

20. Environmental Policy and Legislation

20.1 Environmental Conservation Policy

20.1.1 Background

The sultanate of Oman is the one of the most environmental concerned countries among the Arab nations in its environmental conservation and pollution control policies.

The first environmental legislation was enacted in 1974 and in 1979, His Majesty the Sultan decided to chair the Council for Conservation of the Environment and Prevention of Pollution; and the Oman became the first Arab country to set up a ministry exclusively concerned with the environment in 1984.

Since then, the laws and acts for the conservation of environment and the prevention of pollution have been issued; furthermore, the number of studies and programs has been implemented to conserve the natural asset of the Sultanate of Oman.

Royal Decree 10/82 – Law on the conservation of Environment and the Prevention of Pollution is the pioneer environmental law that defines the environment to include air, water, soil, flora, fauna, marine life, mineral and chemical resources, energy services and social resources.

Decree No. 26/79 – a designated number of areas as Nature Reserves (NR's) by the Ministry of Commerce with the reinforcement by the IUCN study in 1986 and by the Sub-regional Land Use Plans (SRLUP) defined the zones of the natural conservation areas of the Oman.

Ministerial decision 2/90 established regulations for "Coastal Set-back Zones" to conserve ecological, recreational, cultural and scenic resources identified with coastline.

With these forward-looking endeavors to the environmental protection and conservation, the Oman have drawn an international recognition and was cited as a country with one of the best records in environmental conservation and pollution control measures by the United Nations.

20.1.2 Coastal Zone Management and Wildlife Preservation

Since 1984, an extensive studies and programs have been launched to protect Oman's natural resources and heritage; and the coastal environments have been intensively studied for management purposes.

A seven-year coastal zone management project was started in 1984 in response to the threat posed by rapid urban development. This project covered the entire 1,700 km long coastline of Oman involving detailed ecological survey. Furthermore, a new action plan for coral reef management; and a proposal to grow mangroves were announced by the Ministry in 1997.

Wildlife has been protected by the strict laws from being hunted, and natural reserves have been established to prevent encroachment on the natural habitats of species. Endangered species and rare plants and trees have been protected or studied.

Through these environment protection and conservation acts and achievements, the Sultanate of Oman has become and being recognized as a country keen to the environment concern internationally.

20.1.3 Development and Environment

The judicious balance between environment and development is a key for the Sultanate of Oman.

The MRME (previously, Ministry of Environment and Water Resources or Ministry of Environment) has been entrusted with the task of enforcing the environmental law, establish environmental monitoring system and carry out environmental studies. Several ministerial decisions occur every year to establish environmental standards and practices.

The Ministry of Environment was entrusted with the responsibility of nature conservation, with co-operative participation of other concerned planning policy-making agencies such as MoCI, MNHC, MoHLROP, OMSGD, etc. by Royal Decree 52/88.

The present Ministry's policy is that approval and issuance of certificate are required prior to the implementation of the industrial construction project. The Ministry examines the potentiality of damage to the environment and ensures that all measures have been taken to minimize pollution.

To ensure a proposed projects are sustainable, environmentally sound and any environmental effects that are recognized early and to be considered onto the design, the "environment permits" will be necessary.

All the necessary procedures for processing applications for "environment permits" formally defined as "Owners of new sources of work must submit an Environmental Impact Statement to the Ministry and obtain a No Environmental Objection Letter (NEO) stated by Royal Decree 10/82 " are stated in "the Information Guide for Environmental Permit Application Review Process Ministry, Ministry of Regional Municipalities and Environment, Draft - 7.06. 1999.

20.1.4 Present Concerns for the Environment

The MRME present major concern related to the Study Area is as follows:

- (1) Socioeconomic Impacts of the Proposed Development
- (2) Impact on the Existing Infrastructure and Future Needs

- 1) Water supply
- 2) Wastewater treatment
- 3) Solid waste disposal
- 4) Management of hazardous

- (3) Impact on Tourism

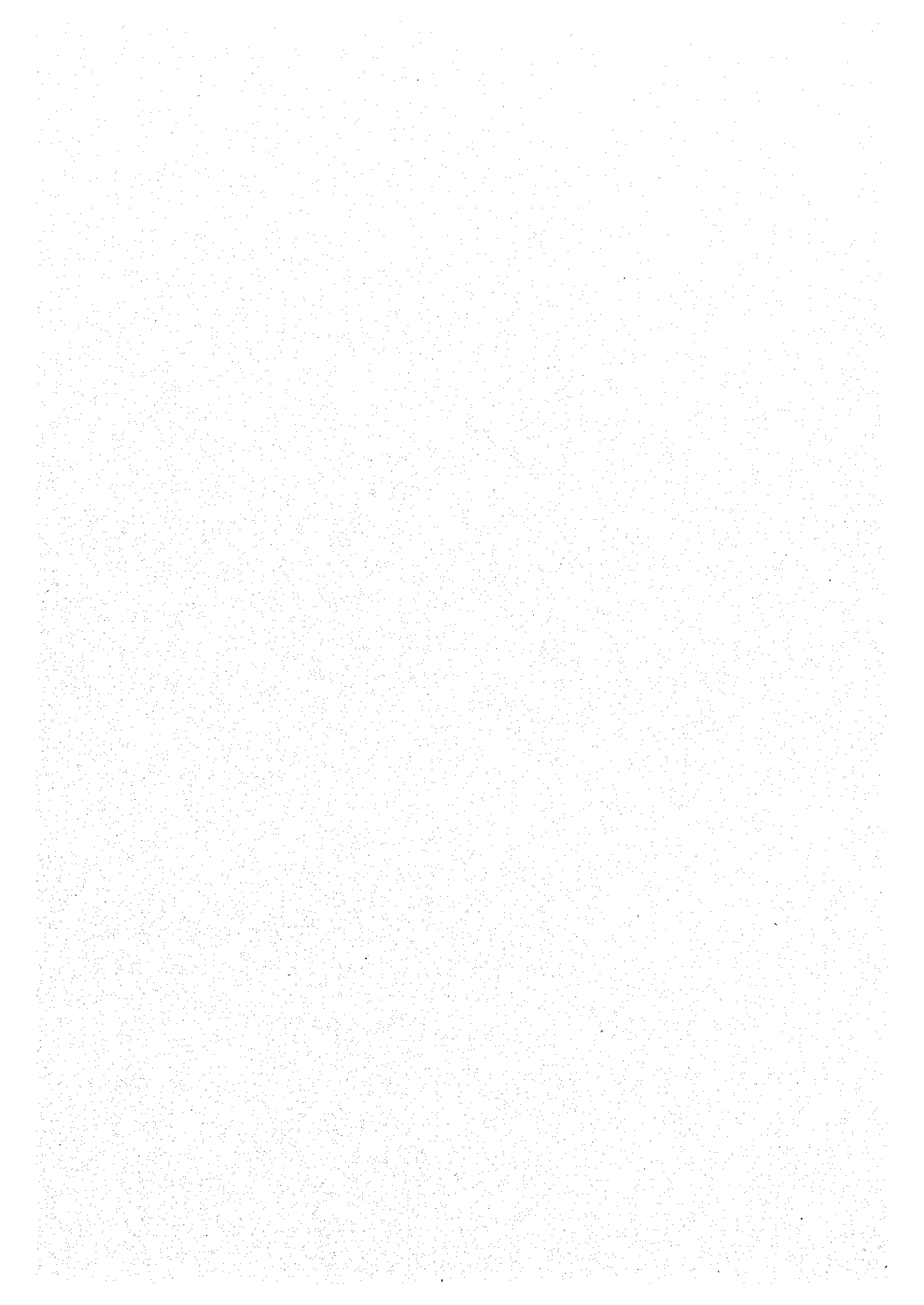
A measures that makes offset the negative impacts of tourism.

- (4) "Green belt" and other Buffer Zones

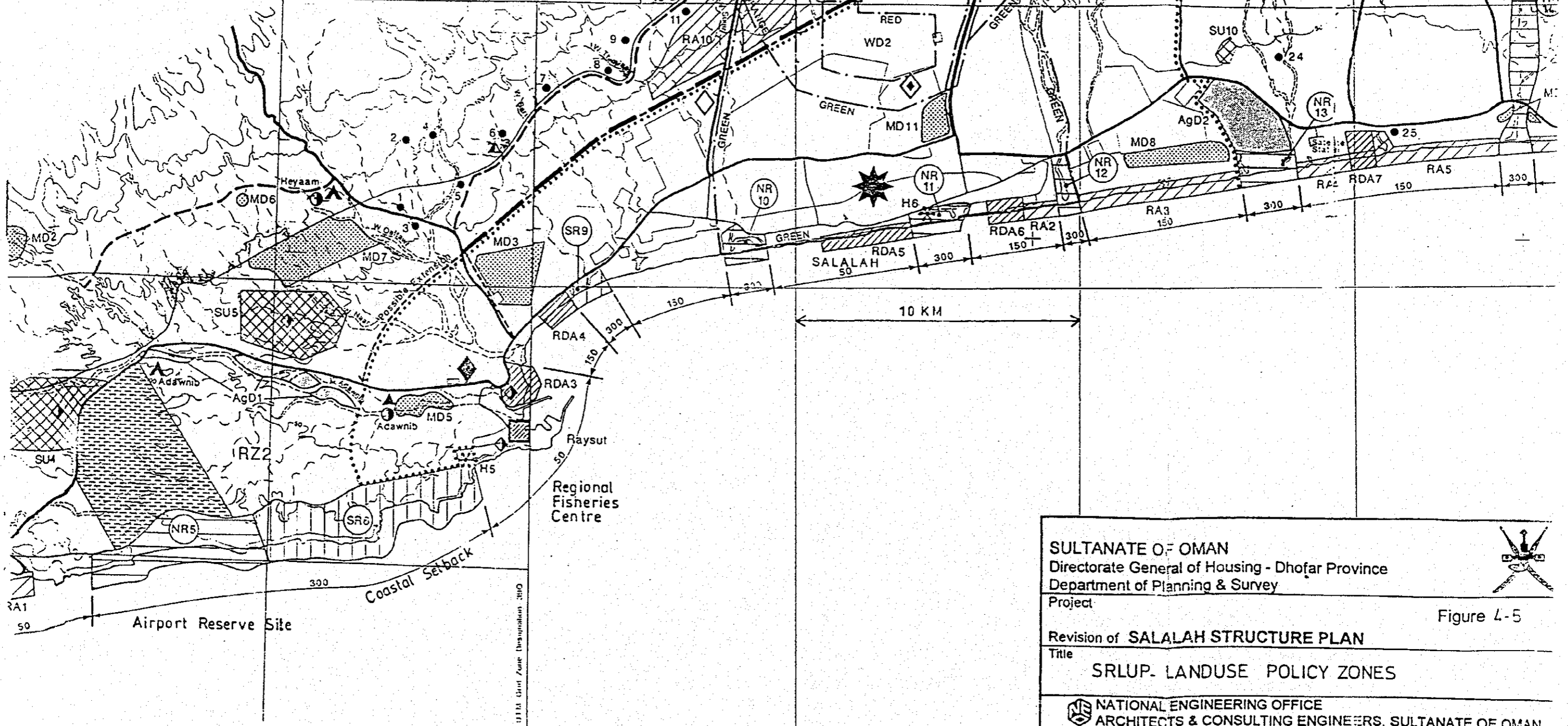
This is to have a function of separating industry from housing areas and other sensitive land uses.

20.1.5 Environmental Conservation Area

The following figure shows the present environmental conservation area in the Salalah region.



