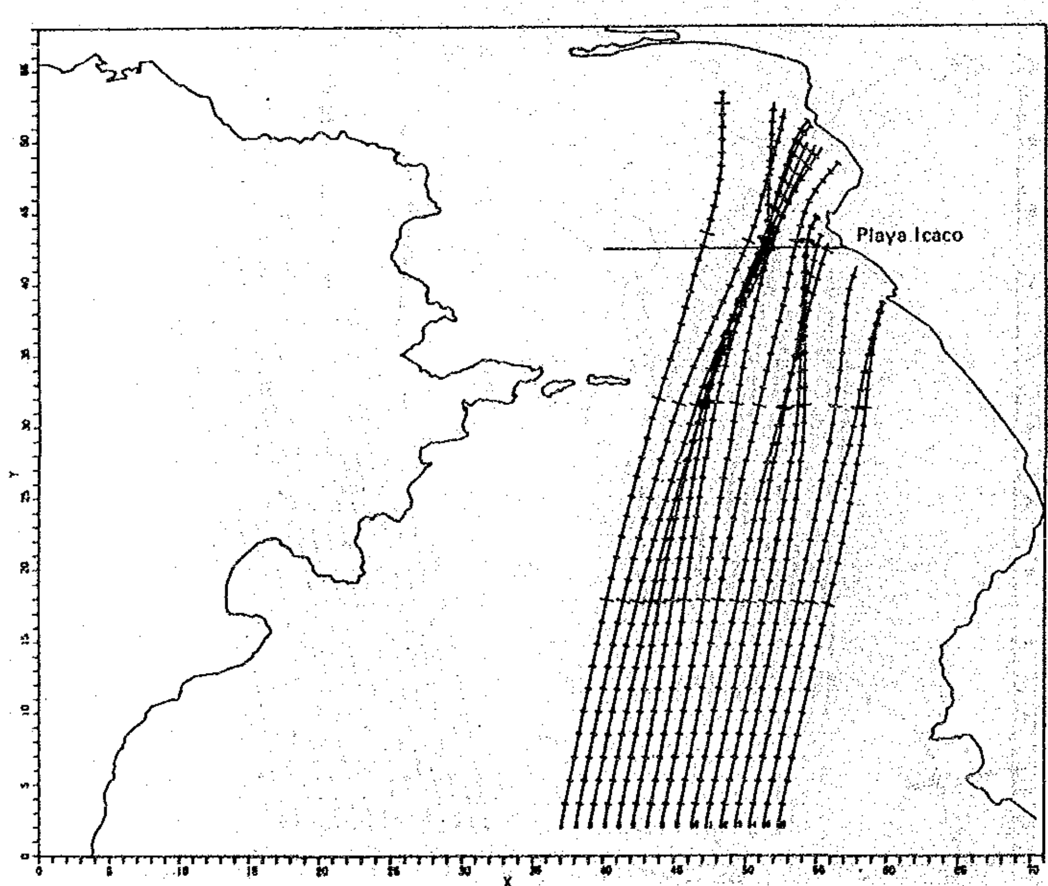


Fig. M-1 (18) Wave Refraction Chart of the Mouth of the Gulf of Nicoya (Wave Direction: N 191.3°, $T_{1/3}$ = 14s)

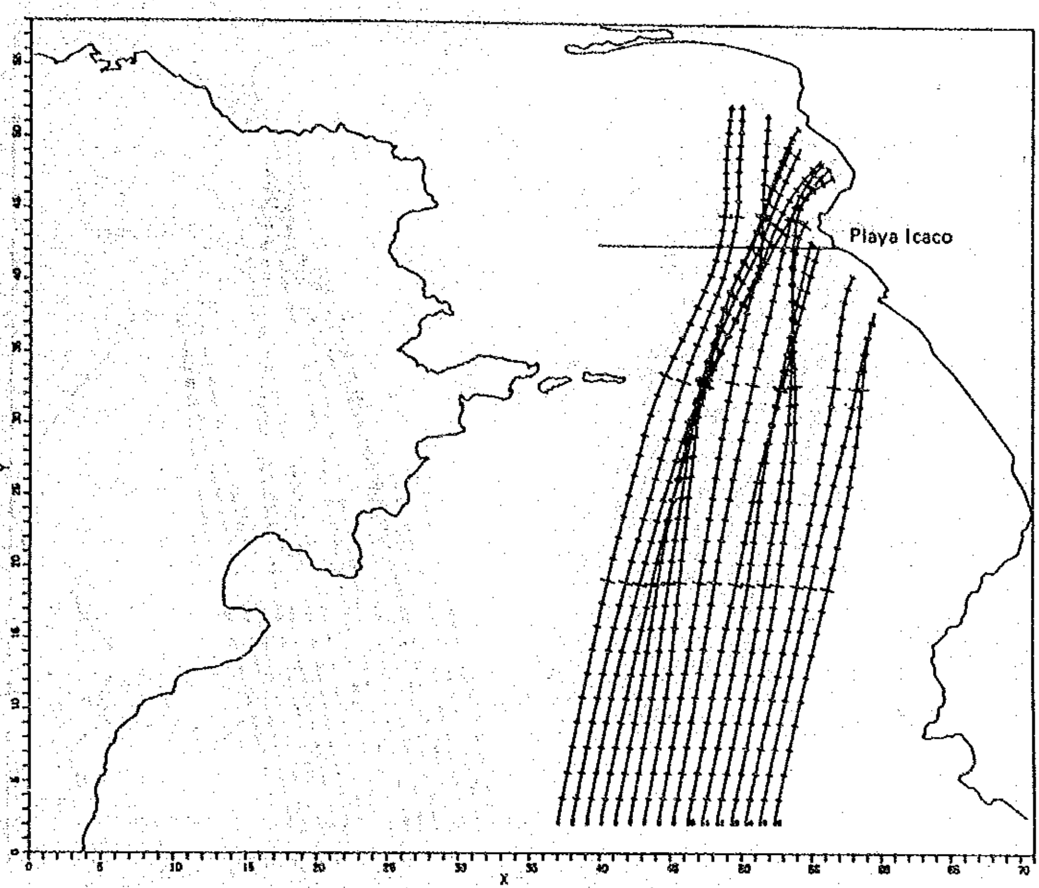


Fig. M-1 (19) Wave Refraction Chart of the Mouth of the Gulf of Nicoya
(Wave Direction: N 191.3°, $T_{1/3}$ = 16s)

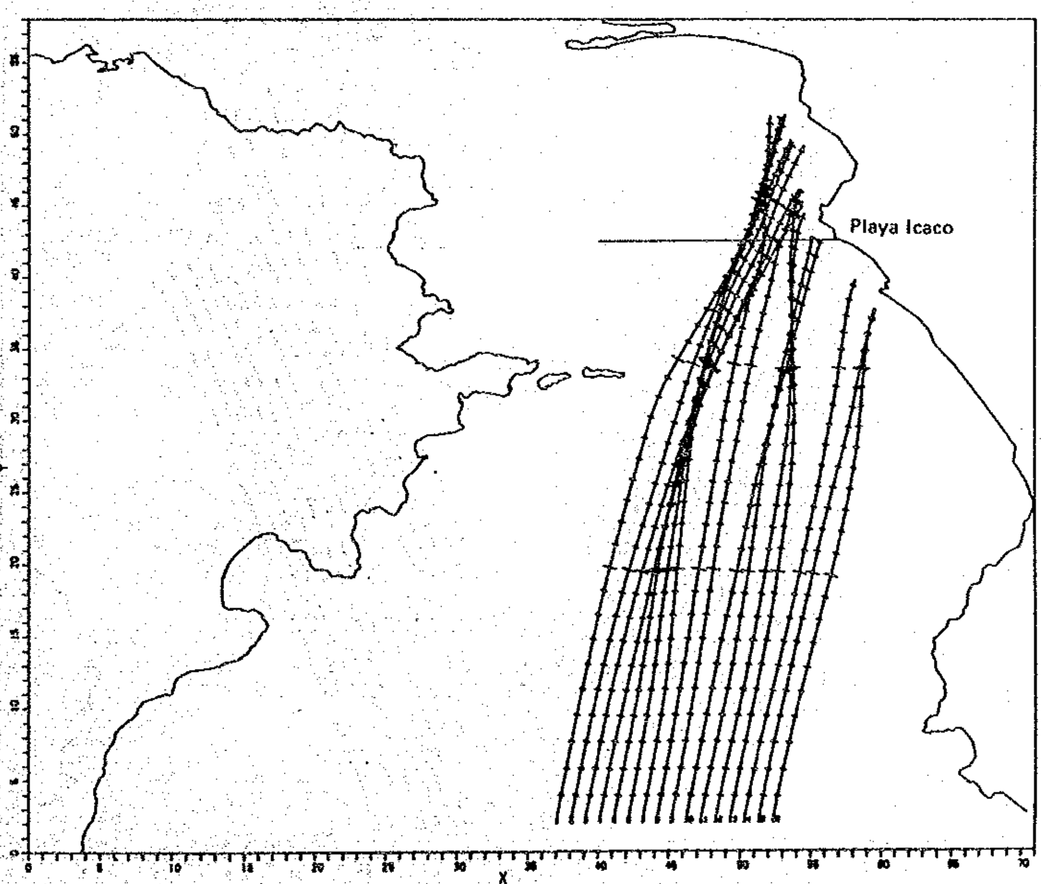


Fig. M-1 (20) Wave Refraction Chart of the Mouth of the Gulf of Nicoya
(Wave Direction: N 191.3°, $T_{1/3}$ = 18s)

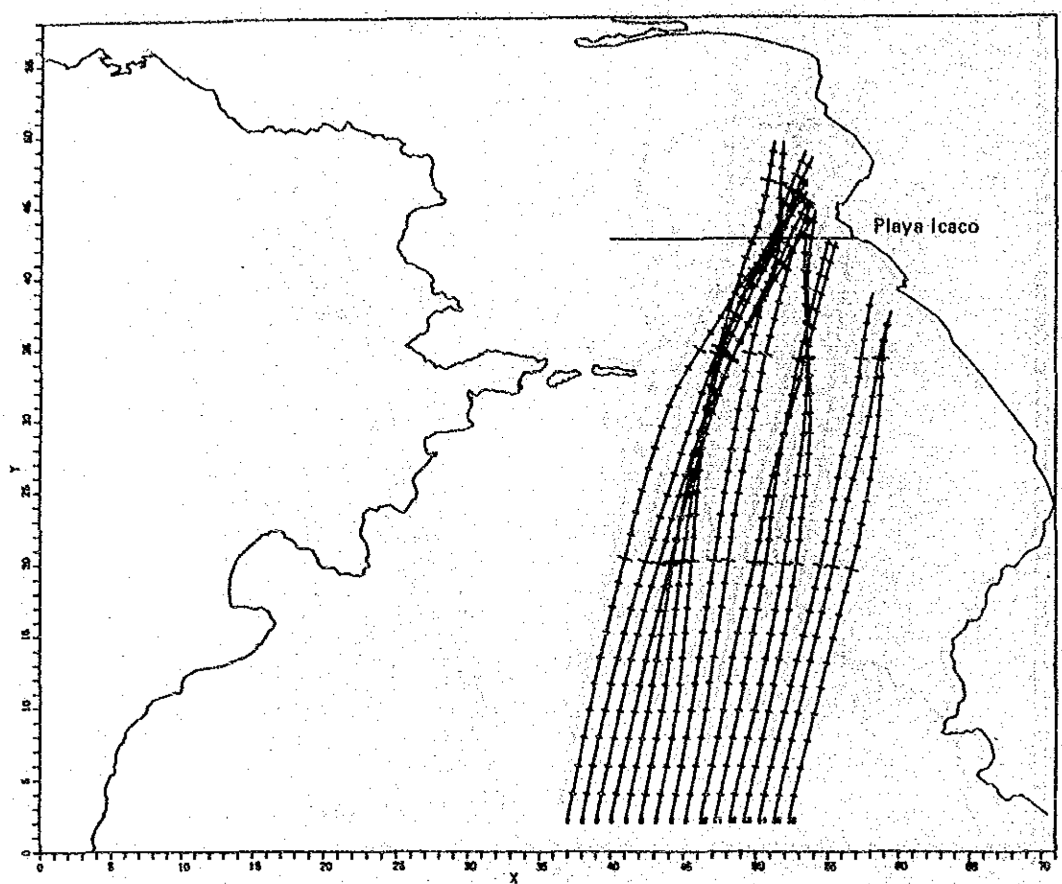


Fig. M-1 (21) **Wave Refraction Chart of the Mouth of the Gulf of Nicoya (Wave Direction: N 191.3°, $T_{1/3}$ = 20s)**

