01 Introduction & Objectives

This Environmental & Social Impact Assessment (ESIA) evaluates the potential environmental, social, economic, cultural, and natural impacts of the proposed Liquefied Natural Gas (LNG) Import Terminal Project. Environmental Management Consultants (EMC) Pakistan has been contracted as a third party consultant by Elengy Terminal Pakistan Limited (hereinafter referred as proponent) to conduct a detailed assessment (ESIA) of the proposed LNG project.

The project includes constructing and operating a Liquefied Natural Gas (LNG) terminal in Port Qasim, inclusive of ship berthing and import facilities, floating storage tanks and regasification equipment. The project intends to provide facilities for receiving supplies of LNG via a conventional LNG carrier, for offloading, transfer and loading into a Floating Storage and Regasification Arrangement (FSRA) which can be an FSRU, or FSU+ On Shore Regasification, or FSU + on barge Regasification. The FSRA will store and re-gasify the LNG and deliver the re-gasified liquefied natural gas (RLNG) via jetty and onshore associated facilities to the gas network operated by the in-country transmission pipeline providers.

Dredging will be required to create the berthing and the turning basin. Dredged material will be utilized for the reclamation and to construct shore protection structure. The balance will be dumped at sites advised by PQA. The construction of the LNG import terminal is expected to begin by 1Q 2014 and will be completed within 11 months. The estimated cost of the proposed project is USD 120 million.

Project at a Glance

Project Type	Floating LNG Import Terminal
FSRU Size	130,000 m^3 (upgradable)
STS	Double Banked Arrangement
Length of Pipeline	22kms
Dredging	Between 1.3 Mn CUM and 1.6 Mn CUM
Turning Circle	Existing at IOCB/QICT2
Channel	260 m wide

This ESIA has been prepared to fulfill the regulatory requirements of Pakistan Environmental Protection Act, 1997 and to satisfy the evaluation criteria of the World Bank and International Finance Corporation (IFC). Applicable National & International Guidelines and regulations have been used as a reference in preparing this ESIA. The project falls in Schedule-II of Pakistan Environmental Protection Agency (Review of IEE/EIA) Regulations-2000 and Category-A of Equator Principles which means it could have significant environmental impacts if appropriate mitigating measures are not implemented.

1.1. The Project Proponent-Elengy Terminal Pakistan Limited (ETPL)

Elengy Terminal Pakistan Limited (ETPL) was registered under the SECP Act 1997, in January 2012, and is a 100% owned subsidiary of Engro Corporation Pakistan to position Engro as a partner of choice with Key Stake holders. ETPL boasts of experience in terminal business due to its affiliation with Engro Vopak Terminal Limited, a joint venture of Engro Corporation (Pakistan) Limited (50%) and Royal Vopak of the Netherlands (50%).

EVTL, formerly Engro Paktank Terminal Ltd. (EPTL), was incorporated in 1995. EVTL provides the chemical and petrochemical industry and traders in Pakistan with the state of the art facilities to handle and store their bulk raw material and products at its terminal in Port Qasim in a safe, efficient and environmentally friendly manner. EVTL is actively engaged in handling about 74% of the bulk liquid chemicals and 70% of LPG imports into Pakistan. The company has ISO 9001, 14001, 18001 and was CDI-T certified which has now been replaced by internal assessment "THA" of Vopak Asia (Figure 1.1). Figure 1.2

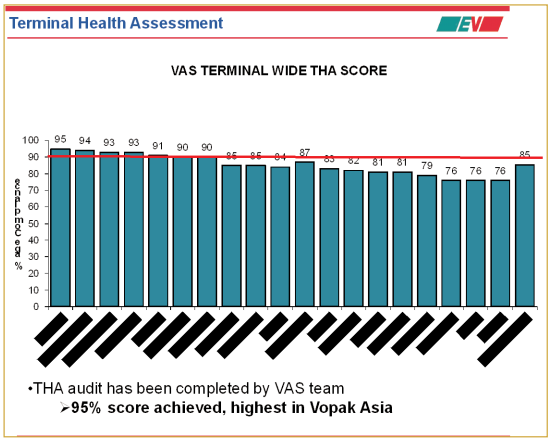


Figure 1.1: Terminal Health Assessment (THA) Score

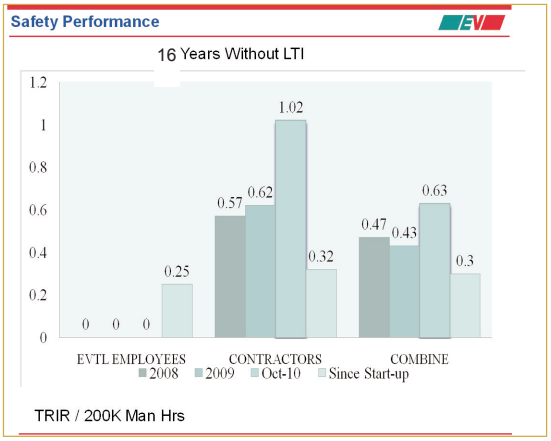


Figure 1.2: Safety Performance

presents the overall safety performance record of EVTL.

- ETPL wishes to develop the proposed LNG project in full compliance with applicable Pakistan's statutory requirements;
- EVTL's own policy statements on Health, Safety and Environment (HSE) to be modified for LNG handling
- LNG terminal international standards;
- Applicable international conventions, treaties and agreements;
- International guidelines including World Bank& IFC.

In line with these standards, ETPL aims to contribute to Sustainable Development. This means that a strategy will be followed that integrates economic, social, health and environmental considerations in all project decisions and actions. This also implies that ETPL is committed to carry out a full Environmental and Social Impact Assessment (ESIA), parallel to and as part of the development of this project. Engro Corp. has always conducted ESIA for its projects, with the most recent being for the investment in Pakistan.

This ESIA process for another cryogenic product LNG was started by ETPL as early as possible and in such a way that any implications resulting from the assessment could be included in the design and operation. The current report reflects the outcome of this ESIA process and takes into account the natural environmental, human health and social aspects, and any trans-boundary and global environmental aspects in an integrated way. The sustainability principle 'engage and work with stakeholders' entails that ETPL, during the ESIA, consults project-affected groups, local non-governmental organizations (NGOs) and any other group of stakeholders about the project's environmental and social aspects and takes their views into account.

ETPL aims at zero incidents by placing safety, health and environment above all other objectives. The company maintains the highest industry standards to ensure safety and reliability and meets all requirements of Pakistan Environmental Protection Agency. Its customers and financing institutions including SEPA have had audits conducted by local and international firms.

ETPL is committed to playing a leading role in the development of standards in the terminal services business in Pakistan and leads the industry by a distance.

1.2. PROJECT BACKGROUND

Natural gas accounts for the largest share of Pakistan's energy use, amounting to almost 45 percent of total energy consumption. Pakistan currently consumes all of its domestic natural gas production. Limited new gas discoveries and ever increasing demand has resulted in widening the gap between (demand and supply), and (supply and availability).

The projected demand/supply/availability analysis had

indicated a shortfall of 3.0 MTOE in 2010 and the gap is expected to reach 19.9 MTOE in 2015 and 85.3 MTOE in 2030. Pakistan is exploring all possible avenues for cheap, abundant and environment-friendly sources of gas in order to continue with sustained economic growth in the coming years.

The gap between supply and demand of natural gas (NG) emerged in 2007- 08 and was projected to build up to 2,100 MMCFD by 2015, as the current gas fields gradually go off plateau. The demand and supply projections had indicated a widening gap of approximately 500 million cubic feet per day (MMCFD) by the year 2010. Winter of 2010-11has actually shown higher shortage then envisaged (Figure 1.3).

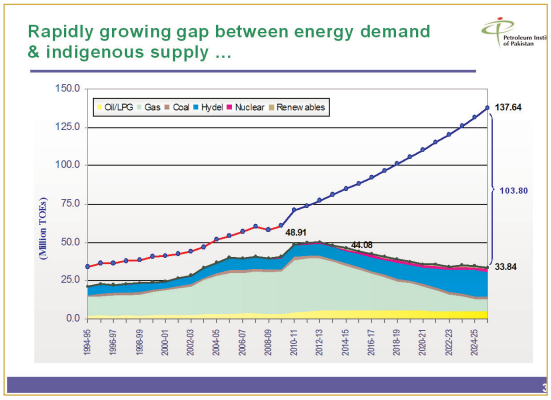


Figure 1.3: Energy Demand & Supply Gap

The existing demand of NG in the country is 5190.5 MMCFD, out of which 3895.5MMCFD is met by internal sources. As of June 30, 2010 the NG reserves were 28.90 trillion cubic feet. With no external source of NG available, Pakistan meets the demand from internal sources only. The increasing demand of NG has created a shortfall of 1,295 MMCFD and is expected to increase further. Gas load shedding has become a phenomenon with industry being forced to shut down for five days in a week in Punjab and fertilizer industry for 30-45 days. KESC and other IPPs had their gas allocations curtailed significantly resulting in gas load shedding of over 6-8 hours in the country. Industry running boilers to generate steam is being forced to use coal, furnace oil or diesel and diesel for power generation, with households utilizing charcoal and firewood, thus inducing rapid deforestation & warming of their microenvironment.

The present requirement of oil in the country is around 19 million tons per annum, out of which about three million tons (15%) is met from internal sources. The oil reserves being only 314.39 million barrels, the balance demand is met through imports of crude oil and other petroleum products.

Oil imports cost $ 32.26 billion for 58.64 million tons oil during last four years (2006-2009). In order to attract local and multi-national companies for investment in oil and gas sectors and in aggressive exploration, the government has given incentives in new Petroleum Policy 2009.

Since inception, exploration and production companies made 223 oil and gas discoveries in the country and that so far cumulative production from these discoveries is 543 million barrels oil and 24.433 trillion cubic feet of gas having worth of about Rs 27000 billion and Rs. 4930 billion respectively at an average international market price of oil and average wellhead value of gas for 2009.

In order to explore more oil and gas reserves the government granted 115 exploration licenses. Presently, 16 foreign companies are operating in 44 blocks in Pakistan for the purpose.

To fill the growing energy supply deficit, GOP is in earnest implementing a multi-pronged strategy which includes: (i) increasing domestic oil & gas exploration and production, (ii) fast track utilization of hydro power potential, (iii) expediting the development of vast local coal reserves, (iv) importing piped natural gas from neighboring countries, (v) importing LNG, (vi) setting-up new nuclear power plants, and (vii) exploiting affordable alternate energy resources.

Any commitment of additional gas supplies to industries, power and fertilizer production on a long term basis have not been possible, without confirmation of additional sources of gas supply. This may, however, have been possible through:

1) Gas pipeline import which at the earliest could come on-stream by 2017 as per the Gap Coverage Strategy from Iran or Turkmenistan,

2) A major on-shore/off-shore gas field discovery in the current year (the gas to market period being five years), or

3) LNG import which by current assessment could provide

gas by the year 2012-13. It was supposed to have started by 2010-11 under the Mashaal Project.

The GOP had mandated SSGC to develop a project for the import of LNG. The first supply of LNG of 3.5 million tons per annum (equivalent to 500MMCFD of gas) was targeted for the year 2011; followed by another for supply of 2.0mtpa by the year 2013. The projects stand delayed, while the shortage keeps multiplying.

ETPL intends to follow a fast track approach towards developing the LNG import terminal in order to bridge the gap between supply and demand of energy. The Project is primarily based on developing the required infrastructure so that LNG can be brought into the Natural Gas (NG) market, which has witnessed phenomenal growth in the energy sector in Pakistan. In the first stage, the focus is on the fastest method to facilitate LNG flow into the NG pipeline network in Pakistan.

The proponent is best placed in the energy sector, particularly in handling about 70% of LPG imports into Pakistan and the only cryogenic facility in Pakistan. EVTL operates a state of the art first LPG and chemical terminal in south western zone of Port Qasim. The terminal consists of a jetty, suitable for handling ships up to 75,000 DWT and houses storage tanks with a storage capacity of 10,100 cubic meters of LPG and balance for chemicals for a total storage capacity of EVTL 82,400 cbm.

The proposed site at Port Qasim is a dedicated area for Oil and Gas development and is promoting local energy supply system. FOTCO is utilized for oil imports and PRO-GAS for LPG in addition to EVTL. Proposed ETPL-LNG terminal for import of NG will also be located in the same zone. It will thus be integrated into the infrastructure of Oil & Gas sector being developed.

1.3. OBJECTIVES OF PROJECT

The main objectives of the Project are to:

- Bridge the gap between supply and demand of energy in Pakistan by facilitating import of LNG from countries that have liquefaction facilities;

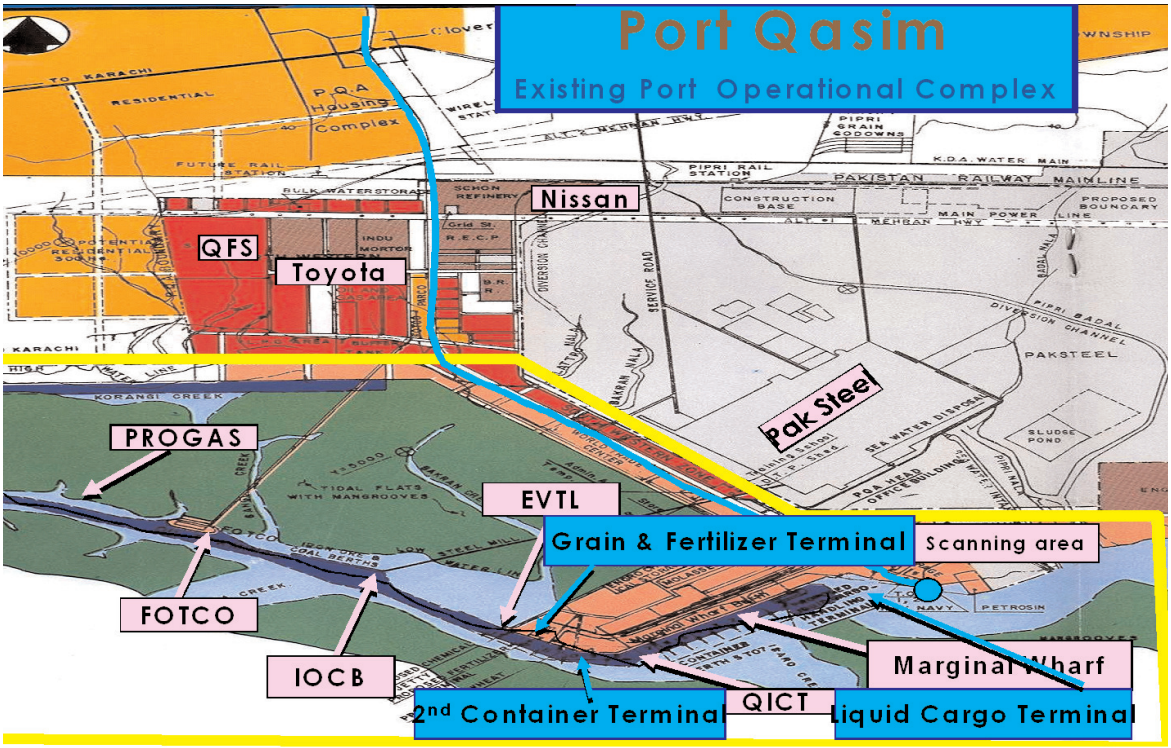


Figure 1.4: Location of EVTL in Port Qasim

- Create benefits for local economies through job creation and services;
- Ensure the availability of natural gas to industrial, commercial and residential customers throughout Pakistan;
- Observe the principles of sustainability by providing the benefits of economic gains while sustainably modifying the social and physical environment; and
- Promote sustainable development and ensure a better quality of life for everyone, now and for generations to come through the three strands of social equity which recognize the needs of all citizens of Pakistan, maintain stable levels of economic growth and employment, and use the natural resources including natural gas prudently, while protecting the environment and, enhancing its quality.

1.4. Overview of Siting Process

The proposed LNG Import Terminal project will be sited in Port Qasim area which comes under the jurisdiction of Port Qasim Authority, Government of Pakistan. ETPL requested PQA for designation of suitable site(s) in Port Qasim to establish an LNG terminal. PQA in response identified the following sites for ETPL to carry out necessary studies including an ESIA:

1) Two (Green Field) sites located on Khiprianwala Island.

i. OPTION 1: Lat: 24°46'60".53 N, Long: 067°12'54".12 E

ii. OPTION 2: Lat: 24°44'54".87 N, Long: 067°10'08".60 E

2) The Brown Field site referred as Option 3 where EVTL Chemical terminal and other terminals are located.

3) Existing EVTL Jetty as Option 4 that may be upgraded to accommodate berthing of an LNG FSRU (floating storage and regasification unit), which will also act as a carrier vessel and will bring in LNG supplies to the jetty.

This ESIA identifies the potential environmental and social aspects associated with the proposed **Brown Field** site (OPTION 3) keeping in view the relevant standards / guidelines / procedures on siting an LNG facility. A Quantitative / Qualitative Risk Assessment (QRA) has been carried out separately by ETPL. The study was undertaken by Lloyd's Register of UK and covers a wide scope which includes HAZARD IDENTIFICATION (HAZID) in participation of Vopak, PQA and its consultants ECIL, navigational simulations, Risk Assessment studies and Dispersion Modelling. The QRA likewise covers all the sites as stated herein and proposes certain mitigation measures which make all the sites technically viable after adopting of the relevant measures. The QRA can be found as Annexure 9.

1.5. Environmental & Social Impact Assessment (ESIA)

1.5.1 Justification for ESIA Study

Section 12 of Pakistan Environmental Protection Act 1997 and Pakistan Environmental Protection Agency (PEPA) Review of IEE/EIA Regulations 2000 require that every new development project in Pakistan has to be preceded by an Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA) depending upon the size and severity of impacts anticipated on commissioning of the project.

1.5.2 Categorization of the Project

PEPA Review of IEE/EIA Regulations 2000 categorizes projects in two separate Schedules, which require either an IEE or an EIA. The LNG jetty comes under both Schedules which have port and harbor development projects listed. Schedule-I projects require an IEE and concerns ports and harbors having ship displacement of less than gross 500 tons. Schedule-II is applicable if the gross displacement exceeds 500 tons and requires an EIA. The proposed LNG terminal project falls under Schedule-II as it involves shipping activity having gross displacement above 500 tons and will thus require an EIA.

1.5.3 Purpose of ESIA Study

The main purpose of this EIA Study is to respond to

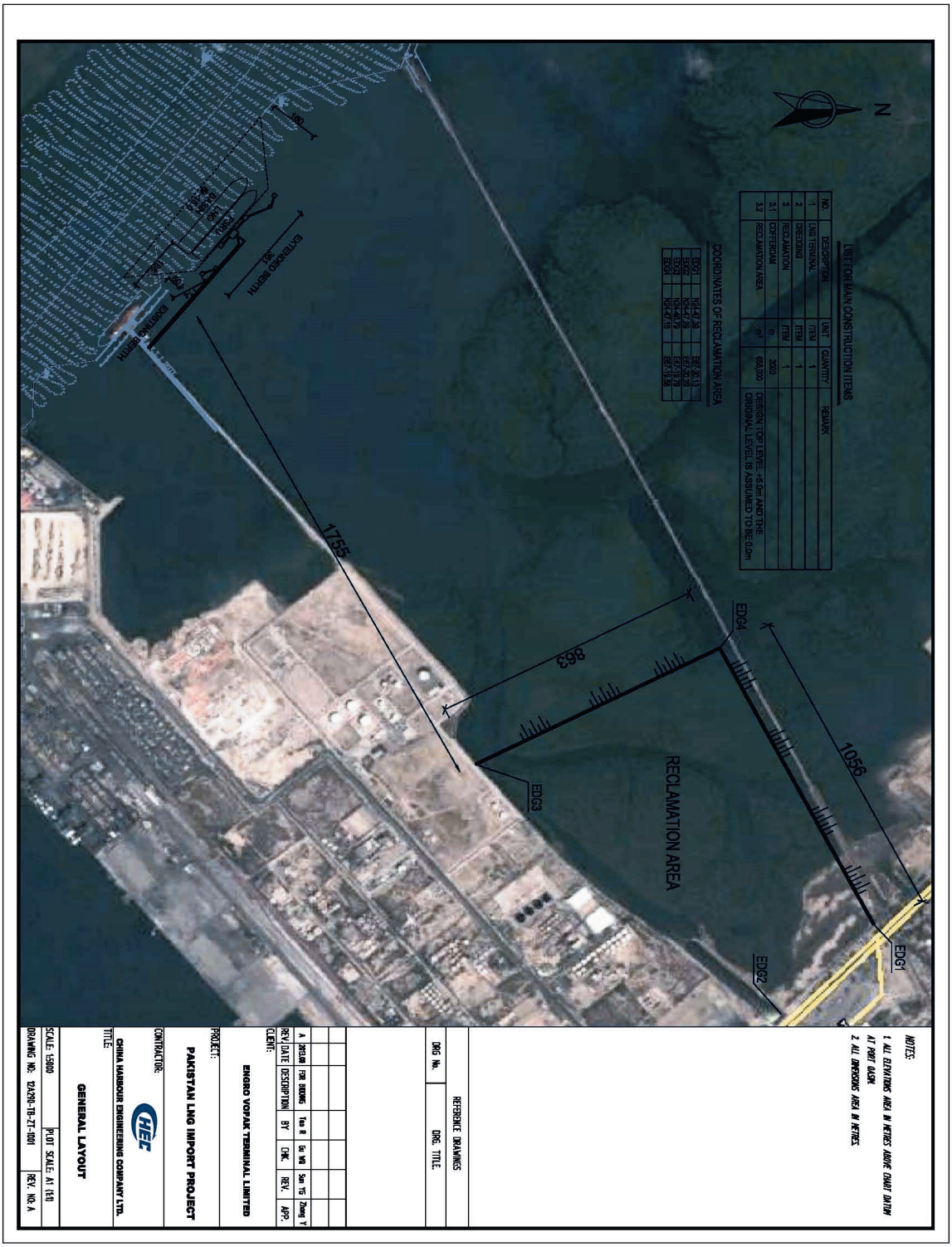


Figure 1.5: Location of Option 3: Brown Field Site near EVTL suitable for Fast Track LNG Project

provision of Environmental Protection Act 1997, to provide information on the nature and extent of environmental impacts arising from the construction and operation of the project and related activities that would take place concurrently or subsequently. The ESIA study is conducted for the purpose of:

- Describing the existing environmental setting of the project area;
- Summarizing the project activities in relation to the environment;
- Ascertaining applicability of relevant rules and regulations to the project siting and operations;
- Undertaking the EIA from the perspective of environmental and social aspects in the project area, and suggesting mitigation measures for sustainable development;
- Identifying the environmental consequences of siting the project and inception of associated activities;
- Identifying conditions that may require detailed design, and specification on activities during construction and operations of the project, besides measures necessary to mitigate the adverse environmental consequences;
- Assessment of impact of major LNG escape and consequential hazards that is being covered under the QRA underway, including measures necessary to mitigate risks identified
- Determining the adequacy of proposed mitigation measures to deal with residual impacts after implementation of the Project.

1.5.4 Adopted Methodologies for ESIA

EMC adopted the following procedures for making assessment of impact of different activities during the construction, commissioning and operational phases on microenvironment and macroenvironment of the project activity areas:

1) Scoping Exercise

Holding meetings with ETPL Project Officials and other stakeholders to:

- Discuss and define the magnitude of study in the light of scope of work
- Plan a work schedule for collecting baseline data needed for Rapid Assessment of status of microenvironment of proposed project site, and its surrounding i.e. macro environment, and
- Obtain information on location and technology alternatives and on LNG import options.
- Incorporating views and comments of different stakeholders and their concerns on the project so as to prepare a generally consented document for approval of the decision makers.

2) Literature Reviews

Preparation of this study has input from field data collected by Environmental experts during their visits to the site, meeting with ETPL / EVTL Officials, EPA Sindh, Port Qasim Authority, stakeholders and the archives of the consultants. EMC contacted ETPL for the collection of project specific data such as design, site specification, soil survey, construction activities and operations besides HSE and Environmental Management and Emergency Response Plans which ETPL would adopt for the management of LNG Import Terminal. The information so obtained was reviewed for better understanding of project by experts prior to conducting detailed site visits of project area.

Additionally latest authenticated published data on the physical and social environment of the project area was reviewed to match up with the information obtained during the surveys.

3) Surveys

EMC organized surveys for collection of information on settlements around project specific location within 5 km

radius, considered here as forming the boundary of the microenvironment for ESIA study. Socio-economic surveys were conducted by socio-economic experts. Issues related to project were discussed with stakeholders including relevant departments. Surveys were conducted by ecologists/marine biologist to investigate the marine ecosystem of the microenvironment to generate baseline data for impact assessment.

4) Monitoring & Analysis

EMC acquired the services of SUPARCO to conduct air dispersion monitoring for 24 hours to examine and establish air quality profile of the site and to assess the possible impact of round the clock operations at the LNG terminal. The monitoring results were analyzed by SUPARCO experts to assess the risk in case of accidental release of LNG.

5) Identification of Aspects

The aspects identification and significance determination process is fundamentally important to investigate the incidence of impacts at different stages of the Project and their assessment. This step gives an inventory of the aspects. The aspects identified during this step cover all activities during construction/operations, production and services in order to determine those which have or can have significant impact on the environment.

6) Assessment of Anticipated Impacts

Environmental experts at EMC analyzed and assessed the anticipated impacts that are likely to arise due to the identified aspects. This step was followed by the use of collected data for identification of impacts on human health and the environment and risks involved in different activities during construction, commissioning and operation phases of the project.

7) Preventive Measures & EMP

Based on the impacts identified, mitigation and control measures were proposed by the experts in order to minimize the adverse impacts of construction of LNG jetty, pipeline and jetty operations on the environment. All mitigation measures were discussed in detail with the proponent representatives and an environmental management plan (EMP) has been developed to implement the mitigation measures in true spirit. A monitoring plan has also been incorporated in the EMP to monitor impact of all activities and performance of mitigation measures and to identify positive/negative changes in the environment.

8) Documentation & Review

This is the final step that completes the EIA study. The data generated during and for the study are compiled and examined by experts of the respective field. Sections of this report were prepared as the study progressed, by EMC office staff in consultation with experts. The report was finally reviewed by team leader, who analyzed the information, assessed the potential environmental impacts in the light of national and international guidelines and organized the Report to the present form.

1.6. Report Set-Up

This document has been prepared by compiling: i) ESIA for LNG Import Terminal, and ii) IEE for HP Transmission Pipeline and Nitrogen Blending facility. It contains the following sections:

Section#1 Introduction and Objectives: introduces the project, gives its objectives, need for ESIA, categorization and methodology adopted for conducting the ESIA. **Section#2 Legislative and Administrative Framework**: gives an overview of policy and legislation along with International Guidelines relevant to LNG terminal and associated environmental and social aspects. **Section#3 Description of Project**: describes the LNG Import Terminal Project and associated facilities; **Section#4 Screening of Alternatives &/or Subsequent Expansions**: presents the system alternatives to the proposed project, including the siting alternatives evaluated for the proposed Liquefied Natural Gas (LNG) terminal and the alternative technologies considered for the proposed LNG transfer facilities as well as dredging to create the berthing and turning basin, **Section#5 Description of Physical & Biological Environment** & **Section#6 Description of Socioeconomic Environment**: provides a description of the

microenvironment and macro environment of the project area with regards to the environmental & social baseline conditions. **Section#7 Public / Stakeholders Consultation & Information Disclosure**: presents the objectives and outcomes of the stakeholder consultation conducted during the ESIA process and the ongoing community engagement programme. **Section#8 Potential Environmental Impacts of proposed development and recommended mitigation measures** & **Section#9 Potential Social Impacts of proposed development and recommended mitigation measures**: describes the potential environmental and social aspects and of the proposed LNG terminal on the different features of the micro and macro environment, and using the general guidelines present a screening of potential environmental impacts at the design, construction and operation stages. The screening process includes the residual impact as a result of adoption of mitigation measures that may be needed for minimizing the impact. **Section#10 presents Preliminary Cumulative Impact Assessment**. **Section#11 Environmental Management Plan**: presents the environmental management and monitoring plan. Finally **Section#12 Conclusion & Recommendations**: summarizes the report and presents its conclusions and recommendations.

1.7. ESIA Team

This EIA Report has been prepared by Environmental Management Consultants (EMC). EMC organized the following team for the purpose of conducting the environmental assessment and preparing the report:

Sr. No.	Name of Expert	Designation
1	Syed Nadeem Arif	Project Manager
2	Saquib Ejaz Hussain	Team Leader/Expert Pollution Chemistry
3	Dr. Mirza Arshad Ali Beg	Expert on Sustainable Development
4	Dr. Iqbal Ali	Expert on Water Resources
5	Dr. Shahid Amjad	Oceanographic & Marine Biology Expert
6	Dr. Badar Munir Ghauri	Expert on Air Quality
7	Dr. M. Masoom	Waste Management Expert
8	Mr. Sultan Mehmood Zaman	Expert on Soil Science
9	Ms. Zulekha Soorma	EHS Advisor
10	Dr. Kaneez Fatima Mamdani	Senior Sociologist

Contact Person	
Proponent	**Consultant**
Sheikh Imran ul Haque Chief Executive Officer (CEO) Elengy Terminal Pakistan Limited 16th Floor, Harbor Front, Clifton, Karachi. Tel: +92-2135293900 Fax: +92-2135611394 E-mail: sihaque@engrovopak.com	**Syed Nadeem Arif** Managing Director Environmental Management Consultants (EMC) Office # 503, Anum Estate Building, Main Shahrah-e-Faisal, Karachi, Pakistan. Telephone: 021-34311466 Fax: 021-34311467 E-mail: nadeem@emc.com.pk, mail@emc.com.pk

02 Legislative & Administrative Framework

The principles of sustainable development are in the process of being incorporated into national policies and legislation in Pakistan through various statutory instruments. This section describes the policy framework, statutory framework, environmental and social guidelines, and also the legal responsibilities of the proponent in the context of the environment and sustainable development.

The proponent of this project (Elengy Terminal Pakistan Terminal) will comprehensively follow the requirements of the policy documents and legislative framework as well as recommendations of national and international guidelines.

As the possibility of financing for the project from international financing institutions is being explored, the assessment has been carried out to comply with both local and International Requirements of IFC & World Bank.

2.1 Policy Framework

The Pakistan National Conservation Strategy (NCS), which was approved by the Federal Cabinet in March 1992, is the principal policy document for environmental issues in the country. The NCS signifies the country's primary approach towards encouraging sustainable development, conserving natural resources, and improving efficiency in the use and management of resources. The NCS has 68 specific programs in 14 core areas in which policy intervention is considered crucial for the preservation of Pakistan's natural and physical environment. The core areas that are relevant to the proposed project are biodiversity conservation, restoration of rangelands, pollution prevention and abatement, and the preservation of cultural heritage.

Pakistan is a signatory to the Convention on Biological Diversity, and is thereby obligated to develop a national strategy for the conservation of biodiversity. The Government of Pakistan constituted a Biodiversity Working Group, under the auspices of the Ministry of Environment, to develop a Biodiversity Action Plan for the country, which was completed after an extensive consultative exercise. The plan, which has been designed to complement the NCS and the proposed provincial conservation strategies, identifies the causes of biodiversity loss in Pakistan and suggests a series of proposals for action to conserve biodiversity in the country. The Pakistan Environmental Protection Council (PEPC) has approved the action plan and steering committees at the federal and provincial levels have been formed to implement it.

Mid-term Review of NCS: Key Findings

An overview of the key environmental issues facing Pakistan is as follows:

- Per capita water availability in Pakistan has been decreasing at an alarming rate. In 1951, the per capita availability was 5300 cubic meter which has now decreased to 1105 cubic meter just touching water scarcity level of 1000 cubic meter.
- Almost all fresh water resources are severely polluted due to discharge of untreated industrial and municipal wastes. Pollution of coastal waters due to waste discharges and oil spills coupled with reduced freshwater flows is resulting in declining fish yields.
- About 55 percent of population has access to a relatively safe drinking water source. Potable water quality, assessed against WHO standards, fails to meet all the specified criteria, confirming evidence of extremely high pollutant loads.
- Approximately 35 percent of population has access to adequate sanitation facilities.
- Air pollution is on the rise, especially in urban areas.

Recent surveys conducted by Pakistan Environmental Protection Agency revealed presence of very high levels of suspended particulate matter (about 6 times higher than the World Health Organization's guidelines). 'Smog' also seriously affects almost entire Punjab during December and January every year.

- Noise pollution has become a serious issue in major urban centers.
- Of about 54,850 tons of solid waste generated daily in urban areas, less than 60 per cent is collected. No city in Pakistan has proper waste collection and disposal system for municipal, hazardous or healthcare wastes.
- The deforestation rate has been estimated at 0.2-0.5 percent per annum. Forest cover, which was 4.8 percent of total land area in 1992, could hardly be increased substantially despite all efforts.
- Degradation and encroachment of natural forests, rangelands and freshwater and marine ecosystems are resulting in loss of biodiversity. At least four mammal species, including tiger, swamp deer, lion and Indian one-horned rhinoceros, are known to have become extinct from Pakistan while at least 10 ecosystems of particular value for the species richness and uniqueness of their floral and faunal communities are considered to be critically threatened.
- Desertification affects over 43 million hectares of land annually.
- Pakistan is a highly energy in-efficient country. It uses approximately same amount of energy to generate 1 dollar of GNP as the USA.

The situation just mentioned is the result of a number of constraining factors including high population growth rate, prevailing poverty, unplanned urban and industrial expansion, insufficient emphasis on environmental protection in the government policies, lack of public awareness and education and above all the ailing economy which has caused deficiencies in institutional capacity and resources for effective environmental management.

The mid-term review of the NCS led the Government of Pakistan (GOP) and United Nations Development Program (UNDP) to jointly initiate an umbrella support program called the National Environmental Action Plan-Support Program (NEAP-SP) that was signed in October 2001 and implemented in 2002. The development objective supported by NEAP-SP is environmental sustainability and poverty reduction in the context of economic growth. The primary objective of NEAP is to initiate actions and programs for achieving a state of environment that safeguards public health, promotes sustainable livelihood, and enhances the quality of life of the people in Pakistan. The NEAP identifies four primary areas, (1) Clean air (2) Clean water (3) Management of solid waste (4) Ecosystem management. The plan also presents five additional areas of concern (i) Management of fresh water resources (ii) Marine pollution (iii) Toxic and hazardous substances handling and disposal (iv) Energy conservation and management (v) Compliance with international treaties and protocol.

Studies conducted by GOP and Donor Agencies in Pakistan have identified a number of environmental concerns with regard to energy, water and air pollution, waste management, irrigated agriculture, and biodiversity. These studies suggest an overall degradation in the quality and impoverishment of renewable natural resources such as water, forests and other flora as well as key biological habitats. The GOP, private sector and civil society have, with few exceptions, not responded positively to meet the challenges from these concerns.

2.2 Administrative Framework

Environmental issues are governed by three levels of the government viz. Federal, Provincial and Local Government. The Ministry of Environment and Local Government is the Ministry at the Federal level, which oversees the affairs of

the environment in the country. The Provincial Governments have designated the Ministries of Local Government to oversee matters related to the environment at the provincial level. The Provincial EPAs are directly under the respective Provincial Ministry of Local Government and Environment. Sindh EPA is placed under the Ministry of Environment and Alternative Energy, GoS.

2.2.1 Institutional Setup for Environmental Management

The apex environmental body in the country is the Pakistan Environmental Protection Council (PEPC), which is presided over by the Chief Executive of the Country. Other bodies include the Pakistan Environmental Protection Agency (Pak-EPA), provincial EPAs (for four provinces, AJK and Northern Areas), and environmental tribunals.

The EPAs were first established under the 1983 Environmental Protection Ordinance; the PEPA 1997 further strengthened their powers. The EPAs have been empowered to receive and review the environmental assessment reports (IEEs and EIAs) of the proposed projects, and provide their approval (or otherwise).

The proposed project would be located in Sindh Province. Hence this EIA Report will be sent to the Sindh EPA for review and issue of No Objection Certificate (NOC).

The GoS involvement in local government and municipal affairs has been devolved to the Environment Department of the CDGK. However, the devolution program has not been implemented since an environment officer, required to oversee the environmental issues has not been appointed. Coordination of the environmental monitoring activity continues as a provincial subject and is assigned to Provincial EPAs, in this case EPA Sindh, which has been duly authorized to enforce environmental compliance.

The main organizations responsible for providing services in the areas where the Project will be established include the Port Qasim Authority directly.

2.3 Statutory Framework

The Constitution of Pakistan distributes legislative powers between the federal and provincial governments through two 'lists' attached to the Constitution as Schedules. The Federal List covers the subjects over which the federal government has exclusive legislative power, while the Concurrent List contains subjects regarding which both the federal and provincial governments can enact laws.

The development of statutory and other instruments for environmental management has steadily gained priority in Pakistan since the late 1970s. The Pakistan Environmental Protection Ordinance, 1983 was the first piece of legislation designed specifically for the protection of the environment. The promulgation of this ordinance was followed, in 1984, by the establishment of the Pakistan Environmental Protection Agency, the primary government institution dealing with environmental issues. Significant work on developing environmental policy was carried out in the late 1980s, which culminated in the drafting of the Pakistan National Conservation Strategy. Provincial environmental protection agencies were also established at about the same time. The National Environmental Quality Standards were established in 1993. The enactment of the Pakistan Environmental Protection Act (PEPA), 1997 has conferred broad-based enforcement powers to the environmental protection agencies. The publication of the Pakistan Environmental Protection Agency Review of IEE and EIA Regulations (IEE-EIA Regulations), 2000 provided the necessary details on the preparation, submission, and review of initial environmental examinations (IEE) and environmental impact assessments (EIA).

In addition to the PEPA, 1997, Pakistan's statute books contain a number of other laws that have clauses concerning the regulation and protection of the environment.

2.3.1 Pakistan Environmental Protection Act, 1997

Pakistan Environmental Protection Act was introduced in December 1997 to provide for protection, conservation,

rehabilitation and improvement of the environment, for prevention and control of pollution and for sustainability of all development activities. The Act is the basic legislative tool that empowers the government to frame regulations to protect the environment. It broadly applies to air, water, soil, and noise pollution. There are 33 sections in the PEP Act, 1997. Following are very important clauses pertinent to establishment of proposed LNG Project:

- S.R.O. 339 (1)/2001 - In exercise of the powers referred in Section 33 of the PEPA 1997 (XXXIV of 1997), Pak - EPA has, with the approval of the Federal Government introduced "Pak-EPA (Review of IEE and EIA) Regulations, 2000.
- Clause 14 - "Handling of Hazardous Substances" requires anyone who generates, collects, consigns, transports, treats, disposes of stores, handles hazardous material or imports any hazardous waste has to have a permit to do so from EPA.
- Clause 16 - "Environmental Protection Order" permits EPA to enforce protection measures and remediation where contamination of the environment has taken place. Where an order is not carried out, FEPA has the authority to carry out the required works and to recover the costs from the person responsible for the source of environmental contamination.
- Clause 18 - "Offences by Bodies Corporate" identifies individual responsibility and liability to prosecution where contravention of an Ordinance is committed by a body corporate. Accordingly powers of the Federal and Provincial EPAs have been enhanced and they have the powers to conduct enquiries into possible breaches of environmental laws either of their own accord, or upon filing a complaint.
- Clause 30 - "Ordinance to over-ride other laws", takes precedence over other laws in effect at the time.

Under this Act no project including construction activities or any change in the existing physical environment can commence unless the fulfilment of pre-requisite to IEE or EIA has been conducted and its approval obtained from the Responsible Authority, in the present case from Sindh EPA.

A copy of PEPA Act, 1997 is attached as Annex-II.

2.3.2 Pak-EPA (Review of IEE/EIA) Regulations 2000

Pakistan Environmental Protection Agency Review of IEE and EIA Regulations, 2000 promulgated under PEPA 1997 were enforced in June 2000. These Regulations define the applicability and procedures for preparation, submission and review of IEE and EIA. These Regulations also give legal status to the Pakistan Environmental Assessment Procedures prepared by the Federal EPA in 1997.

Accordingly the Environmental Protection Agencies, including Sindh EPA are bound to conduct a preliminary scrutiny and reply within 10 days of the submittal of the IEE/EIA report. These regulations require submission of a monitoring report to the concerned EPA after completion of the construction, followed by regular monitoring reports, in the case of EIAs, during subsequent operations. EPA is bound to approve or disapprove the report within a period of four months or else the ESIA would be deemed approved.

This regulation also provides procedures for classification of projects on the basis of expected severity of the adverse environmental impact and lists them into three separate schedules. Projects that may not have significant impacts on the environment are included in Schedule-A, and they therefore require an IEE. Schedule-II includes Projects having potentially significant environmental impacts and such projects require submission of an EIA. Schedule-C includes those projects which do not fall in Schedules I and II and do not require an EIA or IEE but require an environmental approval to be sought.

Placement of LNG Project in Schedule-II is based on its severity and due to the reason that it involves shipping activity having gross displacement above 500 tons.

A copy of PEPA IEE/EIA Regulations-2000 is attached as Annex-III.

2.3.3 National Environmental Quality Standards (NEQS)

One of the functions of the Pak EPA under the provision of PEPO of 1983 was to issue NEQS for municipal and liquid industrial effluent, industrial gaseous emissions and motor vehicle exhaust and noise. The Pak EPA issued a statutory regulatory order (S.R.O) in 1994. It required all units coming into production after 1st July 1994 to comply immediately with the new standards. Those already in production at the time of S.R.O were required to comply starting 1st July 1996. The Pak EPA was not able to implement the NEQS effectively for many reasons, including lack of implementation capacity and resistance from industry.

With the PEPA, 1997 the Pak EPA revised the NEQS with full consultation of the private sector, industrialist, trade and business associations and NGOs. The municipal and liquid industrial effluent standards cover 32 parameters. The standards for industrial gaseous emissions specify limits for 16 parameters, and the standards for motor vehicles prescribe maximum permissible limits for smoke, carbon monoxide and noise. Revised standards cover discharges limits of effluents into inland water, sewage treatment plant and the sea. The NEQS are primarily concentration based. Unfortunately, the limits on industrial effluents are neither industry specific nor do they have any relationship with the quantum of production. The NEQS prohibit dilution, but this can be easily circumvented.

ETPL is committed to comply with the applicable NEQS in letter and spirit.

The complete set of NEQS is attached as Annex-IV & V.

2.3.4 Self Monitoring and Reporting Rules 2001

The Self-Monitoring and Reporting System (SMART) aims to make the country's industry owners and operators responsible for systematic monitoring and reporting of their environmental performance.

By implementing this system, the government has in fact transferred the responsibility for examining and evaluating industry's environmental performance to individual industrial facilities. Apart from saving EPAs considerable expense, time and effort, this measure has enabled industry owners and operators to make long-term provisions for eco-friendly production. The reported data enables government agencies to assist industrial units in controlling their pollution levels.

All industry owners, majority being small or medium scale operators have not responded to the Self-Monitoring and Reporting System and efforts are underway to bring them in the SMART network.

LNG project should because of its severity fall under the Category A of industrial categorization and reporting procedure for SMART. Regular environmental reports on priority parameters will be sent to the relevant authorities as per the requirements of ESIA approval.

2.3.5 The Biodiversity Action Plan

The key to protecting the biological heritage of Pakistan lies in the involvement of local people and in the support provided by competent institutions for conservation and sustainable use. The Government of Pakistan has recognized the importance of these measures in the preparation of the National Conservation Strategy and in becoming a signatory to, and in ratifying, the Convention on Biological Diversity (CBD) in 1994. Developing the Biodiversity Action Plan for Pakistan, 2000 has been the most significant direct steps towards addressing the biodiversity loss.

This EIA study has addressed all aspects of conservation, including Wildlife, and forest. It has specifically addressed the mangrove tree removal aspect and suggested mitigation measures.

2.3.6 The Sindh Fisheries Ordinance, 1980

The Sindh Fisheries Ordinance, 1980 regulates fishing in the public waters, including the coastal areas, of Sindh. It

empowers the government of Sindh to issue licenses for fishing in public waters, put restriction on the type of equipment that can be used for fishing, restrict fishing in certain areas or of certain species of fish, regulate the onshore trade of fish catch, and regulate the fish processing industry. Article 8 of the Ordinance prohibits the discharge of wastewater to public waters without the consent of the Director Fisheries. Sindh Fisheries Department has been informed of the establishment of the LNG Terminal at the sites under consideration.

2.3.7 Antiquity Act 1975

The Antiquities Act of 1975 ensures the protection of cultural resources in Pakistan. The act is designed to protect antiquities from destruction, theft, negligence, unlawful excavation, trade, and export. Antiquities have been defined in the Act as ancient products of human activity, historical sites, or sites of anthropological or cultural interest, national monuments, etc. The law prohibits new construction in the proximity of a protected antiquity and empowers the Government of Pakistan to prohibit excavation in any area that may contain such articles of archaeological significance. Under the Act, the project proponents are obligated to:

- Ensure that no activity is undertaken in the proximity of a protected antiquity
- If an archaeological discovery is made during the course of the project, it should be reported to the Department of Archaeology, Government of Pakistan.

The Act of 1975 is considered quite effective, provided it is administered appropriately. For its proper administration, the federal department of Archaeology needs adequate staff which has not been provided to it. Civic agencies authorized to grant permission for new constructions must keep in view the provisions of the Act. It has been suggested that the Act must be amended to make compulsory registration of the antiquities and the owner of the property be made responsible for preservation of the antiquity.

This ESIA Study has not found any antiquity artifact in the area concerned and does not find that the said Act would apply to siting of the LNG Terminal under consideration.

2.3.8 Sindh Cultural Heritage (Preservation) Act, 1994

The Sindh Cultural Heritage (Preservation) Act, 1994 is the provincial law for the protection of cultural heritage. Its objectives are similar to those of the Antiquity Act, 1975.

None of the sites protected under this law have been identified in the vicinity of Project site.

2.3.9 Forest Act 1927

This act empowers provincial forest authorities to declare any area as forest. The proposed project is not in forest declared area; however, mangroves (limited impact area) will have the prime importance and their conservation will be considered when the project is executed.

The Forestry Departments manage official forestry reserves and have expressed concern about the level of woodcutting, camel breeding which has taken place in the area. IUCN, Engro Polymer Chemical Pakistan Ltd as well as ETPL have undertaken plantation of mangrove trees in a systematic manner and their experience will ensure that the mangroves are conserved/replanted.

Conservation practices must be adopted at the proposed project site at the pre-construction and construction stages.

2.3.10 Sindh Wildlife Protection (Second Amendment) Ordinance, 2001

Sindh Wildlife Department is responsible for protection of wildlife in the Province. The Department's concerns are limited to areas designated as game reserves, national parks or wildlife sanctuaries and to protecting species afforded protection under the law. So long as the law is not being contravened they have no official interest in activities carried on outside game reserves, national parks and wildlife sanctuaries. The Department nevertheless

has the powers to halt illegal activities outside the protected areas.

Sindh Wildlife Protection Ordinance 1972 was enacted to protect wildlife resources of the province directly, and other natural resources indirectly. It classifies wildlife by degree of protection, i.e., animals that may be hunted on a permit or special license, and species that are protected and cannot be hunted under any circumstances. The Ordinance specifies restrictions on hunting, and trade in animals, trophies, or meat. The Ordinance also provides for the creation of three classes of special protected areas: National Parks (Section 15), Wildlife Sanctuaries (Section 14), and Game Reserves (Section 16).

The 2001-Amendment to Sindh Wildlife Protection Ordinance (1972) allows carrying out activities for exploration of oil and gas in wildlife sanctuaries of national park areas in the province. The Ordinance relates to oil and gas exploration activities in Kirthar National Park, which was declared protected area under Sindh Wildlife Protection Ordinance 1972.

The Wild Birds and Animals Protection Act, 1992, the West Pakistan Wildlife Protection Ordinance 1959, the Wildlife Protection Rules and the Forest Act, 1927 provide for the protection of flora and fauna in the territory, including vegetation and protected forests.

As no activities are planned in or in the vicinity of any protected areas and no provision of this law is applicable to the proposed project.

2.4 Environmental and Social Guidelines

Two sets of guidelines, the Pak-EPA's guidelines and the World Bank Environmental Guidelines are reviewed in this Report. These guidelines address the environmental as well as social aspects relevant to the proposed project.

2.4.1 Environmental Protection Agency's Environmental and Social Guidelines

The Federal EPA has prepared a set of guidelines for conducting environmental and social assessments. The guidelines derive from much of the existing work done by international donor agencies and NGOs. The package of regulations, of which the environmental and social guidelines form a part, includes the PEPA 1997 and the NEQS. These guidelines are listed below.

- Guidelines for the Preparation and Review of Environmental Reports,
- Guidelines for Public Consultation,
- Guidelines for Sensitive and Critical Areas,
- Sectoral Guidelines.

It is stated in the Pakistan Environmental Protection Agency (Review of IEE and EIA) Regulations, 2000 that the EIA or IEE must be prepared, to the extent practicable, in accordance with the Pakistan Environmental Protection Agency Environmental Guidelines.

a. Policy And Procedures For Filing, Review& Approval Of Environmental Assessments

These guidelines define the policy context and the administrative procedures that will govern the environmental assessment process, from the project pre-feasibility stage, to the approval of the environmental report.

This ESIA Study has followed the procedures laid out in the PEPA 1997 and Review guidelines 2000, and the ESIA will be submitted to the EPA Sindh in whose jurisdiction the project will be implemented. The PEPA has, however, been given the right to review any environmental report at any time and the power to revoke the decision of the provincial EPA, if it deems this to be necessary. Figure 2.1 shows EIA preparation and approval procedure.

b. Guidelines for Preparation & Review of Environmental Reports

It requires proponents to prepare terms of reference for the environmental assessment reports. It requires that all

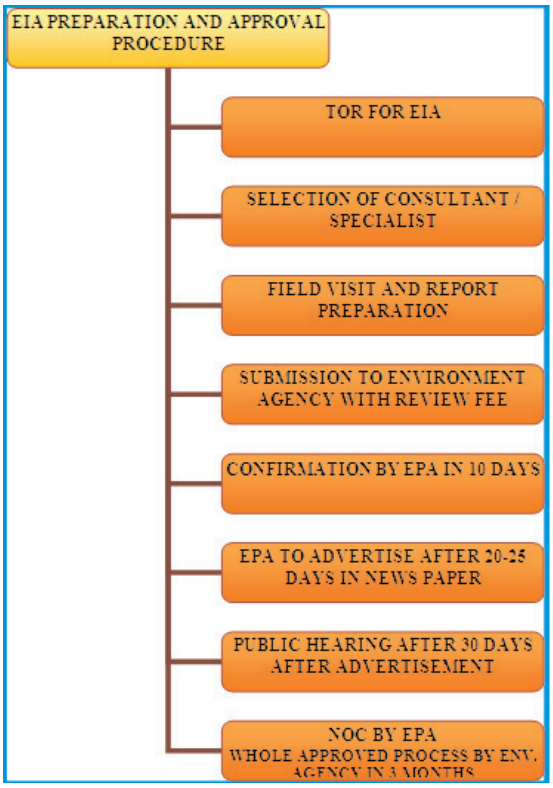


Figure 2.1: EIA Preparation and Approval Procedure

studies should contain baseline data on the area and must contain an assessment of the potential environmental impacts and the recommended mitigation measures.

The guidelines have been duly followed while preparing this ESIA.

c. Guidelines for Public Consultation

These guidelines are part of the package of regulations and guidelines. They provide assistance throughout the environmental assessment of project by involving the public which can lead to better and more acceptable decision-making. The guidelines envisage that public involvement, if undertaken in a positive manner and supported by real desire to use the information gained to improve the proposal, will lead to better outcomes, and lay the basis for ongoing positive relationships among the stakeholders.

2.4.2 World Bank Guidelines on Environment

The principal World Bank publications that contain environmental guidelines are listed below:

a. Environmental Assessment-Operational Policy 4.01. Washington, DC, USA. World Bank 1999;

b. Environmental Assessment Sourcebook, Volume I: Policies, Procedures, and Cross- Sectoral Issues. World Bank Technical Paper Number 139, Environment Department, the World Bank, 1991;

c. Environmental Assessment Sourcebook, Volume III: Guidelines for Environmental Assessment of Energy and Industry Projects. World Bank Technical Paper No. 154, Environment Department, the World Bank, 1991;

d. Pollution Prevention and Abatement Handbook: Towards Cleaner Production, Environment Department, the World Bank, United Nations Industrial Development Organization and the United Nations Environment Program, 1998.

The first two publications listed here provide general guidelines for the conduct of an IEE/EIA, and address the IEE/EIA practitioners themselves as well as project designers. While the Sourcebook in particular has been designed for the Bank projects, and is especially relevant for the impact assessment of large-scale infrastructure projects, it contains enormous information which is useful to environmentalists and project proponents.

2.4.3 Equator Principle

The Equator Principles (EP) comprises a series of standards for the management of environmental and social issues in financing development projects globally. Once adopted by banks and other financial institutions, the Equator Principles commit the adoptees to refrain from financing projects that fail to follow the processes defined by the Principles. The private sector banks which developed the Equator Principles chose to model the Equator Principles on the environmental standards of the World Bank and the social policies of the

International Finance Corporation (IFC). The Equator Principles have become the de facto standards for banks and investors on assessment of major development projects around the world.

Project financiers may encounter social and environmental issues that are both complex and challenging, particularly with respect to projects in the emerging markets. The Equator Principles Financial Institutions (EPFIs) have consequently adopted these Principles to ensure that the projects they finance are developed in a manner that is socially responsible and reflects sound environmental management practices. By doing so, negative impacts on project-affected ecosystems and communities are avoided where possible, and if these impacts are unavoidable, they are to be reduced, mitigated and/or compensated for appropriately. It is believed that adoption of and adherence to these principles offer significant benefits to institutions, their borrowers and local stakeholders through their borrowers' engagement with locally affected communities. It is therefore recognized that the role of the institutions as financiers affords them opportunities to promote responsible environmental stewardship and socially responsible development.

EPFIs therefore consider reviewing these principles from time-to-time based on implementation experience, and in order to reflect ongoing learning and emerging good practice. These principles are intended to serve as a common baseline and framework for the implementation by each EPFI of its own internal social and environmental policies, procedures and standards related to its project financing activities. The institutions will not provide loans to projects where the borrower will not or are unable to comply with their respective social and environmental policies and procedures that implement the Equator Principles.

The Equator Principles apply to projects over 10 million US dollars. The Principles state that adopting financial institutions will provide loans directly to projects only under the following circumstances:

A. Principle 1: Review and Categorization

The risk of the project is categorized in accordance with internal guidelines based upon the environmental and social screening criteria of the IFC. Projects are classified, relating to social or environmental impacts, in Category A (significant impacts), Category B (limited impacts) and Category C (minimal or no impacts).

B. Principle 2: Social and Environmental Assessment

For all medium or high risk projects (Category A and B projects), sponsors complete an Environmental Assessment, the preparation of which must meet the National and International requirements and satisfactorily address the key environmental and social issues.

C. Principle 3: Applicable Social and Environmental Standards

The Environmental Assessment report addresses baseline environmental and social conditions, requirements under host country laws and regulations, applicable international treaties and agreements, sustainable development and use of renewable natural resources, protection of human health, cultural properties, and biodiversity, including endangered species and sensitive ecosystems, use of dangerous substances, major hazards, occupational health, and safety, fire prevention and life safety, socio-economic impacts, land acquisition and land use, involuntary resettlement, impacts on indigenous peoples and communities, cumulative impacts of existing projects, the proposed project, and anticipated future projects, participation of affected parties in the design, review and implementation of the project, consideration of feasible environmentally and socially preferable alternatives, efficient production, delivery and use of energy, pollution prevention and waste minimization, pollution control (liquid effluents and air emissions) and solid and chemical waste management.

