(2) Port Tariff

PC's port tariff is very complicated, making it difficult for port users to estimate port charge.

Furthermore, many staffs are in charge of calculating port charges. It should be revised so that it can be easily understood by port users. By so doing, staff could be reduced.

5.10.3 Establishment of Effective Maintenance System

There are several damaged structures which require both periodical maintenance and urgent rehabilitation.

Maintenance works are required for not only ensuring safety to port users but also extending the life of facilities. It is recommended that the required maintenance works should be evaluated during the design stage by totaling the initial cost and maintenance cost. More economical maintenance works can be conducted if proper preparation works on objective structure are carried out.

Findings and recommendations on this aspect are shown below.

a) Inadequate identification of required maintenance works is observed.
It is recommended to prepare a list of facilities together with possible damage.

b) Insufficient inspection works are also observed. Monitoring of the present usage and damage inspection should be conducted periodically. Inspection survey should be extended to underwater structures, under surface of deck structure and embedded facilities in the berth.

Maintenance work on the structures can be divided into two categories, namely the routine maintenance and the urgent rehabilitation. The former consists of preventive measures in which required cost is minor, however the latter consists of corrective measures against large scale damage in which required cost is large. According to past experience, if preventive maintenance is appropriately performed, the required cost for corrective maintenance works will be minimum.

5.10.4 Training System

(1) Reformation of the Training System

1) Establishment of the Information Center (Effective use of the existing library)

The existing library of Training Center will function as the Information Center in order to widen instructor's and staff's knowledge.

Many departments dispatch staffs to foreign countries to acquire the latest information. The fruits of such training presently seem to be retained by individuals, but these should be utilized for the whole organization in a systematic way.

This Information Center should gather the above mentioned data and documents which are kept by all departments.

Furthermore, Information Center should prepare updated technical texts, port related journals, brochures of foreign ports and training institutions, etc.

All of this information should be sorted in good condition and available to all staffs.

2) Widening instructor's knowledge

It is recommended to bring up instructors who have the latest and broad knowledge of port management and operation and they should belong to training center exclusively. Instructors must have an overall knowledge of the port in order to promote better understanding on the part of trainees and be able to teach several related training courses systematically. Furthermore, instructors can enlarge their knowledge through exchanges with one another.

In order to widen instructor's knowledge, PC should send several staffs to foreign ports for a long term and let them acquire broad knowledge of port management and operation.

In addition to above measure, instructors should get the latest information from the staffs who are dispatched to foreign ports.

Personnel changes of dispatched staff and instructor for a limited period is also a possibility.

3) Practical training

As mentioned in the Master Plan, investment for practical training institution with port facilities and the latest equipment is very costly. Especially initial and maintenance cost for training equipment such as ship's crane and derrick crane is so high that such equipment should be indroduced after ensuring financial resources in the future, because PC has to raise a large amount of funds for the new port development.

It is recommended for PC to send several operators to the training institutions in foreign countries to heighten skill of ship's crane and derrick crane operators. These trained operators guide unskilled ones by the programmed training periodically using actual ship's crane and derrick crane (on-the-job training).

Regarding the land handling machines (mobile crane, forklift, etc.), it is possible to execute controlled practical training if suitable space is secured. After arranging this space, skilled operators can guide unskilled ones using land handling machines which are exclusively used for practical training.

(2) For the Projects of the Short-term Improvement Plan

In order to execute the projects and operate and maintain new port facilities and equipment, following training courses should be prepared as soon as possible.

1) For operation of the new container terminal

Transfer cranes (5 sets), additional gantry crane (1 set) and operation system by computer are proposed in the Short-term Improvement Plan (target year : 2000). In order to correspond to drastic change of cargo handling system (straddle carrier to transfer crane)

and introduction of computer control, PC should post capable operation staffs and operators in the Operation Department until 2000.

Following training courses are necessary to rear capable operation staffs and operators.

a) Training for container terminal operation staffs
b) Training for transfer crane operators

Several staffs and operators could be sent to foreign ports and to acquire knowledge or skill based on the latest management and operation or cargo handling technique. They should pass on their knowledge or skill to other staffs or operators.

c) Training for new additional gantry crane

Skilled operators guide unskilled ones periodically using actual gantry cranes. It is advisable that when PC purchase above new gantry crane and transfer cranes, PC should turn to the supplier for guidance on operation for a certain period.

2) For executing the projects

Expansion or improvement of the berths, pavement of the container yard and manufacturing and setting of a gantry crane, etc., are proposed in the Short-Term Improvement Plan. These projects are planned to start from 1996. Project Department will be in charge of the control of design and construction work of the projects. However, PC has not constructed port facilities since completion of the Container Terminal (1984) or Oil Jetty (1986) so PC does not have enough capable technical staffs.

Furthermore, there are several berths which require rehabilitation. These defects seem to be caused by superannuation, low level of construction work and lack of regular maintenance.

Considering above issues, PC should rear capable technical staffs by the beginning year of the project, 1996. And following training courses are recommended;

a) Training for port planning

To rear capable technical staffs who understand how to plan the port facilities and are able to alter the planning should unexpected problems arise.
Not many staffs are required for port planning so the following training should be considered;

- Send selected staffs to domestic or foreign technical school or related organ
- Invite experts for a long term (Experts should be assigned to port planning section which is recommended in this study to assist in on-the-job training)

b) Training for design, construction and maintenance work

To rear capable technical staffs who have knowledge of design, construction and maintenance work in order to supervise the design, construction work of the projects and maintenance of existing and new port facilities.

PC has many port facilities and equipment. Many staffs for civil, mechanical or

electrical works are required considering the scale of port.
Following training should be introduced;

- Invite part-time instructors from domestic technical school or experts for a long term from foreign countries as instructors of Training Center.

3) For effective cargo handling and office work

a) Training for heightening self-awareness

It is very important to raise employee's morale which leads to efficiency of cargo handling and office work. PC should make all staffs understand the importance of their jobs, that is, that they are contributing to Jordan's economic development. Current training courses include lectures on discipline and self-awareness education. However, more attention should be given to this matter. PC should provide following training periodically for heightening self-awareness of all staffs. (Instructors...Representative of each department)

- Port related laws and regulations, Functions of each Department
- Personnel administration system (Promotion system, Pay system)
- Port facilities and equipment (Structure, Function)
- Port activities (Cargo flow, Cargo volume, Cargo handling system)
- Future plan and target, Problems to be solved

b) Training on personal computer

In order to ensure more quickness and accuracy of office work, PC should introduce personal computers to every section. Practical training on personal computer using application software such as word processor, spread sheet, drawing processor should be strengthened.

5.11 Economic Analysis

5.11.1 Purpose

The purpose of the economic analysis is to appraise the economic feasibility of the short term plan for the new facilities of the ports of Aqaba from the viewpoint of the national economy.

Therefore, the purpose of this section is to investigate the economic benefits as well as the economic costs which arise from the project and to evaluate whether the net benefits of the projects exceed those which could be obtained from other investment opportunities in Jordan.

5.11.2 Methodology

The economic evaluation of a project should show whether the project is justifiable from the economic point of view by assessing its contribution to the national economy.

(1) EIRR

The economic evaluation of the short term plan is identified to clarify the justification of the projects by the Economic Rate of Return (EIRR).

(2) "With" and "Without" analysis

The EIRR value is obtained from the annual economic benefit-cost value. The economic benefits are obtained from the difference between the "With the project" case (hereinafter referred to as the "With" case) and "Without the project" case (hereinafter referred to as the "Without" case).

(3) Measurement of Costs and Benefits

In estimating the costs of the project, "economic pricing" is applied. Economic pricing means that costs are appraised in terms of international prices (border prices).

The general procedure of the economic analysis is shown in Figure 5.11.1.

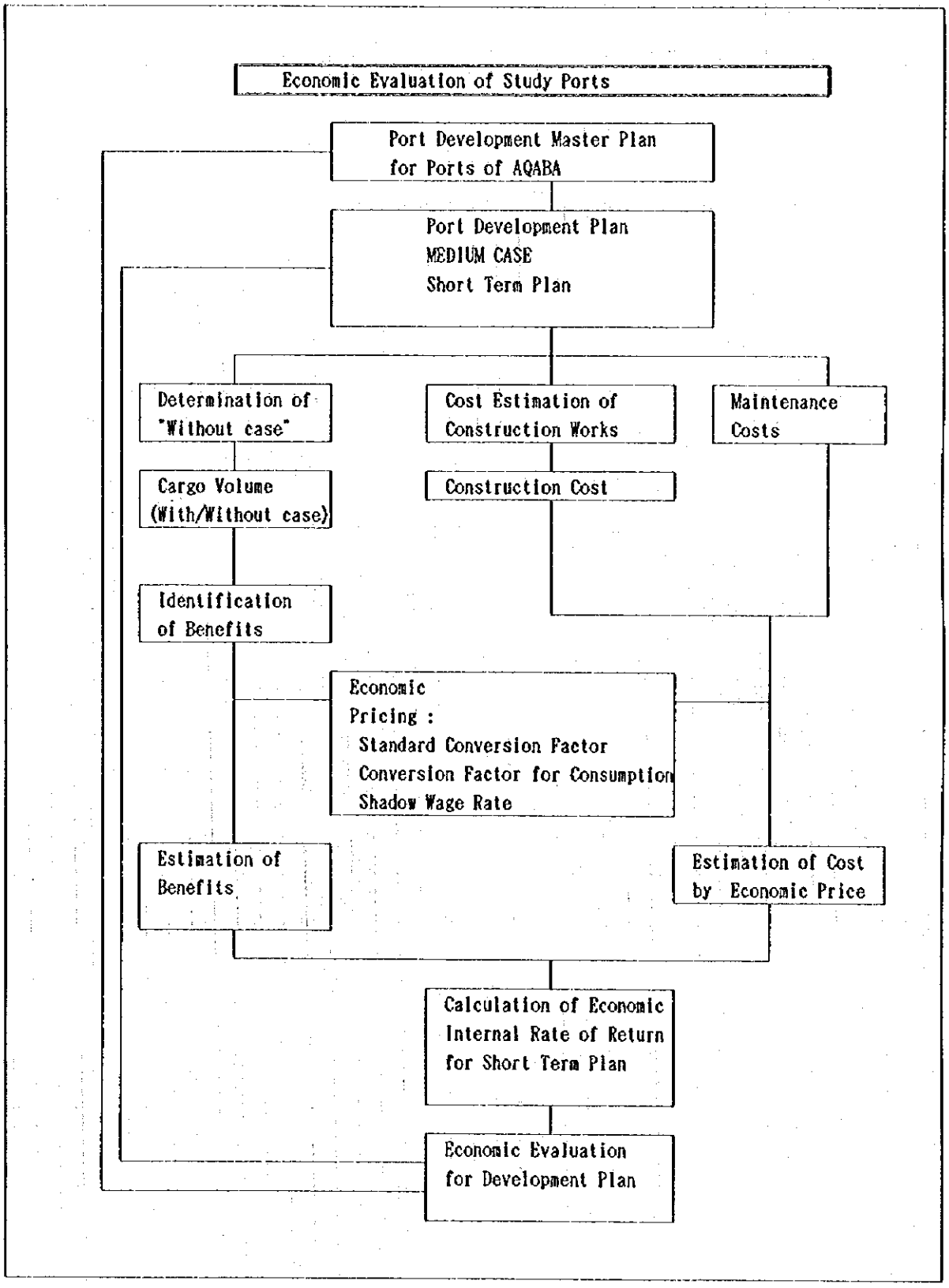


Figure 5.11.1 Flow Chart of Economic Analysis

5.11.3 Prerequisites of Analysis

(1) Base year

The base year of the short term plan is the starting year of the economic analysis. In this study, 1994 is set as the base year taking the construction and investment schedule of the project into account.

(2) Project life

The period of the calculation for the economic analysis is assumed to be 30 years after completion of the construction work (in the year 1999) taking into consideration the economic lives of the port facilities.

(3) Scope of the project

The scope of the project for the economic analysis consists of the following;

a) Grain Berth is transferred and depth is deepened (PROJECT1)
b) Container Terminal is enlarged and a gantry crane and transfer cranes are installed (PROJECT2)
c) JFI-North Berth is constructed and installs handling equipments (PROJECT3)
d) JFI-1 (livestock) Berth is enlarged and deepened at Timber berth (PROJECT4)

(4) "With" Case

In an economic analysis, benefits are mainly brought about by improvements in productivity. The "With" case includes all improvements in productivity.

(5) "Without" Case

A cost-benefit analysis is conducted on the difference between the "With" and "Without" investment cases.

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

(for PROJECT1-Grain Berth)

a) No investment is made for the port
b) The sizes of vessels and the working efficiency of cargo handling is the same as "With" case.
c) Loaded vessel is shifted after draft is available at Berth No.1
d) Cargo handling is available up to berth occupancy rate of 80%

(for PROJECT2-Container Port)

a) No investment is made for the port
b) The size of container vessel and the working efficiency of one gantry crane is the same as "With" case.
c) Cargo handling is available up to berth occupancy rate of 90%

(for PROJECT3-JFI North Berth)

a) No investment is made for the port
b) The size of vessels and the working efficiency of cargo handling is the same as "With" case.
c) Cargo handling is available up to berth occupancy rate of 83%

(for PROJECT4-JFI-1 Berth)

a) No investment is made for the port
b) The size of vessels and the working efficiency of cargo handling is the same as "With" case.
c) In case of calling of large sized vessel (24 times per year), Mo'ta(Rice) Berth accommodates her.
d) Cargo handling is available up to berth occupancy rate of 90%

5.11.4 Economic Pricing

(1) Methodology

The purpose of the economic analysis is to examine the value of a project, that is, to see if it represents an efficient allocation of resources in the national economy. The values of goods quoted at a market price do not always represent the true value of those goods from the viewpoint of the national economy. The local currency portion of the goods and materials at a market price often includes customs duties. The labor cost at market prices is often influenced by a minimum wage system. Therefore, "economic pricing" should be conducted for the economic analysis.

In this study, the prices of domestic goods and services are revised to border prices in an effort to determine a more rational valuation. In general, these border prices are intended to represent the international market value, or the world prices, of these goods and services.

The market prices are changed to border prices by various conversion factors such as "Standard Conversion Factor", "Conversion Factor for Consumption" and so forth.

Import duties, other taxes and subsidies are merely transfer items which do not actually reflect any consumption of national resources. Therefore, these transfer items should be excluded in the calculation of the costs and benefits of the project for the economic analysis.

(2) Standard Conversion Factor(SCF)

Import duties and export subsidies cause a price differential between the domestic market and the international market. The Standard Conversion Factor (SCF) is used to determine the economic prices of certain non-traded goods and services which cannot be directly valued at border prices.

SCF is expressed by the following formula:

$$SCF = \frac{I + E}{(I+Di) + (E-De)}$$

where, I : Total amount of imports in CIF
E : Total amount of exports in FOB
Di : Total amount of import duties
De : Total amount of export duties

In this study, the SCF of 0.94 is adopted according to the past records of trades and customs as shown in Table 5.11.1.

Table 5.11.1 Standard Conversion Factor

Year	1990	1991	1992	1993
I (Million JDs)	1,725.8	1,770.0	2,297.0	2,453.6
E (Million JDs)	706.1	770.7	829.3	864.7
Di (Million JDs)	116.7	136.1	286.4	237.7
De (Million JDs)	0.0	0.0	0.0	0.0
SCF	0.95	0.95	0.92	0.93

(3) Conversion Factor for Consumption(CFC)

The CFC is used for converting the prices of consumer goods from domestic market prices to border prices. This is particularly required in converting domestic labor costs to the corresponding border prices. The CFC is usually calculated in the same manner as the SCF, replacing figures of the formula mentioned above by that of consumer goods only.

In this study, CFC is set as equivalent to SCF because trade statistics concerning consumer goods are not available..

CFC = SCF = 0.94

1) Conversion Factor for Skilled Labor

The cost of skilled labor is calculated based on actual market wages, assuming that the market mechanism is functioning properly. However, since these are domestic costs, they should be converted to border prices by multiplying the local wage by the CFC.

Conversion Factor for Skilled Labor = Nominal Wage Rate × CFC
= 1 × 0.94
= 0.94

2) Conversion Factor for Unskilled Labor

Although minimum wages are set in Jordan, some of the actual wages are lower than the official minimum wages due to the high unemployment level.

Accordingly, unskilled labor wages should be adjusted by the shadow wage rate. According to interview with Egyptian labors, this shadow wage rate is thought to be 50%.

Conversion Factor for Unskilled Labor = Nominal Wage Rate × Shadow Wage Rate × CFC
= 1 × 0.5 × 0.94
= 0.47

5.11.5 Benefit

(1) Benefit Items

As benefits brought about by the short term plan of ports, the following items are identified:

a) Savings in waiting costs of vessels
b) Savings in time costs of cargoes
c) Savings in land transportation costs
d) Savings of cost in cargo handling
e) Promotion of regional development in Aqaba Governorate
f) Increase in employment opportunities/incomes

Of the above, items a), b), c) and d) are considered as the benefits suitable for the cost-benefit analysis in this Study. But item d) is not easy to evaluate. Items e) and f) are difficult to evaluate in strictly monetary terms. So, items a), b) and c) are counted as a benefit.

1) Savings in waiting costs of vessels.

If the (new) berths are not constructed or not improved, the increased cargo volume would have to be handled at the existing berths only and the waiting time of calling vessels would increase in accordance with the port congestion.

Implementing the project will prevent this problem. Investment in the (new) berths will reduce the waiting time of calling vessels and this cost reduction is one of the major benefits of the project.

Benefits that will accrue to Jordan economy from the project can be calculated by comparing the "With" case to the "Without" case.

The formula used to calculate this benefit is as follows:

Savings in vessels' waiting costs = Difference in waiting time between "With" and "Without" cases (days/year)
*Vessel cost (unit cost)
*Share of benefits accruing to Jordan economy (=0.5)

Vessel costs are estimated as follows by cargo;

Cargo	Vessel Type	Vessel Size (DWT)	Cost (JDs/day)
Grain	Bulk	50000	10,600
Container	Container	20000	8,400
Industrial Cargo (Solid&Liquid)	Bulk&Tanker	25000	8,000
Livestock	General Cargo	5000	6,660

Tables 5.11.2, 5.11.3, 5.11.4 and 5.11.5 show details.

2) Savings in time costs of cargoes

The reduction of vessels' waiting time due to the construction (improvement) of the (new) berths brings about a reduction in the time required for transportation.

This will bring about a reduction in usance interest because invested funds will be called in faster. Converted into monetary terms, this reduced time can be estimated by the following equation:

Savings in time costs of cargoes = Volumes of cargo (tons/year)
*Reduction of vessels' waiting time (days)
*Average cargo value (JDs/ton)
*Interest rate (/day)

Average cargo values are estimated as follows;

Cargo	Value (JDs/ton)
Grain	105
Container	700
Industrial Cargo for JFI Berth	125
Livestock	800

Interest rate is set at 10% based on recent rate of commercial banks.

Tables 5.11.2, 5.11.3, 5.11.4 and 5.11.5 show details.

3) Savings in land transportation costs

In case of livestock discharging from large size vessel, number of trucks and drivers engaged in cargo transportation works will be reduced comparison of "With" case at JFI-1 berth and "Without" case at Mo'ta floating berth. Benefit by reduction of cost is counted as follows:

Savings in land transportation costs =	(Cost in land transportation at Mo'ta berth - Cost in land transportation at JFI-1 berth)

The following preconditions are set;

a. Large vessel with 70,000 heads calls 24 times per year.
b. Average distance from berth to farm is 50 km.
c. Number of discharging heads per hour is 500 for Without Case and 1500 for With Case.
d. Traffic cost per day is equal to 300 JDs per day.
e. Turn round time of truck is 150 minutes.

Results are listed in the following Table;

	Discharging Head (150 minutes)	Truck Transport	Truck Waiting	Truck Total	Discharging Day per Vessel	Required Truck per Vessel
Without Case	1250	4.2	2.8	8	8	64
With Case	3750	12.5	2.5	16	3	48

5.11.6 Costs

The items that should be considered as costs of the projects are:construction costs, maintenance costs, and renewal investment costs.

(1) Construction costs

Construction costs are divided into such categories as foreign currency portion, local currency portion, skilled labor, unskilled labor and others.

The costs of local currency portion and others at financial prices are changed to economic prices by multiplying by the standard conversion factor (SCF).

The costs of skilled labor and unskilled labor at financial prices are changed to economic prices by multiplying by the conversion factor for skilled labor and the conversion factor for unskilled labor, respectively.

(2) Maintenance costs

The costs of maintaining the port facilities are estimated as a fixed proportion (1% for structures, 4% for handling equipment) of the original construction costs excluding the costs of dredging and reclamation costs.

(3) Renewal investment costs

If the depreciation period of a construction item is shorter than the project life, the construction cost includes renewal investment cost. Renewal investment costs are counted in 15 years after commencement of operation in due consideration of an actual management.