CONSERVATION AREAS : NATURE RESERVES AND SCENIC RESERVES		MINERAL DEVELOPMENT AREAS		HERITAGE SITES	
Sidah	NR5	Ayn Sarit	MD2	Raysut Heights	H5
Jebel Hamer	SR5	Raysut Cement Plant	MD3	Al Baleed	H6
Khawr Qurm	SR9	W/E of Khawr Sawli	MD4	Ayn Hamran	H21
Khawr Salah	NR10	Wadi Adawnib	MD5	AGRICULTURAL DEVELOPMENT AREAS	
Khawr Baleed	NR11	Raysut Sink Hole	MD6	Wadi Adawnib	AgD1
Khawr Dhariz	NR12	W+NW of Cement Plant	MD7	East of Razat Farm	AgD2
Rzat Coast	NR13	Wadi Hayeed	MD10	SPECIAL USE ZONES	
Khawr Sawli	NR14	Salalah-Surplus Agricultural Land	MD11	Adawnib Ammunition Depot	SU4
WATER RESOURCES DEVELOPMENT ZONES		RECREATION DEVELOPMENT AREAS		RECREATION AREAS	
Salalah	WD2	Raysut Frontier Force	RDA3	Mughsal Beach	RA1
Wadi Garzeez	WD3	W of Al Muhit	RDA4	W of Khawr Dhariz	RA2
Sahalnawt	WD4	Al Hafa Corniche	RDA5	Razat Farm Coast	RA3
Al Saadah	WD5	Holiday Inn Beach	RDA6	East Razat Coast	RA4
Ayn Razat	WD6	Khawr Qurm	RDA7	Khawr Sawli West	RA5
Ayn Hamran	WD7	Ayn Razat Garden	RDA14	Khawr Sawli East	RA6
Ayn Tobruk	WD8	Ayn Hamran Garden	RDA15	Ayn Garzeez	RA10
				SPECIAL USE ZONES	
				Adawnib Ammunition Depot	SU4
				Raysut Range	SU5
				Marmarah Palace	SU10
				Ayn Razat camp	SU12



SULTANATE OF OMAN
 Directorate General of Housing - Dhofar Province
 Department of Planning & Survey

Project: Figure 4-5

Revision of SALALAH STRUCTURE PLAN

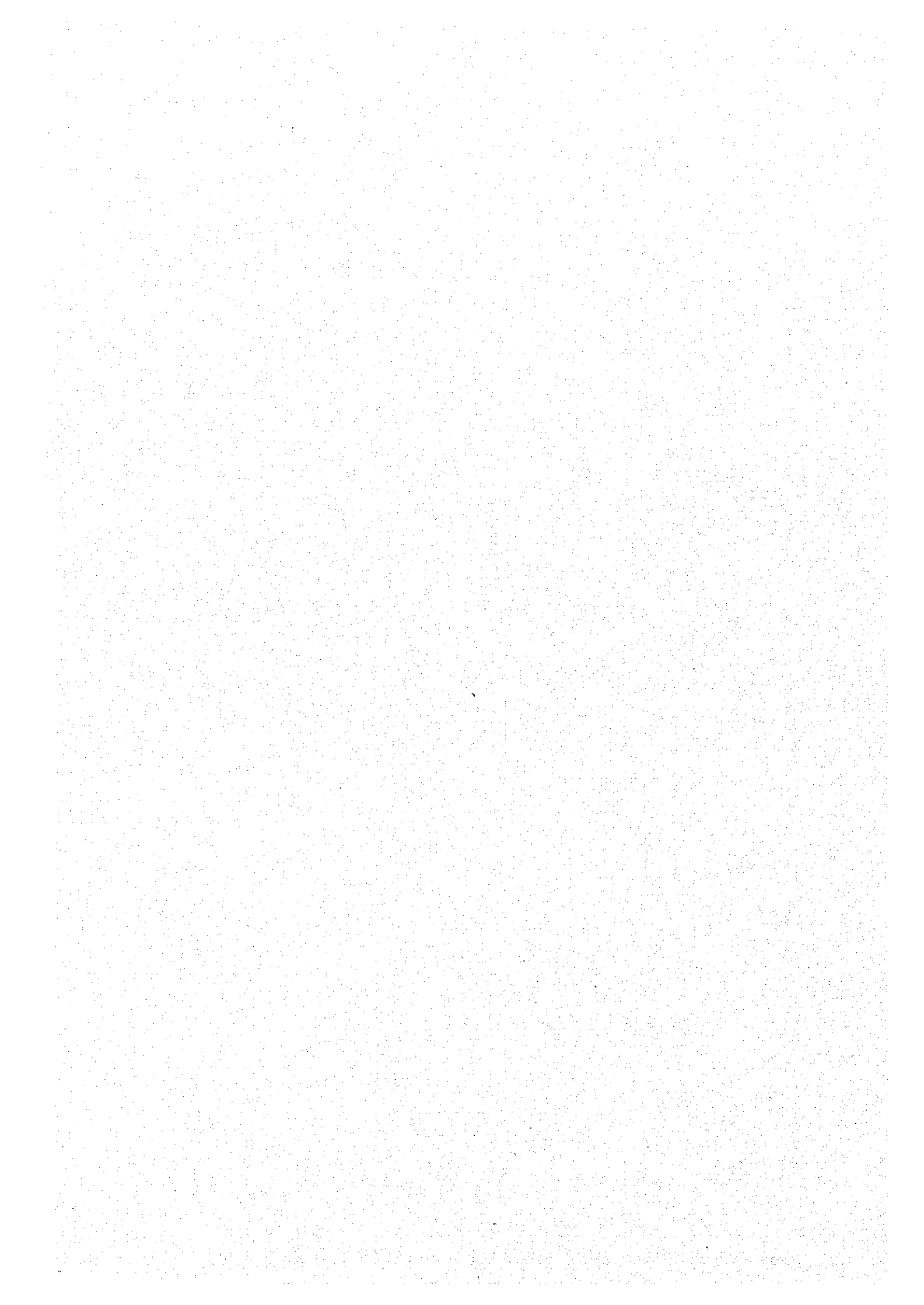
Title: SRLUP. LANDUSE POLICY ZONES

NATIONAL ENGINEERING OFFICE
 ARCHITECTS & CONSULTING ENGINEERS, SULTANATE OF OMAN

DOXIADIS ASSOCIATES
 CONSULTANTS ON DEVELOPMENT AND EKISTICS, ATHENS, G

Regional land Use Plan for Salah Sub-Region
 Prepared by WS Atkins for PCDESR in 1990

Figure 20.1.1 Environment Conservation Area in Salah



20.2 National Environmental Legislation 2000

At the present time (April 2000), the following Royal Decrees/ Ministerial Decisions and sub-permits/licences are relevant to the Environment Permits that introduces in the next section.

(1) Air / Noise & Radioactive Materials

- MD 5/86 Regulations for air pollution control from stationary sources.
 - MD 80/94 Regulations for noise pollution control in the working environment.
 - MD 79/94 Regulations for noise pollution control in the public environment.
 - MD 249/97 Regulations for the control and management of radioactive materials.
- and
PERMIT to import/use radioactive materials.

(2) Water / Waste Water / Non-hazardous & Hazardous Waste

- MD 8/84 Regulations for the disposal of liquid industrial waste.
 - MD 421/98 Regulations for the septic tanks, soak away pits and holding tanks.
 - MD 5/86 Regulations for external building drainage.
 - MD 17/93 Regulations for the management of solid non-hazardous waste.
- and
LICENCE to operate non-hazardous waste disposal site.
LICENCE to transport non-hazardous waste.
LICENCE to dispose non-hazardous waste.
LICENCE to recycle non-hazardous waste.

- MD 18/93 Regulations for the management of hazardous waste.
- and
LICENCE to operate hazardous waste disposal site.
LICENCE to transport hazardous waste.
LICENCE to dispose hazardous waste.
LICENCE to recycle hazardous waste.
LICENCE to store hazardous waste.

- MD 145/93 Regulations for the wastewater reuse and discharge.
- and
PERMIT to discharge or reuse wastewater.
PERMIT to construct wastewater treatment facility.

- MD 40/88 Wadi Adai water supply well field protection zone and action plan.
- MD 45/88 Salalah water supply well field protection zone and action plan.
- MD 11/89 Western water supply well field protection zone and action plan.

(3) Marine

MD7/84 Regulations concerning the disposal of liquid effluents to the marine environment.

PERMIT for dumping at sea under the International Marine Organization, London Convention 1972.

(4) Potentially Toxic Chemicals

MD 248/97 Regulations for the handling of toxic substances.
and

PERMIT-Environmental permit for dealing with toxic chemicals.

(5) Other Relevant Environmental Legislation at 2000

Reference	Legislation Title
RD 34/73	Omani Labour Law
RD 42/74	Law of Petroleum and Minerals
RD 9/75	The Economic Development Law. Includes consideration of environmental protection.
MD 4/76	Protection of Certain Species of Birds.
RD 23/78	Signing of the Kuwait Regional Convention on The Protection of the Marine Environment from Pollution and its Protocol.
RD 8/79	Ratifies the Kuwait Regional Convention on the Protection of the Marine Environment and Protocol for Regional Cooperation in Combating Pollution Caused by Oil and other Harmful Substances.
RD 26/79	Law on National Parks and Protected Nature Areas
RD 2/80 & RD 6/80	Law on National Heritage Protection (Regarding historical and archeological sites)
RD 5/80	Decrees that all land in Oman belong to the Government . No differentiation Between land and sea.
RD 25/81	International Convention for prevention of Pollution From Ships: MARPOL 73/78
RD 25/81	Convention on Prevention of Marine Pollution by Dumping of Wastes and Other Matters: London Convention 1972
MD 40/81	Building code for Oman . Defines buildings, permanent buildings, temporary Buildings, requirement for building permits, setback, and inspections and violations.
RD 53/81	Law of the Sea Fishing and the Protection of Marine Biological Wealth
RD 69/81	Ratification of Accession of the Convention on the Protection of the World's Culture and Natural Heritage (UNESCO's World Heritage Convention)
RD 10/82	Law for the Convention of the Environment and Prevention of Pollution (refined in RD 63/85 and RD 71/89)

MD 19/82	Occupational Health and Industrial Safety Precautions
RD 81/84	Regulations concerning the distribution of land for agricultural, commercial and Industrial purposes. Land is allocated by the Ministry of Housing. Since 1991 no new lands are to be allocated to agriculture because of water problems.
RD 27/85	Establishment of the Supreme Committee for Town Planning. This prepares and oversees general policies for town planning for approved development plans. Has prepared interim guidelines for development in flood hazard wadi areas. Any such proposed developments are reviewed by the Ministry of Water Resources.
RD 63/85	Amending Certain Provisions of the Law on pollution of the Environment and Prevention of pollution Rd 10/82. This amendment requires that an environment Impact statement be submitted with development applications to the authorities
MD4/87	Contains standards for the issuance of licences for quarries and mines
RD 75/87	Land Expropriation Law.
RD 82/88	Water reserves as a National wealth
RD 88/88	Accession of the Sultanate Oman to the International Plant Protection Convention
17.08.89	Accession of the Sultanate to the United nations Convention on the Law of The Sea.
RD 71/89	Amending some Provisions of the Law of Conservation of the Environment and Prevention of pollution RD 10/82. Requires the submission of an environmental impact statement to obtain a No Environmental Objection letter and a permit to Discharge. Once a Discharge Permit is issued, status reports are required every 3 months. Any rectification costs for affected parties must be covered by the transgressor.
RD 92/89	Ratification of the Protocol concerning marine pollution resulting from the Exploration and Exploitation of the Continental Shelf (23.02.89)
MD 100/89	Establish the Ministry of Water Resources
MD 2/90	Regulations for the Registration of Existing Water Wells and New Well Permits
MD 15/90	Establishing the Permanent Committee for National Conservation Strategy (NCS) - lists its members and competencies.
MD 20/90	Establishes a System for Coastal Setbacks for new construction along the coastline. Natural coastline setback 300m, sandy beach around khawrs 150m, sandy beaches 50m.
MD 79/90	Establish the Technical Coordination Committee for the Southern Region
RD 90/91	Accession to Protocol for the Protection of Marine Environment against Pollution from land - based Sources (10.11.91)
RD 117/91	Establishes the MRME and transfers all powers of the Ministry of the Environment and the CCEPP to it
MD 167/92	Establishment of a Committee for the Sound Management of Chemical Substances