D. Principle 4: Action Plan and

Management System

Based on the Environmental Assessment, Equator banks then make agreements with their clients on how they mitigate, monitor and manage those risks through a 'Social Environmental Management Plan'.

e. Principle 5: Consultation and Disclosure

For risky projects, the borrower consults with stakeholders (NGOs and project affected groups) and provides them with information on the risks of the project. The borrower has to consult the project affected communities in a structured and culturally appropriate manner. The process will ensure free, prior and informed consultation for affected communities.

f. Principle 6: Grievance Mechanism

The borrower will establish a grievance mechanism as part of the management system.

g. Principle 7: Independent Review

Assessment, preparation of Assessment Plan and consultation process.

h. Principle 8: Covenants

Incorporation of Covenants linked to compliance. Compliance with the plan is required in the covenant. If the borrower does not comply with the agreed terms, the bank will take corrective action, which if unsuccessful, could ultimately result in the bank cancelling the loan and demanding immediate repayment.

i. Principle 9: Independent Monitoring and Reporting

An independent expert is consulted during the life of the loan for Category A and, if necessary in Category B.

j. Principle 10: EPFI Reporting

Each EPFI commits to report publicly at least annually about its implementation processes and experience on Equator Principles.

This ESIA study has adequately addressed the Equator Principles applicable to risky projects as stated hereunder:

a. Principle 1 Review and Categorization: The study has reviewed the National and International Laws and Guidelines on different environmental aspects and has categorized the LNG Project in Schedule-A (Major Hazard), requiring EIA.

b. Principle 2 Social and Environmental Assessment: The Study has been prepared to respond to the National and International requirements and to satisfactorily address the key environmental and social issues.

c. Principle 3 Applicable Social and Environmental Standards: For the purpose of this EIA Study, primary data on the baseline environmental and social conditions have been generated wherever necessary to address the requirements of National laws and regulations; applicable International Treaties and Agreements; sustainable development and use of renewable natural resources; protection of human health, cultural properties, and biodiversity and other physical, ecological and socioeconomic issues required to be addressed under this Principle.

d. Principle 4 Action Plan and Management System: Chapter 5 of this study screens the potential environmental impacts and proposes/provides Mitigation Measures to reduce the severity of impact. The study also includes the Environmental Monitoring and Management Plan, Contingency Plan and Disaster Management Plan.

e. Principle 5 Consultation and Disclosure: Being a risky project of Schedule -A, the public consultation is limited to the scoping sessions with stakeholders and an extensive socioeconomic survey of the villages/hamlets that are all outside the boundary of the Project area. The surveys and consultation meetings have established that no resettlement or temporary relocation or acquisition of land is involved.

f. Principle 6 Grievance Mechanism: This Principle will not apply since no resettlement or temporary relocation or acquisition of land is involved.

g. Principle 7 Independent Review: Being placed in Schedule-A, an independent review may be needed.

h. Principle 8 Covenants: The EIA study has incorporated Covenants linked to compliance. Moreover, No Objection Certificates are issued to Proponents of Project under conditions of compliance with the Mitigation and Performance Monitoring Plan. Needless to say that if the proponent does not comply with the agreed terms, Sindh EPA is authorized to take corrective and even coercive action.

i. Principle 9 Independent Monitoring and Reporting: This Principle will be applicable to the LNG Project since it is a high risk project.

j. Principle 10 EPFI Reporting: The concerned EPFI may safely commit to report publicly at least annually about its Equator Principles implementation processes and experience.

2.4.4 IFC Performance Standards on Social and Environmental Sustainability

International Finance Corporation (IFC) applies the Performance Standards to manage social and environmental risks and impacts and to enhance development opportunities in its private sector financing in its member countries eligible for financing. The Performance Standards may also be applied by other financial institutions electing to apply them to projects in emerging markets. Together, the eight Performance Standards establish standards that the Proponent is to meet throughout the life of an investment by IFC/WB or other relevant financial institution.

The objectives of Performance standards are given below:

- To identify and assess social and environment impacts, both adverse and beneficial, in the project's area of influence
- To avoid, or where avoidance is not possible, minimize, mitigate, or compensate for adverse impacts on workers, affected communities , and the environment
- To ensure that affected communities are appropriately engaged on issues that could potentially affect them
- To promote improved social and environment performance of companies through the effective use of management systems.

a. Performance Standard-1: Assessment and Management of Environmental and Social Risks and Impacts

This Performance Standard seeks to:

i) Identify and assess social and environment impacts in the project's area of influence;

ii) Avoid, minimize, mitigate, or compensate for adverse impacts on workers, affected communities, and the environment;

iii) Ensure that affected communities are appropriately engaged on issues that could potentially affect them; and

iv) Promote improved social and environment performance of the project through the effective use of management systems.

Under this Standard, the project is required to establish and maintain a social and environmental management system appropriate to the nature and scale of the project and in accordance with the level of social and environmental risks and impacts. The management system is required to incorporate the following elements:

- Social and Environmental Assessment;
- Management program;
- Organizational capacity;
- Training;

- Community engagement;
- Monitoring; and
- Reporting

This ESIA study has been conducted to respond to requirements of national legislation and international Guidelines and just as well fulfills the above requirements of the IFC Performance Standards PS1.

B. Performance Standard-2: Labor and Working Conditions

This PS seeks to establish, maintain and improve the worker-management relationship; promote fair treatment, non-discrimination and equal opportunity for workers, and compliance with national labor and employment laws; protect the workforce by addressing child labor and forced labor issues; and promote safe and healthy working conditions, and to protect and promote the health of workers.

The Sponsors of proposed project and their contractors will be required to adhere to this PS, in particular with regard to compliance with national labor and employment laws; employment of child labor, and promoting safe and healthy working conditions, besides protecting and promoting the health of workers. The proponent and its sponsors have actively pursued CSR activities and are responsible corporate citizens.

C. Performance Standard-3: Resource Efficiency and Pollution Prevention

The PS 3 seeks to avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities, and to promote the reduction of emissions that contribute to climate change. The Standard requires the project to consider during its entire lifecycle ambient conditions and apply pollution prevention and control technologies and practices that are best suited to avoid or, where avoidance is not feasible, minimize or reduce adverse impacts on human health and the environment while remaining technically and financially feasible and cost-effective.

PS 3 will be applicable to all stages of the LNG Project. Various aspects of pollution prevention and abatement of the proposed project are discussed separately in this report.

D. Performance Standard-4: Community Health, Safety, and Security

The PS 4 seeks to avoid or minimize risks to and impacts on the health and safety of local community during the project lifecycle from both routine and non-routine circumstances, and to ensure that the safeguarding of personnel and property is carried out in a legitimate manner that avoids or minimizes risks to the community's safety and security. The PS requires the project to evaluate the risks and impacts to the health and safety of the affected community during the design, construction, operation, and decommissioning of the project and establish preventive measures to address them in a manner commensurate with the identified risks and impacts.

The present assessment addresses the requirement of PS 4 for the proposed LNG Poject, and has evaluated the impacts of siting the LNG Terminal on health, safety and security of the community in the microenvironment as well as the macroenvironment. The Environmental Management Plan also addresses company community aspects.

E. Performance Standard-5: Land Acquisition and Involuntary Resettlement

This PS aims to address the adverse impacts associated with land acquisition and involuntary resettlement caused by the project. The PS seeks to:

- avoid or at least minimize involuntary resettlement wherever feasible by exploring alternative project

designs

- mitigate adverse social and economic impacts from land acquisition or restrictions on affected persons' use of land by: (i) providing compensation for loss of assets at replacement cost; and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected
- improve or at least restore the livelihoods and standards of living of displaced persons
- improve living conditions among displaced persons through provision of adequate housing with security of tenure at resettlement sites.

The LNG Project site is dedicated to establishment of facilities of similar nature. Moreover there is no settlement or hamlet within the designated area. Land acquisition by the Project will therefore not cause any involuntary resettlement as it is to be allocated by PQA.

f. Performance Standard-6: Biodiversity Conservation and Sustainable Management of Living Natural Resources

The PS 6 seeks to protect and conserve biodiversity, and promote sustainable management and use of natural resources through adoption of practices that integrate conservation needs and development priorities.

The present environmental assessment addresses the potential impacts of the LNG Project on the biodiversity. This ESIA has recommended measures for the conservation of flora, fauna and other natural resources including impact on marine life in case of leakage.

g. Performance Standard-7: Indigenous Peoples

The PS 7 seeks to address the impacts of the project on the indigenous people. Specifically, the objectives of the PS are to:

- ensure that the development process fosters full respect for the dignity, human rights, aspirations, cultures and natural resource-based livelihoods of Indigenous Peoples
- avoid adverse impacts of projects on communities of Indigenous Peoples, or when avoidance is not feasible, to minimize, mitigate, or compensate for such impacts , and to provide opportunities for development benefits, in a culturally appropriate manner
- establish and maintain an ongoing relationship with the Indigenous Peoples affected by a project throughout the life of the project
- foster good faith negotiation with and informed participation of Indigenous Peoples when projects are to be located on traditional or customary lands under use by the Indigenous Peoples
- respect and preserve the culture, knowledge and practices of Indigenous Peoples

No indigenous people - with a social and cultural identity distinct from the existing dominant society that makes them vulnerable to being disadvantaged in the development process of the LNG Project are known to exist in and around the proposed site. No such people were found in the area during the present study either. Therefore, this PS is not applicable for the proposed project.

h. Performance Standard-8: Cultural Heritage

The objectives of this PS are to protect cultural heritage from the adverse impacts of project activities and support its preservation, and to promote the equitable sharing of benefits from the use of cultural heritage in project activities.

No sites of cultural heritage are known to exist at or in the immediate vicinity of the LNG Project location. There are also no indications of any old settlement in the area, nor is there any site covered under the listing of cultural heritage sites. This PS will therefore not be applicable to the Project.

2.4.5 National Strategy and Action Plan for Mangroves for the Future (MFF)

MFF National Strategy and Action Plan (NSAP) will support the development vision of the Government of Pakistan and associated policies as they relate to sustainable use and management of coastal ecosystems and adaptation to climate change in the context of integrated coastal management. The NSAP does not solely focus mangrove forests but entails mangrove ecosystem and associated biodiversity, thus the term 'mangrove' is used as a symbolic label. Pakistan's NSAP specifically addresses and treats issues related to the dominant coastal ecosystems viz mangroves, estuaries turtle nesting beaches and coral reef. NSAP Pakistan will contribute towards ecosystem-based integrated coastal management (ICM) and its goal would be to improve the quality of life of dependent communities. ICM by its inherent nature requires actions at local geographic sites - both entire ecosystems and parts thereof.

The NSAP conforms to Government of Pakistan's basic requirement of good governance and community participation in development programmes. It builds on the principles that a central body (NCB) should perform only those tasks which cannot be performed effectively at a more immediate or local level. However at local level Programme of Works (PoW) will be implemented by different organizations under the guidance of NCB. The NSAP follows a cross sectoral collaborative approach in harmony with other policies and programmes of development sectors including climate change mitigation and adaptation policy.

In the context of challenges to the coastal areas of Pakistan, the NSAP paves the way for development of ICM programme for Pakistan to ensure good governance, knowledge management, community empowerment, and public-private partnership (sustainable financing) by:

- Setting up ICM models in selected coastal ecosystems
- Scaling up the successful models at the entire coastal belt

2.4.6 National Climate Change Policy

The National Climate Change Policy provides a framework for addressing the issues that Pakistan faces or will face in future due to the changing climate.

The main objectives of Pakistan's climate change policy include:

- To pursue sustained economic growth by appropriately addressing the challenges of climate change;
- To integrate climate change policy with other interrelated national policies;
- To focus on pro-poor gender sensitive adaptation while also promoting mitigation to the extent possible in a cost effective manner;
- To ensure Water Security, Food Security and Energy Security of the country in the face of challenges posed by climate change;
- To minimize the risks arising from expected increase in frequency and intensity of extreme weather events: floods, droughts, tropical storms etc;
- To strengthen inter-ministerial decision making and coordination mechanism on climate change;
- To facilitate effective use of the opportunities, particularly financial, available both nationally and internationally;
- To foster the development of appropriate economic incentives to encourage public and private sector investment in adaptation measures;
- To enhance the awareness, skill and institutional capacity of relevant stakeholders;
- To promote conservation of natural resources and long term sustainability.

2.4.7 IFC- Environment, Health & Safety Guidelines for LNG

A- EHS guidelines for LNG

These EHS Guidelines are applied as required by their respective policies and standards. These industry sector EHS guidelines are designed to be used together with the General EHS Guidelines document, which provides guidance to users on common EHS issues potentially applicable to all industry sectors.

B- General EHS Guidelines

The General EHS Guidelines contain information on cross-cutting environmental, health, and safety issues potentially applicable to all industry sectors. These General EHS Guidelines are designed to be used together with the relevant Industry Sector EHS Guidelines which provide guidance to users on EHS issues in Specific industry sectors. EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. The General EHS Guidelines are organized as follows:

- Environmental
- Occupational health and safety
- Community health and safety
- Construction and decommissioning

This guideline applies to facilities or projects that generate emissions to air at any stage of the project life-cycle. The applicability of the EHS Guidelines need to be tailored to the hazards and risks established for each project on the basis of the results of an environmental assessment.

C- Environmental, Health, and Safety Guidelines for Liquefied Natural Gas (LNG) Facilities

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry. These EHS Guidelines are applied as required by their respective policies and standards. EHS guidelines for LNG facilities are designed to be used together with the General EHS Guidelines document, which Provides guidance to users on common EHS issues potentially applicable to all industrial sectors.

The applicability of EHS Guidelines for Crude Oil and Petroleum Product Terminals include information relevant to land and shore-based petroleum storage terminals receiving and dispatching bulk shipments of crude oil, gasoline, middle distillates, aviation gas, lube oil, residual fuel oil, compressed natural gas (CNG), liquid petroleum gas (LPG), and specialty products from pipelines, tankers, railcars, and trucks for subsequent commercial distribution. This guideline covers Industry-Specific Impacts and Management and Performance Indicators and Monitoring.

The EHS Guidelines for Liquefied Natural Gas (LNG) Facilities include information relevant to LNG base load liquefaction plants, transport by sea, and re-gasification and peak sharing terminals. For coastal LNG facilities including harbors, jetties and in general coastal facilities (e.g. coastal terminals marine supply bases, loading / offloading terminals), additional guidance is provided in the EHS Guidelines for Ports, Harbors, and Terminals. For EHS issues related to vessels, guidance is provided in the EHS Guidelines for Shipping. Issues related to LPG/Condensate production and storage in liquefaction plants are not covered in this Guideline.

Certain objectives have been set in IFC performance standards to achieve sustainable development. Those objectives are given below:

- To identify and assess social and environment impacts, both adverse and beneficial, in the area of influence of LNG project
- To avoid, or where avoidance is not possible, minimize, mitigate, or compensate for adverse impacts on workers, affected communities , and the environment
- To ensure that affected communities are appropriately engaged on issues that could potentially affect them

- To promote improved social and environment performance of companies through the effective use of management systems.

Relevant International Standards for Noise and Effluent discharges have been tabulated & provided as Annex-VI.

2.5 Acts, Regulations, Guidelines & Policies on LNG

2.5.1 Ports Act 1908 & Pakistan Territorial Waters & Maritime Zones Act 1976

The Ports Act 1908 ensures safe shipping in the sea and prevention of pollution in waters. Pakistan Territorial Waters and Maritime Act 1976 regulates the exploration, development, conservation, and management of living and nonliving resources in Pakistan's Exclusive Economic Zone (EEZ), which extends up to 200 miles from the country's coastal zone.

Ports Act 1908 and Pakistan Territorial Waters and Maritime Zones Act 1976 will both apply to the Project. The Project proponent will be mandated to ensure safe shipping of the LNG Carriers (LNGC)s and to adopt measures for prevention of pollution of the sea and the resources in Pakistan's Exclusive Economic Zone (EEZ), which extends up to 200 miles from the country's coastal zone.

2.5.2 Port Qasim Authority Act, 1973 (Modified in 2002)

This act empowers PQA to prepare master plan and a master-program for development of the port area. Environmental control and prevention of pollution in the port area are also responsibilities of this authority. This act encourages promising proponents to conduct EIA or IEE prior to any development in the port area. Clause 71B and 71C, explains the responsibilities of authorities and the penalties for non-compliance. Both the clauses are stated hereunder:

A. 71B (Port to be Pollution Free, etc)

- The authority shall be responsible for maintaining the marine environments of the port's limit in order to ensure that the sea, land and air are free from pollution.
- No owner or master of the vessel or any industry, manufacturing establishment, mill, factory or any kind, cargo handling company, terminal operator, etc. shall discharge any solid or liquid waste, oily, noxious radioactive and hazardous substances, bilge discharges, residues and mixtures containing noxious solid and liquid wastes, de blasting of unwashed cargo tanks and line washing, garbage, emission of any effluent or waste or air pollution or noise in any amount concentration or level in excess of NEQS, or standards, which may be specified, from time to time, by the Authority of Port limits.
- Any person contravening the provision of sub-section (2) shall be liable to penalty as determined and noticed by the authority from time to time for each contravention in addition to the charges for cleaning of port and removal of pollution therefrom.

B. Section 71C (Environmental Pollution)

No proponent of the project shall commence construction or operation unless he has filed with this authority an IEE or, where the project is likely to cause an adverse environmental effect, an EIA, and has obtained from authority approval thereof.

The authority shall:

- Review the IEE and accord its approval, or required submission of an EIA by the proponent; or
- Review the EIA and accord its approval subject to such condition as it may deem fit to impose, or require that the EIA be re-submitted after such modification as may be stipulated.

2.5.3 Coastal Zone Regulation 1991

Coastal Zone Regulation (CZR) 1991 concerns the coastal stretches of seas, bays, estuaries, creeks, rivers

and backwaters. It extends on the beach up to 500 meters from the high tide line (HTL) and includes the land between the low tide land (LTL) and the HTL.

Setting up of new industries or expansion of existing industries, handling of hazardous wastes, discharge of untreated wastes and effluents, dumping of municipal wastes as landfill or otherwise, mining of sand, rocks and sub-strata materials and land reclamation within the CZR is forbidden, except for the purpose of construction of ports, harbors, jetties, wharves, quays, bridges and sea links.

CZR specifically lays down that reclamation for commercial purposes such as shopping and housing complexes, hotels and entertainment activities shall not be permitted. However, separate guidelines for construction of beach tourist resorts/hotels in CZR-III are provided for a no development zone (NDZ) for 200 meters from the HTL and within the area between the HTL and LTL is defined. With the prior approval of the ministry of environment and forests, two-storey structures can be built in this NDZ

This EIA Study has taken cognizance of Coastal Zone Regulation 1991 in screening the potential environmental impact of siting the LNG Terminal.

2.5.4 LNG Policy 2011

The LNG Policy 2011 aims to facilitate the potential investors in LNG sector, by bringing more clarity and predictability for investors, on the basis of their experience and the bottlenecks pointed out by the potential investors during various interactions with OGRA. The LNG Policy, 2011 covers Import Project Structure, LNG Procurement, Ownership & Operation of the LNG Terminal, RLNG Marketing & Transportation, and Regulatory Framework during construction period and operational period, Government Incentives, Pricing of RLNG, Government Guarantee, Freedom to Participate in the LNG Business, Technical Codes and Standards, Shipping of LNG, Other Permits and Licenses. Prior permission of GoP for Spot purchase of LNG will not be required. SSGCL/SNGPL will not sell gas priced under weighted average cost of gas mechanism, to industries, which are selected by GOP to use RLNG from time to time. Licensees will be required to furnish guarantee against their delivery commitment. In case of failure of the licensee to deliver LNG by stipulated date, its first right to 3rd Party Access will stand waived off. The involvement of Coast Guards or any other agency to control activities of entry and exit of shipping traffic and requirement of security escort through Coast Guards at the expense of LNG developer, LNG Terminal Owner/Operator and LNG Buyer will no longer be necessary.

Port authorities have been obligated to convey their decision on acceptance of site within one month of submittal of NOC from Sindh Environmental Protection Agency, Quantitative Risk Assessment Study and Navigational Simulation Study. OGRA's discretionary rights to grant exemptions from mandatory Regulated 3rd Party Access or Negotiated Third Party Access requirements are no longer valid. The project proponents have been allowed to establish gas storage facility subject to applicable rules and OGRA has been mandated to determine storage tariff. The committee will take up the tariff rationalization in the next meeting.

Pakistan's policy for the sustainable development of the energy sector, including the provision of reliable and competitively-priced energy is based on the following objectives:

a) Optimization of the primary energy mix, based on economic and strategic considerations;

b) Maximizing the utilization of indigenous energy resources;

c) Enhancing private sector participation in the energy sector by strengthening the regulatory framework and institutional capacity;

d) Developing energy infrastructure; and

e) Developing human resources with emphasis on energy sector-specific technical skills and expertise

Natural gas plays a key role in Pakistan's energy balance which is currently around 50% of the country's primary energy supplies. With accelerating economic growth, the demand for gas is projected to increase sharply and the country's recoverable indigenous gas reserves will be insufficient to meet this demand. Gas shortages have already emerged and shall increase substantially in the following years if indigenous supply is not supplemented through imports. In order to address the shortage, strong emphasis is being laid on importing gas from neighboring gas-producing countries through cross-border gas pipelines and also in the form of liquefied natural gas ("LNG"). Necessary measures are being taken for installation of LNG receiving, storage, re-gasification facilities and expansion of gas transmission infrastructure, for the distribution and sale of Regasified LNG ("RLNG") in the domestic market.

The LNG Policy aims to facilitate expeditious implementation of the LNG Projects. It has laid out the following framework for the Ownership & Operation of LNG Terminals:

The LNG Developer or LNG TO/O, as the case may be, will obtain a license to design, construct, operate and own a LNG terminal from OGRA under the Oil and Gas Regulatory Authority Ordinance, 2002 subject to satisfying the following criteria:

(a) Technical: At least one member of the consortium of LNG Developer or LNG TO/O, as the case may be, should have experience in developing and operating a liquefaction plant or a regasification terminal. The LNG terminal will be constructed based on technical standards as prescribed by the OGRA from time to time, in consultation and approval of Department of Explosives, including internationally acceptable industry technical standards as stipulated in Appendix-1.

(b) Financial: The LNG Developer or LNG TO/O consortium (on a several or joint and several basis) should have liquidity, revenues, net income and net worth above prescribed minimum thresholds (to be set by OGRA taking into consideration the financial obligations associated with the development and operation of the LNG import terminal).

(c) Health, Safety & Environmental ("HSE") Standards:

1. The LNG Developer, LNG TO/O or LNG Buyer as the case may be, will ensure that the project complies with World Bank HSE Guidelines, Pakistan's Environmental Protection Act 1997 rules, regulations and guidelines made there under, National Environmental Quality Standards, Pakistan's health, environment and safety standards and is consistent with the best international LNG industry practices.

2. The LNG Developer or LNG TO/O will undertake a comprehensive environmental impact assessment of the design, construction and operational aspects of the project including impact assessment of shipping associated with the project, in accordance with international standards and practices. The studies and approvals required at the planning, construction, commissioning and operating phases are defined in the Pakistan Environmental Protection Act, 1997.

3. All LNG terminals shall be surrounded by safety zones which shall meet the industry standards set forth in safety codes of the National Fire Protection Association of USA and as per the risk assessment studies so as to ensure protection of neighboring communities and shipping traffic.

4. Site approval: The site (either land based terminal or offshore terminal of any type) for setting up an LNG terminal shall be selected by LNG Developer or LNG TO/O, as the case may be, taking into account the following factors:

- Existing and projected population and demographic characteristics of the location;
- Existing and proposed land use near the location;
- Physical aspects of the location;
- Medical, law enforcement and fire protection capabilities near the location that can cope with a

risk caused by the facility;

- Exclusion zone distances from the terminal to property and population as per international standards are complied with;
- Proximity to existing gas infrastructure and market;
- Need to encourage remote sitting;
- Any other significant community concerns; and
- Environmental considerations.

In applying for the license, the LNG Developer or LNG TO/O will have the onus of demonstrating compliance with the above criteria through risk assessment and simulation studies.

Port Authorities will convey their decision on acceptance of site within one month of submission of NOC from SEPA, QRA study and navigational simulation study.

The licensee shall:

- Ensure delivery of LNG on fast track basis.
- Furnish guarantee against it commitment.

In case of licensee's failure to deliver LNG by stipulated date its right to Third Party Access will be subject to cancellation/review by OGRA.

2.5.5 Maritime Policy of Pakistan

The National Maritime Policy of Pakistan was approved and notified on October 16, 2002. The policy advocates "Management of Assets in a judicious manner with conscientious regard to the environment and international law". The objective of the policy is "protection and conservation of maritime environment/ecosystem" and section IV of the Policy holds the Port Authorities responsible to protect the maritime environment within their prescribed limits. This includes tasks of monitoring and combating spills of all kinds.

2.5.6 International Maritime Conventions

ETPL and its suppliers will comply with International Maritime Conventions in the import of LNG. These will include the conventions of the International Maritime Organization, International Labor Organization, United Nations, World Health Organization and others as appropriate.

The primary International Maritime Organization (IMO) safety standard governing the marine transport of LNG is the "International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk," (IGC Code - 1993 Edition).

A. MARPOL 1973 (modified in 1978

Ship-generated waste is regulated globally as part of the implementation of the International Convention for the prevention of pollution from Ships 1973 as modified by the Protocol of 1978 (MARPOL 73/78). The requirement of MARPOL 73/78 is established in 20 Articles, two Protocols and five annexes; these include contamination by oil, noxious liquid substances carried in bulk, harmful substances, sewage and garbage. Pakistan is signatory to all five annexes. Nevertheless, pollution prevention practices consistent with MARPOL requirements will be adhered to during all the phases of project. The Project proponent will be mandated to ensure safe shipping of the LNG Carriers (LNGC)s and besides adopting measures for prevention of pollution of the sea, will follow the International Convention for the prevention of pollution from Ships 1973 as modified by the Protocol of 1978 (MARPOL 73/78).

B. SIGTTO

The Society of International Gas Tankers and Terminal Operators (SIGTTO 1997) and The International Navigation Association (PIANC 1997) guidelines for LNG Docking facilities will be referred to during project design and construction.

C. London Convention 1972

In 1972, The London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other

Matter defines a Black List of toxic substances, and a Grey List of less hazardous substances that may only be dumped under a prior special permit, the dumping of any other wastes not specified in these lists requires a prior general permit. In 1990 this Convention was amended to require signatory countries to consider whether an adequate scientific basis exists for assessing the environmental impact of a substance (i.e. dredged material) before issuing a permit for dumping. Pakistan is signatory to the London Convention and a Notification came into force on 8th April 1995.

The Project Proponent will follow the procedures adopted by the other units based in Port Qasim area for dumping the wastes including dredged material and on guidelines of PQA. PQA has notified locations of dumping dredged material.

D. Laws of Seas:

The UN Convention on the Law of the Sea was adopted and opened for signature in 1982. On November 16th 1994, it entered into force for 68 countries. Pakistan is signatory to the convention. It establishes a basic structure of obligations, objectives and principles covering all sources of marine pollution that include:

- Pollution by vessels (operational and accidental discharges from ships), and
- Dumping (the deliberate disposal of wastes at sea by ships, aircrafts, platforms, or other manmade structures).

PQA will be mandated to ensure safe shipping of the LNG Carriers (LNGC)s and follow the Laws of Seas for prevention of pollution by vessels, besides taking measures to avoid dumping of ship wastes into the seas.

2.5.7 Technical Guidelines, Standards and Regulations:

1) Design Codes and Standards for Floating LNG terminals

- Pressure Vessels - ASME Boiler and Pressure Vessel Code
- Hydrocarbon Piping - IMO IGC Code (International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk) where appropriate.
- Electrical Systems - NFPA 70, National Electrical Code
- Hydrocarbon Pumps - API Standard 610, Centrifugal Pumps for Refinery Service
- Fired Heaters - API Standard 560, Fired Heaters for General Refinery Services
- Shell and Tube Heat Exchangers - API Standard 660, Shell-and-Tube Heat Exchangers for General Refinery Service
- Fire Protection - NFPA, various.
- Structural - AISC, Manual of Steel Construction (including requirements for acceleration due to transportation and in-service motions)

2) Technical Codes and Standards from LNG Policy 2011

(a) Shipping and Marine Facilities Standards

- Standard for the Production, Storage and Handling of Liquefied Natural Gas (LNG) - 2006, NFPA 59A, NFPA.
- Installations and Equipment for Liquefied Natural Gas - Design of Onshore Installations - 1997, (BS EN 1473) CEN.
- Installations and Equipment for Liquefied Natural Gas - Design and Testing of Loading/Unloading Arms - 1996, (BS EN 1474) CEN.
- Installations and Equipment for Liquefied Natural Gas - Ship to Shore Interface for Liquefied Natural Gas - 1996, (BS EN 1532) CEN.
- Installations and Equipment for Liquefied Natural Gas - General Characteristics of Liquefied Natural

Gas - 1997, (BS EN 1160) CEN.

- Maritime Structures - Part 1, General Criteria - 1984. (BS 6349), BSI.
- Maritime Structures - Part 4. Code of Practice for Design of Fendering and Mooring Systems - 1994, (BS 6349), BSI.
- IGC Code - IMO-104E - International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk - IGC Code, 1993 including amendments.
- Guidance Notes, Classification and Certification of Floating Offshore Liquefied Gas Installations - Lloyd's Register, April 2004, Revision 2.
- Guidance Notes, Classification and Certification of Offshore Gravity Based Liquefied Gas Terminals - Lloyd's Register, April 2004, Revision 1.

(B) GUIDELINES

- Site Selection and Design for LNG Ports and Jetties - 1997. SIGTTO, ISBN 1 85609 129 5.
- Recommendations on the Safe Transport of Dangerous Cargoes and Related Activities in Port Areas - 1995, (IMO 290E) IMO, ISBN 92-801-1329-1.
- Dangerous Goods in Ports: Recommendations for Port Designers and Port Operators - 1985, PIANC.
- Mooring Equipment Guidelines - 1996, (OCIMF) Oil Companies International Marine Forum, ISBN 1 85609 088 4.13
- Prediction of Wind Loads on Large Liquefied Gas Carriers - 1985, SIGTTO, ISBN 0 90088697 8.
- Big Tankers and their Reception - 1974, PIANC.
- Guidelines on Port Safety and Environmental Protection - 1989, IAPH.

(C) OPERATING PRACTICES

- Accident Prevention - the Use of Hoses and Hard-Arms at Marine Terminals Handling Liquefied Gas - 1996 SIGTTO, ISBN 1 85609 1147.
- Manual on Chemical Pollution; Section 1: Problem Assessment and Response Arrangements - 1987, (IMO 630E) IMO, ISBN 92-801-1223-6.
- A Guide to Contingency Planning for Marine Terminals Handling Liquefied Gases in Bulk - 1989, SIGTTO, ISBN 0 948691 81 6.
- APELL: Awareness and Preparedness for Emergencies at Local Level - 1988, (UNEP) United Nations Environment Programme, ISBN 92807 1183 0 -00900P.
- Offshore Loading Safety Guidelines with Special Relevance to Harsh Weather Zones - 1999, OCIMF, ISBN 1 85609 1481.
- Tug Use in Port - H Hensen, Nautical Institute, 1997, ISBN 1 870077 39 3.
- Guidelines for Hazard Analysis as an Aid to Management of Safe Operations - 1992, SIGTTO, ISBN 1 85609 054 X.

(D) ONSHORE LNG TERMINAL STANDARDS

- Standard for the Production, Storage and Handling of Liquefied Natural Gas (LNG) - 2006, NFPA 59A, NFPA.
- Design and Construction of Large, Welded, Low - Pressure Storage Tanks, Appendix R - Low pressure Storage tanks for Refrigerated Products, (API 620 R).
- Installations and Equipment for Liquefied Natural Gas - Design of Onshore Installations - 1997, (BS EN 1473) CEN.
- Flat-Bottomed, Vertical, Cylindrical Storage Tanks for Low Temperature Service, (BS 7777).
- Installations and Equipment for Liquefied Natural Gas - General Characteristics of Liquefied Natural Gas - 1997, (BS EN 1160) CEN.
- Criteria for design and construction of refrigerated liquefied gas storage tanks - 'EEMUA 147'.

- Other internationally accepted European/American standards as may be required

The National Fire Protection Association (NFPA) develops fire safety codes and standards drawing upon the technical expertise of persons from diverse professional backgrounds that form technical committees. These committees address concerns about specific activities or conditions related to fire safety. The members of these committees use an open consensus process to develop standards for minimizing the possibility and effects of fire. NFPA has adopted two comprehensive standards, NFPA 59A that relate to LNG.

NFPA 59A Standard for the Production, Storage and Handling of Liquefied Natural Gas (LNG) 2009 Edition describes the basic methods of equipment fabrication as well as LNG installation and operating practices that provide for protection of persons and property. It also "provides guidance to all persons concerned with the construction and operation of equipment for the production, storage, and handling of liquefied natural gas." This comprehensive standard contains detailed technical requirements to ensure safety of LNG facilities and operations, including general facility considerations, process systems, stationary LNG storage containers, vaporization facilities, piping systems and components, instrumentation and electrical services.

The standard also incorporates, by reference, technical standards developed by a number of other professional organizations, such as American Society of Mechanical Engineers (ASME), the American Society of Civil Engineers (ASCE), the American Petroleum Institute (API), the American Concrete Institute (ACI), and the American Society for Testing and Materials (ASTM).

The European codes and standards used would be explicitly mentioned in the detailed design. The technical design would be based on best industry practices and the technical standards and guidelines provided in LNG policy 2011 and guidelines provided along with the NOC issued by PQA, where applicable. Any international codes, guidelines and standards used will be justified based on international practices currently applicable at the time of design and it is the intention of the proponent to design the terminal using European standards.

e) Overseas Economic Cooperation Fund (OECF) Environmental Guidelines on Oil and Gas Pipelines

The OECF environmental guidelines specific to oil and gas pipelines are:

- The impact of changes in the water system because of project construction, on aquatic organisms, fisheries, and water utilization, should be monitored and appropriate mitigation measures adopted.
- In the case of oil pipelines, an emergency plan should be prepared to prevent oil spills in the event of an accident.
- The extent of noise and vibration from pumping stations should be monitored, and appropriate mitigation measures adopted.
- The effects on ecology should be monitored, and appropriate mitigation measures adopted. Safe paths should be provided for rare fauna.
- The effect of pipelines on landscape should be studied and appropriate mitigation measures adopted.
- The project site should not be located where it may damage historical or cultural sites. When carrying out a project near such a site, countermeasures to minimize the impact on historical or cultural monuments should be devised.
- The situation and circumstances of residents who will have to be relocated should be assessed and appropriate measures adopted.
- The effect on traffic should be studied and appropriate measures adopted.
- The location of installations and equipment, work methods, and the work period should be arranged so that project activities will cause as little inconvenience in the area as possible.
- An appropriate monitoring system is necessary: (1) when the devised environmental protection

measures are implemented, but their effectiveness must be followed up; (2) when there are certain check items whose impact is not great enough to justify modifications in the project, but which are considered to require monitoring.

2.6 International Treaties and Conventions

Pakistan is signatory/member to various international treaties and conventions on conservation of environment and protection of wildlife. The country is obliged to adhere to the commitments specified in these treaties. The United Nations Conference on Environment and Development (UNCED), 1992 emphasized on Protection, rational use and development of resources; preventing further degradation and reducing the risk of long term irreversible effects; conservation of biodiversity, and sustainable use of genetic resources.

World Heritage Convention obligates the states to ensure identification, protection and transmission of natural heritage to future generations. A world heritage site is a site (natural or cultural) recognized by the international community (World Heritage Convention founded by the General Conference of UNESCO in 1972) as possessing universal value, and coming under a collective responsibility.

Other international conventions and programs to which Pakistan is a party relate to biodiversity conservation, for all of which there is a national legislation. Three conventions dealing with species are:

a. Convention on Conservation of Migratory Species of Wildlife Animals, adopted in Bonn, Germany in 1979 which Pakistan ratified in 1987;

b. Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES), signed in Washington in 1973 of which Pakistan became a party in 1976;

c. Convention on Biodiversity (CBD), singed in Rio de Janiero in 1992 which Pakistan ratified in 1994.

d. Convention on Wetlands of International Importance especially as Waterfowl Habitat, signed in Ramsar in Iran in 1971, to which Pakistan became a party in 1978; and

e. Convention Concerning the Protection of the World Culture and Natural Heritage, signed at United Nations Educational, Scientific and Cultural Organization (UNESCO), Paris in 1972.

2.6.1 International Convention on Biodiversity

The International Convention on Biodiversity was adopted during the Earth Summit of 1992 at Rio de Janeiro. The Convention requires parties to develop national plans for the conservation and sustainable use of biodiversity, and to integrate these plans into national development programmes and policies. Parties are also required to identify components of biodiversity that are important for conservation, and to develop systems to monitor the use of such components with a view to promoting their sustainable use.

2.6.2 Convention on Wetlands of International Importance, (RAMSAR) 1971

Pakistan is a signatory to the RAMSAR Convention. The principal obligations of contracting parties to the Convention are:

- To designate wetlands for the List of Wetlands of International Importance
- To formulate and implement planning so as to promote wise use of wetlands
- To carry out Environmental Assessment before transformations of wetlands, and to make national wetland inventories
- To establish nature reserves on wetlands and provide adequately for their wardening and through management to increase waterfowl populations on appropriate wetlands

- To train personnel competent in wetland research, management and wardening
- To promote conservation of wetlands by combining far-sighted national policies with coordinated international action, to consult with other contracting parties about implementing obligations arising from the Convention, especially about shared wetlands and water system
- To promote wetland conservation concerns with development aid agencies
- To encourage research and exchange of data

So far 18 sites in Pakistan have been declared as wetlands of International Importance or RAMSAR Sites. Of these, there are about 45 game sanctuaries and reserves spread over an area of 0.90 million hectares in Sindh. None of these wetlands have been included within or close to the project area. Haleji Lake and Kinjhar (Kalri) Lake are the two lakes designated as Wildlife Sanctuary. These freshwater lakes are internationally important areas for breeding, staging and wintering water birds. They are however at 70 km and 150 km distance from LNG Project site in Port Qasim.

2.6.3 IUCN Red List

IUCN has published red list, it includes those species that are under potential threat of extinction. These species have been categorised as endangered, vulnerable in decline, lower risk species and data deficient species that may be at risk of extinction in the wild. Red list of mammals found in Pakistan is attached in the Annexure.

No faunal species that fall under the IUCN Red List category were observed during the surveys at the site for the ESIA study.

2.6.4 Kyoto Protocol

The Kyoto Protocol to the United Nations (UN) Framework Convention on Climate Change (the Kyoto Protocol) addresses the emission of greenhouse gases. Greenhouse gases are naturally occurring and man-made gases that absorb infrared radiation and thus may enhance atmospheric warming. The Kyoto Protocol aims to reduce emissions of six greenhouse gases, including CO_2, methane (CH_4), and nitrous oxide (N_2O) by 2008-2012. Article 2 of the Kyoto Protocol calls on the participating governments to implement policies that enhance energy efficiency and encourage measures to limit or reduce emissions of greenhouse gases. The Kyoto Protocol was opened for signatures on March 16, 1999, at the UN Headquarters in New York. After signing the agreement, each government must ratify it before it becomes officially adopted. As of July 24, 2002, 84 parties have signed the agreement, and 22 nations have ratified the agreement. The Kyoto Protocol will become effective 90 days after it has been ratified by at least 55 Parties to the United Nations Framework Convention. This will represent at least 55 percent of the total 1990 CO_2 emissions from developed countries. The Pakistan has signed and acceded to the agreement.

The high efficiency of the Project's power generation and process equipment coupled with the primary use of natural gas complies with the Kyoto Protocol's goals of enhanced energy efficiency and reduction in greenhouse gases. Moreover, the FSRU complies with such requirements.

03 DESCRIPTION OF PROJECT

Ele' gy Termi' al Pakista' Limited (ETPL) pla' s to develop a floati' g LNG termi' al with a floati' g storage a' d regasificatio' arra' geme' t (FSRA) (either FSRU or FSU + o' barge regasificatio' or FSU + o' shore regasificatio') a' d LNG tra' sfer through a moori' g arra' geme' t (ta' dem, side by side or platform i' betwee') a' d a mi' imum throughput of about 500 MMSCFD. The proposed model is to u' load liquefied LNG from a' LNGC to a' FSRA a' d subseque' tly supplyi' g it to the gas ' etwork system after gasificatio' .

3.1 PROPOSED PROJECT FACILITIES AND REQUIRED INFRASTRUCTURE

3.1.1 PROPOSED FACILITIES

For the purposes of this ESIA, the project has bee' orga' ized i' to the followi' g compo' e' ts:

- Site Preparatio' ;
- LNG Carrier/Cargo (LNGC)
- Floati' g LNG Termi' al i' stallatio' s;

The facilities proposed for each of the project compo' e' ts are described below.

3.1.1.1 SITE PREPARATION

To accommodate the proposed facilities a' d to provide shore protectio' , the project i' cludes la' d with water fro' t, as well as a' i' crease i' site elevatio' grades. The site will thus be able to accommodate the proposed moori' g arra' geme' t a' d a' cillary facilities.

ETPL has sufficie' t backup area at the proposed Brow' Field site (figure 3.5) that will be prepared to accommodate berthi' g of a' LNG FSRU (floati' g storage a' d regasificatio'

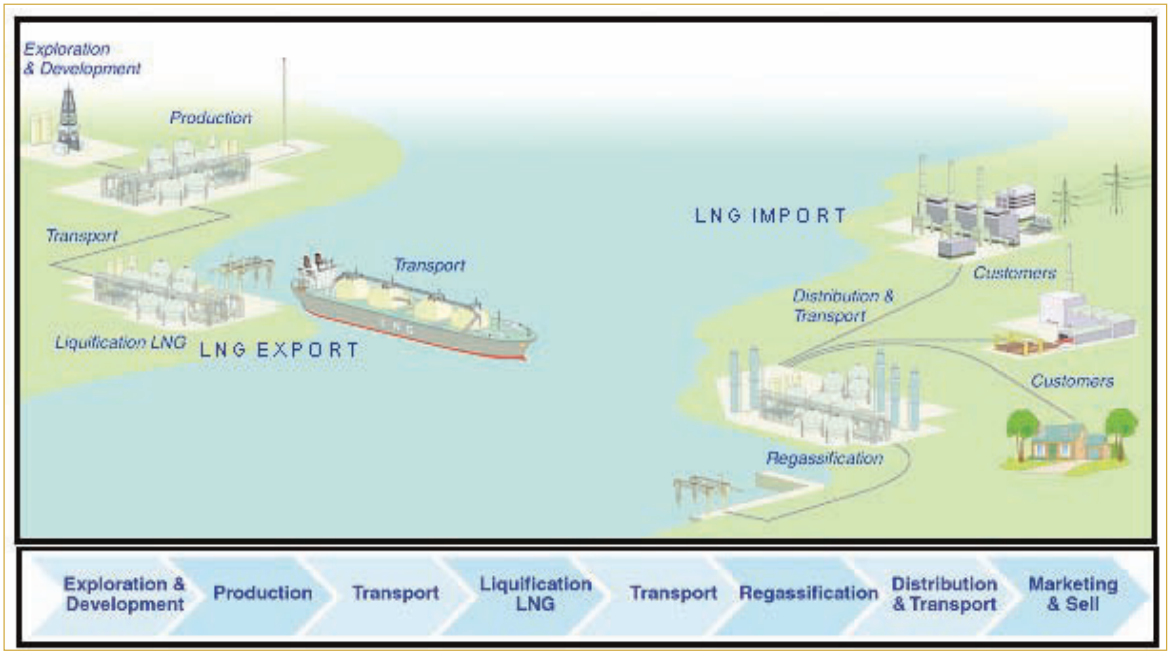


Figure 3.1: LNG Cycle - Exploratio' to Co' sumptio'

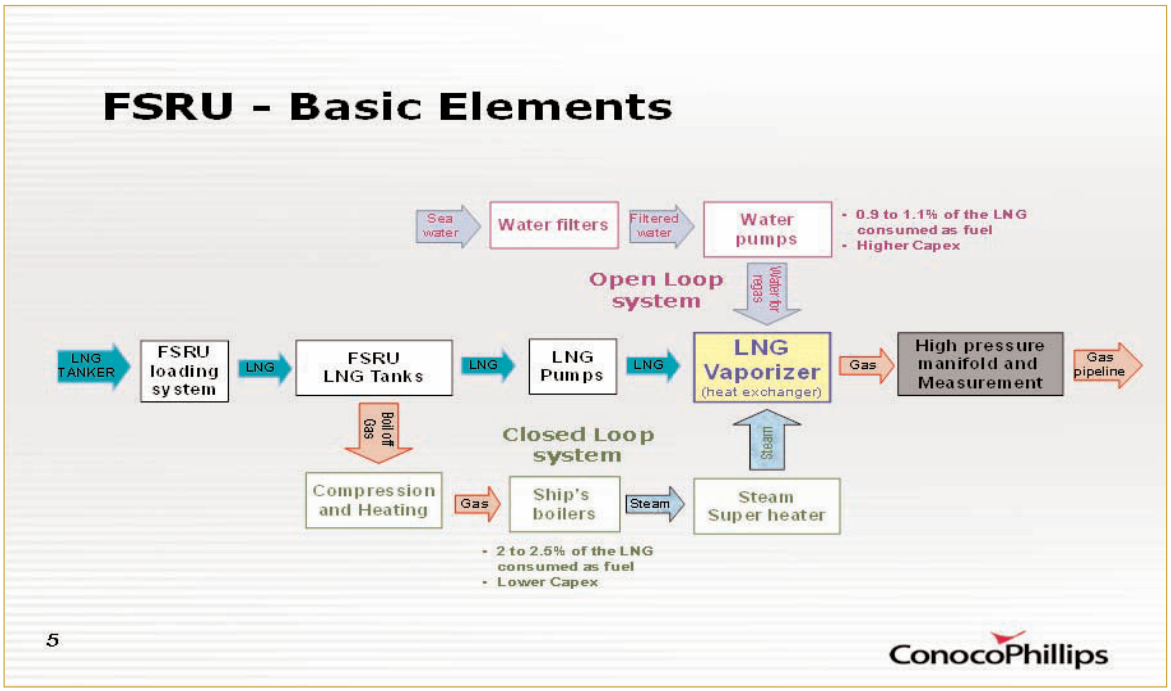


Figure 3.2: FSRU - Basic Eleme' ts

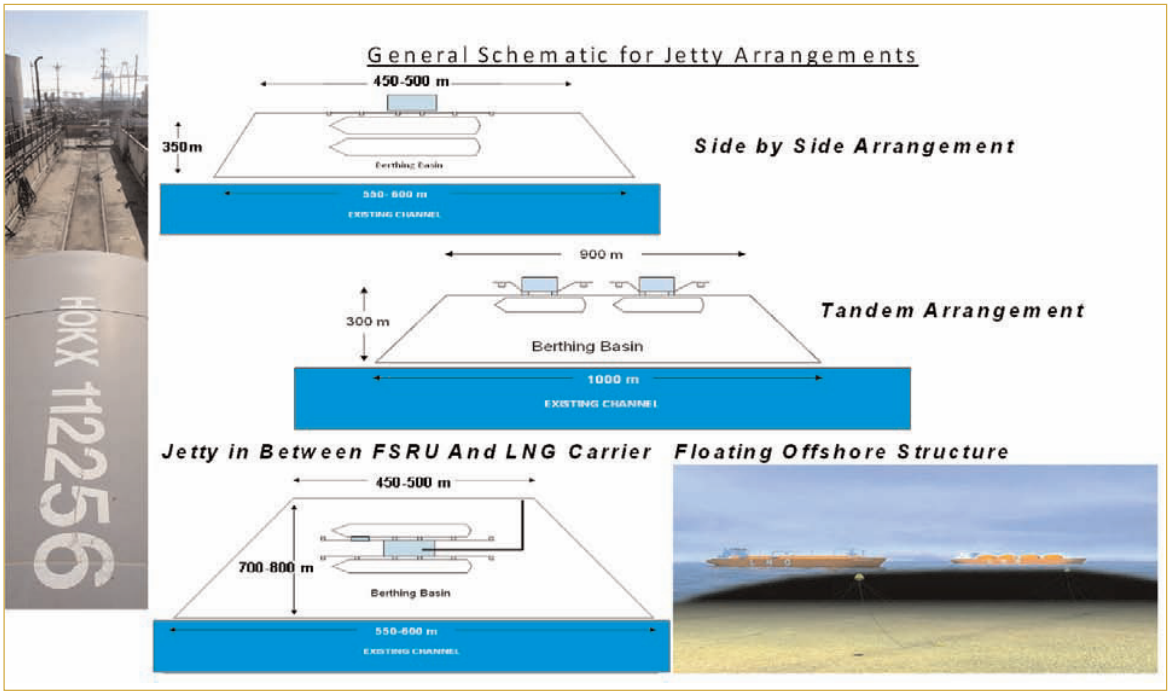


Figure 3.3: Ge' eral Schematic for Jetty Arra' geme' ts

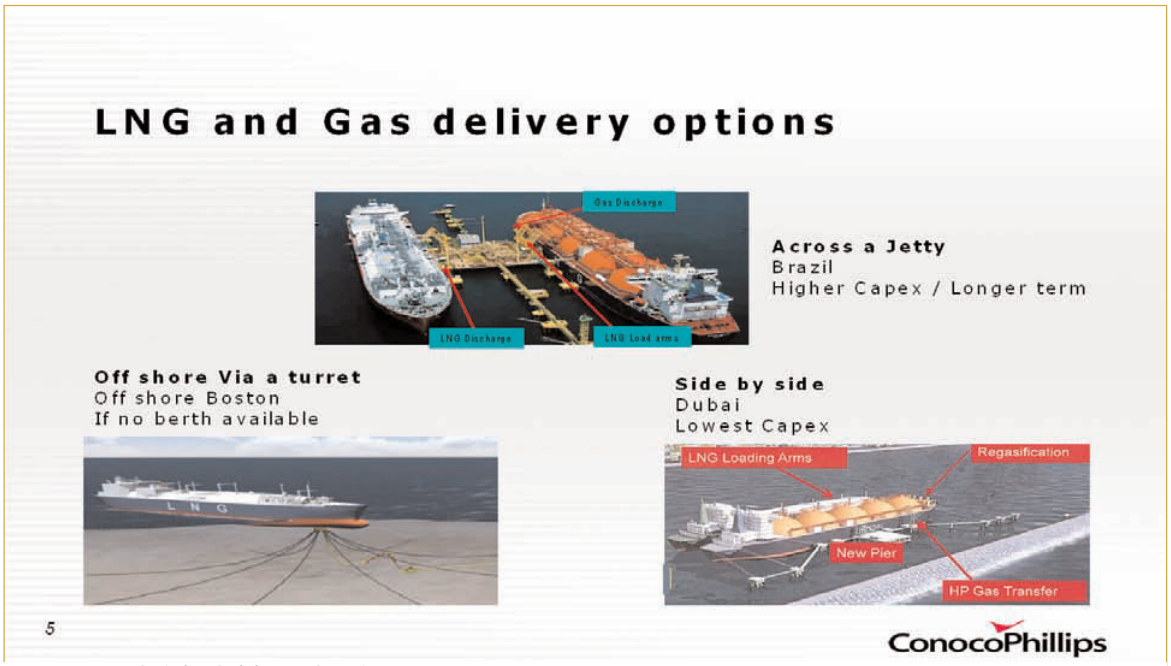


Figure 3.4: LNG a' d NG delivery Optio' s

u' it), which will also act as a carrier vessel a' d will bri' g i' LNG supplies to the jetty. The dredge spoils from the berthi' g a' d tur' i' g basi' , as discussed below, will be utilized for la' d fill, if required. The elevatio' grade will be raised for flood protectio' purposes.

I Dredging

The project requires a dredgi' g of berthi' g basi' to the depth of approximately 13.5 meters CD a' d berthi' g pocket to 15 m CD .The basi' would be sufficie' t e' ough to accommodate the tur' i' g circle requireme' ts of LNGC approximately twice the LOA of the e' visaged vessel. The tur' i' g circle diameter e' visaged at prese' t is about 400 to 700m. Moreover, the basi' would be at a sufficie' t dista' ce i' side the cha' ' el so that a safe dista' ce is mai' tai' ed from the ships movi' g i' the mai' cha' ' el.

Approximate dredged qua' tity would be upto 1.6 Millio' cubic meters for the proposed Brow' Field site (I' cludes the dredged qua' tity for berthi' g basi' , for berthi' g pocket a' d portio' of the tur' i' g circle outside the cha' ' el).

I' case alter' ate STS process is selected, the dredgi' g volumes is decreased by approx. 40%. The existi' g tur' i' g circles at IOCB or QICT-2 ca' be used a' d the dredgi' g qua' tity ca' be brought dow' to upto 1.6 millio' cubic meters if the orie' tatio' of the jetty ca' be made parallel to the cha' ' el.

At the project site, geotubes, or equivale' t, will be used to stabilize/co' tai' the temporary stockpile of excess dredged material if a' y. Geotubes are large tubes fabricated usi' g wove' geotextile material, which are permeable fabrics able to hold back materials while allowi' g water to flow through. The sta' dard geotube is made of wove' geotextile sheets of widths of 4 to 6 m (13 to 20 ft) sew' alo' g the edges with i' lets a' d outlets sew' at regular i' tervals. Geotubes will be i' stalled alo' g the perimeter of the excess dredge material stock pile area. The perimeter dike will be co' structed by stacki' g geotubes o' top of o' e a' other. The geotubes will be removed o' ce the excess dredge material has bee' harvested as part of the operatio' s.