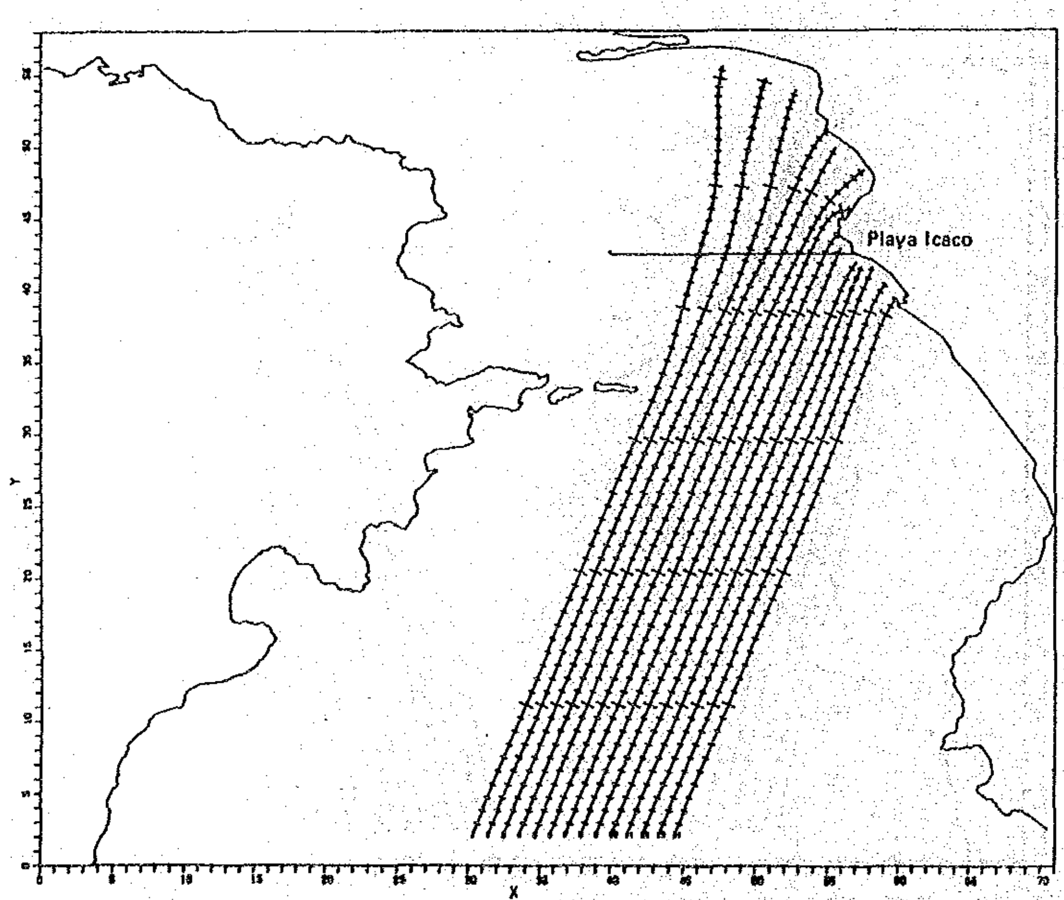


Fig. M-1 (22) **Wave Refraction Chart of the Mouth of the Gulf of Nicoya (Wave Direction: SSW, $T_{1/3}$ = 8s)**

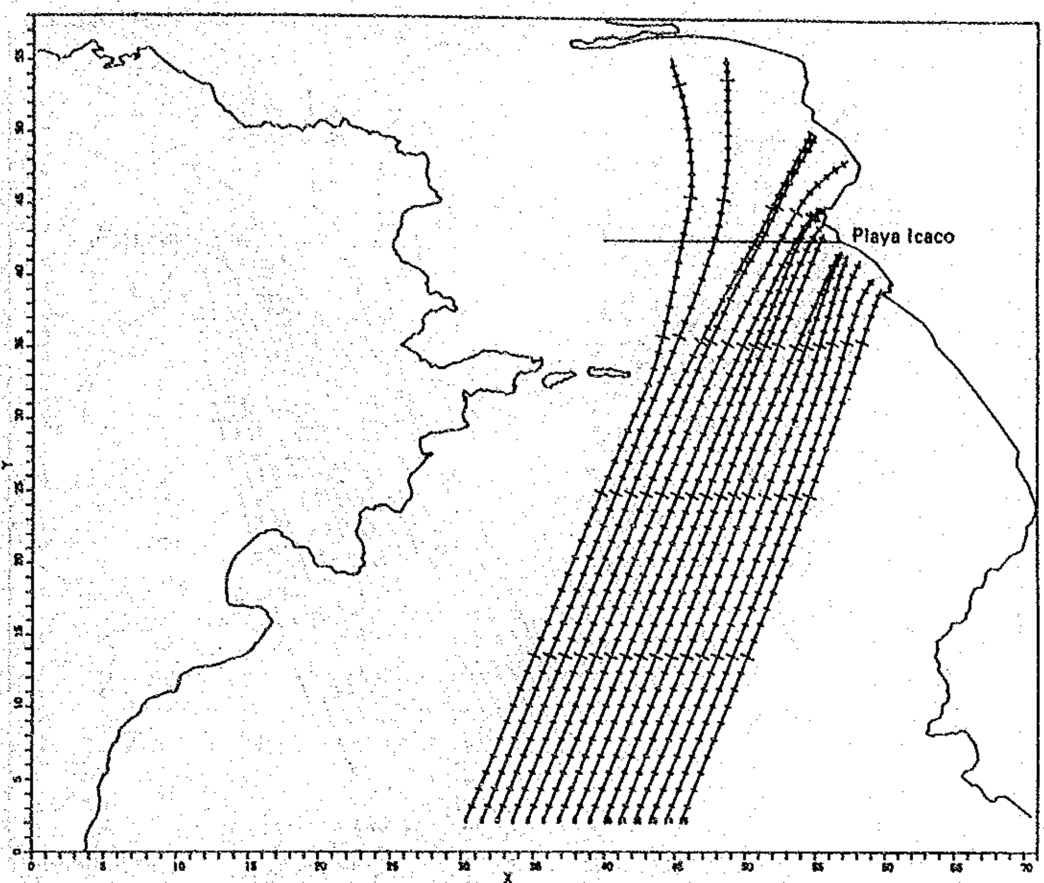


Fig. M-1 (23) Wave Refraction Chart of the Mouth of the Gulf of Nicoya
(Wave Direction: SSW, $T_{1/3}$ = 10s)

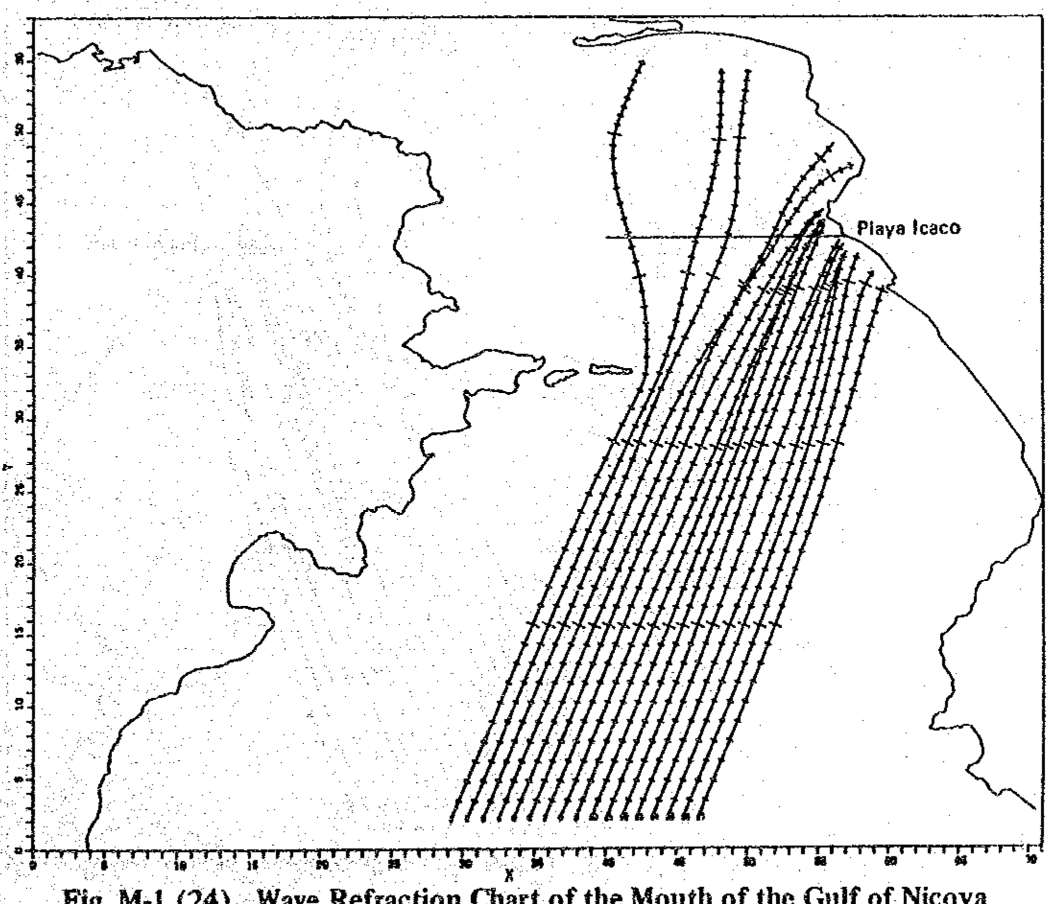


Fig. M-1 (24) Wave Refraction Chart of the Mouth of the Gulf of Nicoya
(Wave Direction: SSW, $T_{1/3}$ = 12s)

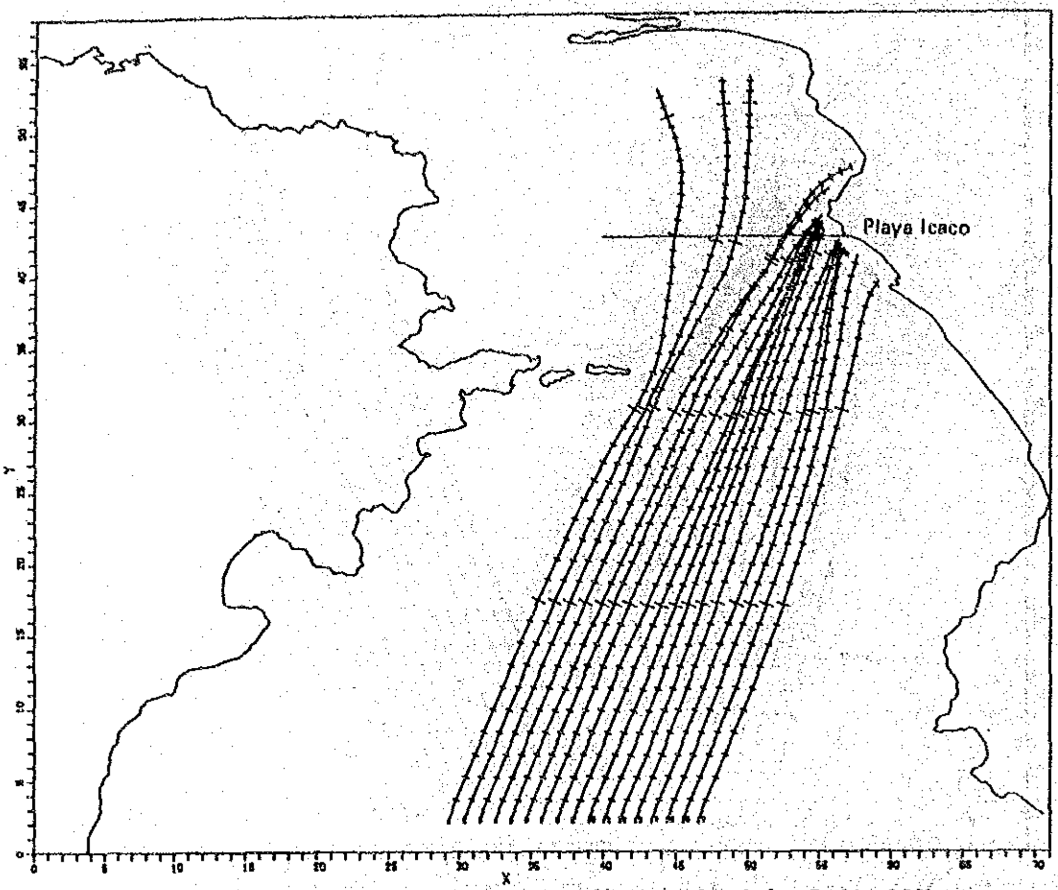


Fig. M-1 (25) Wave Refraction Chart of the Mouth of the Gulf of Nicoya (Wave Direction: SSW, $T_{1/3}$ = 14s)