Table 5.11.2 Savings in Vessel Waiting Cost and in Time Cost of Cargo
- PROJECT 1 (Grain Berth)

Year	Cargo Vol. (000ton)	No. of Vessel	Without Cargo Volume (000ton)	Without No. of Vessel	With Cargo Volume (000ton)	With No. of Vessel	Benefit Vessel Waiting Time (000JDs)	Benefit Cargo Waiting Time (000JDs)
2000	1,550	39	1,550	39	1,550	39	411	44
2005	1,780	45	1,780	45	1,780	45	754	82
2010	2,010	50	2,010	50	2,010	51	1,612	174
2015	2,251	56	2,049	51	2,251	56	1,373	149
2020	2,493	62	2,049	51	2,268	57	1,253	136
2025	2,734	68	2,049	51	2,268	57	1,253	136
2029	2,927	73	2,049	51	2,268	57	1,253	136

Table 5.11.3 Savings in Vessel Waiting Cost and in Time Cost of Cargo
- PROJECT 2 (Container Berth)

Year	Cargo Vol. (000TEU)	No. of Vessel	Without Cargo Volume (000TEU)	Without No. of Vessel	With Cargo Volume (000TEU)	With No. of Vessel	Benefit Vessel Waiting Time (000JDs)	Benefit Cargo Waiting Time (000JDs)
2000	227	378	227	378	227	378	3,828	245
2005	321	459	272	389	317	454	4,771	357
2010	416	520	303	378	353	441	4,253	364
2015	522	580	303	336	353	392	3,780	364
2020	628	628	303	303	353	353	3,402	364
2025	733	666	303	275	353	321	3,093	364
2029	818	693	303	256	353	299	2,883	364

Table 5.11.4 Savings in Vessel Waiting Cost and in Time Cost of Cargo - PROJECT 3 (JFI-North Berth)

Year	Cargo Vol. (000ton)	No. of Vessel	Without Cargo Volume (000ton)	Without No. of Vessel	With Cargo Volume (000ton)	With No. of Vessel	Benefit Vessel Waiting Time (000JDs)	Benefit Cargo Waiting Time (000JDs)
2000	7,610	381	7,610	381	7,610	381	3,330	286
2005	8,300	415	7,670	384	8,300	415	3,730	320
2010	9,880	494	7,670	384	8,502	425	3,710	318
2015	10,594	530	7,670	384	8,502	425	3,710	318
2020	11,308	565	7,670	384	8,502	425	3,710	318
2025	12,021	601	7,670	384	8,502	425	3,710	318
2029	12,592	630	7,670	384	8,502	425	3,710	318

Table 5.11.5 Savings in Vessel Waiting Cost and in Time Cost of Cargo - PROJECT 4 (JFI-1 Berth)

Year	Cargo Vol. (ton)	No. of Vessel	Without Cargo Volume (ton)	Without No. of Vessel	With Cargo Volume (ton)	With No. of Vessel	Benefit Vessel Waiting Time (000JDs)	Benefit Cargo Waiting Time (000JDs)
2000	81,000	405	81,000	405	81,000	405	302	2
2005	96,000	384	96,000	384	96,000	384	404	3
2010	110,000	367	110,000	367	110,000	367	547	5
2015	120,000	400	120,000	400	120,000	400	850	8
2020	130,000	433	130,000	433	130,000	433	1,397	14
2025	140,000	467	140,000	467	140,000	467	2,718	27
2029	148,000	493	146,000	487	148,000	493	4,139	41

Table 5.11.6 Economic Internal Rate of Return - Project 1 (Grain Berth)

YEAR	COST CONSTRUCTION & RENEWAL (JD)	COST MAINTENANCE (JD)	COST TOTAL (JD)	BENEFIT VESSEL WT (JD)	BENEFIT CARGO WT (JD)	BENEFIT TOTAL (JD)	BALANCE (JD)	PRESENT VALUE COST (JD)	PRESENT VALUE BENEFIT (JD)	NET PRESENT VALUE (JD)
1996	12.000		12.000			0	-12.000	12.000	0	-12.000
1997	46.000		46.000			0	-46.000	36.416	0	-36.416
1998	2.091.000		2.091.000			0	-2.091.000	1.310.487	0	-1.310.487
1999	35.000		35.000			0	-35.000	17.365	0	-17.365
2000		55.280	55.280	411.061	44.257	455.318	400.038	21.713	178.843	157.130
2001		55.280	55.280	448.884	48.828	497.712	442.432	17.190	154.766	137.576
2002		55.280	55.280	509.666	54.904	564.571	509.291	13.608	138.981	125.372
2003		55.280	55.280	599.924	65.258	665.182	609.902	10.773	129.633	118.860
2004		55.280	55.280	725.566	78.201	803.767	748.487	8.529	124.007	115.478
2005		55.280	55.280	754.171	82.036	836.207	780.927	6.752	102.133	95.382
2006		55.280	55.280	921.022	99.315	1.020.336	965.056	5.345	98.659	93.314
2007		55.280	55.280	1.059.214	115.218	1.174.431	1.119.151	4.232	89.900	85.669
2008		55.280	55.280	1.262.105	136.150	1.398.255	1.342.975	3.350	84.734	81.384
2009		55.280	55.280	1.493.862	162.498	1.656.359	1.601.079	2.652	79.463	76.811
2010		55.280	55.280	1.611.871	173.950	1.785.820	1.730.540	2.100	67.825	65.725
2011		55.280	55.280	1.940.616	211.094	2.151.710	2.096.430	1.662	64.696	63.033
2012		55.280	55.280	1.832.388	197.819	2.030.207	1.974.927	1.316	48.325	47.009
2013		55.280	55.280	1.634.913	177.841	1.812.753	1.757.473	1.042	34.159	33.118
2014	1.230.000	55.280	1.285.280	1.491.520	161.073	1.652.593	367.313	19.174	24.653	5.480
2015		55.280	55.280	1.372.658	149.313	1.521.972	1.466.692	653	17.974	17.322
2016		55.280	55.280	1.253.296	136.330	1.389.626	1.334.346	517	12.992	12.475
2017		55.280	55.280	1.253.296	136.330	1.389.626	1.334.346	409	10.285	9.876
2018		55.280	55.280	1.253.296	136.330	1.389.626	1.334.346	324	8.143	7.819
2019		55.280	55.280	1.253.296	136.330	1.389.626	1.334.346	256	6.446	6.190
2020		55.280	55.280	1.253.296	136.330	1.389.626	1.334.346	203	5.103	4.900
2021		55.280	55.280	1.253.296	136.330	1.389.626	1.334.346	161	4.040	3.879
2022		55.280	55.280	1.253.296	136.330	1.389.626	1.334.346	127	3.198	3.071
2023		55.280	55.280	1.253.296	136.330	1.389.626	1.334.346	101	2.532	2.431
2024		55.280	55.280	1.253.296	136.330	1.389.626	1.334.346	80	2.004	1.925
2025		55.280	55.280	1.253.296	136.330	1.389.626	1.334.346	63	1.587	1.524
2026		55.280	55.280	1.253.296	136.330	1.389.626	1.334.346	50	1.256	1.206
2027		55.280	55.280	1.253.296	136.330	1.389.626	1.334.346	40	995	955
2028		55.280	55.280	1.253.296	136.330	1.389.626	1.334.346	31	787	756
2029		55.280	55.280	1.253.296	136.330	1.389.626	1.334.346	25	623	599
TOTAL	3.414.000	1.658.400	5.072.400	35.615.586	3.866.369	39.481.956	34.409.556	1.498.745	1.498.745	-0

EIRR = 0.26

Table 5.11.7 Economic Internal Rate of Return - Project 2 (Container Berth)

YEAR	COST CONSTRUCTION & RENEWAL (JD)	COST MAINTENANCE (JD)	COST TOTAL (JD)	BENEFIT VESSEL WAITING (JD)	BENEFIT TIME COST OF CARGO (JD)	BENEFIT TOTAL (JD)	BALANCE (JD)	PRESENT VALUE COST (JD)	PRESENT VALUE BENEFIT (JD)	NET PRESENT VALUE (JD)
1996	117,000		117,000				-117,000	117,000		-117,000
1997	5,169,000		5,169,000				-5,169,000	4,341,182		-4,341,182
1998	10,577,000	179,040	10,756,040	1,416,714	84,770	1,501,484	-9,254,556	7,586,743	1,059,068	-6,527,676
1999	6,446,000	422,050	6,868,050	2,043,010	126,611	2,169,621	-4,698,429	4,068,534	1,285,252	-2,783,282
2000		556,390	556,390	3,828,003	245,412	4,073,415	3,517,025	276,812	2,026,584	1,749,772
2001		556,390	556,390	6,214,638	411,699	6,626,337	6,069,947	232,481	2,768,732	2,536,252
2002		556,390	556,390	5,882,331	402,255	6,284,586	5,728,196	195,249	2,205,391	2,010,142
2003		556,390	556,390	5,468,194	385,620	5,853,814	5,297,424	163,980	1,725,240	1,561,260
2004		556,390	556,390	5,121,098	372,086	5,493,185	4,936,795	137,713	1,359,678	1,221,960
2005		556,390	556,390	4,770,835	356,832	5,127,667	4,571,277	115,663	1,065,941	950,279
2006		556,390	556,390	4,655,531	358,157	5,013,688	4,457,298	97,139	875,331	778,192
2007		556,390	556,390	4,546,522	359,487	4,906,009	4,349,619	81,582	719,358	637,775
2008		556,390	556,390	4,443,312	360,821	4,804,133	4,247,743	68,517	591,606	523,090
2009		556,390	556,390	4,345,453	362,161	4,707,614	4,151,224	57,544	486,878	429,334
2010		556,390	556,390	4,252,546	363,505	4,616,051	4,059,661	48,328	400,951	352,623
2011		556,390	556,390	4,148,825	363,505	4,512,330	3,955,940	40,588	329,172	288,584
2012		556,390	556,390	4,050,044	363,505	4,413,549	3,857,159	34,088	270,403	236,315
2013		556,390	556,390	3,955,856	363,505	4,319,362	3,762,972	28,629	222,252	193,623
2014	12,740,000	556,390	13,296,390	3,865,951	363,505	4,229,456	-9,066,934	574,593	182,773	-391,821
2015		556,390	556,390	3,780,041	363,505	4,143,546	3,587,156	20,193	150,384	130,190
2016		556,390	556,390	3,697,866	363,505	4,061,371	3,504,981	16,959	123,795	106,835
2017		556,390	556,390	3,619,188	363,505	3,982,693	3,426,303	14,243	101,955	87,712
2018		556,390	556,390	3,543,788	363,505	3,907,293	3,350,903	11,962	84,006	72,043
2019		556,390	556,390	3,471,466	363,505	3,834,971	3,278,581	10,046	69,246	59,200
2020		556,390	556,390	3,402,037	363,505	3,765,542	3,209,152	8,438	57,104	48,666
2021		556,390	556,390	3,335,330	363,505	3,698,835	3,142,445	7,086	47,109	40,023
2022		556,390	556,390	3,271,189	363,505	3,634,694	3,078,304	5,951	38,878	32,927
2023		556,390	556,390	3,209,468	363,505	3,572,974	3,016,584	4,998	32,097	27,099
2024		556,390	556,390	3,150,034	363,505	3,513,539	2,957,149	4,198	26,509	22,311
2025		556,390	556,390	3,092,761	363,505	3,456,266	2,899,876	3,526	21,900	18,375
2026		556,390	556,390	3,037,533	363,505	3,401,038	2,844,648	2,961	18,099	15,138
2027		556,390	556,390	2,984,243	363,505	3,347,748	2,791,358	2,487	14,962	12,476
2028		556,390	556,390	2,932,790	363,505	3,296,295	2,739,905	2,088	12,373	10,285
2029		556,390	556,390	2,883,082	363,505	3,246,587	2,690,197	1,754	10,235	8,481
TOTAL	35,049,000	17,292,790	52,341,790	122,419,678	11,096,016	133,515,694	81,173,904	18,383,262	18,383,262	-0

EIRR= 0.19

Table 5.11.8 Economic Internal Rate of Return - Project 3 (JFI-North Berth)

YEAR	COST CONSTRUCTION & RENEWAL (JD)	COST MAINTENANCE (JD)	COST TOTAL (JD)	BENEFIT VESSEL WAITING (JD)	BENEFIT TIME COST OF CARGO (JD)	BENEFIT TOTAL (JD)	BALANCE (JD)	PRESENT TOTAL COST (JD)	PRESENT TOTAL BENEFIT (JD)	NET PRESENT (JD)
1996	69,000		69,000				-69,000	69,000		-69,000
1997	5,467,000		5,467,000				-5,467,000	4,377,357		-4,377,357
1998	6,047,000		6,047,000				-6,047,000	3,876,732		-3,876,732
1999	208,000	239,000	447,000	1,716,966	147,369	1,864,335	1,417,335	229,454	957,002	727,547
2000		239,000	239,000	3,329,830	285,803	3,615,633	3,376,633	98,231	1,486,059	1,387,828
2001		239,000	239,000	3,764,446	323,106	4,087,552	3,848,552	78,653	1,345,172	1,266,520
2002		239,000	239,000	3,758,782	322,620	4,081,402	3,842,402	62,976	1,075,442	1,012,466
2003		239,000	239,000	3,765,245	323,175	4,088,419	3,849,419	50,424	862,573	812,149
2004		239,000	239,000	3,766,222	323,259	4,089,481	3,850,481	40,374	690,831	650,457
2005		239,000	239,000	3,730,352	320,180	4,050,532	3,811,532	32,327	547,871	515,544
2006		239,000	239,000	3,709,551	318,395	4,027,946	3,788,946	25,884	436,227	410,344
2007		239,000	239,000	3,636,940	312,162	3,949,102	3,710,102	20,725	342,445	321,720
2008		239,000	239,000	3,661,252	314,249	3,975,501	3,736,501	16,594	276,024	259,430
2009		239,000	239,000	3,685,638	316,342	4,001,980	3,762,980	13,287	222,481	209,194
2010		239,000	239,000	3,710,098	318,441	4,028,540	3,789,540	10,638	179,320	168,682
2011		239,000	239,000	3,710,098	318,441	4,028,540	3,789,540	8,518	143,579	135,061
2012		239,000	239,000	3,710,098	318,441	4,028,540	3,789,540	6,820	114,962	108,142
2013		239,000	239,000	3,710,098	318,441	4,028,540	3,789,540	5,461	92,049	86,588
2014	4,728,000	239,000	4,967,000	3,710,098	318,441	4,028,540	-938,460	90,871	73,702	-17,169
2015		239,000	239,000	3,710,098	318,441	4,028,540	3,789,540	3,501	59,012	55,511
2016		239,000	239,000	3,710,098	318,441	4,028,540	3,789,540	2,803	47,250	44,447
2017		239,000	239,000	3,710,098	318,441	4,028,540	3,789,540	2,244	37,833	35,588
2018		239,000	239,000	3,710,098	318,441	4,028,540	3,789,540	1,797	30,292	28,495
2019		239,000	239,000	3,710,098	318,441	4,028,540	3,789,540	1,439	24,255	22,816
2020		239,000	239,000	3,710,098	318,441	4,028,540	3,789,540	1,152	19,420	18,268
2021		239,000	239,000	3,710,098	318,441	4,028,540	3,789,540	923	15,550	14,627
2022		239,000	239,000	3,710,098	318,441	4,028,540	3,789,540	739	12,450	11,712
2023		239,000	239,000	3,710,098	318,441	4,028,540	3,789,540	591	9,969	9,377
2024		239,000	239,000	3,710,098	318,441	4,028,540	3,789,540	474	7,982	7,508
2025		239,000	239,000	3,710,098	318,441	4,028,540	3,789,540	379	6,391	6,012
2026		239,000	239,000	3,710,098	318,441	4,028,540	3,789,540	304	5,117	4,814
2027		239,000	239,000	3,710,098	318,441	4,028,540	3,789,540	243	4,097	3,854
2028		239,000	239,000	3,710,098	318,441	4,028,540	3,789,540	195	3,281	3,086
2029		239,000	239,000	3,710,098	318,441	4,028,540	3,789,540	156	2,627	2,471
TOTAL	16,519,000	7,409,000	23,928,000	112,727,186	9,675,489	122,402,675	98,474,675	9,131,267	9,131,267	-0

EIRR= 0.25

Table 5.11.9 Economic Internal Rate of Return - Project 4 (JFI-1 Berth)

YEAR	COST CONSTRUCTION & RENEWAL (JD)	COST MAINTENANCE (JD)	COST TOTAL (JD)	BENEFIT VESSEL WAITING (JD)	BENEFIT TIME COST OF CARGO (JD)	BENEFIT LAND TRANSPO. (JD)	BENEFIT TOTAL (JD)	BALANCE (JD)	PRESENT VALUE COST (JD)	PRESENT VALUE BENEFIT (JD)	NET PRESENT VALUE (JD)
1996	46.000		46.000					-46.000	46.000		-46.000
1997	183.000		183.000				0	-183.000	165.558		-165.558
1998	3.182.000		3.182.000			0	0	-3.182.000	2.604.355		-2.604.355
1999	2.801.000		2.801.000			0	0	-2.801.000	2.074.020		-2.074.020
2000		48.850	48.850	302.279	1.988	115.200	419.467	370.617	32.724	280.995	248.271
2001		48.850	48.850	308.943	2.134	115.200	426.277	377.427	29.605	258.340	228.735
2002		48.850	48.850	327.042	2.366	115.200	444.608	395.758	26.783	243.768	216.985
2003		48.850	48.850	333.779	2.525	115.200	451.504	402.654	24.231	223.956	199.725
2004		48.850	48.850	386.312	3.049	115.200	504.561	455.711	21.921	226.419	204.498
2005		48.850	48.850	403.806	3.320	115.200	522.327	473.477	19.832	212.052	192.220
2006		48.850	48.850	416.395	3.561	115.200	535.156	486.306	17.942	196.553	178.611
2007		48.850	48.850	435.026	3.863	115.200	554.089	505.239	16.232	184.111	167.879
2008		48.850	48.850	488.305	4.497	115.200	608.001	559.151	14.685	182.770	168.085
2009		48.850	48.850	513.725	4.900	115.200	633.825	584.975	13.285	172.373	159.088
2010		48.850	48.850	546.848	5.396	115.200	667.444	618.594	12.019	164.215	152.197
2011		48.850	48.850	584.406	5.766	115.200	705.372	656.522	10.873	157.007	146.133
2012		48.850	48.850	629.028	6.207	115.200	750.435	701.585	9.837	151.117	141.280
2013		48.850	48.850	682.323	6.732	115.200	804.255	755.405	8.899	146.519	137.619
2014		48.850	48.850	798.672	7.880	115.200	921.752	872.902	8.051	151.919	143.868
2015		48.850	48.850	849.527	8.382	115.200	973.109	924.259	7.284	145.098	137.814
2016		48.850	48.850	915.989	9.038	115.200	1.040.227	991.377	6.590	140.323	133.733
2017		48.850	48.850	982.789	9.697	115.200	1.107.686	1.058.836	5.962	135.181	129.219
2018		48.850	48.850	1.104.998	10.903	115.200	1.231.101	1.182.251	5.393	135.923	130.530
2019		48.850	48.850	1.266.124	12.493	115.200	1.393.817	1.344.967	4.879	139.221	134.342
2020		48.850	48.850	1.397.085	13.785	115.200	1.526.070	1.477.220	4.414	137.903	133.489
2021		48.850	48.850	1.545.542	15.250	115.200	1.675.991	1.627.141	3.994	137.016	133.022
2022		48.850	48.850	1.983.300	19.569	115.200	2.118.069	2.069.219	3.613	156.653	153.040
2023		48.850	48.850	2.232.227	22.025	115.200	2.369.452	2.320.602	3.269	158.543	155.274
2024		48.850	48.850	2.456.644	24.240	115.200	2.596.083	2.547.233	2.957	157.151	154.194
2025		48.850	48.850	2.718.023	26.819	115.200	2.860.042	2.811.192	2.675	156.629	153.953
2026		48.850	48.850	3.049.571	30.090	115.200	3.194.861	3.146.011	2.420	158.289	155.869
2027		48.850	48.850	3.740.903	36.911	115.200	3.893.014	3.844.164	2.190	174.496	172.306
2028		48.850	48.850	4.138.904	40.838	115.200	4.294.942	4.246.092	1.981	174.163	172.182
2029		48.850	48.850	4.138.904	40.838	115.200	4.294.942	4.246.092	1.792	157.564	155.772
TOTAL	6.212.000	1.465.500	7.677.500	39.677.418	385.064	3.456.000	43.518.482	35.840.982	5.216.265	5.216.265	-0

EIRR = 0.11

Table 5.11.10 Economic Internal Rate of Return - Short Term Improvement Plan (Total)

YEAR	COST TOTAL (JD)	BENEFIT TOTAL (JD)	BALANCE (JD)	PRESENT VALUE COST (JD)	PRESENT VALUE BENEFIT (JD)	NET PRESENT VALUE (JD)
1996	244,000		-244,000	244,000		-244,000
1997	10,865,000		-10,865,000	9,042,106		-9,042,106
1998	22,076,040	1,501,484	-20,574,556	15,289,769	1,039,921	-14,249,848
1999	10,151,050	4,033,956	-6,117,094	5,851,007	2,325,149	-3,525,858
2000	899,520	8,563,833	7,664,313	431,490	4,107,974	3,676,484
2001	899,520	11,637,878	10,738,358	359,096	4,645,935	4,286,840
2002	899,520	11,375,166	10,475,646	298,348	3,779,175	3,480,327
2003	899,520	11,058,920	10,159,400	248,708	3,057,679	2,808,971
2004	899,520	10,890,995	9,991,475	206,981	2,506,032	2,299,051
2005	899,520	10,536,733	9,637,213	172,254	2,017,738	1,845,484
2006	899,520	10,597,126	9,697,606	143,354	1,688,834	1,545,480
2007	899,520	10,583,632	9,684,112	119,302	1,403,697	1,284,394
2008	899,520	10,785,891	9,886,371	99,286	1,190,514	1,091,228
2009	899,520	10,999,779	10,100,259	82,628	1,010,421	927,793
2010	899,520	11,097,854	10,198,334	68,765	848,393	779,628
2011	899,520	11,397,952	10,498,432	57,228	725,145	667,917
2012	899,520	11,222,730	10,323,210	47,627	594,205	546,579
2013	899,520	10,964,909	10,065,389	39,636	483,151	443,515
2014	19,597,520	10,832,341	-8,765,179	718,652	397,228	-321,424
2015	899,520	10,667,166	9,767,646	27,452	325,542	298,090
2016	899,520	10,519,763	9,620,243	22,846	267,180	244,334
2017	899,520	10,508,545	9,609,025	19,013	222,116	203,103
2018	899,520	10,556,560	9,657,040	15,823	185,695	169,872
2019	899,520	10,646,954	9,747,434	13,168	155,863	142,695
2020	899,520	10,709,778	9,810,258	10,959	130,478	119,519
2021	899,520	10,792,992	9,893,472	9,120	109,431	100,310
2022	899,520	11,170,923	10,271,408	7,590	94,260	86,670
2023	899,520	11,360,591	10,461,071	6,317	79,777	73,460
2024	899,520	11,527,788	10,628,268	5,257	67,369	62,112
2025	899,520	11,734,473	10,834,953	4,375	57,072	52,697
2026	899,520	12,014,064	11,114,544	3,641	48,628	44,987
2027	899,520	12,658,928	11,759,408	3,030	42,642	39,612
2028	899,520	13,009,403	12,109,883	2,522	36,470	33,948
2029	899,520	12,959,695	12,060,175	2,099	30,235	28,136
TOTAL	89,019,690	338,918,806	249,899,116	33,673,948	33,673,948	-0

EIRR= 0.20

5.11.7 Evaluation

(1) Calculation of EIRR

The economic profitability of the project is evaluated in terms of the economic internal rate of return (EIRR). EIRR is a discount ratio satisfying the following equation:

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

Where, Bi : Benefit at i-th year
Ci : Cost at i-th year
r : Rate of discount
n : Period of economic calculation

(2) Sensitivity Analysis

To see if the project is still feasible when some factors vary, alternate cases are examined as follows.