RD 31/93	Amending the Law for Conservation of Environment and Prevention of Pollution (26 May 1993)
MD 120/93	Prohibits the digging and removal of sand from coastal beaches, coasts, wadi's without a permit from Ministry.
MD 128/93	Ban on cutting Green Trees
MD 207/93	Ban on Hunting, Trapping or Shooting Animals or Birds in the Sultanate
MD 298/93	Regulates operation of stone crushers and quarries
MD 300/93	Regulating Issuance of Environmental Permits
RD 4/94	Declares the Boundaries of the Arabian Oryx Nature Reserve
8.01.94	Accession of the Sultanate to the Convention on Biological Diversity
7.12.94	Accession of the Sultanate to the Basel Convention on the control of Transboundary Movements of Wastes and their Disposal
RD 120/94	Promulgating the Law on Organization of Engineering Consultancy Offices
RD 46/95	Regulations on the Circulation and use of Chemicals
RD 47/95	Amends some Provisions of the law Establishing National Parks and Protected Nature Areas
MD 209/95	Specifying penalties for business and industrial establishments not complying with conditions of an environmental permit.
RD 25/96	Designating the Ra's Al Hadd Turtle Reserve
MD 42/96	Approving Policies and Provisions of Privatization
RD 23/97	Designating the Juzur ad Dimaaniyat Nature Reserve
RD 48/97	Designating the Jebel Samhan National Park, As Saleel National Park and the Dhofar Akwaar
MD 248/97	Regulates issuance of permits and handling of chemical substances.
MD 77/98	Prohibits illegal dumping of refuse and littering.
MD 421/98	Regulations for septic tanks, soak away pits and holding tanks. It replaces MD 5/86.
RD 73/98	Ratifies the Sultanate joining the Vienna Agreement on the Protection of Ozone Layer and Montreal Protocol on Ozone Layer Depleting Materials.
RD 75/98	Amends the Law of Environmental Protection and Combating Pollution (RD 10/82) Article 30 increasing penalties to people causing damage to nature reserves, including plants and animal life.
RD 18/99	Defines the powers of the MRME and approves its organizational structure. It cancels RD 117/91 and 95/92

20.3 Environment Permit Application Review Process

20.3.1 General

At present, most of projects implemented in the Sultanate of Oman will be required to follow the following the Environmental Permit Application Review Process to obtain the Environmental Permit and other sub-Permits/licenses from MRME.

Environmental Permit Application Review Process DRAFT - 7.06.1999

The following sub-sections are an introduction of the above Environmental Permit Application Review Process.

20.3.2 Information Guide

The purpose of the Ministry's policy and procedures for processing applications for environmental permits is to ensure that proposed projects are sustainable, environmentally sound and that any environmental effects are recognized early and taken into consideration in project, design. The following five points define the legal framework of the permitting process and some technical terms frequently used in this document.

- (1) Article 14 of Royal Decree 10/82 requires that feasibility studies should contain an Environmental Chapter. Feasibility studies are normally required for larger projects and for all projects where Government financial assistance is required. This ensures, among other things, that environmental issues affecting the costs of the projects are taken into account from the outset (for example: mitigation costs or location in high sensitivity areas).
- (2) Article 13 of Royal Decree 71 /89 "Amending some Provision of the law on Conservation of new sources of work and Prevention of Pollution (Royal Decree 10/82) " states that "Owners of new sources of work must submit an Environmental Impact Statement to the Ministry and obtain a No Environmental Objection Letter (NEO) ", and Permit to Discharge the Ministry.

The Ministry is now the Ministry of Regional Municipalities and Environment (MRME), and the NEO letter is now referred to as the "Environmental Permit". The "New sources of work" refer to new projects, construction decommissioning abandonment or expansion of facility that would result in a significant increase in its production capacity

- (3) The terms "permit to discharge", or " permit to use and handle chemicals", or "waste licenses" refer to the documents arising from the Environmental Permit. These documents are required by Regulations issued by Ministerial Decisions that govern the technical specifications and standards for emissions and related activities.

- (4) The terms "Environmental Impact Statement (EIS)" refers to a document which summarizes the environmental impacts and proposed mitigation measures.
- (5) The terms "Environmental Impact Assessment (EIA)" refers to a detailed environmental study of a development project that has diverse and significant, environmental impacts. A formal EIA should include but not be limited to:
 - 1) Project description
 - 2) Baseline data
 - 3) Comparison of alternatives and their impacts (negative or positive) on all aspects of the environment
 - 4) Proposed mitigation measures
 - 5) Risk assessment
 - 6) Evaluation of the net effects of the development
 - 7) Proposed monitoring and follow-up activities
 - 8) Inter-agency coordination
 - 9) Consultation with affected communities
 - 10) Clear and complete EIS document.

20.3.3 Environmental Permit Procedure

(1) Preliminary Consultation

Before submitting the application, the proponent should contact the Ministry to discuss details of required documentation. The proponents are encouraged to discuss proposed projects informally with staff of the Ministry (for example: Directorate-General of Nature Reserves, Directorate-General of Environmental Affairs, etc) at an early stage, before detailed studies or plans are drawn up.

A feasibility study, complete with its environmental chapter, may be utilized during the preliminary consultation. This preliminary consultation may give the proponent an early warning of environmental sensitivities of the chosen area, or serious secondary effects related to the project.

The preliminary consultation is very important and may save the proponent time and money spent on unnecessary studies or on projects located in inappropriate locations.

(2) Application Review Process

The procedure for processing of an application for the Environmental Permit from the Ministry can be divided into three (3) stages.

1) Stage 1: Application Submission Stage

This stage begins the application review process and consists of submitting a completed set of documents required by the Ministry. The submission package shall consist of completed and signed copies of Application for Environmental Permit form, supporting technical documents, permits from other Ministries (if necessary). The review is requested for most projects with exception of small projects with insignificant environmental impacts.

Under the current system, Regional offices accept applications for Environmental Permits, conduct site visits, write recommendations and subsequently send the files to the Department of Environmental Permits and Impact Assessment in Muscat.

The time required for this stage depends entirely on the applicant's ability to assemble and submit the completed application package. Once this stage is completed, the application package undergoes a technical appraisal by the Ministry.

2) Stage 2: Technical Stage Appraisal / Screening

At this stage of the review process, technical staff of the Ministry conducts a screening followed by a detailed review of the application to determine the type of environmental analysis that is required for the project.

(a) Small Development Projects

In many cases for simple small business/light industries the requirements of the Environmental Permit review process will be fulfilled by filling out Environmental Permit Application forms and the subsequent issue of an Environmental Permit with appropriate conditions.

(b) Large Scale Potentially Environmental Impacting Polluting Industries

A comprehensive environmental impact assessment study may be required. EIA and other analysis are the responsibility of the applicant, but Ministry's staff is available to assist whenever requested, for example in discussing the scope of the EIA study or terms of reference. EIA is a flexible process, designed to accommodate the entire range of projects and different circumstances.

There is no fixed list of specific industries, developments or their sizes which would trigger a detailed EIA; instead the Ministry's procedure relies on screening, identifying significant impacts on sensitive areas, and discussion between the Ministry and applicant to identify any critical issues and to establish the scope of the EIA. However, certain types of projects or their elements commonly fall into categories of projects requiring a detailed EIA study.

Illustrative examples of some projects that commonly require a detailed EIA study are as follows.

- a) Aquaculture projects
- b) Dams and reservoirs
- c) Electrical transmission (large scale)
- d) Industrial plants and industrial estates (large scale)
- e) Irrigation and drainage schemes (Large scale)
- f) Mineral development (including oil & gas)
- g) Pipeline (oil, gas, water)
- h) Port and harbor developments
- i) Desalination plants
- j) Primary and rural roads
- k) Thermal power development
- l) Large scale tourism projects
- m) Urban water supply and sanitation (large scale)
- n) Transportation (airports, railways, roads)
- o) Urban development (large scale)
- p) Manufacture, transportation and use of pesticides or other hazardous and/or toxic materials.
- q) Projects which pose serious accident risks
- r) Projects with the potential for significant impact on the following sensitive areas: marine environment, ground water, designated and proposed National Parks and Nature Reserves, the atmosphere.
- s) Large scale Government camps and military training areas.
- t) Regional and sub-regional development plans
- u) Any project or activity designated by the Minister.

A detailed EIA study is normally unnecessary for projects which due to their scale, location or characteristics are unlikely to cause significant environmental impacts. MRME will decide in consultation with the applicant whether or not a detailed EIA study is required. The final decision is that of MRME.

The outcome of this decision affects the amount of time required for this stage of review, mainly because of the additional time required to prepare and review the EIA. If no detailed EIA study is required, the time required for this stage shall not exceed 60 days after submitting all necessary documents and information.

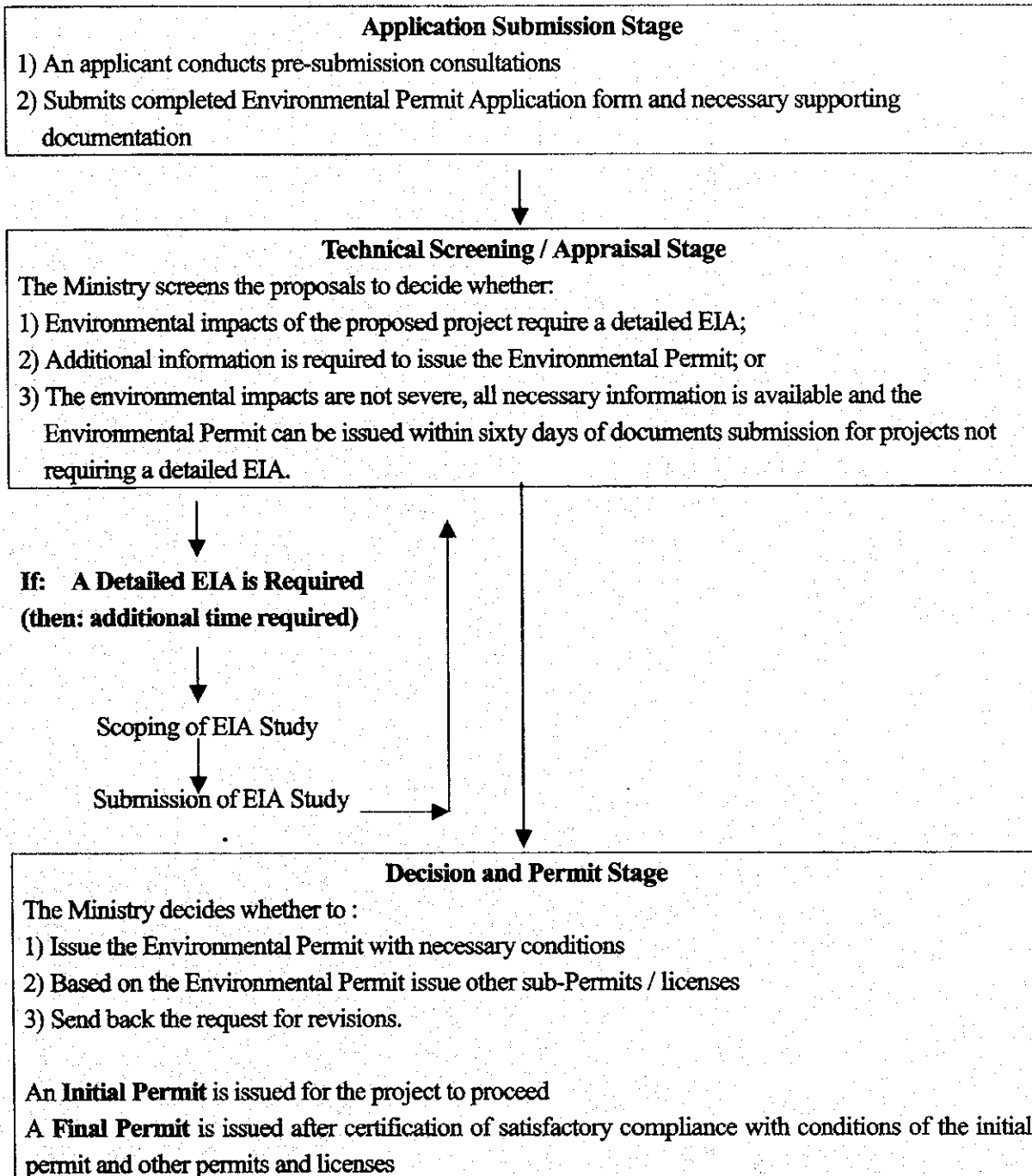
3) Stage 3: Decision and Permit Stage

After technical review of the complete application package (with or without an EIA study), the Ministry decides whether to issue the Environmental Permit or send back the request for revisions. The Environmental Permit may contain a number of conditions necessary to

ensure the environmentally safe implementation and operation of the development.