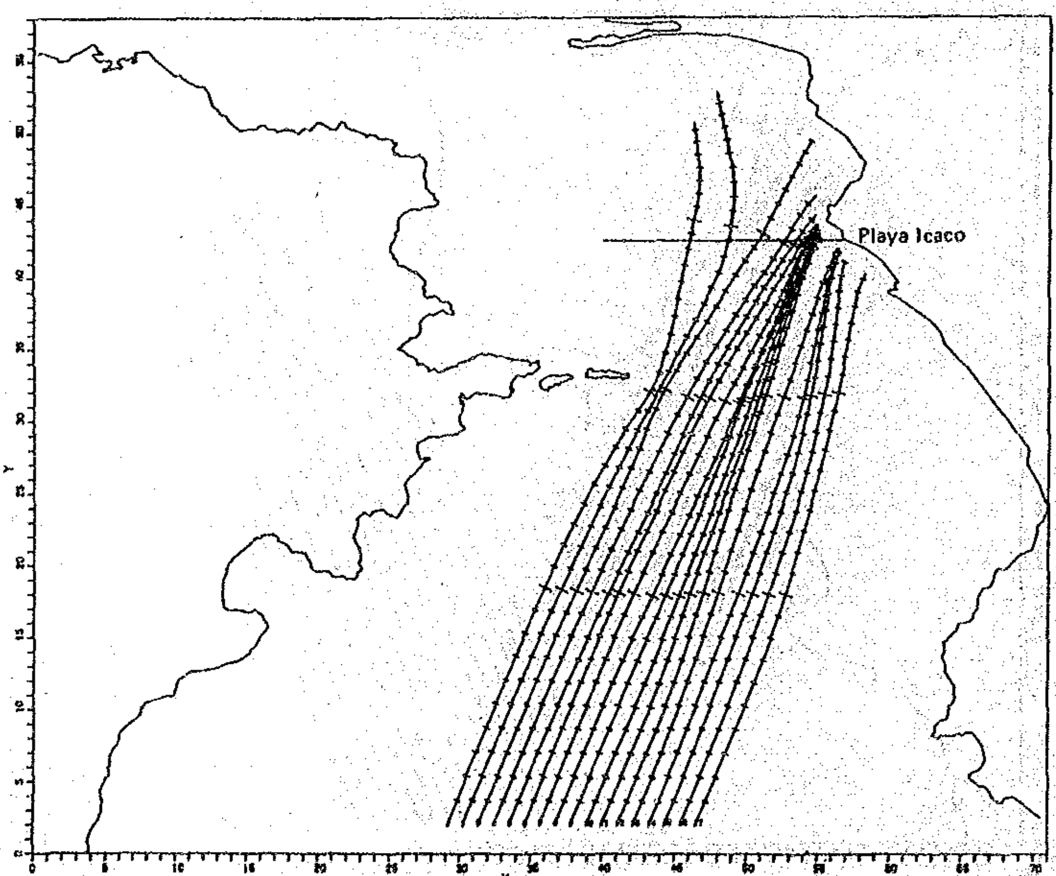


Fig. M-1 (26) Wave Refraction Chart of the Mouth of the Gulf of Nicoya (Wave Direction: SSW, $T_{1/3}$ = 16s)

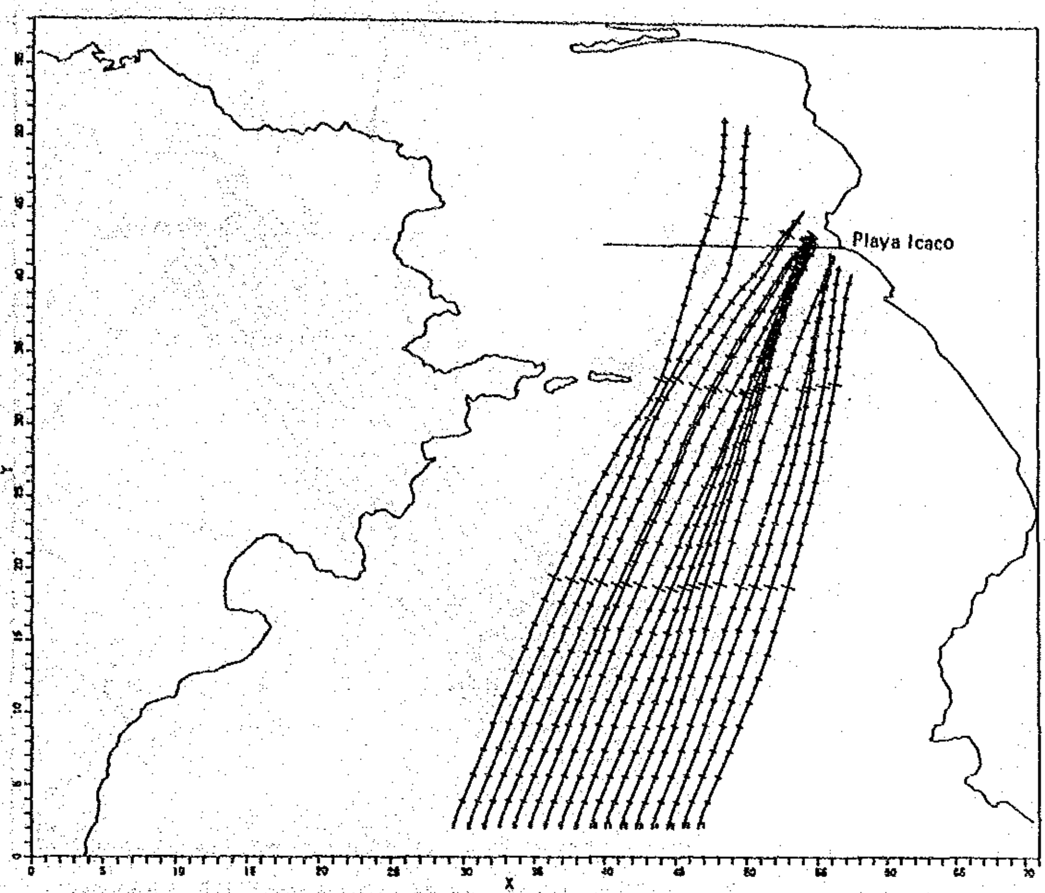


Fig. M-1 (27) Wave Refraction Chart of the Mouth of the Gulf of Nicoya (Wave Direction: SSW, $T_{1/3}$ = 18s)

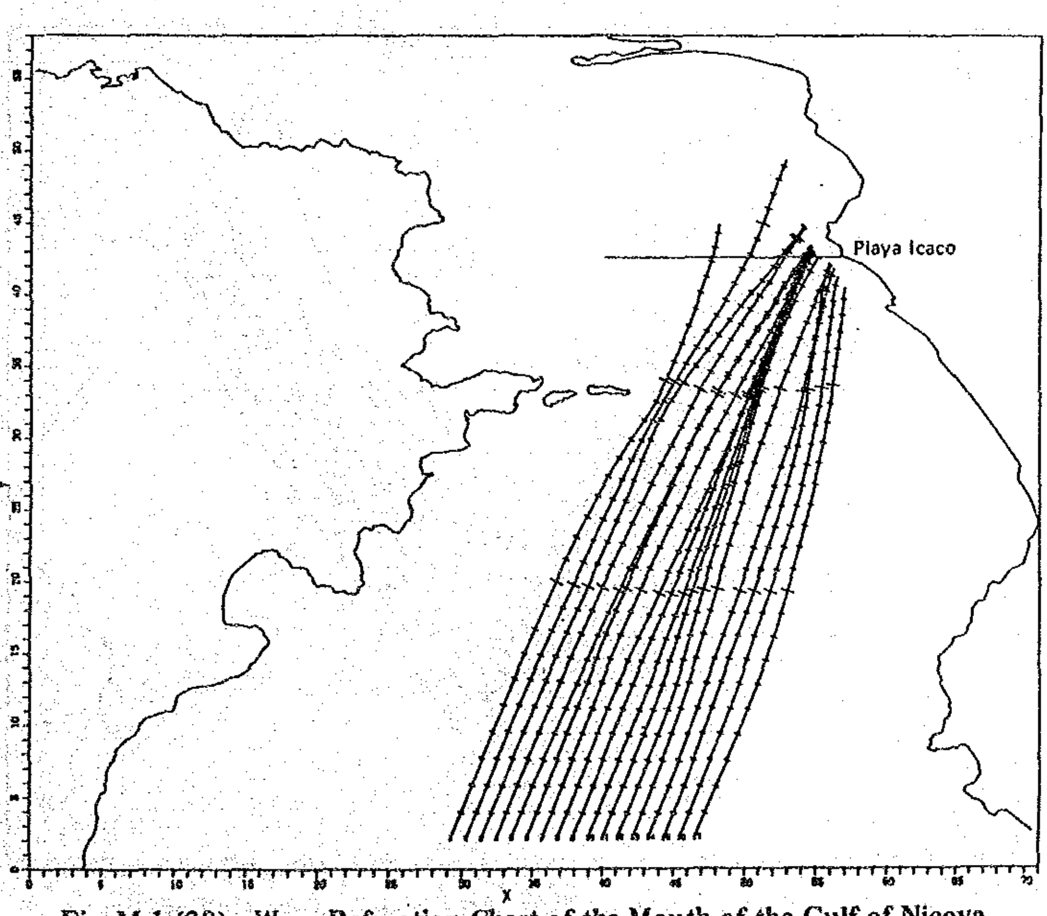


Fig. M-1 (28) Wave Refraction Chart of the Mouth of the Gulf of Nicoya (Wave Direction: SSW, $T_{1/3}$ = 20s)

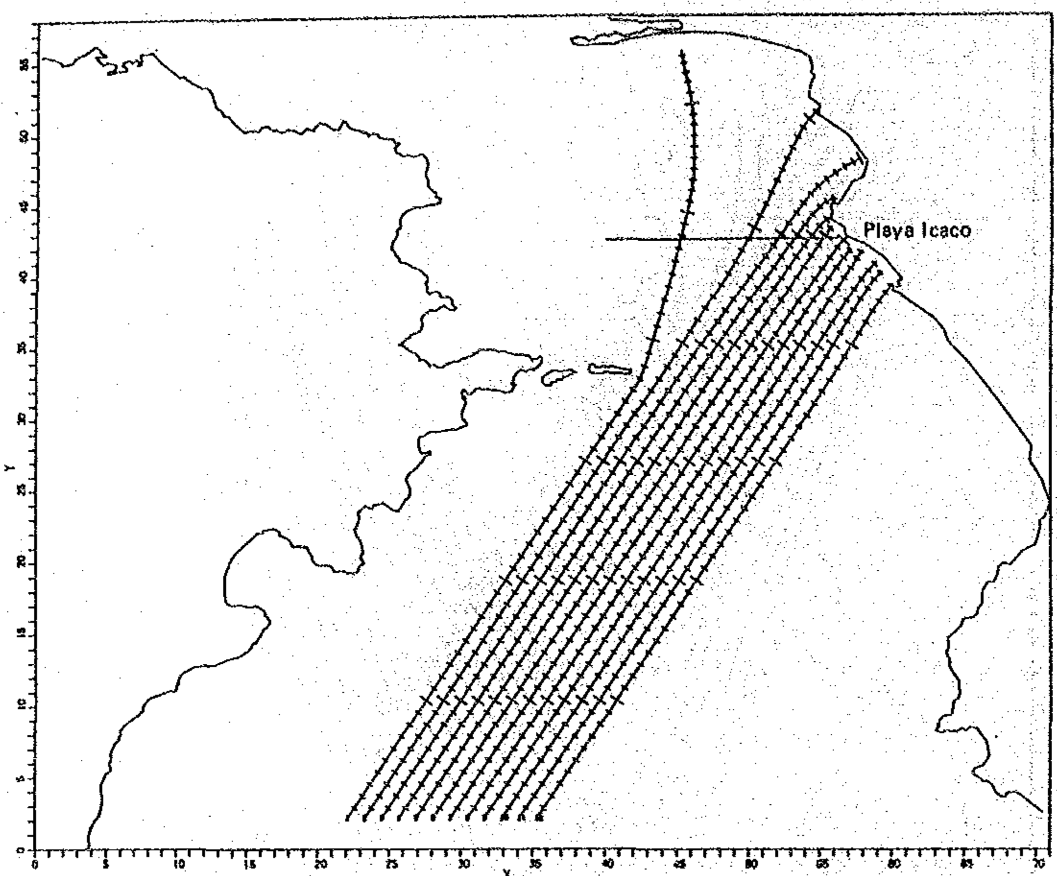


Fig. M-1 (29) Wave Refraction Chart of the Mouth of the Gulf of Nicoya (Wave Direction: N 213.8°, $T_{1/3}$ = 8s)