Case-A : The costs increase by 10%
Case-B : The benefits decrease by 10%
Case-C : The costs increase by 10% and the benefits decrease by 10%

The results of the sensitivity analysis are shown in Table 5.11.11 (Refer to Tables 5.11.6, 5.11.7, 5.11.8, 5.11.9 and 5.11.10).

Table 5.11.11 Sensitivity Analysis for EIRR

Case	PROJECT-1 (Grain)	PROJECT-2 (Container)	PROJECT-3 (JFI North)	PROJECT-4 (JFI-1)	Total
Base	26 %	19 %	25 %	11 %	20 %
Case-A	25 %	17 %	23 %	10 %	18 %
Case-B	25 %	17 %	23 %	10 %	18 %
Case-C	23 %	14 %	21 %	9 %	16 %

5.11.8 Economic Feasibility

The leading view is that a project is feasible if EIRR exceeds the opportunity cost of capital. The opportunity cost of capital in many developing countries is 10%.

Proposed projects are evaluated as follows:

a) Although contribution to GDP or GRDP is difficult to quantitatively determine, and thus not treated here, it is thought to be high for Project-1, -2, -3.

b) Project-4 indicates lowest EIRR and nearly equals opportunity cost of capital. This plan would entail a lesser scale plan or more cargo would be necessary.

5.12 Financial Analysis

5.12.1 Purpose and Methodology of the Financial Analysis

(1) Purpose of the Financial Analysis

The purpose of the financial analysis is to appraise the financial feasibility of the port facility development plan. The analysis focuses on the viability of the project itself and the influence on the soundness of the port management body during the project life.

The project in this study is defined as construction in the Short-Term Improvement Plan.

(2) Methodology of the Financial Analysis

1) Viability of the project

The viability of the project is analyzed using the Discount Cash Flow Method and appraised by the FIRR (Financial Internal Rate of Return). The revenues and expenditures in this analysis are defined as the difference between the "With" the project and the "Without" the project case in order to analyze the viability of the project of the Short-Term Improvement Plan itself.

The FIRR is a discount rate that makes the costs and revenues during the project life equal, and it is calculated using the following formula;

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

n : Project life
Bi : Revenue in the i-th year
Ci : Cost in the i-th year
r : Discount rate

Revenues and costs which are taken into account for the calculation of the FIRR are summarized as follows;

Revenues : a) Port operating revenues
b) Residual value of the fixed assets at the end of the project life
Costs : a) Investments for the project (Initial investments for the projects and its re-investment)
b) Operating expense such as maintenance, repair, personnel and other costs

The following revenues and costs are exempted from calculation of the FIRR.

Revenues : Fund management income
Costs : Depreciation cost
Repayment of the principal loan
Interest on loan

When the calculated FIRR exceeds the weighted average interest rate of the total funds for the investment, the project is regarded as financially feasible.

2) Financial soundness of the port management body

The influence on the financial soundness of the port management body is appraised based on projected financial statements (Profit and Loss Statement, Cash Flow Statement and Balance Sheet) using the revenues and expenditures in With Case. The appraisal is made from the viewpoints of profitability, loan repayment capacity and operational efficiency, using the following ratios;

a) Profitability

Rate of Return on Net Fixed Assets:

$$\frac{\text{Net Operating Income}}{\text{Total Fixed Assets}} \times 100(\%)$$

This indicator shows the profitability of the investments, which are presented as net total fixed assets. It is necessary to keep the rate above the average interest rate of the funds for investment.

b) Loan repayment capacity

Debt Service Coverage Ratio:

$$\frac{\text{Net Operating Income before Depreciation}}{\text{Repayment of and interest on Long-term loans}}$$

This indicator shows whether the operating income can cover the repayment and the interest on long-term loans. The ratio must be higher than 1.0.

c) Operational efficiency

Operating Ratio:

$$\frac{\text{Operating Expenses}}{\text{Operating Revenues}} \times 100(\%)$$

Working Ratio:

$$\frac{\text{Operating Expenses - Depreciation Expense}}{\text{Operating Revenues}} \times 100(\%)$$

The operating ratio shows the operational efficiency of the organization as an enterprise, and the working ratio shows the efficiency of the routine operations of the port. When the calculated operating ratios are less than 70-75%, and the working ratios are less than 50-60%, the operations of port are considered to be efficient.

5.12.2 Prerequisites of the Financial Analysis

(1) Cargo Handling Capacity in With Case and Without Case

Compared with Without Case, the following facilities are improved in cargo handling productivity in the Short-Term Improvement Plan (With Case).

a) Grain Berth
Improvement of cargo handling efficiency due to the expansion of berth length and depth

b) Container Berth
Increase in cargo handling capacity due to the establishment of additional gantry crane and improvement of cargo handling efficiency due to the reformation of the container yard and cargo handling system

c) JFI-East, West
Increase in cargo handling capacity due to the establishment of additional cargo handling equipment

d) JFI-1
Improvement of cargo handling efficiency due to the expansion of berth length and depth

When cargo handling volume in each berth will reach maximum handling capacity of berth (berth occupancy rate : 70%) or capacity of cargo handling equipment, its volume is defined as the maximum cargo handling volume.

The maximum cargo handling volume and its year in each berth is shown in Appendix 5.12.1 (With Case) and 5.12.2 (without Case).

(2) Project Life

Taking account of the conditions of the long-term loans and the service lives of the port facilities, the project life for the financial analysis is determined to be 34 years, including 4 years of detailed design and construction of port facilities.

(3) Base Year

For the estimation, costs, expenditures and revenues analyzed quantitatively here, 1994 prices are predominantly used. Neither price inflation nor increases in nominal wages are considered during the project life.

(4) Fund Raising

Seventy-five percent of initial investment costs is assumed to be raised by foreign fund. The remain initial investment costs (25%) and all of renewal investment costs are assumed to be raised by the internal resources of port management body (PC).

The following conditions apply to the above foreign fund.

[Foreign Fund]
Loan period : 30 years
Grace period : 10 years
Interest rate : 2.7 %

(Note) These conditions are quoted from those of the OECF in 1995 (Japan)

5.12.3 Revenue and Expenditure

(1) Revenue

The revenues from the port activities are calculated by the present port charges and the cargo handling volume or the number of calling vessels which are estimated based on the demand forecast.

The revenues per year during the project life are shown in Appendix 5.12.3 (With Case) and 5.12.4 (Without Case). The viability of the project (FIRR) is analyzed using the difference of revenues between both cases (See Appendix 5.12.5). These are the revenues which are gained by the implementation of the project. The influence on the financial soundness of the port management body is analyzed using revenues of With Case.

Relationship between port charges and cargoes which are charged based on the port tariff is shown in Appendix 5.12.6

(2) Expenditure

1) Initial investment costs

The initial investment costs of the project are estimated in Section 5.9.
These are summarized in Appendix 5.12.7.

2) Renewal investment costs

The facilities and equipment will be renewed based on their service lives which are as follows;

Berth	: 50 years
Yard and Road	: 50 years
Building	: 50 years
Gantry Crane	: 14 years
Transfer Crane	: 14 years
Loader and Unloader	: 14 years
Other Cargo Handling Equipment	: 8 years
Utilities	: 8 years

The funds for renewal investment costs will be financed by internal resources of PC.

Two expenditures mentioned above are equal to the difference of expenditures between the With Case and Without Case(=0). Therefore, the viability of the project and the influence on the financial soundness is analyzed using these expenditures.

3) Operating expense

a) Personnel cost

PC has a sufficient number of employees to manage and operate the future cargo handling volume and port facilities. It is rather necessary to decrease number of employees with the advance of Jordan's economy. However PC can not actively decrease the number of employees because PC has a responsibility to minimize unemployment as a government organization. Therefore the annual personnel costs are set to the amount in 1994 (13 million JD).

b) Administration Cost

Generally administration cost is required to be 60 % of personnel costs. Therefore present administration cost (3 million JD) should be raised to 60 % of present personnel costs except casual labor's wage (9.8 million JD x 0.6 = 6 million JD) until 2000. Personnel cost in 1994 is shown in Appendix 5.12.8.

The rise in above administration cost should be appropriated for employee training or improving communication within the organization.

Two expenditures mentioned above are the same situation in the With Case and Without Case. Therefore, the difference of expenditures between the With Case and Without Case is zero. In the analysis of the viability of the project these expenditures are zero and the influence on the financial soundness is analyzed using these expenditures.

c) Maintenance and repair cost

The annual maintenance and repair costs for port facilities are calculated as follows;

Infrastructure : 1% of the original construction cost
Cargo handling equipment : 4% of the original procurement cost

In the With Case maintenance and repair cost is calculated on the existing facilities which belong to PC and the facilities which are planned in the Short-Term Improvement Plan. In the Without Case maintenance and repair cost is calculated on the existing facilities only.

Therefore the viability of the project is analyzed using the maintenance and repair cost for the planning facilities which means the difference between the With Case and Without Case. The viability of the project is analyzed using the maintenance and repair cost in the With Case (existing and planned facilities).

Maintenance and repair cost for existing facilities is calculated based on the investment costs of PC until 1994 (See Appendix 5.12.9).

4) Depreciation cost

The annual depreciation costs of port facilities and equipment are calculated by the straight line method based on their service lives. Residual values after all depreciations are estimated as zero. At the end of the project life, fixed assets are assumed to be sold at their

residual values.

Depreciation cost is exempted from calculation of the analysis of the viability of the project. In the analysis of the influence on the financial soundness depreciation cost is calculated on the existing and planned facilities, the same as for the maintenance and repair cost.

5.12.4 Sensitivity Analysis

Sensitivity Analysis is conducted to examine the impact of unexpected future changes. The following three cases are envisioned;

Case A : The revenue decreases by 10%
Case B : The project cost increases by 10%
Case C : The revenue decreases by 10% and the project cost increases by 10%

Unexpected future changes could be as follows;

1) Decrease of the revenue
   Decrease of the estimated cargo volume
   Decrease of the tariff level

2) Increase of the project cost
   Increase of the facilities construction cost by soil condition
   Sudden rise in building materials prices

5.12.5 Appraisal of Project

The calculation of the FIRR is examined to clarify the viability of the project.

(1) Results of the FIRR calculation

The results of the FIRR calculation are shown in Table 5.12.1 and the FIRR calculation and its details are shown in Appendix 5.12.10.

Weighted average interest rate of the funds, which is the floor limit, is 2.025 % in this study. Including above three cases of sensitivity analysis, FIRR exceeds this rate, even in Case C of the sensitivity analysis, therefore this project can be judged to be financially feasible. (See Table 5.12.1)

Table 5.12.1 Results of the FIRR Calculation

Original Case	8.0 %	
Sensitivity Analysis A	6.6 %	Revenue decreases by 10%
Sensitivity Analysis B	6.8 %	Project cost increases by 10%
Sensitivity Analysis C	5.4 %	Revenue decreases by 10%, Project cost increases by 10%

(2) Financial soundness of the port management body

The projected financial statement for the short-term projects and financial indicators, working ratio, operating ratio, rate of return on net fixed assets and debt service coverage ratio are shown in Appendix 5.12.11.

a) Profitability

The rate of return on net fixed assets maintains higher rate than the average interest rate of the funds for the investments during the project life.

b) Loan repayment capacity

The debt service coverage ratios keep over 1 during the project life.

c) Operational efficiency

The operating ratios keeps below 70% after and the working ratios keeps below 60% during the project life.

d) Appraisal

Based on the above indicators, it can be judged that financial soundness of the port management body can be easily secured.

Chapter 6 Environmental Impact Assessment

6.1 Environmental Policy in Jordan

6.1.1 Administration

The Government of Jordan has strengthened its environmental administration system steadily. In 1980 the Government of Jordan established the Department of Environment (DOE) within the Ministry of Municipal and Rural Affairs and the Environment (MMRAE) to deal directly with the environmental protection issues in cooperation and coordination with other concerned agencies. In 1991 MMRAE formulated a National Environment Strategy (NES) with the objective to ensure that future generations are not burdened with the environmental debt of today's actions. The main issues related to the environment are thus handled by MMRAE including legislative aspects of environmental protection in the country.

According to the Environmental Protection Law enacted recently, an official public corporation, Public Corporation for Environment Protection, will be formed. All personnel, employees and workers of DOE will be transferred to the Corporation as soon as this law comes into force. This corporation will be regarded as the body in charge of environmental protection in Jordan.

6.1.2 Laws and Regulations related to the Environment

The current legislation relating to environmental protection is summarized in the Table 6.1.1

Table 6.1.1 Legal Framework for Management of Natural Systems

	Laws
Water	1. Military Ordinance No.6/1980 2. Water authority Law No.18/1988 3. Regulation No.202 wastewater limits 4. Regulation No.286 (Drinking water quality standards.)
Air quality	There are no legal requirements for the control of air pollution emissions and for ambient air quality standard. Air quality related laws are: 1. Public Health Law No.21/1976 2. Traffic Law No.14/1984
Soil	1. No law regulating waste disposal 2. Agriculture Law No.20/1973
Coastal zone	1. Aqaba Region Authority Law No.7/1987 2. Aqaba Port Services Fee Law No.44/1976;3. Shipping Law; 3. Agriculture Law No.20/1973; 4. Water Authority Law No.18/1988;6. Regulation No.202

Source: DOE, PRIDE project (USAID)

Since 1992, a draft of the Jordan Environmental Act had been proposed. Most recently, "The Environment Protection Law for 1995" was enacted. As the Corporation will enact a special ordinance laying down the proper basis and the necessary measures for evaluating the environmental impact of the projects with the aim of ensuring their adherence to the requirements of the environment and sustainable development, the regulations relative to this Law will be made hereafter.

6.2 Enviromental Consideration

6.2.1 Basic concept of EIA

The purpose of using the environmental impact assessment (EIA) is to incorporate into development a planning tool which identifies a plan for environmental protection and enhancement on a project-by-project basis.

The EIA procedure may be divided into two complementary tasks: the initial environmental examination (IEE) and the environmental impact assessment (EIA). In most countries, the port development project is required to prepare EIA reports because of its significant environmental impacts.

The IEE was basically designed as a means of reviewing the environmental integrity of projects to determine whether EIA-level studies must be performed. In this sense the IEE is used for project screening to determine which projects require a full-scale EIA. The IEE has several other uses for ensuring project-oriented environmental management as well as to minimize effort, expense, and delay in carrying out such planning. The IEE assesses the potential environmental effects of a proposed project, is done within a very limited budget, and is based on information at hand or readily available. If the IEE results indicate that a full-scale EIA is not required, then any necessary environmental protection measures or a monitoring programme would be prescribed, thus completing the EIA for this project.

In the event that a full-scale EIA is required, the IEE is of great value as a mechanism to determine and identify key issues that merit full analysis in the EIA and designate those that deserve only cursory discussion. It also identifies other environmental review and consultation requirements so that other required analysis or studies can be prepared concurrently with the EIA. This would reduce delay and eliminate redundant or extraneous discussion from EIA reports. The IEE is a means of providing the most efficient and feasible preparation of adequate environmental management plans with or without the requirement of a full-scale EIA. Therefore, for development projects the IEE will be desirable, simply from the economic and project delay standpoint.

The introduction of Environmental Impact Assessment (EIA) as a prerequisite to all major development projects has not been achieved by the Jordanian government. This activity is currently implemented through MMRAE by licensing the location of the project.

Considering the significant aspect of the environment in the Gulf of Aqaba, this study should conduct IEE, though Jordanian institution may not require it. Here the Study Team would require full-scale EIA about environmental impact examined at IEE stage.

6.2.2 Procedure of EIA on Port of Aqaba Development Project

To protect the environment of Aqaba and its adjacent sea area, there is The Gulf of Aqaba Environmental Action Plan (GAEAP). Though the GAEAP was not opened to the general public, it seems that the plan represented for the Government of Jordan a first step towards achieving the national environmental objectives which had been outlined in the 1991 "National Environmental Strategy". The GAEAP is also said to set the pace for regional protection of the Gulf of Aqaba. While some of the actions proposed are curative, the focus of the plan is on preventive measures to protect the Gulf's land and water interface. In harmony with the concept of this GAEAP, it was believed that introduction of IEE in an earlier stage of the port planning would be desirable to avert irreversible damage to the environment of the Gulf of Aqaba and ensure conservation of natural resources within a framework in which economic development could take place.

In order to carry out the IEE in this study, as cited in the Interim report, the JICA Study Team used a checklist, which is shown in "Environmental Assessment Handbook for Port Development Projects" (1993, OCDI). It has been prepared as a comprehensive technical guidebook for EIA to satisfy requirements from any funding countries or international funding agencies. Impact size and present level of the environment are examined for each item and the impact on the environment will be assessed. The obtained result will be ranked in the left column of the checklist according to the size of the impact. Basic information and materials to conduct this task were derived from the results of the study of the JICA Study Team and past examples which can show actual impacts on the environment during construction and operation phase.

6.3 Result of IEE

Potential impacts were assessed one by one and evaluated as shown in Table 6.3.1. Though three alternative Master Plans are prepared in this study, no remarkable difference can be seen among them because the basic idea is almost same except for Iraqi oil export through a pipeline (Jordan Iraq Joint Project) in Case 1. The tabulated results, therefore, can be applied to all alternatives. As for the impacts caused by dredging, stirring of bottom soil and soil dumping into water and operation of construction machines, by cargo loading activities and utilization of storage facilities, small negative impacts were estimated. Other potential impacts were evaluated to have no adverse effect. Reasons for the evaluation will be explained briefly in the following Table 6.3.1.