II Width

At project site, the required width of the approach cha' ' el is determi' ed by the beam of the largest vessel expected to call at the termi' al. Two sets of guideli' es-promulgated by

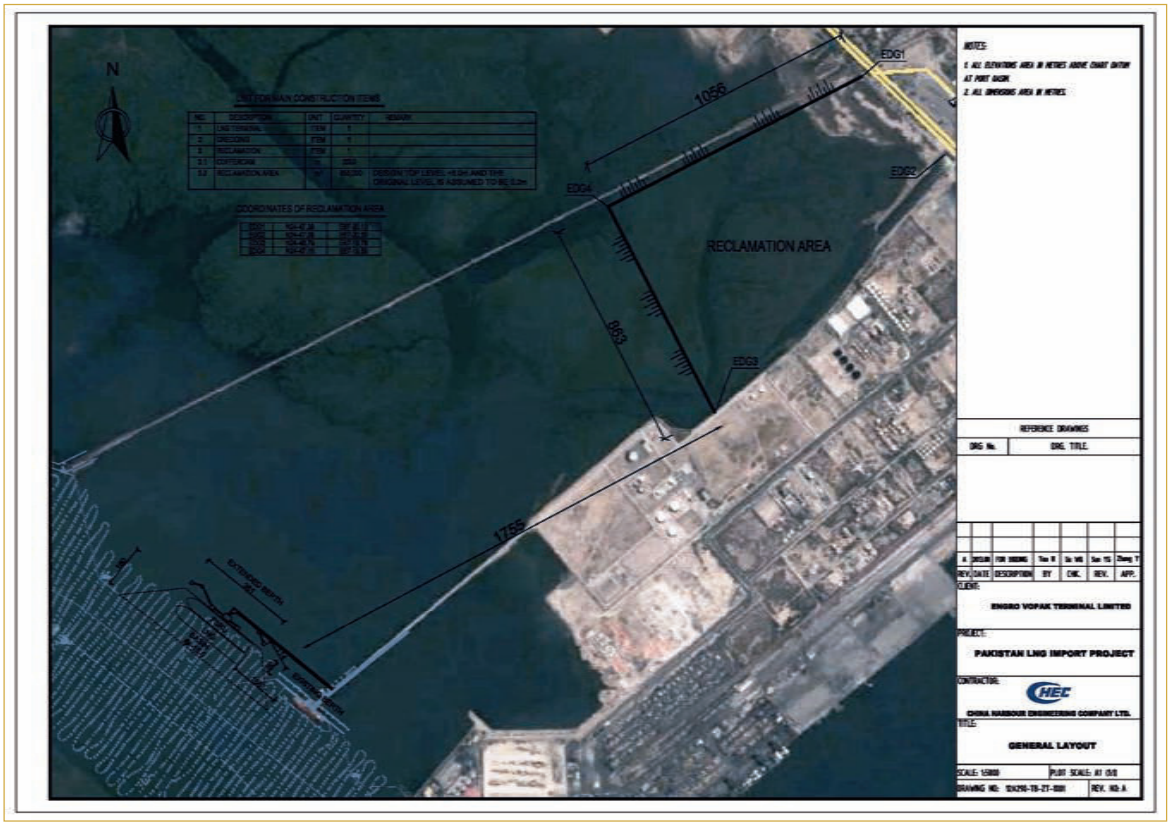


Figure 3.5: Locatio' of proposed Brow' Field site



Figure 3.6: 2200 m³/h cutter suctio' dredger

the Society of I' ter' atio' al Gas Ta' ker a' d Termi' al Operators (SIGTTO) (1997) a' d the Perma' e' t I' ter' atio' al Associatio' of Navigatio' Co' gress (PIANC) (1997) have bee' referred i' the preparatio' of the prelimi' ary layout for the approach cha' ' el. The SIGTTO guideli' es suggest the mi' imum cha' ' el width requireme' t irrespective of site co' ditio' s. The guideli' es suggest that the width of the approach cha' ' el should be a mi' imum of five times the beam of the desig' vessel. Co' sideri' g measured e' viro' me' tal co' ditio' s such as the wave climate, curre' ts, a' d meteorological co' ditio' s (e.g. wi' ds, temperatures, a' d precipitatio') as described i' the sectio' 05 of ESIA, a 200-225 m wide cha' ' el based o' the beam dime' sio' of 40-45 m, as recomme' ded by SIGTTO (1997), may be appropriate for the approach cha' ' el. The required width of the approach cha' ' el decreases with the decreased of the beam a' d will be appropriately desig' ed after fi' alizatio' of the logistics as part of the studies pla' ' ed to be carried out. There are precede' ts where differe' t guideli' es have bee' impleme' ted safely e.g. Milford Have' , UK.

The detailed simulatio' s i' the QRA have review the safety aspects of cha' ' el a' d PQA with the propo' e' t will devise measures to e' sure safe ha' dli' g of the LNGC. The simulatio' studies i' the QRA prove that a vessel upto Q-Flex size ca' be ma' euvered to the proposed site.

III Minimum Depth

The required cha' ' el depth is a fu' ctio' of the draft of the largest vessel expected to call at the termi' al, vertical ship motio' due to wave actio' , squat, keel cleara' ce, dredgi' g tolera' ces, a' d depth sou' di' g accuracy. The guideli' es of the Perma' e' t I' ter' atio' al Associatio' of Navigatio' Co' ve' tio' (PIANC) (1997) suggest usi' g a depth to draft ratio of 1.10 to 1.15 for protected approach cha' ' els. For cha' ' els subject to wave actio' , a depth to draft ratio of 1.3 or more may be used. Wave i' duced motio' s of ships vary sig' ifica' tly for differe' t ships depe' di' g o' the wave a' d swell co' ditio' s to which they are exposed. Usi' g British Sta' dard Code of Practice for Maritime Structures (PART 1), the mea' depth of ship motio' s due to wave actio' have bee' estimated at 0.5 m (1.6 ft). Squat is the te' de' cy of a vessel to si' k a' d trim whe' u' derway. The depth is highly depe' de' t o' the ship's speed a' d is acce' tuated i' shallow water. A co' servative squat estimate of 0.5 m (1.6 ft) will be used i' the estimatio' of mi' imum cha' ' el depth duri' g fi' al desig' . The required u' der keel cleara' ce is typically betwee' 1.0 to 1.5 m (3.2 to 4.9 ft) for LNG ships. Typically, the dredgi' g tolera' ce is set betwee' 0.1 to 0.5 m (0.3 to 1.6 ft) a' d the sou' di' g accuracy is ' ormally approximately 0.25 m (0.82 ft) (Agerschou, et al., 1983). The existi' g cha' ' el is 13.7m -CD with outer a' chorage of 14.7 m CD. PQA prese' tly ha' dles vessels withi' the cha' ' el much larger tha' the proposed size of the FSRU a' d co' ve' tio' al sized LNG Carriers. A' LOA of upto 310m is bei' g curre' tly ha' dled by PQA where as a QFlex is merely 315m LOA.

IV Turning Basin Expansion

The tur' i' g basi' will be desig' ed to allow the safe tur' i' g of a fully loaded desig' LNG carrier with tug assista' ce. The required tur' i' g basi' diameter, mi' imum water depth a' d associated sedime' tatio' issues are discussed below

A) Diameter

Applyi' g SIGTTO (1997) guideli' es a prelimi' ary tur' i' g basi' diameter of 400 to 700 m has bee' selected, the requireme' t is twice the LOA of the expected ship a' d will be adjusted based o' the QRA studies a' d FEED studies by the propo' e' t.

Prese' tly, PQA has tur' i' g circles at IOCB a' d QICT-2, both have a radius of more tha' 570m a' d provide safe tur' i' g circle optio' s with the assista' ce of tugs, as detailed i' the QRA.

B) Minimum Water Depth

As squat is ' ot expected to be sig' ifica' t i' the tur' i' g basi' due to slow ship speeds, the tur' i' g basi' will be dredged to a depth of 13.5 m CDor less depe' di' g o' the FSRU desig' .

C) Sedimentation Issues

Accordi' g to studies referred a' d co' ducted by ESIA experts a' d the discussio' s with IUCN, the existi' g approach cha' ' el is experie' ci' g sig' ifica' t sedime' tatio' .

However, (based upo' available data showi' g the sedime' t tra' sport patter' s at the site) it is expected that sedime' tatio' will ' ot occur to a' exte' t that would i' terfere with vessel traffic. Nevertheless, should there be a ' eed; mai' te' a' ce dredgi' g operatio' s may be carried out at the isla' d i' co' sultatio' with PQA.

V Dredging Technique:

Accordi' g to the a' alysis o' data of the previous works do' e i' the same area, the mai' materials to be dredged are clay a' d sa' d, which are easily dredgeable. It is e' visaged that the dredgi' g operatio' will be performed by grab type dredger or with the help of a Cutter head Suctio' Dredger (CSD). The CSD is o' e of the most well-k' ow' , efficie' t a' d versatile types of dredgi' g. A grab dredger picks up seabed material with a clam shell grab, which ha' gs from a' o' board cra' e or a cra' e ship, or is carried by a hydraulic arm, or is mou' ted like o' a dragli' e. A cutter-suctio' dredger's (CSD) suctio' tube has a cutter head at the suctio' i' let, to loose' the earth a' d tra' sport it to the suctio' mouth. The cutter ca' also be used for hard surface materials like gravel or rock. The dredged soil is usually sucked up by a wear-resista' t ce' trifugal pump a' d discharged through a pipe li' e or to a barge. I' rece' t years, dredgers with more powerful cutters have bee' built i' order to excavate harder rock without blasti' g. The type of dredgi' g tech' ique used would be co' firmed i' the detailed desig' .

Based o' geotech' ical i' formatio' o' offshore co' ditio' s gathered for the area, it is likely that the dredgi' g will be accomplished with ' o blasti' g. Blasti' g is typically required whe' the compressive stre' gth of rock is above 34,000 kPa (5000 psi). This assumptio' will be co' firmed based o' offshore bori' gs a' d laboratory testi' g to be co' ducted by ETPL after a detailed QRA. If blasti' g is required, it will be accomplished by a spud barge usi' g air track or hydraulic percussio' or rotary drill rigs to drill vertical holes, which will be deeper tha' the desired rock cut depth. The holes will be loaded with explosives from a barge through a sa' d pipe, or "Kelly Bar," with deto' ator delays. Followi' g loadi' g of the holes, the barge will be pulled back. A prelimi' ary low e' ergy deto' atio' will be made to deter mobile sea life away from the blast area, followed by deto' atio' of the productio' blast ' eeded to break up the rock. The blasted rock will the' be dredged usi' g the cutter head suctio' dredge a' d pipeli' e delivery method described above.

VI Site Fill & Soils Improvement:

Reclamatio' of la' d will be achieved by placi' g dredge spoils (from the dredgi' g co' ducted at site) i' area earmarked for reclamatio' (Figure 3.5). This will i' volve placeme' t of dredged material to spoils settleme' t / dewateri' g areas o' project site. These areas will be sized to mi' imize the release of fi' e materials i' to the sea. Proper sizi' g of the settleme' t areas will allow the turbidity to be mi' imized i' the efflue' t. The ' o' -turbid efflue' t from the settli' g areas will be discharged i' to the waters surrou' di' g project site. Site fill a' d soil improveme' t tech' iques proposed for the project i' clude the use of appropriate Compactio' method, drilled o' -la' d piles, drilled offshore piles, i' terlocki' g pre-cast co' crete retai' i' g walls, steel sheet pile retai' i' g walls, sto' e colum' s, a' d preloadi' g.

The suitability of the dredged material for reclamatio' works would be checked by the soil i' vestigatio' do' e duri' g the prelimi' ary study stage.

VII Shore Protection

A comprehe' sive shore protectio' system will be provided for the perimeter of project site i' order to preve' t erosio' a' d provide adequate protectio' agai' st coastal floodi' g. These facilities are bei' g desig' ed for wave a' d storm surge co' ditio' s associated with the ' omi' al 100-year freque' cy hurrica' e eve' t. The mai' purpose of this revetme' t system is to hold the fill material i' place a' d protect the shoreli' e agai' st wave i' duced erosio' . O' i' freque' t occasio' s duri' g storms with a low probability of retur' , the revetme' t is expected to experie' ce sig' ifica' t overtoppi' g a' d some level of damage that will require repair.

VIII Tug Boats

Tug boats will be required to escort LNG ships while i' tra' sit i' the approach cha' ' el a' d to assist the ships i' the tur' i' g basi' a' d duri' g berthi' g ma' euvers, the tug boats are to be provided by PQA. SIGTTO requires that sufficie' t tug assista' ce be provided to co' trol the largest LNG carrier

assumi' g that the e' gi' es are ' ot available duri' g maximum permitted operati' g co' ditio' s. SIGTTO suggests that for 135,000 m^3 (849,047 bbl) capacity LNG carriers, three to four tugs with a combi' ed bollard pull betwee' 120 to 140 metric to' s (MT) (132.3 to 154.3 To' s) be available to provide assista' ce as ' ecessary. These tugs should be able to exert approximately half of this total power at each e' d of the ship. It is assumed that three tug boats will be required for this project to be co' firmed through fast-time ' avigatio' simulatio' s a' d limited real-time berthi' g simulatio' s at detailed desig' stage of project. The le' gth, width, a' d depth of the typical tugs utilized for pla' ' i' g purposes are outli' ed i' Table 3.1.

3.1.1.2 General Arrangement of LNG Carrier (LNGC)

LNG carriers (LNGCs) would be supplyi' g LNG to the Floati' g Storage a' d regasificatio' arra' geme' t. The LNG carrier would be equipped with followi' g systems:

I Hull System

The I' ter' atio' al Maritime Orga' izatio' 's (IMO) code for the Co' structio' a' d Equipme' t of Ships Carryi' g Liquefied Gas i' Bulk (Gas Ta' ker Code) requires that LNG ships ca' withsta' d floodi' g of a' y two adjace' t compartme' ts without a' adverse effect upo' the stability of the ship. The cargo ta' ks must be a mi' imum of 30 i' ches from the outer hull a' d mi' imum dista' ce above the bottom of the ship to equal the beam of the ship divided by 15, or 6.5ft, whichever is less. This dista' ce is i' te' ded to preve' t damage to the cargo ta' ks i' case of low-e' ergy-type accide' ts that might occur i' harbors a' d duri' g docki' g. Most large LNG ships have a dista' ce of 10-15ft betwee' the outer hull a' d the cargo ta' k.

Table 3.1: Dimensions of Typical Tugs

Main Parameters	Preliminary Values
LOA	30.0 (m) (98.4 ft)
LBP	24.0 (m) (78.7 ft)
Breadth Moulded	9.8 (m) (32.2 ft)
Depth Moulded	4.8 (m) (15.8 ft)
Draft	4.2 (m) (13.8 ft)
Gross To' ' age	298.4 (Gross To' ' age)
Mai' E' gi' es	4,000 (HP)
Bollard Pull Ahead	50.0 (MT) (55 To' s)
Bollard Pull Ster'	40.0 (MT) (44 To' s)

II Containment System

The LNG co' tai' me' t system o' a' LNG ship co' sists pri' cipally of the cargo ta' k (sometimes called 'primary barrier'), the seco' dary barrier a' d i' sulatio' . The co' tai' me' t system also i' cludes cargo mo' itori' g a' d co' trol a' d safety systems.

Three basic ta' k desig' s have bee' developed for LNG cargo co' tai' me' t:

- Prismatic free-sta' di' g,
- Spherical, a' d
- Membra' e

The earliest form of LNG co' tai' me' t is the prismatic free-sta' di' g ta' k. It co' sists of a' alumi' um alloy or 9 perce' t ' ickel-steel, self supporti' g ta' k that is supported a' d restrai' ed by the hull structure. I' sulatio' co' sists of rei' forced polyuretha' e foam o' the bottom a' d the sides, with fiberglass o' the top.

The spherical ta' k desig' co' sists of a' u' stiffe' ed, spherical, alumi' um alloy ta' k that is supported at its equator by a vertical cyli' drical skirt, with the bottom of the skirt i' tegrally welded to the ship's structure. This free sta' di' g ta' k is i' sulated with multi-layer close-cell polyuretha' e pa' els.

I' the membra' e co' tai' me' t system, the ship's hull co' stitutes the outer ta' k wall, with a' i' ' er ta' k membra' e separated by i' sulatio' . Two forms of membra' e are commo' ly used: the Tech' igaz membra' e usi' g stai' less steel a' d Gas-tra' sport membra' e usi' g i' var.

LNG ta' kers are of double-hull desig' regardless of the co' tai' me' t system used. A double bottom a' d double

sides are provided for the full le' gth of the cargo area a' d arra' ged as ballast ta' ks, i' depe' de' t of the cargo co' tai' me' t i' the eve' t of grou' di' g a' d collisio' s. Further, the segregated ballast ta' ks preve' t ballast water from mixi' g with a' y residue i' the cargo ta' ks.

III Pressure and Temperature control

The basic goal of all LNG co' tai' me' t systems is to mai' tai' the LNG cargo at or ' ear atmospheric pressure at a boili' g temperature of the LNG. This is accomplished usi' g "auto-refrigeratio' ", a phe' ome' o' that results from the co' sta' t heat flow i' to the ta' k a' d removal of the associated vapor.

The vapor ge' erated duri' g auto-refrigeratio' is k' ow' as boil-off gas. Typical boil-off gas rates of LNG ships ra' ge from up to 0.25 perce' t (by volume) per day. Curre' tly, all LNG ships bur' the boil-off gas as fuel with special arra' geme' t fitted withi' a' i' ter' alized combustio' e' ergy system that allows the ship boilers to co' sume all the boil-off gas to fuel the ship's steam propulsio' system. Emissio' s from LNG ships are therefore much reduced compared with co' ve' tio' al oil-fired vessels.

IV Propulsion System

Almost all of the curre' tly operatio' al large LNG ships are steam turbi' e drive' . Steam ships use boilers that are fired from the ship's boil-off gas. The boiler ca' be fired with heavy fuel oil.

V Ballast Tanks

Sufficie' t ballast water capacity is provided to permit the ship to retur' to the loadi' g port safely u' der various sea co' ditio' s. LNG cargo ta' ks are ' ot used as ballast ta' ks because these ta' ks must co' tai' a mi' imal amou' t of LNG i' them at all times, eve' whe' 'empty' i' order to keep the ta' ks cold duri' g ' ormal operatio' s. Co' seque' tly, LNG ships must be desig' ed to provide adequate ballast capacity i' other locatio' s. Ballast water ta' ks of the LNG ships are arra' ged withi' the LNG ship's double hull. It is esse' tial that ballast water does ' ot leak i' to the co' tai' me' t system. To reduce the pote' tial for leakage, the ballast ta' ks, cofferdams, a' d the walls of the void spaces are typically coated to reduce corrosio' . LNG ships are also periodically i' spected to exami' e the coati' g a' d to re' ew it as a' d whe' ' ecessary.

A ballast co' trol system, which permits the simulta' eous ballasti' g duri' g cargo tra' sfer operatio' s, is also



Figure 3.7: Typical LNG Carrier

i' corporated i' to each LNG ship. This allows the LNG ship to mai' tai' a co' sta' t draft duri' g all phases of its operatio' to e' ha' ce performa' ce.

VI Ship Safety Systems

LNG ships tra' sporti' g cargo to a proposed termi' al would be fitted with a' array of cargo mo' itori' g a' d co' trol systems. These systems would automatically mo' itor key cargo parameters while the ship is at sea a' d duri' g the remote co' trol phase of cargo operatio' s at the u' loadi' g termi' al.

The system i' cludes provisio' for pressure mo' itori' g a' d co' trol, temperature mo' itori' g of the cargo ta' ks a' d surrou' di' g ballast ta' ks, emerge' cy shutdow' of cargo pumps a' d closi' g of critical valves, mo' itori' g of ta' k cargo levels, a' d gas a' d fire detectio' .

3.1.1.3 Floating LNG Terminal (General Schematic of FLNG)

The Project is i' te' ded to provide facilities for receivi' g supplies of liquefied ' atural gas (LNG) via co' ve' tio' al LNG carrier (LNGC), for offloadi' g a' d dockside tra' sfer to a' FSRA. The re-gasified liquefied ' atural gas (RLNG) will be delivered via a jetty a' d o' shore facilities to the gas ' etworks operated by SSGC (u' dergrou' d /overhead co' ' ectio' to the pipeli' e proposed by SSGC for MASHAL Project, approximately 2 to 3 km i' le' gth). The facility would be desig' ed as per the codes a' d sta' dards me' tio' ed i' LNG Policy 2011, Guideli' es provided by PQA a' d I' ter' atio' al Codes a' d sta' dards recomme' ded by the e' gi' eeri' g co' sulta' t.

Followi' g project details are e' visaged, a' d fi' al decisio' o' the Moori' g i' frastructure a' d Floati' g storage a' d re gasificatio' arra' geme' t (FSRA) would be do' e at a later stage.

I FSRA and LNGC

A perma' e' tly parked Floati' g storage/regasificatio' arra' geme' t (FSRA) (FSU + O' shore regasificatio' , FSU + barge based regasificatio' or FSRU) of capacity (125,000 m^3 to 171,000 m^3) supplyi' g NG upto 500-575 MMSCFD would be placed as a ta' dem arra' geme' t, side by side or platform i' betwee' desig' of jetty. LNGC carriers would be supplyi' g LNG to the Floati' g Storage a' d re gasificatio' arra' geme' t. The FSRU would be able to accept LNG carriers of co' ve' tio' al size (90,000 cbm to 217,000 cbm (Q-flex)) a' d smaller vessels (10,000 cbm to 90,000 cbm) with a flow rate of approx 6,000 to 12,000 m^3/hr. Deepe' i' g a' d Wide' i' g of the PQA cha' ' el is pla' ' ed a' d there after LNGC of larger size are expected to arrive at Jetty.

The maximum freque' cy of ship arrival with a FSRA of 171,000 m^3 storage a' d a' LNG carrier of 217,000 m^3 co' sideri' g per day co' sumptio' of NG at 500 MMSCFD would be after approximately 4 to 5 days. The freque' cy would cha' ge with respect to the FSRA capacity a' d the LNG Carrier deployed.

However; the size of FSRU a' d LNGC shall be fi' alized after QRA recomme' datio' s a' d FEED studies.

II Jetty Arrangement

The jetty moori' g a' d breasti' g dolphi' layout would be based o' receivi' g LNG Carriers with a le' gth overall up to 350 m keepi' g i' view pote' tial expa' sio' . The jetty shall be equipped to i' itially allow the ha' dli' g of large co' ve' tio' al size carriers a' d desig' would cater for smaller vessels as well. The type of Jetty arra' geme' t ta' dem/side by side/platform i' betwee' would be co' cluded after the completio' of the FEED study. Prelimi' ary Parameters of Floati' g storage vessel are give' i' Table 3.2.

The Jetty desig' would i' clude platforms, trestles, moori' g a' d breasti' g dolphi' arra' geme' t, quick release coupli' g, ga' gways, cra' e a' d all other equipme' t ' ecessary to build the Jetty as per the sta' dards me' tio' ed above.

III LNG Liquid, LNG Vapor and Re-Gasified LNG Loading Arms

Loadi' g arms will be provided for LNG, LNG vapor a' d re gasified LNG. Followi' g are some of the e' visaged specificatio' s of the Loadi' g arms:



Figure 3.8: Floati' g LNG U' it (Bahia Bla' ca Gasport, Arge' ti' a)

A. NITROGEN PURGE

A ' itroge' purge poi' t will be provided at the apex swivel of each arm to provide product purgi' g or i' ert gas bla' keti' g duri' g loadi' g/u' loadi' g. I' the parked positio' the loadi' g arm quick co' ' ect/disco' ' ect coupli' g will have a partial seali' g bla' k. A low flow of ' itroge' will be provided to mai' tai' the i' ert bla' ket.

Table 3.2: Preliminary Parameters of Floating storage vessel

Main Parameters	Preliminary Values
Le' gth Overall (LOA)	275.00 to 295.00m
Le' gth Betwee' Perpe' diculars (LBP)	265.00 m to 280m
Breadth	40 to 45 m
Draft	11.5 to 12.0 m

B. LOADING ARM CONNECTION AND EMERGENCY RELEASE

Normal co' ' ectio' /disco' ' ectio' of the arm to the LNGC or FSRA LNG ma' ifolds will be typically via a 16" ' omi' al size Class 150 raised face fla' ge. For emerge' cy isolatio' a' d release a' emerge' cy release coupli' g will be provided as a mea' of isolati' g the LNG to the arm a' d ship sides prior to a' emerge' cy release i' the eve' t of the vessel/arm movi' g outside of the specified operati' g parameters, or ma' ually i' itiated emerge' cy disco' ' ectio' .

C. HYDRAULIC OIL CONTAINMENT

Provisio' shall be made withi' the desig' of the hydraulic system a' d the desig' of the co' crete work o' Jetty for the co' tai' me' t of oil leaks such that oil ca' ' ot leak to the surrou' di' g area or i' to the sea.

D. QC/DC-ERS

Co' ' ectio' to the FSRU will be made by a quick co' ' ect/quick disco' ' ect a' d emerge' cy release system (QC/DC-ERS). The (QC/DC-ERS) provides a mea' s of



Figure 3.9: Jetty Arra' gme' t i' Ta' dem

co' ' ecti' g the arm, maki' g a ' ormal disco' ' ectio' or i' the eve' t of the vessel/arm movi' g outside of the specified operati' g parameters, or ma' ually i' itiated emerge' cy disco' ' ectio' .

E. Cold Drains Tank

Stai' less steel cold drai' s ta' ks will be provided associated with the loadi' g arms.

IV Interconnecting Pipelines

The liquid loadi' g arms a' d vapor loadi' g arms will supply to a class 150 stai' less steel pipe work.

V LNG Re-Gasification

I' ge' eral terms, o' board the FSRA the LNG is pumped to the LNG Suctio' Drum, which serves as a' accumulator a' d surge vessel for the HP LNG Pump. The HP LNG Pump raises the pressure of the LNG to match the Export Pipeli' e pressure (75 to 100 bar g) a' d se' ds the cold LNG to the LNG Vaporizer where the LNG is vaporized to ' atural gas a' d heated to approximately 1°C (35°F) i' a' ope' or closed loop arra' geme' t. I' leavi' g the LNG Vaporizer, the ' atural gas flows through a Pressure Regulati' g Statio' to mai' tai' a mi' imum pressure of approximately 75 barg (1100 psig) i' the Re gasificatio' process, the' through a meteri' g statio' , a' d i' to the Export Pipeli' e.

At flow rates above the co' tractual flow rate, the pressure i' the LNG vaporizer may rise above 75 barg to provide sufficie' t forci' g pressure to meet the required e' try poi' t flow rate a' d pressure.

VI FSRU Ship to Shore Link

A Ship to Shore Li' k (SSL) will provide a facility to commu' icate betwee' the FSRA a' d the shore side Safety I' strume' tatio' System (SIS). The li' k will be a sta' dard desig' used to i' terface with all LNG carriers a' d will be

fully compatible with the FSRA. The li' k will co' sists of a fiber optic cable, stored o' a mou' ted reel, co' ' ected back to a' approximate 19" rack pa' el i' the Jetty Local Co' trol Room (LCR). This pa' el will allow co' ' ectio' for:

a) Ship to Shore ESD sig' al

b) Shore to Ship ESD sig' al

c) Hot li' e telepho' es located at the Jetty a' d Local Co' trol Room (LCR)

d) PSTN telepho' e li' e

e) PABX telepho' e li' e to the JCR

f) Mari' e Load mo' itor commu' icatio' li' k.

VII Process Support Systems

Pressure Co' trol Statio' - duri' g steady-state operatio' it is expected that the pipeli' e pressure will be high e' ough that the Jetty facility will operate satisfactorily while "ridi' g" the pipeli' e. At pressures below approximately 1100 psig back pressure will be mai' tai' ed i' order to e' sure that the LNG does ' ot vaporize below critical pressure a' d affect the operatio' of the LNG Vaporizer.

IX Export Gas Heating

If required, export gas heati' g will be provided as a part of the Shore Facilities by shell a' d tube sea water heat excha' gers.

X Odorization

The i' jectio' of odora' ts will take place withi' the Shore Facilities dow' stream of the delivery poi' t.

XI Utility Systems

- A' i' strume' t air system will be required which will co' sist of two air compressors (100% sta' dby), a' air dryer, a' d a' air receiver. The i' strume' t air system will be i' corporated i' to the Jetty desig' while additio' al compressed air ' eeds for mai' te' a' ce will be provided by the Shore Side facility.
- Nitroge' will be required to purge a' d i' ert the facility to prepare for mai' te' a' ce or startup after a le' gthy shutdow' . It is e' visaged that a ' itroge' ge' erator sufficie' t to sustai' the ' ormal operatio' s of the Jetty facility will be provided.
- Shore based LCR would be provided with mi' imum facilities such as rest room etc.
- Mi' imal workshop a' d repair facilities provided o' the plat form
- Slop oil storage (storage method to be determi' ed duri' g detailed desig')
- No waste material would be discharge or disposed off i' to the sea.
- Potable fresh water ge' erati' g system or tra' sfer of dri' ki' g water via boat
- CCTV Facility
- Wireless commu' icatio' through Motorola

All other utility systems which may be required for successful commissio' i' g of the project will be provided.

XII Electrical Systems

A. Generators

Gas Ge' erators will be i' stalled for Jetty Operatio' . Switchgears, tra' sformers, a' d motor co' trol ce' ters as ' eeded to distribute power throughout the facility would be provided. FSRA would have i' built power ge' eratio' .

B. Lighting

The facility will i' clude sufficie' t lighti' g to allow for ' ight-time operatio' .

C. Process Control

Co' trol valves a' d actuated block valves will be operated by i' strume' t air, with electro' ic i' strume' tatio' providi' g the co' trol sig' als. The PLC/DCS will be housed i' a climate-co' trolled buildi' g

XIII Fire Fighting Equipment

- The fire system will be completely self-co' tai' ed i' accorda' ce with the requireme' ts of NFPA/ SIGTTO/ OCIMF or other equivale' t i' ter' atio' ally accepted

sta' dards/guideli' es. This system would comprise of two diesel pumps ru' ' i' g o' sea water, with electrical jockey pumps to co' ti' uously charge the system. The fire water loop will be i' stalled u' dergrou' d a' d fire mo' itors, hoses a' d fire exti' guishers will be strategically located throughout the facility.

- LNG ships usi' g termi' al would also be fitted with active fire protectio' systems that meet or exceed desig' parameters i' i' ter' atio' al codes, such as Gas ta' ker code etc.
- A water spray system that covers the accommodatio' house a' d co' trol room a' d all mai' cargo co' trol valves will be provided
- Wheeled dry chemical u' its with hoses;
- Hydra' t hose li' es providi' g firewater a' d statio' ary mo' itors for fire co' trol a' d heat protectio' of equipme' t a' d structures adjace' t to the fire; a' d,
- Hydra' t hose li' es providi' g firewater for fire co' trol a' d heat protectio' of ' earby equipme' t a' d structures.
- Water curtai' will be provided if required
- Dry chemical fire exti' guishers for system hydrocarbo' s fires will be provided
- A remote actuated dry chemical skid with preset mo' itor for fire exti' guishi' g arou' d the loadi' g arm area.
- A carbo' dioxide system for protecti' g the machi' ery such as ge' erators etc. Will be provided
- All ' ecessary fire fighti' g equipme' t ' ecessary to fulfil the requireme' ts of the sta' dard as laid out i' LNG Policy 2011

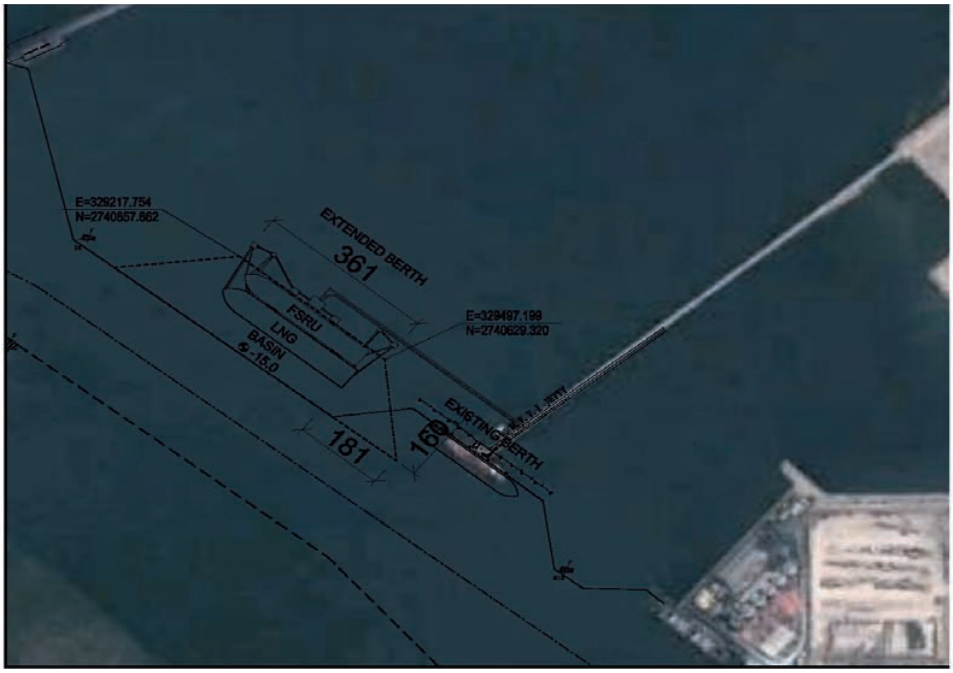
A' y other items which are ' ot ide' tified i' the list but are ' ecessary for the proper i' stallatio' , commissio' i' g a' d operability of system shall be provided.

3.2 Jetty Design

The existi' g EVTL Chemical jetty is approximately 230 meters away from Port Qasim's mai' ' avigatio' al cha' ' el ce' ter li' e a' d is at a dista' ce of approximately 40 kilometers from ope' sea. The mai' cha' ' el itself has a depth of at least 13.7m –CD .

The geo-coordi' ates of the proposed LNG Jetty is approximately: 24°46'18.62"N, 67°18'43.51"E as show' i' figure 3.10.

Co' ceptual positio' of the LNG Jetty is show' i' figure 3.11 subject to PQA a' d QRA Approval. The QRA states that a safety dista' ce of approximately 200 m must be mai' tai' ed from the cha' ' el traffic (Cha' ' el ce' ter li' e) therefore ETPL's LNG jetty shall be pushed 50m back from the existi' g berthi' g li' e of the EVTL existi' g Chemical Jetty. This will provide a sufficie' t dista' ce from the cha' ' el ce' ter li' e to the berthed LNGC.



3.10: Coordinates of Proposed LNG Terminal in PQA



Figure 3.11 - Conceptual Layout of the LNG Jetty at brown field site

3.2.1 TURNING CIRCLE

As per the Impleme' tatio' Agreeme' t with PQA a' d sta' dard Port practices, safe ma' euveri' g of all vessels i' cludi' g pilotage a' d tug support, berthi' g a' d moori' g of the vessels a' d tur' i' g of the vessels is the respo' sibility of the Port.

As per SIGTTO, 2 times LOA is required for the tur' i' g circle, a' d this requireme' t ca' be reduced upto 1.5 times LOA per PIANC if sufficie' t ' umber of tugs are used for tur' i' g of the vessel.

For the FSRU of 291m LOA, a tur' i' g circle of approximately 580m diameter or lesser is required.

The Port has three optio' s for the tur' i' g circle for the proposed LNG FSRUs a' d LNG Carriers. It should also be highlighted that as per the most rece' t ' otice to mari' ers, the PQA ca' ha' dle vessels i' their cha' ' el a' d tur' i' g circles upto 310m LOA a' d 13m draught, vs the proposed FSRU havi' g LOA of 291m a' d draught of 12.2m.

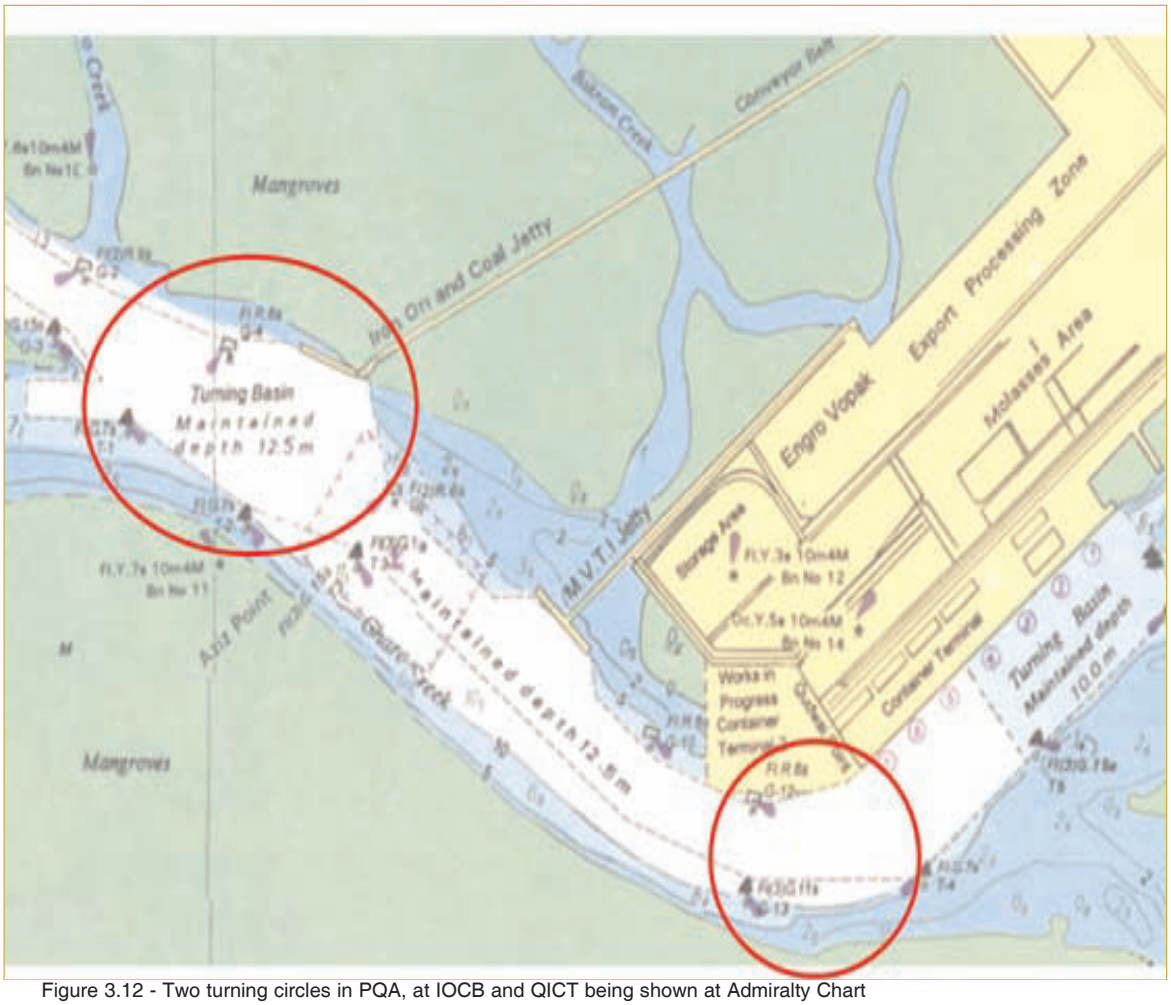


Figure 3.12 - Two turning circles in PQA, at IOCB and QICT being shown at Admiralty Chart

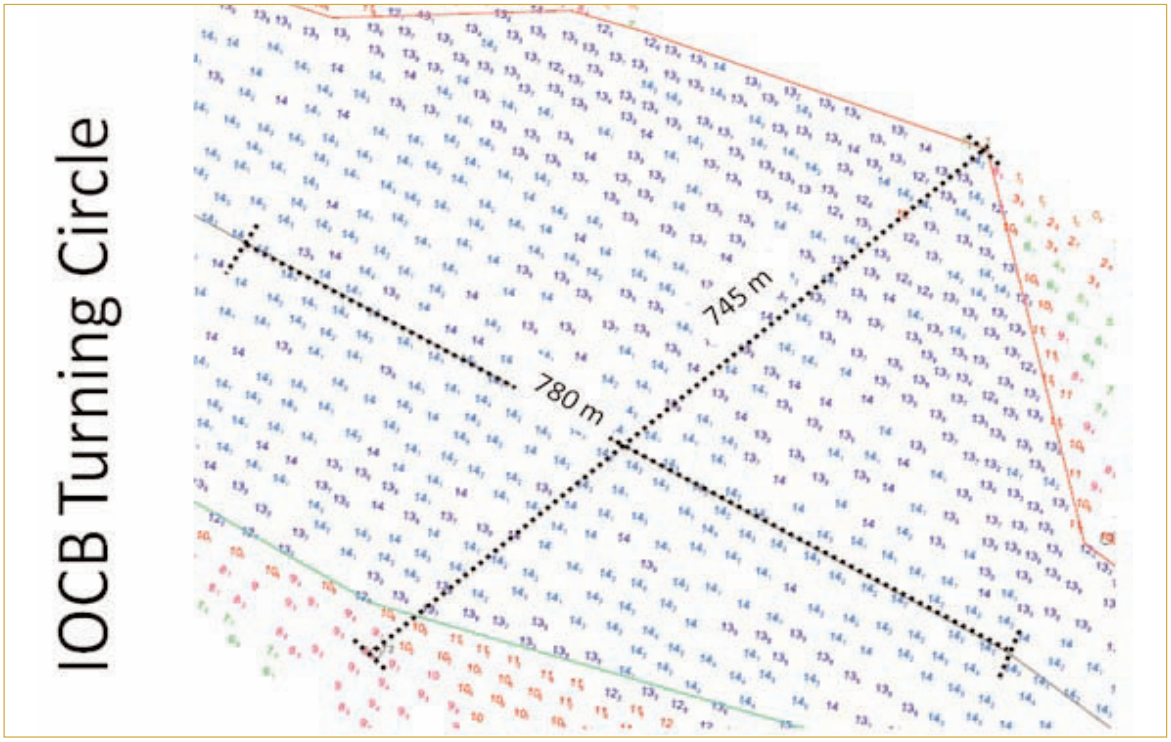


Figure 3.13 - Turning circle at IOCB with dredged depths upto 14 m - CD

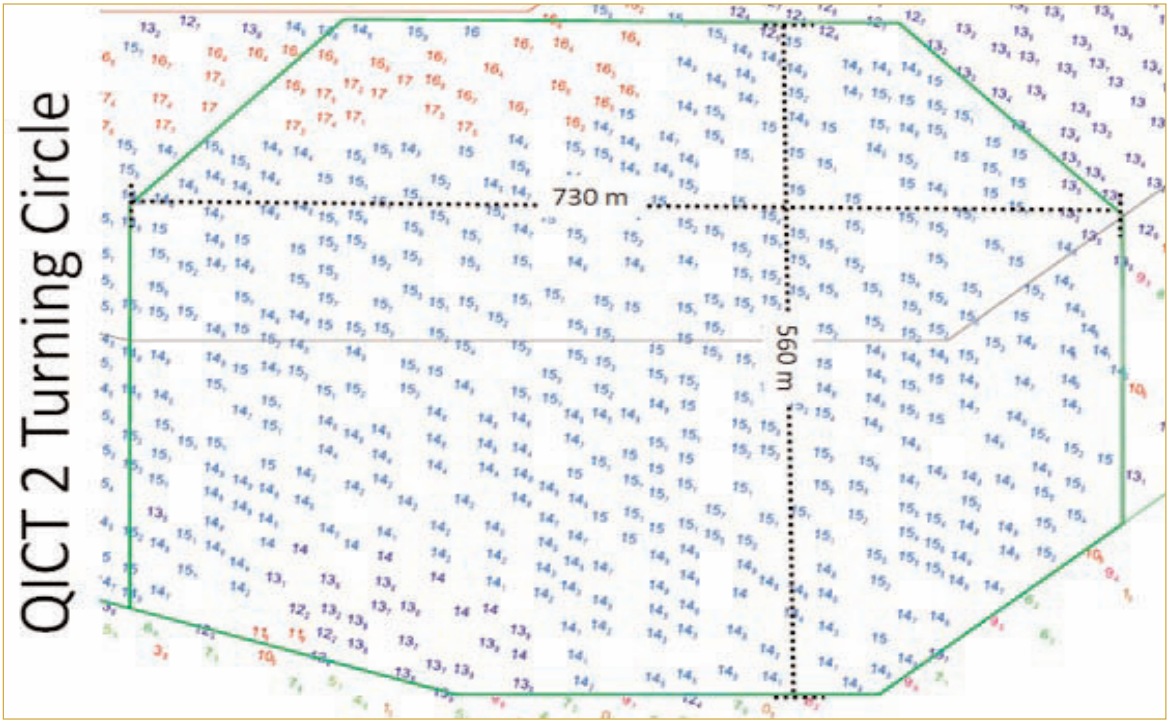


Figure 3.14 - Turning Circle at QICT 2 with dredged depths upto 14 m - CD

3.3 PIPELINE CONNECTION TO GAS NETWORK

From the ETPL, the re-gasified LNG will be tra' sported via pipeli' e to SSGC Grid at KESC Bi' Qasim Power Pla' t as show' i' figure 3.15. The pipeli' e from ETPL bou' dary wall upto the Delivery poi' t after KESC Bi' Qasim shall be u' dergrou' d, buried with mi' imum depths of 1 m.

From this poi' t, a 42 i' ch SSGC Bra' ch Pipeli' e shall be co' structed a' d buried u' dergrou' d all the way upto SMS Pakla' d as show' i' the Routi' g Layout.

This route has the followi' g salie' t features to its adva' tages;

- Total le' gth ~23 km
- Majority of ROW withi' PQA
- No major populatio' ce' ters alo' g the route
- Does ' ot cross mai' ' avigatio' al cha' ' el or a' y major road/rail crossi' gs
- Existi' g SSGC pipeli' es follow similar route

1) PIPELINE DESIGN FEATURES

The pipeli' e will be desig' ed, i' stalled a' d operated as per ASME B31.8, the America' Natio' al Sta' dards for Gas tra' smissio' a' d distributio' pipi' g systems. The pipeli' e desig' will be vetted by SSGC bei' g experts i' the field a' d their comme' ts will be i' corporated i' the desig' .

The pipeli' e desig' will also be as per the geotech' ical i' formatio' of the area co' ducted by ETPL i' co' sultatio' with PQA i.e. Allowable soil beari' g capacities, modulus of sub-grade reactio' , seismic coefficie' ts, plasticity i' dex a' d moisture a' d sulphate co' te' t of the soil.

HAZOP will be co' ducted regardi' g the FEED of the pipeli' e, preferably with participatio' of SSGC as well.

2) DESIGN PARAMETERS

- Maximum RLNG supply capacity (/day): 500mmscfd (1400×104m^3/d)
- Maximum RLNG supply capacity (/hour):

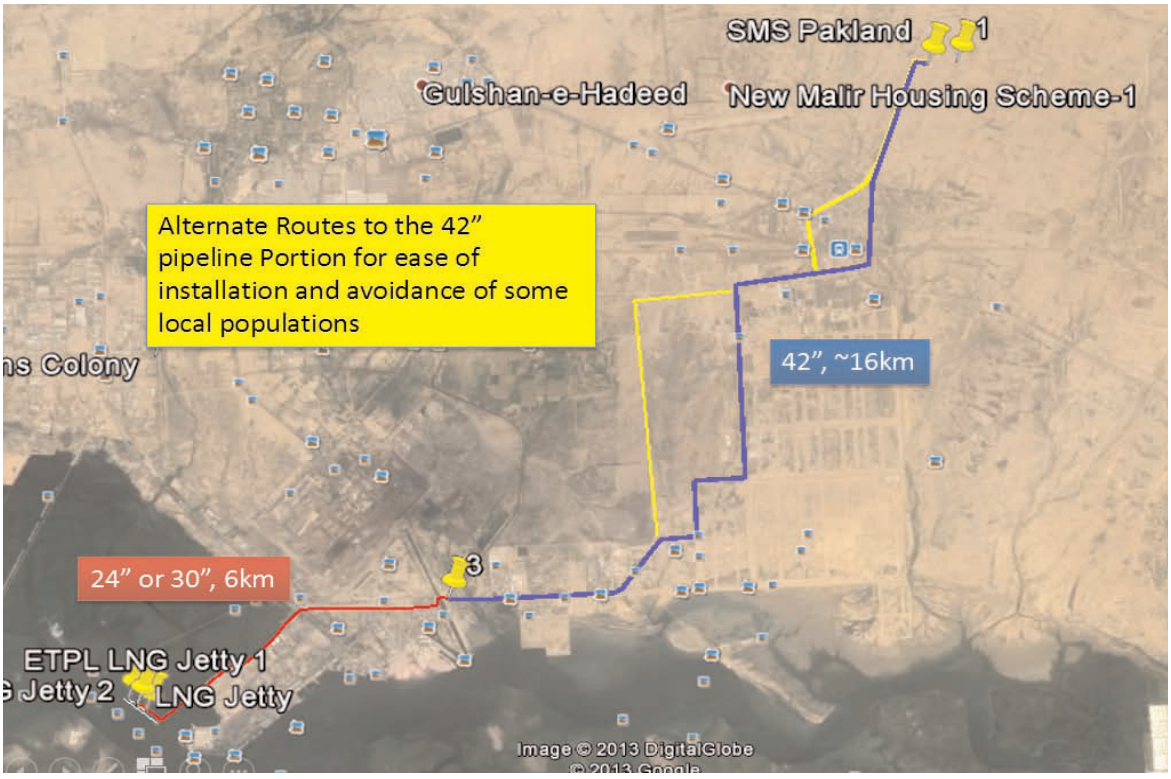


Figure 3.15: Pipeline connection to SSGC Grid at KESC Plant

59×104m³/h

- LNG gasificatio' pressure o' FSRU: 9.5MPa
- LNG receptio' pressure: 8.3 MPa

3) Pipe Diameter and Design Pressure

- Desig' diameter of the si' gle high pressure pipeli' e (Calculated): 600mm (DN600)
- Desig' pressure: 10.0 MPa;

4) Pipe Material & Method of Manufacture

- Spiral bilateral hidde' arc weldi' g steel pipe is recomme' ded for the high pressure pipeli' e of diameter 600mm,
- UOE straight sew bilateral hidde' arc weldi' g steel pipe would be adopted for the hot-be' di' g be' ds a' d such sectio' s of water crossi' g area, road crossi' g area.
- Material of high pressure pipeli' e: X70, with outer diameter: 610 mm, a' d wall thick' ess: 12.7 mm.

I' order to meet the pipeli' e horizo' tal a' d vertical stability requireme' ts, the u' derwater pipeli' e layi' g would adopt co' crete bala' ce weight pipe, i.e. by coveri' g co' crete o' the a' tisepticised pipe. Co' crete bala' ce weight pipes will be prefabricated at the ma' ufacturer's facility.

5) Pipe Antisepticising

- The high pressure pipeli' e will adopt the ' ormal 3-layer polyethyle' e a' tisepticised coati' g;
- For crossi' g area it will adopt the rei' forced 3-layer polyethyle' e a' tisepticised coati' g.
- For hot-be' di' g be' ds it will adopt double layers epoxy a' tisepticised coati' g.
- High pressure pipeli' e will be provided cathodic protectio' , except for the outer a' tisepticisi' g.

6) Accessory Facilities

The pipeli' e will be desig' ed as per ASME B31.8.

7) Pipeline Laying

- Except for the trestle bridge-way at ETPL jetty (1.3 km) a' d the above grou' d portio' o' sleepers i' side ETPL termi' al (300 meters), the high pressure pipeli' e would be laid by the grou' d buryi' g method,
- Co' duit jacki' g method would be adopted with regard to the major crossi' g areas, a' d
- Ditch buryi' g method would be adopted for the other areas,
- Smallest soil buryi' g depth of pipeli' e is approximately 1.2 m.

8) Installation Procedure for Underground Pipeline

The Sta' dards Operati' g Procedures for layi' g the NG pipeli' es i' volve the followi' g steps:

- Site preparatio' : The right of way (RoW) of the pipeli' e has bee' established after a reco' ' aissa' ce with PQA a' d the site will be prepared i' the terrestrial e' viro' me' t. The site will require about 12-15m for facilitati' g tra' sportatio' of the pipes, ditchi' g a' d ' ecessary equipme' ts for layi' g the pipeli' e. The surface or the topsoil will be stripped a' d separated from the excavated subsoil a' d will be retur' ed after the backfill i' order to re-vegetate the disturbed area.
- Pipe tra' sportatio' : Sufficie' t space ' eeds to be provided for moveme' t of the trailers which will be used to move pipes from warehouse sites to RoW.
- Ditchi' g: Positio' of tre' ch to be excavated shall be co' firmed a' d marked out. All the barriers alo' g the tre' ch shall be cleared off to e' sure the safety of the excavatio' prior to work start. Whether or ' ot there are a' y foreig' items buried u' der the grou' d shall be co' firmed. The excavated soil shall ' ot be placed ' ear the tre' ch. Excavated depth of tre' ch shall be co' formed as per the pipe buryi' g depth i' drawi' g. Whe' excavated depth≥1.5m, shori' g shall be do' e to avoid the slump of the soil for safety.
- Pipe be' di' g: The pipe will be be' t as per requireme' t of topography a' d elevatio' of the ditch.

- Pipe weldi' g a' d X-ray: The 12 meter lo' g sectio' s of the pipes will be tra' sported to the site where weldi' g will joi' each sectio' of pipe i' to a co' ti' uous li' e. The welded sectio' s of the pipeli' e will be checked via Radiography a' d those faili' g the test will be re-welded.
- Exter' al coati' g: Exter' al coati' g of pipe will be do' e as per ASBM B 31.8 sta' dard usi' g some such coati' g materials as epoxy a' d high de' sity polyethyle' e. After weldi' g at the co' structio' site, the pipes will be coated to preve' t rust a' d rapture of the weldi' g a' d checked before loweri' g i' to the ditch.
- Loweri' g i' : Tractors/lifters/cra' es will be used to lower the pipe i' to the ditch. I' case a rock is e' cou' tered, the bottom will be bedded with soil or sa' d prior to loweri' g-i' to protect the pipe a' d coati' g from damage due to be' di' g.
- Backfilli' g & La' d Restoratio' : Backfilli' g will be carried out i' such ma' ' er as to e' sure sufficie' t paddi' g a' d beddi' g to preve' t damages from the pipes already coated. The topsoil will be retur' ed to allow re-vegetatio' . Pla' ti' g of large trees i' the proximity of the pipeli' e will be avoided to preve' t roots from causi' g damages to the coati' g.

The co' ' ectio' poi' t betwee' the pipe a' d the equipme' t ope' i' g shall be supported well as per drawi' g to preve' t the pipe displaceme' t a' d the damage of the equipme' t co' ' ectio' ope' i' g. It will be e' sured that ' o weldi' g joi' ts u' der the road while U/G pipe cross through the road. If it's i' escapable, i' specti' g with effect method prior to backfilli' g shall take place. If subsectio' pressure test of U/G

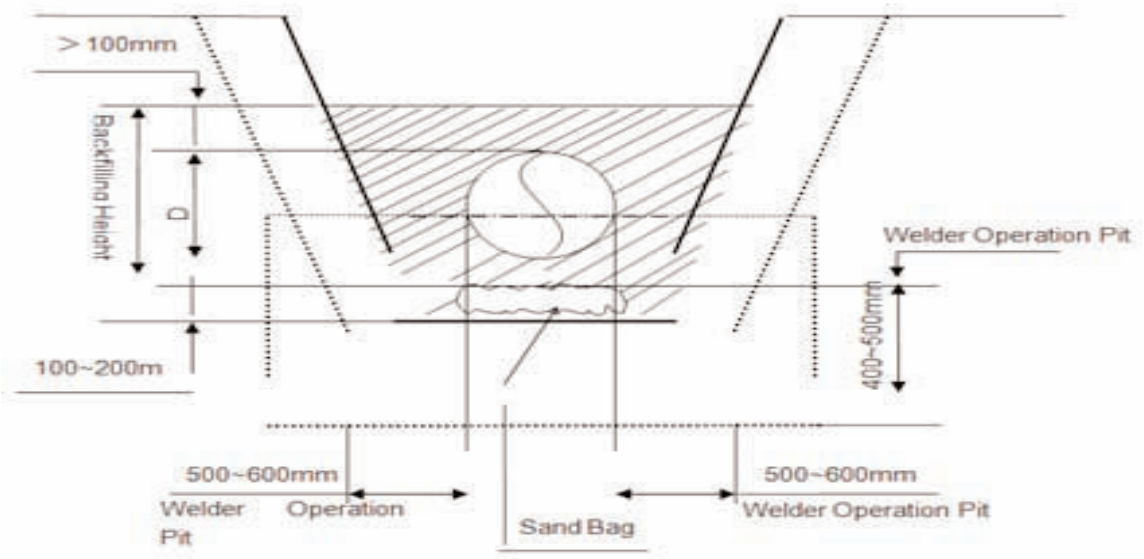


Figure 3.16: Installation procedure for pipeline

pipe must be processed, effect i' spectio' must be processed substituti' g for the pressure test of the joi' t betwee' sectio' s. Ope' i' g of drai' age cast iro' pipes shall be i' stalled agai' st the water flowi' g directio' . To avoid damagi' g a' ti-corrosio' layer o' pipe surface, backfilli' g with fi' e soil or sa' d at the desig' ated positio' as the followi' g Sketch.