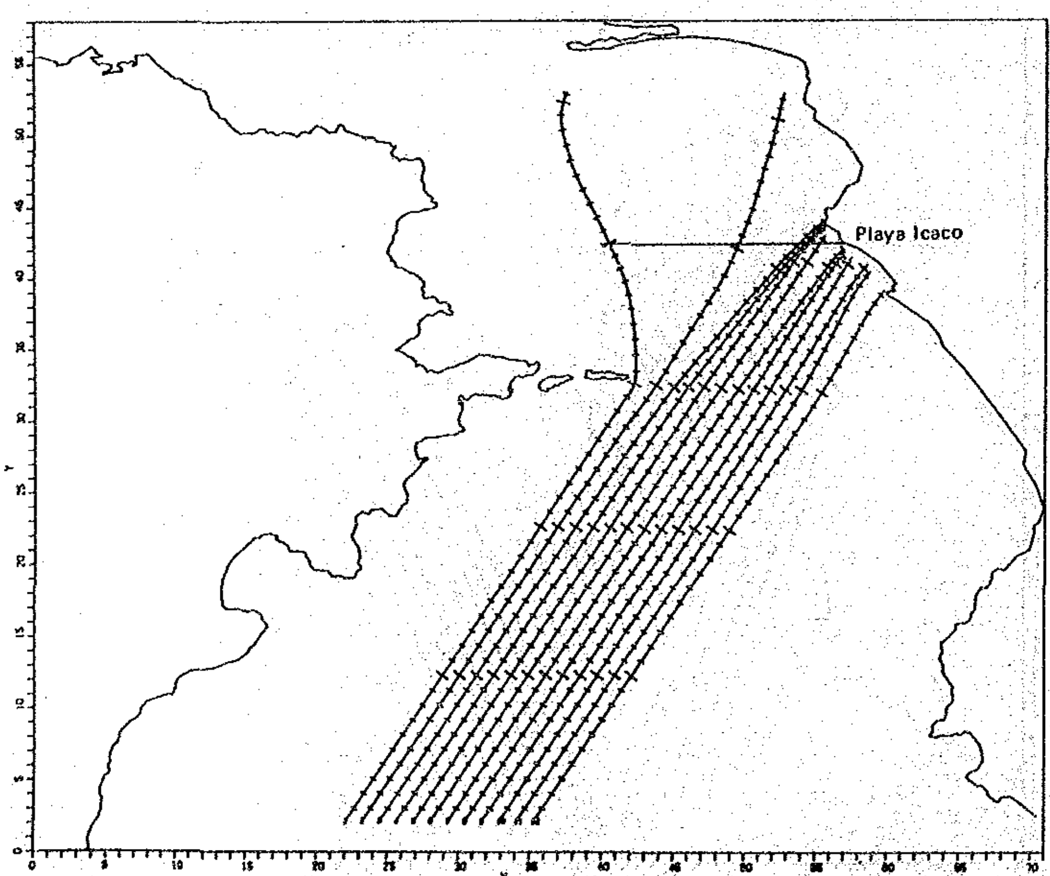


Fig. M-1 (30) Wave Refraction Chart of the Mouth of the Gulf of Nicoya (Wave Direction. N 213.8°, $T_{1/3}$ = 10s)

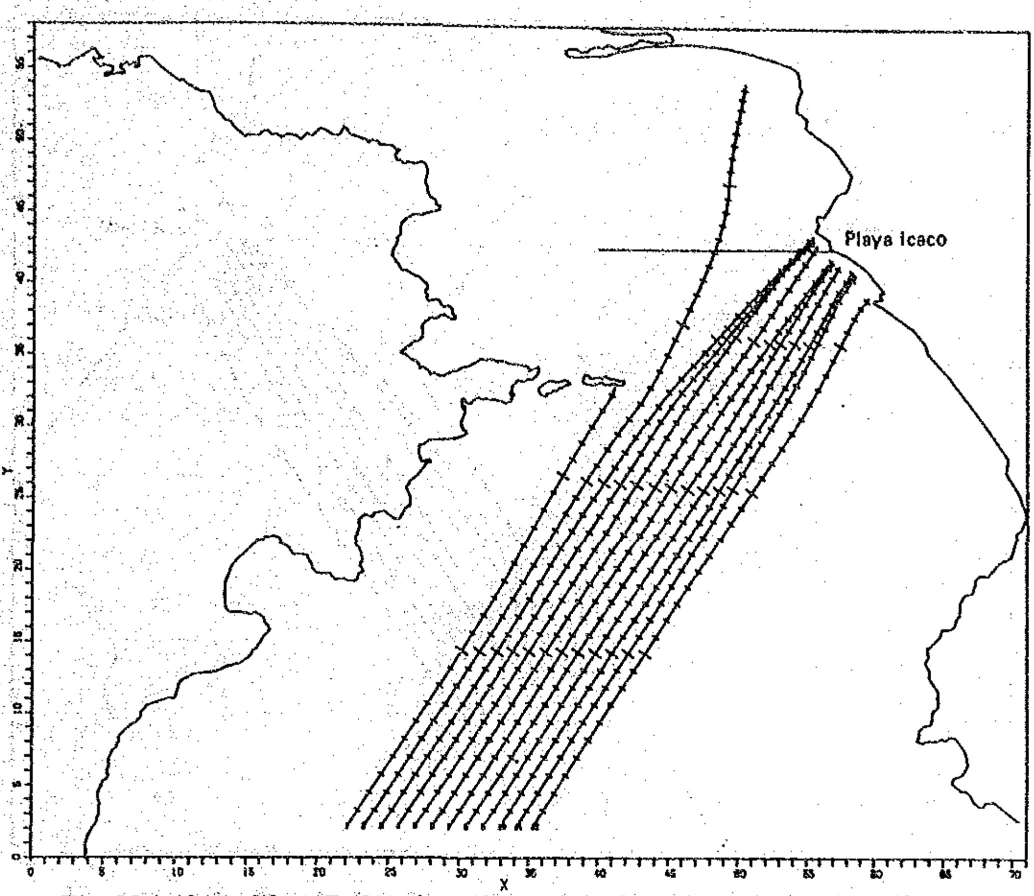


Fig. M-1 (31) Wave Refraction Chart of the Mouth of the Gulf of Nicoya
(Wave Direction: N 213.8°, $T_{1/3}$ = 12s)

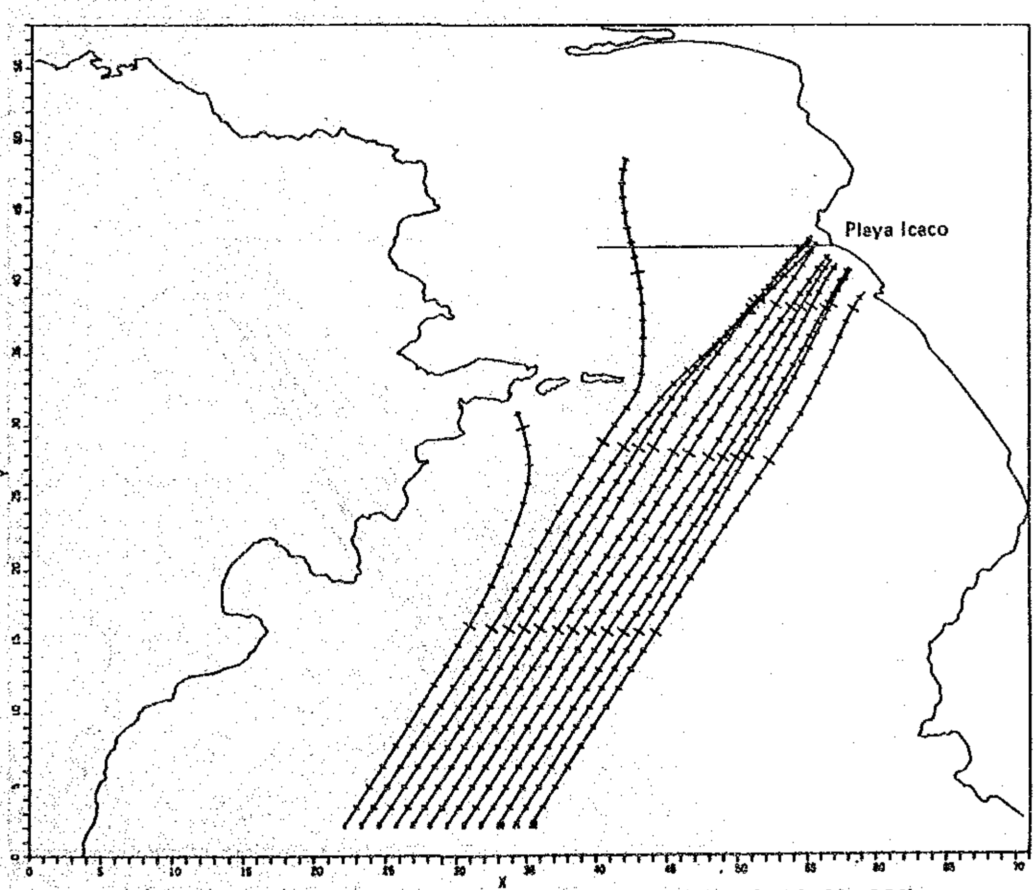


Fig. M-1 (32) Wave Refraction Chart of the Mouth of the Gulf of Nicoya
(Wave Direction: N 213.8°, $T_{1/3}$ = 14s)

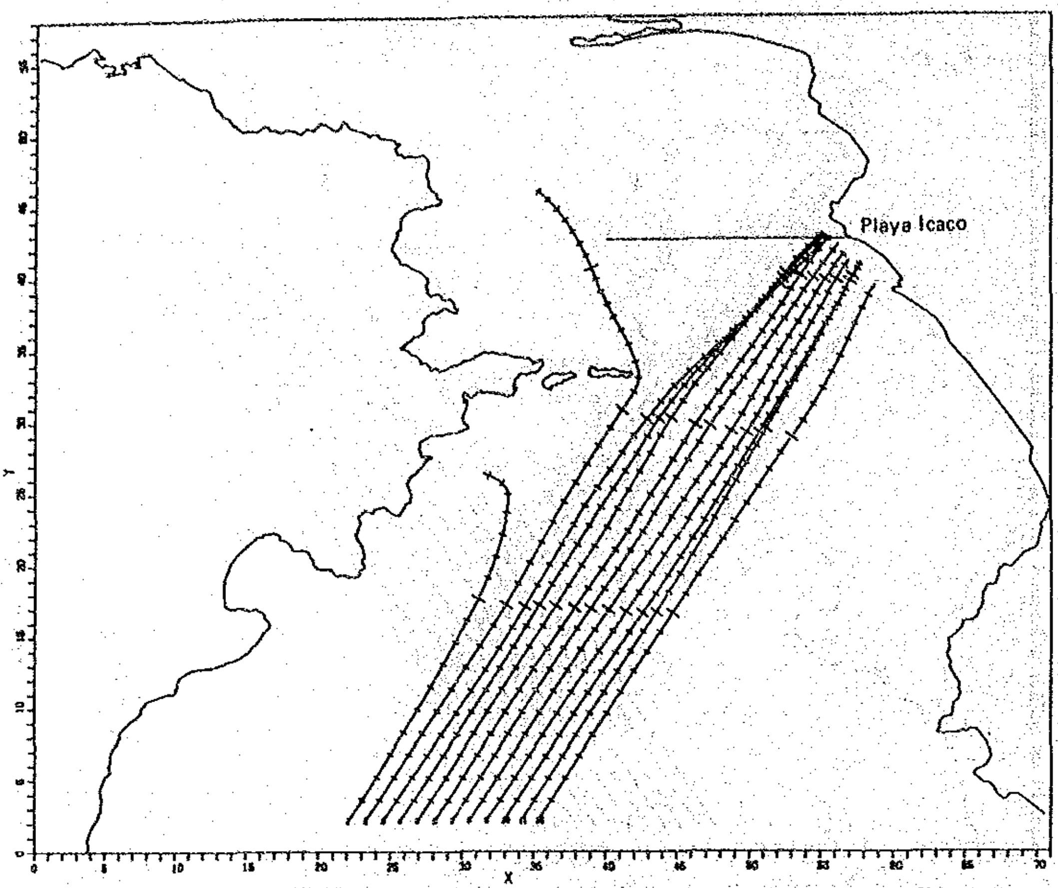


Fig. M-1 (33) Wave Refraction Chart of the Mouth of the Gulf of Nicoya
(Wave Direction: N 213.8°, $T_{1/3}$ = 16s)