Table 6.3.1 Environmental Impact Checklist for Port Development

Environmental impact factors	Environmental impact	Size of impact (check appropriate boxes)			
		No	Small	Moderate	Major
I. Impact from construction works					
1.1 Operation of working boats, construction machines	1.1.1 Air pollution	✓			
	1.1.2 Generation of noise/vibration		✓		
	1.1.3 Change in terrestrial ecosystem	✓			
1.2 Dredging, stirring of bottom soil, soil dumping into water	1.2.1 Pollution of water and bottom sediments (SS, hazardous materials)		✓		
	1.2.2 Offensive odor	✓			
	1.2.3 Reduction of aquatic lives		✓		
	1.2.4 Pollution of marine products	✓			
	1.2.5 Devaluation of tourism resources (water color, coral reef)		✓		
1.3 Soil removal	1.3.1 Change in topography, underground water system	✓			
	1.3.2 Extinction of terrestrial ecosystem	✓			
1.4 Generation of surplus soil, wastes, dumping of dredged soil on ground	1.4.1 Pollution of water/bottom sediments	✓			
	1.4.2 Impact on terrestrial ecosystem	✓			
1.5 Employment of laborers	1.5.1 Inflow of alien cultures	✓			
	1.5.2 Change in economic activities	✓			
1.6 Congestion of work vehicles and boats	1.6.1 Economic loss (traffic jam)	✓			
	1.6.2 Devaluation of fishing ground	✓			

Table 6.3.1 Environmental Impact Checklist for Port Development (Continued)

Environmental impact factors	Environmental impact	Size of impact (check appropriate boxes)			
		No	Small	Moderate	Major
2. Impact from port facilities and site					
2.1 Emergence of site (including landfill)	2.1.1 Pollution of water and bottom sediments	✓			
	2.1.2 Beach erosion and accretion	✓			
	2.1.3 Change in coastal currents	✓			
	2.1.4 Decrease of habitats for aquatic lives	✓			
	2.1.5 Decrease of habitats for terrestrial lives	✓			
	2.1.6 Change in scenic beauty	✓			
	2.1.7 Resettlement of local residents and culture	✓			
	2.1.8 Extinction of fishing grounds	✓			
2.2 Emergence of external facilities	2.2.1 Pollution of water and bottom sediments	✓			
	2.2.2 Beach erosion and accretion	✓			
	2.2.3 Change in coastal current	✓			
	2.2.4 Decrease of habitats for aquatic lives	✓			
	2.2.5 Change of scenic beauty	✓			
2.3 Emergence of sea route	2.3.1 Change in coastal current	✓			
	2.3.2 Decrease of habitats for aquatic lives	✓			
2.4 Emergence of anchorage	2.4.1 Change in coastal current	✓			
	2.4.2 Decrease of habitats for aquatic lives	✓			
3. Impact from utilization of facilities in water area and anchorage					
3.1 Impact from boats	3.1.1 Air pollution	✓			
	3.1.2 Water pollution (bilge)	✓			
	3.1.3 Generation of wastes (dredged material included)	✓			
	3.1.4 Obstruction to fisheries activities	✓			

Table 6.3.1 Environmental Impact Checklist for Port Development (Continued)

Environmental impact factors	Environmental Impact	Size of Impact (check appropriate boxes)			
		No	Small	Moderate	Major
4. Impact from cargo loading and utilization of storage facilities					
4.1 Cargo loading activities and utilization of storage facilities	4.1.1 Air pollution (dust)		✓		
	4.1.2 Pollution of water and bottom sediments	✓			
	4.1.3 Generation of noise	✓			
	4.1.4 Generation of offensive odor	✓			
	4.1.5 Change in coastal ecosystem	✓			
	4.1.6 Generation of wastes	✓			
	4.1.7 Employment effect	✓			
5.Impact from operation of facilities handling hazardous materials					
5.1 Operation of oil distribution base and facilities handling hazardous materials	5.1.1 Air pollution	✓			
	5.1.2 Pollution of water and bottom sediments (oil)	✓			
	5.1.3 Generation of offensive odor	✓			
	5.1.4 Change in coastal ecosystem	✓			
	5.1.5 Change in terrestrial ecosystem	✓			
	5.1.6 Decrease in amount of agricultural products, fisheries products and price	✓			
6. Impact from waste treatment and disposal					
6.1 Operation of waste treatment/facilities	6.1.1 Air pollution	✓			
	6.1.2 Pollution of water and bottom sediments	✓			
	6.1.3 Generation of offensive odor	✓			
	6.1.4 Change in coastal ecosystem	✓			
	6.1.5 Change in terrestrial ecosystem	✓			
6.2 Impact from waste disposal facility	6.2.1 Air pollution(dust)	✓			
	6.2.2 Pollution of water and bottom sediments	✓			
	6.2.3 Generation of offensive odor	✓			
	6.2.4 Change in coastal ecosystem	✓			
	6.2.5 Change in terrestrial ecosystem	✓			
	6.2.6 Formation of slums	✓			

Table 6.3.1 Environmental Impact Checklist for Port Development (Continued)

Environmental impact factors	Environmental impact	Size of impact (check appropriate boxes)			
		No	Small	Moderate	Major
7. Impact from traffic function					
7.1 Road traffic	7.1.1 Air pollution	✓			
	7.1.2 Generation of noise/vibration	✓			
	7.1.3 Change in terrestrial ecosystem	✓			
	7.1.4 Change in local population	✓			
	7.1.5 Traffic jam/accidents	✓			
8. Impact from industrial production activities					
8.1 Operation of factories and plans	8.1.1 Air pollution	✓			
	8.1.2 Pollution of water/bottom sediments	✓			
	8.1.3 Generation of noise/vibration	✓			
	8.1.4 Generation of offensive odor	✓			
	8.1.5 Ground subsidence	✓			
	8.1.6 Change in coastal ecosystem	✓			
	8.1.7 Change in terrestrial ecosystem	✓			
	8.1.8 Generation of wastes	✓			
	8.1.9 Change in local population distribution	✓			
	8.1.10 Employment effect	✓			
9. Impact from distribution and storage functions					
9.1 Storage functions (including outdoor storage)	9.1.1 Air pollution (dust)	✓			
	9.1.2 Pollution of water and bottom sediments	✓			
	9.1.3 Generation of offensive odor	✓			
9.2 Cargo handling	9.2.1 Generation of noise	✓			
	9.2.2 Employment effect	✓			

The evaluation of environmental impacts was based on factors which are summarized as follows. Numerals at the head of each line correspond to those in the checklist(Table 6.3.1).

1.1.1 No major construction work is planned.

1.1.2 Minor construction work is planned for construction of JFI-North Berth, which involves small pile driving.

1.1.3 Land use pattern would not be changed.

1.2.1 Dredging would be required to some extent, but not so much.

1.2.2 No source of offensive odor is expected.

1.2.3 Corals are very sensitive to turbidity of water, which may increase due to dredging. Table 6.3.2 indicates that the sedimentation of particles would have a major adverse impact on the coral reef.

Table 6.3.2 Extent of Damage to Coral Reefs of Maldives, Sri Lanka, India and Bangladesh

No.	Cause of damage	Maldives	Sri Lanka	India	Bangladesh
1.	(a) Collection of shells and corals by tourists	?	1-2	0	2
	(b) Collection of shells and corals for commercial purposes:				
	(i) Souvenirs	1-2	1-2	1-2	2
	(ii) Coral mining	1-2	2	2	0
2.	Spearfishing	?	1-2	0	0
3.	Collection of aquarium reef fishes	0	2	0	0-1
4.	Commercial fishing of reef fishes	0	1	1	0
5.	Explosives used for fishing and for public works	0-1	2	1-2	0
6.	Poisons used for fishing	?	?	?	0
7.	Other fishing methods destructive to coral	?	?	?	0
8.	Pesticides and detergents	0	0-1	?	0
9.	Sedimentation from freshwater run-off	0	0-1	1-2	1-2
10.	(a) Domestic sewage and eutrophication	0	0-1	?	0
	(b) Red tides	?	?	?	0
11.	Industrial wastes	0	1-2	0	0
12.	Dredging activities	?	?	0	0
13.	Construction activities on reefs	0	?	?	0
14.	Recreational impacts (scuba, snorkelling, boat and anchor damage)	0-1	1-2	0	0
15.	Acanthaster problems	?	0-2	?	0
	Most damage caused by:	1b	1,3, 5,14	1,5 9	1,9

(Code: 0 = no problem;
1 = minor problem;
2 = major problem;
? = unknown)

Source: MARINE ENVIRONMENTAL PROBLEMS AND ISSUES IN THE ESCAP REGION

1.2.4 Fishing ground is offset from the port area.

1.2.5 Corals are very sensitive to turbidity of water, which may increase due to dredging.

1.3.1 This construction work is expected to require only small scale land excavation.

1.3.2 This construction work will need only a small amount of materials.

1.4.1 The amount of dredged materials is small.

1.4.2 The amount of dredged materials is small.

1.5.1 Construction work may not need so many skilled workers.

1.5.2 No negative impact is expected.

1.6.1 Background traffic is low and the construction work will not require transportation of materials of a large scale.

1.6.2 The construction work will disturb just a small area.

2.1.1 No significant change is expected in land configuration.

2.1.2 Alignment of shoreline would not be disturbed.

2.1.3 Alignment of shoreline would not be disturbed.

2.1.4 No large reclamation of land is planned.

2.1.5 Land use pattern would not be changed.

2.1.6 No significant change is expected in landscape.

2.1.7 Local people will not be requested to resettle.

2.1.8 No large reclamation of land is planned.

2.2.1 No external facilities would be added.

2.2.2 No external facilities would be added.

2.2.3 No external facilities would be added.

2.2.4 No external facilities would be added.

2.2.5 No external facilities would be added.

2.3.1 Configuration of sea bottom will not be changed, because there will be no sea route alternation.

2.3.2 Configuration of sea bottom will not be changed, because there will be no sea

route alternation.

2.4.1 Configuration of sea bottom will not be significantly changed.

2.4.2 Configuration of sea bottom will not be significantly changed.

3.1.1 No remarkable increase of calling vessels would be expected.

3.1.2 No remarkable increase of calling vessels would be expected.

3.1.3 No remarkable increase of calling vessels would be expected.

3.1.4 No remarkable increase of calling vessels would be expected.

4.1.1 Phosphate generates fine particles resulting in diffusion of suspended particulate matter(SPM).

4.1.2 No source can be expected, judging from the structure of loading/unloading facilities and the type of commodities handled.

4.1.3 The residential area is remote from the port.

4.1.4 No source of offensive odor is expected.

4.1.5 Significant change is not anticipated in aspects of the non-biological environment, therefore little change would be expected in biological aspects.

4.1.6 A waste disposal site is located 14 km south of Aqaba and 6 km east of the coast,within a mountainous area.

4.1.7 With increase of cargo volume, more income would be expected. The economic effect, however, may not be significant because new employment would be limited.

In alternative case 1, an oil pipeline from Iran was integrated with the port project plan. The pipeline project must be environmentally sound in terms of oil handling and treatment. Here, an evaluation has been made from the standpoint of the port project.

5.1.1 Oil handling facilities are far from residential area.

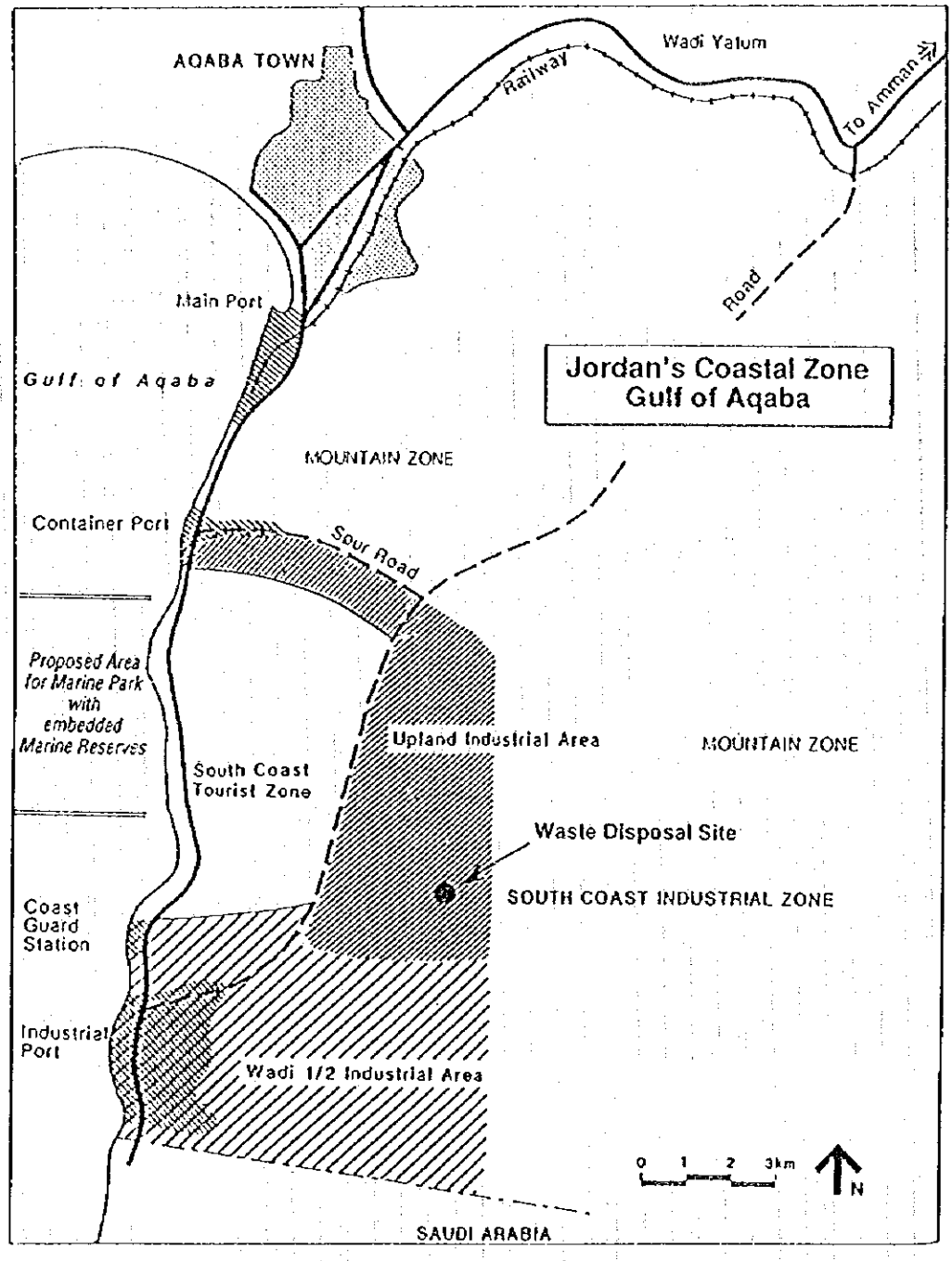
5.1.2 Port of Aqaba is equipped with oil recovery vessels.

5.1.3 No source of offensive odor is expected.

5.1.4 Significant change is not anticipated in aspects of the non-biological environment, therefore little change would be expected in biological aspects.

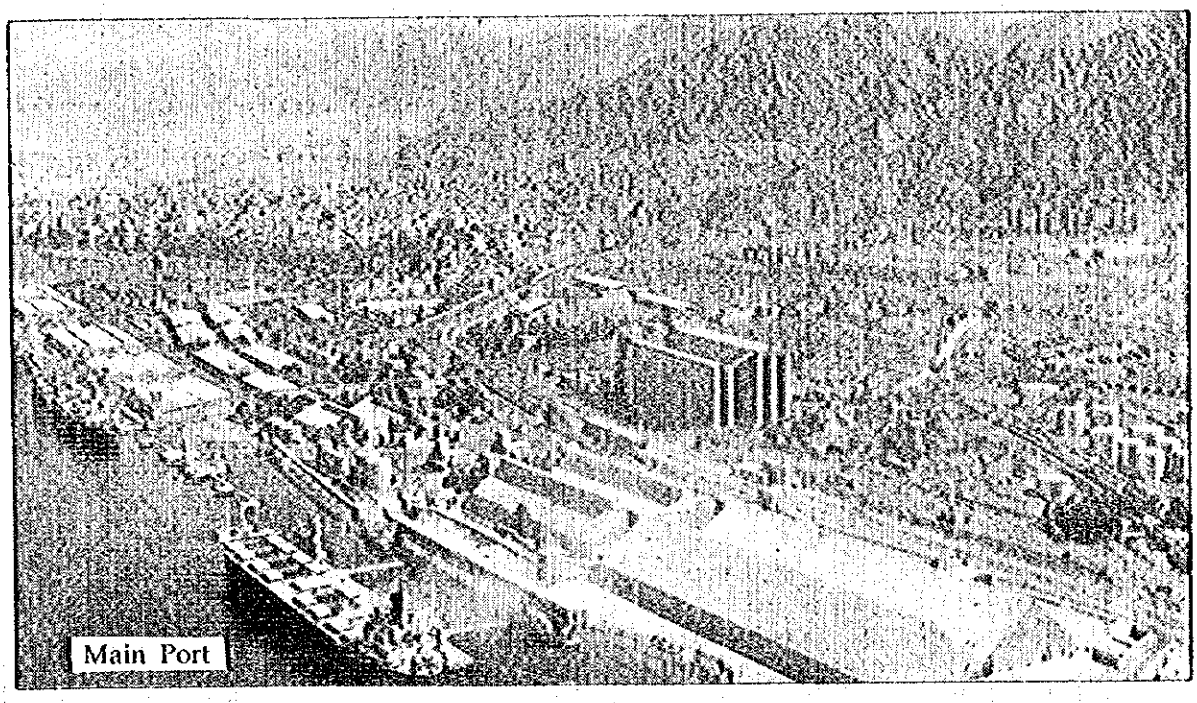
5.1.5 Significant change is not anticipated in aspects of the non-biological environment, therefore little change would be expected in biological aspects.

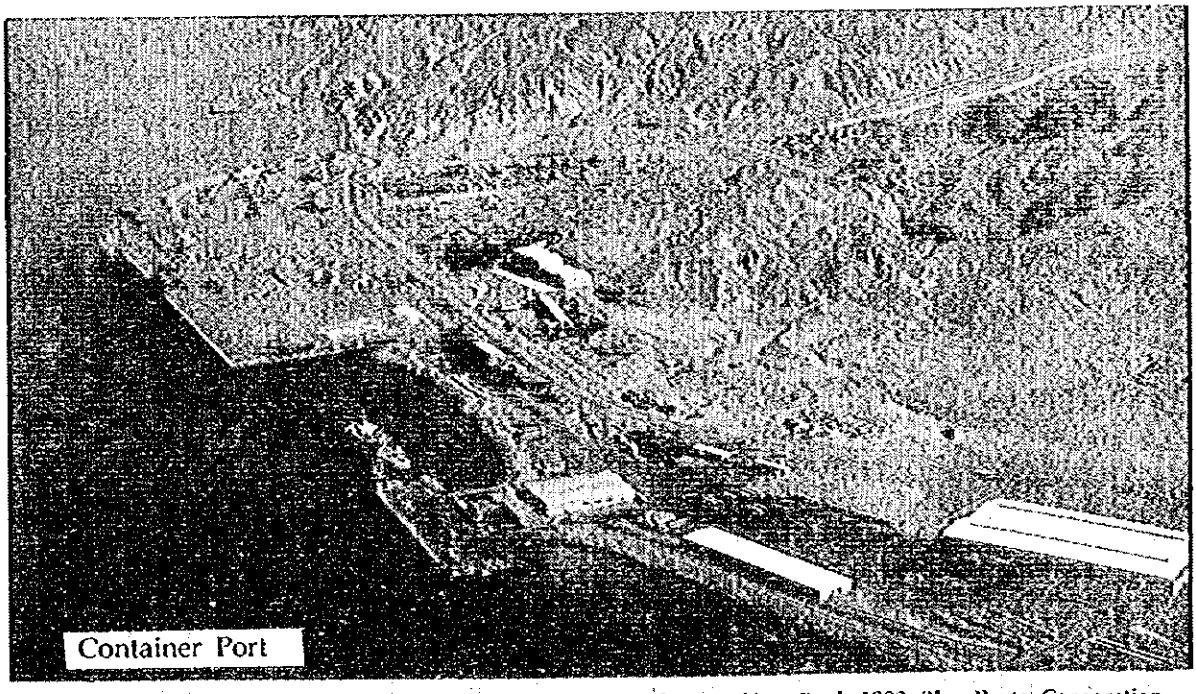
5.1.6 Land/sea area use pattern suggests that the economic productivity of the surrounding area of the port is not high.



Source: NATIONAL ENVIRONMENT STRATEGY FOR JORDAN

Figure 6.3.1 Jordan's Coastal Zone





Source: Year Book 1993, The Ports Corporation

Picture 6.3.1 Port of Aqaba

6.1.1 A waste disposal is located 14 km south of Aqaba and 6 km east of the coast, within a mountainous area.

6.1.2 Waste oil would be transported to the waste oil treatment facilities.

6.1.3 Waste oil would be transported to the waste oil treatment facilities.

6.1.4 Significant change is not anticipated in aspects of the non-biological environment, therefore little change would be expected in biological aspects.

6.1.5 No significant terrestrial ecosystem can be observed around the disposal site.

6.2.1 A waste disposal site is located 14 km south of Aqaba and 6 km east of the coast, within a mountainous area.

6.2.2 Waste oil would be transported to the waste oil treatment facilities.

6.2.3 Waste oil would be transported to the waste oil treatment facilities.

6.2.4 Significant change is not anticipated in aspects of the non-biological environment, therefore little change would be expected in biological aspects.

6.2.5 No significant terrestrial ecosystem can be observed around the disposal site.

6.2.6 None is allowed to stay at the disposal site.

7.1.1 Transportation of cargo is expected to increase remarkably, but it passes through the back road or spur which is distant from the residential area.

7.1.2 Residential area is far from the main transport route.

7.1.3 No significant terrestrial ecosystem is observed around the transport route.

7.1.4 This project will not cause a change in industrial structure or land use pattern.

7.1.5 Cargo transport will not occur in the city area, but through back road.

Impacts of industrial activities should be assessed in the industrial development study. Here, an evaluation was made from the standpoint of the port project.

8.1.1 Industrial activities in the port area will increase to some extent, but the residential area is far from the port and air quality in the city area is unlikely to be seriously affected.

8.1.2 Industrial waste water discharge in the port area is limited to a small amount, because, in regions such as this where water resources are often scarce, waste water is recycled rather than discharged.

8.1.3 No significant increase of industrial activities will be expected.

8.1.4 No significant increase of industrial activities will be expected.

8.1.5 A large amount of pumping up of underground water can not be done.

8.1.6 Industrial discharge will not increase largely.

8.1.7 No significant terrestrial ecosystem is observed around the industrial area.

8.1.8 Wastes will be dumped at a site far from the city.

8.1.9 This project will not cause a change in industrial structure or land use pattern.

8.1.10 No significant increase of industrial activities will be expected.

9.1.1 Inland deposit yard will not be required.

9.1.2 Inland deposit yard will not be required.

9.1.3 Inland deposit yard will not be required.

9.2.1 Inland deposit yard will not be required.

9.2.2 Inland deposit yard will not be required. Therefore, need for new labor will be limited.

6.4 Environmental Impact Assessment

According to the result of IEE, it is considered that following activities would affect the environment and need further inspection. These activities are operation of construction machines, which generates noise and vibration, and dredging, stirring of bottom soil and soil dumping into water which induce dispersion of turbid water, reduction of aquatic lives and devaluation of tourism resources. Regarding cargo loading activities and utilization of storage facilities, they are expected to cause dust dispersion accompanied with phosphate handling.

6.4.1 Noise and Vibration of Construction Machines

A piling boat, two cranes and several work vehicles will cause noise and vibration during construction of JFI-North Berth. There would be, however, no noticeable effect, because there are no residential areas in the vicinity of the work site.

6.4.2 Dispersion of Turbid Water due to Dredging and Reclamation

As the first step for numerical simulation of turbid water dispersion, calculation of current pattern was carried out using a single layer model with the finite difference equation.

The calculation conditions to simulate current pattern are shown in Table 6.4.1.