The development must also be in conformity with the various Regulations / Ministerial Decisions, some of which require sub-permits/ licenses to the Environmental Permit and these must also be obtained by the applicant.

The following flow chart shows the procedure of Environmental Permits Procedure - Application for Permit Review Process.



21. Project Description

21.1 Proposed Project

21.1.1 General

The primary purpose of this Project is to contribute the Oman's economic policy that aim to reduce oil dependency of their present economy by developing one of major port of the region of Oman, Salalah by the year of 2020.

To realize this purpose, the Scope of Work on the Master Plan of Study for Port Salalah and its hinterland was established in March 1999; and the actual Study was implemented in December 1999 by the grant of Japan International Cooperation Agency (JICA) that is the body of organization for international cooperation and the agency of Ministry of Foreign Affairs of Japan.

The following sections show the main element of the Master Plan Study.

21.1.2 Port Development Plan

(1) Demand Forecast

Demand forecast at the target year of 2020 is as follows.

- | | | |
|---------------------|-----------|-------------------|
| 1) Container Cargo: | 280,000 | TEU |
| 2) General Cargo: | 330,000 | tons |
| 3) Bulk Cargo: | 1,800,000 | tons (except oil) |

(2) Layout Plan

The layout plan for 2020 is shown in Figure 21.1.1. This plan comprises two (2) main basins with deep alongside draft that is protected from waves and sedimentation by a breakwater and groin. Main components of the plan are shown in the following Table 21.1.1.

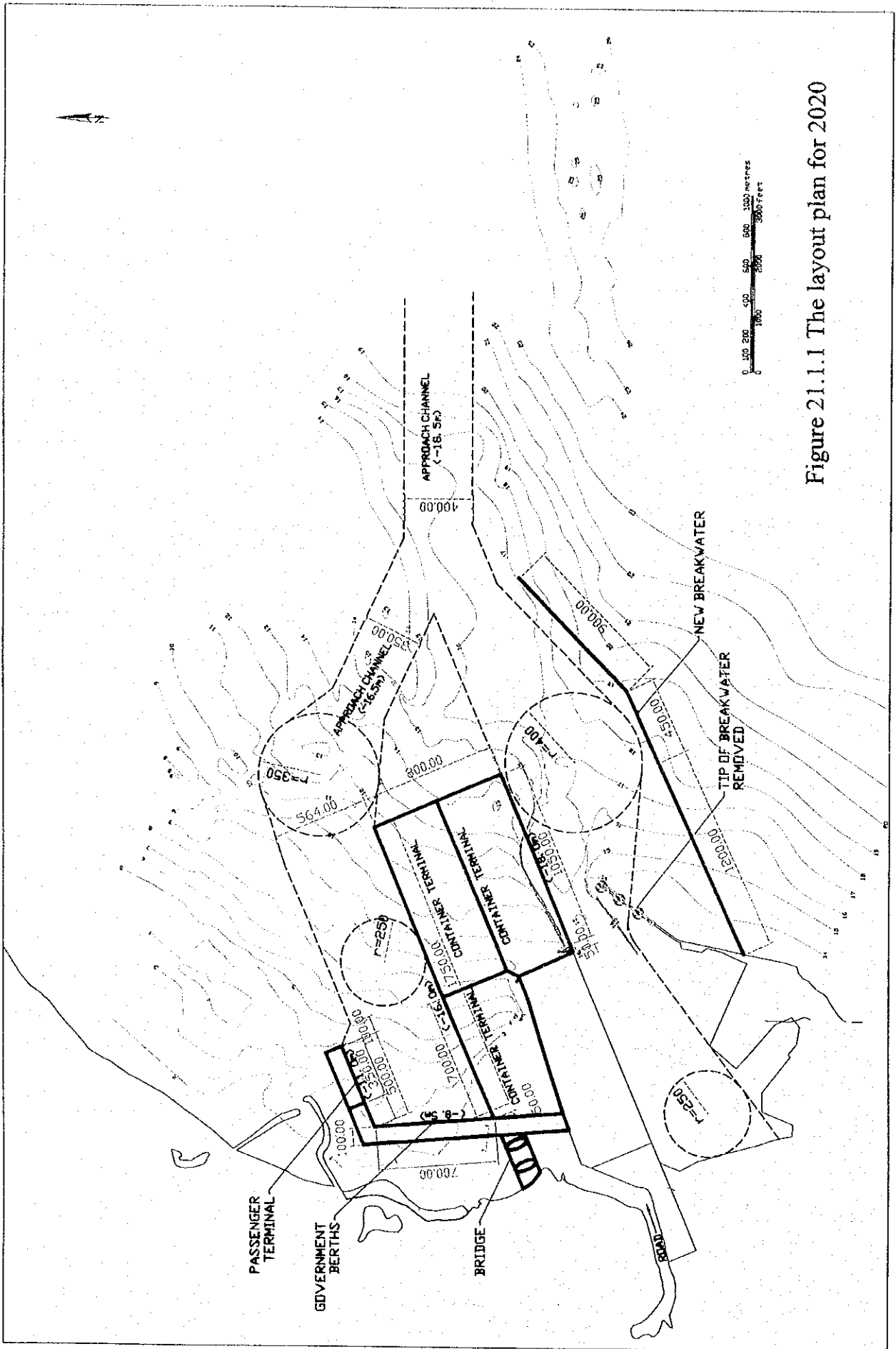


Figure 21.1.1 The layout plan for 2020

Table 21.1.1 Master Plan for 2020

Facility	Dimensions
Additional Berths	18m draft container quay: 1,050m 16m draft container quay: 1,750m Passenger berth: 350m Government berth: 800m (Future expansion: 980m with 12m depth)
Additional Terminal Area	112ha (Additional 42ha for future expansion)
Handling Equipment	Container: 15 gantries (18 rows), 9 gantries (22 rows), 48 RTGs, 96 yard tractors Conventional: 2 grab bucket cranes
Container Handling Capacity	6 million TEUs/year
Breakwater	2,550 m
Dredging	17,393,000 m ³ (Additional 331,000 m ² for future expansion)
Reclamation	15,062,000 m ³ (Additional 7,271,000 m ² for future expansion)
Total Cost	310 million R.O.

(3) Short Term Plan

Since the capacity of existing container terminal is assumed as 2 million tones, it is expected that its capacity will reach its maximum and insufficient to handle all the demand by the year of 2002 or 2003.

The short-term plan was prepared and shown in the following Table 21.1.2. Two (2) plans, Short-term A and B, were designed and compared in term of capacity evaluation, wave disturbance, terminal operation, balance of dredge and land reclamation volume, and so forth.

Base on the evaluation of these two plans, the Short-term B was recommended. The layout plan of Short-term B is shown in Figure 21.1.2.

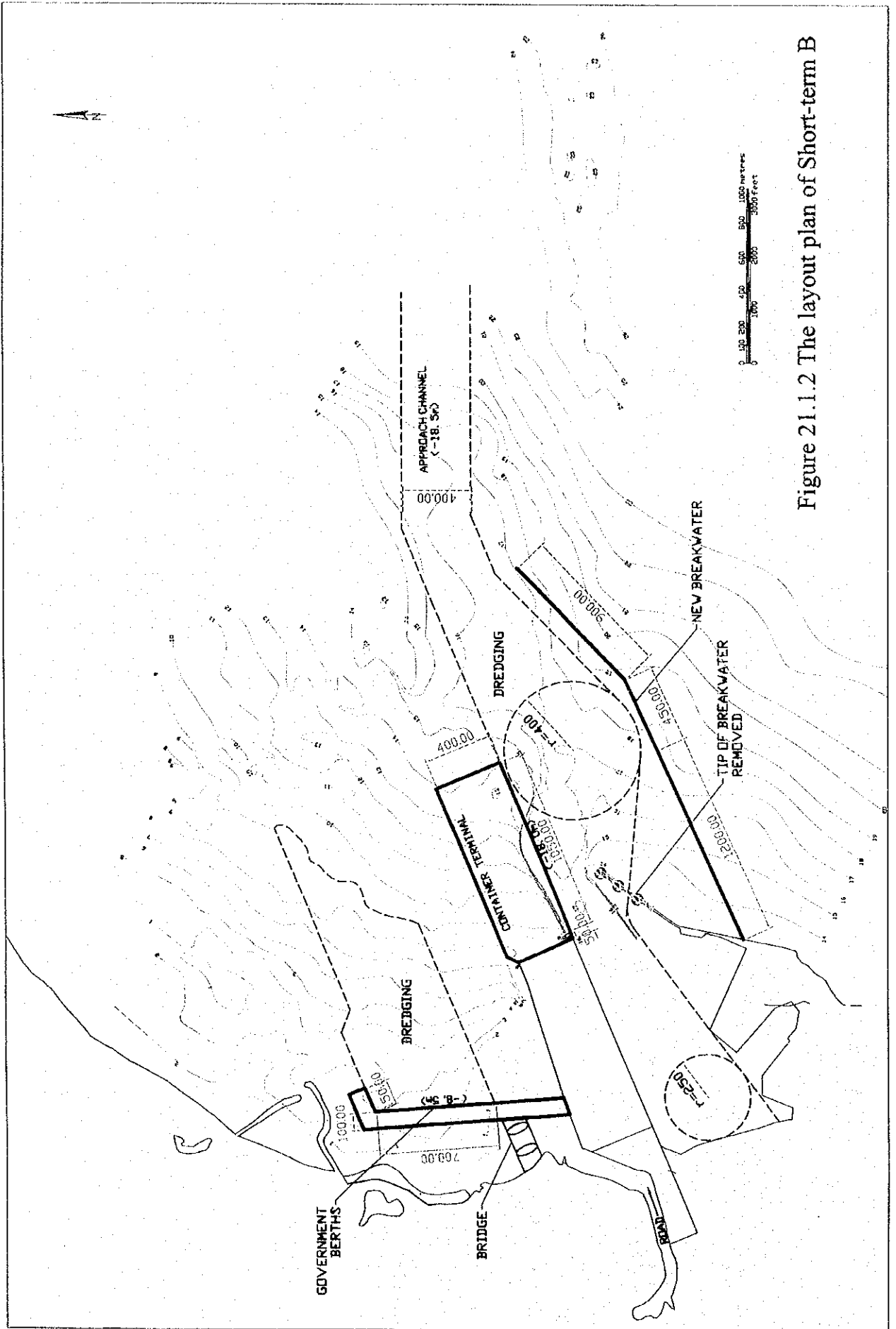


Figure 21.1.2 The layout plan of Short-term B

Table 21.12 Short-term Plan 2005

Facility	Dimensions	
	Plan A	Plan B
Additional Berths	16m draft container quay: 700m Government berth: 800m	18m draft container quay: 1,050m Government berth: 800m
Additional Terminal Area	28 ha	42 ha
Handling Equipment	6 gantries (18 rows), 12 RTGs 24 yard tractors	9 gantries (22 rows), 18 RTGs 36 yard tractors
Container Handling Capacity	3 million TEUs/year	3.5 million TEUs/year
Breakwater	1,200 m	2,550 m
Dredging	13,779,000 m ³	6,722,000 m ³
Reclamation	3,060,000 m ³	7,003,000 m ³
Total Cost	118 million R.O.	165 million R.O.
Wave Disturbance	Not ensure safe berthing	Sufficient protection
Waiting Time	Long	Short
Evaluation	Not suitable	Suitable

21.1.3 Hinterland Development Plan

(1) Definition and Assumption

Among the long-term fundamental goal set as the basis of economic and social strategy in the Sultanate, this Industrial Development Plan for 2020 assumes particularly of the following for future development consideration:

- 1) Enhancing the proportion of investments directed towards income generating projects, with particular emphasis on industry, mining, agriculture and fisheries.