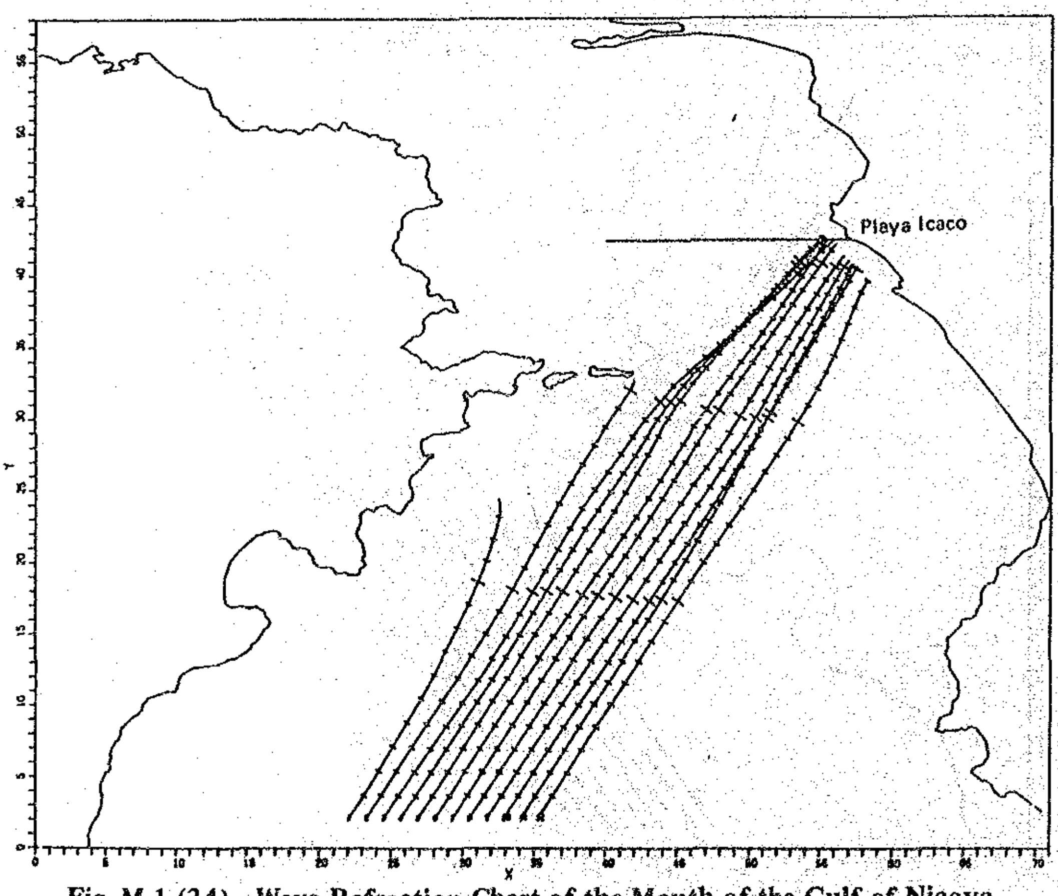


Fig. M-1 (34) Wave Refraction Chart of the Mouth of the Gulf of Nicoya
(Wave Direction: N 213.8°, $T_{1/3}$ = 18s)

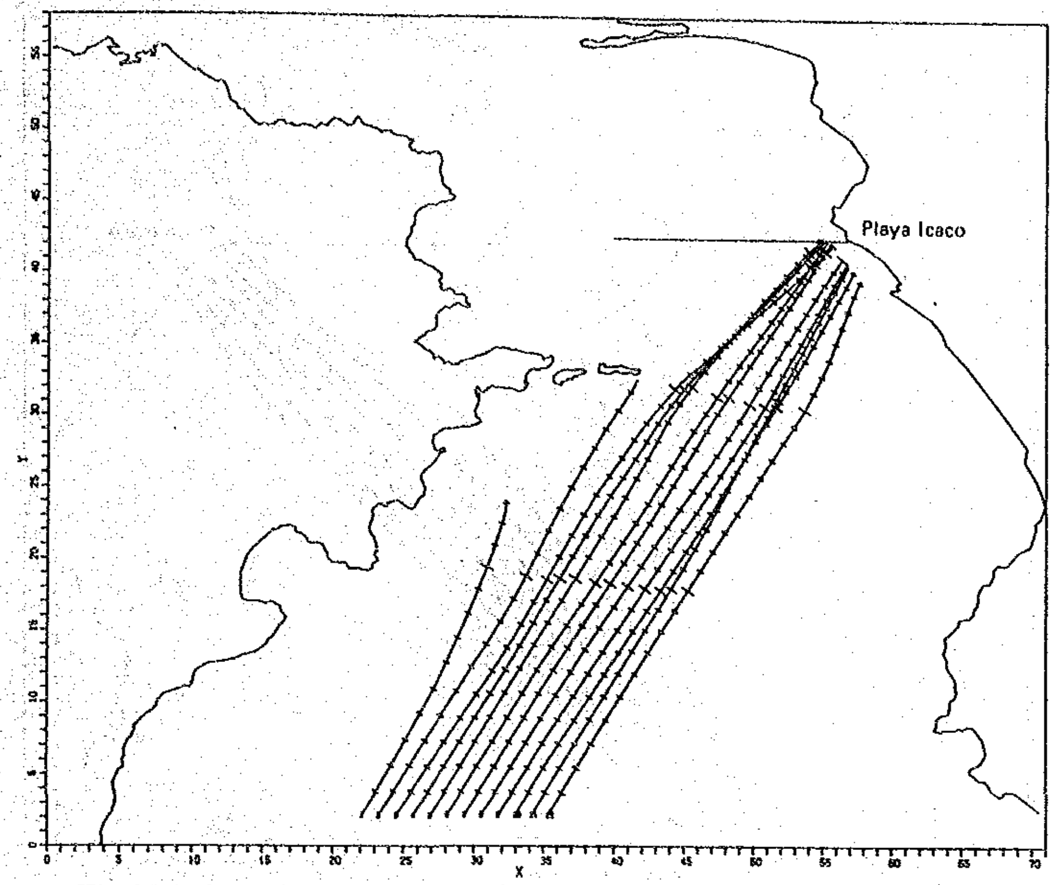


Fig. M-1 (35) Wave Refraction Chart of the Mouth of the Gulf of Nicoya
(Wave Direction: N 213.8°, $T_{1/3}$ = 20s)

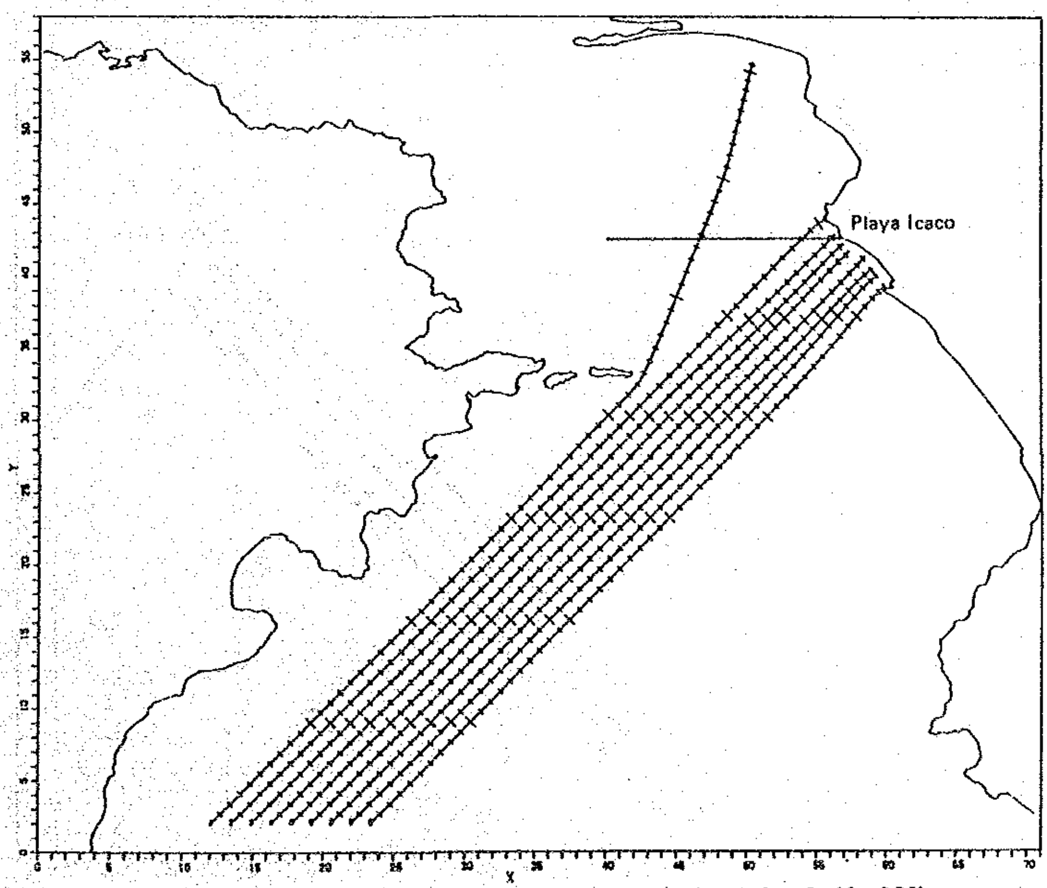


Fig. M-1 (36) Wave Refraction Chart of the Mouth of the Gulf of Nicoya
(Wave Direction: SW, $T_{1/3}$ = 8s)

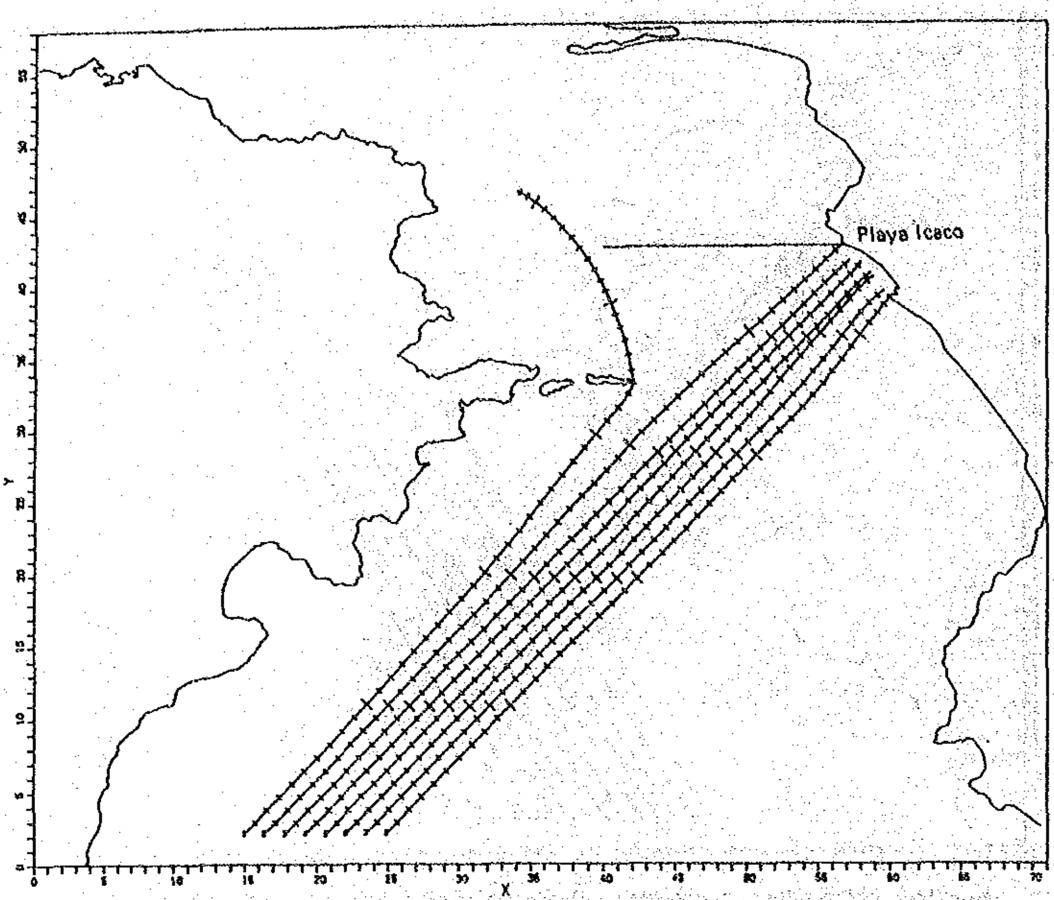


Fig. M-1 (37) Wave Refraction Chart of the Mouth of the Gulf of Nicoya (Wave Direction: SW, $T_{1/3}$ = 10s)