Table 6.4.1 Calculation Condition of Current

Conditions	Large domain	Small domain
Calculation area	see Figure 6.4.1	see Figure 6.4.2
Grid length	400m	100m
Time step	4 seconds	1 second
Depth of water	see Figure 6.4.1	see Figure 6.4.2
Considered tide	M_2 tide	
Integration time	120 h (10 tide)	48 h (4 tide)
Forced water level	Forced vibration of 12 h cycle (Tidal amplitude 27.9cm)	Use the result of Large domain
Bottom friction	0.0026	
Horizontal eddy viscosity	$1.0 \times 10^5 cm^2/s$	$1.0 \times 10^4 cm^2/s$
Corioris parameter	$f=2\omega\sin\phi$ $\phi=29.3°$	

Cases examined with the numerical simulation are as follows;

Large domain for current pattern 1 case
Small domain for current pattern 2 case
Small domain for current pattern 2 case

The result of the calculation of large domain is shown in Figure 6.4.3. Comparing this result with the record observed at a field survey from January 13 to 15 in 1995, the result of the calculation is obviously smaller than the observed one. Therefore in order to carry out the calculation of small domain, model calibration, in advance, was done under the conditions shown in Table 6.4.2, instead of using the result of the calculation of large domain.

Table 6.4.2 Calculation Condition for Small Domain

Conditions	Container Port	Industrial Port
Time step	4 seconds	
Maximum depth of water	50m	
Forced water level	Tidal amplitude North: 31.5cm, South: 30.0cm	Tidal amplitude North: 30.17cm, South: 30.0cm

The result of calculated current pattern using the calculation condition above is shown in Appendix.

Simulation of turbid water dispersion was made based on the simulated current pattern and the work plan. Activities considered to cause turbid water are reclamation of the berth extension in Container Port and dredging at the Timber Berth in Industrial Port.

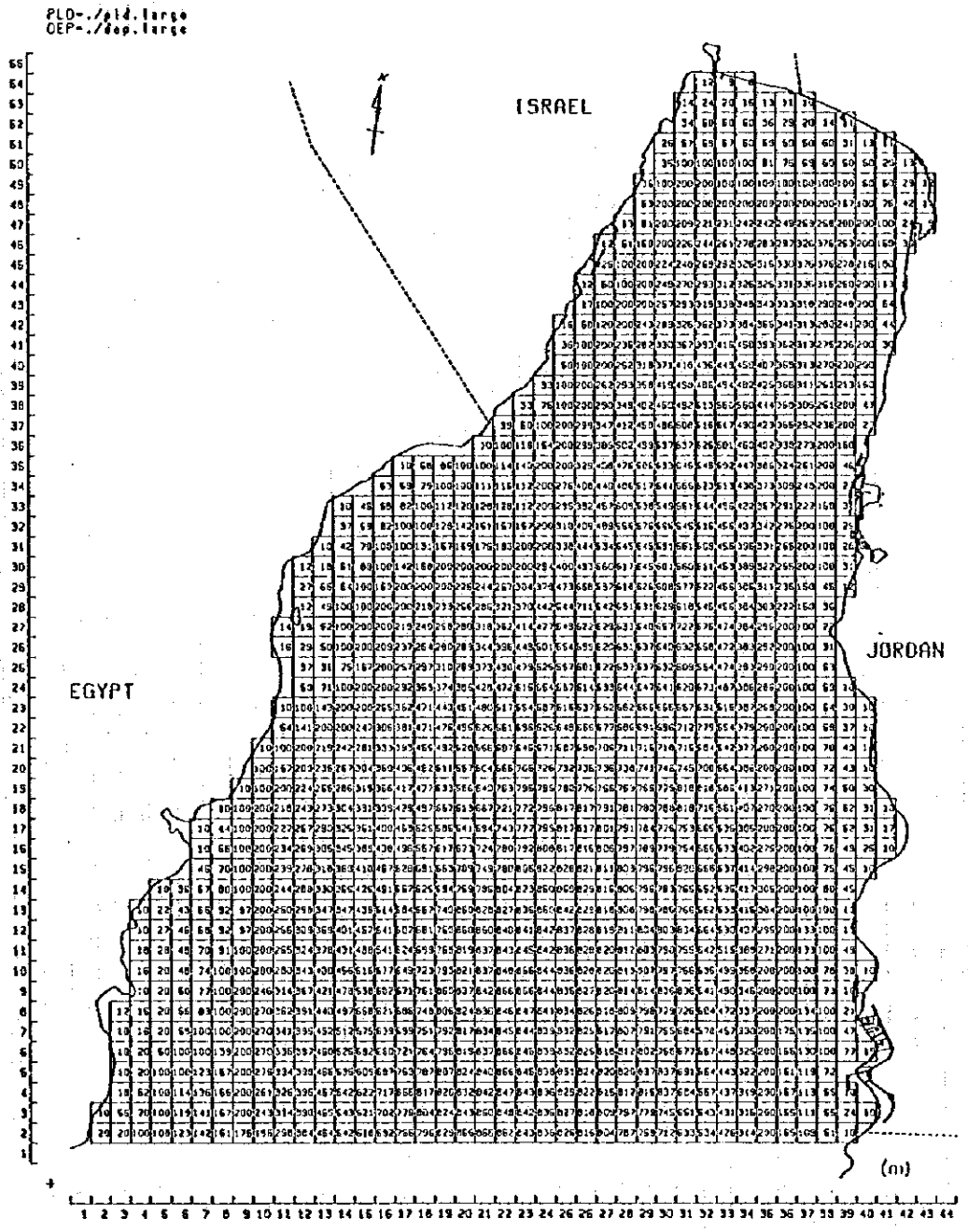


Figure 6.4.1 Calculation Area and Depth of Water for the Numerical Simulation of the Large Domain

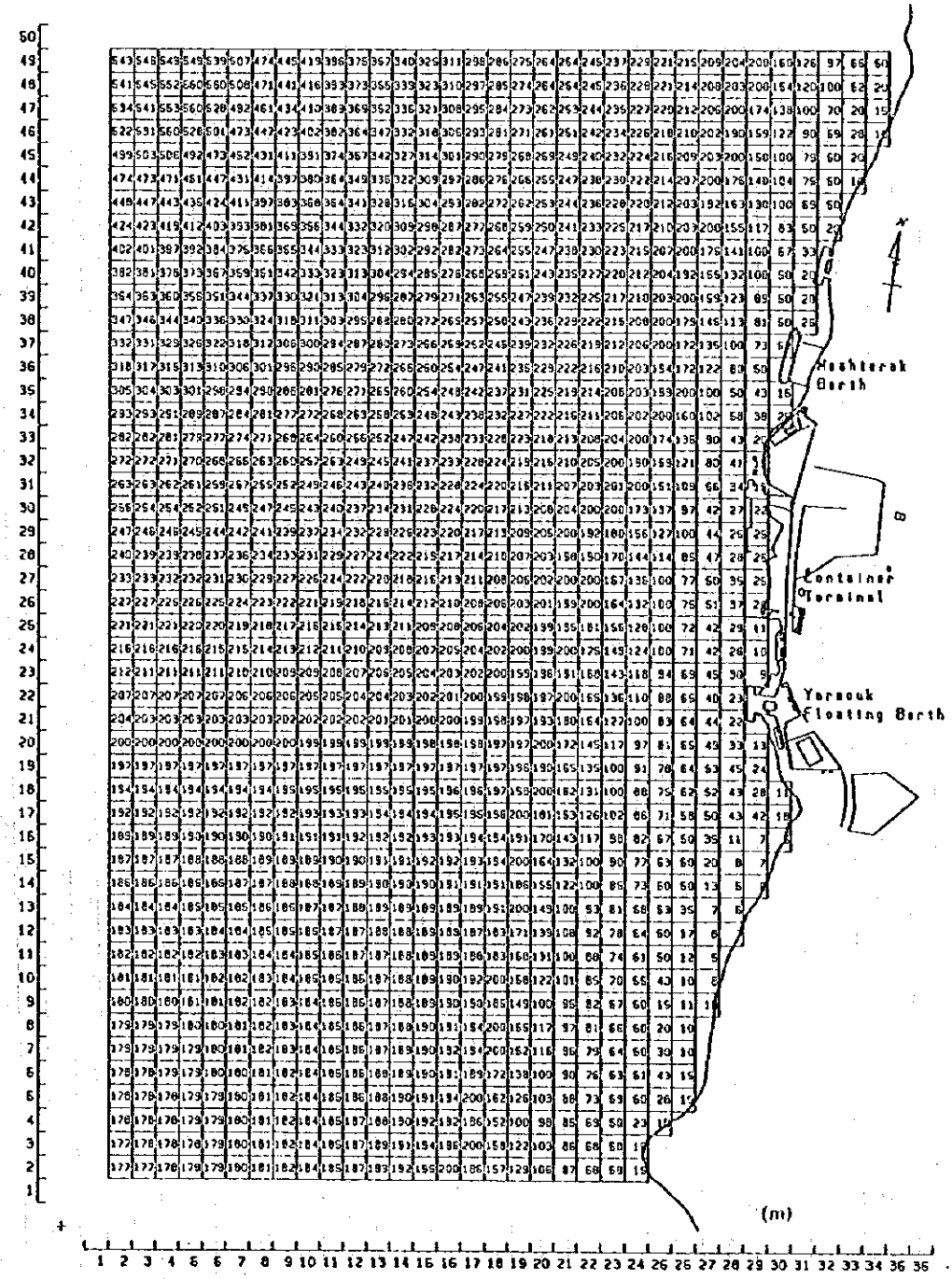


Figure 6.4.2(1) Calculation Area and Depth of Water for the Numerical Simulation of the Small Domain Around the Container Port

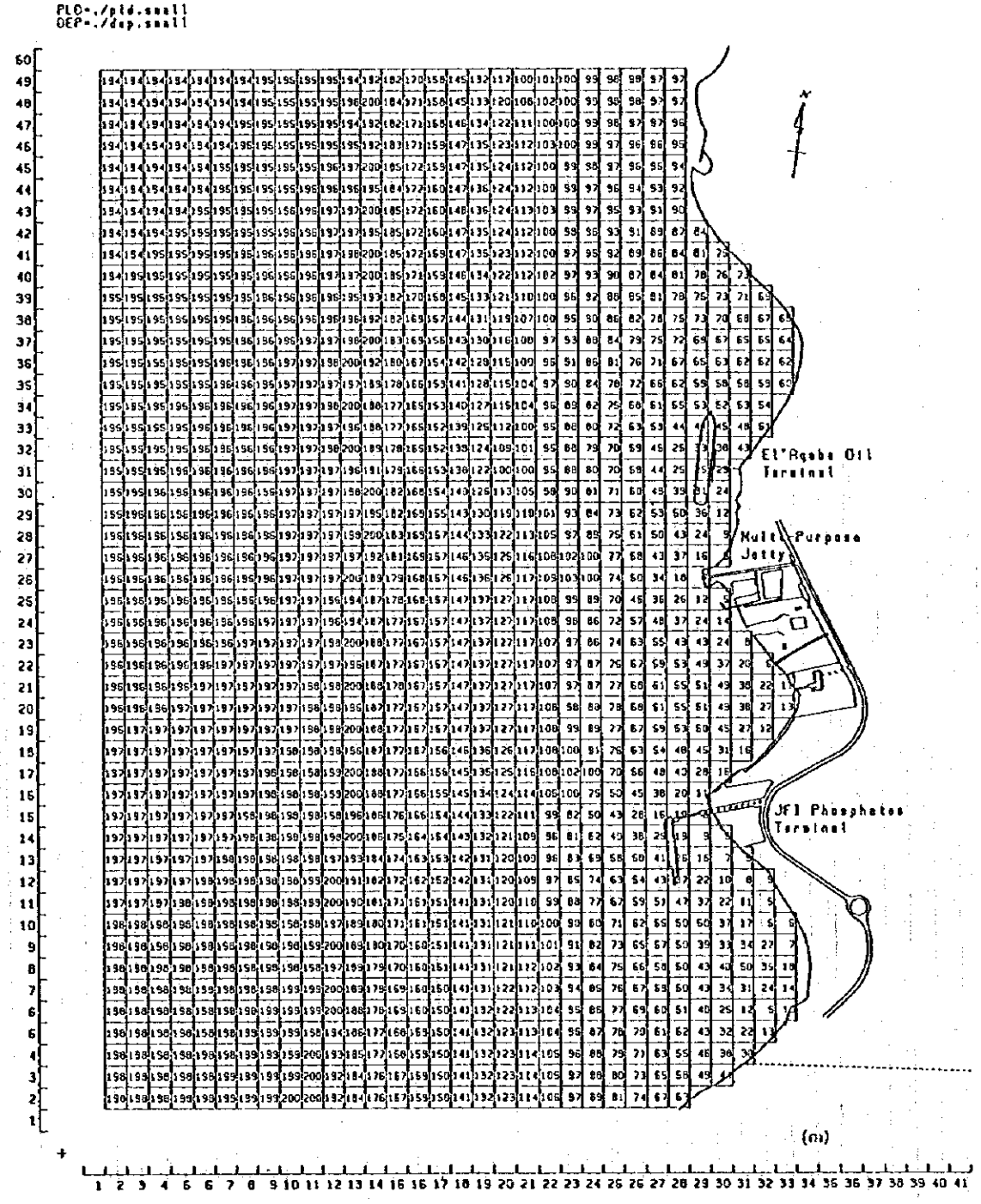


Figure 6.4.2(2) Calculation Area and Depth of Water for the Numerical Simulation of the Small Domain Around the Industrial Port

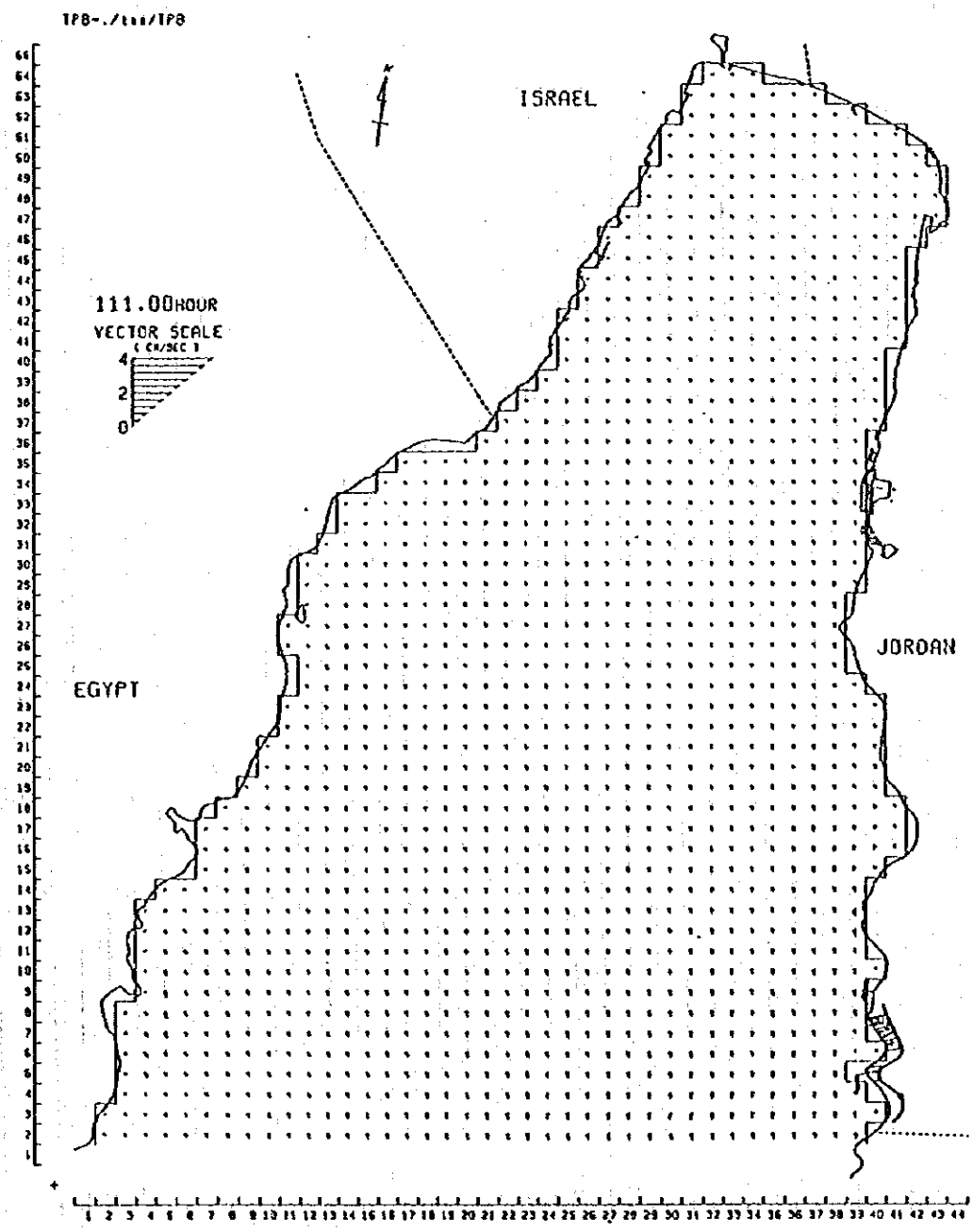


Figure 6.4.3 Result of the Calculation of Current Flow for Large Domain at an Ebb Tide

Concentration of suspended solid (SS) was employed for an indicator of the turbidity.

A calculation was performed using the formula shown below.

$$\frac{\delta Sh}{\delta t}+\frac{\delta MS}{\delta x}+\frac{\delta NS}{\delta y}=\frac{\delta}{\delta x}(hK_x\frac{\delta S}{\delta x})+\frac{\delta}{\delta y}(hK_y\frac{\delta S}{\delta y})-VS+W_i$$

where,
- S : Concentration of SS by particle size
- M : The amount of flowing water of x axis direction
- N : The amount of flowing water of y axis direction
- h : Depth of water
- K_x, K_y : Coefficient of dispersion
- V : Sedimentation rate
- Wi : Load of SS

Value of 1×10^4 cm^2/s was set for coefficient of dispersion. Load of SS(W_i) was obtained from the following equation.

$$W_i=W_o\times\frac{R}{R_o}\times Q$$

where,
- Wo : Unit loading for SS (8.4×10^{-3}t/m^3 and 1.6×10^{-3}t/m^3 for dredging and reclamation respectively, after "Assessment Manual for Dredging and Reclamation, Ministry of Transport, Japan, 1982)
- R : Percentage composition of particles(in weight) which contribute to the dispersion
- R_o : Percentage composition of particles smaller than 74μm.
- Q : Volume of earth work (m^3/d)

Here, R/R_o was assumed to be 1 ($R_o/R=1$). Based on the value of unit loading and the work plan, Q for dredging at Industrial Port is estimated to be 0.84t/day, while that for reclamation at Container Port is calculated to be 0.6t/day taking into account that a 50% sheltering effect from a silt protection sheet can be expected.

Sedimentation rate was determined with Stokes' equation and a value of 0.42cm/s was obtained.

The locations of dredging site and reclamation site are indicated in Figure 6.4.4, along with the load of SS.

Results of the numerical simulation of the turbid water dispersion are shown in Figure 6.4.5.

The maximum concentration of SS due to reclamation at Container Port was forecast as 2.5mg/l at the neighboring water area of the site. Considering the background SS value (2-5mg/l), the estimated SS concentration in construction phase would be 4.5-7.5mg/l.