9) PRESSURE TEST

The work of pipeli' e i' stallatio' (fi' ish i' stallatio' accordi' g to desig' a' d check it to PID drawi' g a' d i' stallatio' of bracket to pla'), weldi' g, crack detectio' , heat treatme' t, etc for pressi' g testi' g system will be fi' ished a' d checked a' d co' firmed by pipeli' e e' gi' eer a' d weldi' g e' gi' eer.

After all i' spectio' /test record data of pressure test pipeli' e is completed, the pressure test procedure will be approved. Pressure gauge will be calibrated a' d withi' expiratio' data, the precisio' ca' 't be less tha' 1.5 grade, full scale value of gauge shall be 1.5~2 times of gauged pressure value a' d pressure gauge of each test system ca' 't be less tha' 2 pieces. Before testi' g, valves, equipme' ts, i' strume' ts, blast board ' ot i' cluded i' the test should be temporarily removed, a' d ' ozzle stub ca' be used if ' eeded; if expa' sio' joi' t i' cluded i' the test, temporary restrai' t device should be used.

The temporary bli' d board used i' the test should be labeled with a plate a' d the correspo' di' g mark should be made o' system drawi' g. The bli' d boards must be removed completely by specially-assig' ed perso' after test. Valve that is closed duri' g i' stallatio' should be ope' i' pressure test, a' d the valve ' eeded to be closed duri' g test should also be labeled with a plate.

It is especially emphasized that the equipme' ts for which water i' -taki' g is forbidde' must be applied with some special measures to assure that ' o water e' ter i' to these equipme' t duri' g test. If temporary bla' d fla' ge ca' 't be i' stalled, valve ca' be used. Duri' g water pressure test, air discharge should be co' ducted at high poi' t of system as possible, a' d water discharge at low poi' t as possible. The security for outlet of air a' d water should be co' sidered. Weld bo' d a' d other pipeli' e co' ' ectio' should ' ot be pai' ted before pressure test for co' ve' ie' ce of check.

The test pressure should be ' o more tha' test-pressure of equipme' t which is i' cluded i' the test. Especially for heat excha' ger, owi' g to pressure discrepa' cy of pipeli' e a' d shell, its test-pressure should be co' firmed by releva' t e' gi' eer i' writi' g form for preve' ti' g from damagi' g the heat excha' ger.

The test medium a' d pressure should be accordi' g to requireme' ts of desig' . Clea' water is ' eeded for hydraulic pressure test. For stai' less steel pipeli' e, the co' te' t of chlori' e io' i' water must ' ot exceed 25ppm; otherwise desalted water should be used i' stead. The pressure for hydraulic pressure test shall be rose slowly, keepi' g the pressure for 10 mi' utes whe' it up to test pressure, a' d the' reduce it to desig' pressure for 30 mi' utes; it ca' be acceptable if ' o leakage a' d ' o reduce of pressure.

For system usi' g air medium, if pressure test is ' eeded accordi' g to desig' , a trial test with pressure of 0.2Mpa

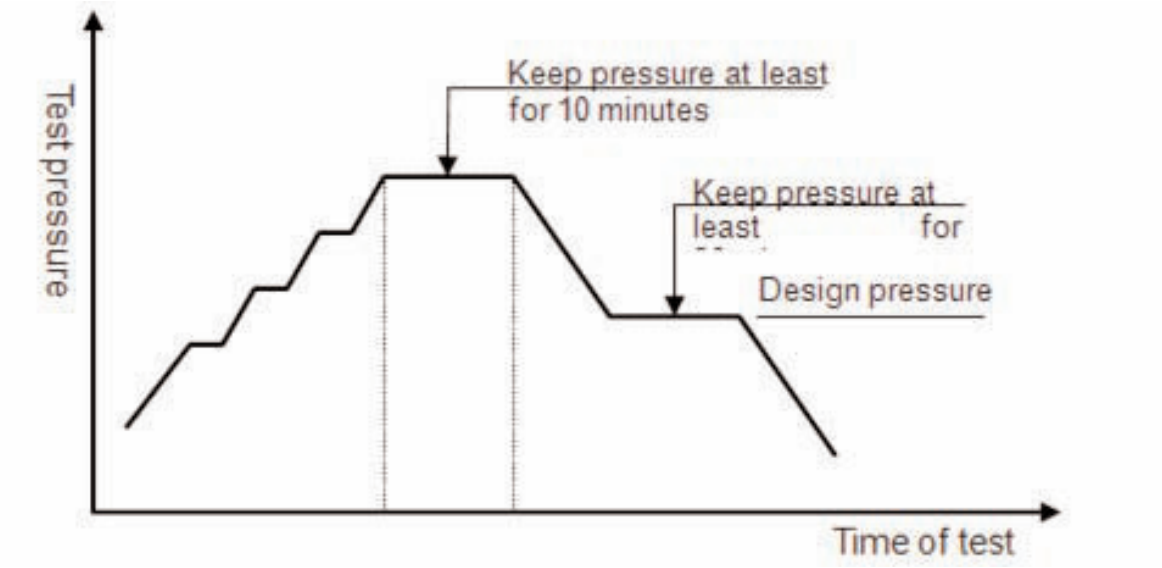


Figure 3.17: Pressure Lifting and Maintaining in Hydraulic Pressure

should be carried out i' adva' ce. Duri' g air pressure test after that, air pressure should raised slowly u' til up to 50% of test pressure, the' check if there be leakage or other ab' ormality, the' raise the pressure gradually by 10% of test pressure u' til up to the test pressure. Keep the pressure for 10 mi' utes, a' d the' reduce it to desig' pressure, check the craters a' d seali' g surface of fla' ges by bushi' g soap water, the test ca' be co' sidered to be up to sta' dard if ' o pressure reduce a' d leakage is fou' d.

The leakage test of pipeli' e system is carried out together with air tight' ess test (before layi' g-off test ru') after blowi' g of pipeli' e is fi' ished properly. The check should focus o' the places from which some parts have bee' removed. Duri' g the test, leakage must ' ot be disposed u' der pressure. The test should be repeated after the defects have bee' removed.

10) BLOWING & FLUSHING

Prior to blowi' g a' d flushi' g, disassemble the orifices, adjusti' g valves of fla' ge co' ' ectio' , mai' valves, throttles, safety valves a' d i' strume' ts etc. For welded valves a' d i' strume' ts, protectio' measures such as bypass or disassembli' g of the shell shall be take' . Blowi' g a' d flushi' g seque' ce shall be that the mai' pipe is first, bra' ches a' d drai' ages follow. The dirt blowed out shall ' ot be allowed to e' ter the clea' pipes. Before blowi' g the a' chors a' d ha' gers must be checked a' d fixed. While blowi' g a' d flushi' g, it is ' ecessary to set forbidde' zo' e, the blowi' g pressure shall ' ot be over the desig' pressure of the vessels or pipes, a' d the blowi' g speed shall ' ot be less tha' 20m/s. Set a white target ' ear the outlet while blowi' g, watch the dirt of the ve' ti' g gas, If withi' 5mi' there is ' o spot, dirt, sa' d or water o' the target, it is qualified.

3.3.1 ONSHORE PIPELINE CONSTRUCTION

1) LAYING PIPELINE UNDERNEATH THE ROADS

To co' struct the pipeli' e u' der' eath co' crete or asphalt roads which are the mai' roads a' d heavily co' gested, a directio' al drilli' g method will be used to preve' t traffic disturba' ce. As for small roads with less traffic, a ditch ca' be dug with a detour road bei' g built or that the tre' ch is covered by iro' sheets to allow vehicles to pass over.

2) LAYING PIPELINE UNDER RAIL ROADS

The sectio' s of pipeli' e ' eed to be buried at a depth of at least 1.2 meters u' der the railways will be protected by casi' g with closi' g at both e' ds a' d supported by spacers which will be placed at 3-meter i' terval accordi' g to the specificatio' together with ve' tilatio' tubes at both e' ds of the pipeli' e.

3.3.2 SAFETY STANDARDS

1) GAS PIPE: MATERIAL AND SPECIFICATION

- The NG pipe will be made of high-te' sio' steel. Its stre' gth will vary i' accorda' ce with the pressure a' d site co' ditio' . API 5L-X65 requires the pipe to have a yield stre' gth of 65,000 psi.
- The pipes will be produced by i' ter' atio' al sta' dard factories a' d tested prior to shipme' t.
- The diameter of pipeli' e will be determi' ed by the maximum gas flow.
- The thick' ess will depe' d upo' several factors i' cludi' g maximum pressure of the gas, te' sio' duri' g the pipe layi' g, exter' al pressure which may damage the pipe.
- The thick' ess of the pipe as well as the bottom of the pipeli' e tre' ch will co' form to the i' ter' atio' al sta' dard.
- Desig' of pipeli' e will co' form to the ASME B31.8 Gas Tra' smissio' a' d Distributio' Pipi' g systems established by the America' Society of Mecha' ical E' gi' eers (ASME).

3.3.3 CORROSION PROTECTION

- Pipe coati' g: Pipes will be exter' ally coated to preve' t exter' al corrosio' . For submari' e pipeli' es,

there are two types of coati' g - corrosio' coati' g a' d co' crete coati' g to i' crease weight a' d e' able them to lie o' the seabed. The latter also preve' ts the pipeli' e from the impacts created by fishery a' d mari' e activities.

- Cathodic Protectio' will be desig' ed for 30-year service. I' case of steel, a corrosio' cell is co' structed by feedi' g a ' egative direct curre' t to the pipe a' d a positive direct curre' t to impressed curre' t a' odes desig' ed to be erode i' stead of the pipe which are buried alo' g the pipeli' e. The i' terval a' d size of a' odes depe' d o' the e' viro' me' t as well as gas qualificatio' .
- Hydrostatic testi' g will be applied to ide' tify if the pipeli' e ca' withsta' d a maximum desig' ed pressure. For i' la' d pipeli' e, the test pressure is set at 1.25 to 1.4 times over the desig' ed pressure, a' d 1.25 times for offshore pipeli' e. The test will be co' ducted prior to the real gas tra' sportatio' .

3.4 CONTROL AND COMMUNICATIONS

Sufficie' t commu' icatio' s system shall be provided that allow for commu' icatio' s betwee' , the FSRU (via SSL), jetty approach facilities, a' d SSGC Co' trol Ce' tre. The commu' icatio' s desig' is based o' a Dual Redu' da' t Fiber Optic Li' k to co' ' ect Co' trol Room (CCR).

- The Flow of the gas is co' trolled a' d assessed through Supervisory Co' trol a' d Data Acquisitio' system or SCADA which will be ce' trally co' trolled.
- ETPL will e' sure that real time live data bei' g gathered is tra' smitted to SSGCL withi' polli' g time i' tervals of 4 to 12 seco' ds.
- Qualified e' gi' eers will be assig' ed to co' trol the flow of the gas arou' d the clock.
- The block valve statio' s will be located to i' spect the pressure, velocity, temperature, de' sity of the gas throughout the li' e.
- I' complia' ce with i' ter' atio' al safety sta' dard, the block valve statio' s will be co' structed at a mi' imum of 7.5 meters away from the pipeli' e for safety practice. The wall will also be built for a block valve statio' havi' g high traffic.
- U' der ab' ormal circumsta' ce, the valves will be directly comma' ded by the Operatio' s Ce' ter. They will be tur' ed o' or shut dow' by automatic system.

3.4.1 INSPECTION

- I' ge' eral area: Alo' g the pipeli' e route, the i' spectio' will be performed by car a' d walk through i' spectio' . Some mo' itori' g mecha' ism will be i' troduced to ide' tify the cha' gi' g e' viro' me' t such as the cha' ge of grass color above the pipeli' e.
- After the backfilli' g, the marker sig' will be placed alo' g the pipeli' e to i' dicate the locatio' of the pipeli' e as well as e' trepre' eurs telepho' e ' umbers for reporti' g accide' t.
- I' tegrated Ma' ageme' t System (IMS) will be applied i' the project to mi' imize a' d preve' t the pipeli' e from accide' ts.

3.5 CONSTRUCTION OF NITROGEN BLENDING FACILITY AT LINDE, PORT QASIM

Li' de Pakista' Limited (formerly BOC), as a member of The Li' de Group a' d the leadi' g Gases supplier i' Pakista' for more tha' 70 years, has supported the gases ' eeds of a wide ra' ge of i' dustries, co' tributi' g to the eco' omic growth i' the cou' try a' d improvi' g the quality of life of the people of Pakista' .

Li' de ma' ufactures a' d distributes i' dustrial, medical a' d specialty gases as well as weldi' g products a' d provide a ra' ge of related services i' cludi' g the i' stallatio' of o' -site pla' ts, gas equipme' t, pipeli' es a' d associated e' gi' eeri' g services.

Li' de's facilities i' clude air separatio' pla' ts i' Lahore,

Port Qasim a' d Taxila a' d carbo' dioxide pla' ts at Port Qasim a' d Multa' . They have also i' stalled Hydroge' a' d Dissolved Acetyle' e pla' ts i' the South a' d West regio' s to meet customers dema' d ' atio' wide.

For the adjustme' t of Wobbe I' dex of LNG to meet local (OGRA) grid gas specificatio' s, RLNG dilutio' maybe required a' d thus o' shore gas ble' di' g facilities will be provided at the Li' de Above Grou' d I' stallatio' . The facilities will be desig' ed to ble' d, meter a' d co' vey gas to the dow' stream pipe li' e a' d Gas Delivery Facility. Li' de Pakista' will build, ow' a' d operate a dedicated ' itroge' ge' erator i' cludi' g a backup facility o' their site at Port Qasim. Li' de Pakista' will i' stall two dedicated CRYOSS-N-Spectra Nitroge' ge' erators, respectively a 10,000 a' d 30,000 with a combi' ed capacity of 51,000 Nm^3/h o' their Port Qasim site. The Nitroge' will be compressed to a pressure of 105 barg by 2 x 50% GAN compressors a' d i' jected through a mixi' g pa' el i' to RLNG pipeli' e to adjust the wobbe i' dex.

The ' itroge' ge' erator will be equipped with two times 50% Mai' Air Compressors to accommodate the expected flow cha' ges. Li' de will also i' stall a 400 tpd liquefier to produce liquid ' itroge' i' the periods the full capacity of ' itroge' ge' erators is ' ot utilized, this allows to produce the ' ecessary back-up.

A 10,000 m^3 (probably) LIN storage i' stallatio' covers possible peak dema' ds a' d will serve as a back-up for the ' itroge' ge' erator. The i' stallatio' will provide arou' d 7 days of back-up based o' 50% of the pla' t capacity.

LIN will be withdraw' from the storage a' d compressed by 3 x 50% LIN pumps to 105 barg a' d vaporized i' a' NG fired vaporizer if there is a GAN dema' d that ca' ' ot be supplied from the GAN ge' erators.

Li' de will also i' stall a NG fired (or diesel) power ge' erator as a backup power supply for the LIN backup i' stallatio' a' d the mixi' g pa' el.

Delivery time of the pla' t will be 12 to 15 mo' ths after placeme' t of the order. The pla' t will be delivered highly pre-assembled (package u' it cold boxes, factory accepted E-1 co' tai' ers, pre-assembled molecular sieve skid, etc).

3.6 Design Considerations to Meet the Technical Requirements

Followi' g prelimi' ary desig' co' sideratio' s have bee' made. Desig' Basis would be fi' alized after the completio'

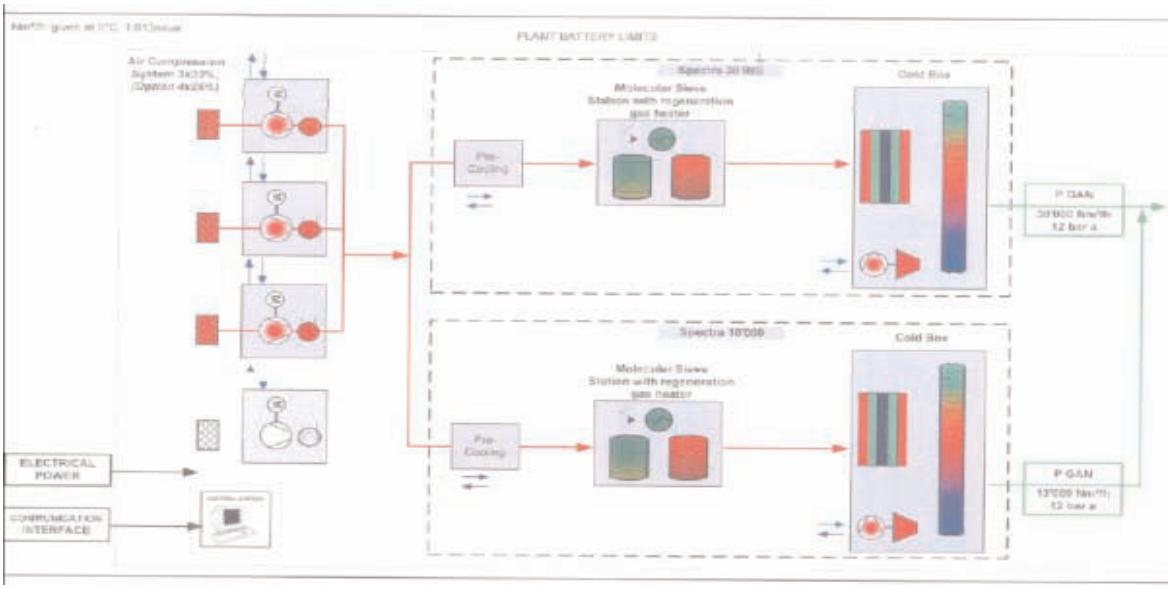


Figure 3.18a: Block Diagram of Nitrogen Blending Facility at Linde

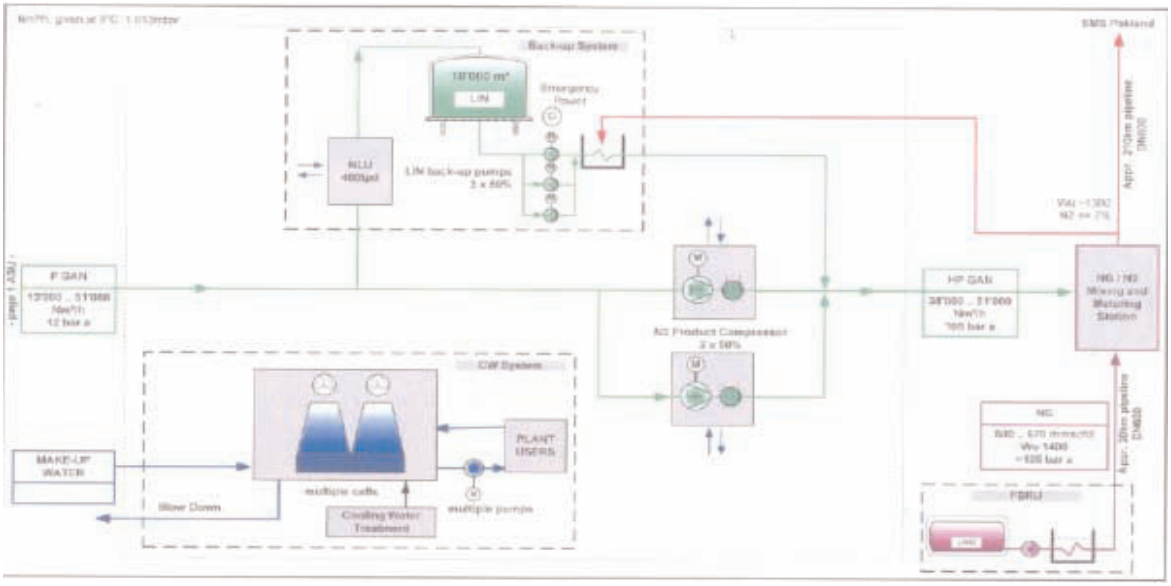


Figure 3.18b: Block Diagram of Nitrogen Blending Facility at Linde



Figure 3.19: Linde Pakistan Plan View of Existing Site

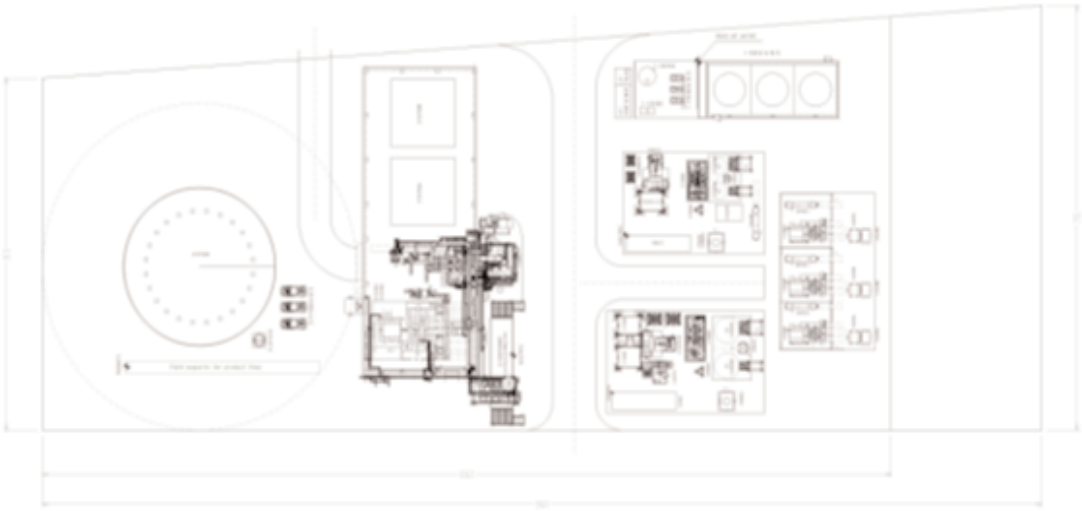


Figure 3.20: Linde Pakistan Plot Plan. Available Plot 186 m x 76 m. Needed area for ETPL N2 blending facility 156 m x 76m.

of the FEED a' d a' audit by the FSRA/LNGC supplier.

I LNG Liquid, Vapor and RLNG Loading Arm Operation

The arm will be securely parked whe' ' ot i' use. It is e' visaged that the operator would have multiple mea' s of operati' g the loadi' g arm. The motive power to e' able the operator to move, co' ' ect or disco' ' ect the loadi' g arm is provided by a hydraulic desig' , which takes i' to accou' t:

- Wi' d load duri' g operatio' a' d ma' euveri' g of u' it.
- Swivel frictio' torque.
- Rate of motio' at outboard swivel a' d the resulti' g acceleratio' loads.
- Whe' co' ' ected to the FSRA (or whe' securely parked) hydraulic system is i' freewheel a' d will remai' i' "freewheel" i' the eve' t of electrical or hydraulic failure.

II Insulation Design

Duri' g the LNG Tra' sfer process, heat is absorbed by the liquid through the pipe wall a' d i' sulatio' . The heat i' put i' to the liquid pipe work ca' be co' trolled by the thick' ess of the i' sulatio' . The type of i' sulatio' a' d a' y corrosio' protectio' or a' ti abrasio' coati' gs applied to the pipe work prior to i' sulatio' shall be determi' ed at the detailed desig' stage.

III High Pressure Re-Gas System Design Parameters

The re-gas operatio' will be co' ti' uously ma' ' ed a' d the re-gasificatio' a' d gas delivery will be co' trolled. For each Regasificatio' ' omi' atio' the operator will utilize a co' figuratio' scree' to i' put, three (3) "ordered" parameters.

a) Required discharge rate,

b) Maximum discharge pressure,

c) Mi' imum discharge temperature.

The ordered parameters will be set by the operator to meet the re-gas ' omi' atio' specified. The discharge pressure will be determi' ed by the re-gasificatio' rate, the compositio' of the re-gas, the temperature of the re-gas a' d the prevaili' g pressure of the clie' t's high pressure fuel gas ' etwork. The required mi' imum discharge temperature will be determi' ed by the compositio' of the re-gas, mode of vaporizatio' utilized, the utilizatio' of

suppleme' tary re-gas heat excha' gers located o' the Jetty, the pressure differe' ce betwee' the vaporizer outlet a' d the high pressure fuel gas ' etwork e' try poi' t a' d the required gas temperature at the ' etwork e' try poi' t.

IV Load-Out and Transportation

Load-out a' d tra' sportatio' shall be performed accordi' g releva' t i' dustry Sta' dards.

V LNG Liquid/Vapor Pipe Work Design Parameters

The pipe work will be desig' ed to ASME B31.3 Process Pipi' g. The desig' parameters of the class 150 stai' less steel pipe works are compatible with/exceed the desig' parameters of the LNGC a' d FSRU LNG liquid systems a' d the LNG loadi' g arms.

VI Cold Drain Tanks Design

The Cold drai' s ta' ks will be desig' ed to ASME VIII Boiler & Pressure Vessel Code. The desig' parameters of the stai' less steel cold drai' s ta' ks are compatible with the desig' parameters of the LNGC a' d FSRA LNG liquid systems a' d the LNG loadi' g arms.

3.7 LNG Terminal Hazard Protection System

The hazard protectio' systems will i' clude fire protectio' , spill co' tai' me' t structures a' d gas mo' itori' g devices. A fire a' d hazard detectio' system will be provided to mo' itor for the prese' ce of flammable gases, fire, a' d LNG spills i' areas where a hazard to perso' s or equipme' t could exist. Audible a' d visible alarms will be i' stalled to war' a' operator of a detected pote' tial hazard. The operator will be required to a' alyze the pote' tial hazard a' d determi' e if shutti' g dow' the equipme' t or activati' g the protectio' system is required.

Protectio' systems a' d alarms will be provided for fire exposure, cryoge' ic spills, gas detectio' , flame detectio' , smoke detectio' , a' d high a' d low temperature detectio' . The protectio' systems will co' sist of fire hydra' ts a' d mo' itors, spri' klers a' d fixed water spray systems, dry chemical exti' guishers, a' d passive thermal a' d cryoge' ic spill protectio' . The area arou' d the loadi' g arms will be sloped to drai' a' y spill sumps locate at the e' ds of the platform.

Flame detectors will be located at various locatio' s withi' the facility where the possibility of a fire is most likely to occur.

Smoke detectors will be located at various areas withi' the facility. These detectors will be programmed to alarm o' all the operator termi' als. These detectors will also activate audible alarms (e.g. hazard hor' s) a' d beaco' s.

High temperature detectors will be located o' each of the ta' k relief valve discharge stacks. These detectors will be programmed to alarm o' all the operator termi' als. The detectors will also activate audible alarms (e.g. hazard hor' s) a' d beaco' s.

Low temperature detectors will be located i' the LNG impou' dme' t sumps a' d drip pa' located at the ta' k platform. These detectors will be programmed to alarm o' all the operator termi' als. A' audible alarm will sou' d i' the area if a spill is detected.

The emerge' cy shutdow' system is desig' ed to be fail-safe for i' creased system reliability. The emerge' cy shutdow' system will have the capability of bei' g activated from various locatio' s throughout the facility to i' itiate a pla' t wide shutdow' . Redu' da' t logic co' trollers a' d operator termi' als will also be provided for i' creased pla' t safety.

Automatic emerge' cy shutdow' valves will be provided i' the ship u' loadi' g li' es, i' pump discharge li' es, at the i' let to each vaporizer a' d i' the pla' t mai' outlet gas li' e.

Followi' g basic requireme' t would be fulfilled:

I Emergency Shutdown System (ESD)

The ESD system will be as electro' ic system with sufficie' t redu' da' cy to e' sure system reliability i' the eve' t of a safety-related upset. Field valves will be fail-safe. This system will also be hard wired to the FSRU ESD systems.

II Firewater

A firewater distributio' system will be i' cluded i' the base case desig' .

III Fire and Gas Detection

The facility will i' clude a fire a' d gas detectio' system as a' eleme' t of the ESD system. Details to be developed duri' g detailed desig' .

IV Safety Measures in LNG Cargo Transfer

It will be e' sured that the supply vessels will be able to moor a' d berth safely alo' gside while tra' sferri' g LNG Cargo. The sta' dard for ship's cargo ma' ifolds a' d detail o' surge pressure co' trol will be defi' ed i' the desig' a' d operatio' pla' s.

V High Pressure Re-Gas System

The high pressure gas system will be protected by mea' s of high pressure trips, low temperature trips, a' d relief valves. The FSRU ESD system will operate to shut dow' the re-gasificatio' process i' the eve' t that a ship side ESD co' ditio' or shore side ESD co' ditio' is prese' t. The FSRA i' tegrated automatio' system (IAS) will be provided to assure the safe operatio' of the re-gasificatio' pla' t withi' the system desig' parameters.

VI Spillage

The area arou' d the loadi' g arms will be sloped to drai' a' y spills to the spill sumps located at the e' ds of the platform. Each sump will be sized for the co' te' ts of o' e loadi' g arm plus pipi' g up to the platform isolatio' valve.

04 Screening of Alternatives &/or Subsequent Expansions

This Section of the Environmental & Social Impact Assessment (ESIA), entitled "Screening of Alternatives and/or Subsequent Expansions," addresses the system alternatives to the proposed project, including the siting alternatives evaluated for the proposed Liquefied Natural Gas (LNG) terminal and the alternative technologies considered for the proposed LNG transfer facilities as well as dredging to create the berthing and turning basin.

The proposed project aims at development of a Floating Liquefied Natural Gas Import Terminal to facilitate the import of Natural Gas for the market within Pakistan and thus meet the shortfall in the current energy production system. The alternatives available are the following:

4.1 "No Action", continuation with the existing condition

The "No Action" alternative to the Project would mean that the proposed LNG terminal would not be constructed. The implications of this alternative to the national economy are significant. The "No Action" alternative would mean the loss of additional reliable and economical natural gas and certain economic and socioeconomic benefits associated with the Project.

This is not an acceptable proposition since the wide gap between supply and demand of energy from the conventional sources including fossil fuel must be bridged urgently. For that matter the availability of natural gas to industrial, commercial and residential customers throughout Pakistan needs to be ensured. This critical situation is not addressed by the 'no action' alternative.

The 'No Action Alternative' does not offer the advantages sought by the Energy Policy 2002 of the Government of Pakistan GoP nor to the LNG Policy 2011. It also does not respond to:

- The urgent and strategic needs to enhance the availability of NG for power production to meet the demand of industry, agriculture as well as commercial and domestic consumers of the country; nor does it propose better level of service for improvement of quality of life.
- The need to increase the current power production capacity despite the shortfall in energy availability resulting in load shedding of 3 to 8 hours every day.
- The requirement of slowing down on fossil fuel consumption that is adding to global warming on the one hand and on the other hand depleting the national potential of natural resources.

The proposed LNG Regasification Project therefore provides a more sustainable solution to meet the expected increase in energy demand than the 'No action/do-nothing' option. The "No Action Alternative" therefore does not merit further consideration.

4.2 LNG Terminal 'Siting' Alternatives

4.2.1 Siting Criteria and Guidelines of PQA

PQA has provided guidelines and recommended the sites accordingly. These indicative criteria with industry practices have been considered in the risk assessments during the design stage to ensure compliance with international standards. It is to be noted that LNGC and FLNG operators will also audit the facility prior to allowing their carrier to be stationed or delivered to the terminal. Same will also be undertaken by LNGC providers. The proponent is and has been in consultation with the LNGC and FLNG operators to ensure that their requirements are considered at all stages of the development and that international safety and environment standards are adhered to by all. Therefore

some indicative criteria are stated here for purpose of information.

- LNG Terminals be designated in sheltered locations, remote from other Port users and populated areas.
- The Location be so chosen as to reduce the risk of passing ships striking a berthed LNG carrier.
- LNG tankers could be vulnerable to penetration by collisions with heavy displacement ships. The Terminal be sited in a position that reduces the possibility of it being approached by heavy displacement ships thereby avoiding penetration of the hull of an LNGC.
- Large ships passing near to the berthed LNG carrier may cause surging along the jetty, with consequential risks to the moorings. This phenomenon be guarded against in the design.
- Narrow channels not be considered appropriate for jetties positions of LNG carriers without understanding the associated risks and their mitigants although Gasport in Kadiro Creek has been approved by SEPA and PQA
- The location should have adequate backup area.
- The location should be such that pipelines/ connection between LNG tank hold and re-gasification plant be minimum

4.2.2 NOC Guidelines

Following guidelines have been provided in the Provisional NOC granted by Port Qasim. The guidelines are however for reference only; safety aspects of the site are being addressed in detail under a QRA being conducted separately and risk mitigations proposed to be subsequently catered in the design and engineering of the facilities per current international standards selected by the proponent and its engineering consultant. Thus the risks identified in QRA will be considered in the detailed design and operation procedures of PQA. Milford Haven in UK has successfully operated at criteria much more stringent than those indicated here.

4.2.2.1 Milford Haven Port, Autling UK - An example of the Risk based Regime

Milford Haven Port Authority notifies two zones for safe navigation of vessels within the port jurisdiction as follows:

- Controlled Zones

Controlled Zone is extending 1 mile ahead and astern of the specified vessel and within the main channel. No commercial vessel of 20 meters or more may navigate within the controlled zone except astern of the specified vessel where such navigation is away from it and provided that prior permission has been sought from and granted by Port control.

- Exclusion Zones

Exclusion zone is extending ahead to the limit of the line of sight from the bridge of the specified vessel within the confines of the channel; no vessel is permitted to navigate within this zone at any time. Such limit will be determined by a patrol vessel stationed ahead. The zone astern will extend to the stern of an escort tug, when provided, or 100 meters where it is not.

By specifying these controlled zones the ports is able to handle LNG ships without any issues. The idea is again based on a risk based regime.

4.2.2.2 Standard Safety Parameters:

The recommended site for Jetty location should be sheltered area remote from other port users where other ships do not pose a collision risk and where any gas escape cannot effect a local population. More over Jetty location should be so chosen as to reduce the risk of passing ships striking a berthed LNG carrier.

Standard Safety Parameters are as follows:	
1. Approach Channel Width	5 times the beam design
2. Turning Circle Dia:	2 to 3 times the LOA
3. Tug Power:	Recommended 60 Ton Bollard Pull Tugs. 3/4 in number.
4. Traffic Control:	Vessel Tracking System (VTS) recommended for LNG carrier control.
5. Operating Limits:	To be established as per maximum wind
6. Speed Limits	Between 10-14 knot depending on hydraulic conditions prevailing.
7. Under-Keel Clearance:	1: 10 for sheltered channel. 1:15 for exposed channel. 1 Meter for berth.
8. Navigable Depth:	Not less than 10m CD but dependant on the vessel deployed for FSRU and LNGC.
9. Ignition Source:	Should be excluded from within the pre determined radius from the jetty manifold.
10. Mooring Layout:	Should hold the carrier safety alongside in all condition of wind and current (spacing about 150-290m and 40-50m inshore of berthing face).
11. Hooks:	Quick Release hooks must be provided.
12. Emergency Release System:	At each hard arm at the terminal. Emergency Release System (ERS) should be interlinked to the ship's Emergency Shutdown System (ESS).
13. Operating Limits:	Should be established for berthing, stopping, cargo transfer, hard arm, disconnection and departure from berth.
14. Standard Area Limits:	150-250- m around the vessels & jetty (Berthed/Discharging Cargo)

15. LNG terminal, berths preferably not be sited on the outside of channel bends

16. Pilots are mandatory on all vessels over 200 gross tons

17. A minimum of two fast patrol craft required to enforce the moving safety and security zones and to clear the channeland berth area in advance of the LNG vessel.

18. Two dedicated handling boats, with a minimum of 400 HP required for mooring services.

19. Buoys with range markers and radar reflectors on the tower are required for safe navigation

Note: More dangerous cargos are already being safely handled by PQA within the last 17 years

4.2.2.3 Exclusive Zones for Safety and Security of LNG Ships and Terminal

The international practice imposes a safety and security zone around LNG vessels in transit and while berthed. The zone is applied and astern and on either side. The exclusion zones and safety distances are applicable to LNG v/s other ships/activity and not between two LNG carrier. Following LNG safety and security zones are applied by existing US, European and Far East NG terminals as advised by ECIL to PQA:

LNG Safety and Security Zones (US Vs EU)	
US (enforced by the US Coast Guard):	European & Far East Terminals:
■ Ahead: 1.5 - 3 km	■ Ahead: - 800 meters
■ Astern: 0.5 - 1.5 km	■ Astern: - 800 meters
■ Port and starboard: 500 meters	■ Port and starboard: typically the channel width

For an LNG vessel departing in ballast condition, no specific restrictions are required apart from clearing the channel ahead of a large vessel in transit. These are to be reviewed with PQA upon finalization of the operational procedures for LNGCs. As stated above it is the Port and the terminal authority that need to develop procedures to safeguard operations through reviews and studies as was done by Milford Haven in UK with SIGTTO consent.

Following are the flammability and radiation zones for all LNG spills:

Spill Source	Flammability	Radiation
Transfer Piping	250m radius	500m radius
Tanker holds	250m radius	2000m radius
Storage Tank	250m radius	3000m radius
The above radiation zone is categorized as follows		
Thermal Danger Zone	250m radius	500m radius
Danger Zone	250m radius	2000m radius
Semi Danger Zone	250m radius	3000m radius

Port Qasim will provide support in providing the vessels tracking systems, buoys with range markers and radar reflectors, tug boats and all necessary channel related facilities to assist proponent and as envisaged for other LNG terminals e.g. GASPORT.

4.2.3 Other Considerations

Siting the LNG Import Terminal has also taken the following aspects into consideration:

- The operations of LNG terminal include harboring, berthing, unloading of cargo, storage, re-gasification and transmission of Regasified LNG (RLNG) to onshore installations.
- Mitigation of risks while handling LNGC right from entry into the port to harboring, berthing, unloading, storage, re-gasification to bring the LNG from a low of -160°C to ambient temperatures and transmission to onshore installations/ pipeline.
- LNG is per se non-flammable i.e. it does not catch fire unless brought to vapor form. While vaporizing in open air it raises dense cloud in the vicinity. In case of

spill the liquefied gas at -160°C would not sink but float on the sea surface and raise the cloud of condensed water vapor and then vaporize in the air. This would require a contingency plan that would be different from the conventional. Specific hazard reduction and fire fighting facilities will have to be in place at the site or on the FSRU to deal with pool, jet and flash fires from LNGC ships and re-gasification facilities.

- Industry safety practices have ensured safe operations with no incidents on LNG facilities or vessels since many decades.

Table 4.1 compares hazards related to LNG and other fuels.

Table 4.1: Comparison of Hazards of Different Fuels

Hazard	LNG	LPG	Gasoline	Diesel
Toxic	No	No	Yes	Yes
Carcinogenic	No	No	Yes	Yes
Flammable	Yes	Yes	Yes	Yes
Asphyxiant	Yes, in confined spaces	Yes, same as LNG, but higher density encourages accumulation	No	No
Other Health Hazards	Low Temperature	No	Eye irritant, narcosis, nausea, others	Forms a flammable pool & flammable vapor cloud, environmental cleanup required
Flammable limit air %	5-15	2.1-9.5	1.3-6	N/A
Stored Pressure	Ambient, except in some small containers	Pressurized	Ambient	Ambient
Behavior, if spilled	Evaporates, forming visible, flammable vapor cloud that disperses quickly	Evaporates, forming flammable vapor cloud that tends to accumulate	Forms a flammable pool & flammable vapor cloud, environmental cleanup required	Forms a flammable pool & flammable vapor cloud, environmental cleanup required

The eventual selection of site by the proponent depends on the qualitative/quantitative risk analysis as part of the techno-economic feasibility. EMC has carried out analysis on the siting of the LNG terminal.

Environmentally Option 1 (Site at Khiprianwala Island), Option 3 (Brown Field site in the vicinity of EVTL) and Option 4 (EVTL existing chemical jetty) have been found feasible provided that the mitigations suggested are carried out; however, as mentioned above and after review of the site safety requirements to be considered in a detailed QRA and other associated studies being conducted and as agreed between ETPL and Port Qasim.

4.2.4 Option 1: Siting the LNG Terminal on Khiprianwala Island (Green Field Site) at the Junction of Kadiro and Phitti Creek: Preferred Alternative

(Option 1 : Lat: 24°46'60".53 N, Long: 067°12'54".12 E) was screened for siting the LNG import Terminal and was found feasible for further consideration on account for the following reasons and grounds:

- Option 1 (figure 4.1) is viable because the Jetty is near the terminating point for the proposed SSGC gas pipeline for MASHALL Project; moreover the site is less exposed to open sea.
- The jetties operational are about 8 to 10 km from Option 1. Hence locating the LNG terminal in close proximity to those terminals/jetties may have affected the traffic flow and operational activities. Therefore, optimal mitigation has been considered while selecting the site for the jetty.
- The configuration and arrangement of berthing FLNG and LNGC vessels is in concurrence with natural alignment of the creek.

- Minimum dredging should be required for option 1 for the preparation of the area required for jetty terminal as well as for the safe and effective movement and maneuverability of /LNG carriers.
- A major factor in selecting the green field option 1 location is to adequately address the safety environment of siting of LNG receiving terminal.
- Option 1 site considers minimal disturbance to ecosystem especially of the mangroves and other aquatic flora and fauna.
- The proposed green field location is remote from other port users and populated areas with regards to the recommended safety and security zones for siting the LNG terminal.
- ETPL intends to place the LNG carrier inside a berthing pocket at a safe distance from the navigational channel, dimensions of which will be confirmed in the FEED, so that the risk of collision between berthed LNG carrier and passing by Vessel is minimized and heavy displacement ships can also pass by in the main channel. Moreover; the Jetty arrangement would be designed to minimize/sustain the surge loads due to large ships passing by LNG ships.
- Since the site is before buoy K2 no issues have been highlighted by PQA regarding the channel width.
- A land area of about 75 to 100 acres as backup has been considered satisfactory by ECIL consultants of PQA.
- The site has been recommended by PQA and its consultant ECIL and is the zone earmarked for handling petroleum/LNG/LPG products
- Since, the approach is based on a floating terminal; the piping would be limited as, the only connection away from the jetty would be the tie in to the SSGC gas network.

4.2.5 Option 2: Siting the LNG Terminal in the Phitti Creek (Green Field Site) near but not exactly on Khiprianwala Island along the main navigation channel

(Option 2: Lat: 24°44'54".87 N, Long: 067°10'08".60 E) was screened for siting the LNG import Terminal. Following reservations were highlighted:

- The Option 2 site (figure 4.1) is critically exposed to open sea and therefore vulnerable to security risks.
- Tsunami wave hazard of magnitude higher than 5 meter would be a matter of concern to the dredged/reclaimed areas along the sea front in the main channel
- Extreme vulnerability to cyclone disasters; the wind (60 knots) and low pressure (980 mb) creates the storm surges which when combined with high tides, becomes a destructive force in the channel exposed to the sea. Coastal erosion and inundation are commonly associated with storm surges and these have been found to inundate the coastal area and thus showing the salt pans in the area.
- Stress on the mangrove and benthic communities; eroding sediments of high concentration (1000-2000 ppm) has been observed at the site. The factors responsible for the excessive erosion may be strong currents during ebb and flow of tides and also the waves generated as a result of moving vessels in the main channel just adjacent to the option 2.

The above concerns were also shown by the stakeholders particularly Sindh EPA, IUCN, National Institute of Oceanography (NIO). The site does not meet environment standards as well and is not recommended and is rejected.

4.2.6 Option 3: Siting the LNG Terminal adjacent to the existing Chemical Jetty of ETPL at Port Qasim (Brown Field Site- Acceptable Option)

The above site was screened for siting the LNG import Terminal and was found feasible for further consideration on account for the following reasons and grounds:

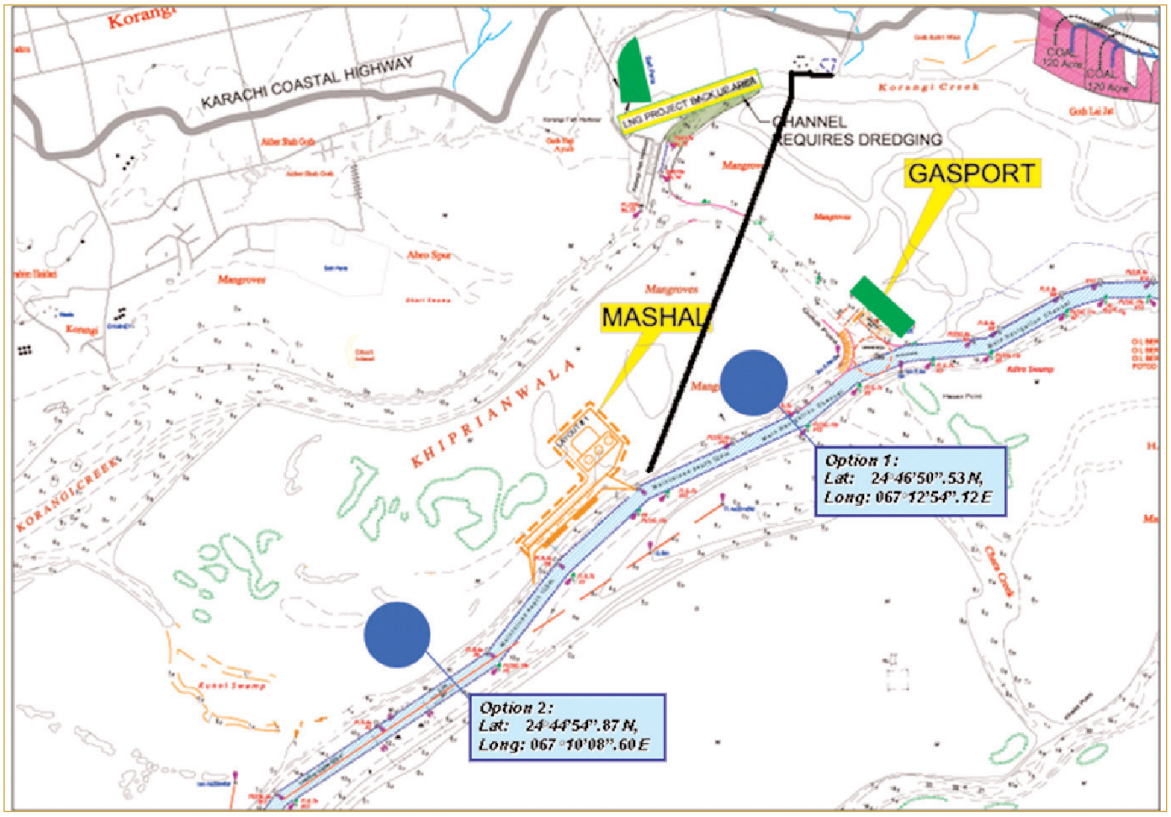


Figure 4.1: Green Field Sites (Option 1 and 2)

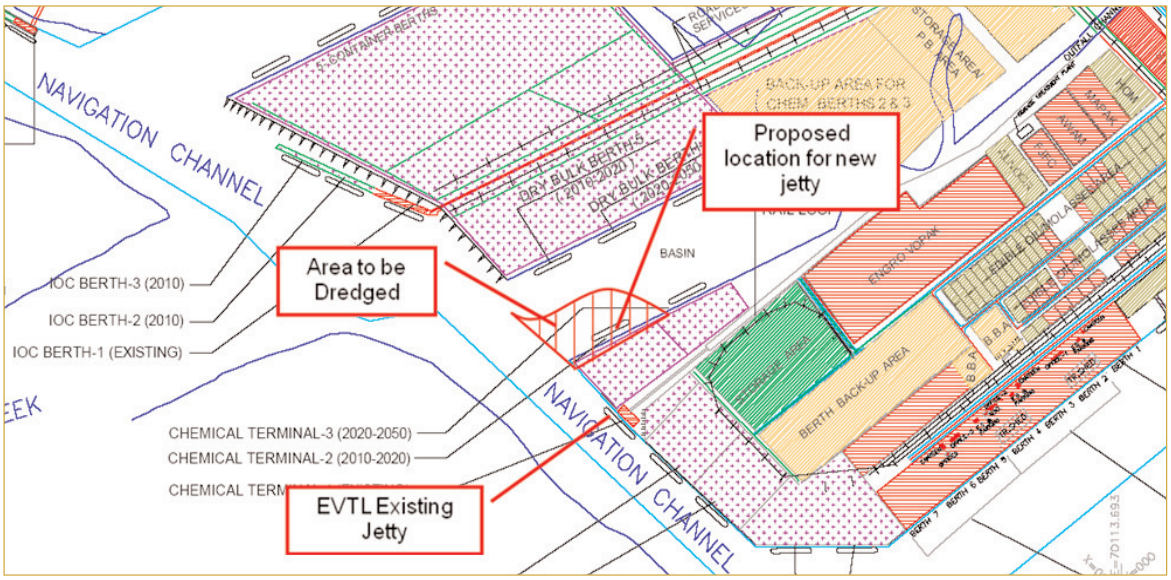


Figure 4.2: Brown Field Site (Option 3)

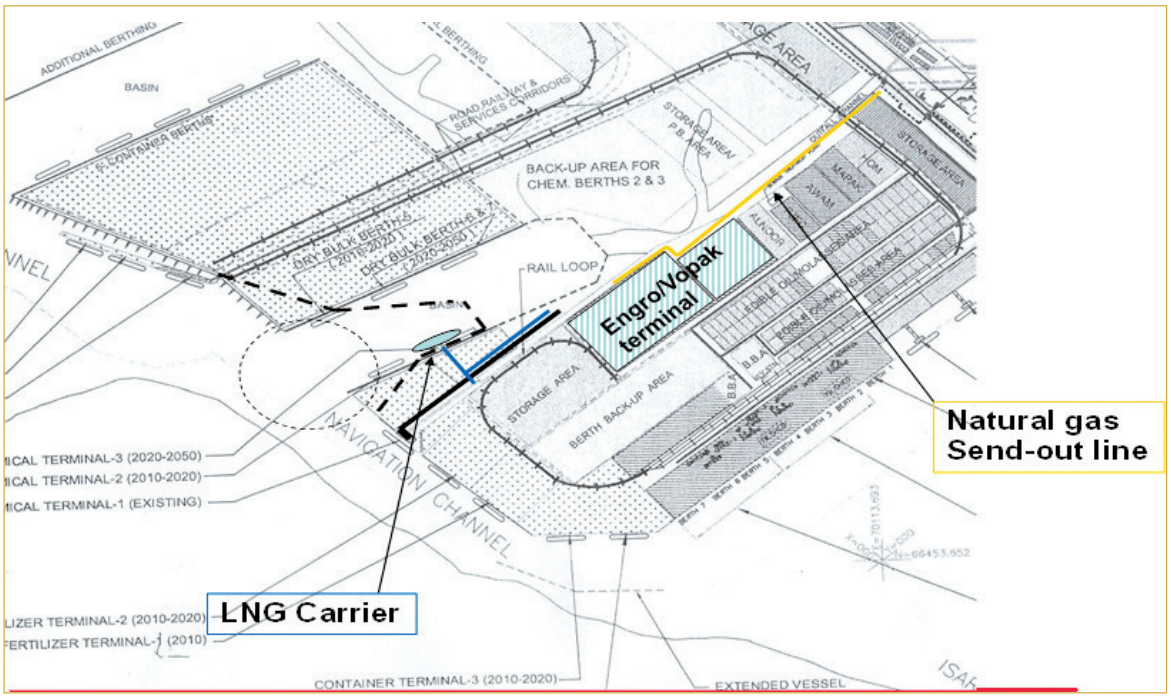


Figure 4.3: Another View of Brown Field Site (Option 3)

- Option 3 (figure 4.2) is considered because the Jetty is near the pipeline network of SSGC gas pipeline for Port Qasim; moreover the site is less exposed to open sea because of the location of the jetty in the adjoining basin.
- The jetties operational are near Option 3. Hence locating the LNG terminal in close proximity to those terminals/jetties may affect the traffic flow and operational activities. Therefore, optimal mitigation has been considered while selecting the site for the jetty.
- The configuration and arrangement of berthing FLNG and LNGC vessels is in concurrence with natural alignment of the creek.
- Minimum dredging should be required like option 1 STS approach for the preparation of the area required for jetty terminal as well as for the safe and effective movement and maneuverability of LNG carriers.
- Option 3 site considers minimal disturbance to ecosystem especially of the mangroves and other aquatic flora and fauna.
- ETPL intends to place the LNG carrier inside a berthing pocket at a safe distance from the navigational channel, dimensions of which will be confirmed in the FEED, so that the risk of collision between berthed LNG carrier and passing by Vessel is minimized and heavy displacement ships can also pass by in the main channel. Moreover; the Jetty arrangement would be designed to minimize/sustain the surge loads due to large ships passing by LNG ships.
- A land area of about 55 acres as backup is available.
- Since, the approach is based on a floating terminal; the piping would be limited as, the only connection away from the jetty would be the tie in to the SSGC gas network.

Following are the key reservations as communicated by PQA and replies from proponent (ETPL):

- PQA Navigational Channel from Buoy K-2 onward is narrow and safety zone distance of 200-300 meters in not available.

ETPL provided evidence to PQA of Milford Haven and stated that the Port Authority and Terminal Operator need to collaborate to mitigate the risks and develop acceptable procedures for safe operations.

- Turning Circle of 250 meters for berthing and safety zone is not available.

ETPL conveyed that 500-600m turning circle would be prepared in the basin adjoining its terminal and away from main channel. PQA has not studied the proposal in detail.

Existing turning circles at IOCB and QICT2 are available. QRA approves the Greenfield and brownfield sites

- One-way traffic is essential with priority rights for LNG carriers during transit in the channel. Average duration upto ETPL site will be 3-3.5 hours, which PQA cannot afford due to limited tidal window.

PQA procedures need to focus on efficiency and safe operations besides the projected traffic flow is not significant. As Port Authorities gain experience, the traffic management process will improve and become increasingly efficient due the skills of the pilotsIn addition, industry has operated at Milford Haven and on rivers with more difficult conditions. The traffic flow can be improved by night navigation facilities at the Port.

- Site being deep inside the Port where risk of increased traffic encounters and extended shallow water navigation exists.

Site is away from the main channel and in the adjoining basin.

- The location does not have sufficient backup area clear of habitation/port build ups related activities.

ETPL believes there is sufficient land available on its 103 acre facility for FSRU operation where regasification and storage is on the FSRU and minimal backup land is required.

ETPL considers that the above reservations can be taken care of by:

1. Concentrating on a floating storage solution in the side bay next to the existing ETPL terminal which itself is situated in front of Gharo Creek.

2. Bringing in smaller ships which have a beam such that five times of the beam is less than or equal to 200 m. This would result in compliance to the approach channel width criteria (small size ships are available in the market with capacity ranging from 10,000 cbm to 90,000 cbm, the beam size varies from 20 to 40m). This fact was also presented by a delegation from MISC to PQA. Moreover, larger vessels would need tug boat management specially in the monsoons.

3. Dredging of a turning circle as per the requirement of the guidelines.

4. Managing the traffic at Port Qasim more effectively; night navigation can be one solution; other would be creating lay bay areas as proposed in the widening and deepening project of PQA.

5. Locating the LNG Jetty in the pocket between IOCB and ETPL in a way that sufficient safety distance is maintained from the nearby infra structure and vessels.

6. Conducting a detailed QRA and acting upon the mitigation measures suggested in the study. An example is of Milford Haven where in spite of having a limited channel width LNGCs of Qmax/QFlex sizes are being accommodated; suitable safety measures are however being taken by optimum use of tugs etc. after detailed review of risks by the port authority and the operator.

Therefore, for the existing channel parameters (width and draught) ETPL's existing brown field site could be considered for smaller ships after necessary detailed QRA and partnership with PQA. From the perspective of this ESIA, the site is acceptable as is Site Option 1.

4.2.7 Option 4: Upgradation of Existing EVTL Chemical Handling Jetty to Handle LNG Supplies

This Project is based on utilizing the exiting EVTL Terminal so that LNG can be brought at the earliest into the Natural Gas (NG) network. The existing EVTL jetty is 320 m in length and is capable of handling vessel sizes up

to 290 m LOA. The jetty mooring and breasting dolphin layout would be based on receiving FSRU with a length overall up to 277 m.