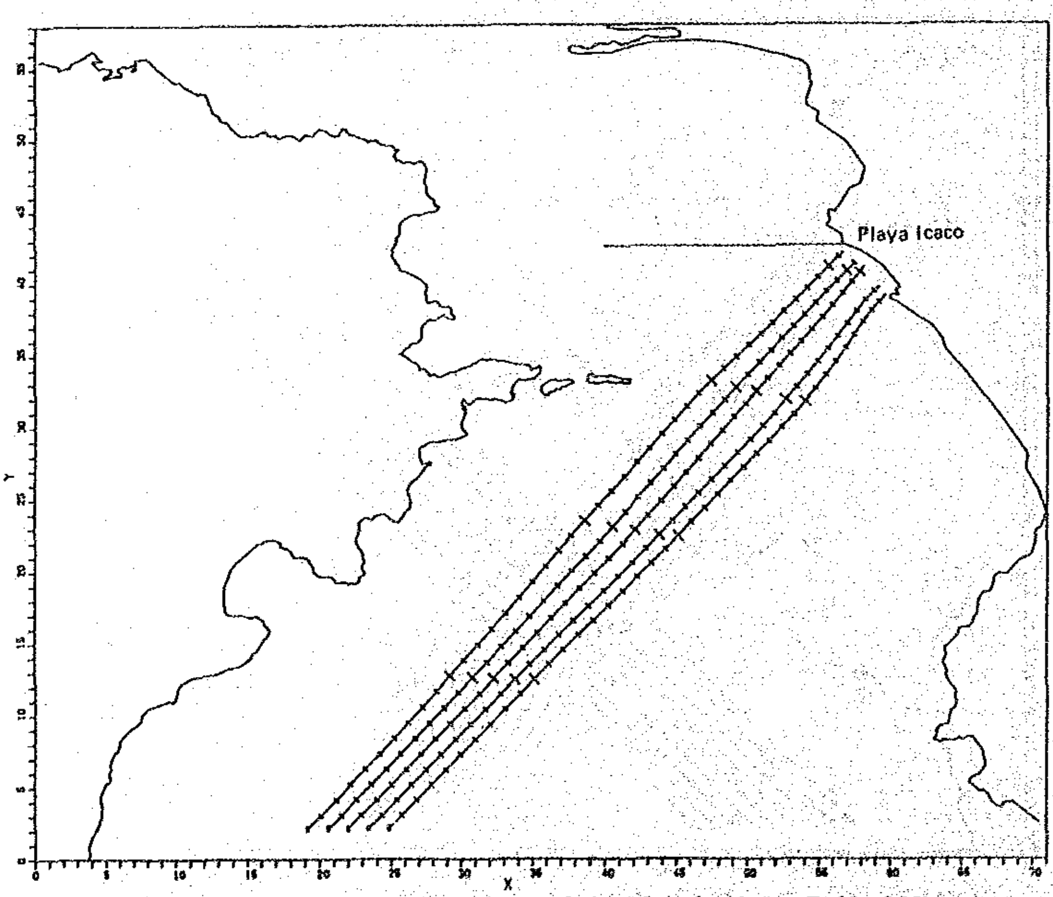


Fig. M-1 (38) Wave Refraction Chart of the Mouth of the Gulf of Nicoya (Wave Direction: SW, $T_{1/3}$ = 12s)

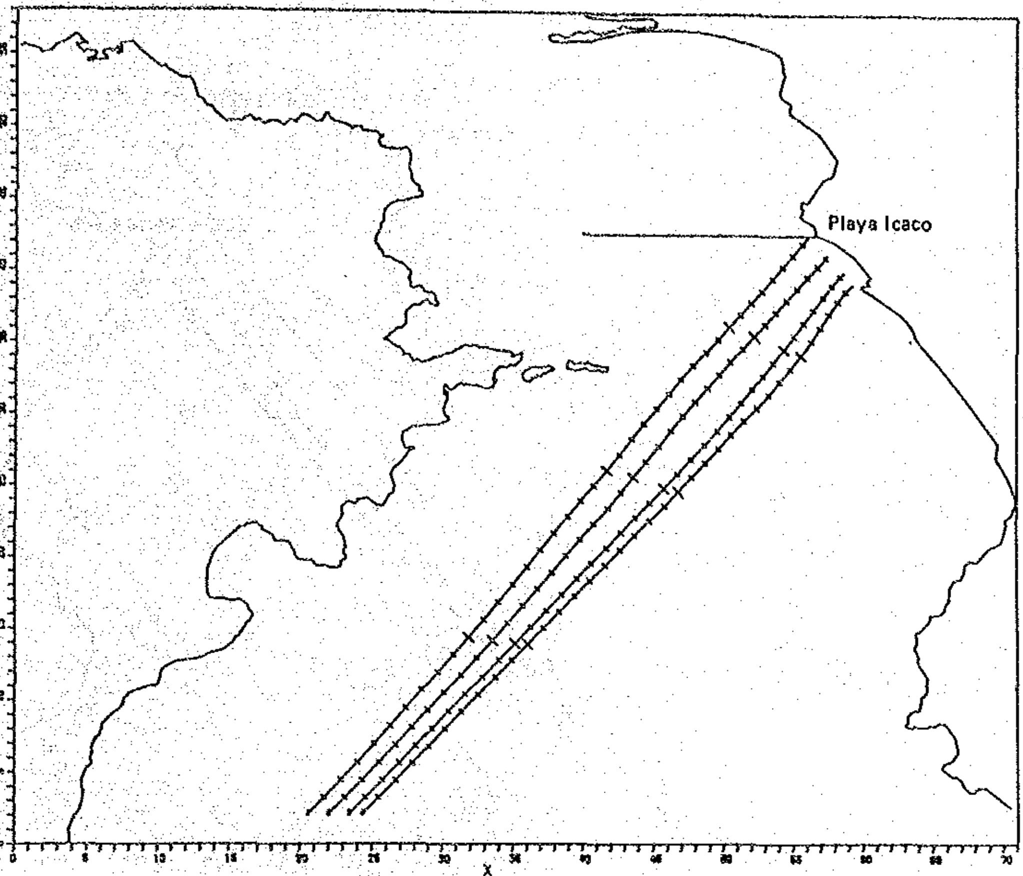


Fig. M-1 (39) Wave Refraction Chart of the Mouth of the Gulf of Nicoya
(Wave Direction: SW, $T_{1/3}$ = 14s)

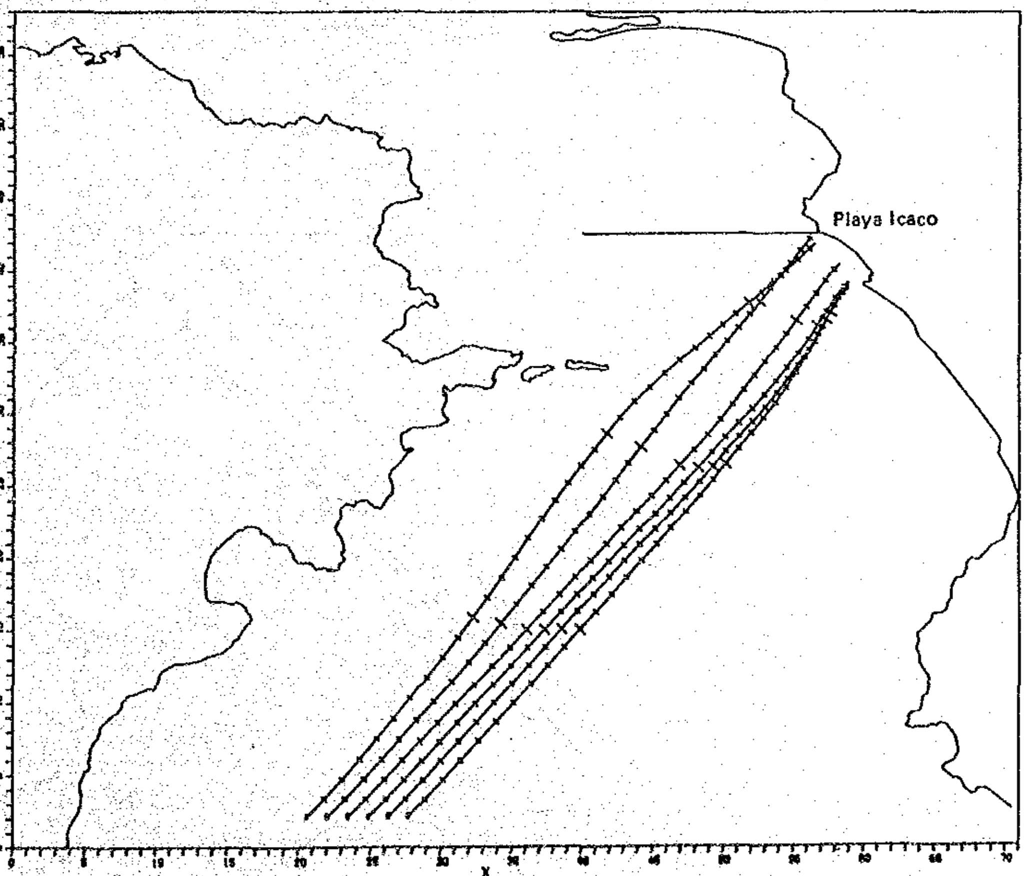


Fig. M-1 (40) Wave Refraction Chart of the Mouth of the Gulf of Nicoya
(Wave Direction: SW, $T_{1/3}$ = 16s)

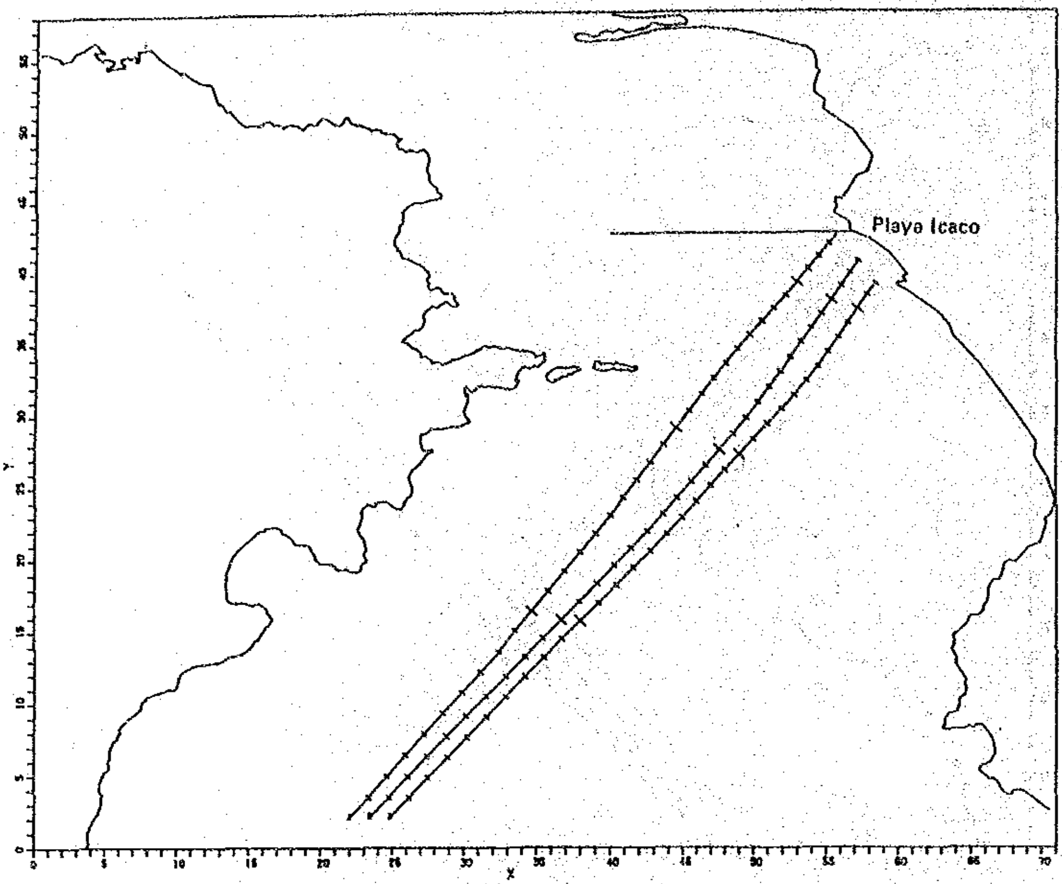


Fig. M-1 (41) Wave Refraction Chart of the Mouth of the Gulf of Nicoya (Wave Direction: SW, $T_{1/3}$ = 18s)