Namely, the encouragement of local production will be emphasized in this plan, besides promotion of redistribution and related businesses.

- 2) Concentrating on the development and upgrading of local human resources thus enabling them to fulfill their role in the Omani economy.

The plan is necessary to take into account the possibility to provide job opportunity, which will be available through the planned development, for the local people.

- 3) Completing the basis of establishing a national economy based on private sector activity in a competitive market with loan provision for vital projects in accordance with resources available to the state.

The Government function is assumed only in promotional and supporting areas. The Government will not be involved directly to production and commercial projects.

(2) The Industrial Development Plan of the Hinterland for 2020

The Study proposes the Industrial Development Plan as follows:

1) Development Concept

Development of the hinterland area as the regional center of redistribution businesses, taking advantage of its geographic location, and among others, the advantage of the area as the hinterland of international trunk line port of container, where the network of feeder lines are also developed so that the Salalah Port has easy access to the countries in the region.

Development of the regional redistribution center, which was networked and further enhanced by the linkages with other zones, which are specially designed for trade, production and distribution, including Mazuyunah Free Trade Zone, Salalah Airport, Raysut Industrial Estate, and JAFZ and other Free Zones in the peripheral countries.

Development of area as a center encouraging local production, with promotion of the local production for establishing the basis of sustainable growth of economy in Salalah, taking advantage, not only of, the development of the area as the redistribution center of the region, but also of:

- (a) Natural resources available in Salalah and peripheral areas
- (b) Industrial experiences in Oman
- (c) Port of international container lines accessible to the worldwide potential markets

2) Projected Development Size

As a result of the analysis of prospective markets accessible from Salalah, and the possible change in a competitive position of Salalah with the current exporting, importing and distributing countries, the Study projected two (2) levels of development sizes, namely, Low risk and High risk scenarios.

- (a) Low risk scenario assumes the markets, for which the access from Salalah will be definitely advantageous compared with the access from Dubai, as the major markets to be covered by redistribution through Salalah.

The scenario also assumes the use of available resources as a basis for promotion of local production. The development size projected with this scenario can be used as the planning basis of immediate actions.

- (b) High-risk scenario assumes the overwhelming advantageous position of Salalah over the competitors (particularly Dubai). Salalah is assumed to be the leading redistribution center in the region, though the scenario still assumes existence of many redistribution centers in the region.

This projected development size is recommended to be used to figure out the size, which will be reserved for future considerations expecting potentials. The size should be reviewed time to time taking into account the change in competitive position of Salalah among the competitors in the region.

The projected development sizes are shown in Table 21.1.3, and some estimate by development are shown in Table 21.1.4 and Table 21.1.6, respectively.

Table 3.1.3 Projection of Local Production, Export, and Re-export in Oman

	1,000 Tons			Million RO		
	2003	2010	2020	2003	2010	2020
Case-Without						
Local Production	970	1,263	1,704	163	187	229
Export	486	675	919	125	145	178
Re-export	12	15	20	28	34	46
Projection Scenario (1): Low Risk						
Local Production	970	1,726	2,304	163	310	472
Export	486	1,734	2,310	125	256	397
Re-export	521	627	767	334	408	564
Projection Scenario (2): High Risk						
Local Production	970	1,726	2,304	163	310	472
Export	486	1,734	2,310	125	256	397
Re-export	1,075	1,309	1,730	692	849	1,220
Notes:						
Local Production: Local production on the Study area.						
Export: Including the goods produced outside of the Study area in Oman.						
Local Production and Export are the same for all the Projection Scenarios.						
Source: Projection by the Study Team						

Table 21.1.4 Industrial Land Forecast

	Without Year 2003			Without Year 2010			Without Year 2020			With Forecasting Scenario (1)			With Forecasting Scenario (2)		
	Area ha	Cost F	Cost L	Area ha	Cost F	Cost L	Area ha	Cost F	Cost L	Area ha	Cost F	Cost L	Area ha	Cost F	Cost L
Infra and Site works															
site works	98.78	0.52	0.03	0.50	0.74	0.89	176.83	0.94	0.05	0.89	808.54	4.29	0.21	4.07	7.34
roads	98.78	0.52	0.00	0.52	0.78	0.94	176.83	0.94	0.00	0.94	808.54	4.29	0.00	4.29	7.73
water supply	98.78	0.25	0.12	0.12	0.37	0.22	176.83	0.44	0.22	0.22	808.54	2.03	1.01	1.01	1.83
sewages	98.78	0.86	0.17	0.69	1.28	1.23	176.83	1.53	0.31	1.23	808.54	7.02	1.40	5.61	10.12
storm drain	98.78	0.28	0.06	0.22	0.41	0.40	176.83	0.49	0.10	0.40	808.54	2.26	0.45	1.81	3.26
solid waste	98.78	0.04	0.00	0.04	0.06	0.06	176.83	0.07	0.00	0.06	808.54	0.31	0.02	0.30	0.53
land scaping & irrigation	98.78	0.14	0.01	0.14	0.21	0.24	176.83	0.26	0.01	0.24	808.54	1.17	0.06	1.11	2.00
power supply	98.78	0.98	0.74	0.25	1.47	0.44	176.83	1.76	1.32	0.44	808.54	8.03	6.02	2.01	3.62
telecommunications	98.78	0.09	0.07	0.02	0.14	0.04	176.83	0.17	0.13	0.04	808.54	0.76	0.57	0.19	0.34
Buildings															
Administration	98.78	0.54	0.11	0.43	0.59	0.78	176.83	0.97	0.19	0.78	808.54	4.44	0.89	3.56	6.41
Advancing factory building	98.78	4.11	0.82	3.28	4.46	5.88	176.83	7.35	1.47	5.88	808.54	33.60	6.72	26.88	48.46
Off site works															
roads	98.78	0.06	0.00	0.06	0.06	0.10	176.83	0.10	0.00	0.10	808.54	0.47	0.00	0.47	0.84
water supply	98.78	0.04	0.03	0.01	0.04	0.02	176.83	0.07	0.05	0.02	808.54	0.31	0.23	0.08	0.14
stormwater drainage	98.78	0.03	0.00	0.03	0.03	0.05	176.83	0.05	0.01	0.05	808.54	0.23	0.02	0.21	0.38
power supply	98.78	0.33	0.25	0.08	0.36	0.15	176.83	0.60	0.45	0.15	808.54	2.73	2.05	0.68	1.23
Contingency		1.32	0.36	0.96	1.66	1.72		2.36	0.65	1.72		10.79	2.95	7.84	14.14
Total		10.11	2.76	7.35	12.71	13.15		18.10	4.95	13.15		82.74	22.62	60.12	108.37
Escalation	F	0.00	0.41	0.00	0.00	0.00		0.00	0.74	0.00		0.00	3.39	0.00	0.00
L		0.00	0.00	0.07	0.00	0.13		0.00	0.00	0.13		0.00	0.00	0.60	1.08
Investment Cost		10.60	3.18	7.42	13.33	13.28		18.97	5.69	13.28		86.74	26.01	60.73	109.45

Legends L: Local Currency Portion
F: Foreign Currency Portion

Table 21.1.5 Estimates for Infrastructures in Dhofar Region

Infrastructure	Case	Year	Unit	Demand in 1998	Estimated Demand	Unit	Estimated Demand as Plant	Supply Capacity in 1998	Calculated Additional Supply Capacity	Required Investment Cost (Mn. R.O.)			Maintenance Cost Mn. R.O./yr only
										F	L	F+L	
261													
Electric Power ^{1), 2)}	-	-	GWh/yr	673.0		MW	76.8	261.0 MW	-				
1) The Supply Capacity in 1998 will be expanded to 181+230-150 = 261 MW in and after Apr. 2002 (ref. to para. 5.1.1).	With	S1 S2	GWh ³⁾ GWh/yr		634.7 883.4	MW MW	72.5 100.8		-7.3 MW 21.1 MW			0 0	
2) The Estimated Additional Capacity is calculated assuming 24 hours operation for 365 days a year, in maintaining a capacity utilization ratio of 60%. The additional need 21 MW in Scenario 2 is assumed to be met by reducing magnitude of plant replacement.	Without	2003 2010 2020	GWh/yr GWh/yr GWh/yr		56.8 103.6 162.0	MW MW MW	6.5 11.8 18.5		-73.3 MW -67.9 MW -61.3 MW			0 0 0	
3) GWh = million kWh = thousand MWh													
Water ¹⁾	-	-	Mn. Gallon	2,687.3				2,740.9 Mn. Gallon	-				
1) For all of "With" cases, the estimated demand is higher than 10 % increase from the demand in 1998, or 2,687.3 x 0.10 = 269 million gallon. Therefore, additional demand is to be supplied through desalinated water.	With	S1 S2	Mn. Gallon Mn. Gallon		1,008.6 1,398.4	Mn. Gallon/d Mn. Gallon/d	2.8 3.8		2.8 Mn. Gallon/d 3.8 Mn. Gallon/d			8.1 10.2	40.5 50.9
	Without	2003 2010 2020	Mn. Gallon Mn. Gallon Mn. Gallon		83.6 153.5 235.8	Mn. Gallon/d Mn. Gallon/d Mn. Gallon/d	0.2 0.4 0.6		0.0 Mn. Gallon/d 0.0 Mn. Gallon/d 0.0 Mn. Gallon/d				0.0 0.0 0.0
Land for industrial Use	With	S1 S2	ha ha		808.5 1,457.3							21.3 38.4	49.8 89.8
Existing capacity: 103.7 ha and 300,000m ² However, cost is estimated as all the demands are newly constructed	Without	2003 2010 2020	ha ha ha		98.8 147.6 176.8							2.6 2.8 4.7	6.1 6.8 10.9
													71.1 128.2
													1.4 2.6
													0.2 0.2 0.3

Legends
L: local currency portion
F: foreign currency portion

Post Development

Sector / Subsector	Contribution to:	Increase in GDP		Additional Job Creation		Increase in Foreign Exchange Earning / Saving	
	Year:	2010	2020	2010	2020	2010	2020
	Unit:	(Mn R.O.)		(Number of persons)		(Mn R.O.)	
Scenario 1: Low Risk Case							
Agriculture		-	-	-	-	-	-
Fishery		1.8	1.0	150	100	-	-
Mining & Quarrying		1.3	3.4	100	150	-	-
Manufacturing		49.7	100.8	4,800	8,600	51.8	102.3
Commerce		101.0	197.3	800	1,500	-	-
Redistribution		125.3	170.8	1,100	1,300	96.4	131.4
Transportation, Storage & Communication		173.4	289.8	5,000	5,900	-	-
Tourism		5.9	11.7	500	1,000	7.1	14.2
Others		237.2	360.6	9,200	9,200	-	-
Total		695.6	1,135.4	21,650	27,750	155.3	247.9
Scenario 2: High Risk Case							
Agriculture		-	-	-	-	-	-
Fishery		1.8	1.0	150	100	-	-
Mining & Quarrying		1.3	3.4	100	150	-	-
Manufacturing		49.7	100.8	4,800	8,600	51.8	102.3
Commerce		101.5	197.6	800	1,500	-	-
Redistribution		254.6	366.0	2,200	2,700	195.9	281.6
Transportation, Storage & Communication		260.9	421.9	7,500	8,500	-	-
Tourism		5.9	11.7	500	1,000	7.1	14.2
Others		415.7	629.5	16,000	16,000	-	-
Total		1,091.4	1,731.9	32,050	38,550	254.8	398.1

Sources: Tables 17.5.4 through 17.5.11

21.1.4 EIRR

The economic internal rate of return (EIRR) based on the cost-benefit analysis is used to appraise the economic feasibility of the project from the viewpoint of the national economy, and help the government to consider priority among various projects in the country.