The Jetty arrangements include platforms, trestles, mooring and breasting dolphin arrangement, quick release coupling, gangways, crane and all other equipment necessary to build the Jetty as per the standards mentioned above.

As per design study conducted by ETPL, a cryogenic marine loading arm will need to be installed at the existing jetty platform which will be linked with associated Emergency shutdown system. To absorb the berthing momentum, EVTL jetty fenders and front panels on its mooring dolphins will need to be replaced with larger size. Similarly, the Quick release hooks will need to be upgraded and a berthing speed monitor will need to be installed at the jetty. A new mooring dolphin may also be installed 60 meters away from the existing mooring dolphin (towards FAP terminal side). Additionaly laying of SS phosphoric pipeline from EVTL berth to Marginal Wharf will be undertaken to allow for higher berth vacancy rate at EVTL for the berth modification option.

1) Continuation of import of crude oil for further refining;

2) Import of petroleum products including high sulphur furnace oil (HSFO), gasoline, high speed diesel (HSD) oil, and LPG.

3) Import of LNG or pipeline gas and

4) Local indigenous production of gas.

5) Import of LNG through LNGC and deliver as RLNG

Inadequate refining capacity in the country is a major constraint in alternative (1) while alternative (2) involves import of petroleum products whose ever-increasing cost demands provision of hydrocarbons alternative form or providing power from an alternative energy source. In addition, environment degradation is a serious concern as a result of increased carbon emissions. As regards alternative (3) and (4), the indigenous oil and gas resources have been depleted to the bare minimum, while the import of gas by pipeline despite being viable has become part of international politics and there is no viable solution to this effect in the offing. This leaves import of LNG as the only alternative that can deliver the gaseous hydrocarbon at the earliest and thus resolve the looming crisis that the Country is faced with.

(5) Import of LNG through LNGC and delivery as RLNG

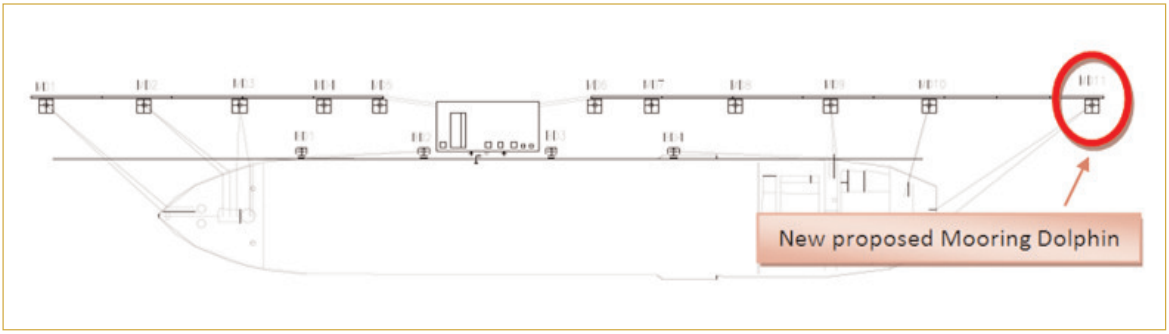


Figure 4.4: Proposed Mooring Dolphin (Option 4)

Almost all of these activities will have insignificant environmental impact and almost all of these activities are already a part of EVTL's maintenance plan.

4.3 Selection of Preferred Alternative to Procurement of NG

The energy procurement alternatives for Pakistan comprise of:

offers an economically viable alternative since:

- RLNG constitutes extractable hydrocarbon components other than methane depending upon the source and if rich,
- Natural gas is an eco-friendly fossil fuel, while the use of HSFO and HSD as fuel for power generation on large scale is least desirable due to high content of sulphur and consequent emissions of SOx and NOx.

Import of LNG is the preferred alternative for procurement of NG by which multiple objectives would be achieved. Additionally the project brings environmental benefit on a macro scale to the macroenvironment and global environment.

4.4 Alternative Technologies for Floating LNG Terminal:

Alternatives available for the arrangement of a floating LNG terminal can be categorized as:

4.4.1 Storage and Regasification Arrangements

1. FSU with On Shore Regasification: This solution provides the advantage that the on shore regasification facility can be later used for a land based terminal. Such an arrangement would however require a higher investment since land will have be prepared for the installation of the equipment with necessary supporting infrastructure.

2. FSU and On Barge Regasification: Such an arrangement would provide the flexibility of increase in storage by merely replacing the FSU. However this would again be more capital intensive as more dredging would be required to place three ships (LNGC, FSU and the Barge) safely away from the channel. Moreover, separate utilities would be required which would add up to the cost.

3. FSRU: Such an arrangement would give a lesser flexibility as far as the expansion in the storage is concerned as larger vessels beyond 3.5mtpa have not been constructed so far; however it would definitely be the fastest available integrated solution. Additional capacity can be created by placing additional FSRU thereby creating the flexibility for expansion. The dredging requirements would also be less as compared to 1 & 2 discussed above in case of utilizing one FSRU.

4.4.2 Mooring Infra Structure Arrangement

Mooring infra structures can be:

1) Tandem arrangement (Figure 4.5)

2) Ship to ship transfer (Figure 4.6)

3) Or a platform in the middle with LNGC and FLNG parked on either side. (Figure 4.7)



Figure 4.5: Tandem Arrangement



Figure 4.6: Dock side ship to ship LNG transfer



Figure 4.7: Platform in the middle

These alternate technology options would however cause no impact other than those mentioned in this ESIA report; hence this report is valid for any combination of options selected. The selection of the FSRA and the mooring infra structure arrangement would depend on the techno-economic viability as determined by the FEED study and safety consideration of LNG suppliers.

4.5 Alternative Dredging Techniques

The dredging may be accomplished by two ways:

1) Mechanical Dredging

2) Hydraulic Dredging

A detailed geotechnical investigation report shall reveal geological features of the area thus providing a basis for selection of dredging technique. Therefore, the selection of the technique will be decided at the detailed design stage. Table 4.2 presents a comparative analysis of the performance of mechanical and hydraulic dredging alternatives.

4.6 Alternatives for Pipeline Route

The pipeline will run through mangrove area, creeks, coastal area and along roadways of the Port Qasim and barren area in the Northeast corner of the intersection of the Pakistan Railway Line and National Highway N-5. The possible routes of proposed NG pipeline are shown in Figure 4.8-4.12.

The pipeline from the ETPL LNG Jetty to the existing pipeline trestle of EVTL shall be on pipe supports. The pipeline within EVTL boundary limits shall be on sleepers and shall be approximately 2 kms.

The pipeline from Option 3 (Greenfield), Option 4 (existing EVTL jetty) and Option 5 (ETPL jetty brownfield site) shall not interfere with any mangroves or population centers. It raises minimum social and environmental issues and avoids the laying of pipeline in the sub-sea environment; it additionally is economically more viable than the others.

Table 4.2: Analysis of Mechanical and Hydraulic Dredging Alternatives

Mechanical Dredges	Sedimentation Rate	Material capable of being Dredged	Production Rate	Comments
Grapple Dredge	High	Very Soft Deposits	Low	Not suitable for hard materials
Dragline Dredge	High	Very Soft Deposits	Low	Not suitable for hard materials
Dipper Dredge	High	Hard Compacted Rock	Low	Inefficient use of scows for disposal of materials
Bucket Dredge	High	Clays, gravel and coarse materials	Low	High noise, high fuel consumption due to barges for disposal of dredged material
Backhoe Dredge	Moderate	Clays, gravel and coarse materials	Low	Compact size, can be equipped with turbidity controls
Hydraulic Dredges				
Hopper Dredge	Low	Loose sediments and unconsolidated sand	High	Disposal of dredged material may require dredging operations to be suspended
Cutter head Suction Dredge	Low	All alluvial materials, compacted deposits and rock-like formations	High	Not designed for heavy sea conditions, floating pipeline can deposit dredge spoils in disposal area



Figure 4.8: NG Pipeline – Alternate Route # 1 for Green Field



Figure 4.9: NG Pipeline – Alternate Route # 2 for Green Field



Figure 4.10: NG Pipeline – Alternate Route # 3 for Green Field



Figure 4.11 - RLNG Pipeline routing - Alternate Route # 4 - Existing Jetty

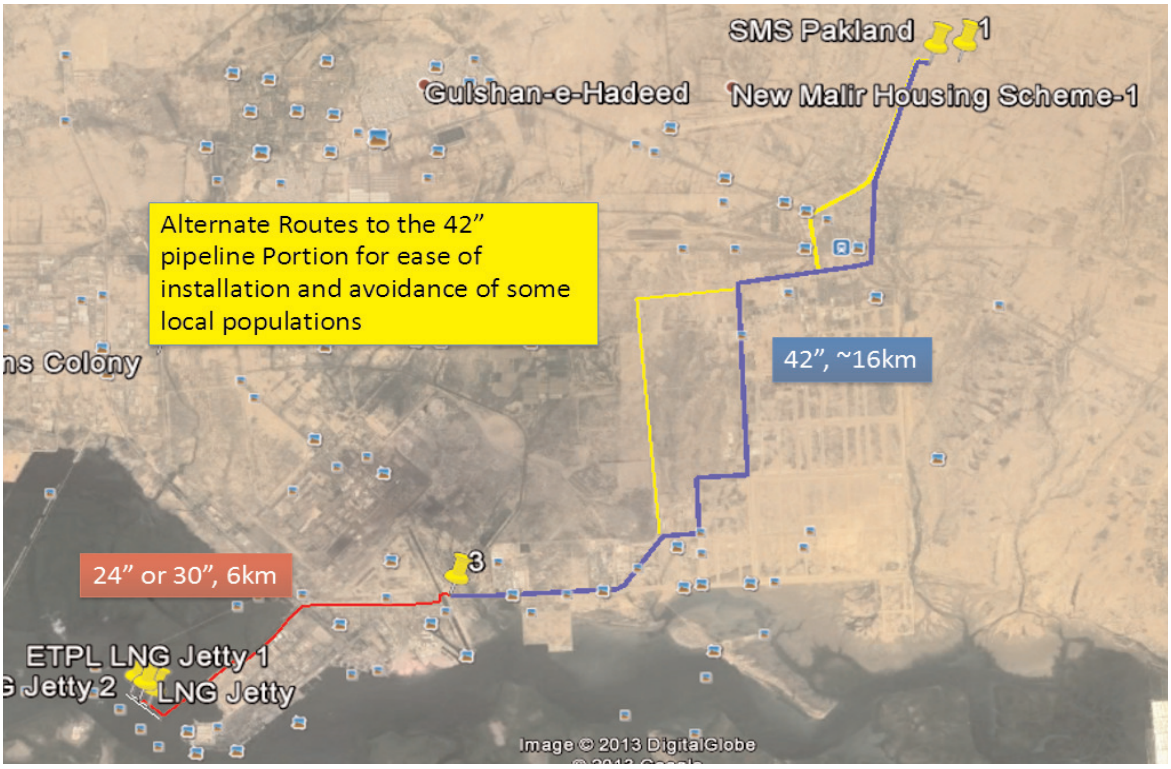


Figure 4.12 - RLNG Pipeline routing - Alternate Route # 5 - Brown Field

05 Description Of Physical & Biological Environment

This section describes the environmental setting of the project area. Baseline data reported here pertain to the physical, biological and socio-economic aspects of the macroenvironment as well as the microenvironment of proposed LNG Import Terminal site. The microenvironment i.e. the project site is a sub-component of the macroenvironment. The macroenvironment of the Project is the Port Qasim navigation channel while its hinterland extends from the Port area northward to the National Highway, and from Ghaggar Phatak on the east to Mehran Highway on the west. The Gharo Creek forms the microenvironment for the brown field site. Figure 5.1 shows macroenvironment of PQ.

Foundation stone of Port Qasim situated at a distance of about 45 km south-east of Karachi was laid on 25th August, 1973 by the then Prime Minister of Pakistan late Mr. Zulfiqar Ali Bhutto. Its inception was connected with the establishment of Pakistan Steel Mills situated in the same vicinity. Primarily, the purpose of this port was to facilitate and accelerate raw material imports of Pakistan Steel Mills. The planners also had in mind to expand the port to handle bulk imports so as to provide a sort of "load-shedding" at the Karachi Port.

This port is situated on the eastern coast of the country which has a mesh of numerous creeks interconnecting coastal area and high sea waters. One of these navigable



Figure 5.1: The Macroenvironment of Port Qasim

5.1 The Macroenvironment:

The main institutions that induced entrepreneurial potential in the macroenvironment of the LNG Import Terminal Project are Port Qasim Authority (PQA) and Pakistan Steel Mills (PSM).

creeks named "Phitti" was chosen to serve as approaching navigational channel to connect the open sea (Arabian Sea) with berthing site of Port Qasim. The channel runs along one of the many natural waterways that make up the historic Indus Delta. The channel was initially dredged in

1978 and is a total of 43.7 km long from Buoys Number 1 and Number 2 to the marginal wharf turning basin. The channel can be considered in three sections, namely:

i. The exposed Outer (Ahsan) Channel between the open sea and Bundal Island;

ii. The more sheltered Inner Channel from Bundal Island to the IOCB;

iii. The 'Reach' from the IOCB to the marginal wharfs.

*The depths currently maintained along the channel are shown in Table 5.1

Table - 5.1: Existing Channel Parameters *(Source: PQA)*

	Dredged Depth (m) (below CD)	Width(m)	Length(km)
Outer channel Buoy No. 1/2 to Bundal Island	14.7*	Varies from 200 to 250	15.1
Inner Channel Bundal Island to the IOCB	13.0	200-250	25.1
Reach Channel (IOCB to QICT-2)	13.0	Varies from 250 to 450	3.0
Turning Basin adjacent IOCB	13.0	600 diameter	-
Turning Basin adjacent QICT-1	12.5	450 diameter	-
Turning Basin adjacent MW 1-4	11.5	450 diameter	-
Turning Basin adjacent LCT	10.0	450 diameter	-
Berthing Basin IOCB	13.0	50 wide	-
Berthing Basin QICT-1	11.5	50 wide	-
Berthing Basin MW 1-4	10.5	50 wide	-
Service Jetty & its approaches	5.0	75 wide	-

The Iron Ore and Coal Berth (IOCB), commonly known as "steel jetty" was the first berthing place which was completed by 1980 to receive the first ship in the last week of September, 1980 carrying iron ore for Pakistan Steel Mills. Simultaneously, four berths were also constructed on the marginal wharves. The number of berths on the marginal wharf was then increased from 4 to 7. In the early days of its operation the port was considered to be meant for handling bulk imports such as wheat, cement, fertilizers, coal, machinery/plants and raw material for Pakistan Steel besides export of rice etc. in bulk. The National Highway which is about 10 kilometers from the main port provides the mean of ready link between port and upcountry destinations.

Till 1980s the frequency of shipping activities remained low at Port Qasim. Port's future operational plan, however, had provision for the establishment of various storage and manufacturing sites in the area. Since early 1990s, the site caught the attention of private sector and investment started in the area this resulted in establishment of some sizeable storage sheds and manufacturing/processing units. This includes three car manufacturing units and a couple of edible oil refineries plus large scale chemical and fertilizer plants are operating in full swing in the Industrial Area of the Port. It was during this period that a number of bulk oil terminals were also established inside the port area. Establishment of these industrial / storage units brought a revolutionary upward trend in the shipping activities at Port Qasim. The berthing and cargo handling facilities at Port Qasim were accordingly modernized.

The Karachi coastline between Korangi creek inlet and Kadiro Creek encompasses coastline of three islands; Bundal Island, Buddo Island and Khiprianwala Island and two large and deep openings towards the sea viz. Phitti Creek Mouth (Approach channel of Port Qasim) and the Kadiro Creek Mouth. The eastern coast has tidal creeks

with mangrove and mudflats which are linked with a network of creeks of Indus Delta. The sea bed at the eastern and south eastern coast is generally smooth and regular as depicted by the bed contours. The land slope is gentle, usually being in the order of 1/500 to 1/1000.

PQA has adopted its Environmental Management Plan in view of the environmental hazards inherent in the handling of liquid cargo including oil and molasses and other hazardous materials. It has been able to avoid what could have been certain eco-disasters. Such facilities and contingency plans are, according to information available, an integral part of the facilities at the oil terminal.

5.1.1 Port Development Status

All development projects at the port are being undertaken in private sector on BOT basis without costing a penny to PQA. Foreign Direct Investment (FDI) to the tune of US$ 1.22 billion is expected over a period of five years through development projects at the port.

1) Liquid Cargo terminal (LCT)

Liquid cargo Terminal, with handling capacity of 4 million tonnes per annum, has been developed through joint venture of by M/s Felda, Westbury and Qasim (FWQ). LCT has been formally inaugurated on 14th August 2009.



Figure 5.2: The Liquid Cargo Terminal in Port Qasim

2) 2nd Container Terminal

2nd Container Terminal is being developed by DP World at a cost of US$ 300 million with handling capacity of 1.175 million TEUs per annum. The Terminal is likely to be completed in 2011 recently.



Figure 5.3: The 2nd Container Terminal in Port Qasim

3) GasPort LNG Floating Terminal

To meet the energy demands, an LNG Floating Terminal is being developed by M/s GasPort at a with handling capacity of 3 million tonnes per annum. The terminal has yet to commence construction

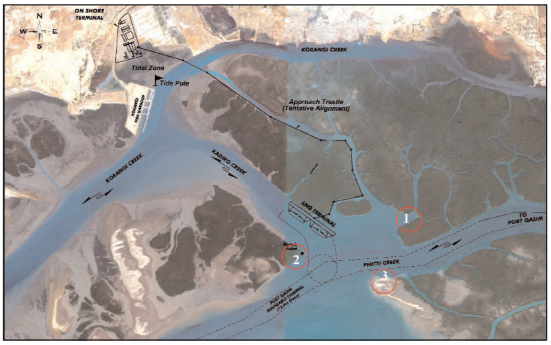


Figure 5.4: Location of proposed Gasport Terminal

4) Grain & Fertilizer Terminal

A specialized Grain & Fertilizer Terminal developed by M/s Fauji Akbar Portia at a cost of US$ 135 million with handling capacity of over 4 million tonnes per annum has



Figure 5.5: Grain and Fertilizer Terminal in Port Qasim

been formally inaugurated by Prime Minister of Pakistan on 26th October 2010. This terminal was created by reclaiming 22 acres of water and has a 300 meter long jetty.

5) Coal, Clinker & Cement Terminal

A dedicated Coal, Clinker & Cement Terminal is being undertaken at a cost of US$ 180 million with handling capacity of 8 million tonnes per annum with a storage capacity of 0.9 million tons. An Implementation Agreement has been signed on November 6, 2010 with PIBT (Pakistan International Bulk Terminal). The Terminal would be country's first dedicated dirty bulk cargo handling facility and is expected to become operational within next three years.

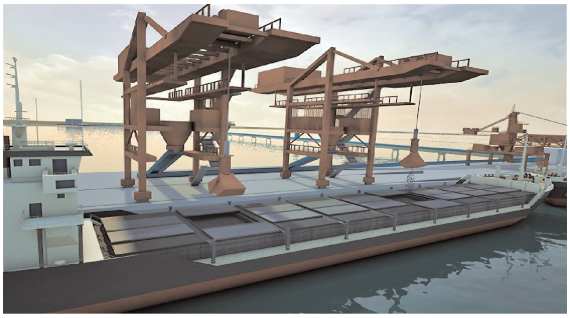


Figure 5.6: Proposed Coal, Clinker and Cement Terminal

6) LNG Terminal by Granada

An LNG Terminal was planned to be developed by Granada group of Companies at a cost of US$ 274 million with handling capacity of 3.5 million tonnes per annum.



Figure 5.7: Proposed LNG Terminal by Granada

7) 2nd Oil Terminal

To handle increased volume of POL imports, a second Oil Terminal is planned to be developed at a cost of US$ 51.4 million with handling capacity of 9 million tonnes per annum.

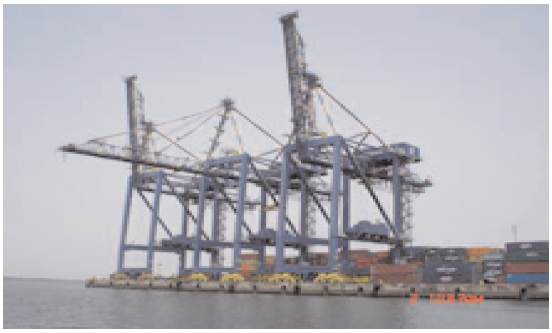


Figure 5.8: 2nd Oil Terminal in Port Qasim

The Terminal is expected to be completed by 2012. Technical & Financial proposals are currently being evaluated.

8) 2nd Steel Jetty

To handle increased volume of Pakistan Steel Mills and to accommodate Al-Tuwairqui Steel Mills imports, a second Iron Ore & Coal berth is planned to be developed at a cost of US$ 150 million with handling capacity of 8 million tonnes per annum. Outsourcing of the terminal is under active consideration. The development of the Terminal will be linked with Pak Steel Expansion program.



Figure 5.9: 2nd Steel Jetty in Port Qasim

9) Deepening of Navigation Channel

The project of Deepening & Widening of navigation Channel is crucial for PQA. PQA plans deepening of navigation channel for all weather 14 meter draught vessels at a cost of US$ 200 million on Design, Construct and Finance basis. The project has Government approval and is in the bidding process.

10) Infrastructure Development Projects

Besides capacity building projects, PQA is equally concerned

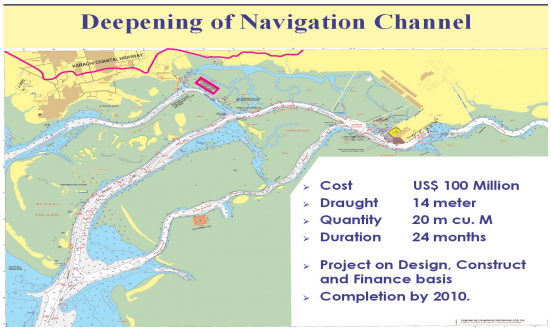


Figure5.10: Project for Deepening of Navigation Channel

for provision of infrastructure facilities in its industrial zones to gear up development of port based industrial and commercial activities, to facilitate the traffic flow PQA plans construction of 26 KM long Dual Carriageway from National Highway T-junction passing through PQA commercial areas (Western Industrial Zone and Eastern Industrial Zone), ending at Sassui Bridge Ghaghar Railway Crossing including up-gradation of Main Access Road and construction of two flyover on BOT basis at the estimated cost of Rs. 6.00 billion.

PQA has also awarded contract for development of Infrastructure facilities i.e. Roads, Water Supply, Sewerage and Drainage in Eastern Industrial Zone to FWO and NLC at the cost of Rs. 8.88 billion and work in progress.


Figure 5.11: Infrastructure Development Projects in PQ

11) ENGRO VOPAK TERMINAL LTD

The terminal has been developed to cater for liquid chemical imports by Engro Chemical Pakistan in collaboration with Vopak of Netherlands, on BOT basis, at a cost US$ 115 million. Operational since January 1998, the terminal can accommodate 75000 DWT class vessels with designed capacity of 4 million tonnes per annum. Engro Vopak Terminal Limited at present has total capacity of 82400 cbm it


Figure 5.12: Engro Vopak Terminal Limited

comprises of 10 mounded bullets, 2 spheres and 9 tanks.

12) TEXTILE CITY

To enhance production and export of value added textile products, GOP plans setting up a "Textile City" on 1250 acres in the Eastern Industrial Zone of PQA. PQA has handed over possession of 1250 acres of land. 5% leveling/Grading work completed - Combined Effluent Treatment Plant-Consultant appointed. Road/water Work to be commenced in June 09. LOI for establishment of 250WM power Plant in June 09. Environment Impact Assessment approved. This would not only facilitate vendors and suppliers of raw material and emergence of downstream and support industries but would also create immense employment opportunities as a result, during construction and operation phases besides earning valuable foreign exchange for the country.


Figure 5.13: Development of Pakistan Textile City Project in Port Qasim

5.1.2 MAJOR INDUSTRIAL AND COMMERCIAL PROJECTS

Some of the major Industrial and Commercial Projects

developed at PQA are:

1) KESC Thermal Power Plant

The plant spread over an area 223 acres of land with 1260 MW power generation capacity has been developed at a cost of Rs.1.4 billion and is operational since 1984.

2) Indus Motors Automobile Plant

Developed through joint venture between Toyota Company of Japan and House Habib is of Pakistan at a cost of US$100 million over an area of 105 acres of land, the plant is operational since 1993.

3) Engro Polymer Chemical Ltd

The plant developed over an area of 30 acres of land at a cost of Rs.560 million to produce PVC and is operational since 2002. It has recently expanded its capacity and also produces caustic soda and chlorine

4) PPTA Plant

Operational since 1998 with designed capacity of 0.43 million tonnes of annual productions, the plant is spread over an area of 150 acres and has been completed at a cost of US$ 500 million.

5) Bin Qasim Fertilizer Plant

Developed by Fauji Foundation of Pakistan over an area of 350 acres of land at a cost of US$ 370 million, the plant is operational since 1998.

6) IFFCO Pakistan

The refinery is developed over an area of 15 acres at a cost of US$ 34 million, integrated with its bulk oil terminal. It is operational since 1993 and has manufacturing capacity of 0.4 million tonnes per annum.

7) BOC Gases, UK

Established over an area of 10 acres of land, the plant has been developed at a cost of Rs.1.25 billion production hydrogen gas, nitrogen gas etc. The plant is operational since 1998.

8) Engro Chemicals (NPK Plant)

The facility has been developed over an area of 30 acres of land at a cost of US$ 81 million to produce fertilizers of various types and has been operational since 1999.

9) Mapak Edible Oil Refinery

The refinery has been developed at Port Qasim through joint venture of Malaysia and Pakistan with a refining capacity of around 0.4 million tonnes per annum at a cost of US$ 20 million. The plant was commissioned in 2006.

The Project macroenvironment extends over the administrative district viz. #17 Bin Qasim, Union Councils, UCs: Ibrahim Haidery, Rehri, Gulshan-i-Hadeed and Ghaggar. Geographical area of the macro-environment extends from the Korangi Creek on the west and along UC Ibrahim Haidery, Rehri, Chashma Goth, Korangi Fish Harbour, the deep sea fish harbour and salt works along the coast, Lath Basti, Juma Goth in the north; the FOTCO Jetty and Port Qasim Industrial Area in the northeast; the Steel Mills in the far east, and the large mudflat covered by mangroves forest in addition to the navigation channel of Port Qasim in the south.

5.2 Natural Environmental Baseline

5.2.1 Topography

The project area is located in Karachi that is part of a major synclinorium stretching from Ranpathani River in the east to Cape Monze in the west; Mehar and Mol Jabals (mountains) in the north, and the Arabian Sea in the south. The rock units just mentioned have been folded to form anticlinal hills and synclinal valleys, with moderate to gentle dips. The fold axes run approximately north-south.

Structurally the area may be divided into two zones: 1) the zone that lies to the east and northeast and is characterized by relatively more intense folding and faulting, with rocks ranging in age from Paleocene to Oligocene also exposed in this section, 2) the zone that is located in the centre and to the west and southwest and comprises the large area, which opens southwards and largely consists of horizontal or near horizontal strata which form gentle structural undulations in the form of synclines and anticlines with low dips of 2 to 6 degrees (rarely up to 10 degrees). These folds have a general

southward plunge direction. These structural features clearly indicate that the structure of the Gaj basin (Khadeji basin) is more suitable for the accumulation and storage of ground water by virtue of more extensive recharge zones, locations of probable groundwater aquifers at shallower depths and several shallow synclinal structures.

A number of structures such as Pipri, Gulistane Jauhar, Pir Mangho and Cape Monze are exposed within the synclinorium. The presence of concealed structures under the Malir River Valley, Gadap and Mauripur plains can be deduced reasonably. The potentials of rock aggregates, sand, glass sand, lime stone and clay are being gainfully utilized. Gulistane Jauhar members of the Gaj Formation offer ground water potential but the same finds limited use.

Sub-Recent and Recent Deposits

Alluvial Deposits: Alluvial deposits are present mainly in flood basin and streams; they consist of poorly sorted, unconsolidated/loose gravels, sand and slit.

Stream bed Deposits: These deposits consist of material brought down by streams and laid down in their channels comprising loose fine to coarse sand, gravels, pebbles and boulders.

Piedmont and Sub-piedmont Deposits: The sub-recent deposits in the area have been mapped as un-differentiated piedmont and sub-piedmont deposits consisting of loosely packed boulders, cobbles, pebbles and coarse to fine stand.

5.2.2 Climate

The coastal meteorology and hydrography of Karachi is controlled by the seasonal change in the north Arabian Sea viz. monsoon system. The data collected for a number of studies along the Karachi coast show the influence of NE and SW monsoon winds. The meteorological conditions in the area around Port Qasim are characterized by generally hot and relatively humid conditions especially in the summers (April to October) when the prevailing wind is from the south west. The south west monsoon brings humid air in from the sea, but the rainfall is generally very low with nearly 80% of the 265mm of rain falling from July to September. Rainfall, when it does come is often torrential causing problems of drainage and erosion of the light and sparsely vegetated land.

The winters are short and mild from December to mid-February with the prevailing wind coming from the northeast with very little rainfall. The most important characteristics of the prevailing meteorological conditions are the generally high dusty conditions as a result of the aridity of the surrounding area; dust storms occur especially during the summer as well as winter monsoons. The higher winds during the south west monsoon tend to carry any air-borne contaminant inland during the summer months. In winter the winds tend to be light to moderate in intensity.

The LNG Import Terminal Project will be located in the coastal zone that has a relatively mild climate, characterized by dry, hot and humid conditions. There is minor seasonal intervention of a mild winter from mid-December to mid-February into a long hot and humid summer extending from April to mid-September.

Variation of climatic parameters during the past few years is described hereunder:

5.2.2.1 Temperature

The air temperature in the coastal area of Karachi City is generally temperate throughout the year. During winter the range of variation of temperature is large for Karachi coast especially with respect to maximum and minimum temperatures. The air temperature for Karachi has an average annual range of ~6°C to ~42°C. The highest temperatures (40°C or above) occur in May, June and October. During SW monsoon in July and August the temperature is relatively moderate due to cloud cover but humidity remains high (~70%). The mean monthly maximum and minimum temperatures recorded during the last nine years at Karachi Airport Meteorological Station of Pakistan Meteorological Department are given in the Tables 5.2 and 5.3.

The above Tables and Figure 5.14 indicate that the mean monthly maximum temperature in Karachi ranged between 32.0°C and 33.0°C during the 2001-2009 periods, while the mean monthly minimum temperature ranged between 21.0°C

Table 5.2: Mean Monthly Maximum Temperature °C

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2001	27.2	29.6	33.1	34.6	35.1	34.9	32.2	32.3	33.1	36.0	33.5	30.4	32.7
2002	27.0	28.2	33.3	35.4	35.6	35.1	32.2	31.6	31.4	36.5	32.7	28.1	32.3
2003	27.6	28.5	32.4	36.6	35.7	34.9	34.1	32.6	32.5	37.0	32.2	28.3	32.7
2004	26.6	29.9	36.2	35.4	36.8	35.6	33.8	32.7	32.8	33.7	33.1	29.4	33.0
2005	24.9	26.3	31.5	35.3	35.4	36.0	33.2	32.2	34.2	35.2	33.1	28.4	32.1
2006	26.0	31.3	31.8	34.0	34.6	35.3	33.8	31.0	34.2	35.0	33.4	26.3	32.2
2007	26.9	29.4	31.4	37.7	36.0	36.4	N/A	N/A	N/A	N/A	N/A	N/A	33.0
2008	24.4	26.9	34.3	34.4	33.9	35.1	33.5	31.9	34.7	35.5	32.5	27.2	32.0
2009	26.2	29.8	33.0	36.0	36.8	35.7	34.5	33.0	32.8	35.9	33.0	28.6	32.9

Source: Pakistan Meteorological Department

Table 5.3: Mean Monthly Minimum Temperature °C

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2001	11.5	14.9	19.6	23.8	28.1	29.0	27.1	26.5	25.9	24.4	18.6	15.8	22.1
2002	12.8	13.8	19.5	23.9	27.0	28.2	29.6	25.6	24.8	22.5	17.7	14.9	21.7
2003	12.7	16.9	19.8	24.2	26.5	28.2	23.6	27.0	25.3	20.9	15.2	12.0	21.0
2004	12.9	14.5	19.1	24.8	27.3	28.8	27.5	26.3	25.3	22.4	18.0	15.4	21.9
2005	12.3	11.3	20.3	23.0	26.4	28.3	27.2	26.6	26.6	22.9	18.9	13.0	21.4
2006	11.7	18.1	19.6	24.5	27.5	28.5	28.3	26.3	26.8	25.7	19.4	14.0	22.5
2007	13.0	17.3	19.7	24.7	27.6	28.6	N/A	N/A	N/A	N/A	N/A	N/A	21.8
2008	10.1	11.1	19.6	24.0	27.3	29.1	27.9	26.8	26.6	23.8	17.6	14.9	21.6
2009	14.7	16.5	20.8	23.8	27.6	28.7	28.1	27.5	26.5	22.6	17.0	13.9	22.3

Source: Pakistan Meteorological Department

and 22.5°C. The mean maximum and mean minimum temperature during 1991-99 period were 32.2 °C and 20.9°C, which indicates that there has been a slight but significant rise in the mean minimum temperature during the last 20 years.

5.2.2.2 PRECIPITATION

The mean relative humidity in summer is 60-70% while the mean relative humidity during winter is 25-30%. The rain fall in the Karachi coastal zone is extremely low and erratic; accordingly this region falls in the semi arid climatic zone. Table 5.4 shows the last nine years precipitation data recorded at Karachi Airport station.

The 9-years record for rainfall of PMD at Karachi Airport (2001-2009) suggests that July and August are the wettest months and that the maximum rainfall recorded in Karachi during 2001-2009 period was 270.4 mm during the month of July 2003, while the maximum annual rainfall was 324.9 mm

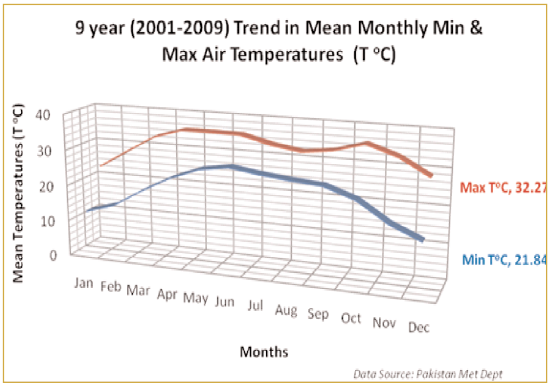


Figure5.14: 9 year trend in Mean Monthly Min & Max Temp

during the year 2003, followed by 301 mm in 2006 and 279.9 mm in 2009. The wet years followed a 3-year cycle during the first 9 years of the New Millennium. The year 2010 seems to be among the wettest years since Karachi City had witnessed more than 5 spells of 50 mm each during the month of July, three major spells of 60 to 100 mm in August and two spells of

Table 5.4: Monthly Amount of Precipitation (mm) at Karachi Air Port

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2001	0.0	0.0	0.0	0.0	0.0	10.6	73.6	16.2	N/A	0.0	0.0	0.0	100.4
2002	0.0	2.4	0.0	0.0	0.0	N/A	N/A	52.2	N/A	0.0	0.5	0.4	55.5
2003	6.4	21.8	0.0	0.0	0.0	16.3	270.4	9.8	N/A	0.0	0.2	0.0	324.9
2004	13.7	0.0	0.0	0.0	0.0	N/A	3.0	5.6	N/A	39.3	0.0	4.3	65.9
2005	6.6	12.8	N/A	0.0	0.0	N/A	N/A	0.3	54.9	0.0	0.0	17.1	91.7
2006	N/A	0.0	N/A	0.0	0.0	0.0	66.2	148.6	21.9	0.0	3.1	61.3	301.1
2007	0.0	13.2	33.4	0.0	0.0	110.2	N/A	N/A	N/A	N/A	N/A	N/A	156.8
2008	8.0	Trace	1.1	0.0	0.0	0.0	54.0	37.5	Trace	0.0	0.0	21.0	121.6
2009	3.0	Trace	0.0	Trace	0.0	2.6	159.9	44.0	68.9	0.0	0.0	1.5	279.9

Source: Pakistan Meteorological Department

25 and 10 mm each in the month of September.

Karachi was facing drought conditions in the past and rainfall was erratic at around 50 mm for three years followed by wet spells every third year. The average of two decades (70s and 80s) shows that rainfall varies between 150 and 250 mm during the years. For Karachi the average number of rainy days / year is less than ten. However, most of the precipitation usually takes place within a short spell of 2 to 7 days. About 50 to 65 percent of the total annual rainfall occurs during July and August while the southwest monsoon is on, another 15 to 25 percent of the annual rainfall occurs during NE monsoon in winter months (December - February). The rest of the rainfall occurs in the form of occasional cloud burst.

5.2.2.3 WIND SPEED AND DIRECTION

The meteorology of Karachi is controlled by the seasonal changes in the north Arabian Sea. In summer, Southwest monsoon prevails with wind force ranging between 3.8 m/s and 14.1 m/s on account of low pressure prevailing over most of Balochistan - Sindh - Punjab region that forms the heat zone. Heavy storms of severe intensity are rare but strong gusts of winds take place abruptly due to changes in atmospheric pressure. The wind blows throughout the year with highest velocities during the summer months (from June to August), when the direction is southwest to west with wind speed exceeding 40 km/hr (22 knots) for about 71% of the time. Inter-monsoon transitions occur from October to November and March to May. The wind direction and speed between the summer and winter monsoon seasons are rather unsettled and large variations are noted both with respect to speed and direction. During winter or the northeast monsoon (from December to March), winds blow from northeast and north, shifting southwest to west in the evening hours, with wind speed exceeding 20 km/hr (11 knots) only for 12% of the time. The strongest winds with

Table 5.5: Wind Speed (m/s) at 12:00 UTS

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2001	2.6	3.4	4.3	5.6	7.5	8.1	6.8	7.3	5.5	3.7	2.0	2.4	4.9
2002	3.6	3.9	4.0	6.5	8.5	8.2	9.8	7.3	7.7	3.3	2.9	3.2	5.7
2003	4.0	5.0	5.4	5.2	7.7	8.8	6.7	7.1	6.0	3.2	3.1	3.0	5.4
2004	3.4	3.7	4.0	6.0	8.0	9.0	10.0	9.5	7.3	3.8	1.0	2.5	5.7
2005	3.6	4.2	4.8	5.1	7.1	7.5	9.0	6.9	6.4	3.9	2.0	1.5	5.2
2006	2.0	3.0	3.0	6.2	8.0	7.7	8.3	6.2	4.7	4.2	2.2	3.0	4.9
2007	2.0	3.7	4.0	4.0	6.0	6.3	N/A	N/A	N/A	N/A	N/A	N/A	4.3
2008	4.3	7.6	8.2	10.5	12.6	7.6	11.0	9.3	8.7	6.6	5.1	3.9	7.9
2009	7.0	7.2	7.9	9.3	9.8	9.7	9.5	9.3	9.1	6.1	5.0	3.9	7.8

Source: Pakistan Meteorological Department

Table 5.6: Wind Direction at 12:00 UTS

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	S54W	S43W	S42W	S45W	S46W	S45W	N52W	S59W	S44W	N56W	S45W	S06W
2002	S67W	S52W	S51W	S55W	S51W	S42W	S54W	S45W	S48W	S56W	N54W	S41W
2003	S60W	N50W	S45W	S48W	S45W	S68W	S60W	S47W	S43W	S54W	S50W	S27W
2004	N27E	S46W	S53W	S49W	S52W	S54W	S54W	S62W	S56W	S47W	S45W	N86E
2005	N63E	S51W	S50W	S52W	S63W	S48W	S54W	S49W	S87W	S54W	S52W	N23W
2006	S48W	S62W	S50W	S57W	S64W	S60W	S67W	S78W	S51W	S53W	S49W	N79E
2007	S30W	S62W	S47W	S55W	S58W	S47W	S41W	S55W	S60W	S48W	S48W	N45E
2008	N45E	S47W	S54W	S51W	S52W	S39W	S50W	S52W	S46W	S39W	S38W	N
2009	N45E	S45W	S41W	S58W	S46W	S46W	S56W	S49W	S56W	S42W	S39W	S45E

Source: Pakistan Meteorological Department

velocities greater than 40 km/hr (22 knots) blow only for 1% of the time. The wind usually carries sand and salt resulting in severe erosion and corrosion.

The nine years wind velocity record (2001-2009) indicates that the velocity varies and ranges between 2.6 m/s to 12.6 m/s. The Tables 5.5 and 5.6 show the wind speed and direction respectively.

5.2.2.4 HUMIDITY

Being on the coastline, the humidity level in Karachi generally remains high throughout the year. Annual range is from 50% (December, driest month) to 85 % (August, most moist month). The Table 5.7 describes typical variation of humidity during the year 2006.

5.2.2.5 VISIBILITY

Visibility depends on weather conditions such as fog, haze, rainfall and dust storms also to a certain extent on the amount of particulate matter present in the ambient urban atmosphere. Visibility in Karachi generally ranges up to 10 nautical miles. Haze generally prevails in the morning, which clears by noon. In SW monsoon period however, the visibility is reduced to about 2 to 5 nautical miles with sky mostly overcast while in NE monsoon sky is clear but the visibility is occasionally less than 1 nautical mile due to dust storms that frequent a large area of Balochistan. The hanging dust takes time but the fog dissipates by afternoon. This occurs less than 3 to 4 days a month in winter.

5.2.3 REGIONAL GEOLOGY & GEOMORPHOLOGY

5.2.3.1 MORPHOLOGY OF THE INDUS RIVER SHELF

In natural conditions, the Indus River had one of the largest sediment loads in the world, building an extensive delta on the high energy coast of the Arabian Sea. However, water and sediment discharge have been drastically altered in the Indus since the early 1960s, when several barrages were built along the river to feed the world's largest irrigations system. A digital terrain model based on detailed 19th century surveys has been constructed to assess the morphology of the Indus shelf.

Table 5.7: Relative Humidity data of Karachi

Month	Relative Humidity (%)	
	AM	PM
January	63	3.6
February	72	6.4
March	79	8.3
April	87	4.9
May	88	0.0
June	86	3.9
July	28	64.4
August	90	44.8
September	89	22.8
October	83	0.3
November	68	1.7
December	64	4.5

Source: Pakistan Meteorological Department

Comparison of the digital terrain to a 1950s Pakistani Bathymetric Survey allowed an estimation of the natural sedimentation regime before extensive human induced changes. Digital analysis of the Indus delta coast line based on satellite imagery was used to explore the effects of the drastic decrease in sediment delivery following extensive dam building.

The Indus canyon is a dominant feature of the region dissecting the shelf to with in 20m water depth and 3.5km of the coast. Theoretical considerations based on estimated of the relative important energy vs fluid sediment delivery suggests that the Indus delta should develop a mid shelf subaqueous clinoform, the Indus shelf exhibits a compound clinoform morphology. A shallow delta front clinoform extends along the entire delta coast from the shoreline to the 10 - 25m water depth. A mid shelf slinoform developed probably as a prodella clinoform between 30 and 90 m water depth. The advanced position of the mid shelf clinoform east of the Indus canyon might reflect either reflect either a prolonged sediment delivery from the Indus River in that area compared to the shelf west of the canyon or the presence of a relict pre Holocene and mid shelf delta. A distinct lobe of the mid shelf clinoform developed along the kutuch (kachchh) coast probably as sediment advected alongshore was redeposited on the mid shelf by strong as sediment advected offshore directed tidal currents in the gulf of Kutch Mouth.

Accumulation and erosion between 1895/96 and 1952/54 occurred primarily on the delta front clinoform, but also on the prodelta clinoform sector covered by both the surveys. During the time period, at the active Indus mouths, the delta front clinoforms has built directly into the Indus Canyon, where sedimentation rates exceeded 50 cm/year. A sediment budget for the shelf for the 1895/96-1952/54 period suggests that the previous estimate of an Indus sediment discharge rate of 250 million tons per year in natural conditions is probably a minimum estimate. For the same interval, the shore line advanced along most of the delta coast. The progradation rate at the active mouths along the central delta coast surpassed 100m/year. Following the 80% reduction in sediment discharge after the 1950s, the deltaic shore line along the central delta coast started to recede at average rates of ~ 50 m/year. The abandoned delta shore (south eastern and north eastern sectors of the delta coast) remained largely progradational over the same period, with the south western sector prograding over the same period, with the south eastern sector prograding at an even greater rate than before. The differential behavior of the delta shoreline suggests a significant role for delta front sediment transfer processes in the evolution of abandoned deltaic coast.

5.2.3.2 General Site Conditions

Phitti - Gharo creek system is the largest amongst the group of creeks developed on the western parts of the Indus delta formerly the delta of the Indus river. Phitti Creek is connected to a system of creeks including Jhari, Kadiro, Korangi and Gharo Creeks. Some smaller creeks branch of these major creeks forming a big network of the Indus delta. This network of creeks is a very sensitive ecological area of the delta and has all the characteristics of the deltaic behavior. A chain of small Islands such as Bundal, Buddo, and Khiprianwala are off shoots of Indus Delta formation system and are either sand banks or swamps partially submerged at high tide. Extensive vegetation of mangrove also exists. The islands are mostly flat and swampy.

The main creek is a tidal channel with mangroves and mud flats. The coastal land forms of beaches, sand bars, tidal flats and mangrove swamps are the result of erosion/deposition activities of tidal currents and sea waves. Sand dunes of varying heights along the shoreline are major topographical features displaying typical characteristics of semi desert. Surface soil is dry and loose, which remains subjected to wind erosion and transportation. There is a wide sand bar with shallow depth at the mouth of the creek.

Configuration of the coast line of Phitti - Gharo Creek system and its environs are erratic due to the deltaic formation where sea boundary cannot be defined. Sand formation is brown in color and the grain size ranges from fine to medium. Normally sand thrown by sea waves on the coast are carried inwards, work-up into dunes by wind action. Beach and sea bottom material in the vicinity of Phitti mouth is predominantly composed of Micaceous, very well sorted fine

sand. Acoustic images suggest fine to medium grained homogenous seafloor material, most probably clay/silt and fine sand etc.

Compaction is moderate with shrub growth. Beach deposits vary from very fine soft grey clay sediments to round pebbles. Coastal morphology and the historical data of Indus delta indicate that Buddo, the arch shape island evolved about 50 to 160 years back, has now eroded again. This island acted as a protective sand barrier for Bundal and Khiprianwala Islands but now they are exposed to the high-energy waves and tidal currents especially during SW monsoon. Sediments in suspension in the channel were observed to be variable with respect to NE and SW monsoon intensity.

A general geotechnical survey record indicates that the Port Qasim area is mainly composed of grey sand or friable sand stone, grey to brownish clay inter-bedded with brown, medium to coarse sand and assorted gravels of various sizes poorly cemented to form a mass like conglomerate.

Tectonically, the Indus zone is moderately active. Tidal wave generated due to an earthquake in Karachi (1945) gave a surge of about 4m in the shape of Tsunami. Low rise in tide was due to the coincidence of Tsunami rise with ebb tide. The effects of 2005 Tsunami in the Indian Ocean, which ravaged Indonesia and Sri Lanka, was very low in Port Qasim Area. However, geologically and seismically the area remains prone to these activities.

Within Karachi area, only the middle and upper Tertiary are represented. Nari beds of Oligocene system for the lower most our crops. These are over lain by Miocene Rocks, the Gaj formation of Late Miocene and Lower Mancher of Early Miocene age. The Upper Mancher are included in Pliocene System, which is better developed in Makran.

Quaternary deposits are represented by conglomerates, which uncomfortably overlie the Mancher rocks and slightly over lap on the Gaj formation of comparatively recent origin that is made up of alluvial sand and gravels, windblown material and other shore line deposits.

General sub soil conditions of the Approach Channel are described as homogenous formation of dark grey very fine micaceous sand (75 to 125 microns) exists below the seabed. Relative density is the range of 40% to 65% which may be termined as medium dense state of compactness. Channel along Bundal Island shows a uniform stratum of dark clay silt. Overlaying sand-layers have generally medium dense compactness. The underlying clay stratum appears to be very stiff to hard.

Geological investigations for the Bin Qasim area suggest the presence of only middle and upper tertiary rock formations comprising fresh, and slightly weathered recent and sub-recent shoreline deposits. Principal constituents of the deposits are the inter-bedded sandstone and shale together with subordinate amounts of large sized gravels or conglomerate

The creek area is covered with mudflats supporting mangrove vegetation and does not exhibit much geological and pedagogical diversity. The information, as per geologic survey of Pakistan, reveals that in the project area and in its adjoining areas only the middle and upper tertiary formations are present. The formation found in the area is fresh and slightly weathered, recent and sub recent shore line deposits. These deposits are derived from Gaj/ Manchar formations of lower Miocene to middle Miocene/Upper Miocene to Pliocene age. Similar deposits are found all along the coastal belt of Karachi and adjoining areas. The seabed is predominantly sand and silt while the sediment of the delta is fine grained and resembles the soil from the continental shelf at the mouth of the Indus delta. The gravels or conglomerates are poorly transfixed with medium to coarse brown sand and are derived from Manchar formations of Pleistocene age. The Gaj formation consists of mostly limestone with sub ordinate shales and sand stones. The limestone is hard, sandy and extremely and fossilforus, this formation over lies nari formation which consists of harder lime stones beds and shales, conformably overlying Gaj formation is Manchar formation. Similar Manchar formation exists all along the coastal areas of Karachi and thus exposed in Clifton, Ibrahim Haidery, ghazi, orange and land areas. This formation is composed of sand stone, clay bed, cemented sand and grave (pseudo conglomerate). Sand stone is thick, porous and friable and also contains bands of conglomerate. The clay has various colors including grey, brown chocolate and orange, however the most widely occurring clay are of light brown and

dark grey in color. Sandy layers are also found inter bedded with clay and gravel

The mud flats are recent deposits of delta are while soil cover is the drift type that has been slightly withered with time and marine activity, it seems to have been transferred with the flood flow from malir rivers from the west and Indus from the east.

5.2.4 SEISMICITY

Karachi is situated close to the junction of three tectonic plates (Indo-Pakistan, Arabian and Eurasian Plates). The earth hazard in the Indus Delta and the estuaries of the passive continental margin is mainly from the intra-plate active faults, principally the Rann-of-Kutch Karachi Fault (also known as Karachi-Jati-Allah Bund fault), the Pab-Null Fault and their respective strands. The Rann-of-Kutch Fault passes close to the Eastern industrial Zone of Port Qasim.

Karachi coast has three other segments namely the Jhimpir fault, the Pab fault, and the Surjani fault. These are the intra-plate active faults that pose major earthquake hazard in the Indus delta and the estuaries of the passive continental margin. The orientation of the Rann of Kutch fault is roughly east-west; it is 225 km in length and is responsible for the production of earthquakes of considerably high magnitude of up to 7.6 M on Richter scale and of IX to X intensity on the Modified Mercali (MM) scale. The Pab fault on the other hand is 135 Km in length and is oriented north-south. On the basis of the study of the seismic potential of the active faults viz. Rann of Kutch and Pab faults over their entire length, along with analysis of historical and instrumental records of the Pakistan coastal zone the risk factor for this region is estimated to be 7.7 to 8.2 M for the former and 7.2 to 7.8 M for the later.

The Geological Survey of Pakistan has, however, defined the area of Port Qasim, where the site under study is located, to fall in a Seismic Zone 2B region. This suggests the possibility of moderate to major seismic hazard i.e. probability of earthquakes of intensity VI to VIII MM scale and 5.6 to 6.6 on Richter scale. From the charts published (such as figure 5.15), the peak ground level acceleration (PGA) for this zone is 28%. The seismic risk factor of 0.3 is advisable and will need to be incorporated in the design for constructions and installations in the coastal zone, for operational basis earthquakes (OBE) pertaining to damage due to moderate level earthquakes (MM-VI to VIII). The seismicity in the Karachi and at Project site is considered to be low. According to the published data the Project area lies in zone of low seismic activity, with

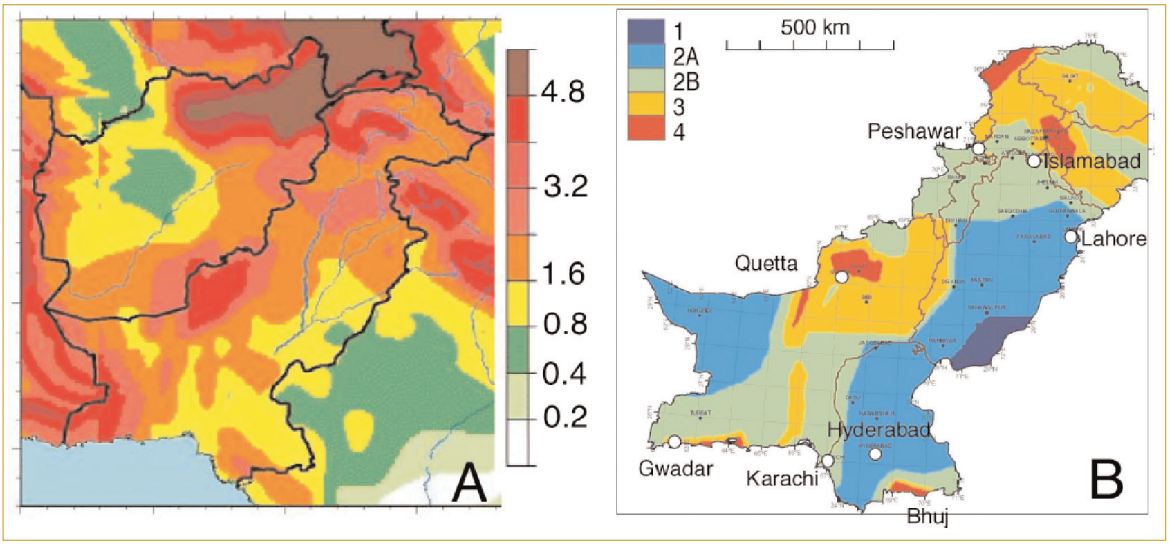


Figure 5.15:(A) GSHAP hazard map of Pakistan (Giardini et al. 1999; color scale indicates peak ground acceleration (m/s/s) with 10% probability of exceedance in 50 years) compared to (B) a recently revised hazard map following the 2005 earthquake (working group on Pakistan Hazard 2006; zonation 4 is most hazardous, 1 is least hazardous).

acceleration ranging from 1.6 to 2.8 m/sec^2. A factor of 2.8 m/sec^2 will, on the other hand, have to be taken for a maximum credible earthquake (MCE). The design of the LNG terminal should take these values into consideration.

The coastal areas of Karachi also cover the Indus Deltaic region and the seismic activity in the Indus Deltaic region is mainly due to active faults. The northern flank of Indus Delta is delimited by an E-W-fault. This tectonic lineament shows signatures of reactivation during Pleistocene and is also well evidenced by frequent seismicity, although of low magnitude.

The most spectacular effect of the active fault of Rann of Kutch which lies close to the Steel Mills was due to the severe earthquake of June, 1891. It resulted in the 6m uplift of 16km vide and 81km long tract of alluvial land which blocked an eastern branch of the Indus River and therefore the locals called it Allah Band (Oldham, 1926). Figure-5.16 represents onshore and offshore historical Earthquakes recorded in Pakistan and its vicinity.

A list of earthquakes with inland epicentres, since 1977 to date which affected the Indus Deltaic Creeks are given in Table-5.8.