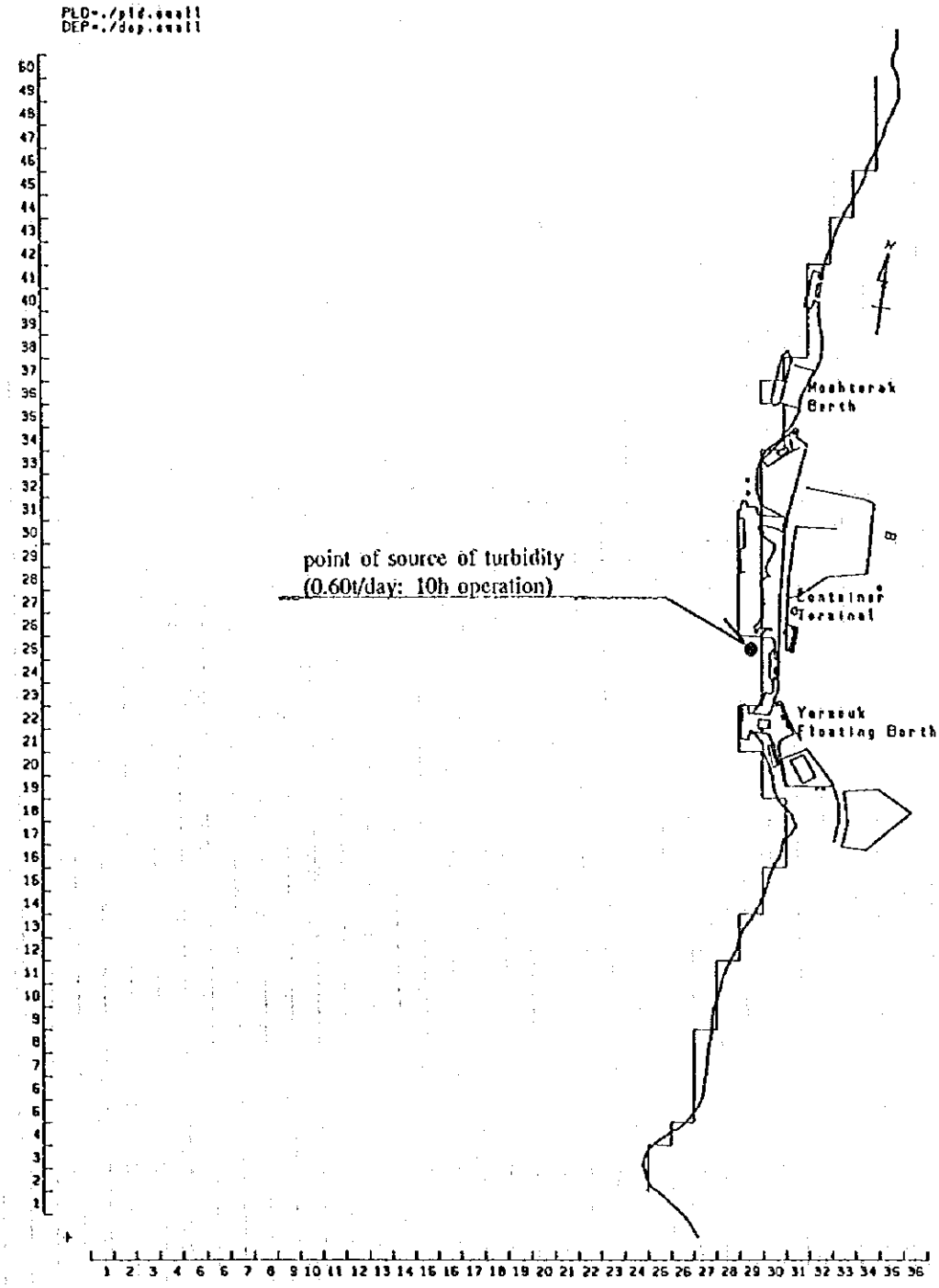


Figure 6.4.4(1) Location of Activity and Load of SS (Reclamation at Container Port)

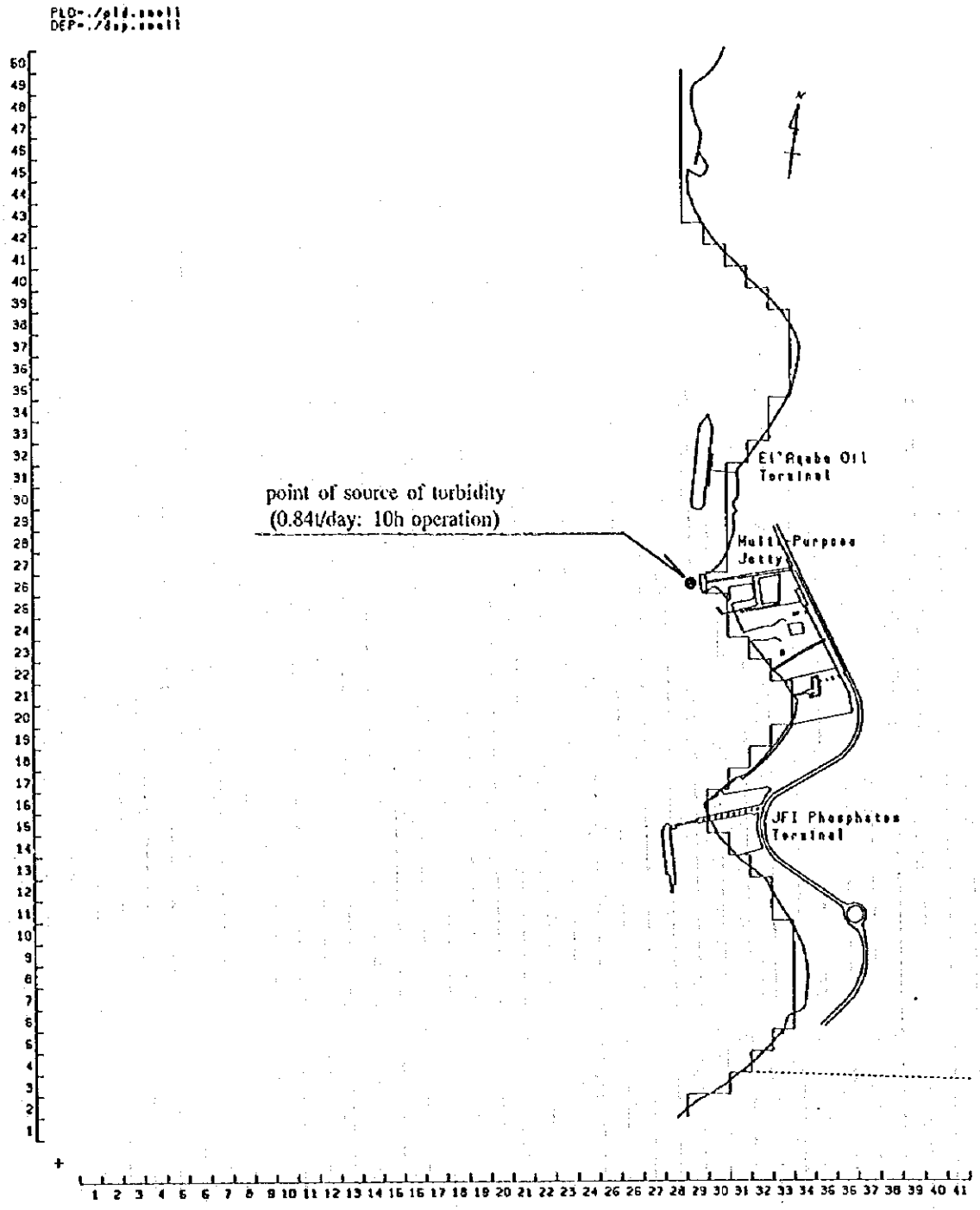


Figure 6.4.4(2) Location of Activity and Load of SS (Dredging at Industrial Port)

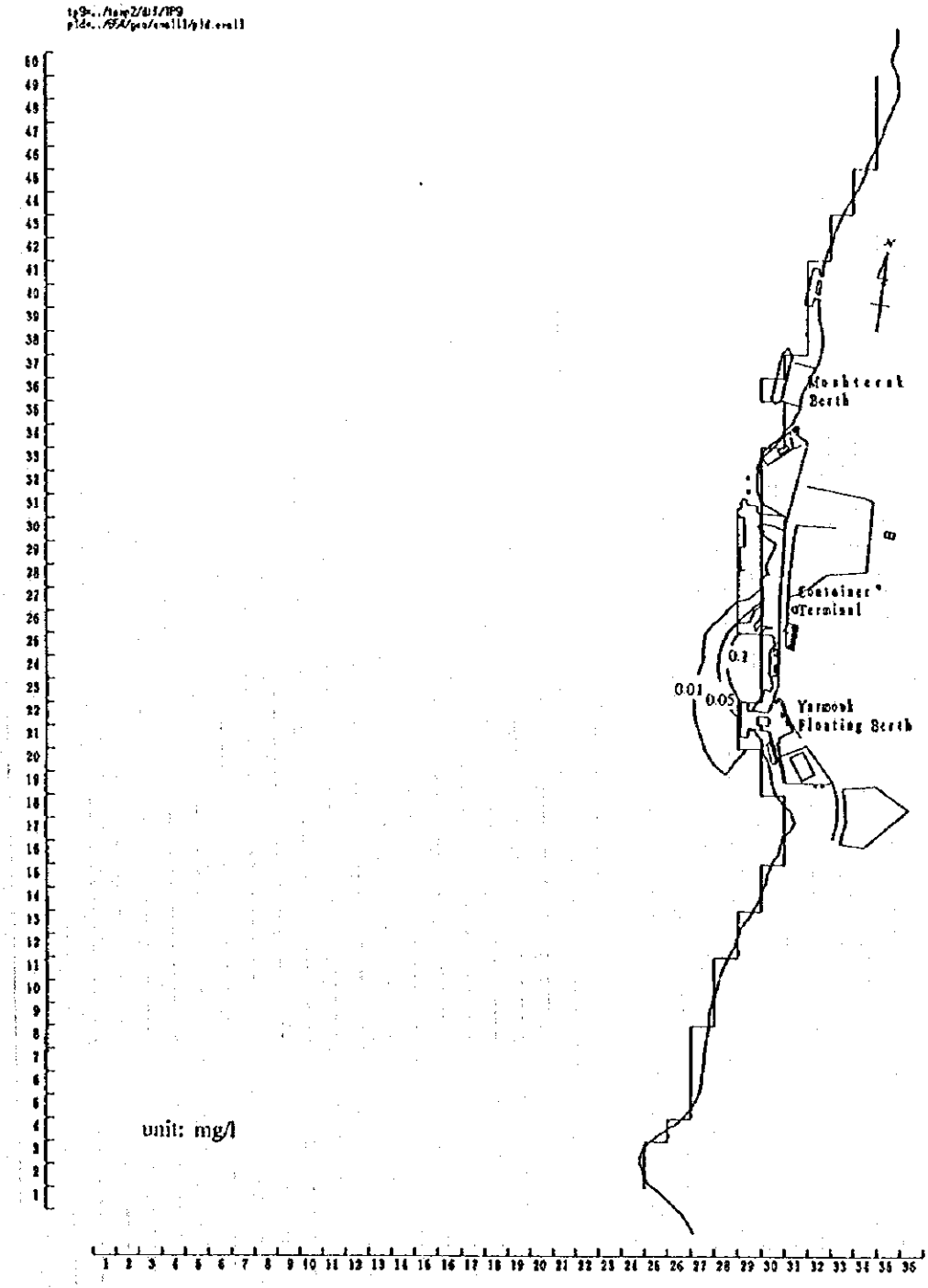


Figure 6.4.5(1) Horizontal Distribution of Maximum Concentration of SS due to Construction Work (Reclamation at Container Port)

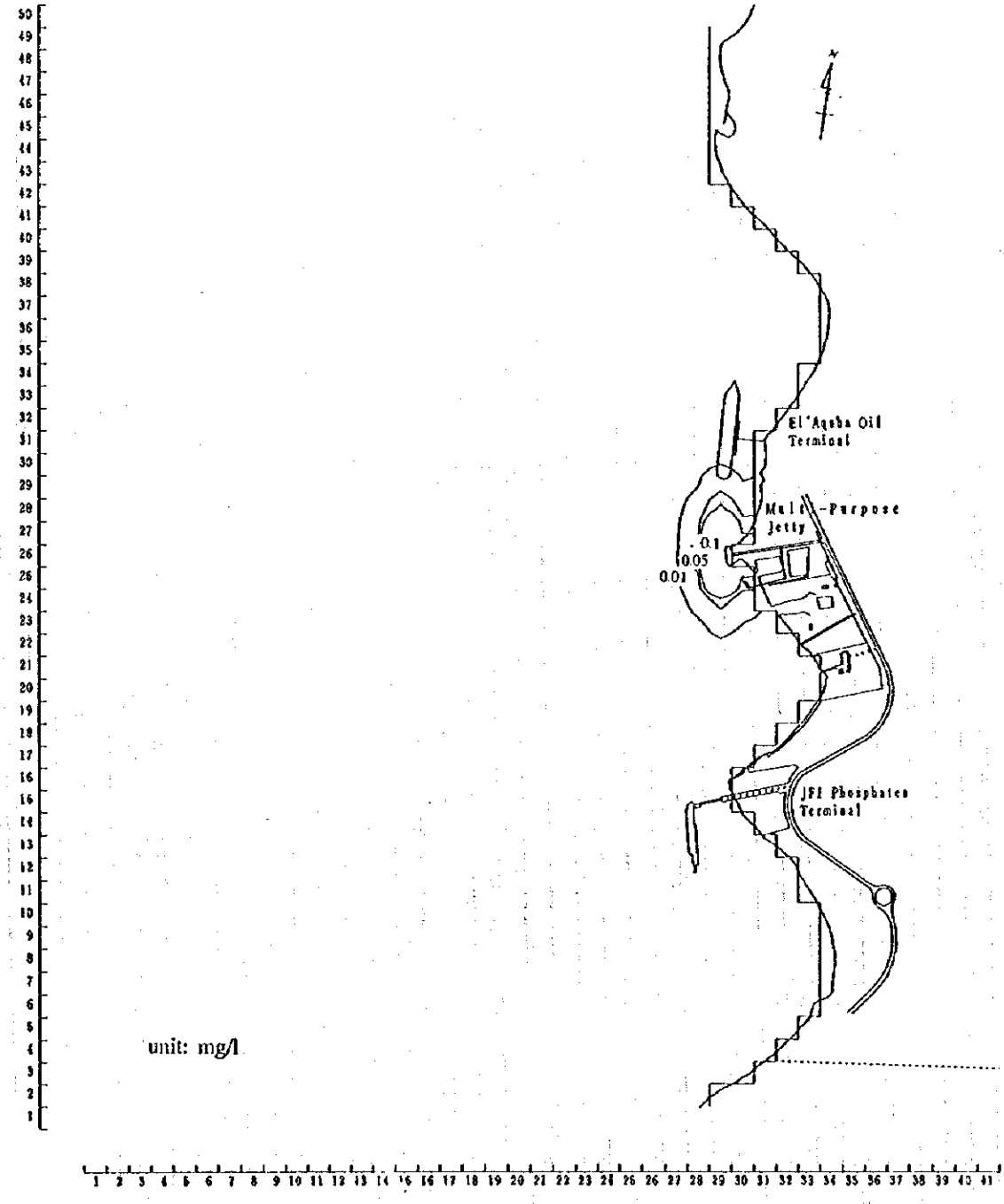


Figure 6.4.5(2) Horizontal Distribution of Maximum Concentration of SS due to Construction Work (Reclamation at Industrial Port)

As for dredging at Industrial Port, predicted SS concentration at the site due to the work was 5mg/1, then 7-10mg/1 would be expected for future SS concentration during dredging.

High concentration of SS is observed only at vicinity of the construction sites. Therefore, the turbid water would be expected to appear only in a small limited area.

6.4.3 Reduction of Aquatic Lives due to Dispersion of Turbid Water

The extent of dispersion of turbid water is not large because each volume is very low and the bottom soil at the construction site contains only small portions of silt and clay which contribute to the dispersion.

There are various types of aquatic life in the Gulf of Aqaba which is characterized as an enclosed water area. Table 6.4.3 shows number of species by major taxa. Mollusks, Fish, Cnidaria and Crustacea are common members of marine fauna in the Gulf of Aqaba. Twelve percent (80 species) of mollusks and a similar proportion of echinodermata occurring in the Gulf of Aqaba may be endemic. Fifteen percent of the Gulfs amphipod species have only been recorded in the Gulf of Aqaba and adjacent neighboring Red Sea areas. Several species of algae are also believed to be endemic.

Commercial fishing in the Gulf of Aqaba started in the early 1970s with the development of local markets among restaurants and hotels catering to tourists. More than 140 Aqaba households are, in varying degrees, economically dependent on commercial fishing. Roughly half of these are reported to be totally dependent on fishing as their sole source of income. Nevertheless commercial fishing has never been developed fully, and general remarks by fishermen and others indicate a sharp decrease in quantities of fish suitable for human consumption(Table 6.4.4). Many marine species such as the turtle are disappearing from the Gulf waters and the coral groups have been decreasing or destroyed due to various human activities, including tourism, shipping and industries.

Table 6.4.3 Number of Species by Major Taxa

Category	Groups Included	Species	Remarks
Algae	Cyanophyta(blue-green),Chloro(green), Phaeophyta(brown), Rohodophyta(red)	71	
Sea grasses		3	threatened by disappearance due to sedimentation & navigation
Porifera	Calcarea,Hyelospongia,Demospongia, Sclerospongia	37	
Cnidaria	Soft and hard corels,Crinoidea(sea lilies) & water corals	263	threatened because of uprooting & breaking by anchors
Worms	Nematoda(roundworms)Polychaeta(numerous setae),tapeworms	60	
Mollusca	Shells,Cephalopoda(cuttlefish,squids,octopus)	637	some are threatened by over-harvesting
Echinodermata	Stelleroidea(starfish), Echinoidea, Holothuroidea, Crinoidea(sea lilies)	56	
Crustacea	Malacostraca(crabs, shrimp,lobsters)	200	
Fish		340	
Turtles		2	rare species,need protection
Mammals	Dolphins and sea cows	5	rare species,need protection

Source: NATIONAL ENVIRONMENT STRATEGY FOR JORDAN

Table 6.4.4 Quantities and Types of Fish Caught

Type *	Season	Fishing Techalque	Quantity(tons)
Emperor	May-Aug.	Net & Sakhawi	2
Tuna	Dec.-April	Nets	20
Sardine	June-Aug.	Nets	20
Bigeye	April-Aug.	Nets	0.5
Siganus	April-Aug.	Sakhawi	2.5
Friden	April-Aug.	Nets & Sakhawi	3
Mullid	May-Aug.	Nets	0.5
Squirrel fish	May-Aug.	Nets	0.5
Mullet	Oct.-Jan.	Sakhawi & Nets	0.5
Fusilier & Jack	April-Aug.	Nets	4
Other types,over 25 in number	April-Aug.	Nets	4
*These fish are seasonal, except for the tuna, which are pelagic and the bigeyes, the fusilier and the Jack, which are native.			

Source: NATIONAL ENVIRONMENT STRATEGY FOR JORDAN

In this construction work, it is necessary to take appropriate action to prevent further degradation of the Gulf of Aqaba. Therefore, setting the target concentration of SS to protect aquatic life is indispensable. Table 6.4.5 shows the examples of the environmental water quality standards for SS and transparency in some countries, though Jordanian standards have not yet been established. With respect of SS in the Gulf of Aqaba, taking the importance of aquatic life into consideration, it may be necessary to set stricter criteria of SS concentration than those of other countries in south east Asia, because many of these countries have excessively high background SS value in the coastal area, while Jordanian coastal water reveals only 2-4 mg/l of SS in normal conditions (Table 6.4.6 and 6.4.7).

In Japan, where marine resources are diverse and aquaculture is developed, project-originated SS load is recommended to be 2mg/l or less. Therefore in this construction work, regarding the concentration of SS of Japan, where the same level of SS background value is observed in the coastal water, the target concentration of SS which is originated from construction work can be set below 2mg/l.

Comparing the simulated SS value with the target concentration of SS (2mg/l), the impact of turbid water dispersion on aquatic life will be negligible.

Table 6.4.5 Environmental Quality Standards in Some Countries

country	Water area	purpose of use	SS mg/l	Transparency
Thailand	Karon Bay,Phuket	coral reef conservation	≤10	≥15
Indonesia	Coastal water	Aquaculture	≤25	≥5
Malaysia		Conservation of natural environment and very sensitive aquatic species	25	—
		sensitive aquatic species	50	—

Source: ENVIRONMENTAL ASSESSMENT HANDBOOK for Port Development Projects

Table 6.4.6 Total Suspended Solids and Secchi Disc Readings (Transparency)

19 June 1994

Station*	Depth(m)	TSS(mg/l)	Transparency Secchi disc(m)	Color Forel Scale
Hotels Area S1	1	2.09		1
	10	3.08		1
	20	2.67		1
	Mean	2.61	21.00	1
Main Port S2	1	2.12		1
	10	2.63		1
	20	2.03		1
	Mean	2.26	22.50	1
Phosphate Berth S3	1	2.97		1
	10	2.83		1
	20	1.96		1
	Mean	2.56	21.80	1
Container Port S4	1	2.46		1
	10	2.99		1
	20	1.93		1
	Mean	2.46	21.00	1
Tourist Area (Al-Mamlah) S5	1	1.80		1
	10	1.92		1
	20	3.45		1
	Mean	2.39	18.70	1
Industrial Area S6	1	2.29		1
	10	3.86		1
	20	2.29		1
	Mean	2.81	18.30	1

* See Figure 6.4.6

Source: FINAL REPORT MARINE ENVIRONMENTAL SURVEY OF PHYSICAL, GEOCHEMICAL AND BIOLOGICAL CHARACTERISTICS OF COASTAL WATERS, NEARSHORE SEDIMENTS AND CORAL REEFS OF THE GULF OF AQABA (JORDAN)