The EIRR is the discount rate that makes the difference between costs and benefits of a project during the project life zero. Calculation formula is as follows:

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

Where

- n: Period of economic calculation
- B_i: Benefits in *i*-th year
- C_i: Costs in *i*-th year
- r: Discount rate

EIRR of the present study calculated are as follows:

Cases	FIRR	EIRR Port only	EIRR with Industry Value Added
High Cargo Growth			
Plan A Short Term	21.50	5.56	15.35
Long Term	16.78	7.41	14.66
Plan B Short Term	15.31	5.44	13.87
Long Term	14.21	7.57	14.69
Low cargo Growth			
Plan A Short Term	24.66	6.03	16.01
Long Term	18.71	7.04	14.95
Plan B Short Term	19.28	6.13	14.66
Long Term	16.74	7.57	14.63

21.1.5 Project Prospective

There are various views concerning the appropriate EIRR level to determine whether a project is feasible or not. The leading view is that the project is feasible if the EIRR exceeds the opportunity cost of capital in the country.

According to the leading investment companies, opportunity cost of the private capital in Oman for equity investment is over 22% per year, taking into account tax, dividend and risk. The interest for savings in the bank rates is from 5 to 7% per year, while interest of bank loan rates is between 7 and 10%. Omani government has opportunities to negotiate foreign governmental loans, and their interest level is 3 to 6%.

For infrastructure or social service projects, 5 to 10% are considered to be reasonable level because they will stimulate regional economy helping create additional benefits including job opportunities.

EIRR of the port development excluding the industrial development turned out to be rather low. On the other hand, EIRR of the Salalah development as a whole will be very high. These results show that the transshipment business itself is not so beneficial to regional economy and that successful industrial promotion is vital in realizing regional development.

Taking into account the above factors, the Team concludes that the proposed projects are feasible in view of the national economy of Oman, on condition that an adequate set of policies will be taken for the development of industry and social infrastructure in the region.

21.2 Proposed Schedule

The proposed schedule for this Master Plan is shown in the following Table 21.2.1. Figure 21.2.1 shows the port layout for each stage of port facility expansion on Table 21.2.1 such as,

- (1) Short Term I: Short-term Plan 2005
- (2) Long Term II-1, II-2, and II-3: Master Plan for 2020.

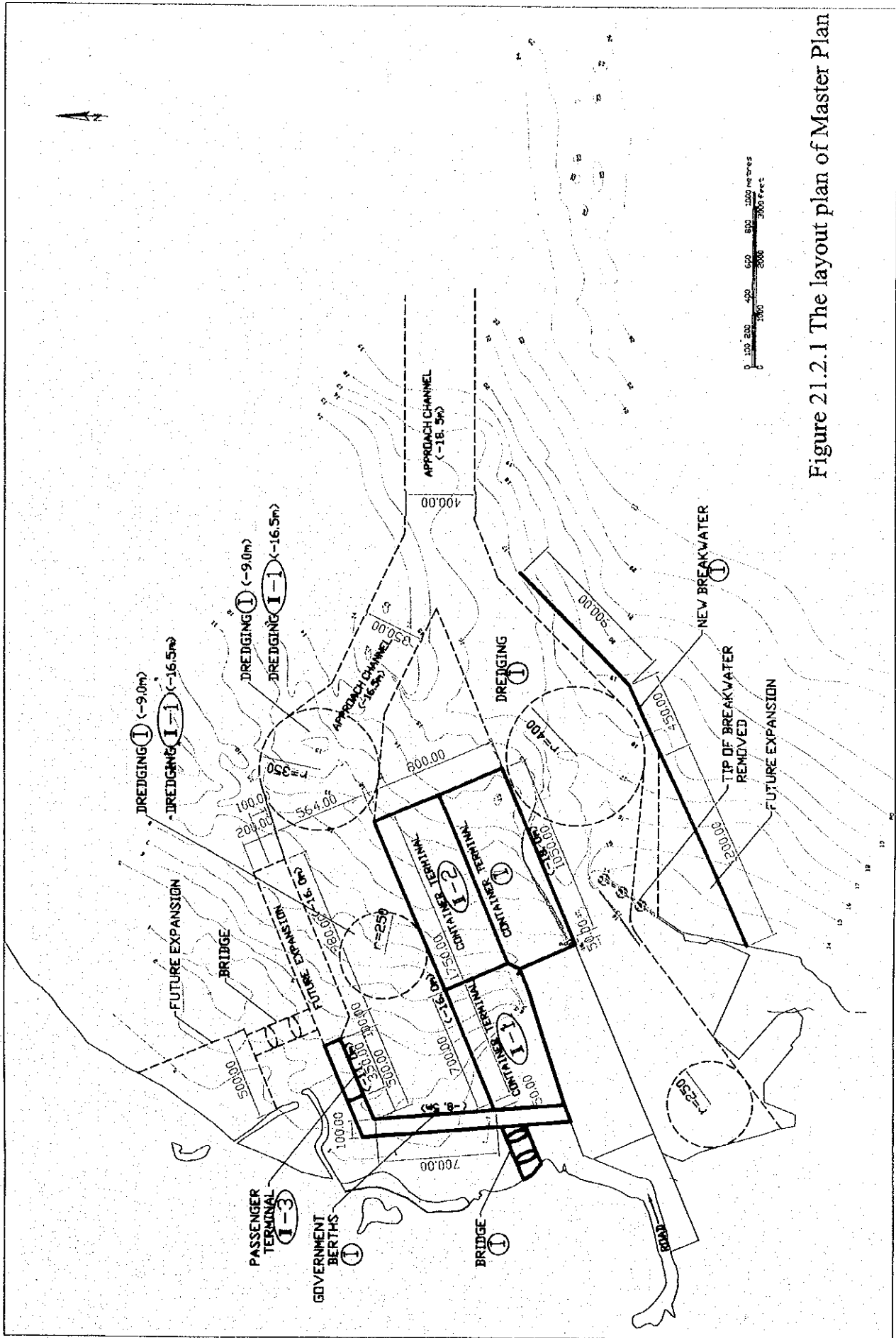


Figure 21.2.1 The layout plan of Master Plan

Table 21.2.1 Construction Schedule of JICA PLAN B

No.	Description	Quantity	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
Short Term I	1 Preparatory Work																						
	2 Breakwater	2,550m																					
	3 Dredging & Reclamation	7,003,146m ³																					
	4 Wharf	1,050m -18m 3Berth																					
	5 Government Berth	850m -8.5m																					
	6 Bridge	350m																					
	7 Building																						
	8 Electrical																						
	9 Mechanical																						
	10 Cargo Handling Equipment	Container Crane 22lines 9Nos .etc 54Nos.																					
	11 Miscellaneous Work																						
	12 Engineering Services																						
Long Term II -1	1 Preparatory Work																						
	2 Dredging & Reclamation	10,801,725m ³																					
	3 Wharf	700m -16m 2Berth																					
	4 Building																						
	5 Electrical																						
	6 Mechanical																						
	7 Cargo Handling Equipment	Container Crane 18lines 6Nos .etc 36Nos.																					
	8 Miscellaneous Work																						
	9 Engineering Services																						
II -2	1 Preparatory Work																						
	2 Wharf	1,050m -16m 3Berth																					
	3 Building																						
	4 Electrical																						
	5 Mechanical																						
	6 Cargo Handling Equipment	Container Crane 18lines 9Nos .etc 54Nos.																					
	7 Miscellaneous Work																						
	8 Bulk Terminal crane	800t/h																					
	9 Engineering Services																						
II -3	1 Preparatory Work																						
	2 Dredging & Reclamation	96,850 m ³																					
	3 Passenger Berth	350m -11.0m																					
	4 Building etc																						
	5 Gange Way	2Nos																					
	6 Miscellaneous Work																						
	7 Engineering Services																						

22. Initial Environmental Examinations

22.1 General

As described in Chapter 20.3, the Environmental Impact Assessment (EIA) has been introduced in the Sultanate of Oman in 1999, and most large projects are required to implement EIA studies. The Wilayat Sohar new port construction was such case of EIA required, implementing the detailed EIA study in 1998.

In this part of the report, adverse effects of this JICA Study were evaluated and selected a potential ones in accordance with the guidelines set by JICA for Initial Environment Examination (IEE) that is implemented at Master Plan Study Stage.

Table 22.1.1 Project Implementation Stages and Corresponding Environmental Consideration Stages

Project Implementation Stages				Environmental Consideration Stages
Implementation by JICA	Preparatory Study			Preliminary Environmental Survey
	Full-scale Study	Master Plan Study	Feasibility Study	Initial Environmental Examination (IEE)
		Feasibility Study		Environmental Impact Assessment (EIA)
Implementation by Executing Agency	Preparation of Project Implementation Plan (Including Detailed Design)			Examination of Environmental Conservation Measures
	Project Construction			Implementation of Environmental Conservation Measures
	Project Facility Operation			Environmental Monitoring

Source: Environmental Guidelines for Infrastructure Projects by JICA (1992)

Environmental facets to be considered in relation to the development of the Salalah Port and its hinterland Master Plan are categorized into the following groups.

Table 22.1.2 Environmental Facets to be considered at this Type of Study

Facet	Item	Items
Social Environment	1	Resettlement
	2	Economic Activities
	3	Traffic and Public Facilities
	4	Cultural Property
	5	Water Right/Rights of Common
	6	Waste
	7	Hazards (Risk)
Natural Environment	8	Topography and Soil Condition
	9	Groundwater
	10	Hydrographic Situation
	11	Coastal Zone
	12	Fauna and Flora
	13	Landscape
Pollution	14	Air Pollution
	15	Water Pollution
	16	Soil Contamination
	17	Noise and Vibration
	18	Offensive Odor

Based on the JICA guidelines, a screening was conducted on the above items to evaluate and select potential adverse effects by the Future Plan of Salalah Port and its hinterland based on Master Plan Study.

The checklist used for this evaluation and selection is shown in Table 22.1.3.

Table 22.1.3 Initial Environmental Examination Check List (1/3)

Field	Items	Impacts		Evaluation
		Port Development	Hinterland Development	
Social Environment	1 Resettlement	No relocation of residential area is planned except some port employee's accommodation.	No relocation is planned.	×
	2 Economic Activities	Fish catch may decrease some extent due to a loss of fishing ground partially by port expansion; however, there is no data and document clearly showing the fishing ground and fishing product currently at MAF. Regular base census on fishermen and fishing ground and also fish resources survey of Salalah coast by MAF are necessary to monitor trends of fishery.	Impact on the growth of GDP, job creation and foreign exchange earning are expected to be significant based on the Industrial Development Scenario, Chapter 12 and also described its analysis on Section 17.5 on this Study. Since the absence of reliable data on economic situation in the Study Area, a regular census of monitoring socio-cultural impact is recommended in the course of implementation stage of this Master Planning.	△
	3 Traffic and Public Facilities	Not expected.	Not expected.	×
	4 Cultural Property	Not existed.	Not existed.	×
	5 Water Right/Rights of Common	Expecting an obstruction of fishing rights, but it is not clearly defined and specified. As stated in Item 2, the implementation on census by MAF is recommended regularly.	Not expected.	△
	6 Waste	Port rules and regulations strictly controlled waste related to the port activities; furthermore, all solid waste are brought to Municipality dumping site.	All solid waste are brought to Municipality dumping site that has enough capacity up to 2015.	×
	7 Hazards (Risk)	Storage and handling hazardous materials strictly controlled by port rules and regulations. Only an oil handling facility exists presently; however, it is fairly no chance to be damaged by earthquake, natural disaster.	Not expecting any such kind of materials.	×

Remarks: Evaluation categories are as follows.

○: Special attention has to be paid.

△: Some impact is expected.

×: No impact is expected.