Table 5.8: List of Earthquakes in Indus Deltaic region and surroundings within latitude 23.0 - 25.0 °N and longitude 67.5 - 71.0 °E

DATE	LAT. (°N)	LONG. (°E)	DEPTH (km)	MAGNITUDE (RITCHER SCALE)
26-09-1977	25.4	68.2	33	4.5
25-11-1982	25.6	67.9	33	4.9
17-12-1985	24.9	67.4	33	4.9
24-12-1985	24.8	67.6	33	4.7
10-09-1991	24.4	68.7	33	4.8
19-09-1991	24.3	68.7	33	4.7
23-04-1992	24.3	68.8	33	3.7
24-12-1992	25.2	67.7	33	3.6
05-02-1993	24.6	68.9	4.3	4.3
26-01-2001	23.4	70.32	7.6	7.6

Source: Pakistan Meteorological Department

5.2.5 TSUNAMIS

Major damages done by Tsunamis, the impulsively generated seawater waves that are a result of underwater earthquakes, have not been recorded for the coastal area south of Karachi. There are, however, evidences of a 1.2 m tsunami generated by an offshore earthquake of intensity 8 M in 1945, which caused only minor damages in Port Qasim area. This event was followed by another Tidal wave that was recorded in 1953. The Tsunami of December 26, 2004 had no impact on the macroenvironment of the Port Qasim area.

Tsunami hazards exist on the contiguous coastline. The > 1-hour delay between the main shock and the arrival of the damaging tsunami associated with the 1945 earthquake was very probably caused by submarine slumping offshore rather than direct uplift of the coast. If this were indeed the case, even a modest earthquake in the Rann of Cutch region would be sufficient to trigger a submarine slide that would endanger the shoreline of District Thatta, which however is more than 80 km from the Project site. There is therefore no likelihood of Tsunami threat to the site.

Tsunamis in Indo-Pak region are relatively rare. Destructive tsunamis that may have occurred in the Arabian Sea have not been documented. The oldest known tsunamis in North Indian Ocean are:

a. 326 BC

b. 1st April and 9th May 1008

c. 1884

d. 26th June 1941

e. 27th /28th November 1945(origin Makran)

The 1945 Tsunami having a magnitude of 8.3 on Richter Scale was the deadliest. It originated off the Makran coast in Pakistan and was centered at 97.6 kilometers SSW of

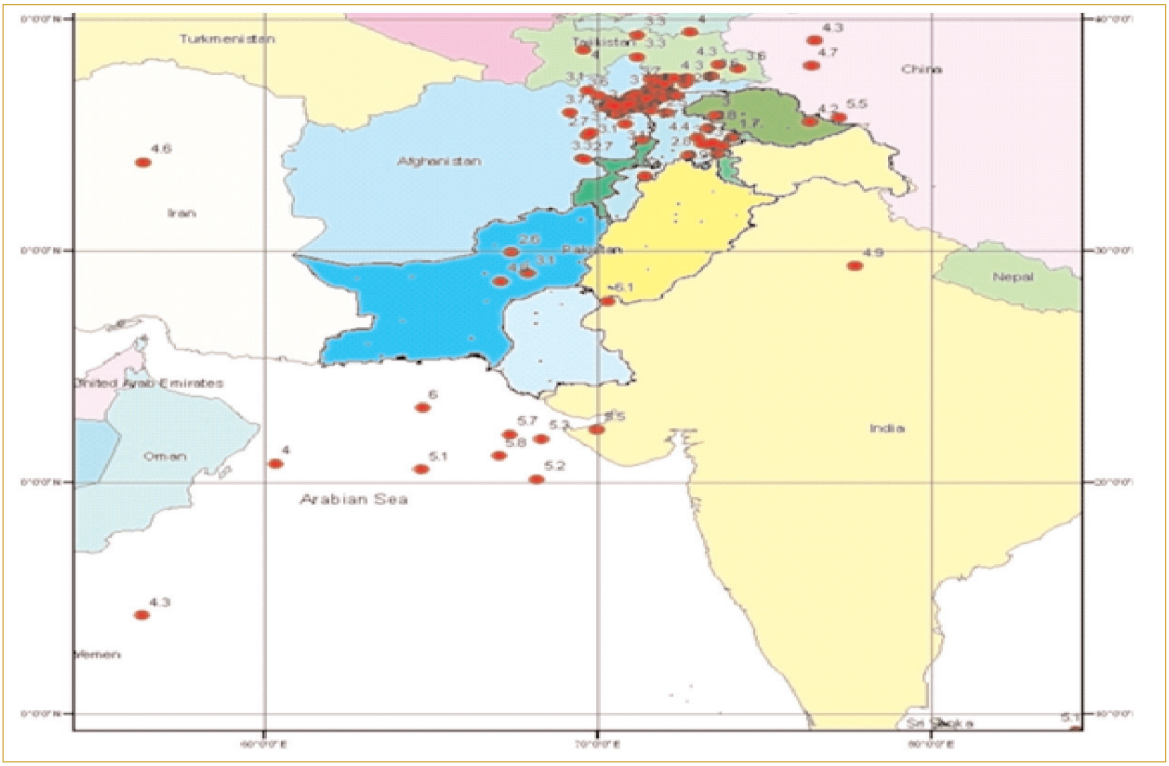


Figure 5.16: Onshore and offshore historical Earthquakes reordered in Pakistan and its vicinity (values are in Richter scale).

Pasni, 98.5 kilometers SE of Gwadar, and 408 kilometers W of Karachi. It reached a height of 40 feet in some Makran ports and caused great damage to the entire coastal region. The fishing village of Khudi, some 30 miles west of Karachi, was wiped out completely. All the inhabitants and their huts were washed away. The towns of Pasni and Ormara were badly affected. Both were reportedly under water after the tsunami.

At Karachi, the tsunami arrived from the direction of Clifton and Gizri. It ran along the oil installations at Keamari and flooded a few compounds. The waves were 6.5 feet or 2.0 meter high when they reached Karachi. There was a delay of more than one hour between the main shock and arrival of the damaging tsunami at Karachi.

The sea is 3.36 meter (11ft) below the road level at FOTCO and 2.7 meters (8.8 ft) below the average ground level at Native Jetty in the Manora Channel. This would suggest that a tsunami of magnitude similar to the 1945 Tsunami would affect the 2.5 meter contour on the beach front at Clifton but not the 5 to 9 meter contour from Korangi Creek to Ghaggar nala. A tsunami wave of magnitude higher than 5 meter would nevertheless be a matter of concern to the reclaimed areas along the sea front in the DHA, Korangi- Ibrahim Hyderi-Rehri- Lath Busti and Port Qasim area. Such events are less likely to occur in the north of the Arabian Sea.

5.2.6 Oceanographic Conditions

5.2.6.1 Recent Trend in Monsoon Pattern

The regular monsoon system was rendered inoperative by the persistence of the El-Nino and La-Nina effects in the earlier part of the first decade of the New Millennium. The monsoon system in the north of Indian Ocean and in

particular between the west and east Arabian Sea has not been active for quite some time but seems to have been activated after the year 2004. It may be recalled that the monsoon system on the western coast of India had become dormant for some seven to eight years and was revived in the year 2005, as suggested in an article in August 18, 2006 and subsequently presented at a Conference on Climate Change. (Climate Change Variations & Vulnerability Coastal Areas of Pakistan to Hazards of Climate Change, Paper presented at Euro-Asian Research and Training Workshop on Climate Change Management, Karachi University, June 30, 2007) For the earlier four to seven years this system was unable to operate because of the persistence of the El-Nino effect.

It may be recalled that the monsoon system on the western coast of India had become dormant for some seven to eight years. For the earlier four to seven years this system was unable to operate because of the persistence of the El-Nino effect. That system seems to have been broken by the powerful Tsunami of December 2004 which was caused by the 1000 km long and 4 km wide rupture under the Indonesian Seas that initiated the propagation of sea waves. The powerful Tsunami waves were traveling at a speed of 700 km/hour and were cause for the disruption of the ocean current system of the Indian Ocean that had been operating under the El-Nino system.

It has been hypothesized (Climate Change Variations & Vulnerability Coastal Areas of Pakistan to Hazards of Climate Change, Paper presented at Euro-Asian Research and Training Workshop on Climate Change Management, Karachi University, June 30, 2007) that the dormancy of the system was broken by the powerful December 26, 2004 Tsunami which was caused by the 1000 km long and 4 km wide rupture under the Indonesian Seas that initiated the propagation of tsunami waves. The powerful Tsunami was traveling at a speed of 700 km/hour and was cause for disruption of the Indian Ocean current system that had been operating under the El-Nino system for almost seven years. The Tsunami seems to have affected the Ekman effect whereby the slow moving deep layers of the western edge of the Indian Ocean current were forced to move rapidly. This disturbed the salinity of the deep layers of the Indian Ocean and flushed the Arabian Sea besides changing the equilibrium at the boundary layer between the surface layer and deep waters in the eastern boundary current of the Arabian Sea that contributes to the Indian Ocean Current. The disturbance caused by the Tsunami to the underwater movement of the deep layers identified the Arabian Sea as a separate ecosystem that has developed into a highly saline system resulting from high evaporation leading to increase in salinity and higher heat content of the Sea. The increase in salinity was also caused by substantially reduced input of freshwater into the Arabian Sea. Freshwater flow into the Arabian Sea has been reduced from all sides by each country bordering this Sea. None of the rivers in East Africa, Arabian Peninsula, Gulf of Oman, Iran, Balochistan, Sindh, the Tapti at Cutch Peninsula, the Narmada and all the rivers along the Western Ghat of India allows a reasonable flow of freshwater into the Arabian Sea.

All the rivers have been dammed and have thus damned the Arabian Sea by making it hyper-saline. The hyper-salinity and high rate of evaporation are cause for retention of thermal energy and thus for raising the temperature of the Arabian Sea by at least 1°C to 1.5°C and higher near the shoreline. This small but significant rise is not a recent phenomenon but spans over at least half a century during which the Arabian Sea has been under serious stress while all the rivers failed to deliver freshwater into their delta and the sea.

The Tsunami aggravated the stress with its shearing action to restrain the outflow of the Arabian Sea current and containing the stress into the ecosystem just north of the tip of the Indian Peninsula. Time has shown that the Tsunami has had long range impact on the Indian Ocean by identifying the Arabian Sea as a separate ecosystem under high stress of salinity.

It seems that the disturbance caused by the Tsunami of December 2004 system was instrumental in bringing rains though still below average in Sindh in the year 2005. The disruption of the oceanic current system firmed up in the year 2006, suggesting revival of the past system when there would be heavy rains after periods of drought.

The revival of the system seems to be persistent during subsequent years. This is authenticated by the Long

Range Forecast for 2007 South-west Monsoon Season Rainfall, by which the Indian Meteorological Department reported that moderate El Nino conditions developed over the equatorial Pacific Ocean during the end of August 2006, but the event was very short lived. The warm sea surface temperature (SST) anomalies over the east equatorial Pacific disappeared during February 2007. By the end of February, SSTs were near average in the vicinity of the date line, and below average over the eastern equatorial Pacific. The equatorial upper-ocean heat content (average temperature departures in the upper 300 m of the ocean) also decreased rapidly. These trends in surface and subsurface ocean temperatures indicate that the warm (El Niño) episode had ended and that conditions were becoming favorable for La Niña to develop.

It seems that the disturbance caused by the December 2004 Tsunami system was instrumental in setting off the 3-year temperature cycle on Karachi coast mentioned above and also initiated rainfall events though still below average in Sindh. This caused serious disturbances in the current pattern in the Arabian Sea leading to major cyclonic events thereafter. The disruption of the oceanic current system firmed up hereafter and thus there was revival of the past system when there would be heavy rains after periods of drought.

Monsoon history of recent and distant past suggests that excessive sunshine results in high input of solar energy over the heat zone on Pakistan that extends from Nokundi-Sibi-Mianwali to Gilgit. Accordingly the temperatures from the third week of April to second week of May all along the heat belt and the plains eastward into India are 45 degrees and above. Historically, these are indications of above normal rainfall in the monsoon season.

May is usually one of the hottest months of the year. Starting from the 1st to 15th May weather would be hot and dry over most parts of Pakistan. Isolated dust storm and thunderstorm occur during the third week, while light rain accompanies the storms over northeast Balochistan, Upper Sindh, Punjab, Upper KP, Northern Areas and Kashmir. Scattered dust storm or thunderstorm with rain occurs in the last week of May over most of the agriculture plains of the country.

The monsoon system that has been bringing rains to Pakistan comprises two system, one that travels over the tip of the Indian Peninsula into the Bay of Bengal in the east and the other that operates from the Gulf of Oman in the west Arabian Sea and travels into Balochistan, the Khyber Pakhtunkhwa (KP) and Kashmir. It is initiated every year by input of solar radiation over the heat zone which covers a vast area from Nokundi-Sibi-Jacobabad-Multan-Mianwali and over to Gilgit. The year 2007 was however witness to 10% above normal total duration of bright sunshine in Pakistan. It ranged for 6 to 9 hrs/day with increasing intensity of radiation ranging from 19 MJ/M^2 to 23 MJ/M^2/day and had an increasing trend from North to South.

The west Arabian Sea system was expected in the year 2007 to cross into Maharashtra by June 09. Gonu had held up the monsoon system and when it faded away, other weather conditions turned favorable, and the powerful South West Monsoon took its annual course from the tip of the Indian Peninsula and over the Western Ghat to the Bay of Bengal and along the slopes of the Himalayas to Kashmir and finally to the plains in Pakistan.

High temperatures, intense rainfall followed in these areas over the few days before the landing of Gonu. A punishing heat wave started sweeping across the country and pushed the mercury to 51 degrees centigrade in at least three cities, making June 09 one of the hottest days of the year.

Lahore sizzled at 48 degrees centigrade, a feat accomplished after 78 years. Islamabad was exceptionally warm at 43.5 degrees centigrade. Karachi fared a little better at 36.5 degrees centigrade, but high humidity (65 per cent), gusty winds and long-drawn spells of load-shedding caused outbreaks of power riots across the city.

Sibi, Mianwali and Larkana bore the brunt of the heat wave where the mercury rose to 51 degrees centigrade, according to the data input by the Pakistan Meteorology

Department.

The onset of high heat zone came to an end after India's annual monsoon rains gathered strength on the west coast of India or East Arabian Sea and reached Mumbai in two days after their movement to the western region from the south.

Western System: On the western side of the monsoon belt, the west Arabian Sea had also witnessed major incidents during the 2007 monsoon season. Low pressure had developed high up in the air of the surface in the Gulf of Oman. This was suggested to be part of the South West Monsoon, which was brewing in the second week of May. North and west of this low, the air was hot and dry owing to high pressure up in the air. Such conditions are indicators of formation of a cyclone.

Stray thunderstorms started blowing from the 14th May over the mountains of northwest Pakistan; along the Hindu Kush and the western Himalayas further north. Stray thunderstorms were incident over SW Asia between Iran, Syria and Turkey in the north and the highlands of Yemen and SW Saudi Arabia in the south. Low pressure over the easternmost Mediterranean Sea triggered more stray thunderstorms on the following day. They were accompanied by low rainfall. Faizabad in Afghanistan was inundated on May 16, 2007 by flash floods and heavy rainfall killed more than 24 people and damaged over 530 houses in several districts of the northeastern Afghan province of Badakhshan. Flooding of course inflicted serious agricultural damage and killed dozens of farm animals in the isolated and impoverished province.

5.2.6.2 Cyclones & Storms

High heat content of the Arabian Sea that is adjacent to the extensive heat zone of Pakistan usually upsets the heat balance and hence the water-balance of the region, particularly because it is the destination of windstorms. Tropical cyclones generally develop over Arabian Sea in low latitude i.e. 5-20 degrees north and dissipate after they move over land. The maximum frequency of tropical cyclone formation occurs in April, May and June and in the October-November period. The month of June receives least tropical cyclones in the region. About 76% of tropical cyclones in Karachi approach from the south through the east.

Tropical cyclones that come near the proximity of Karachi are generally weakened. The one that came near the coastal area on May 12, 1999 changed its direction and hit the coastal area of Badin, however Karachi was safe from this cyclone as it is located in the peripheral area and only rain showers of moderate intensity were recorded.

The cyclone in September 2006 proceeded towards coastal belt of Badin; but it did not hit the area and changed its direction. Although some cyclones have passed near the coastal belt of Badin but still it is classified outside the zone of cyclone activity for the Arabian Sea.

In late May 2007 the heat zone in Pakistan attracted the Tropical Cyclone Gonu, and by Tropical Cyclone 03A from the south of Mumbai, and thereafter by Tropical Cyclone 04B nicknamed Yemyin, and then a series of depressions travelling almost directly to the heat zone in Pakistan.

Soon after the beginning of June 07 the tropical cyclone Gonu visited the Coastal area of Oman for the first time in history and set the beginning of destruction over the coastal area of western Baluchistan. At this time it seemed that cyclone Yemyin was trekking westward south of Sindh and Baluchistan while also weakening, but numerical forecasts were indicating that a huge, strong system was developing high up in the sky diagonally on the path i.e. Arabia and Iran and thereby cutting off the impact and almost restraining the cyclonic system to proceed further from the Indus Delta and proceeding towards Karachi. On the night of July 3, 2007 Sindh especially lower Sindh received widespread rains, but luckily Karachi escaped from a high impact of this system. Scattered rains in Sindh with isolated heavy falls in eastern Sindh occurred.

The June 6, 2010 cyclone 03A, nicknamed Phet had landed on the coast of Oman and had lost its intensity. Moving in clockwise direction it poured heavy rains on Gwadar and Pasni. The rain bearing winds moved along the coastline

towards Karachi. It touched Karachi only tangentially and brought 100 mm rainfall two days before it landed south of Thatta District.

The low cloud covers and increased sunshine results in rise in temperature of landmass in the hinterland. Moenjo Daro recorded the world record of 55°C on May 25. Such high temperatures on vast territory has (i) turned large territory of Pakistan into an extensive heat zone, and (ii) raised the temperature of the North Arabian Sea by 1°C to 1.5°C. The heat zone serves as the main heat engine and the significant rise in temperature of the Arabian Sea leading to higher salinity can trigger cyclones in the Arabian Sea just south of Project area besides heavy monsoon rains all over the Indo-Pakistan region.

Such rise in temperature indicates onset of low-pressure zone on land and salinity steep gradient on the sea. The former parameter can attract rain bearing winds in case they are around, while the latter can nucleate cyclones/storms.

Such attraction of moisture laden winds did cause severe storms, the latest on June 6, 2010; June 5, 2007; on August 21, 2007; and on August 17, 2006 and brought sudden heavy rains of as much as 50 to 100 mm in two to three hours. Earlier on 150 mm rain fell in 3 hours in 1967 and caused accumulation of 8 ft water in Shershah. In the 1977 monsoon season the incessant pouring brought 200 mm rains in five hours. The cyclonic event that was incident on June 6, 2010 brought 100 mm rainfall in two hours; on August 10 and 11 of 2007 it brought unusually high rainfall of 107mm in 24 hours as compared with the normal of about 60mm for August.

The wettest August ever experienced by the city of Karachi was in 1979, when over 262mm rainfall was recorded. The record for maximum rainfall within 24 hours was 166mm of rain on August 7, 1979. The heavy rainfall was thus not unusual particularly because it was caused by the system that travelled from across Rajasthan and lay over Sindh. The monsoon weather system did not move towards Baluchistan but the penetration of moist currents from Sindh brought scattered to heavy rain in southern Baluchistan, particularly along its coastal regions.

The rainfall system that started on July 30, 2006 was a repetition of the 50 year cycle since in 1956 also the recorded rainfall was 400 mm. The regular monsoon system was rendered inoperative by the persistence of the El-Nino and La-Nina effects. That system seems to have been broken by the powerful Tsunami which was caused by the 1000 km long and 4 km wide rupture under the Indonesian Seas that initiated the propagation of sea waves. The powerful Tsunami waves were traveling at a speed of 700 km/hour and were cause for the disruption of the ocean current system of the Indian Ocean that had been operating under the El-Nino system.

It seems that the disturbance caused by the Tsunami of December 2004 system was instrumental in bringing rains though still below average in Sindh. The disruption of the oceanic current system firmed up in the year 2006 and thus there was revival of the past system when there would be heavy rains after periods of drought.

The monsoon activity does not subside until mid September but in 2007 it was more than usual. One of the indicators of its activity is the up welling that comes along. Up welling had intensified during the year 2007 because of the increased input of sunshine over the land area of Pakistan. This has caused serious disturbances in the current pattern in the Arabian Sea leading to major cyclonic events during the year 2007.

The Table 5.9 shows the movement of cyclones and storms in the Arabian Sea. The movement is generally in the west-north-westerly direction. The one that moved into the coastal area on May 12, 1999 changed direction and hit the coastal area of Badin while the coastal area southeast of Karachi was in the periphery and only rain showers of moderate intensity were recorded. This coast is otherwise classified outside the zone of cyclone activity for the Arabian Sea. Thunderstorm frequency is also low and is reported to occur at an average rate of 10 thunderstorms/year.

The pattern seems heading towards a change during the

Table 5.9: CYCLONES & STORMS DURING LAST 15 YEARS

Sr. No.	Year	Type/ Location of Cyclone	Wind Speed Range (km/h)
1	November 1993	Tropical Cyclone/ Northeast Arabian Sea	62 - 88
2.	June 1996	Cyclonic Storm /East Central Arabian Sea	62 - 88
3.	October 1996	Tropical Storm /Southeast Arabian Sea	62 - 88
4.	June 1998	Cyclonic Storm /Southeast Arabian Sea	62 - 88
5.	October 1998	Cyclonic Storm /East Central Arabian Sea	62 - 88
6.	May 1999	Very Severe Cyclonic Storm /East Central Arabian Sea	> 118
7.	May 2001	Very Severe Cyclonic Storm /East Central Arabian Sea	> 118
8.	September 2001	Cyclonic Storm /East Central Arabian Sea	62 - 88
9.	May 2002	Tropical Cyclone /West Central Arabian Sea	62 - 88
10.	May 2004	Very Severe Cyclonic Storm /Southeast Arabian Sea	> 118
11.	October 2004	Severe Cyclonic Storm /Northeast Arabian Sea	89 - 117
12.	September 2006	Tropical Cyclone /East Central Adjoining Northeast Arabian Sea	62 - 88
13.	02 June 2007	Tropical Cyclone /East Central Arabian Sea	62 - 88
14.	07 June 2007	Very Severe Cyclonic Storm /Northwesterly of East Central Arabian Sea	> 118
15.	21 June 2007	Tropical Cyclone (Deep Depression) /Northeast Arabian Sea	> 50
16	07 June 2010	Tropical Cyclone /Northeast Arabian Sea	> 50

Source: AEDB

last two years. Coastal area of Pakistan has experienced an increase in the frequency of storms in the southern part of Pakistan especially along Balochistan coast. In the month of June 2007 two tropical cyclonic storms namely Gonu and Yemyin hit the Balochistan coast. Under their influence, rain /thunder showers associated with gusty winds and thunderstorms occurred at isolated places of Makran Coast, while the sea conditions were very rough along the coast of Sindh. The high heat content of the Arabian Sea that is adjacent to the heat zone of Pakistan had disturbed the heat balance and water balance of the region. This induced the windstorm in late May, followed by the Tropical Cyclone Gonu in the first week of June, then by Tropical Cyclone 03A from the south of Mumbai, and thereafter by Tropical Cyclone 04B nicknamed Yemyin.

The June 6, 2010 cyclone 03A, nicknamed Phet had landed on the coast of Oman and had lost its intensity. Moving in clockwise direction it poured heavy rains on Gwadar and Pasni. The rain bearing winds moved along the coastline towards Karachi. It touched Karachi only tangentially and brought 100 mm rainfall in Karachi and 50 mm rainfall in Hyderabad two days before it landed south of Thatta District.

Tropical Cyclones contain heavy bands of clouds and cause heavy rains during landfall or sometimes cross along the coast far away. Heavy rainfall occurs as the end result. The Arabian Sea is known to be frequented by general cyclonic storms and some of these had been among the worst cyclonic storms of the world from their severity point of view, resulting in huge losses to life and property in the coastal areas. A significant number of the cyclonic storms produced in the Arabian Sea move towards north and northeast and some of them land in Pakistan. However most of these cyclones which tend to move towards southern part of the Pakistan coast very often reciprocate towards eastern coast of India.

Coastal Sindh is more vulnerable than the west coast of Pakistan to storm surges, associated with the severe cyclonic storm generated in the adjoining Arabian Sea. The available data on cyclones and storm reveals that Pakistan is vulnerable mostly during the period from April through June while no storm has ever been observed during January to March (news report).

The main cyclonic activity in the Project Area takes place in the month of June. All the cyclonic storms that emerge

in the Arabian Sea either curve sharply into the Gulf of Kutch or cross the Arabian Sea from East to West and end up at the coast of the Arabian Peninsula creating some storm surges at the coast (UNESCAP, 1996). When the cyclones cross the coast they are accompanied by storm surges, generally known as storm tides. The cyclones that cross the coast in the month of June generate winds of approximately 15- 18 m/s.

Tropical cyclones squander between Gulf of Cambay and Karachi. The size of the tropical cyclones is generally 270 -720 Km with an average speed of 7 to 18 Km/hr. Majority of the cyclones land in the vicinity of Indus deltaic creek system creating storm surges of few feet height. In the creek system the tidal range is quite high which is favorable for the amplification of surges. If the peak surge does not occur close to the time of high tide, no major water level oscillations occur in this region.

Table -5.10 Month-Wise Intensity And Location Of Storms In Arabian Sea

Months	Intensity of Storms on an arbitrary scale 0-4	Primary Area of activity
Jan	0-no storm	
Feb	0-no storm	
Mar	0-no storm	
Apr	2	S. Arabian Sea
May	3	S. Arabian Sea
Jun	3	N Arabian Sea
Jul	1	N Arabian Sea
Aug	1	N Arabian Sea
Sep	2	North and Central Arabian Sea
Oct	4-severe	South eastern Arabian Sea
Nov	4-severe	South eastern Arabian Sea
Dec	1	South eastern Arabian Sea

Information source Marine Investigators 1998

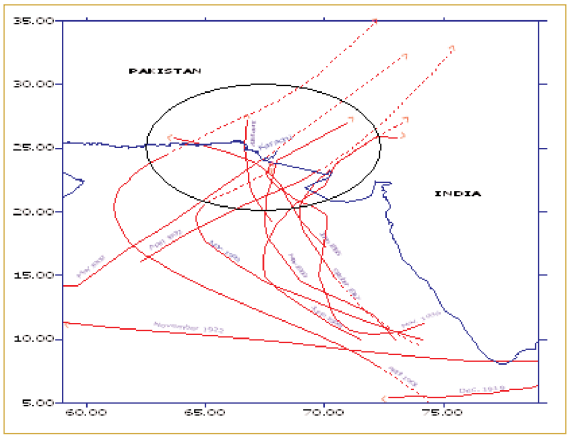


Figure 5.17: Historical Record of Tropical Cyclones within 300nm radius (encircled) of Karachi (Data Obtained from the Archives of National Institute of Oceanography)

Beside these, the SW monsoon wind also blows in June and adds about 0.3 m of surge to the current tides. Thus very high tidal level over 4.0 m prevailing in the Port Qasim region inundate the creek banks and erode the coastal areas. Such high tides were experienced in 1986, 1990, 1993 and 1999 when heavy damage was recorded in the coastal areas of Badin and Thatta districts.

Sometime the cyclones cross the deltaic coast itself. Cyclones generally constitute the strong winds having the speed of over 60 Knots and the central pressure as low as 980 mb. The wind and low pressure creates the storm surges which when combined with high tides, becomes a destructive force in the coastal area. Coastal erosion and inundation are commonly associated with storm surges. Beside the cyclones, several depression with less severe intensity frequently occur in the northern Arabian sea, which are also related with surges. These surges which are about 0.5 m in height, when combined with HHW becomes the potential source of the erosion thus creating high waves in the open sandy coast thereby increasing

tide water level favoring tidal inundation.

According to the studies hitherto carried out, the Sindh coast falls in a dangerous zone. In this belt the frequency of the storm striking the coast is low (for over a 75 year period only four storms struck the coast between 18 and 19o N and only three of these struck between 19 and 20° N). Since the tidal range in this belt is quite high unless peak surge occurs close to the time of high tide no major water level oscillation occurs in this region. In between Dwarka (India) and Karachi there is sparsely populated extensive marshy area known as Rann of Kutch. The frequency of storm in the region is generally low and the tracks are not usually favorable for major surge development.

Tidal data recorded at Port Qasim as well Karachi Port was obtained and analyzed for the separation of surges on the basis of the recorded values. 1982 was selected for analysis due to the fact that the data for both the parts was available for that particular year. It was observed that maximum surge was never more than 2.0 feet. Analysis of the tidal data on surges for Karachi for the period of fourteen years has been extracted and is recorded in Table 5.11.

Table 5.11 High tides and surges in past

Month	Height of tide (ft)	Height of surges (ft)
Jun58	9.7	1.3
Jul58	8.2	1.3
Oct58	9.6	1.4
Nov58	8.1	0.8
May59	9.9	1.8
Jun59	6.9	1.6
Jun59	9.2	1.5
Jun64	8.6	1.7
Jun70	8.4	2.0

Source: Quraishee G.S et al (1984)

The highest surge of 2.6 feet so far recorded at Karachi was due to a storm that crossed the coast 80 Km east of Karachi on May 1920. Although most of the storms resulted in the rise of sea level but the surge height was never critical. Nevertheless, the coastal topography being gentle and flat, even a surge of 2.0 feet during spring tide can create flooding.

Relationship between predicted astronomical tide and the time of occurrence of surge was developed by Quraishee in the year 1974 which is considered as fairly applicable to prediction of surge level. When surge occurs at the rising tide, it builds up whereas during falling tide the interactive effect reduces its intensity.

5.2.6.3 WAVES

The waves and their height at Karachi Coast vary with the season. During NE winter monsoon the wind speed is around 10 knots and the coastal waters are almost calm and the wave height is less than 1 meter. During SW summer monsoon the winds pick up speed of about 25 knots; the wave height on the Karachi Coast is then in the range of 3 to 4 meters. In the interim months i.e. inter-monsoon period the wave height is around 1.5 to 2.5 meters.

5.2.6.4 TIDES

Tides along Karachi Coast are semidiurnal but diurnal inequality is also present. The effect of this inequality shows up in daily tidal cycle as there are two High Waters and two Low Waters which also vary considerably from each other in tidal heights. These are classified as HHW, LHW, LLW and HLW. The tides move from west to east i.e. the tide at the Hub River estuary arrives about 20 minutes earlier than at Karachi. Similarly the tides at Karachi Harbour arrive at about 10 minutes earlier than at entrance of Port Qasim. When tides progress up the Phitti Creek its magnitude increases and there is a time lag. At Port Bin Qasim which is about 32 km from Karachi and is located about 25 km up the creek from the sea the tides reach after 22 minutes. At Gharo Creek tides fall rapidly due to frictional effects and the gradual weakening of the tidal forces. At Gharo 60 km from the Phitti Creek entrance the tides are almost half of the mean sea tides at the entrance.

The tides at Port Qasim are predominantly semi-diurnal with a substantial diurnal component. The Mean Higher

High Water (MHHW) to Mean Lower Low Water (MLLW) range is about 2.4 m at the port complex while the peak tide over diurnal range is about 3.5m. The tide levels at Port Qasim are presented in Table 5.12. The flow pattern within this large, relatively deep and generally stable creek system around Port Qasim is strongly influenced by tides and the presence of extensive inter-tidal flats.

Table 5.12: Tidal Levels at Port Qasim

Location	MLLW	MHLW	MLHW	MHHW	HAT	LAT
Bundal Island	+0.6	+1.2	+2.3	+2.9	NA	NA
Hasan Point	+0.6	+1.3	+2.8	+2.9	+3.4	+0.6
Port Qasim	01.0	+1.4	+2.1	+3.4	+4.00	-0.6

5.2.6.5 SEAWATER CURRENTS

The speed of sea currents is generally low:~0.5 knots. The speed increases up to 1 knot during SW monsoon. The direction of the sea current is directly related with the prevailing wind system. The set is generally easterly in the SW monsoon and westerly in the NE monsoon. The slight difference in direction in the Western and Eastern part of Karachi Coast is due to circulatory pattern of the current around gyrals which are usually formed at the center of the sea. There is a clockwise gyre during SW monsoon and anti-clockwise gyre during NE monsoon (Quraishee, 1988). Quraishee (1984, 1988) has also observed the existence of warm core eddies in the offshore areas of Pakistan.

5.2.6.6 SEAWATER TEMPERATURE

According to UNESCAP Report (1996) the average annual sea-surface temperature in near shore waters along Karachi Coast Ranges between 20.7°C and 29.3°C as shown in table 5.13. During winter months the temperature range is 20.7°C to 23.8°C whereas during summer months the range is between 27.9°C to 29.3°C. In the creeks along Indus Delta the sea-surface temperature generally ranges between 23.4°C to 29.5°C as shown in table 5.13. Water temperature in tidal channels in the Indus Delta creeks have been reported form 19°C in January to 30°C in June (Harrison et al. 1994, Zaqoot, 2000). The temperatures at a depth of 100 m are lower and generally have an annual range between 19.5°C to 24.5°C.

5.2.6.7 SEAWATER SALINITY

According to UNEP (1986) the salinity ranges from 3.55 to 3.69 percent in the inshore waters of Karachi and may rise to as high as 4.1 to 4.2 percent in the back water and tidal creeks. The average annual salinity in coastal waters along Karachi and Indus Delta ranges from 3.6 to 3.67 percent (UNEP, 1996). The monthly distributions of salinity along Sindh coast are presented in Table 5.14.

The tidal channels in Indus Deltaic area are generally hyper-saline with salinity range of 3.8 to 4.5 percent over the year except during August and September when due to rainy season the runoff from Indus River reduces the sea water Salinity to 2.6 to 3.0 percent (Harrison et al., 1994).

Table 5.13 Monthly distribution of temperature in °Calong the Pakistan Coast (UNESCAP, 1996)

	Jan	Temp.	Feb	Temp.	Mar	Temp.	Apr	Temp.	May	Temp.	Jun	Temp.
Indus delta	19.2	23.6	20.2	23.8	24.3	24.9	29.0	27.0	29.5	27.9	30.0	29.5
Karachi	19.2	23.5	20.5	23.8	24.0	24.8	27.0	26.5	29.0	27.9	30.0	29.3
Gawadar	18.3	20.2	19.5	20.2	22.3	22.0	27.5	24.2	30.1	26.5	31.2	28.3
	Jul	Temp.	Aug	Temp.	Sep	Temp.	Oct	Temp.	Nov	Temp.	Dec	Temp.
	Air	Sea	Air	Sea	Air	Sea	Air	Sea	Air	Sea	Air	Sea
Indus delta	29.5	28.7	28.0	28.5	26.5	27.0	27.0	27.8	23.5	26.5	19.5	23.4
Karachi	29.3	28.0	28.0	28.0	28.5	27.3	27.2	27.0	27.5	24.4	27.0	20.7
Gawadar	29.2	27.3	28.5	28.0	29.4	28.3	27.0	28.0	23.1	25.3	20.1	23.2

Table 5.14: Monthly distribution of salinity along the Pakistan Coast (UNESCAP, 1996)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Indus delta	36.1	36.15	36.5	36.4	36.6	36.6	36.7	36.61	36.48	36.47	36.5	36.2
Karachi	36.0	36.2	36.5	36.5	36.5	36.6	36.7	36.6	36.5	36.5	36.5	36.2
Gawadar	36.05	36.26	36.53	36.55	36.58	36.65	36.74	36.68	36.55	36.55	26.54	26.3

Table 5.15: Sea Temp, Salinity and Density of Creeks

Locations	Sea water Temp	SalinityPpt	Density kg/m3
Gizri Ck (top end)	21	33.95	1.025
Gizri Ck (DHA club)	20	33.4	1.025
Korangi Ck (Rehri)	22	37.8	1.028
Korangi Ck (Lath Basti)	23	36	1.027
PSO Oil Jetty	25	37	1.028
Phitti Creek	22.7	38.78	1.029
Jhari Creek	23	39.2	1.03
Chara Creek	23	38.41	1.03
Gharo Creek	24	38.44	1.029

Low salinity values of 2.8 to 3.0 percent were reported by Rabbani and Khan (1988) for Khobar Creek of Indus Delta. Inside Karachi Harbour from Lyari River mouth to the mouth of Manora Channel the Salinity values in the range of 2.5 to 3.4 percent have also been reported (Zaqoot, 2000).

5.2.7 HYDROLOGY AND HYDROGEOLOGY

The Indus Delta represents a major example of negative effects of the progressive reduction in fresh water discharge over a period of many years. Historical records indicate that the distribution of mangroves in the Indus Delta has significantly changed during the past several hundred years with the shifting pattern of the river (Snedaker, 1984).

Until recently the Indus River had a largely river dominated estuary but increased utilization of the river for agriculture etc. has resulted in discharge to the Arabian Sea only during the summer southwest monsoon. During remaining nine to ten months the Indus River has no estuary due to elimination of the river discharge (Geology of the Indus Delta, AH Kazmi, in Marine Geology & Oceanography of Arabian Sea and Coastal Pakistan, ed. BU Haq, JD Milliman, Van Nostrand Reinhold Company, New York 1984, Sediment Discharge from River Indus to The Ocean, Past, Present & Future, JD Milliman,GS Quraishi and Mirza Arshad Ali Beg). As a result, the mangrove ecosystem has been adversely affected. Some decades ago the area of mangrove cover in the active Indus Delta was estimated at about 250,000ha (Khan, 1966, Mirza et al, 1973, SC Snedaker, Mangroves: A Summary of Knowledge with emphasis on Pakistan, in Marine Geology & Oceanography of Arabian Sea and Coastal Pakistan, ed. BU Haq, JD Milliman, Van Nostrand Reinhold Company, New York 1984).

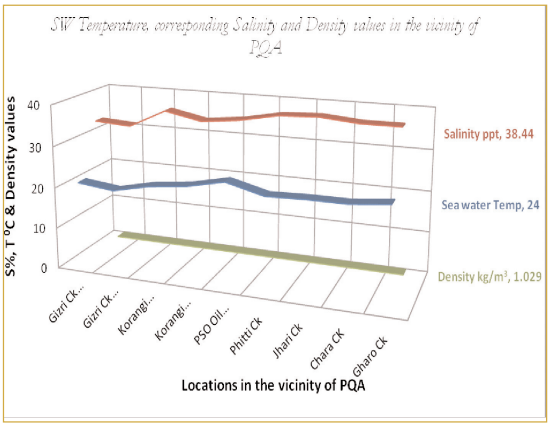


Figure 5.18: Mean concentration seawater surface temperature, salinity and density values in PQA.

The mangroves are degrading rapidly caused by a number of factors such as cutting, browsing and by reduced silt laden river water. (Mirza Arshad Ali Beg, Environmental Impact Assessment of Reduced Flow Downstream Kotri and (2) Environmental Impact Assessment of Groundwater Extraction in Riverine Areas in Sindh), part of studies carried out for the Govt. of Sindh (1993), and Mirza Arshad

Ali Beg, Ecological Imbalances in the coastal areas of Pakistan and Karachi harbour, Pakistan Journal of Marine Sciences, 4(2), 159-74, 1995) These forests which covered 263,000ha in 1977 have recessed to about 160,000ha in 1990 (Kela, 1999, IUCN, 2005).This is probably the most serious problem focusing mangroves of Indus Delta, therefore the salinity value of 40 ppt or more is common in mangrove areas. Although there exist no previous records of salinity values in the area for past some decades, but it was appreciably lower since rice was once cultivated in Keti Bunder in the vicinity of mangrove stands (Saifullah, 1982). Due to hyper salinity and nutrient impoverishment decline in mangrove is now visible everywhere.

Early dense and extensive forest has changed to stunted growth of trees and reduction in forest area. Dams and diversionary barrages also affect bed-load and suspended transport of sediments by capturing this material and preventing its uniform dispersal over mangrove areas during flood season. Thus the mangroves are deprived of an annual silting (and input of inorganic nutrients) and the depositional character of the mangrove environment is severely altered.

Further, in the absence of flushing, distributary rivers in delta regions become silted and cease to function. The filling and death of distributary rivers has occurred and is taking place in such major river deltas as the Ganges and Indus. When dams and barrages are constructed the mangroves below the dam are subject to a variety of stress conditions which leads to shifts in species dominance, reduced structural complexity and lowered productivity which is quite evident in mangroves of Indus Delta including Port Qasim area in the vicinity of Karachi [Mirza Arshad Ali Beg, Ecological Imbalances in the coastal areas of Pakistan and Karachi harbour, Pakistan Journal of Marine Sciences, 4(2), 159-74, 1995].

5.2.7.1 Surface and Ground water Quality in Coastal Area of Karachi

There is no inland surface water body in project area except the mudflat lying between the 9 meter contour and the coastline of Arabian Sea. There are quite a few springs including the Chashma at Chashma goth and some along the coastal road that runs along the base of the 5-9 meter contour that is conspicuous in the region.

The major industrial complexes including Korangi Industrial area (KIA), Landhi Industrial Trading Estate (LITE), Port Qasim Industrial Area and Pakistan Steel Mill are located in the proximity of the creeks adjoining Port Qasim. The KIA is located adjacent to Korangi- Kadiro creeks, LITE is situated close to the Kadiro-Gharo creeks and Steel Mill is located on the Gharo creek. The creeks adjacent to the mudflats are recipient of at least 25% of the total pollution load of Karachi through Malir River and about 15% that is directly discharged into the adjacent open sea coast or to the Gizri, Korangi and Gharo creeks.

Coastal villages such as Ibrahim Haidery, Rehri, Lath Basti are part of the macroenvironment that includes Korangi creek, Phitti creek, Kadiro creek and Gharo creek system which form an inter-related system of creeks receiving bulk of the domestic and industrial wastes generated in the southeast of Karachi.

The complex creek system southeast of Karachi is part of the Indus Delta. The Delta presents a major case study of adverse impact of the progressive reduction in fresh water discharge over a period of time. Whereas construction of dams and barrages has reduced the flow of freshwater into the Arabian Sea, the Indus Basin irrigation system per se has outlived its age. This is the conclusion of an extensive survey for the Ecosystem Research on Water Resource Management in Sindh West (Mirza Arshad Ali Beg, Yasmin Nergis, and Mughal Shareef, HEC Project 1196, 2008-2010) that supports the following hypotheses in quantitative terms:

- Industries, industrial estates, irrigation and municipalities as well as tourism activities have over-exploited the groundwater sources to the extent that critical limits of the hydrological potential of the region have been reached. Consequently the Indus delta as well as areas inland from the sea is at risk to seawater intrusion and of seismic events in the coastal areas.
- Diversion of Indus River water into irrigation canals and channels has depleted the Indus Delta of

freshwater and induced seawater intrusion into extensive areas inland, besides waterlogging and salinizing the land in the terminal zones of the irrigation system in the coastal areas of District Thatta in Sindh West.

- The creek channels are no longer hyper-saline as is being maintained by several reports by concerned agencies. Contrarily the creek channels are hypo-saline for as long as the irrigation system is supplying the water to adjacent land.

The findings of the Surveys suggest that while the Indus delta has been deprived of the 8.2 MAF water flow thus virtually drying it up of the freshwater, the ecosystems adjacent to the canal command area have been salinized and water logged. This has resulted in dilution of the creek water with the seepage from waterlogged land areas and discharge from drainage canals to the extent that their salinity is no longer 40-43ppt, as is being reported, but has come down to 27ppt during the kharif season and after the rains.

The creeks are hyposaline with salinity in the 27 to 29 ppt range, the dilution having been effected by the seepage which has, according to the estimates exceeded the normal 10% and is rated at 15 to 25% as a result of cultivation of the

Table 5.16: Summary of Water Analysis

Sr. #	Parameters/Analytes Descriptions		Results					
		Unit	1	2	3	4	5	6
1	Collection Time	Hr: mn	0550	0600	0649	0700	0910	0920
2	Sample Collection date	d.m.y	03.03.10	03.03.10	03.03.10	03.03.10	06.03.10	06.03.10
3	Temperature	°C	25.9	27.1	23.5	26.2	29.0	26.5
4	pH Value	SU	7.68	8.38	7.47	8.32	7.11	7.24
5	Color	App.	Susp	Susp	Muddy	Susp	Susp	Clear
6	Total Dissolve Solids (TDS)	mg/L	30010	42900	40000	43280	1932	1549
7	Conductivity	µs/cm	61200	68400	60000	67700	4040	3110
8	Dissolve Oxygen (DO)	mg/L	4.04	2.01	3.39	4.02	5.13	5.69
9	Chloride (Cl-1)	mg/L	14400	2281	21701	23230	770	630
10	Bicarbonate (HCO_3)	mg/L	2401	22470	2108	2230	330	260
11	Sulfate (SO_4)	mg/L	1901	970	940	1020	210	120
12	Nitrate (NO_3)	mg/L	31.8	18.8	13.2	9.8	8.7	4.8
13	Carbonate (CO_3)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL
14	Calcium (Ca)	mg/L	830	1203	1170	1302	225	135
15	Magnesium (Mg)	mg/L	520	876	850	990	170	105
16	Sodium (Na)	mg/L	9900	14421	13190	14330	487	220
17	Potassium (K)	mg/L	231	259	312	270	113	27
18	5-Days BOD	mg/L	BDL	237	468	BDL	BDL	218
19	Chemical Oxygen Demand (COD)	mg/L	BDL	304	559	BDL	BDL	426
20	Mercury (Hg)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL
21	Lead (Pb)	mg/L	BDL	1.398	BDL	BDL	BDL	BDL
22	Cadmium (Cd)	mg/L	BDL	0.876	BDL	BDL	BDL	BDL
23	Arsenic (As)	mg/L	BDL	BDL	BDL	BDL	0.0418	BDL
24	Nickel (Ni)	mg/L	BDL	1.174	BDL	BDL	0.0621	0.2617
25	Zinc (Zn)	mg/L	BDL	8.984	3.289	BDL	0.5118	1.9146
26	Total Plate Count @37°C	Cfu	110	TNTC	TNTC	TNTC	TNTC	TNTC
27	Total Coliforms @42°C	Cfu	70	TNTC	TNTC	TNTC	TNTC	TNTC
28	Escherichia Coli @37°C	cfu	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve
29	Sodium Absorption Ratio (SAR)	:	66.09	76.84	71.31	72.53	5.94	3.44

1 -Sea Water (Pakistan Steel Mill-Channel). 2-Pakistan Steel Mill Sewage Effluent. 3-Sea Water Creek Ziarat Hasan Shah. 4-Sea Water/Stagnant way to Ziarat Hasan Shah. 5- Spring Water Baba Juman Shah. 6-Spring Water Drain to Dhabji.

Table 5.17: Summary of Water Analysis

Sr. #	Parameters/Analytes Descriptions	Results						
		Unit	7	8	9	10	11	12
1	Collection Time	Hr: mn	1240	0104	0110	0150	0230	0240
2	Sample Collection date	d.m.y	03.03.10	03.03.10	03.03.10	03.03.10	03.03.10	3.03.10
3	Temperature	°C	26.5	26.6	26.6	28.6	29	28.9
4	pH Value	SU	7.44	8.45	8.17	7.58	7.28	7.06
5	Color	App.	susp	clear	clear	susp	clear	clear
6	Total Dissolve Solids (TDS)	mg/L	38700	228	232	38700	2410	1418
7	Conductivity	µs/cm	61500	496	496	64000	4990	2990
8	Dissolve Oxygen (DO)	mg/L	4.02	5.08	5.10	3.97	4.07	4.96
9	Chloride (Cl-1)	mg/L	20810	58	59	20808	970	528
10	Bicarbonate (HCO_3)	mg/L	1940	70	72	1920	415	270
11	Sulfate (SO_4)	mg/L	920	34	34	930	212	92
12	Nitrate (NO_3)	mg/L	17.6	3.28	1.19	4.26	3.28	7.8
13	Carbonate (CO_3)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL
14	Calcium (Ca)	mg/L	1210	19	20	1220	312	120
15	Magnesium (Mg)	mg/L	965	11	12.0	970	230	115
16	Sodium (Na)	mg/L	12790	34	34	12770	330	195
17	Potassium (K)	mg/L	191	2.9	2.9	189	29.0	43.0
18	5-Days BOD	mg/L	37	BDL	BDL	BDL	BDL	BDL
19	Chemical Oxygen Demand (COD)	mg/L	57	BDL	BDL	BDL	BDL	BDL
20	Mercury (Hg)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL
21	Lead (Pb)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL
22	Cadmium (Cd)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL
23	Arsenic (As)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL
24	Nickel (Ni)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL
25	Zinc (Zn)	mg/L	BDL	BDL	BDL	BDL	BDL	0.0268
26	Total Plate Count @37°C	Cfu	TNTC	210	140	TNTC	TNTC	TNTC
27	Total Coliforms @42°C	Cfu	TNTC	- ve	TNTC	TNTC	TNTC	TNTC
28	Escherichia Coli @37°C	cfu	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve
29	Sodium Absorption Ratio (SAR)	:	66.25	1.53	1.48	65.93	3.44	3.04

7-Sea water Lath Basti. 8-KDA Water Lath Basti #1. 9-KDA Line Water Lath Basti. 10-Sea Water Lath Basti. 11-Boring Water Cattle Farm. 12-Boring Water Cattle Farm 200ft.

water intensive rice crop that by the traditional system also requires puddling the fields, which is in line with the hypotheses proposed earlier [Mirza Arshad Ali Beg, Ecological Imbalances in the coastal areas of Pakistan and Karachi harbour, Pakistan Journal of Marine Sciences, 4(2), 159-74, 1995]. The observation with respect to water logging and salinization supports the hypothesis that the Barrage system of making water available at farm gates has outlived its age and is doing more harm than good to sustainable development through its distribution system.

Reduced water flow downstream Kotri has also resulted in land erosion and land submergence; the seawater current pattern has apparently assumed adequate potential energy to erode the surfaces of the land over the creeks and this is the reason that many of the islands between Mirpur Sakro and Keti Bunder have lost their identity, Lakha Island in Boharo being an example.

Chemical and bacteriological analyses of surface water, groundwater, seawater, and wastewater support the conclusions that:

1) Aater still flowing during the period when there is no discharge downstream Kotri Barrage, is contaminated with seawater that intrudes inland up to Kotri during the high tides in particular during the middle of the Lunar months and around the time of solar and Lunar eclipse.

2) Fresh water being supplied to Karachi marginally meets the drinking water quality standards, while treatment of wastewater remains unattended.

3) Extensive mining of groundwater has dried up the aquifer and it is barely recharged once in three years.

4) Extensive excavation of sand and gravel from the riverine areas has dried up the aquifer and flash floods are taking their toll, while excavation of sand from the coastal area has destabilized the coastline at several places.

The Malir River drains into the Korangi Creek/Ghizri Creek. Korangi Creek forms part of the Indus Delta that harbors the fifth largest single arid region mangrove forest in the world. Physico-chemical characteristics of water from different sources including seawater, groundwater, industrial wastewater, spring overflow in the macroenvironment of PQA are summarized in Table 5.16 & 5.17.

Sea water samples collected from Steel Mills intake and outfall channels, and from Ziarat Hasan Shah had lower SAR ~66 76 but TDS varying from 30,000 to 43,280 at 26 and 27°C, pH 7.44 and 8.4, and DO ~4.0 showing dilution with wastewater discharges and concentration due to evaporation on the outside of the creek. Seawater at the Ziarat Hasan Shah beach had SAR 71.3, TDS 40,000, DO 3.39 and pH 7.47 at 23.5°C. The samples from spring and the nala

Table 5.18: Water Quality in the Project Area

S. #	Parameters	Sea Water Sample # 1	Sea Water Sample # 2
1	Temperature	28.5	29.2
2	pH	7.41	7.19
3	Biological Oxygen Demand (BOD5) (mg/L)	19	15
4	Chemical Oxygen Demand (COD) (mg/L)	1080	1070
5	Total Suspended Solids (TSS) (mg/L)	50	47
6	Total Dissolved Solids (TDS) (mg/L)	25700	24600
7	Oil & Grease (mg/L)	< 1	< 1
8	Phenolic Compounds (as Phenols) (mg/L)	ND	ND
9	Chloride (mg/L)	21000	21400
10	Fluoride (mg/L)	1.7	2.7
11	Cyanide (mg/L)	ND	ND
12	An-ionic detergents (as MBAS) (mg/L)	0.045	0.051
13	Sulphate (mg/L)	4500	4250
14	Sulphide (mg/L)	ND	ND
15	Ammonia (mg/L)	0.15	0.15
16	Salinity (mg/L)	27500	27200
17	Cadmium (mg/L)	ND	ND
18	Chromium (mg/L)	0.0470	0.0228
19	Copper	0.1491	0.1154
20	Lead	0.2361	ND
21	Mercury	ND	ND
22	Selenium	0.1064	0.0482
23	Nickel	0.0476	0.0360
24	Silver	0.0132	0.0073
25	Zinc	0.1493	0.6961
26	Arsenic	0.0983	0.0801
27	Barium	0.3851	0.1797
28	Iron	16.2857	7.3580
29	Manganese	0.3180	0.1527
30	Boron	3.2194	2.9542
31	Chlorine	0.03	0.04

receiving the overflow from the spring show characteristics of groundwater having higher proportions of sodium and chloride ions.

Sea water samples collected from Lath Basti had lower SAR ~65 but TDS ~38700 at 26 and 28°C, pH 7.44 and 7.58, and DO ~4.0 showing dilution with wastewater discharges from the surrounding. The samples from boreholes show characteristics of groundwater having higher proportions of sodium and chloride ions. The water supply samples with SAR above 1.2 show characteristics of fresh water contamination with groundwater.

Wastewater samples collected from Korangi Industrial Area which is the outfall region of Malir River, had SAR values ranging from 2.79 to 5.56; TDS ranging from 1228 to 4310; low DO 0.39 to 0.62 and the high BOD and COD values in the samples; they are characterized as industrial wastewater mixed with sewage. The sewage is in higher proportion upstream while industrial effluent is dominant as the river enters its delta area. Seawater intrusion was noted at Malir River/Korangi Industrial Area during high tide. It was noted that the sample collected from here had SAR 57.68, TDS 22300, DO 0.82 and quite high BOD and COD, and is characterized as seawater contaminated with sewage and industrial effluent.

The water quality results of the samples collected from the Gharo Creek in the vicinity of proposed site during the current ESIA study are presented in Table 5.18.

5.2.7.2 Nutrient Concentration

The nutrients including Phosphate, Nitrate, Nitrite and Ammonia play vital role in the food chain of marine ecosystem in primary production of coastal and oceanic waters. They support the growth of phytoplankton which serve as the food for zooplankton as well as larval stages and juveniles of fish and crustaceans and also serve as food for filter feeders.

As may be seen from Table 5.19 the average nutrient concentration (NIO archives) generally increases from Keamari coast towards Gizri creek, suggesting that the coastal waters opposite DHA beaches are very productive which is also influenced by Gizri creek and Korangi creek waters harboring mangrove forest which itself is one of the highly productive marine ecosystems. Nutrients in the Gharo creek do not appear to be limiting to primary productivity in the channels. If there is any limitation, it is due to turbidity and thus to a highly restricted protic zone.

The Karachi Harbour, Gizri creek, Gharo creek and Korangi creek receive large quantities of nutrients as part of the sewage effluent and garbage that is disposed of in these creeks. Higher concentrations of nutrients result in overproduction and exhaustion of dissolved oxygen in the seawater. This leads to anoxic conditions and eutrophication. Anoxic conditions prevail in about 40percent of the bottom areas of Karachi Harbour and about 60 percent of the Gizri creek areas (Rizvi et al. 1999). Eutrophication is conspicuous in the middle and lower parts of Gizri creek.