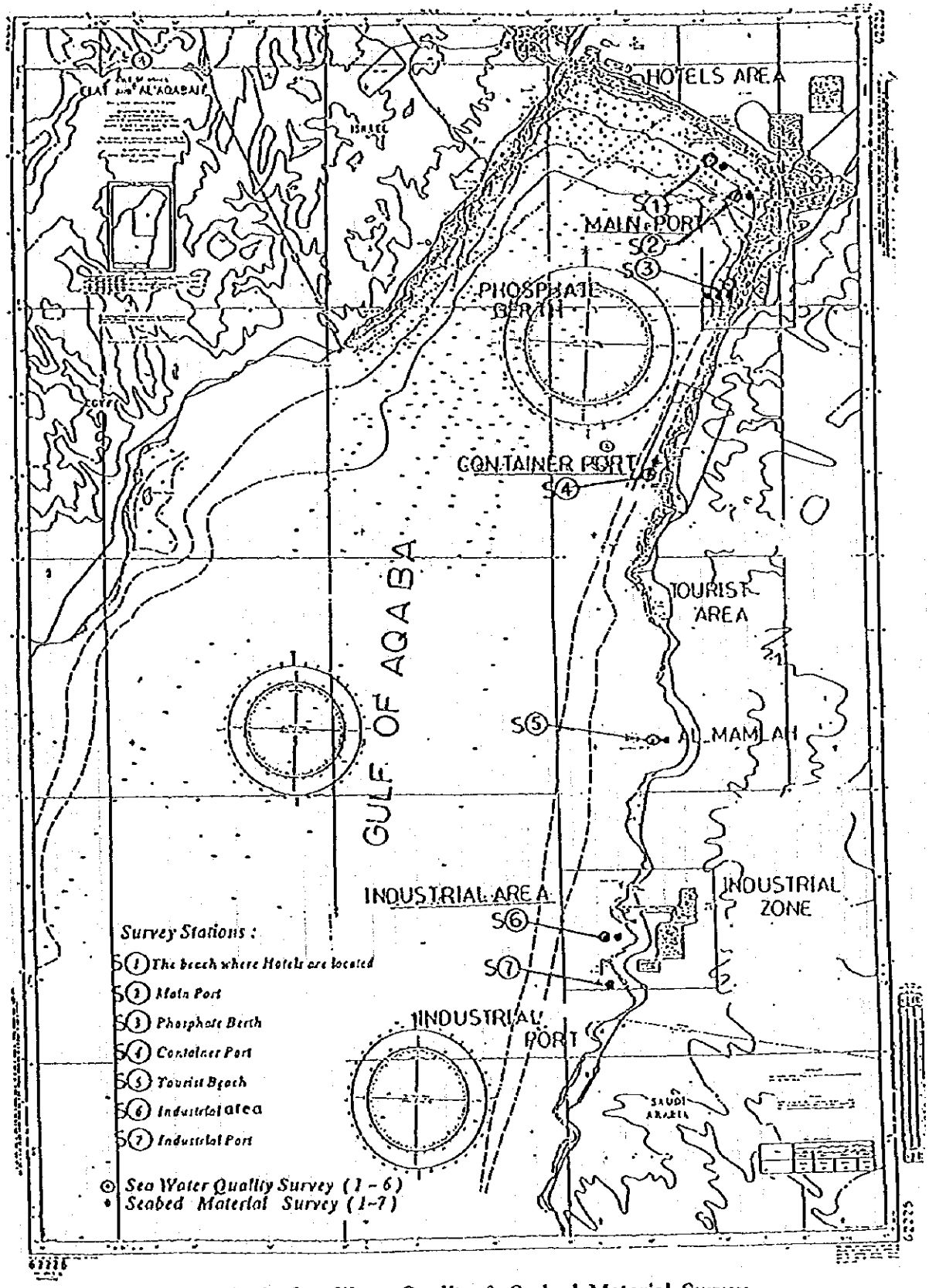


Figure 6.4.6 Sea Water Quality & Seabed Material Survey

Source: FINAL REPORT MARINE ENVIRONMENTAL SURVEY OF PHYSICAL, GEOCHEMICAL AND BIOLOGICAL CHARACTERISTICS OF COASTAL WATERS, NEARSHORE SEDIMENTS AND CORAL REEFS OF THE GULF OF AQABA (JORDAN)

Table 6.4.7 Water Quality Test Results: Aqaba Gulf (Feb. 2 and 4, 1995)

Point*	Time.	Temp. C	App	Clr.	Odor	Tbd mg/l	Do mg/l	pH	Cnd ms/cm	Sal %	Tra M	Day Climate
1	8:45	21.0	Clear	Blue	None	4	5.7	7.90	60.6	3.87	8.8<	2 Fine
2	8:58	21.0	"	"	"	3	5.7	7.86	60.4	3.86	10/2<	"
3	9:07	20.9	"	"	"	4	5.8	8.02	60.5	3.86	16.7<	"
4	9:20	21.0	"	"	"	4	5.7	8.07	60.8	3.88	15.0<	"
5	9:35	21.0	"	"	"	4	5.7	8.04	60.3	3.87	23.5<	"
6	9:44	21.1	"	"	"	4	5.6	8.05	60.9	3.89	30.0<	"
7	9:56	21.2	"	"	"	4	5.5	8.06	60.8	3.88	30.0<	"
8	10:09	21.2	"	"	"	4	5.6	8.07	60.8	3.88	24.1<	"
9	10:20	21.2	"	"	"	4	5.8	8.06	60.7	3.88	27.5<	"
10	10:47	21.7	"	"	"	4	5.5	8.04	60.8	3.88	30.0<	"
11	10:54	23.0	"	"	"	4	5.6	8.03	59.2	3.81	0.5<	"
12	10:59	21.2	"	"	"	4	5.6	8.05	60.8	3.88	30.0<	"
13	11:25	21.2	"	"	"	4	5.5	8.05	60.8	3.88	15.0<	"
14	11:42	21.2	"	"	"	5	5.6	8.03	60.4	3.85	18.0<	"
15	12:38	21.2	"	"	"	4	5.6	8.03	60.4	3.86	23.0<	"
16	13:08	21.2	"	"	"	4	5.6	8.03	60.6	3.87	20.0<	"
17	13:20	21.2	"	"	"	4	5.6	8.03	60.1	3.84	13.5<	"
18	10:00	21.2	"	"	"	3	5.9	8.03	59.7	3.81	15.0<	4 Fine
19	10:15	21.1	"	"	"	5	5.6	8.02	59.9	3.81	27.5<	"
20	10:27	21.1	ST	"	"	5	5.6	8.03	60.0	3.83	16.0<	"
21	10:39	21.1	Clear	"	"	4	5.6	8.06	60.2	3.84	-	"
22	10:50	21.4	"	"	"	4	5.9	8.06	59.8	3.81	3.81	"
23	10:59	21.6	"	"	"	4	5.9	8.05	60.1	3.84	-	"
24	11:10	21.2	"	"	"	4	5.6	8.04	59.8	3.81	23.0<	"
25	11:20	21.3	"	"	"	4	5.6	8.06	60.8	3.88	-	"
26	12:14	21.2	"	"	"	4	5.9	8.04	59.7	3.81	-	"

*See Figure 6.4.7

Note: Temp : Temperature
App : Appearance
Clr : Color
Tbd : Turbidity
DO : Dissolved Oxygen
Cnd : Conductivity
Sal : Salinity
Tra : Transparency
ST : Slight Turbid

Source: THE STUDY ON THE IMPROVEMENT PLAN OF THE PORT OF AQABA IN THE HASHEMITE KINGDOM OF JORDAN

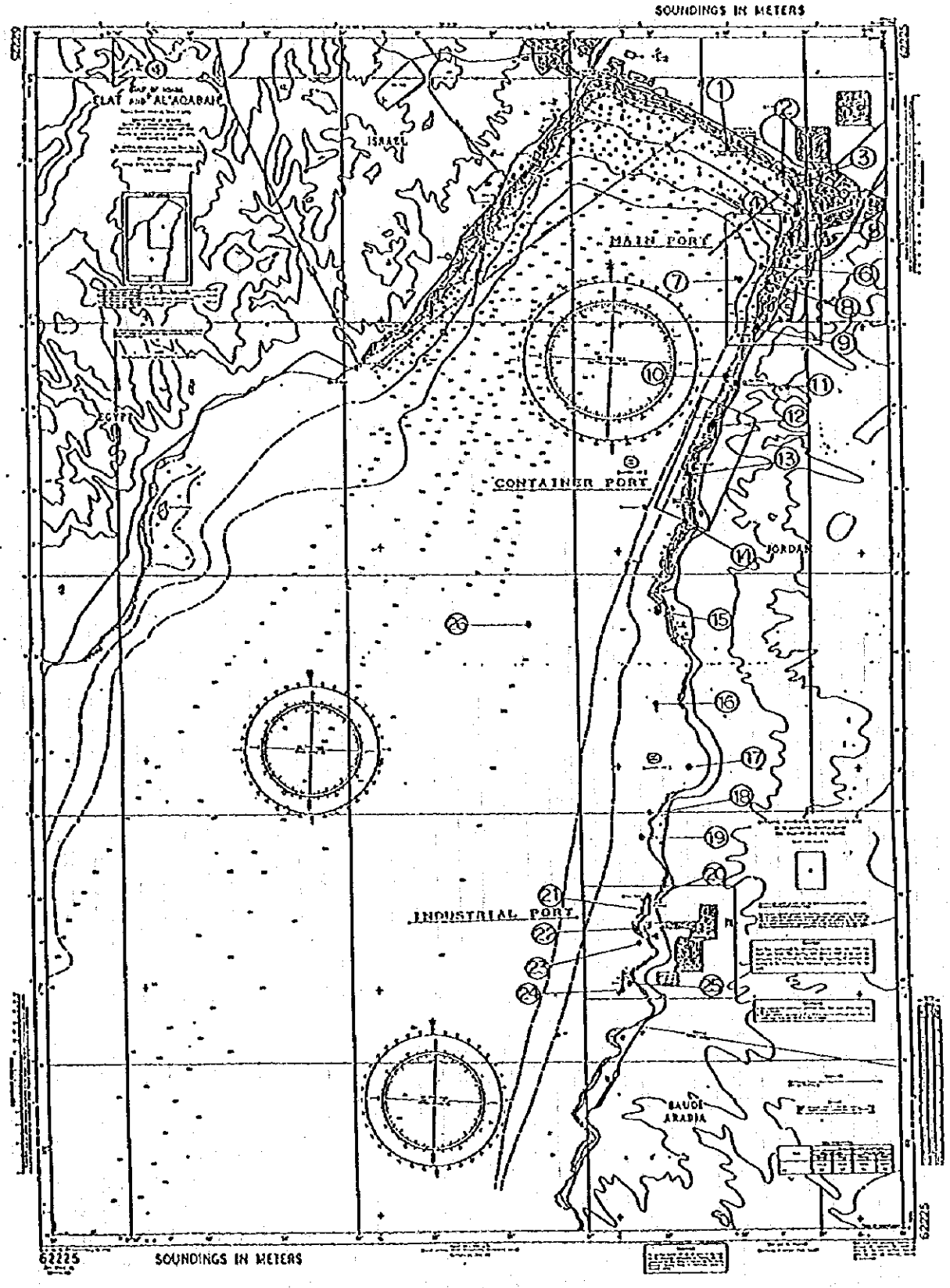


Figure 6.4.7 Sea Water Quality Survey

Source: THE STUDY ON THE IMPROVEMENT PLAN OF THE PORT OF AQABA IN THE HASHEMITE KINGDOM OF JORDAN

6.4.4 Devaluation of Tourism Resources

Coral reef of Gulf of Aqaba, with its high proportion of endemic species, attracts many tourists and divers. Therefore, preservation of corals is one of the most important issues in planning the port improvement.

Dredging and reclamation activities are expected to result directly in localized mechanical damage to corals and other elements of the coral reef biota. In some regions damage could also stem from interference with water movements across and around reefs and possibly from lowering of water levels on reef flats at low tide. Then too, large volumes of sediment released into the ambient seawater as a result of these activities could be inimical to the establishment, development, and perhaps survival of many benthic species, particularly corals.

It is known that there are two major mechanisms through which dredging and filling affect corals adversely; reduction in light intensity and sedimentation. Reduction of light intensity is caused by increase of light extinction due to suspended particles. Sedimentation inhibits the normal growth of coral polyps by physical mechanism.

The critical factor controlling the depth at which corals grow is illumination. The number of species of corals represented decreases markedly at depths where illumination falls to values of 15-20% of surface illumination. Illumination decreases rapidly below 10m. The degree of turbidity of ambient seawater would affect the depth to which light penetrates. Information is required on the extent to which different types of suspended material reduce the amount of light received by corals growing at different depths. It is known that the normal growth rates of corals can be cut by half on a cloudy day and it is conceivable that a marked increase in the amount of suspended material could reduce growth rates of corals considerably and possibly to an extent which would be inimical to the survival of corals growing in deeper water.

As mentioned above, coral colonies may be killed as a result of material in the form of silt or sand falling upon them from above or by an encroachment of accumulated sediment from below. Most colonies appear capable of removing the sediment that normally falls upon them. Colonies belonging to species possessing large polyps are generally more successful at ridding themselves of sediments than colonies belonging to species that have small polyps(e.g., species of Porites). The rate of sedimentation that exceeds the ability of corals to rid themselves of sediment no doubt varies not only from species to species but also with the type of sediment involved.

As target concentration of SS for conservation of corals, project-originated load of 1mg/l or less would be desirable because of following reasons.

As shown in Table 6.4.6 and 6.4.7, actual concentration of SS in the habitat of coral ranges from 2mg/l to 5mg/l. Usually SS concentration around 3mg/l and temporarily it becomes 5mg/l in the natural condition. Therefore in this short-term construction work, it is estimated that 2mg/l increase of SS concentration due to the construction work may be permissible. However it is considered safe to set the target value at half of 2mg/l, so the increase of SS concentration due to the construction work should be 1mg/l or less in this case.

There are few countries that have environmental standards for water quality to preserve coral reef. In Thailand, however, the standard SS concentration of 10mg/l or less has been established aiming at the conservation of corals in Karon Bay and Phuket. Comparing this environmental standard in Thailand with the natural condition of SS in Aqaba Bay (maximum 5mg/l) and additional target concentration of SS mentioned above (1mg/l), the SS concentration in future is expected to stay in the permissible concentration level to protect the coral reef.

In this project, the range of SS dispersion is so small and partial that the turbid water would not affect the coral reserve.

6.4.5 Air Pollution

Prediction of the dust dispersion of phosphate in the surrounding area of the Main Port was carried out using a numerical simulation.

Figure 6.4.8 shows the location of phosphate unloading sites around which the investigation was carried out. These are the recipient site for trucks and freight trains and storehouses. The calculation area was decided to be 4km × 4km centering around the point of source.

Dust is considered to fall due to the gravity, so the calculation of dispersion was made using the formula of air dispersion for plume to estimate the deposition of dust under the condition of the operation phase(in 2000).

In this investigation, the following issues were to be estimated.
(1) Dust deposition for a short period (1h). ---three cases
(2) Dust deposition in April which likely has the most adverse impact on the land. (The frequency of south-southwest wind is the highest in April.) ---one case
(3) Dust deposition. ---one case
Totally, five cases of numerecal simulation were performed.

The meteorological data observed from 1 Jan. 1994 to 31 Dec. 1994 was analyzed to calculate the meteorological condition affecting the pattern of dust dispersion. Monthly and annual wind rose are shown in Appendix.

Specific gravity of phosphates ($P_2 O_6$) was considered to be 2.39 through a literature survey. Information on the particle size composition was obtained from a report, " TSP and $P_2 O_6$ Levers at Selected in Aqaba".

Based on the result of investigation for estimation of unit loading made by the Environment Agency of Japan, emission volume of phosphate dust was estimated as 1kg per handling volume of 1t. The handling volume of phosphate by trucks is calculated to be 2,200,000t/year, while that by freight trains is calculated to be 3,500,000t/year. Therefore, taking the total of this volume into consideration, the volume of the storehouse was assumed to be 5,700,000t/year. Based on those values, the emission volume was estimated as shown in Table 6.4.8.

Table 6.4.8 Amount of Dust Emission

Unit: t/yr

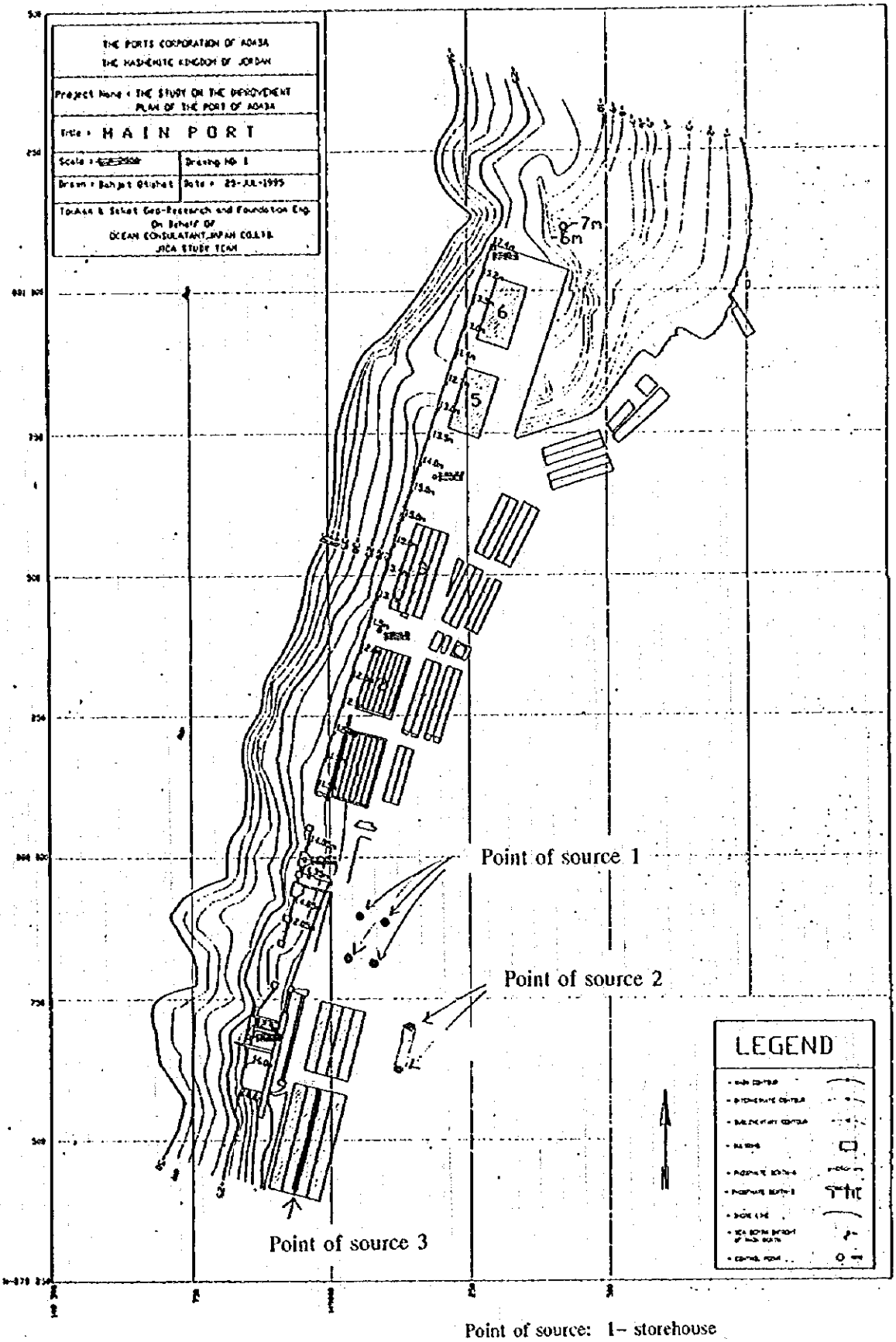
Point of source	Amount of emission
Truck	2,200
Freight train	3,500
Storehouse	5,700

The result of the investigation is shown in Figure 6.4.9-6.4.11. The maximum amount of deposition was estimated to be 21.6, 5.3, 2.9g/m^2/hr in hourly value under the condition of wind velocity of 1, 3, 5m/s respectively (Figure 6.4.9). Wind direction was assumed SSW, which likely had the most adverse impact on the residential area.

Maximum monthly dust deposition was estimated to exceed 100g/m^2 on the sea, and 50g/m^2 on land. The high value which occurred on the sea was caused by prevailing NNE wind which carried dust to the coastal sea area.

As for maximum monthly dust deposition on land, the obtained value almost equaled thats of regions which are known as dust-abundant areas, such as the northern part of China (30-50g/m^2/month). Since low value deposition level was estimated at the residential area, mean dust deposition in the investigated area was around 10g/m^2/month, which is the same level as average value in Japan. Distribution of this high value is limited to the port area, thus the dust would not affect local residents, but port workers.

For the annual value, the maximum amount of dust on the sea site was predicted to be 2.13kg/m^2/yr while that on land was estimated to be 0.42kg/m^2/yr (Figure 6.4.11).