Table 22.1.1.3 Initial Environmental Examination Check List (2/3)

Field	Items	Impacts		Evaluation
		Port Development	Hinterland Development	
Natural Environment	8 Topography and Soil Condition	Expecting change of current conditions due to the port expansion, furthermore, change of coastal line due to coastal erosion and extinction and alternation of tidal inlet and its habitats such as mangrove forests are expected.	Planning plot for Industrial Estate (I.E.) for future plan are mostly "wadi" where there is mostly waste land, non valuable land to be considered of the impact of I.E. settlement to their environment.	○
	9 Groundwater	Not expected.	Present insufficient waste water treatment and water management controlling water demand in Salalah City may cause of contamination of drinking water with saline intrusion already. This has been monitored and managed by MWR.	△
	10 Hydrographic Situation	Not expected.	Not expected.	×
	11 Coastal Zone	Expecting decrease or extinction of mangrove forests due to alternation of coastal topography, coastal erosion caused by change of littoral drift pattern which may affect the natural coast and their habitats.	Not expected since most of the planned plot for I.E. are inland, not a coastal region.	○
	12 Fauna and Flora	Expecting decrease in biomass of mangrove forest and its habitats due to deterioration of habitat conditions caused by substrate change, water pollution and other ambient factor.	Not expected since most of the planned plot for I.E. are inland, not a coastal region. Contrarily, the planned plot for I.E. is mostly located in "wadi" or waste land.	○
	13 Landscape	Expecting change of features of regional landscape and view of the surrounding area by appearance of a large scale artificial structure.	Expecting change of features of regional landscape and view of the surrounding area by appearance of a large scale land development with factory facilities.	○

Remarks: Evaluation categories are as follows.

○: Special attention has to be paid.

△: Some impact is expected.

×: No impact is expected.

Table 22.1.1.3 Initial Environmental Examination Check List (3/3)

Field	Items	Impacts		Evaluation
		Port Development	Hinterland Development	
Pollution	14 Air Pollution	Expecting air pollution caused by emissions from cars commuting and tracks: transporting cargo to the hinterland by increasing port activities and hinterland development.	Impact on drainage or discharging effluent to the coastal water has not been considered yet since its geographical settings.	○
	15 Water Pollution	Expecting water pollution due to change of current conditions, emerging a stagnant water by the port expansion.	Not expected since all such disposal are collected and transported to the dumping site which Dhofar Municipality controls; however, no separation of hazardous and toxic wastes has been done yet. Contamination at dumping site is expected.	○
	16 Soil Contamination	Not expected since all such disposal are collected and transported to the dumping site.	Not expected since most of plots of I.E. will be separated from residential area.	△
	17 Noise and Vibration	Not expected since its location: totally isolated from the residential area and/or other concerned area requiring ambient measures.	Not expected since most of plots of I.E. will be separated from residential area.	×
	18 Offensive Odor	Not expected since its location: totally isolated from the residential area and/or other concerned area requiring ambient measures.	Not expected since most of plots of I.E. will be separated from residential area. Heavy/hazardous industries, sewage stabilization pond, and solid waste dumping site have been isolated and reserved remote area further far from the coastal and residential area.	×

Remarks: Evaluation categories are as follows.

○: Special attention has to be paid.

△: Some impact is expected.

×: No impact is expected.

As the results of screening, the following five (5) factors are selected for a detailed study.

Table 22.1.4 Selected Items for Detailed Study

Study Items #1: Current and Water Pollution	
Study Contents	Evaluating with a computer simulation modeling that predicts the change of current pattern due to the change of port layout by Master Planning of this Study. For water pollution, a case study with charging some effluent to the coastal water is prepared to evaluate the water pollution based on the future expansion scenario of the industries on the hinterland.
Related Impacts to be Examined listed on Table 22.1.3	
Field	Natural Environment
Items	8. Topography and Soil Condition
Impacts by	Port Development
Descriptions	Expecting change of current conditions due to the port expansion; furthermore, change of coastal line due to coastal erosion and extinction and alternation of tidal inlet and its habitats such as mangrove forests are expected.
Field	Pollution
Items	15. Water Pollution
Impacts by	Port Development
Descriptions	Expecting water pollution due to change of current conditions, emerging stagnant water by the port expansion.
Field	Pollution
Items	15. Water Pollution
Impacts by	Hinterland Development
Descriptions	Impact on drainage or discharging effluent to the coastal water has not been considered yet since its geographical settings.

Study Items #2: Coastal Erosion	
Study Contents	Evaluating long-term coastal erosion and shoreline change whether it is caused by the port expansion proposed by Master Planning of this Study.
Related Impacts to be Examined listed on Table 22.1.3	
Field	Natural Environment
Items	8. Topography and Soil Condition
Impacts by	Port Development
Descriptions	Expecting change of current conditions due to the port expansion; furthermore, change of coastal line due to coastal erosion and extinction and alternation of tidal inlet and its habitats such as mangrove forests are expected.

Study Items #2 (Cont.)	
Field	Natural Environment
Items	11. Coastal Zone
Impacts by	Port Development
Descriptions	Expecting decrease or extinction of mangrove forests due to alternation of coastal topography, coastal erosion caused by change of littoral drift pattern that may affect the natural coast and their habitats.

Study Items #3: Mangrove Aqua Culture	
Study Contents	Evaluating diminution and/or vulnerability of mangrove lagoon and its aqua culture due to the shoreline change and/or ambient change which may be caused by the port expansion and hinterland development proposed by Master Planning of this Study.
Related Impacts to be Examined listed on Table 22.1.3	
Field	Natural Environment
Items	8. Topography and Soil Condition
Impacts by	Port Development
Descriptions	Expecting change of current conditions due to the port expansion; furthermore, change of coastal line due to coastal erosion and extinction and alternation of tidal inlet and its habitats such as mangrove forests are expected.
Field	Natural Environment
Items	11. Coastal Zone
Impacts by	Port Development
Descriptions	Expecting decrease or extinction of mangrove forests due to alternation of coastal topography, coastal erosion caused by change of littoral drift pattern that may affect the natural coast and their habitats.
Field	Natural Environment
Items	12. Fauna and Flora
Impacts by	Port Development
Descriptions	Expecting decrease in biomass of mangrove forest and its habitats due to deterioration of habitat conditions caused by substrate change, water pollution and other ambient factor.

Study Items #4: Landscape and Land Use	
Study Contents	Evaluating the impact on the landscape that may be caused by the port expansion and hinterland development proposed by Master Planning of this Study. Some constraints and impacts on emerging new land use to its surroundings are evaluated.
Related Impacts to be Examined listed on Table 22.1.3	
Field	Natural Environment
Items	13. Landscape
Impacts by	Port Development
Descriptions	Expecting change of features of regional landscape and view of the surrounding area by appearance of a large-scale artificial structure.
Field	Natural Environment
Items	13. Landscape
Impacts by	Hinterland Development
Descriptions	Expecting change of features of regional landscape and view of the surrounding area by appearance of a large-scale land development with factory facilities.

Study Items #5: Car Traffic	
Study Contents	Evaluating traffic load on access roads and air pollution that may be caused by the port expansion and hinterland development proposed by Master Planning of this Study.
Related Impacts to be Examined listed on Table 22.1.3	
Field	Pollution
Items	14. Air Pollution
Impacts by	Port Development & Hinterland Development
Descriptions	Expecting air pollution caused by emissions from cars commuting and trucks transporting cargo to the hinterland by increasing port activities and hinterland development.

23. Assessment of Environmental Impacts

The primary purpose of this part of report is to assess the impact on the development of Salalah Port and its hinterland. The object of the assessment is the scenario of future plan as proposed by the Master Plan of this Study that is the final stage of port and hinterland development beyond the target year of 2020.

Based on the results of Initial Environmental Examination as described in the previous chapter, the following five (5) factors are selected for the assessment of impact:

- (1) Current and Water Pollution
- (2) Coastal Erosion
- (3) Mangrove Aqua Culture
- (4) Landscape and Land Use
- (5) Car Traffic

23.1 Current and Water Pollution

23.1.1 General

A computer simulation modeling that predicts a change of current pattern and water pollution was used for this Study. This primarily evaluates the impact on change of coastal line, geometry of the Study Area and change of discharging amount of effluent from industrial origin into the Study Area by the future plan.

23.1.2 Modeling

(1) Area

Area for calculation was set about 13 km to the coastal line around N-S direction and 19 km parallel to the coastal line around E-W direction.

(2) Grid Size

1) Horizontal

200 m around the Salalah Port Development Area and 200 m to 400 m at outside of the development area.

2) Vertical

- (a) Upper layer: Sea surface to 4 m below sea surface
- (b) Lower layer: 4 m below sea surface to the seabed

Figure 23.1.1 and Figure 23.1.2 show the grid size and the bathymetry of modeling area.

(3) Model

Two layers model was adopted for this simulation. Equation for modeling used for this simulation was a three dimensional multi-level model by Leendertse, and this is shown in Equation 23.1.1.

(4) Simulation Cases

1) Current Flow

Based on the result of a 15 days static current observation, the simulation cases for this modeling are set on the following two (2) cases:

- (a) Case 1: K1 component + Northward mean current (NNE)
- (b) Case 2: K1 component + Southward mean current (SW)

Since a tidal component of K1 and mean current of NNE and SW, which were dominated in 25 hours running mean analysis, were prevailed, the simulation case for this study were selected on the above two cases

2) Water Pollution

COD (Mn) is used for an index for water pollution of organic materials in the area for modeling, generally. For constructing simulation model for this Study, the amount of COD (Mn) by the Port expansion and its hinterland development was selected for calculation of simulation.

The simulation cases selected for this modeling are two (2) cases, and these are same as the ones used for the current flow simulation modeling in the previous section.