The nutrient distribution in Karachi Harbour area is presented in Table 5.20. These data show that nutrient enrichment particularly of inorganic phosphate is dominant over the entire harbour area which receives a mix of sewage and industrial discharges. The nutrients enrich the surface and near bottom layers of sea water and their excess is cause for eutrophication in coastal areas.

5.2.7.3 Physico-Chemical Conditions of Creeks in Macroenvironment

General physico-chemical characteristics of various localities in the macroenvironment of PQA are summarized in Table 5.21 and Figure 5.19.

Temperature of sea water was found in the 22-25°C range during winter and 28 to 29°C during summer (SW monsoon). The pH values ranged from 7.43 to 7.83 in the area opposite Lat Basti and Ibrahim Haideri. The density of sea water was found generally in the range of 1.027 to 1.03 and the salinity ranged from 36 to 39% however the tidal channels are hyper saline and the salinity value is much higher in the creek system.

Almost similar conditions were also observed in Gizri

Table 5.19: Average concentrations (Ranges) of Selected Water Quality Parameters along Clifton and DHA Beach

			SELECTED PARAMETER				
S.No	LOCALITY /BEACH	pH	Dissolved Oxygen (mg/l)	Nutrients (ugI-1)			
				PO4-P	NH4-N	NO2-N	NO3-N
1	Keamari (opposite Oil terminal)	8.3-8.4	4.9-6.6	11-48	17-33	0.56-1.1	7.8-27.0
2	Clifton (Opposite Shirin Jinnah Colony)	8.3-8.4	5.4-9.0	12-68	31-41	1.4-4.9	25-26
3	Clifton Beach (Near Casino)	8.3-8.4	4.7-6.6	11-70	59-60	3.9-5.0	8.4-28.0
4	Opposite Sea View	8.3-8.4	4.8-6.5	16-140	57-110	3.6-11.0	16-59.0
5	Gizri Creek	8.3-8.4	4.6-6.4	36-77	36-160	9.8-14	30-81.0

Table 5.20: Nutrient Distribution in Karachi Harbour

General				Nutrients (ugI-1)		
Station	Location	Water Level	Average Depth (m)	PO4-P	NO3-N	NO2-N
1	West Wharf	Surface Bottom	10	10.35 4.28	3.81 –	2.44 –
2	Fish Harbour	Surface Bottom	3	23.25 31.25	0.18 1.83	0.10 1.11
3	Opp.Lyari Mouth	Surface Bottom	3	4.60 4.70	1.35 2.01	0.83 1.28
4	Chari Kund	Surface Bottom	6	6.70 14.0	8.74 6.27	5.16 3.93
5	Manora channel	Surface Bottom	11	14.05 6.05	2.05 6.61	1.02 4.13
6	Mausa Channel near entrance	Surface Bottom	13	4.40 3.05	1.19 16.31	1.29 1.80

Table 5.21: Average concentrations of some physical and chemical characteristics (Nov-Dec, 1999) in the vicinity of Port Qasim

		Parameters						
S.No.	Locations	S.W. Temp °C	Density kg/m3	Salinity %	pH	D.Omg/l	T.D.S ppm	Organic matter mg/l
01	Gizri Creek (Top End)	21.0	1.025	33.950	8.10	2.298	41231	5.75
02	Gizri Creek (DHA Cluub)	20.0	1.025	33.400	8.30	3.957	41385	5.93
03	Korangi Creek (Rehri)	22.0	1.028	37.801	7.83	4.330	33908	2.35
04	Korangi Creek (Lat Basti)	23.0	1.027	36.00	7.43	0.430	50036	3.91
05	PSO Oil Jetty	25.0	1.028	37.00	7.70	3.170	42209	4.96
06	Phitti Creek	22.7	1.029	38.784	7.48	4.250	38972	5.77
07	Jhari Creek	23.0	1.030	39.207	8.10	3.860	34132	6.72
08	Chase Creek	23.0	1.030	38.418	8.20	3.060	42508	4.22
09	Gharo Creek	24.0	1.029	38.443	8.20	3.570	31276	5.48

Creek and Korangi Creek during northeast and Southwest monsoon surveys conducted during 2007 (Kidwai, Personal Communication). They also found the temperature at sub-surface depths in these creeks in the range of 19.38 to 29.08°C, Salinity in the range of 3.6 to 3.89% and dissolved oxygen in the range of 0.15 to 5.76ml/l.

5.2.7.4 SUSPENDED MATTER

The suspended matter in the creek areas has an annual range of 25-170 ppm. The higher values were observed during the southwest monsoon period (usually May-

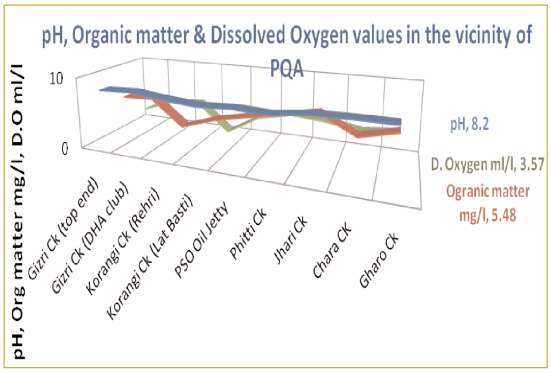


Figure 5.19: Concentration of pH, Organic matter and dissolved values in the Vicinity of PQA.

August). The average suspended load during June-July was between 80-115 ppm. However, higher values (115-170 ppm) were also recorded at some places in the Phitti/Korangi/Kadiro Creek system. Lower suspended matter (25-50 ppm) was recorded from September to March each year when the river flow is considerably reduced. The suspended load in the creeks also exhibits variations with the degree of turbulence during the tidal cycle. During the flood season in the Indus River (June-September) the suspended load rises to about 4000 ppm in Khobar Creek and to about 1500 to 2000ppm in the adjacent creeks.

The transparency of water (Secchi disc disappearance depth) depends on the magnitude of turbidity in the sea water. In Khobar creek the light penetration was up to a depth of <1.0 m. The maximum water transparency in the major creeks of the Indus Delta are 2.5-4.5m in the Gharo creek, 3.0-5.0m in the Phitti creek and 7.0m in the offshore water during the Jan-Feb. period. The minimum values (0.5-1.0m) of sea water transparency in the Gharo/Kadiro creek, <0.2m in the Phitti creek and 0.2 to >2.0m in offshore area adjacent to the creeks, during the May to August period.

The turbidity values in the offshore waters adjacent to the delta are higher during southwest monsoon period than during the rest of the year. Turbidity values are also influenced by the strong tidal flux which reverses its direction during ebbing and flooding. Generally the turbidity is higher during ebb tides, particularly in the shallow creeks. The turbidity is also high within the delta area and in the adjacent coastal waters during river runoff after the rainy season of southwest monsoon.

5.2.7.5 Heavy Metals in Sea Water and Marine Sediments

Some studies conducted during 1990-2000 on Heavy metals have shown higher concentrations of selected heavy metals in water and sediment samples collected from various localities along Karachi coast. (Mirza Arshad Ali Beg, S.N. Mahmood and A.H.K. Yousufzai (1985) Assessment of the Impact of Heavy Metal Pollution on Aquatic Food Animals, Report Prepared for the Pakistan Agricultural Council, pp 32, Saleem et al. 1999, Zaqoot, 2000, Saifullah et al. 2002, 2004). Mangrove habitat has been shown to serve as sink for heavy metals[Mirza Arshad Ali Beg, Ecological Imbalances in the coastal areas of Pakistan and Karachi harbour, Pakistan Journal of Marine Sciences, 4(2), 159-74, 1995].

The sediments are major trap for metals followed by mangrove plants. According to Williams et al. (1996) detrital silicates and sulphides are the principal carriers of iron and other heavy metals and, therefore, make sediments a long term contaminant sink.

The order of accumulation in different sections of habitat is from sediment to pneumatophores to bark to leaves to twigs to flowers. The concentration of copper, iron and nickel in different components of mangrove ecosystem are presented in Tables 5.22-5.26.

5.2.7.6 Sources of Water Pollution

The coastline of Karachi is highly polluted with a variety of hazardous substances of industrial, municipal and agriculture origin, yet there is no proper monitoring or treatment facilities to mitigate their harmful effects. The levels of pollutants particularly heavy metals have already crossed the limits of natural oceanic concentrations (Bruland, 1983) in the vicinity of Karachi such as Karachi Harbour, Sandspit, Korangi creek and creeks adjoining Port Qasim [Mirza Arshad Ali Beg, Ecological Imbalances in the coastal areas of Pakistan and Karachi harbour,

Table 5.22: Concentration (ppb) of Cu in water of mangrove habitat of Karachi

Locality	Average conc. +/- SE*	N**	Range
Sandspit	1.5 +/- 0.49	7	1.06 - 3.26
Karachi Harbour	0.61 +/- 0.18	10	0.02 - 1.86
Korangi Creek	1.17 +/- 0.87	3	0.06 - 1.94
Port Qasim	3.06 +/- 0.63	5	1.89 - 5.17
Lat Basti	1.50 +/- 0.35	7	0.047 - 1.728
Chara Creek	0.78 +/- 0.49	3	0.31 - 1.79
Miani Hor	0.041 +/- 0.00	1	-

*South East ** North

Table 5.23: Concentration of Cu (ppb) in sediments of mangrove habitat of Karachi

LOCATION	Average conc. +/- SE	N	Range
Sandspit	48.09 +/- 2.43	19	28.90 - 65.70
Pir Shams	57.60 +/- 0.0	1	-
Port Qasim	44.02 +/- 0.07	4	36.70 - 51.20
Lat Basti	69.02 +/- 8.09	3	56.90 - 85.60
Chara Creek	46.55 +/- 1.35	2	-
Korangi Creek	48.10 +/- 0.00	2	42.20 - 54.00
Miani Hor	9.80 + 0.0	1	-

*South East ** North

Table 5.24: Average Concentration (ppb) of Fe in water in different mangrove habitats of Karachi

LOCATION	Average conc. +/- SE	N	Range
Sandspit	0.09 +/- 0.025	7	0.020 - 0.176
Port Qasim	0.099 +/- 0.039	5	0.016 - 0.211
Rehri	0.06 +/- 0.03	3	0.021 - 0.118
Chara Creek	0.094 + /-0.042	3	0.010 - 0.152
Karachi Harbour	0.042 +/- 0.114	10	0.019 - 0.059
Lat Basti	0.115 +/- 0.031	1	0.012 - 0.247

*South East ** North

Pakistan Journal of Marine Sciences, 4(2), 159-74, 1995].

The Indus Delta creeks in the vicinity of Karachi and Karachi city have progressively become the Centre of major socioeconomic activities in the country Karachi is not only the major industrial centre but it also has two ports (Karachi and Port Qasim) which play vital role in the development of the economy of the country. It is estimated that about 262 MGD of sewage is generated in Karachi from industrial and domestic sources. Of this 111MGD is contributed through municipal and the remaining from industrial sources (approximately 6000 units). Out of this waste only 20% is treated and the rest is discharged into coastal waters untreated.

It is estimated that Lyari and Malir Rivers contribute 60% and 25% of the total pollution load of Karachi where as 15% of the pollution load is directly discharged into the adjacent open sea coast or to the Gizri, Korangi and Gharo creeks. In the proximity of the creeks adjoining Port

Table 5.25: Average Concentration (ppm) of Fe in sediments of mangrove habitats of Karachi

LOCATION	Average conc. +/- SE	N	Range
Sandspit	25624 + 1778	19	6369 23440
B/Shams Islands	28120 + -	1	-
Port Qasim	27489 + 2481	3	22678 - 31148
Lat Basti	23310 + 4105	3	17657 - 31545
Miani Hor	1248 + -	1	-
Chara reek	30067 + 2515	4	22640 - 33120
Rehri	34436 + 2249	2	29982 - 344336
Phitti Creek	16480 + 9333	2	7240 - 25720
Bkran Creek	23900 + 866	2	23040 - 24760
Shamspir	17060 + 381	2	13280 20840

*South East ** North

Table 5.26: Average Concentration of Ni (ppm) in surface sediments along Karachi Coast

Locality	Average Concentration (ppm)
Sandspit	77.1
B/Shams Islands	58.2
Rehri	52.4
Lat Basti	48.3
Port Qasim	55.1

Qasim area major industrial complexes include Korangi Industrial area (KIA), Landhi Industrial Trading Estate (LITE), Port Qasim Industrial Area and Pakistan Steel Mill. The KIA is located adjacent to Korangi- Kadiro creeks, LITE is situated close to the Kadiro-Gharo creeks and Steel Mill is located on the Gharo creek.

Coastal villages such as Ibrahim Haidery, Rehri, Lath Basti are part of this ecosystem. Thus the entire Korangi creek, Phitti creek, Kadiro creek and Gharo creek form an inter-related system of creeks receiving bulk of the domestic and industrial wastes in the south-east of Karachi.

5.2.7.7 Oil Pollution

The studies on oil pollution prior to Tasman Spirit incident had shown that sediments of Karachi Harbour were generally heavily polluted with oil. The concentration of oil and grease in sediments collected from the creek areas was not as high as found in Karachi Harbour. The concentration of oil in creeks adjoining Port Qasim ranges from 16.25mg/kg to 81.25 mg/kg.

The highest concentration was found in the sediments collected from Gizri creek. Korangi creek sediments are also contaminated by oil and grease which could be attributed to fishing activities at Ibrahim Haideri. The sediments of other creeks adjacent to Port Qasim area have not been found polluted with oil to the same level as Karachi Harbour. The level of oil and grease is very low there and the environment is also not threatened by oil pollution so far (Zaqoot, 2000). The level of total oil and grease in sediments in the vicinity of Port Qasim are presented in Table 5.27.

The seawater samples collected from Gizri creek showed considerable effect of oily wastes mostly released from industrial wastes and Pakistan Refinery effluents discharged through Malir River. Lower degree of oil pollution was observed in the creeks adjoining Port

Table 5.27: Concentration of Oil & grease in marine sediments in the vicinity of Port Qasim (Dec, 1999)

Locality	Average conc + SE
Lath Basti (Korangi Creek)	78.75
Gizri Creek (Opposite Marina Club)	17.50
Phitti Korangi Creek	16.25
Jhari Creek	33.75
Chara Creek	31.25
Opposite Korangi Fish Harbour	20.00

Qasim area such as PSO Jetty, Phitti-Korangi creek, Jhari creek, Chara creek and Gharo creek (Zaqoot, 2000).

In 2003, on 27th July an oil tanker MT Tasman Sprit grounded off Karachi Port Trust near the entrance channel. During August, 2003, approximately 31,000 tons of Crude Oil spilled from this grounded oil tanker and spread along Clifton beach. Scientific investigations to assess the damage to the natural resources as a consequence of the oil spill were undertaken by Pak-EPA under the Ministry of Environment, Government of Pakistan.

The results as summarized were presented at a "National Symposium on Natural Resource Damage Assessment of Tasman Sprit Oil Spill" at Karachi on 30-31 May, 2005. Some of the information presented regarding pollution due to Tasman Spirit Oil Spill along Karachi Coast from August - December, 2003 is presented in Table 5.28.

The oil concentration in surface and deeper water column ranged between 1 to 9 ppm as seen from the Table 5.29. The intertidal area as expected shows higher concentrations which gradually decreasing towards deeper waters. Similar trend was also observed in sediments of intertidal area to deeper waters along the coast of Karachi.

5.2.8 BIOLOGICAL ENVIRONMENT

5.2.8.1 COASTAL & MARINE ECOSYSTEM

Coastal ecosystems provide a wide range of goods and services. They are the primary producers of marine fisheries including shellfish, besides seaweeds for both human and animal consumption. The marine ecosystem is also a source of chemicals, pharmaceuticals, cosmetics, house hold products and construction materials.

5.2.8.2 MARINE FLORA

I) PHYTOPLANKTON

The average, net Primary Production rates are high at Isaro Creek (5-175 mg C/m^3/hour) and Gharo Creek (2 - 111 mg C/m^3/hour) while lower Primary Production rates were

Table-5.28: Concentration of oil in the sediments from coastal waters of Karachi during August to December 2003 after Tasman spirit oil spill

Sampling Zones	Oil concentrations (ppm) (19th August to early September 2003 during the Oil-Spill) Surface Sediments (0-10 cm layer)	Oil Concentration (ppm) (25th October - 10th December 2003) (55 - 65 days after the spill)	
Zone-1	195 ppm	(0-10 cm layer) 300 - 2700 ppm	10 - 30 cm layer 200 - 1800 ppm
Zone-2 (5-10 meter depths)	195 - 968 ppm	(0 - 10 cm layer)	(10 - 30 cm layer)
		300 - 800 ppm	200 - 500 ppm
Zone-3 (10-20 meter depths)	51 - 382 ppm	(0 - 10 cm layer)	(10 - 30 cm layer)
		300 ppm	100 - 250 ppm
Zone-4 (20-30 meter depths)	---	---	---
Average Range	51- 968 ppm	300 - 2700 ppm	100 - 1800 ppm

Table-5.29: concentration of total oil in the water column along Karachi coast after Tasman Spirit oil spill

S.No	Coastal Sampling Zones	Oil Concentrations (ppm) Surface Waters (0.5 m Column)	Oil Concentration (ppm) Bottom waters (0.5 m h)	Oil quantity (tons) (0.5m Column) in 150 Sq km area
1	Zone-I (Inter-tidal areas)	01-09 ppm	15-33 ppm	196.964
2	Zone-2(5-10 meter depths)	02-19 ppm	13-30 ppm	523.361
3	Zone-3(10-20 meter depths)	02-04 ppm	08-25 ppm	225.102
4	Zone-4(20-30 meter depths)	02-03 ppm	08-15 ppm	67.530
	Average Range	02-04 ppm	08-33 ppm	Total = 1012.957

recorded at Gizri Creek (2 -13.5 mg C/m^3/hour) and Phitti-Korangi Creek (1-4 mg C/m^3/hour).

The Primary Production rates at Malir river estuary (5-15.5 mg C/m^3/hour) and at the open sea coastal waters (1.5-14.5 mg C/m^3/hour) adjacent to Phitti-Korangi-Kadiro Creeks were comparable to the rates at Gizri Creek.

The Primary Productivity values from literature for the months of February, March, and June show relatively higher productivity rates for these creeks. The overall Productivity in the mangrove areas has been reported to be high (365-780gC/m^2/year), compared to coastal waters (50-200gC/m^2/Year), which accounts for greater potential for fisheries yield in the former area. (Rizvi 1999.)

II) Mangroves

The Avicenna marina is the dominant species of the mangroves in the Indus Delta. In the PQA creek system the most dominant species are also Avicenna marina that grows on the northern and southern banks of the Phitti - Gharo Creek system. The density of mangrove trees is between 50-60 / 100 m^2. The height of the individual tree within the established Avicenna marina habitats were between 2-3 m near Korangi Creek.

III) Mangrove Population Density

PQA is part of the Indus Delta. The Indus Delta supports one of the largest single mangrove ecosystems in the tropical coastal environments. In the Indus Delta mangrove ecosystem, eight species of mangroves have been reported out of 53 species known to occur in the tropical forests of the world. Other mangrove species in the deltaic region such as the Ceriops tagal occur in localized patches and there are a few plants of Rhizophora mucronata. All other species are rare and have disappeared from most part of the Delta due to adverse environmental conditions.

The mangrove trees growing 200-300 m away from the creek (seawater) in the land ward direction showed an overall decline in the height of the mangrove plantations. The density of mangrove vegetation was randomly evaluated a100 m^2 area within the PQA. The trees were characterized by visual observations according to their arbitrary height (Table 5.30).

- The height of mangrove seedling were characterized as <0.25 m
- Mangrove sapling height 0.5 -1.0 m
- Short mangroves trees were characterized as having 1-2 m height.
- Medium height mangroves trees had were characterized as having 2-3 m height.
- High mangroves trees had were characterized as having 2-3 m height.

Densities of high mangrove plantation were poor at station at the coastline/high water mark of Brown Field site. Mangrove saplings / seedlings / propagules of A. marina were observed to be in greater numbers (100-150 m^2) at the entire area except the one fronting the open channel. Mangroves at high water mark shown in Figure 5.20 (a) and 5.20 (b)

IV) Creek Erosion and Mangroves

Considerable sediment erosion was observed in the project area. Well established mangrove plantations (high tress) were observed to be under stress due to eroding sediments in the Phitti - Gharo Creek system as shown in Figures 5.21 and 5.22. The factors responsible for the excessive erosion may be strong currents during ebb and flow of tides and also the waves generated as a result of moving vessels in the creek. However, low sediment load in the Indus River discharges and human activities including camel grazing is largely responsible for uprooting the trees whose pencil-like roots were holding the sediment/mud. Their removal by the root destabilized the soil of the mud flat. The proposed terminal is before Phitti creek.

Rizvi (1999) observed annual values of the suspended matter in the Indus creek system in the range of 25-170 ppm. The higher values were observed during the southwest monsoon period (usually May-August). The average suspended load during June-July was between 80-115 ppm. However, higher values (115-170 ppm) were

also recorded at some places in the Gharo/Korangi Creek system. Lower suspended matter (25-50 ppm) was recorded during March and the September-November period. The suspended load in these creeks also exhibits variations with the degree of turbulence during a tidal cycle. During the flood season in the Indus River (July - September) the suspended load rises to about 4000 ppm in Khobar Creek and to about 1500 to 2000ppm in the adjacent creeks.



a



b

Figure 5.20 (a) and 5.20 (b). Natural vegetation of Mangroves, young saplings & seedling of Avicenna marina in patches (100-150 m^2) at high water mark, substrate mud to clayey



Figure 5.21: Established mangrove trees Avicenna marina collapse due to Coastal erosion in the southern bank of the Phitti Creek. Bow wave created by large vessels also contributes towards coastal erosion.



Figure 5.22: Eroded mud banks and destruction of mangrove community

5.2.8.3 MARINE AND BENTHIC FAUNA

I) MARINE BENTHIC INVERTEBRATES. (MBI)

The MBI plays an important role in mixing the organically enriched bottom sediments. The MBI are a key linkage in transferring the energy from lower trophic level to the next higher trophic level in the food chain. The species distribution pattern of benthic invertebrates in the PQA area of interest is randomly distributed, while a few species aggregate as shown in table 5.28. The distribution of invertebrates is dependent on the surface current that redistributes the planktonic larval form to locations away from where they were spawned they are hence random in their population densities. Aggregation is also a function of reproduction, where the benthic organisms tend to colonies together. Nematodes, Annelid Polychaete worms, bivalve mollusk, Pinnotherid crabs, and species of Tanaidacean were by far the most dominant benthic species in the

Table 5.30 Density and tree heights of mangrove Avicenna marina in 100 m² area at each of the stations surveyed

Positions Lat/Long.	Mangrove Heights	(%) Mangrove Density/100m²
N 24, 47, 367 E 067, 15, 67	High	60
	Medium	30
	Short	5
	Sapling	5
N 24, 46, 271 E 067,3, 547	High	40
	Medium	40
	Short	10
	Sapling	10
N 24, 46, 850 E 067,19, 955	High	30
	Medium	60
	Short	5
	Sapling	5
N 24, 43, 576 E 067,18, 607	High	0
	Medium	20
	Short	30
	Sapling	50
N 24, 47, 210 E 067,15, 982	High	70
	Medium	20
	Short	5
	Sapling	5
N 24, 46, 302 E 067,18, 032	High	50
	Medium	30
	Short	10
	Sapling	10
N 24, 45, 728 E 067,18, 934	High	50
	Medium	30
	Short	15
	Sapling	5

benthic samples collected from the project area.

Methodology for Habitat Surveys

In order to evaluate the baseline population of coastal faunal communities, four sampling stations were identified approximately 2-3 km in the East/West and North/ South direction from the EVTL Jetty. The surveyed was undertaken at low tide (0.2 m MSL). A shallow draft, fiber boat 4 m in length with an outboard motor (10 HP) was used to access the locations along the coast and to observe changes in coastal habitats. A hand held GPS (GarmineTrek) was used to mark changes in the coastal configuration, and mark any significant marine faunal sightings. The boat was navigated at slow speed between 2-3 Kts, along the coast at shallow depths of less than 1-2 m. The coastal area and the mangroves observation were made from were within 20-25 meters distance from boat. The main objective of a faunal survey was to identify the faunal habitats and the assemblage of species present. Estimates of relative species abundance at each station was accomplished by using a quadrat to represent 0.5 x 0.5 m² surface area. The small quadrat size are considered most suitable for a study of the dispersion of substrate faunal assemblages.

Table 5.31 Specie wise distribution of Marine Benthic Invertebrates and their distribution pattern in PQA benthic samples collected in close vicinity of the proposed jetty

Species	Variance	Mean	Chi-sq	d.f.	Probability	Aggregation
Brittle star (Amphiurid)	0.2292	0.3125	11	15	0.7534056	Random
Annelida (Polychaeta)	3.2292	2.1875	22.1429	15	0.1037196	Random
Mollusca (Gastropods)	2.5958	1.0625	36.6471	15	0.0014828	Aggregated
Ostracods	0.1167	0.125	14	15	0.525942	Random
Crabs (pinnotherid)	2.4667	0.75	49.3333	15	0.0000186	Aggregated
False Crabs	0.0625	0.0625	15	15	0.4515619	Random
Hydrozoan	0.3833	0.375	15.3333	15	0.4277409	Random
Sea anemone	0.0625	0.0625	15	15	0.4515619	Random
Amphipods	6.65	1.125	88.6667	15	0	Aggregated
Nematoda	1.8292	0.6875	39.9091	15	0.0005004	Aggregated
Tanaidacean	26.5333	3	132.6667	15	0	Aggregated

The Habitat surveys were undertaken during low tides at daylight hours. Low tides facilitated in exposing submerged mud flat community. The species were identified upto genus level in the field, using standard field guides. Sediment substrate and sea surface water samples were collected. The substrate samples were collected using a plastic spatula that was penetrated approximately 15-20 cm depth into the soft sediments at each station. The replicated substrate samples were preserved in the field in large mouth plastic containers containing 10% formalin. The preserved samples were sent to the National Institute of Oceanography (NIO) Karachi for analysis of interstitial benthic fauna (macro/meiofauna) and identification of collected specimens. Standard identification and analysis techniques were followed. The specimens were also photographed under state of the art binocular microscope for record.

Appropriate statistical analyses were performed using dedicated statistical software packages for data crunching and interpretation of results.

Four Random stations for Benthic Invertebrates were identified by using a hand held Global Position System (Garmin GPS) along a transect at different locations to correspond to near zero tidal heights during the day light hours that would facilitate in survey of exposed mud flats, coastal habitats and the Mangrove community within a radius of 2 Km from the proposed planned site near EVTL.

The components that were considered necessary for undertaking the survey in order to establish an environmental baseline survey in the proposed area included Marine fauna and the associated ecosystems. Documenting all the plants and animals living in the port area was not a viable option. Instead, the habitat components with the highest likelihood of being affected by the project were examined.

The Marine Benthic Invertebrates (MBI) plays an important role in mixing the organically enriched bottom sediments. The MBI are a key linkage in transferring the energy from lower trophic level to the next higher trophic level in the food chain.

Statistical Analysis of Benthic Invertebrate Fauna

The statistical analysis was performed on benthic invertebrates species observed at different location using statistical software package. The faunal samples were sorted, enumerated and identified using standard identification keys. The overall faunal statistic is shown in Table 5.33.

The species distribution pattern of benthic invertebrates in the PQA area of interest is randomly distributed, while a few species aggregate (Table 5.34). The distribution of benthic invertebrates and interstitial fauna (macro and meiofauna) is dependent on the surface current that

redistributes the planktonic larval form to locations away from where they were spawned they are hence random in their population densities. Aggregation is also a function of reproduction, where the benthic organisms tend to colonies together. The substrate sediment samples taken from the creeks, Littorina sp. Nemetodes, Annelid Polychaete worms, Capitellids, bivalve mollusk, were by far the most dominant interstitial species observed in the benthic sediment samples collected from Kadiro Creek, PQA.

Benthic Species Biodiversity Index

The Shannon Weiner species biodiversity index is a useful tool for measuring the health of the ecosystem. The biodiversity values observed for benthic species to range from a minimum of 0.441 at station D at station location C to a maximum of 0.976 at station location A and 0.677 at Station B respectively. The species diversity values in PQA are generally low, since the whole areas is disturbed due to navigational, dredging and shipping activity. Further, sediment grain size and compactness (Silt/clay) provides less interstitial space and less oxygenated water for the benthic animals to survive, which leads to higher Redox Potential Discontinuity Layer. (RPD).

Marine Benthic Invertebrates Cluster Analysis

Bray and Curtis cluster analysis was performed to evaluate the relationship between the similarities of species in the samples. This is given in the form of a dendrogram figure 5.26. That shows stepwise similarity were groups at locations observed (stations) are not clearly dissimilar from each other. (Sample. A, B and D show similarity), while Species in sample C are placed under a different dendroline although not too dissimilar with AB&D shown in benthic invertebrate groupings.

Refraction Plot

Rarefaction is a technique to assess species richness from the results of sampling. Rarefaction allows the calculation of species richness for a given number of individual samples, based on the construction of so called rarefaction curves. This curve is a plot of the number of species as a function of the number of samples. The steep slope indicates that a large fraction of the species diversity remains to be discovered. If the curve becomes flatter to the right, a reasonable number of individual samples have been taken: more intensive sampling is likely to yield only few additional species. Rarefaction curves generally grow rapidly at first, as the most common species are found, but the curves plateau as only the rarest species remain to be sampled. (Figure 5.27)

Table 5.32: Sampling station and locations in proximity to EVTL Jetty.

Station No	Date	Sampling Location/Station	Lat N. Long E Substrate Type	Tidal height m	Type Survey
A	25th. Nov	24 46 49.53 N, 67 19 18.93 E	Mud to fine sand	0.9 m Ebb	Habitat Survey, benthic invertibrates
B	25th. Nov	24 46 43.23 N, 67 19 28.02 E	Mud to Clay	0.8 m Ebb	Habitat Survey, benthic invertibrates
C	25th. Nov	24 46 42.21 N, 67 19 13.57 E	Mud to Clay	1.0 m Flow	Habitat Survey, benthic invertibrates
D	25th. Nov	24 46 36.08 N, 67 19 21.66 E	Mud to Clay	1.0 mFlow	Habitat Survey, benthic invertibrates

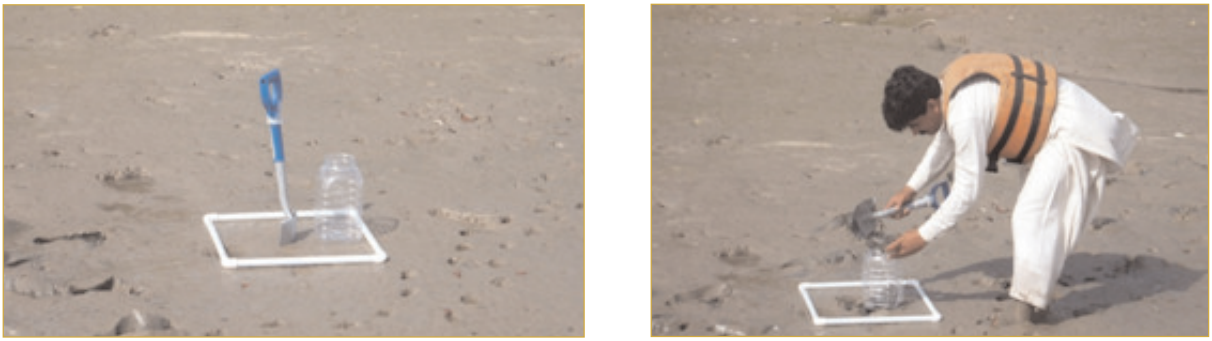
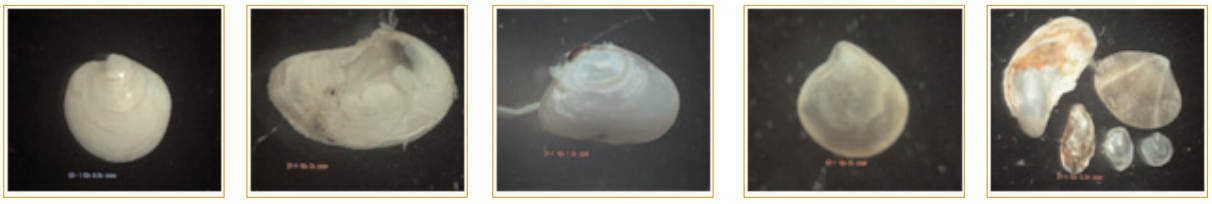


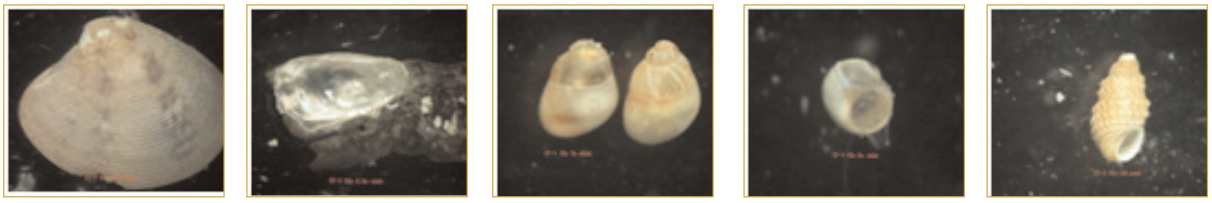
Figure 5.23: Sampling substrate using a 0.5 x0.5 m quadrate at the sampling stations.

Table 5.33:Faunal statistic of marine benthic invertebrates collected from the sampling stations in Kadiro Creek PQA.

Sample	Mean Individuals	Variance	Standard Deviation	Standard Error	Total Individuals	Total Species	Minimum	Maximum	Mean Confidence Interval
Sample A	9.273	224.97	14.999	3.198	204	18	0	64	94.009
Sample B	5.818	149.68	12.234	2.608	128	6	0	44	62.547
Sample C	2.091	37.134	6.094	1.299	46	6	0	28	15.517
Sample D	12.364	1335.861	36.549	7.792	272	5	0	156	558.221



Dosinia sp. Soletellina sp. Trapezium sp. Mactra sp. Bivalves sp

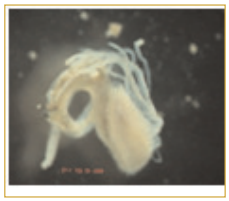


Gafrarium sp. Oyster sp. Littorina sp. Natica sp. Gastropod sp

Figure 5.24: Diversity of Molluscs invertebrate in benthic sediments observed at the sampling stations

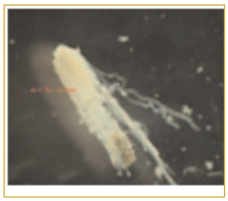
Table 5.34. Species distribution and aggregation behavior in sampled stations

Species	Variance	Mean	Chi-sq	d.f.	Probability	Aggregation
Dosinia sp.	1	0.5	6	3	0.1098782	Random
Soletellina sp.	9	1.5	18	3	0.0005294	Aggregated
Trapezium sp.	1	0.5	6	3	0.1098782	Random
Mactra sp.	9	1.5	18	3	0.0005294	Aggregated
Un identified	36	3	36	3	3.00E-07	Aggregated
Gafrarium sp.	1	0.5	6	3	0.1098782	Random
Littorina sp.	5732	43	399.907	3	0	Aggregated
Natica sp.	1.3333	1	4	3	0.260453	Random
Fam: Spionidae a	9	1.5	18	3	0.0005294	Aggregated
Scolelepis sp.	1	0.5	6	3	0.1098782	Random
Fam: Ampharetidae	169	6.5	78	3	0	Aggregated
Nephthes sp.	1	0.5	6	3	0.1098782	Random
Cossura sp.	289	8.5	102	3	0	Aggregated
Fam: Capitellidae	950.3333	24.5	116.3673	3	0	Aggregated
Spionidae b	4	1	12	3	0.0075408	Aggregated
Tanaidacean	22.6667	3	22.6667	3	7.02E-05	Aggregated
Nematode	1190.333	24.5	145.7551	3	0	Aggregated
Bivalves	187.6667	7.5	75.0667	3	0	Aggregated
Nereid worm	76	5	45.6	3	0	Aggregated
Polycheate	453.3333	22	61.8182	3	0	Aggregated
Ocypod Crabs	76	5	45.6	3	0	Aggregated
Amphipod	1.3333	1	4	3	0.260453	Random

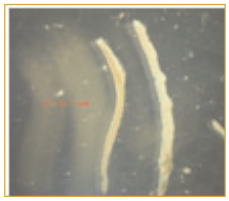

Spionid worm sp.A

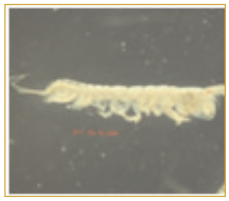

Ampharetidae


Naphthydidae


Spionid worm sp.B


Spionid worm sp.3


Capitellidae


Tanaidacean


Amphipod

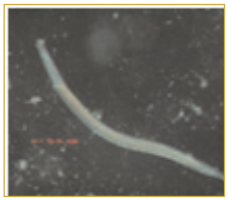

Nematode worm

Figure 5.25. Marine Benthic fauna observed in the samples from Kadiro Creek.

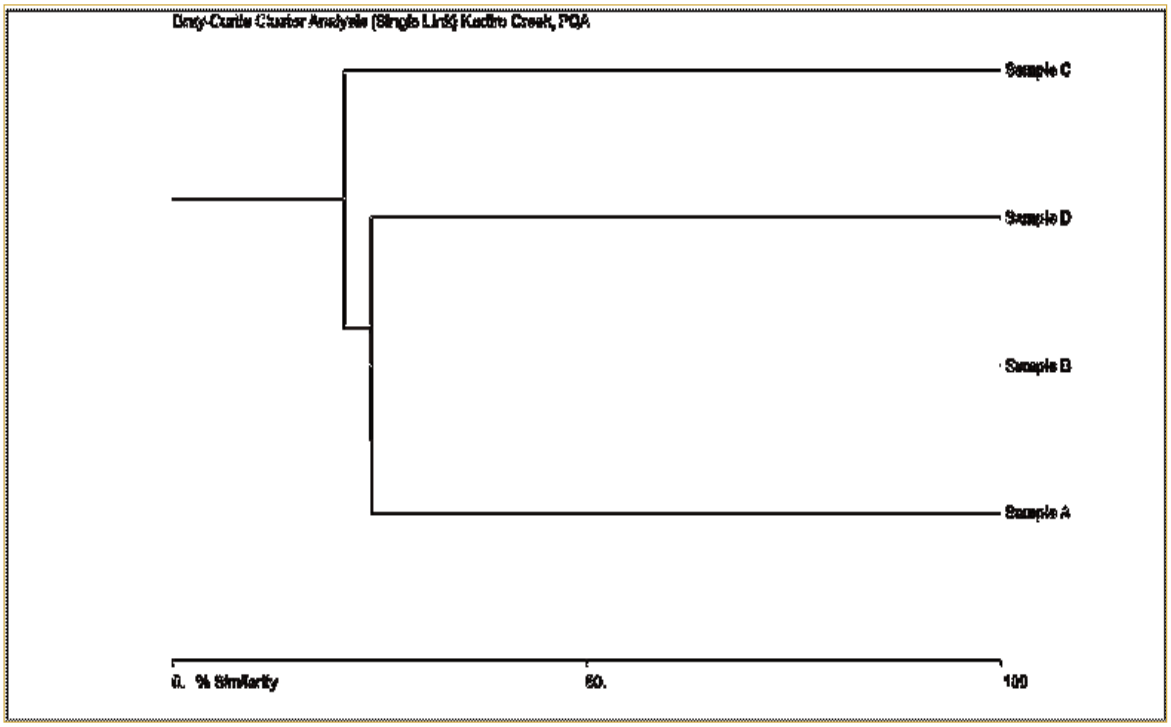


Figure 5.26: Similarity index Bray –Curtis Cluster analysis

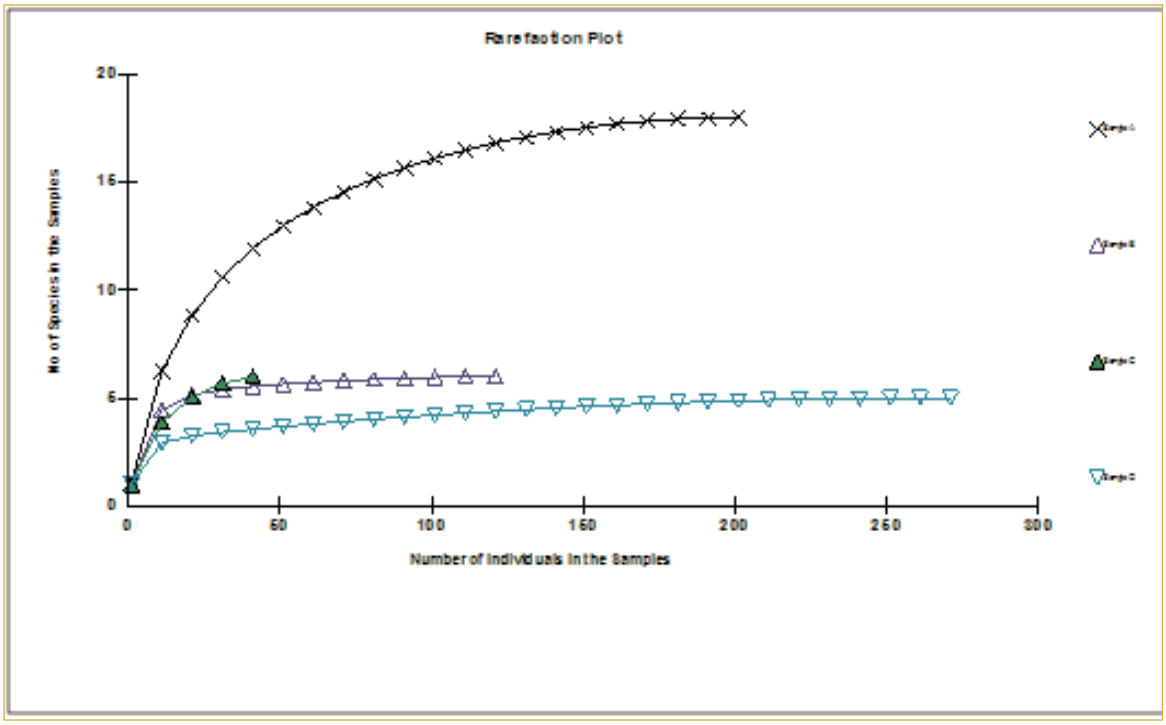
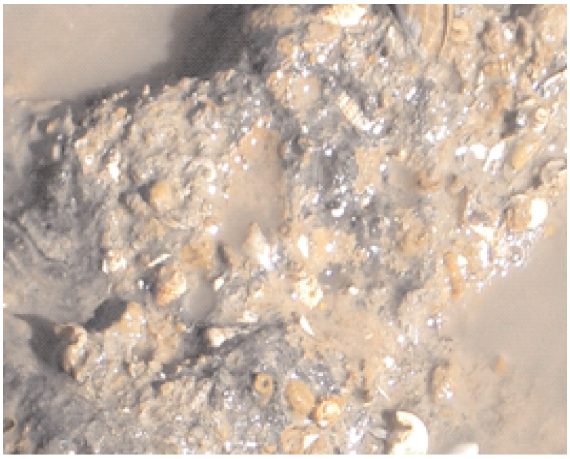


Figure 5.27: Rarefraction plot showing No. of Species and No of individuals in the samples

Table. 5.35. Statistical parameters and dispersion pattern of species observed in the mudflats in the Coastal Habitat Survey conducted at each of the sampled at PQA and its vicinity

Invertebrate sp	Variance	Mean	Chi-sq	d.f.	Probability	Aggregation
Metaplex disctincta	0.2857	0.4286	4	6	0.6788355	Random
Volutidae	0.2381	0.2857	5	6	0.5453557	Random
Caridean Shrimp	19.2381	2.2857	50.5	6	0	Aggregated
Eurycarcinus orientalis	0.2857	0.4286	4	6	0.6788355	Random
Marcinaria	0.619	0.4286	8.66	6	0.192137	Random
Cerithidae	0.2381	0.2857	5	6	0.5453557	Random
Bullia	0.2381	0.2857	5	6	0.5453557	Random
Barbatia	0.2857	0.4286	4	6	0.6788355	Random
Gafrarium	1.2857	0.4286	18	6	0.0063792	Aggregated
Telescopium	1.4762	0.8571	10.33	6	0.1103398	Random
Marcinaria	3.5714	0.7143	30	6	5.19E-05	Aggregated
Tellina (Tellinidae)	0.2381	0.2857	5	6	0.5453557	Random
Codakia(Lucinidae)	0.2381	0.2857	5	6	0.5453557	Random
Cerithium (Cerithidae)	17.2857	1.5714	66	6	0	Aggregated
Turritella(Turritellidae)	20.5714	1.7143	72	6	0	Aggregated
Nerita spp	0.1429	0.1429	6	6	0.4236949	Random
Polycheate (worms)	0.8095	0.8571	5.66	6	0.5375987	Random



a



b

Figure 5.28 (a) and (b): Carid shrimps and Cerithium spp, Turritella spp are clumped together in the mudflat at Phitti Creek near Khiprianwala Island site.

5.2.8.4 COASTAL HABITATS

Coastal areas and the intertidal region is a complex system where the division between land and sea is unclear. Coastal intertidal areas have a diverse range of communities including sandy shores, mudflats, and mangrove forests.

In the PQA, the Phitti Creek has faunal community characteristic of very fine sediments from muddy to

clayey. The communities included mud flats which were dominated by faunal assemblages representing the soft sediments with high percentage of silt and clay. The sediment substrate was generally found to be high in organic content and with black mud just below the substrate.

Results of Coastal Habitat Survey are presented below:

I) Faunal Communities

The PQA area of interest and the associated Creeks had faunal communities that are characteristic of mud flats. The substrate had very fine sediments (mud and clay). The faunal communities present were dominated by faunal assemblages representing the soft sediments. Table 5.34, provides information on the statistics of species at PQA and its vicinity; the mean individuals in along with variance, standard deviation and standard error of mean.

The result of spatial dispersion of a population describes the spatial distribution of the individuals in the population. Temporal changes in dispersion will usually occur, and different stages of the same species will often show different patterns of dispersion.

Crustacean Caridean Shrimp, were abundantly distributed and showed an aggregate distribution pattern at station H6. The Carid shrimps were easily caught with the hand held scoop net. The scoop net measuring 10 X 10 cm caught 15-20 shrimp. The bivales Gafrarium spp, Marcinaria, and Gastropod Cerithium spp, Turritella spp were also found to aggregate in the mud flat habitat collected at the stations surveyed in the PQA area.

Statistically, the dispersion of a Population determines the relations between the variance and the arithmetic mean. If the variance more or less equals the mean then the Population is said to be randomly distributed. If the variance is less than the mean the Population is termed as regularly distributed. And if the variance is greater than the mean then the Population is considered as being an aggregate population that is known as being found in clumps. The highly aggregate populations of Caridean Shrimp Species: Cerithium spp, Turritella spp have been found as clumped together.

Cerithium species are a large group characterized by an upturned canal in their shell that protects the siphon and allows them to live just beneath the substrate. Cerithium spp are algae and detritus feeders and are common prey for predatory mollusks.

Turritella are by far the largest family group and also one of the oldest, being represented in the fossil record as long as 135 million years, during the Cretaceous Period. During this presence on Earth, they have occupied every geographical locality and are ubiquitous.

II) Animal Communities

The beaches of the creeks adjoining Port Qasim area are mostly muddy - sandy or muddy. Hard bottom beaches are generally absent in this area but occasionally one may be found. Animal communities of different substrate (muddy cum sandy and hard substrate) in PQA and its vicinity are shown in Table 5.36.The animal communities inhabiting different creeks are described below:

a) Korangi Creek (Ibrahim Haidery Beach)

This is muddy - sandy beach with very gradual slope. The beach is greatly affected by anthropogenic eutrophication as it receives domestic effluents, fisheries wastes from a fishing village and heated effluents from a KESC power plant. Suspension feeding/filter feeding bivalves are mostly absent from the beach. Sometimes ago Placuna placenta, the window-paneoyster, and the brachiopod Lingula sp which used to abound on this beach have disappeared. The cause of their disappearance may be either too much siltation or anoxic condition of the habitat. The beach is inhabited by fiddler crabs and mud skippers. In winter the mud flats are covered with Enteromorpha and Ulva mats.

b) Bakran Creek of Gharo-Phitti Creek System

This is a long mud-sand flat in the Port Qasim area. It

Table 5.36: Animal communities of different substrate (muddy cum sandy, hard substrate, in PQA and its vicinity.

Species	Variance	Mean	Chi-sq	d.f.	Probability	Aggregation
Uca lactea (fiddler crab)	5.3333	2.6667	4	2	0.132834	Random
U. annulipes (fiddler crab)	1.3333	1.3333	2	2	0.369441	Random
Eurycarcinus orientalis (crab)	0.3333	0.6667	1	2	0.612402	Random
Macrophthalmus pectinipes (crab)	0.3333	0.3333	2	2	0.369441	Random
Grapsus sp (crab)	1.3333	1.3333	2	2	0.369441	Random
Scylla serrata (crab)	1.3333	1.3333	2	2	0.369441	Random
Cerianthus sp (sea anemone)	1.3333	0.6667	4	2	0.132834	Random
Loimia medusa (polycheate)	0.3333	0.6667	1	2	0.612402	Random
Hesione pantharina (polycheate)	0.3333	0.6667	1	2	0.612402	Random
Lycastis indica (polycheate)	1.3333	0.6667	4	2	0.132834	Random
Nemertean worms (nemertean)	1	1	2	2	0.369441	Random
Crassostrea rivularis (oyster)	0.3333	0.6667	1	2	0.612402	Random
C. gryphoides (oyster)	0.3333	0.3333	2	2	0.369441	Random
C. madrasenis (oyster)	0.3333	0.6667	1	2	0.612402	Random
C. globmerata (oyster)	5.3333	2.6667	4	2	0.132834	Random
Placuna placenta (oyster)	0.3333	0.3333	2	2	0.369441	Random
Dosinia sp (clam)	0.3333	0.3333	2	2	0.369441	Random
pitar nobilis (clam)	0.3333	0.3333	2	2	0.369441	Random
Pandora flexuosa (clam)	1.3333	0.6667	4	2	0.132834	Random
Dentalium sp (tusk shell)	0.3333	0.3333	2	2	0.369441	Random
Tellina sp (clam)	0.3333	0.3333	2	2	0.369441	Random
Telescopium telescopium (snail)	0.3333	0.3333	2	2	0.369441	Random
Cerithidea cingulata (snail)	5.3333	1.3333	8	2	0.018062	Aggregated
Thais sp (snail)	2.3333	1.6667	2.8	2	0.245286	Random
Natca sp (snail)	0.3333	0.6667	1	2	0.612402	Random
Mudskipper (fish)	5.3333	2.6667	4	2	0.132834	Random
Balanus amphitrite (barnicle)	5.3333	2.6667	4	2	0.132834	Random
Diodora sp (limpet)	1.3333	0.6667	4	2	0.132834	Random
Glycymeris sp (pectin)	0.3333	0.3333	2	2	0.369441	Random
Anomis sp (oyster)	1.3333	0.6667	4	2	0.132834	Random
Pinna bicolor (mussel)	0.3333	0.3333	2	2	0.369441	Random
Perna sp (mussel)	0.3333	0.3333	2	2	0.369441	Random
Cypraea sp (snail)	0.3333	0.3333	2	2	0.369441	Random
Euchelus sp (snail)	0.3333	0.3333	2	2	0.369441	Random
Ozius rugulosus (crab)	0.3333	0.3333	2	2	0.369441	Random
Ascidians (sea-squirt)	1.3333	0.6667	4	2	0.132834	Random

Table - 5.37: Break-up of Mangrove Habitat Fish Fauna

Species Name	Number of species
Clupeiformls	15 Species
Scopeliformes	04 Species
Cyprinitbormes	06 Species
Anguillifomes	02 Species
Perciformes	46 Species
Betoniformes	03 Species
Syngnathi formes	05 Species
Mugiliformes	06 Species
Polynemiformes	04 Species
Pleuronectifomes	06 Species
Batrachodiformes	61 Species

receives effluents from the Port area and from Pakistan Steel Mill as well as anthropogenic contributions from local villages along the delta. It has a gradual slope with mangrove stands towards low tide. Isolated small stunted mangroves occur further up shore. The barnacle Balanus amphitrite is abundant on the leaves of the mangroves Avicennia marina. In this area Enteromorpha and Ulva cover the beach in winter. The animal communities are not very abundant except mudskipper fish, fiddler crabs and the snail Cerithidea cingulata a pollution indicator species.

c) Broekhoven Jetty Beach (Gharo-Phitti Creek System)

This is an unusual beach in the Gharo-Phitti creek system being a hard rocky beach. It has a slight slope and is covered with mud, sand and on some places, oil sheen. This beach shows the greatest diversity of animal species in the area. It is characterized by the presence of a large bed of dead, edible oysters although live oysters are also found occasionally. The beach has a number of invertebrates, such as sea urchins, ascidians, sponges, colonial coelenterates and ophistho branch mollusks which are indicative of oceanic conditions. The beach is located about 18 km inland from the open sea in the Port Qasim area. The oceanic influence seems to have reached here because of the greater inflow of water from the sea following the deepening of the Port Qasim navigational channel to accommodate large vessels.

d) Marine Algal Epiphytes in Mangroves of Korangi Creek

In the mangrove ecosystem the producers are the mangroves and marine algae both micro and macroscopic. While the algae are not as large and dominant as the mangroves they nevertheless contribute significantly to the energy budget of the system. The macroscopic algae grow on the lower parts of the mangrove plants mostly on the Pneumatophores with the exception of Enteromorpha intestinalis and Ulva reticulatewhich form a green mat on the dark mud of the mangrove habitat (Saifullal and Nizamuddin, 1977). Marine algae inhabiting the mangrove area of Korangi Creek and its vicinity have been reported by Saifullah and Taj (1995). They collected the algae from the Pneumatophores of Avicenia marina growing luxuriantly in the Korangi Creek and adjacent areas. They have reported twelve species of marine macro algae growing as epiphytes. That species belonging to the four major groups of algae i.e. Chlorophyta, Phaeophyta, Rhodophyta and Cyanophyta found in mangroves of Korangi Creek are listed below:

- Chlorophyta
- Boodleopsis Pusilla
- Chaetomorpha gracilis
- Cladophora sp
- Enteromorpha torta
- Rhizoslonium kerneri
- Phaeophyta
- Hincksia terminalis
- Rhodophyta
- Caloglossa leprieurii
- Herposiphonia secunda
- Polysiphnia abcissa
- Cyanophyta (Cyanobacteria)

- Hydrocoleum lyngbaceum
- Lyngbya majuscula
- Phormidium ambiguum

III) FISHERY

According to Government of Pakistan (2005) fish and fishery related sector engages 1% of the Pakistan's population. The fishery sector generates 1% of Pakistan GDP earning through export of fishery products. Coastal and offshore areas of Pakistan support large fisheries.

Fishing grounds for large pelagic species such as tuna, mackerel, sharks etc are located in the offshore waters. Whereas the species like mullet, silver wittings and other small sized demersal fishes specially juveniles of large commercially important estuarine fish are harvested from shallow water in the creek area of Indus as well as enclosed and semi-enclosed bays along the coast of Pakistan.

Ahmed (1983) reported 98 species of fish from mangrove



a



b

Figure 5.29 (a) & (b:) Scylla serrata Mud crab found in the mangrove mud flat in PQA area.



c



d

Figure 5.29 (c) & (d): Local crab fisherman; excavating exposed mud flat at low tide to locate mud crabs and transporting them in live in wet gunny bags in PQA

swamps of Korangi-Phitti creek system and backwaters of sandspit. Out of these 98 species 46 species were fingerling or young stages while 52 species were either sub-adult or adult. Mudskippers have adopted themselves to live in this particular environment. Pleuronectiformes which represent bottom living fish move towards this area for their food. Many detritus feeders like clupeids, grey mullets etc. and small carnivorous fish like silver biddies and pony fish find this environment suitable for their living. The order and species wise break-up of the mangrove habitat fish fauna are given in Table-5.37.