Point of source: 1– storehouse
2– recipient site for freight truck
3– recipient site for truck

Figure 6.4.8 Location of Points of Dust Emission

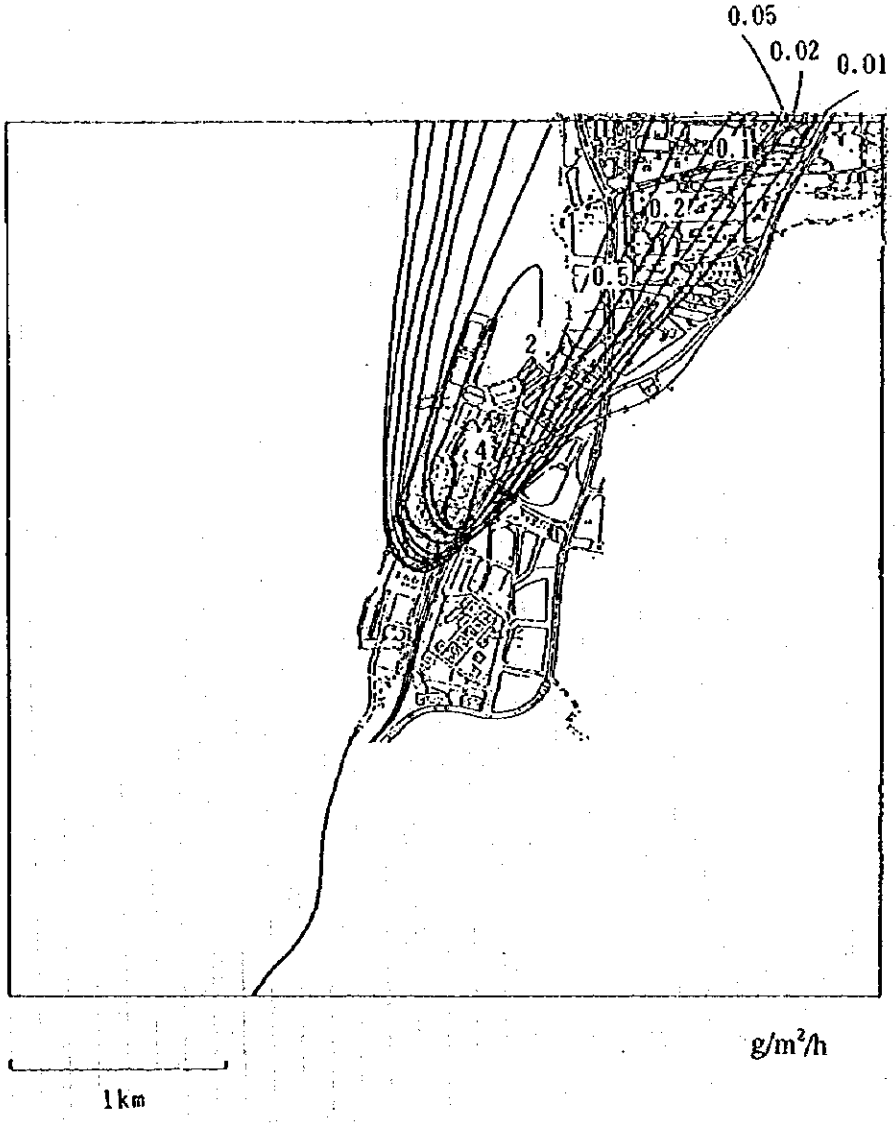


Figure 6.4.9(1) Simulated Horizontal Distribution of Phosphate Dust Precipitation on Hourly Value. Under the Condition of; Wind Velocity: 1m/s, Wind Direction: SSW

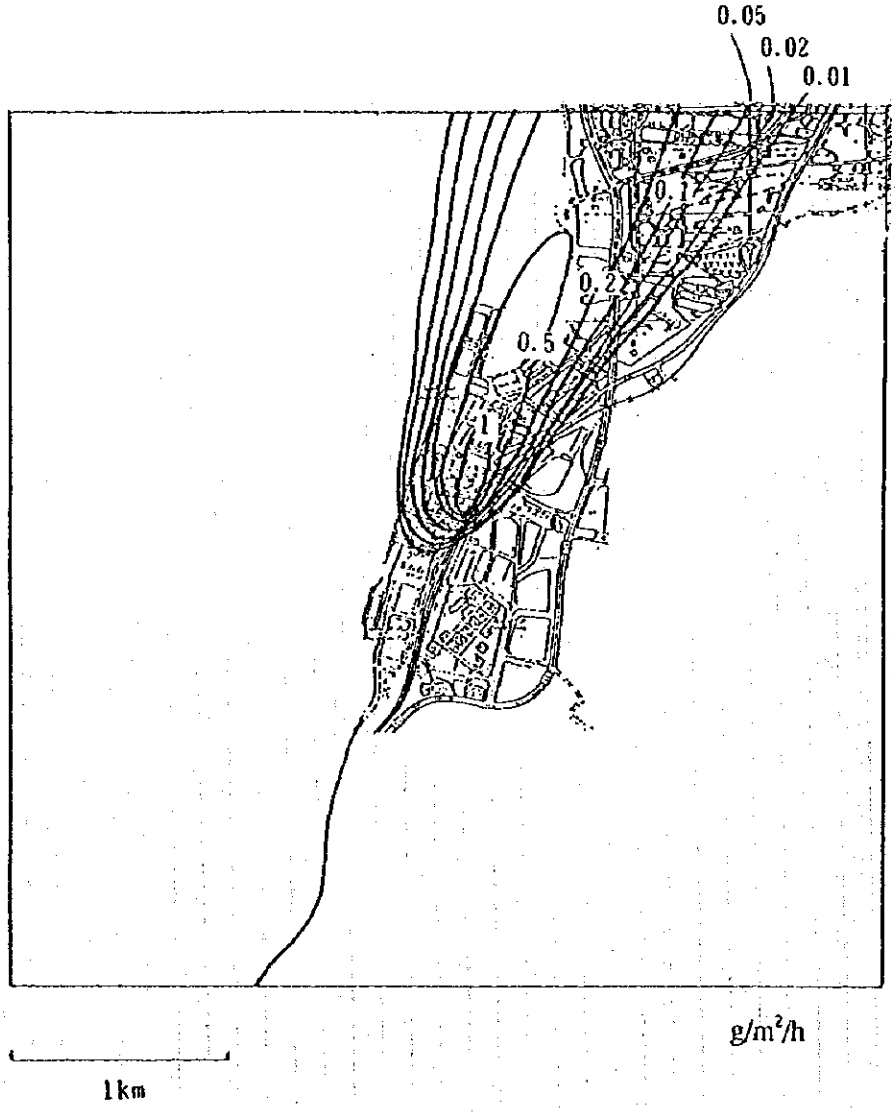


Figure 6.4.9(2) Simulated Horizontal Distribution of Phosphate Dust Precipitation on Hourly Value. Under the Condition of; Wind Velocity: 3m/s, Wind Direction: SSW

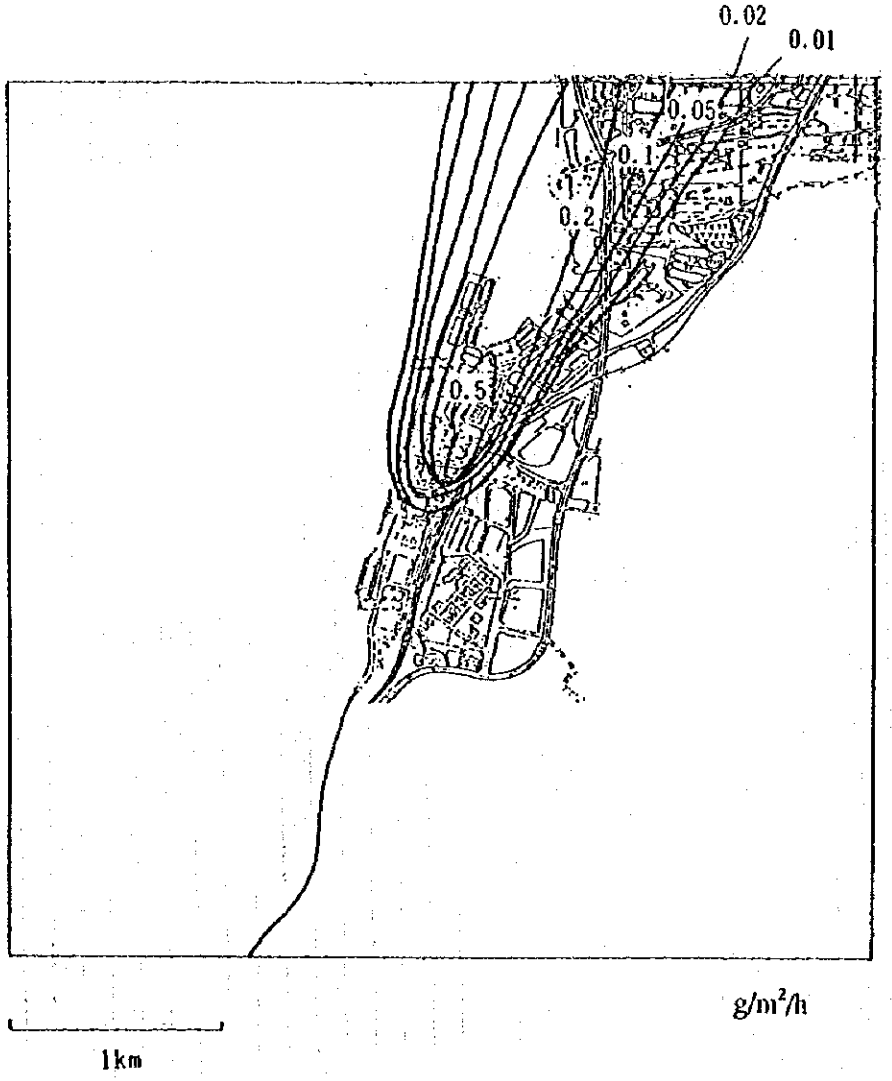


Figure 6.4.9(3) Simulated Horizontal Distribution of Phosphate Dust Precipitation on Hourly Value. Under the Condition of; Wind Velocity: 5m/s, Wind Direction: SSW

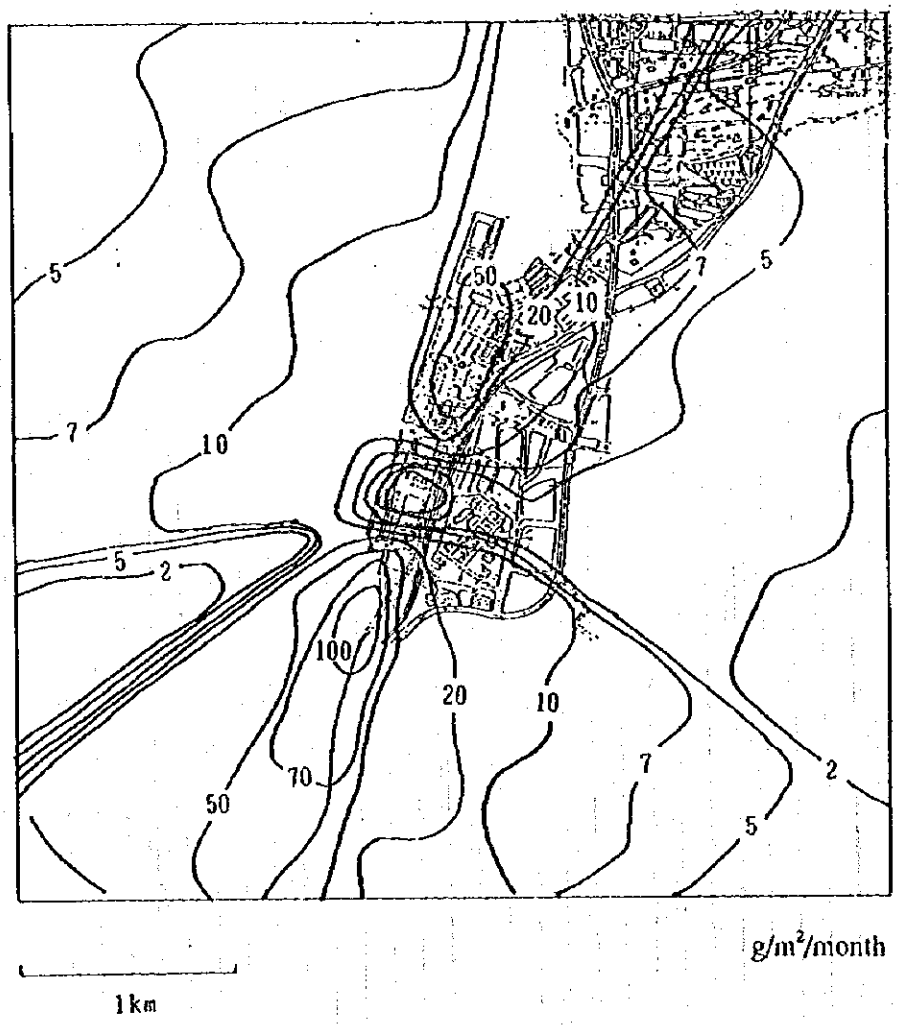


Figure 6.4.10 Simulated Horizontal Distribution of Phosphate Dust Precipitation in Monthly Value

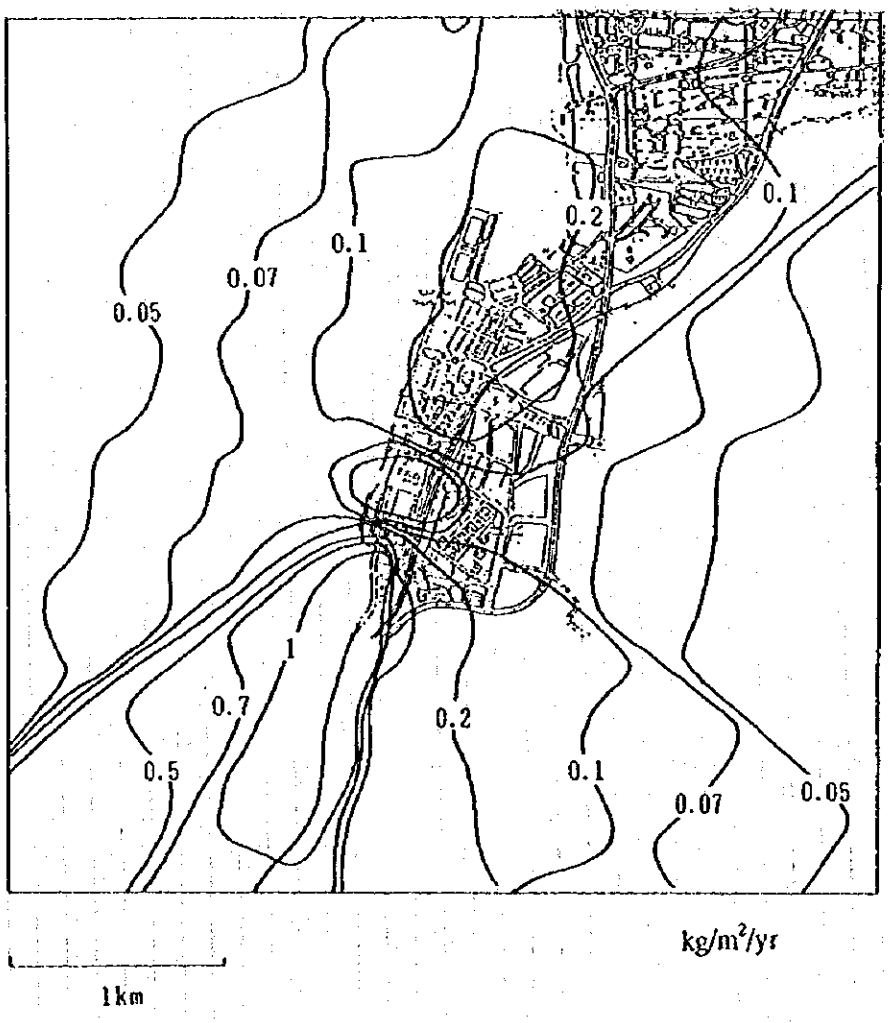


Figure 6.4.11 Simulated Horizontal Distribution of Phosphate Dust in Annual Value

6.5 Environmental Improvement Measures

Result of the examination based on the numerical simulation suggested the adverse impact of phosphate dust on port workers. PC has commenced a dust control project which is divided into three stages. The first stage was already finished and the second is now undergoing. In this numerical simulation, therefore, dust source left for the third stage was considered to contribute to the dust dispersion. They were recipient facilities from trucks and freight trains and storehouses (Shed No.5 and 6). Among them, main source is the storehouses (Table 6.4.9).

Table 6.4.9 Content of Dust Control Project and Percentage Composition of Contribution of Various Dust Sources

Stage	Facilities to be improved	Contribution in dust emission
First stage	* Berth "B" 2 loaders	60 % (Small total 60 %)
Second stage	* Berth "A" 1 loader * Transfer Towers * Truck dumping sheds(No.3 & 4)	10 % 7 % 2 % (Small total 19 %)
Third stage	* Truck dumping sheds(No.5 & 6) * Train dumping station * Stores	3 % 8 % 10 % (Small total 21 %) (G.total 100%)

In order to cope with the dust dispersion, perfect closure of the storehouse would be easiest and most effective.

Jordan Environmental Act has currently been established as a basic law to achieve the environmentally sustainable development. Environmental control carries the negative connotation of preservation and costly protection, conflicting with the urgent need to develop. The consequent point of contention is between those who view resource exploitation as serving the basic human needs and those who regard wasteful use of resources as leading to lowered productivity of the environment for the future.

Better methods and more organized systems of information flow that is more timely, accurate, complete and presented in useful format will help decision makers balance the demand for immediate gains from exploitation of resources with the necessity to maintain long-term ability of ecosystems to sustain development. EIA serves to provide organized information transfer on relevant aspects to decision makers. It includes identification, measurement, analysis, interpretation of technical knowledge and judgement and presentation. The inter-relationship between policy, action and assessment is shown in Figure 6.5.1.

EIA system should be introduced to Jordanian development projects to ensure the appropriate planning in harmony with economy, policy and engineering. Further legislative and administrative strengthening would be required, including preparation of environmental

regulations which support the environmental Act, institutional organizations which are responsible for development of environmental policy, installation of environmental guidelines, environmental evaluation of development projects execution of environmental and cooperation and negotiation with development authorities.

Execution of environmental control requires many activities. Among them, preparation of environmental quality standards and implementation of environmental monitoring will be listed up to the first priority. As for the development project of Port of Aqaba, monitoring of water quality during the construction work, particularly the turbidity, and the phosphate dust dispersion in the operation phase would be inevitable considering the preservation of coral reefs in this water area.

Though the coral reefs near the Container Port and the Industrial Port show healthy condition at present, observation by divers revealed that environmentally sensitive corals had just recovered recently from severe damage in these several years.

This means that coral reefs may be threatened by changes in marine environmental conditions such as water temperature, turbidity, eutrophication and predators. Monitoring of these aspects should be undertaken periodically.

Regarding its uniqueness as an international sea area of the Gulf of Aqaba, international cooperation to conserve the marine environment would be essential. The dispersion of turbid water occurring at the Industrial Port should be noted especially, as it is very close to Saudi Arabia and this may lead to a conflict between the two countries. Mutual understanding should be sought in advance.

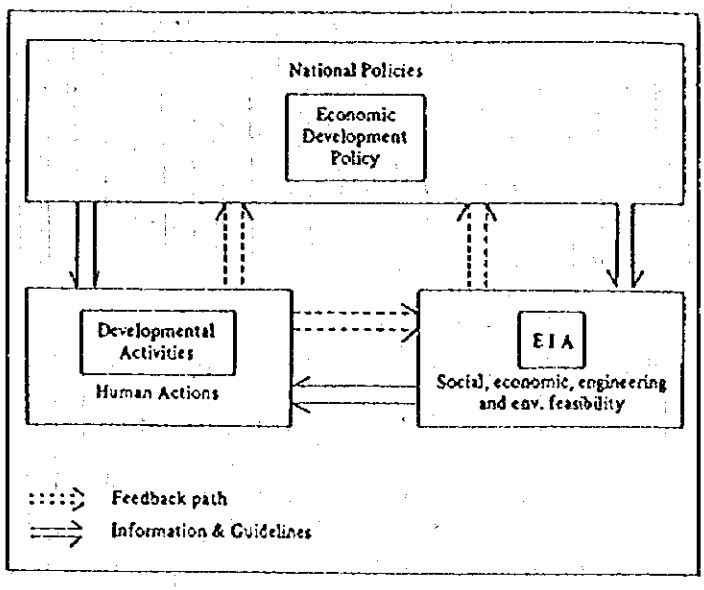


Figure 6.5.1 Inter-Relationship Between Policy, Action and Assessment

Chapter 7 Evaluation of the Feasibility of the Project

According to the feasibility study, the proposed Short-Term Improvement Plan is, as a whole, judged to be viable from economic, financial and environmental viewpoints.

(1) EIRR for the total project is 20 %. This means that EIRR of the proposed project fairly exceeds 10 %, which is employed as the opportunity cost of capital in many developing countries.

(2) Careful attention, however, should be paid to individual project components. The total project is comprised of four individual project components. There is a big difference between individual EIRR's values. The EIRR in case of improvement of JFI.1 Berth is about 11 %. Judging from port capacity at the target year, 2000, forecast cargo volume of livestock could be handled without improvement of JFI.1 Berth provided that other berths (container berth, Mo'ta and Mushtarak berth) could be available. Considering environmental issues and desirable berth allotment in future, this project is proposed. Its EIRR would become bigger if environmental merit can be calculated numerically and taken into account. But revised EIRR would not, in general, be at a good level even if such a calculation method were applied.

(3) There is little relation between individual project components so that they can be separately executed. In this context, the result of EIRR calculation shows the priority among project components, that is to say, the priority in terms of economic sense is, in due order, enlargement of grain berth, improvement of cargo handling system at the Industrial Port, development of new container terminal and improvement of JFI.1 Berth.

(4) FIRR is 8.0 %. This exceeds 2 %, which is estimated as the weighted average interest rate for expected foreign aids in Jordan.

(5) In calculation of FIRR, current tariff rate is adopted. The Ports Corporation has been actually making profit from port activities and contributing to the national budget revenue. Such a situation is not considered in the cash flow analysis. The budgetary statistics indicates that the contribution by PC represents about 1 %. Although this does not seem so high, this calculation precondition should be examined from the viewpoint of the national budgetary system. Due to the contribution, PC has not almost internal resources for future investment. Tariff is basically desirable at a proper level so that the port can make necessary investments. Accordingly, tariff level, if necessary, should be revised.

(6) One means to increase EIRR and FIRR is through reducing construction costs. Such a viewpoint should be regarded as most important when more detailed site investigation and design will be made in the process of implementation.

(7) One practical way of finance is to request external organizations to pay part of the construction costs. The proposed project consists of some components which will serve a specific use. Accordingly, it is reasonable that specific port users, for example, Jordan Phosphate Mine Co. Ltd., The Arab Potash Company Ltd., etc., bear a part of initial investment costs for fertilizer-related port facilities and equipment.

(8) It should be noted, however, that the above (soliciting external funds) does not constitute an application of BOT (Build, Operate and Transfer). BOT is a financial scheme often considered in developing countries which find it difficult to raise investment funds of

their own. Even at the port of Aqaba, introduction of BOT for implementation of some project components has been discussed. In this Study, however, BOT is not proposed because of difficulty in finding BOT investors.

(9) Environmental Impact Analysis shows that the proposed project will not cause serious problems for the environment.

(10) Dust dispersion of phosphate, however, should be reduced. PC has been executing countermeasures to reduce phosphate dust dispersion. Some of them were already completed and others are scheduled by PC. It is, therefore, recommended that PC should monitor the effect of the existing countermeasures and ensure that scheduled ones are executed urgently. It is, in addition, desirable that study on relocation of the existing phosphate berth (including related transportation and storing system) will be carried out as soon as possible.

(11) Other than the above, in order to ensure compatibility between port activities, port development and environment, people and organizations concerned should become conscious of significance of environmental protection and upgrading of the Gulf of Aqaba and thus be ready to take actions needed. PC should become the head of the movement.

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