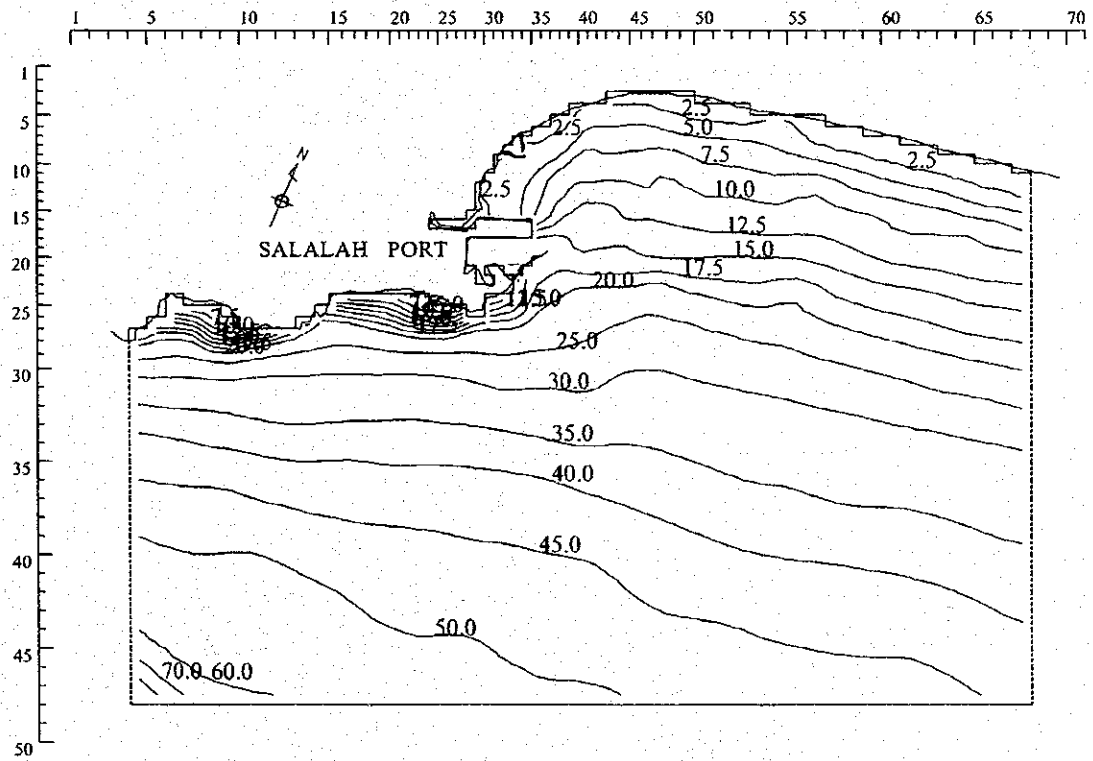
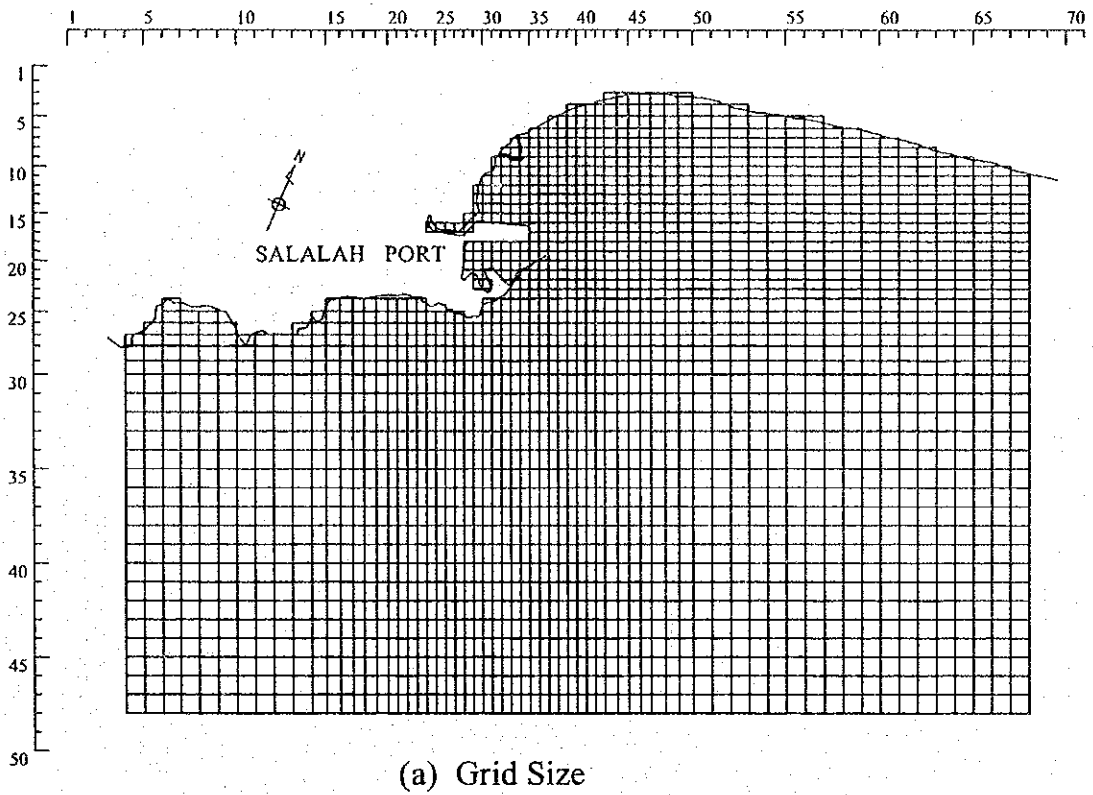


Figure 23.1.1 Grid Size and Bathymetry of Modeling Area (Present)

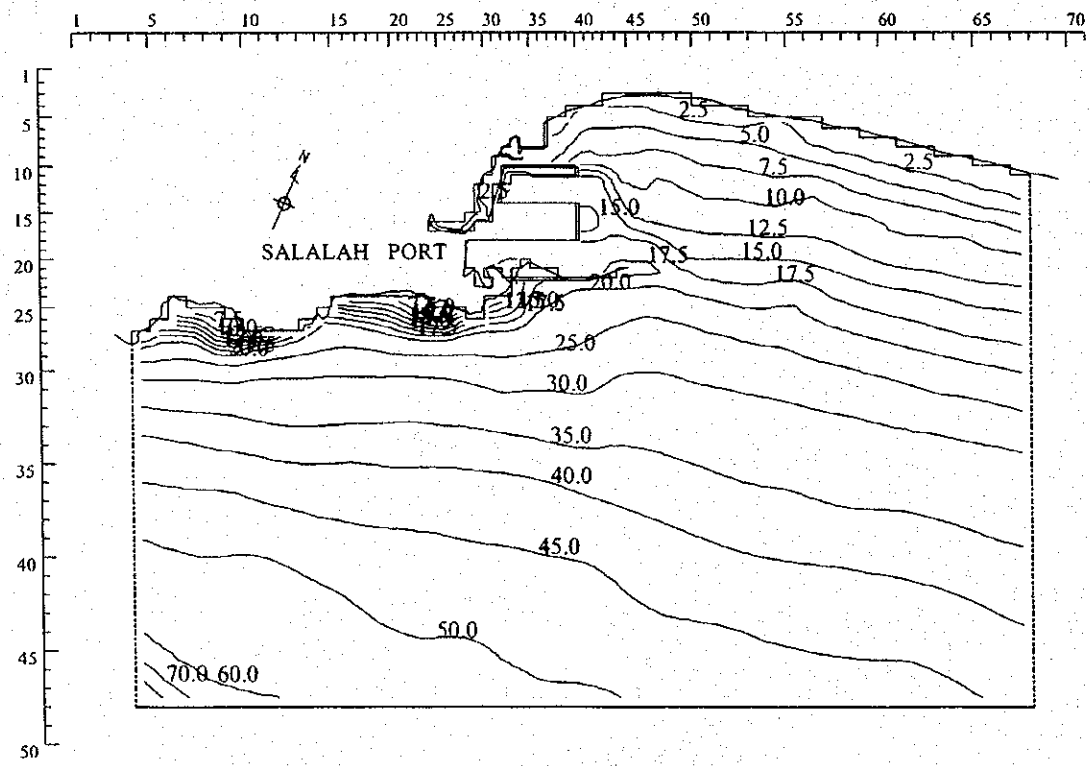
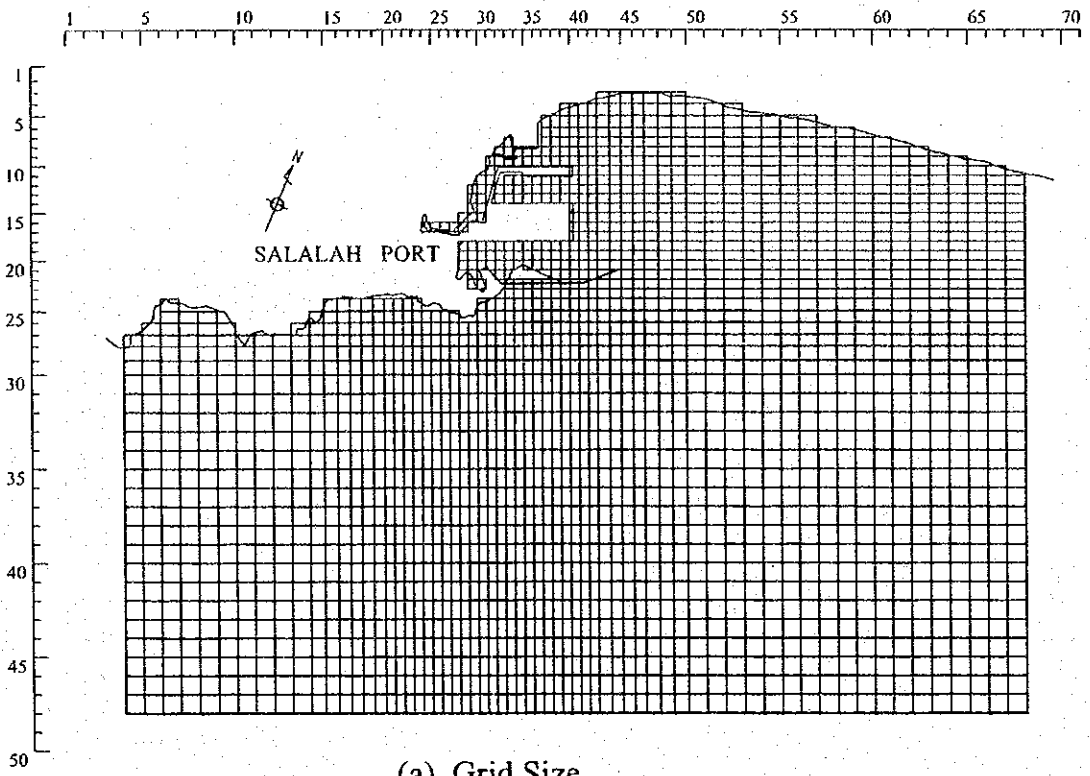


Figure 23.1.2 Grid Size and Bathymetry of Modeling Area (Future Plan)

Equation 23.1.1

(1) Equation of Motion (X-direction)

$$\frac{\partial u}{\partial t} + \frac{\partial(u^2)}{\partial x} + \frac{\partial(uv)}{\partial y} + \frac{\partial(uw)}{\partial z} + \frac{1}{\rho} \frac{\partial P}{\partial x} - \frac{1}{\rho} \left(\frac{\partial \tau_{xx}}{\partial x} + \frac{\partial \tau_{xy}}{\partial y} + \frac{\partial \tau_{xz}}{\partial z} \right) = 0$$

(2) Equation of Motion (Y-direction)

$$\frac{\partial v}{\partial t} + \frac{\partial(vu)}{\partial x} + \frac{\partial(v^2)}{\partial y} + \frac{\partial(vw)}{\partial z} + \frac{1}{\rho} \frac{\partial P}{\partial y} - \frac{1}{\rho} \left(\frac{\partial \tau_{yx}}{\partial x} + \frac{\partial \tau_{yy}}{\partial y} + \frac{\partial \tau_{yz}}{\partial z} \right) = 0$$

(3) Equation of Static

$$\frac{1}{\rho} \frac{\partial P}{\partial z} = 0$$

(4) Equation of Continuity

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = 0$$

(5) Equation of Free Surface

$$\frac{\partial \zeta}{\partial t} = - \frac{\partial}{\partial x} \left(\int_{-H}^{\zeta} u dz \right) - \frac{\partial}{\partial y} \left(\int_{-H}^{\zeta} v dz \right)$$

(6) Diffusion Equation (Salt)

$$\frac{\partial s}{\partial t} + \frac{\partial(us)}{\partial x} + \frac{\partial(vs)}{\partial y} + \frac{\partial(ws)}{\partial z} = \frac{\partial}{\partial x} \left(D_x \frac{\partial s}{\partial x} \right) + \frac{\partial}{\partial y} \left(D_y \frac{\partial s}{\partial y} \right) + \frac{\partial}{\partial z} \left(D_z \frac{\partial s}{\partial z} \right) = 0$$

(7) Diffusion Equation (Water temperature)

$$\frac{\partial T}{\partial t} + \frac{\partial(uT)}{\partial x} + \frac{\partial(vT)}{\partial y} + \frac{\partial(wT)}{\partial z} = \frac{\partial}{\partial x} \left(D_x \frac{\partial T}{\partial x} \right) + \frac{\partial}{\partial y} \left(D_y \frac{\partial T}{\partial y} \right) + \frac{\partial}{\partial z} \left(D_z \frac{\partial T}{\partial z} \right) + \frac{1}{\rho c_w} \frac{\partial Q}{\partial z} = 0$$

(8) Diffusion Equation (COD (Mn))

$$\frac{\partial C}{\partial t} + \frac{\partial(uC)}{\partial x} + \frac{\partial(vC)}{\partial y} + \frac{\partial(wC)}{\partial z} = \frac{\partial}{\partial x} \left(D_x \frac{\partial C}{\partial x} \right) + \frac{\partial}{\partial y} \left(D_y \frac{\partial C}{\partial y} \right) + \frac{\partial}{\partial z} \left(D_z \frac{\partial C}{\partial z} \right) + Q_L = 0$$

(9) Equation of State

$$\rho = \rho(s, T)$$

where ρ : density P: pressure g: gravity ζ : water level H: depth
 s: salinity T: water temperature C: COD (Mn) concentration
 Q_L : amount of pollution load D_x, D_y, D_z : eddy viscosity coefficient
 Cw: specific heat Q: heat balance