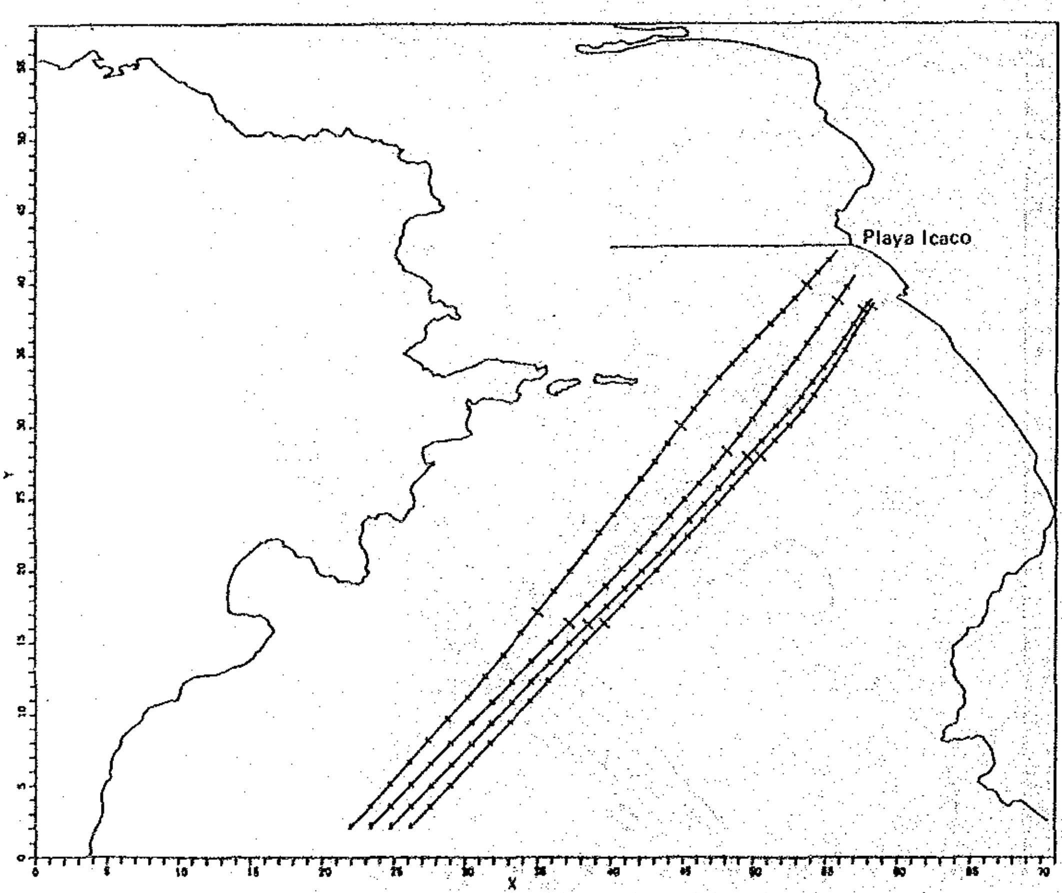


Fig. M-1 (42) Wave Refraction Chart of the Mouth of the Gulf of Nicoya (Wave Direction: SW, $T_{1/3}$ = 20s)

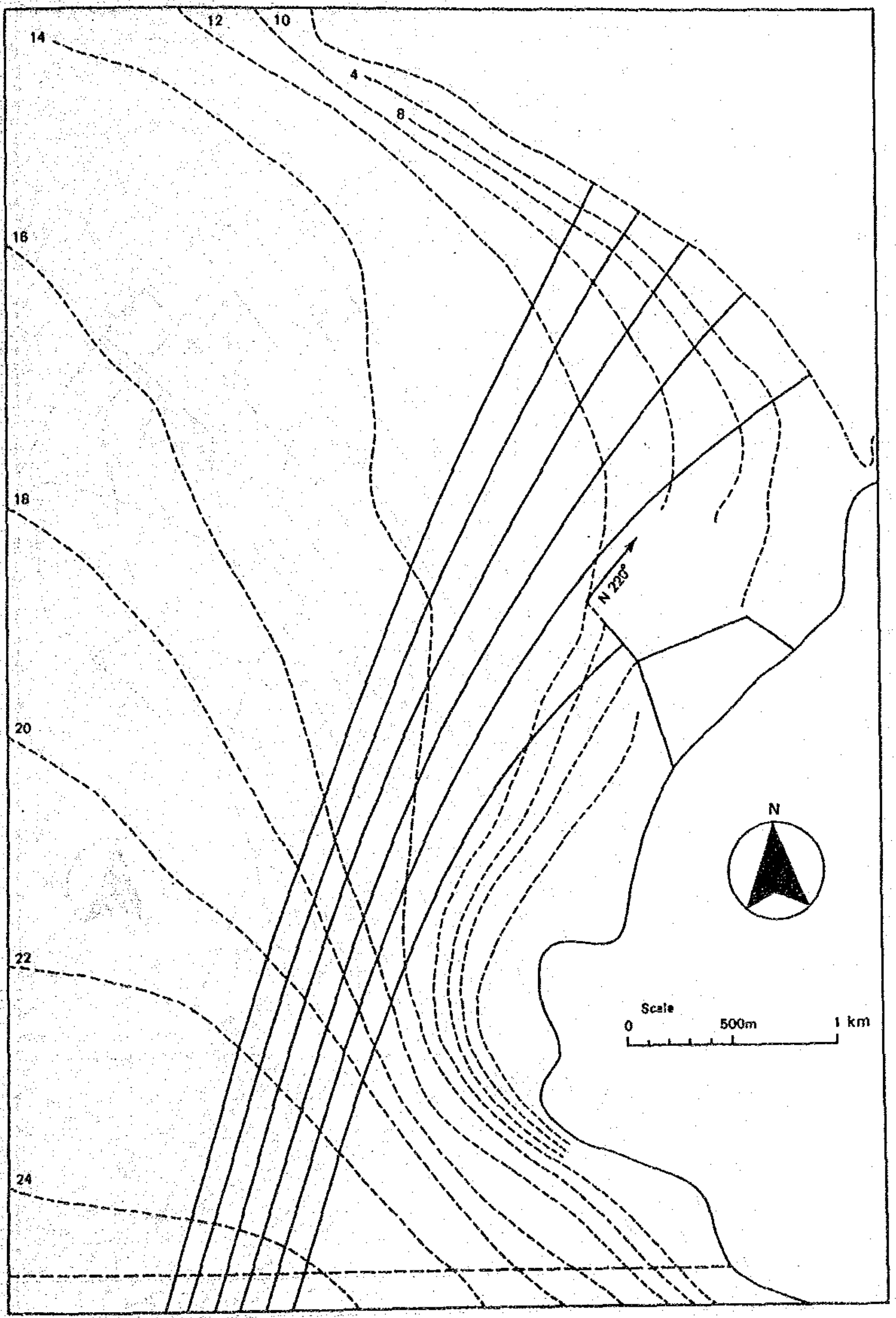


Fig. M-2 (1) Wave Refraction Chart of the Port of Caldera Offshore Area
(Wave Direction: N 196°, $T_{1/3}$ = 12s)

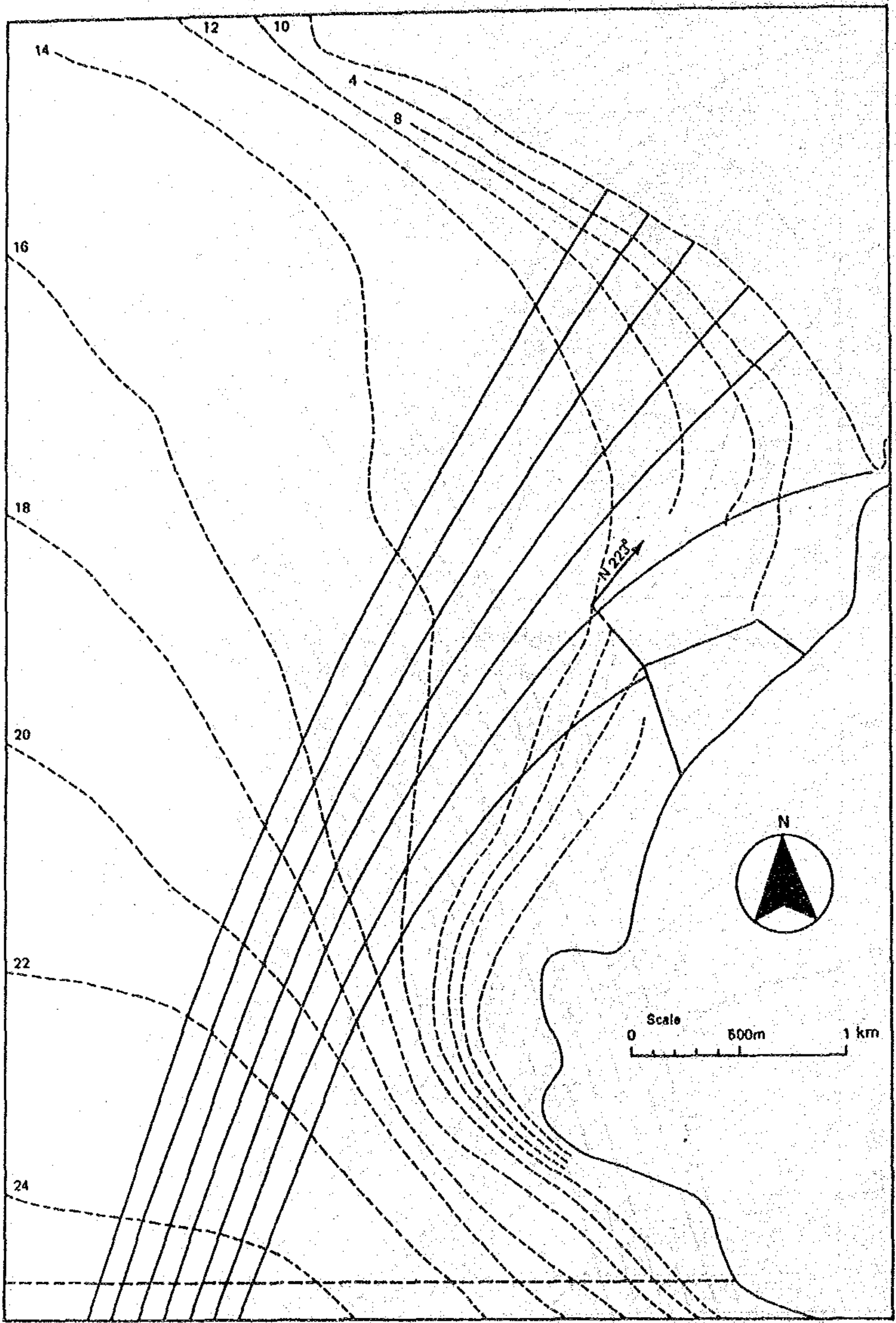


Fig. M-2 (2) Wave Refraction Chart of the Port of Caldera Offshore Area
(Wave Direction: N 199°, $T_{1/3}$ = 16s)

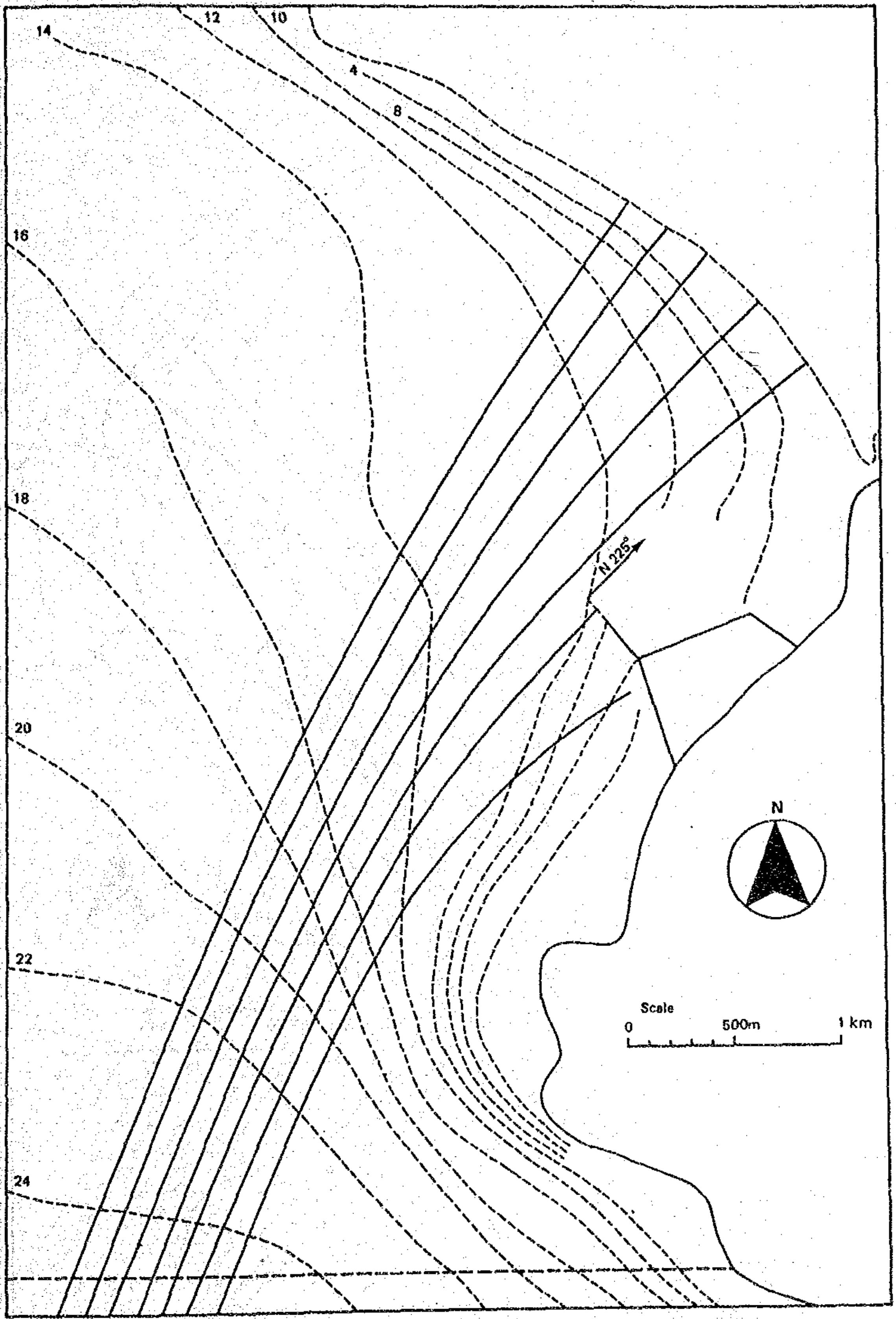


Fig. M-2 (3) Wave Refraction Chart of the Port of Caldera Offshore Area
(Wave Direction: N 204°, $T_{1/3}$ = 20s)

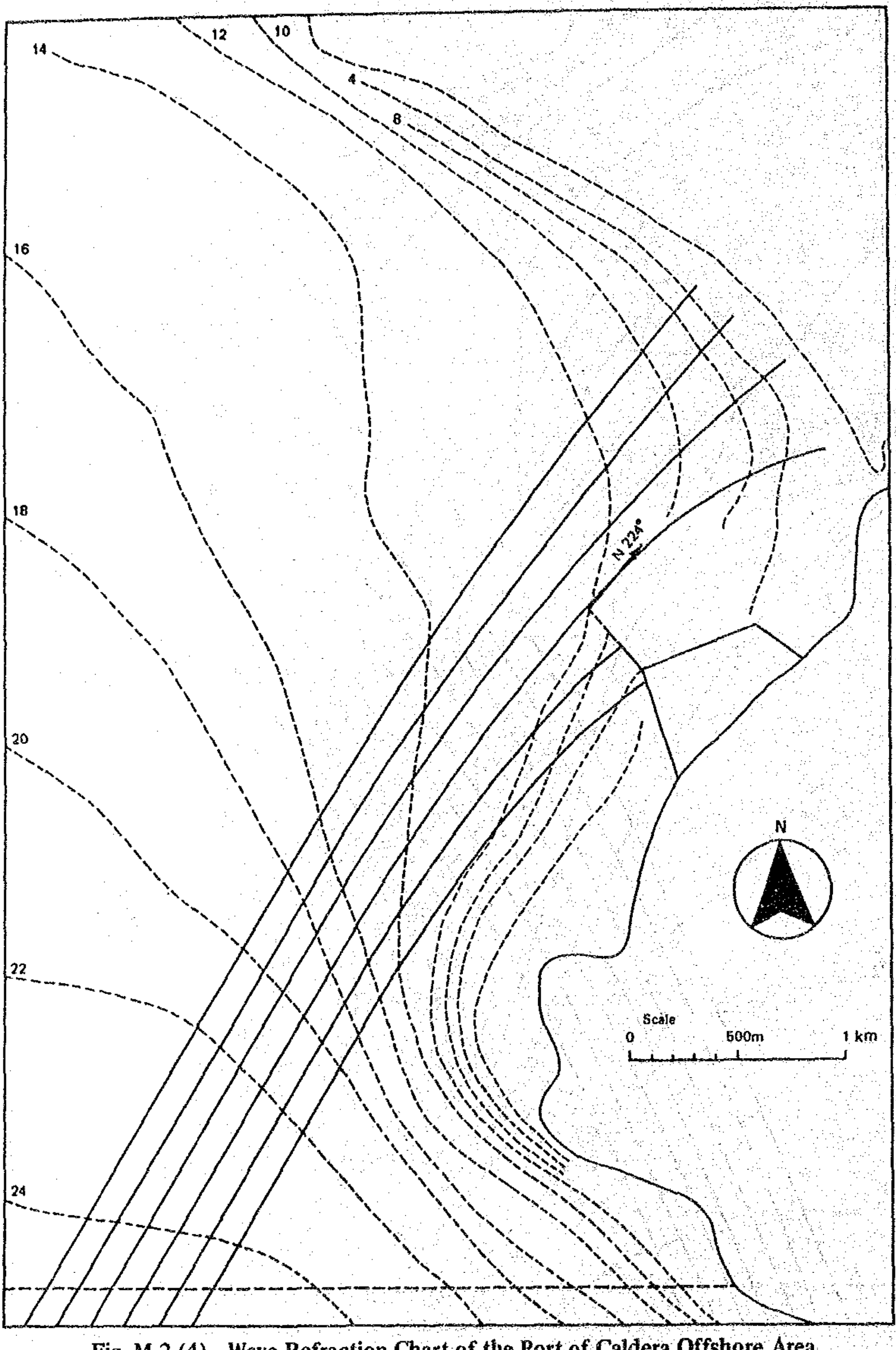


Fig. M-2 (4) Wave Refraction Chart of the Port of Caldera Offshore Area
(Wave Direction: N 210°, $T_{1/3}$ = 12s)

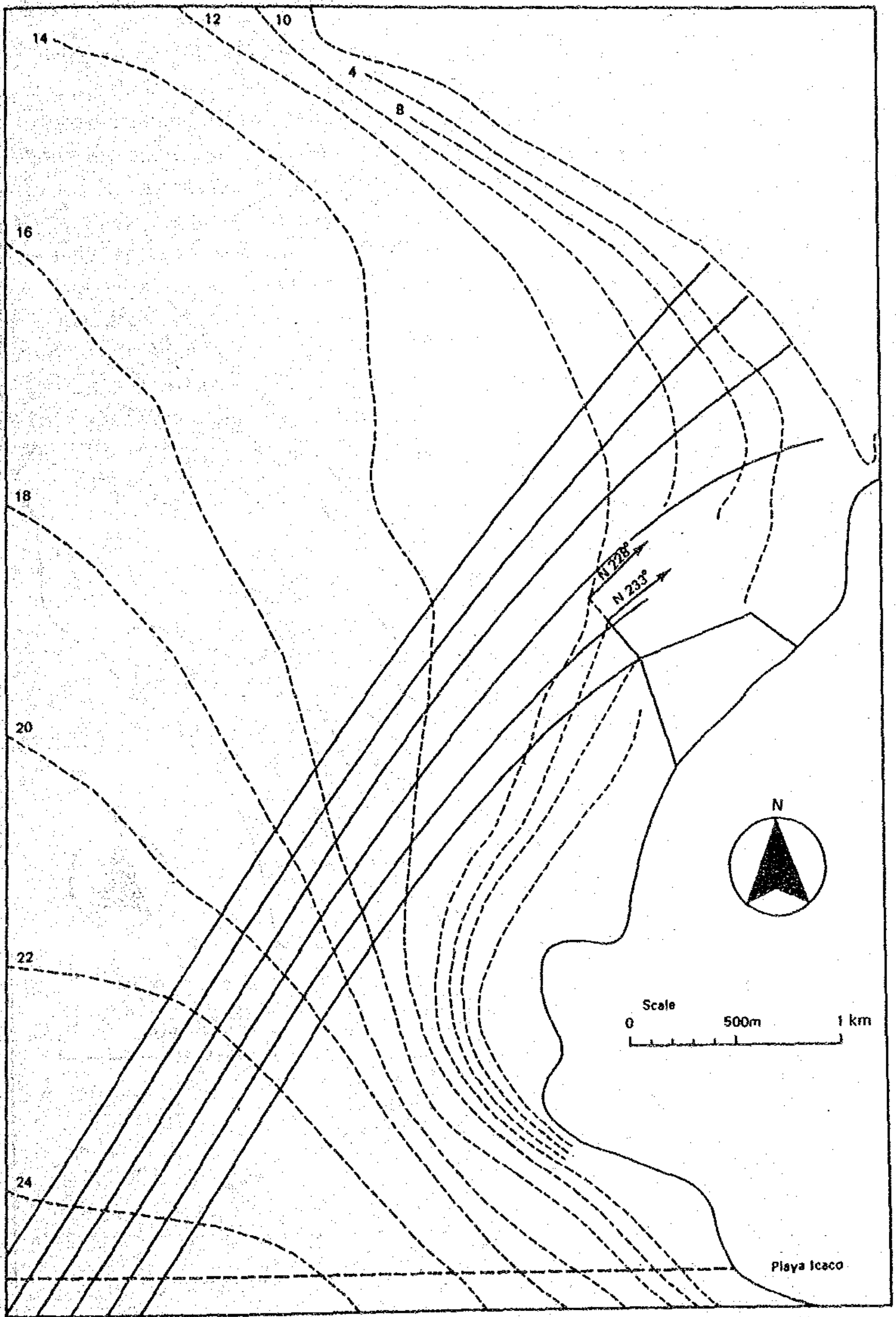


Fig. M-2 (5) Wave Refraction Chart of the Port of Caldera Offshore Area
(Wave Direction: N 212°, $T_{1/3}$ = 16s)

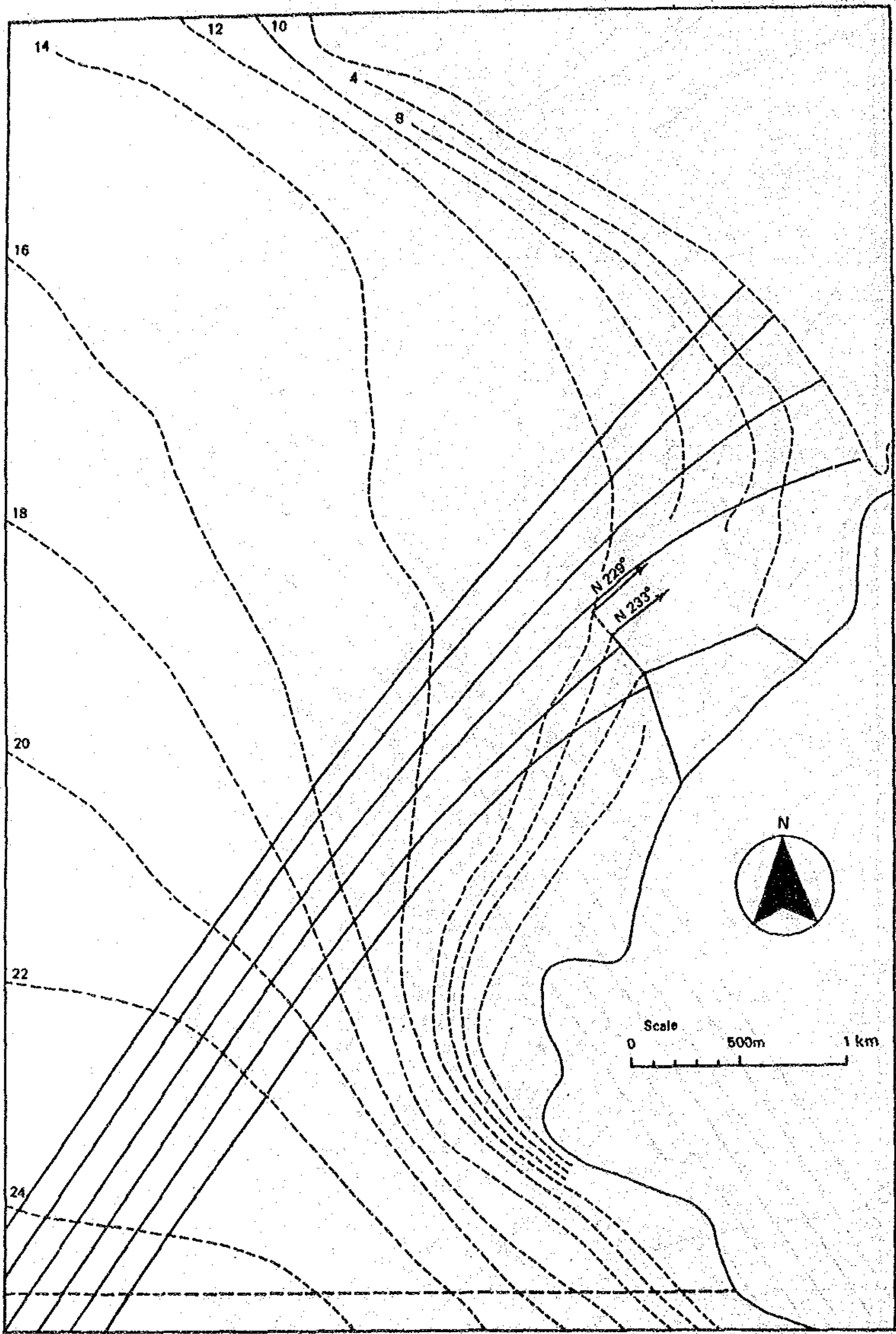


Fig. M-2 (6) Wave Refraction Chart of the Port of Caldera Offshore Area
(Wave Direction: N 215°, $T_{1/3}$ = 20s)