In Korangi Creek and the adjoining creeks areas Ahmed (1988) has described in detail four types of fish groups; the permanent dwellers which are few; partial residents; tidal; and seasonal visitors in the mangrove habitat where over 180 species of fish have been reported. As many as 148 species of fingerlings or young stages and juveniles have been reported from the mangrove of Indus Delta (UNESCAP, 1996). More common larvae of fishes described for Korangi Creek and adjoining creeks in Indus Delta belong to the families Mugilidae, Gerreidae, Clupeidae, Nemipteridae, Gobiidae, Sciaenidae, Engraulidae, Sillaginidae and Lutjanidae. Their abundance from season to season varies. There are a number of settlements of fishermen along the creeks of Indus Delta which depend on the fisheries resources of these creeks.

a) Benthic Fish Community

Benthic fish community includes the microbes: detritus feeders, small and large herbivores, and small and large carnivores. In the mangrove ecosystem, the benthic community of the adjacent shallow water is a subject of interest. Here, the microbes decompose the plant litter into organic detritus-a fundamental commodity of system energy. This detritus matter is picked up by the detritus feeders over the bottom, such as fishes, shrimps and shellfish, and then carried to the littoral zone by wave action, shared by the intertidal fauna such as crabs, shrimps, mudskippers, and other invertebrates. Grey mullets, gizzard shads, flat fishes, many skates and rays are some of the fish which prefer to live on soft bottom and feed on bottom detritus. At low tide, when a large part of muddy bottom is exposed, crabs, mudskippers and" waders are seen in large numbers picking up their food which includes worms and

Table 5.38: Biodiversity of bird fauna at Korangi/Phitti creek system

S.No.	Family	Genera	Species	Population Status		
				A	C	LC
1.	Phalacrocoracidae	1	2			2
2.	Pelecanidae	1	1			1
3.	Ardeidae	4	7		4	3
4.	Phoenicopteridae	1	1			1
5.	Accipitridae	3	4		3	1
6.	Charadriidae	7	18	1	9	8
7.	Recurvistridae	2	2		-	2
8.	Laridae	5	11		5	6
9.	Alecedinidae	3	3		3	
10.	Meriopidae	1	1		1	
11.	Motacillidae	1	1		1	
12.	Corvidae	1	1	1		
	30	52	2	26	24	

A = Abundant, C = Common, LC = Less Common *Source: Hasan (1996)*

different animals left behind by the receding tide.

b) Pelagic Community

Pelagic community includes powerful swimmers, which are exclusively carnivore in nature like predaceous fishes, croakers, snappers, barracudas, sharks, sea basses, carangids breams, perches, mackerels and sea snakes. Dolphin and seagulls are some important forms, which readily pick up fishes, shrimps, and cephalopods for food. In the mangrove ecosystem the predaceous forms are often small in size and easily wander among the mangroves at high tide.

c) Artisanal Crab Fishery

Local fishing community members from nearby village fish for mud crabs Scylla serrata during low tide. The mud crab burrows in mudflats in close proximity to the mangrove plantation. The locals excavate the soft mud with bare hands during low tide. The crabs are caught from their habitats and kept alive in moist gunny bags (Figure 5.24 c & d). The gunny bag containing crabs are towed by a small wooden boat to be sold in the village for



Figure 5.30: Greater flamingos between 70-80 birds in flight

further processing and possibly for exports to foreign countries by the crab processing factory. The local earn their livelihood through the capture and sale of mud crabs.

d) Cetaceans

Dolphins have been sighted in the Korangi-Phitti-Gharo Creeks system and. The survey team did not see any dolphins in the area during the boat survey. There is no published information available with regards to the number of Cetaceans that visit the area.

Similarly, the team did not find any feeding turtles in the area nor any turtle tracks were found on the muddy shores. No turtle nest was observed. It is unlikely that the turtles would nest in muddy substrate, they prefer sandy substrates instead.

5.2.8.5 Birds Population in PQA

Korangi-Phitti-Gharo Creek system is reported to harbour 52 species belonging to 30 genera and 12 families as shown in table 5.38. The Populations of Pluvialis squatarola (Grey Plovers), Pluvialis apricaria apricaria (Golden Plover), Charadrius mongolus atrifrons (Lesser Sand Plover), Numenius arquata arquata (Curlew), Limosa limosa limosa (Bartailed Godwit) and Xenus cinereus (Terek Sandpiper) are fewer in numbers in Korangi/Phitti creek system than the birds observed in Shah Bundar area of the Indus delta.

i) Endemic Birds of Indus Delta

The mangroves of the Indus Delta provide abundant food and shelter to a number of endemic species of birds. The common birds are Oystercatcher, Lesser Sand Plover, Greater Sand Plover, Grey Plover, Golden Plover, Little Ringed Plover, Kentish Plover, Sanderling, Dunlin, Curlew, Whimbrel, Marsh Sandpiper and Common Sandpiper.

Breeding activities of a number of endemic birds have been reported in the coastal wetlands the Delta particularly Little Tern, Common Tern, Gullbilled Tern, Yellow legged Herring, Lesser Black backed Gull and Great Black headed Gull.

ii) Migratory Birds

The common migratory waterfowl of the lakes in the



Figure 5.31: Patches of terrestrial vegetation family Gramineae observed growing at high water mark level.



Figure 5.32: Patches of terrestrial vegetation family Gramineae observed growing at high water mark level



Figure 5.33: Patches of terrestrial vegetation family Chillopodaceae observed growing at high water mark level

Indus Delta include a variety of ducks including Dunlin, Redshank, Coot, White Pelicans, Flamingoes, and Spoonbills. The Indus Delta also provides refuge for the rare species of birds such as Painted Stork, White Stork, Greater Knot, Crane, Ruddy Shelduck (SURKHAB), Greyleg Geese, Common Shelduck and Marbled teal.

5.2.8.6 Marine Mammals

Marine mammals belong to the order Cetacea and include dolphins, porpoises and whales. In Pakistani waters 12 species of cetaceans have been recorded / observed, out of which 10 species have been recorded from Sindh (IUCN, 2005). The blue whale is an endangered species while humpbacked whale is vulnerable. The marine mammals recorded from Sindh are found in coastal and open ocean waters and do not inhabit in the vicinity of proposed site.

5.2.8.7 Endangered Species

The Phitti-Korangi-Gharo Creek systems had in the past a large population of Lingula, the representative of brachiopod occurring on muddy/sandy beaches of Sindh but now it is rarely seen. Similarly windowpane oysters were also commonly found in Korangi creek and adjoining areas. Presently none of these are easily found in this area and the extinction may be attributed to increase in pollution level in the vicinity of Korangi creek due to industrial and sewage pollution brought through Malir River, Gizri Creek and discharges from industrial areas and coastal villages of Landhi and Korangi etc. There is no designated park for conservation in this region and no endangered and rare species is reported from the proposed site.

5.2.8.8 Supra-tidal Community

Part of the coastal belt beyond tidal influence is dry and deserted and includes characteristic xerophytic plantation as shown in figures 5.31, 5.32 & 5.33. Through this part, land fauna enters the system for food and sometimes for shelter also. Land vertebrates constitute the major part of the community. Rodents, hares, squirrels and wild boars are herbivores, whereas snakes, lizards, cats, jackals and foxes are omnivores.

Water and land birds are also found here which are to some extent omnivores, as also is the case with jackals and foxes.

5.3 Ambient Air, Noise Quality & Environmental Contamination

5.3.1 Ambient Air Quality & Noise Level

Records with respect to air quality and noise emission level are not available for the project location. Field data were generated to establish the baseline of ambient air quality at Korangi Fish Harbour, which represents the macroenvironment of PQA. There is not much development activity in the area. The only source of air contamination is the few fishing boats and trawlers emitting a limited amount of air pollutants which get dispersed immediately by the wind on the coastal area. Five samples for air quality at FAP terminal and one sample at EVTL Terminal were taken which represent the microenvironment of proposed Brown Field site.

5.3.2 Methodology and Equipment

Air and noise monitoring was conducted by SUPARCO mobile laboratory and personnel. The Mobile laboratory is equipped with online US EPA designated ambient air analyzers for specific criteria pollutants. The international protocols were followed during the acquisition of ambient air pollutants data such as, monitoring site selection, distance of analyser/sampler above the ground and type of monitoring technique etc. Concentration of TSP/PM10, SO_2, CO, CO_2, and NOx was recorded along with meteorological parameters at each study site. The sampling interval of measurement was 15 minutes and monitoring was carried out continuously for 24 hrs at the site. One-hour means were calculated from 15 minutes data. The peak value in hourly mean has been recorded graphically.

5.3.3 Discussion on Ambient Air and Noise Quality Results

The average observed levels of Total Suspended Particulate (TSP) and PM10 were 173.6 $\mu g/m^3$ and 93.3 $\mu g/m^3$, respectively. These concentrations were well within the prescribed limits for TSP (260 $\mu g/m^3$ for 24 hrs) & PM10 (150 $\mu g/m^3$ for 24 hrs) of USEPA. The measured mean concentrations of gaseous pollutants were, 0.9 ppm for CO, 8.1 ppb for SO_2, 11.9 ppb for NOx and 300.8 ppm CO_2. All these levels of gaseous pollutants were well within limits of USEPA, WHO and World Bank. The major source contributing to the observed level of pollution were long distance transport of urban air pollution and from population centers as the monitoring site was downwind of these sites. The mean noise level at the site was 54 dB(A), which also shows the absence of any source of emission close to the proposed site. Furthermore the substantially strong winds have diluting and dispersive effect on the pervading pollution levels. The levels of air pollutants and noise at FAP terminal & EVTL sites are also within limits.

5.3.4 Environmental Contamination

On the eastern side of Karachi-- between Karachi and Keti Bunder- the area extending from Korangi/ Rehri Creek at the north-eastern side is known as the Korangi Creek which further extends to Phitti, Gizri, Khuddi, Khai, Pitiani, Dobbo, Sisa, Hajamro, Turshian and Khobar creeks. The Korangi-Phitti area is spread over about 64,000 hectares; it comprises dense mangroves and tidal creeks, mud flats and sand. The distance between Bundal Island and Gharo at the farthest end is about 50 km.

Korangi creek is the worst affected area by pollution by the large-scale discharge of effluent from Korangi, Landhi, and Karachi Export Processing Zone and the residential areas. In the Korangi industrial areas, 2500 industrial units including 170 tanneries dispose of untreated waste into the sea.

Highly contaminated water flows from Cattle Colony in Quaidabad into the sea near Chashma goth and is a source of annoyance to people in Rehri. Oil discharge in the Port Qasim area as a result of shipping activities also affects marine communities. Additionally, large oil spills have been observed in the region that disrupt fishing activity, paralyse economic activity and eventually impact the local fishing community.

Table 5.39: Air Emission Standards and Guidelines

S.No.	Family		Genera		Species		Population Status	
	Averaging Time	Standard	Averaging Time	Standard	Averaging Time	Standard	Averaging Time	Standard
SO2	SO2	365ug/m3 (140 ppb)	24 HRS 1 HR	90 ug/m3 (34 ppb) 350 ug/m3	ANNUAL MEAN 24 HRS	100 ug/m3 (38 ppb) 500 ug/m3	ANNUAL MEAN 24 HRS	0 ug/m3 (38 ppb) 400 ug/m3
CO	CO	10 mg/m3 (9 ppm) 40 mg/m3	8 - HRS	10 mg/m3 (8.7 ppm)	-	-	-	-
NOx	NOx	100 ug/m3	1 HR	190-320 ug/m3 120 ug/m3	ANNUAL MEAN	100 ug/m3 (50 ppb)	ANNUAL MEAN	100 ug/m3 (53 ppb)
O3	O3	(53 ppb)	8 HRS1 1 HR	200 ug/m3	-	-	-	-
TSP	TSP	235ug/m3 260 ug/m3	24 HRS	150-230 ug/m3 -	ANNUAL MEAN 24 HRS	100 ug/m3 500 ug/m3	-	-
PM10	PM10	150 ug/m3	-		-	-	-	-

Table 5.40: Ambient Levels of Gaseous Pollutants and Noise Levels (for 24 hours) at Korangi Fish Harbour

	SO_2(ppb)	NOX(ppb)	CO_2 (ppm)	CO (ppm)	Noise(dB)	Wind Speed (m/s)	Humidity(%)
Min.	5	9	282	0.71	51	4.3	50
Max.	11	17	317	1.8	61	6.8	95
Avg.	8.1	11.9	300.8	0.9	54	5.8	74

Table 5.41: Ambient Levels of Particulate Matter (Total Suspended Particulate) TSP, & PM10

Date	Filter Paper No.	Time Duration	Time		Air Volume (m3)	Weight(g)			Conc. (µg/m³)
			Start	Stop		Before	After	Net	
12-09-07	S-003	24 hrs	11:00	11:00	1008	3.941	4.116	0.175	TSP 173.6
12-09-07	S-002	24 hrs	11:00	11:00	1008	4.018	4.112	0.094	PM10 93.3

Table 5.42: Ambient Levels of Gaseous Pollutants and Noise Levels (for 24 hours) at FAP Terminal Site

	Location 1	Location 2	Location 3	Location 4	Location 5
SO2(ppb)	32	30	36	34	36
NOX(ppb)	24	22	26	28	22
CO (ppm)	Nil	Nil	Nil	Nil	Nil
Noise	54	55	63	61	53

Table 5.43: Ambient Air Quality in the microenvironment of EVTL Existing Chemical Handling Terminal

NOx (ppb)				SO_2 (ppb)				CO (ppm)				PM10 (µg/m³)			
Max	Min	Avg.	NEQS	Max	Min	Avg.	NEQS	Max	Min	Avg.	NEQS	Max	Min	Avg.	NEQS
23	13	16.2	43 ppb	16	09	11.8	45	2.6	1.0	1.5	9	152	112	122.4	250

Table 5.44: Noise Levels in Project Area

S. No.	Location	Noise Level (dBA)	NEQS
1.	FOTCO Jetty	55	75
2.	FOTCO Trestle	43	75
3.	Tank Farm Area	49	75
4.	Kadiro Creek	59	75
5.	Port Qasim Road	51	75
6.	Korangi Fish Harbour	63	65
7.	Rehri Goth	58	55
8.	National Highway	87	65
9.	EVTL Jetty	42	75
10.	EVTL Trestle	47	75

Port Qasim, located some 45km up the Phitti-Gharo Creek, is surrounded by mangrove forests, It is estimated from satellite imagery that in the PQA area (64,000 ha) there are 10,500 ha of dense mangroves, 4,645 ha of medium mangroves and 3960 ha of sparse mangroves. Mangroves are recognized as a critical ecosystem for coastal protection; as a breeding ground for many commercial fish species, especially shrimps; providing the coastal village economy with fuel wood, fodder and camel grazing grounds, and being an important destination for migratory bird species. There are plans to make the area fronting Rehri town an important eco-tourism location.

There are clear signs of stress in the mangrove ecosystem due to clear-cutting of mangroves, dumping of dredge spoils, ever-browsing by camels, frequent fodder collection, pollution and Eutrophication of the landward creeks. PQA has no management policy or activities related to the mangrove or coastal environment, although they have allowed Sindh Forest Department to carry out experimental plantations in the area.

Some parts of the PQ area are highly polluted from land based activities which include port operations, thermal effluents from Pakistan Steel and KESC power stations, the Landhi Cattle Colony, Sindh Alkalies plant (defunct), industrial and domestic wastes and the wastes discharged into Gizri Creek by the tannery and refinery effluents. The Korangi and Bakran Creeks are grossly polluted and suffering Eutrophication. The Landhi Industrial Estate and Korangi Industrial Area discharge more than 23 million gallon per day (mgd) effluent into the mangrove mudflats of the Korangi Creek whereas thermal pollution is increasing due to the discharge from the Steel Mills directly into the Gharo Creek.

The Phitti-Kadiro-Gharo creeks are less polluted, and the influence of pollution decreases as one moves away from the land. Overall, the creeks are relatively less polluted at present.

FOTCO is sited in a very sensitive ecological zone, right amongst the mangrove clusters. Whilst this may be the best site functionally, oil spills are the worst kind of pollution for mangroves. Over the course of time oil spills have not endangered the mangrove population as much as the development activities largely including the siting of jetties. Small segments of the mangroves have been removed by the scores of development activities related to establishment of jetties but the entrepreneurs including EVTL have responded by systematically planting the plantlets thus partly compensating for the loss of tree cover.

06 Description Of Socioeconomic Environment

6.1 Socio-economic Profile of the Macroenvironment

The macroenvironment of concern for the consideration of socioeconomic and environmental of the LNG projects is outside of the safety and security zone recommended by PQA and international guidelines such as SIGTTO for siting the LNG terminals. The proposed site in side bay next to existing EVTL terminal in Gharo creek was evaluated for siting the terminal in sheltered locations, remote from populated areas and built environment. Within the limits of Port Qasim, and above the high water line, there is no residential area. However, adjacent to these limits there large urban settlements, including the PQA employees residential colony, Pakistan Steel Mills employees township Gulshane Hadeed across the National Highway, Union Council Ibrahim Haidery located at the mouth of Korangi creek, Chashma Goth, Rehri town, Lath Basti and Juma Goth. The coastal towns of Ibrahim Haidery, Rehri and Chashma Goth, as well as the deep sea fish harbour and salt works along the coast are spread over an area of over 18,000 hectares. They form an outlet for the industrial activities as well as industrial emissions and waste discharges due to which the physical, biological as well as human environment has been seriously degraded.

The proposed brown field site is located in side bay next to existing EVTL terminal in Gharo creek. This site faces the Qasim International Container Terminal (QICT) in the east and Gharo Creek in the east and south. Pipri Badal Nala (stream) flows into the coast on the north of this site. This nala ultimately fall into the Gharo creek located to the south of the proposed site. There are no villages or residential colonies inside the microenvironment in a radius of 5 km. The nearest human settlement from the proposed site is village Lath Basti which is 7 km west to the site. The dargah (shrine) of Noor Hasan Shah is located approximately at 9 km east to the site. Other settlements which lie in the north and northwest of the project area at more than 9 km are Goth Lal Mohammad, Goth Mohammad Keserani and Pipri Colony. The Port Qasim residential colony is located approximately 8 km northwest from the proposed site.

The macroenvironment have the built environment outside of the safety and security zone recommended by PQA and international guidelines such as SIGTTO for siting the LNG terminals. It is scattered over the coastal area of Bin Qasim District, which includes the Union Councils of Rehri and Ibrahim Haidery besides the two settlements of Chashma Goth and Lath Basti. It extends from the Korangi Creek on the North and along UC Ibrahim Haidery, Rehri, Chashma Goth, Korangi Fish Harbour, the deep sea fish harbour and salt works along the coast, Lath Basti and Juma Goth in the north; the FOTCO Jetty and Port Qasim Industrial Area in the northeast; the Steel Mills in the far east, and the large mudflat covered by mangroves forest in addition to the navigation channel of Port Qasim in the south.

At the Phitti Creek inlet (Approach Channel) there are four islands viz. Bundal Island, Buddo Island, Muchak Island and Khiprianwala Island. Buddo and Bundal Islands are the most prominent islands in Phitti Creek to the west of the Project site and at the entrance to Port Qasim. Buddo is about 6 km from Ibrahim Hyderi while Bundal Island is another 6 km from Buddo. Khiprianwala Island is located beyond 3.5 km of Ibrahim Hyderi. Buddo and Bundal islands are both fishermen's transit locations with a few clusters of huts. Buddo is lush green with rich mangrove plantation and provides the area for camel grazing and breeding. The 8 km long and 4 km wide Bundal Island is the largest island in the creek. Approaching from the opening to the sea, it has sand dunes but inland it has large clusters of mangrove trees. On proceeding further inland there are colorful flags hoisted indicating the presence of a shrine. An annual gathering is held here after Eid. The

Fisher Folk Forum claims that about 4,000 trips are made by fishing boats every day near the Bundal coast. The fisher folk forum claims that the deep water channel has narrowed down due to changes that have been effected in the navigation channel.

PQA has claimed jurisdiction over the two islands and had at one time considered the Bundal island as one of the potential sites for setting up LNG Terminal. This could not proceed further due to challenges on ownership from Sindh government. According to a letter sent on Sept 6, 2001 by EDO (Revenue) of Karachi "the ownership of these islands vests in the provincial government. In the past the government of Sindh has made allotments to DHA and PQA but these islands have not been allotted."

Ecology of the two UCs viz. Ibrahim Haidery and Rehri, which are the main constituencies of the macroenvironment of the proposed project site at Khiprianwala, has completely changed by having grown from villages dominated mainly by fishermen until the late 1950s with hardly 250 huts each scattered along the coast to attain the category of towns with population estimated by the local residents to exceed 50,000. Both of them are now the headquarters for Union Council Administration. Lath Basti and Chashma Goth have also grown from villages to small towns; they are both part of Rehri Union Council.

Residents of Ibrahim Haidery and Rehri were traditional fishermen involved in fishing business since the last few centuries. They have been joined by scores of migrants from coastal villages and towns like Shah Bunder and Keti Bunder on the east and west of Indus Delta respectively and also the Bangladeshis and Burmese who appeared here as cheap labor. Lath Basti on the other hand is home for the Jat tribe, who were traditionally engaged in cattle and camel farming. The Jat tribe had migrated from the interior of Sindh and has been residing at the present site of Lath Basti for the last seven or eight decades. Juma Goth with its Railway Station and a large plot of land, designated to house the KCR displaced population, lies between Cattle Colony and Port Qasim Employees Residential area.

Major human settlements in the macro-environment of the LNG terminal alternate sites are the several large and small rural villages and urban townships. Table 6.1 gives the estimated population of these villages.

6.1.1 Demography

Population in the built environment of the alternate sites belongs to different clans and tribes. Traditionally, these clans/tribes had hereditary productive activities. For example, the Khaskhelis were agriculturists; the Jats were pastoral people, breeders of camels and suppliers of timber/fuel. The Memons and Shidis were merchants and traders, the Dablas were fishermen. These people served the clan communities and in exchange were maintained by them. All economic relations between the clans were those of barter. Cash transactions only took place between the Sardars (tribal chiefs) and Waderas (tribal elders) and through them with the outside world. This system guaranteed not only the economic independence of the village but also the supremacy of the feudal class.

Survey of the villages in macroenvironment reveals that "Old Jokhio" used to live there before the industrial developments.

Table 6.1: Population Data

S.#	Name Union Council	Areas/Description	Population as per Census of 1998
1	Ibrahim Haidery	Deh Ibrahim Haidery	43,583
2	Rehri	Deh Rehri & Ganhiaro	31,506

The population mix in UC Ibrahim Haidery is overwhelmingly Sindhi and Balochi speaking, followed by the Bengali-speaking people. Gulshan-i-Hadeed has a combination of all ethnicities with Sindhis forming the slightly larger group. Union Council Rehri is overwhelmingly Sindhi and Balochi and while the

number of other clans is almost negligible.

The cattle colony is the center of cattle and meat trade in Karachi. The Cattle Colony is the dairy products shopping and supply center of Karachi. Its population is overwhelmingly Punjabi.

scarcity of water. In Juma Goth and areas close to Cattle Colony extensive areas are under cultivation of vegetables using the effluent from the cattle yards. Livestock herding is not a healthy and reliable income generating option, and the few livestock holdings in the settlements are primarily

Table 6.2: Significant Population Centres in the Macroenvironment

S.No.	Location	Rural /Urban	Population (Approx.)
1	Port Qasim Colony	Urban	1,260
2	Wireless Colony	Urban	238
3	Gulshan-e-Hadeed	Urban	20,000
4	Steel Town	Urban	12,000
5	Nasirabad	Urban	12,500
6	Railway Marshaling Yard	Urban	2,500
7	Nishtrabad	Urban	1,400
8	Edu Goth	Rural	2,400
9	Pir Nau Goth	Rural	1,000
10	Razzakabad	Rural	3,500
11	Abdullah Goth	Rural	1,050
12	Ranju Goth	Rural	750
13	Kamran Khan Goth	Rural	325
14	Allah Dino Goth	Rural	230
15	Muhammad Raheem Goth	Rural	250
16	Mai Hur Goth	Rural	230
17	Abdul Latif Goth	Rural	200
18	Muhammad Saleem Goth	Rural	180
19	Morund Khan Goth	Rural	200
20	Mayo Khan Goth	Rural	150
21	Ali Khan Goth	Rural	270
22	Asmaj Goth	Rural	85
23	Ahmed Goth	Rural	78
24	Khan Muhammad Goth	Rural	120
25	Allah Bakh Goth	Rural	80
26	Abdul Rehman Goth	Rural	70
27	Abdul Raza Goth	Rural	80
28	Muhammad Ahsan Goth	Rural	80

6.1.2 EMPLOYMENT AND LIVING CONDITIONS

The macroenvironment does not offer opportunities for employment and the population is primarily employed as cheap unskilled labor force in the industrial areas of PQA. Agriculture is limited to subsistence farming due to

for household and domestic use, a source of dairy consumables. Skilled labor is rare and the categories of skilled laborers are mostly drivers, welders, plumbers and electricians. Government service is rarely available.

The population in the UCs can be broadly placed in three categories - fishing communities residing in small clusters of households down south along the coastline, labor class

and workers employed in the industries in the area, and very few white-collar workers. Majority being illiterate or lacking education, the people find employment either in subsistence farming or at best as casual and unskilled labor engaged in the surrounding industrial installations, with the Pakistan Steel, KESC Thermal power plant, Dewan/Pakland Cement factory and the Pakistan Railway Marshalling Yard being major employers. Numerous small villages in the UC have not been supplied with electricity despite the fact that high tension lines bring in power for numerous industries that have been established here.

Port Qasim colony, which is at a distance of about 8 kilometers from the brown field site, has a total estimated population of 2200 consisting of families of PQA's employees having average household comprising 8 persons. Port Qasim Colony has all the basic facilities of life including; electricity, telecommunication, gas, and drinking water. Transportation and access to main highway through the link road is available. Amenities and mosques are present. People working in PQA belong to low to high-income groups having average earning up to Rs 15,000 per month.

The population resident in UC Ibrahim Haidery and Rehri is totally dependent on low level engagements including fishing. The UCs surrounding the microenvironment of the proposed site at Khiprianwala, consist of scattered villages inhabited by old Jokhio tribe. Being farther away from the main highway they have not been provided with all the basic civic facilities and are among the underdeveloped areas of Karachi City District. The area is marked with poverty with average household income not exceeding Rs 7000.

The Settlements in the Korangi Creek area are fisherman's villages but the dwellers are engaged in other low level occupations as well. The employment and therefore earnings for a large section of population in the area is variable, heavily dependent on fisheries. Prawn, shrimp and crab fishing from inshore waters is the main source of income of the majority. However, quite a substantial segment of population is employed on deep-sea fishing boats. The relatively low level of income in this rural setting is reflected in the poor condition of housing, with water supply and sanitation being too inadequate. Some of these villages are now provided with electricity, connected by paved road and served by Public Transport.

6.1.3 Dependence on Mangroves

Mangroves are a valuable resource for many of the coastal villages. They are primarily used as a source of fuel and fodder and provide the feeding grounds for prawn and shrimp, besides protecting the land from erosion. The people have been overexploiting this resource over the years. IUCN has, in association with Sindh Forestry Department, initiated a program of mangrove conservation, replanting and sustainable management along the coastline of Rehri village. Engro Asahi Polymers has undertaken an extensive program of plantation of mangroves. They have a nursery where they cultivate the mangroves from the millions of propogules shed by the mature trees in the surrounding.

6.1.4 Education

Educational facilities in the surrounding area of the UCs Ibrahim Haideri and Rehri are limited to primary and secondary schools. Each village in the area has access to a primary school within a distance of three to four kilometers. There is also a high school in Ibrahim Haideri and Rehri that covers and meets the demands of nearby Deh. Availability and access to education may be regarded inadequate because of lack of efficient and effective schooling system to facilitate and promote literacy and education. Literacy rate among females is low, especially in adult females who are rarely literate.

Training in technical skills is inadequate. Skilled labor consists of drivers, mechanics, water pump attendants which are estimated to be less than 10 % of the total labor force. Thus the resident population in the immediate neighborhood is not capable of being employed in skilled category as might be perceived by the LNG Project in near future.

6.1..5 Health

Clean and safe water is one of the major problems being faced by the residents of UCs Ibrahim Haideri and Rehri.

Though the Karachi Water and Sewerage Board's pipelines bring in approximately 580 million gallons of water daily from the Indus river and Hub Dam to Karachi and route it through Bin Qasim Town, yet a majority of the villages have not been given water connections and have to depend on ground water and other sources including the unhealthy springs, for drinking as well as domestic purposes.

Health problems of the UCs Ibrahim Haideri and Rehri are generally associated with water availability and quality aggravating sanitary conditions due to lack of facilities and reliable water supply. Health facilities are inadequate and sub-standard. Both UCs have one Basic Health Unit (BHU) and a primary health care unit (PHCU) but both units are understaffed and not well-equipped. For advanced medical aid treatment cases are referred to health centres at Quaidabad or city centres of Karachi.

6.1.6 Landscaping

The terrestrial environment around the UCs consists of sparse scrub and a few trees of Acacia nilotica, with some grazing from domesticated animals including camels, goats and cattle. The land adjacent to the coastline has deposits of poorly sorted, unconsolidated loose gravel, sand and silt. It has sand bar deposits comprising medium to coarse sand, which is being exploited for cut-and-fill in the construction industry, and for land preparation for the industrial zone and for reclamation of land area on extensive areas in the south. This has disturbed the landform during and has irreversibly changed the landscape of the near-shore area.

6.1.7 Transportation Network

The built environment of the Project is served by the developed infrastructure of Port Qasim industrial area, Port Qasim International seaport, National highway and also the rail network which connect the macroenvironment with the city centre of Karachi and other cities of the country.

The composition of traffic is similar to other sections of National Highway passing through rural areas. Heavy traffic includes trailer, trucks and tankers that dominate the overall traffic stream. Road network within Port Qasim Industrial Zone is superior to other industrial estates in Karachi and roads are wide enough to support all types of vehicular traffic movement.

6.1.8 Industries

Presently 176 industrial units are operational at PQA industrial area and about 278 industries are in different stages of development.

6.2 Archaeological and Historical Sites

A review of investigations in the Port Qasim area and a visit to the macroenvironment of the alternate sites, did not indicate existence of any feature or structure of cultural significance or of archaeological interest within the area of the proposed activity. There is a grave of a certain saint Baba Kamal Shah about 8 km on the northwest of project area, said to be attracting some devotees. Shallow sweet water well near the shrine is an attraction for the devotees. These features, however, do not suggest that the place has any historical or cultural significance. The nearest archaeological sites of ancient Port of Debal and the town of Bhambore are about 18 kms NW of the site. The graveyard of Chowkhandi is 15 km from the project site.

6.3 LNG Related Hazard Zones and Population Distances

Sandia National Labs has defined the outer limits of the three hazard zones discussed in their report: Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water. These criteria are listed in Table 6.3. The criterion used to define the outer limits of Zone 1 and Zone 2 is incident heat flux, i.e., thermal radiation that would be expected from an intense LNG vapor fire. Within Zone 1, the thermal radiation can cause serious injuries or significant damage to structures. Within Zone 2, thermal radiation can cause injuries or some damage to structures. The outer limit of Zone 3 is defined

based on the lower flammability limit of LNG vapor, i.e., when the concentrations of natural gas and oxygen does not have enough fuel to burn. Within all three zones, the level of risk is reduced as the distance from the source increases.

Table 6.3: Definition of Hazard Zone Boundaries

Zone	Criteria (10 minute exposure time)	Distance	Basis
Zone 1	37.5 kW/m²*	500 m	High potential for major injuries or significant damage to structures
Zone 2	5 kW/m²	1600 m	Potential for injuries and some property damage
Zone 3	Lower flammability limit (5%)	3500 m	Outer limit where LNG vapor can be ignited

Source: Sandia Report
*Note: *Kilowatts per square meter*

The severity of impacts within Hazard Zones 1 through 3 would depend on the location of the incident relative to a specific area, the scope of the incident, and whether or not the released LNG ignited or dispersed. This could be a significant impact, being most severe in Hazard Zone 1 and decreasing outward through Hazard Zones 2 and 3. However, because of the implementation of safety and security measures during marine transit, the likelihood of marine LNG spill is extremely remote.

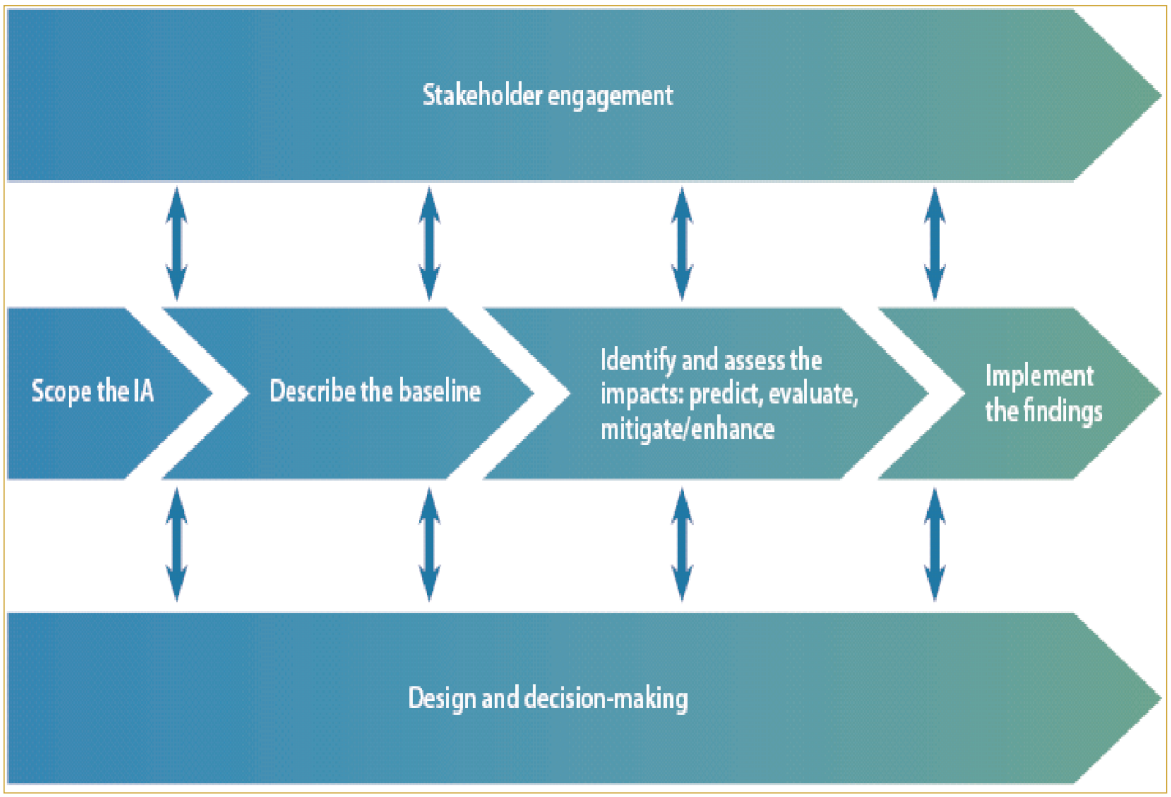
None of the population centre listed above (Table 6.2) is located within or near the hazard zones identified by Sandia. Similarly, the pipeline route would be preferred which raises minimum social and environmental issues.

07 PUBLIC / STAKEHOLDERS CONSULTATION & INFORMATION DISCLOSURE

7.1 PUBLIC CONSULTATION & PARTICIPATION

Public Consultation and Public Participation are two effective tools of social interaction. Public Consultation is an important tool to build up confidence between the stakeholders and the project formulators to minimize the risk of delay of project implementation. It also counters erroneous information, if any, about the project. It helps the project proponent (Elengy Terminal Pakistan Limited; ETPL) make informed assessments of public opinion about the project, and the nature and extent of opposition likely to occur during the implementation stage.

Public Participation, on the other hand, helps project implementation to a great extent. The purpose of involving the public in general and project affected persons, in the decision making process is to have a fair interaction with all community groups and ensuring them that every attempt would be made to minimize negative impacts of the project, and that adequate mitigation measures would be taken to compensate the loss of the affected persons, if any. Thus, it ensures partnering between the community and the project proponent leading to timely completion of the project with least social cost and disruption. Moreover, experience indicates that unexpected project effects on the local community generally give rise to significant issues and concerns among Project Affected Persons (PAPs). These problems get reduced when people are properly informed and consulted about the project and given the opportunity of being heard. Similarly, Non Governmental Organizations (NGOs) will frequently come forward to advocate on behalf of the stakeholders, including PAPs. By making NGO's party to the decision making process, future litigation at later stages can be avoided.



7.2 ETPL's Policy of Public Consultation & Disclosure Plan

Since ETPL's proposed LNG Terminal project is a significant development in Port Qasim, it has special consultation responsibilities. Effective project planning has required regular consultation with a wide range of project stakeholders. Based on an extensive public outreach program, including public meetings, public hearings, and individual and group consultations, the local community is well informed of the project objectives, likely impacts and essential provisions of compensation policy through the Project's conduct of the following activities:

1) Information dissemination campaigns using media, notice of meetings or information leaflets;

2) Holding Public/Stakeholder Consultation Meetings and Focus Group Discussions (FGDs);

3) Arranging interviews with the communities and their stakeholder groups;

4) Formation of focus groups involving key stakeholders, like local/community leaders, women, the poor, and other groups;

5) Setting up various committees for planning, implementation and monitoring of construction and operations; and

6) Involvements of the PAPs in a formal grievance redress process.

To discuss and seek opinion / suggestion from the communities and other stakeholders, their representatives were invited to participate in various meetings regarding project related issues involving impact mitigation and compensation procedures in light of IFC guidelines.

Guiding Principles: The project has followed International Finance Corporation (IFC) Performance Standard 1: Social and Environmental Assessment and Management Systems, in developing the public participation program for the LNG project. A relevant objective adhered to in designing the public involvement program for the project is:

- To ensure that affected communities are appropriately engaged on issues that could potentially affect them.

Requirement 19 of this Performance Standard states "When local communities may be affected by risks or adverse impacts from a project, the engagement process will include consultation with them. …Community engagement will be free of external manipulation, interference, or coercion, and intimidation, and conducted on the basis of timely, relevant, understandable and accessible information."

Requirement 23 of this Performance Standard states "The client will respond to communities' concerns related to the project. If the client anticipates ongoing risks to or adverse impacts on affected communities, the client will establish a grievance mechanism to receive and facilitate resolution of the affected communities' concerns and grievances about the client's environmental and social performance. The grievance mechanism should be scaled to the risks and adverse impacts of the project. It should address concerns promptly, using an understandable and transparent process that is culturally appropriate and readily accessible to all segments of the affected communities, and at no cost and without retribution. The mechanism should not impede access to judicial or administrative remedies. The client will inform the affected communities about the mechanism in the course of its community engagement process."

IFC Performance Standard 4: Community Health, Safety and Security and a relevant objective is to:

- To avoid or minimize risks to and impacts on the health and safety of the local community during the project life cycle from both routine and non-routine circumstances.

IFC Performance Standard 7: Indigenous Peoples and

relevant objectives are to:

- To establish and maintain an ongoing relationship with the Indigenous Peoples affected by a project throughout the life of the project; and
- To foster good faith negotiation with and informed participation of Indigenous Peoples when projects are to be located on traditional or customary lands under use by the Indigenous Peoples.

International standards that are followed by ETPL relevant to community engagement include:

- International Finance Corporation, 'Stakeholder Engagement: A Good Practice Handbook for Companies Doing Business in Emerging Markets' (IFC, 2007); and
- The Core Values of the International Association for Public Participation (IAP2).

The project has striven to rely on the following IFC principles:

- Early engagement: Commencing engagement early is critical in building trust, mutual respect and in establishing relationships with communities. ETPL will ensure that consultation activities are proactive, planned and delivered in a timely way.
- Long-term view: Establishing and maintaining relationships is a long-term investment. To enhance the value of community relationships, ETPL will take a long-term view to engagement.
- Tailored at each phase of project: The outreach and engagement program will be tailored to each phase of the project. In developing the project, activities, issues and stakeholders associated with the phase will be considered and built into the engagement activities for that phase.
- Proactive, not reactive: ETPL will set a proactive path for consultation and will consult in a strategic manner, as opposed to being reactive and responding to grievances as they arise. A proactive approach to consultation will build credibility and relationships with the community.
- Managed as a business priority: ETPL will ensure that engagement activities are planned and delivered through a systematic and consistent approach and that management responsibilities are assigned to each consultation activity.

The major objectives of ETPL's public consultation program are to:

- Create awareness among local people about the project in general and its potential impacts (both positive and negative) on the community, and involve them in the decision making process from the very inception of the project with a view to build trust.
- Identify significant public concerns with a view to reduction of public resistance during implementation of the project. Make them feel that they are not ignored. Take them in confidence by providing them a role in the decision making process.
- Educate potentially affected communities/persons about the project.
- Solicit the views of affected communities on socio-economic aspects of the project. This process serves as an important tool for collection of information on both natural and human environment, which would not be possible through traditional approach of data collection.
- Produce a suitable plan for meaningful and responsive public involvement by incorporating the felt needs and preferences of communities as evolved through community interactions.

7.3 Identification of Stakeholders

Stakeholders are people, groups, or institutions that may be affected by, can significantly influence, or are important to the achievement of the stated purpose of a proposed intervention.

The Primary and secondary stakeholders were identified

based on standard following definitions:

1. Primary Stakeholders are people, groups or institutions affected positively (beneficiaries) or negatively by the project;

2. Secondary Stakeholders are people, groups, or institutions that are important intermediaries in the project delivery process (e.g., the institutions, research organizations, government line agencies, or NGOs etc).

For the purpose of this project, the primary stakeholders are the fishing communities living in the macroenvironment of project area. However, it is pertinent to mention that the living population/ community settlements are located more than 5 km away from the proposed site designated by PQA for LNG Terminal.

Group discussions and consultation meeting were conducted with stakeholders particularly with the Korangi Fishing Harbor Administration, notables of fisheries community, etc. For this purpose semi structured questionnaires were used for data collection. These questionnaires were consisted of open and close ended questions.

The consultation team consisted of Environment & Social issues specialists and enumerators. In most cases, the team was accompanied by a local representative. The local representatives were instrumental in the selection of venues and timings for the meetings and focus group discussions. Local CBOs played a vital role to mobilize the community to attend public consultation meetings.

The comments expressed by the participants at public consultation and focus group discussions were noted (an outline of issues and concerns expressed by individuals, the community, NGOs and public agencies is detailed in the following table and elsewhere in this section). Similarly, the comments made by stakeholders at scoping meeting were noted.

These comments have been analyzed as socio-economically viable statements of the participants and have been reflected in the detailed engineering design as much as possible.

Since these consultation meetings/FGDs were an open forum for all, there was a representation from all groups by language, gender, age and income levels. This is a continuous process and will be continued until the issues pertaining to preconstruction, construction & operational phases of project are settled to the reasonable satisfaction of stakeholders, especially the affected local communities if any.

The result of the consultation was a clear identification of the issues perceived to be important by the community

Table 7.1: People and Organizations Consulted

Organization Consulted	Organization Type	Person Consulted
Environmental Protection Agency (EPA)	Governmental	Mr. Naeem Ahmed Mughal Director General, Sindh EPA
Port Qasim Authority	Governmental	Vice Admiral Muhammad Shafi Chairman, PQA
World Conservation Union(IUCN)	Non-governmental	Mr. Tahir Qureshi Senior Expert on Ecology
Shehri-CBE	Non-governmentalorganizations	Mr. Roland Desouza and Mrs. Amber Ali Bhai
National Institute of Oceanography	Governmental	Dr. Shaukat Hayat Khan Director General
Pakistan Fisher folk Forum (PFF)	Non-governmental organization	Muhammad Ali Shah Chairman
Pakistan Gasport Limited	Private	Mr. Anees Ahmed Ansari Director

and stakeholders and the need to respond to those issues in the ESIA. Mitigation of potential environmental effects of concern to the community and other stakeholders has been incorporated into the project planning and will occur throughout the construction and operational phases of the project.

7.4 Results of Consultation at The Planning Stage

According to the survey conducted by a team of independent experts it has come to know that there are no settlements or sensitive areas including archaeological sites or protected areas in the neighborhood beyond 5 km radius. However, it is predicted that the project may affect the livelihood of the communities residing in the macroenvironment who are mainly fisherman by occupation or are directly or indirectly related to fishing industry to earn their livelihood followed by unskilled labor, self-employed and service providers. Concerns expressed by the stakeholders are presented in Table 7.2. All stake holders expressed serious concerns on the alternative site Option 2 and Option 3 (brown field site) on account of LNG safety and security risks. The same are out of scope of this report and have been separately addressed by ETPL as part of their risk assessment studies.

The stakeholder engagement process is intended to seek the views, concerns and needs of stakeholders and engage with them in a constructive two-way dialogue throughout the project.

Initiating the stakeholder consultation process at an early stage in the project cycle ensures that feedback from communities and other stakeholders directly or indirectly affected by the project can be used to adjust and improve project design, planning, and implementation from an environmental and social perspective.

The stakeholder consultation was conducted with respect to the ETPL's LNG import terminal project. The Scoping process identified data gaps relating to the quality of the marine environment baseline ambient air quality, baseline noise levels, Health & Safety issues, information about other planned developments in the area, Hazards and Risks associated with the constructed and operation activities of the FSRU, and jetty.

Table 7.2: Stakeholder Concerns and Mitigation Measures

Organization Discussion and Concerns	Organization Discussion and Concerns
Environmental Protection Agency (EPA)	The proposed LNG import terminal should not be sited in the main navigational channel (Siting Option 2) due to the safety and security risks associated with this type of project. All relevant legal requirements must be fulfilled at the planning stage of project and those should be referred in detailed EIA study. The impact of dredging and reclamation should be thoroughly studied and measures to be evaluated so that the activities have least impacts on mangroves and benthic communities.
Port Qasim Authority	Initially Port Qasim Authority proposed its consent to ETPL for carrying out studies on three possible sites considered for LNG import terminal. Those included Alternative Site Option 1 & Option 2 (green field) and Option 3 (brown field) near the existing EVTL terminal. Provisional NOC has been issued to ETPL for option 1, 2 & 3 by PQA. PQA will provide NOC if all the studies prove technical viability of the site. Dredging spoil would be off-loaded at Bundal Island which is faced with serious erosion and has lost considerable area to the sea. This activity will reclaim some of the lost land at the island and protect the channel by suitable design. The benthic community loss would be rehabilitated at a suitable place, may be at Bundal Island where a Biodiversity Park proposed by EMC could be establishment in collaboration with the stakeholders including the Fisher folk forum.
World Conservation Union(IUCN)	The proponent should consider the site which is less exposed to open sea (option 1 or 3) instead of placing it in the main navigational channel critically exposed to open sea (option 2) because option 2 would be prone to natural hazards which include cyclones, hurricanes and tsunamis. Placing the LNG terminal in the main navigation channel would face erosion and sedimentation problems and as a result more dredging would be required that will affect the marine ecology. Therefore, Brown Field site seems to be preferred as compare to option 2. It should be ensured that the activity will minimize the impact on mangroves and benthic communities through the adoption of mitigation measures. Strict monitoring of contractor's activities must be carried out during the different stages of project. Any loss to mangroves should be compensated by planting 4-7-10 mangroves for loss of one depending on the canopy.
Shehri-CBE	The LNG terminal should not be sited in the main channel (option 2) and also it must be away far from communities. Detailed hydraulic study should be conducted for this project. SIGTTO siting standards should be considered in evaluating the optimum and safe location for the LNG terminal. Land based LNG terminals like nuclear plants and other infrastructure are vulnerable to natural disasters (earthquakes, tsunamis) and sabotage/terrorist action. Careful planning and mitigation measures need to be considered for the project.
National Institute of Oceanography	The LNG terminal should not be sited on option 2 (green field) which is located along main navigational channel and is therefore most prone to natural hazards including cyclones, storm surges and tsunamis. More dredging would be required for option 2 because of the increased erosion and sedimentation in this area. Option 1 or 3 (Brown Field site) may be considered as the preferred alternative. However, a detailed hydraulic study should be done.
Pakistan Fisher folk Forum (PFF)	LNG terminal is the requirement of the Country due to the short fall of natural gas in the country. PFF would support the project if it does not hinder the commercial fishing activities in the area. Mitigation measures should be adopted to minimize the impacts on communities and fisherman. PFF should be a part of monitoring team for all phases of the project.
Pakistan Gasport Limited	The safety records of LNG terminals are very good and satisfactory worldwide; therefore, the proposed ETPL's LNG terminal would successfully operate if all the mitigation measures are in place. However; the criticality of siting of LNG terminal near the entrance to main channel (option 2) is questionable because this option shall not find favor according to the international guidelines

7.5 Ongoing Community Engagement Plan for Construction & Operation Phases

Elengy Terminal Pakistan Limited (ETPL) will implement the following Community Engagement Management Plan as part of its Environmental (and Social) Management Plan (EMP) outlining a range of mitigation measures designed to avoid or reduce undesired community impacts during construction and operation phases of project.

This plan also establishes a basis and template for use by the project's Contractor(s) to develop their own plans outlining not only mitigation measures but to also incorporate the roles and responsibilities of the EMP.

The objectives of the Community Engagement Management Plan are:

- Establish and maintain positive community relations through effective communication and consultation.
- Effectively manage community grievances and comply with the project's Community Grievance Procedure (a detailed discussion of the CGP is included below).

The project recognizes the potential for creation of adverse impacts on the environment and within the local community, and the potential to make significant positive contributions if impacts are properly addressed. To achieve these goals, the project has developed an ongoing policy framework for mitigation and management of socio-economic impacts, and making long-term investments in the local community. ETPL is committed to human development and protection of biodiversity in the project area by:

- Understanding the social, economic and environmental context of the project area;
- Working with stakeholders and engaging and maintaining dialogue with them to build relationships based on trust and mutual respect;
- Enhancing positive effects of our project while minimizing adverse impacts;
- Providing compensation commensurate with loss where impacts cannot be adequately remedied;
- Preserving a natural environment for future generations;
- Promoting human development in local communities;
- Providing employment and economic opportunity to local communities;
- Monitoring the success of environmental and social programs against reasonable benchmarks;
- Following recognized standards in our social and environmental activities as defined by IFC Guidelines and local requirements.

Interviews and public outreach programs with local communities and stakeholders consultation identified the following major social and economic issues of concern:

- Pollution discharges affecting human health and decreases in fish populations
- Loss of use of near shore boat mooring facilities
- Provision of basic quality of life amenities (jobs, services, resettlements and compensation for lost opportunity or livelihood);
- Increased traffic on main roads affecting mobility of cattle or "females in the course of tending to family matters".

Most of the issues described in meetings with the local community have been addressed in other segments of this report. While few direct impacts have been identified affecting the local community, ETPL's on-going process will effectively monitor its activities and impacts both upon the environment and the socio-economic setting of the project. ETPL will pro-actively address negative impacts that may develop over the course of construction and operation, and develop appropriate mitigation measures to provide satisfactory redress of project-related issues.

7.6 Community Engagement Responsibilities:

ETPL is committed as well as required under its environmental approvals from the Sindh Environmental Improvement Agency to:

- create "no threat to livelihood of local fishermen and communities"
- repair or compensate any damages to boats or equipment caused by project components
- employ an Independent Environmental Monitoring Consultant for the life of the project who will submit quarterly reports on ETPL activities.

In addition, ETPL's Environmental Management Plan identifies a Site Environmental Coordinator charged with monitoring and evaluating permit compliance and environmental impacts associated with constructing and operating the project.

ETPL has also designated a Community Liaison Officer (CLO), reporting to the project's General Manager, who is tasked to help manage and facilitate communications with the local community, including people making their living from fishing. The CLO's duties include providing the main point of contact with the local community, and transmitting concerns and complaints to the projects' management structure. The CLO is responsible for actively identifying and communicating with local community leaders, NGOs active in the area, such as Pakistan Fisher Folk Forum and loosely affiliated common-interest groups. The CLO is available to address questions about and concerns with project activities, and to provide information about jobs (especially during construction), opportunities to provide goods and services to the project, and opportunities for the project to pro-actively engage in promoting the health, welfare and quality of life for the local community. The CLO is charged with creating a positive relationship between the project, its contractors and the local community, managing and planning future public consultations, disclosure meetings and events, maintaining records, and leading dispute resolution proceedings. The CLO is responsible for implementation of the Community Grievance Procedure outlined below.

A outlined above, the major concerns expressed by the local community to date are described below:

Fishing Community: Impacts on fishing are potentially the most significant in terms of economically disadvantaged local persons who earn a subsistence living by fishing. While the local fishery is not significant for most, dredging and other construction related activities may temporarily affect fishing in the area of the project. The project will conduct a survey and comprehensive evaluation of how much fishing pressure exists in the immediate project area. The study will identify individuals or groups fishing in the area, and seasonality of fishing pressure, if applicable. Second, a determination of the duration of reduced fishing productivity will be developed based on construction estimates for timing and duration of dredging and other construction activities that may impact fishing. Once the survey is completed, the CLO, working with the local community and community leaders, will communicate these findings and develop a compensation program, appropriate to the circumstances, to be implemented by the project's General Manager. This program will span the estimated 18 month construction period and an additional 12 month period during initial operations. An on-going process, the CLO, working in consultation with the local community and the project, will propose modifications to the mitigation and compensation programs according to specific circumstances and as appropriate.

The CLO is responsible for communicating job and economic opportunities to the local community. His duties include establishing good relations with the local community and to act as a 'clearinghouse' for questions about how to apply for jobs, how to become qualified for bidding on provision of goods and services to the project, and similar economic opportunities. The CLO and GM will together develop a list of economic opportunities targeted toward the local community to help create goodwill towards the project.

The following compensation plan has been adopted by ETPL in response to project concerns expressed during

the initial consultation process:

- Separate funds allocated to initiate programs such as training centers for fishing communities.
- Loss of assets / houses, if any, shall be compensated by ETPL at "Full Replacement Cost" as per World Bank Operational Policy 4.12.
- In case of any resettlement, compensation shall be paid at full replacement cost with rehabilitation / livelihood assistance.
- For all unskilled jobs, the project will attempt to fill those positions from local applicants.
- Local community leaders and first responders will be informed and updated regularly on emergency response procedures.
- The project's Community Grievance Procedures will be easy to participate in and free of cost.

In addition to project activities, the Project Contractor shall:

- be responsible for community affairs as it relates to industrial relations, human resources, procurement, and sub-contracting associated with the Contractor's Work;
- establish community affairs office(s) as appropriate to support the Contractor's community affairs activities. Such offices shall be located at sites that facilitate effective management of community affairs, industrial relations, recruitment and hiring without disrupting the Work;
- work with appropriate community leaders to reduce the adverse effects of their activities on the community, and to facilitate resolution of community unrest and disruptions resulting from Contractor's performance of the Work;
- confirm that its personnel and the personnel of its sub-contractors are appropriately qualified and trained to be aware of and manage local cultural issues to the extent required to minimize and manage local community disruptions arising as a result of Contractor's performance of its Work. ETPL shall provide induction materials for new workers and necessary briefings for workers and Contractor(s) as required;
- comply with the Community Grievance Procedures detailed below.
- gain the prior approval from ETPL before making any direct agreements with local communities.

7.7 Training On Community Relations

The CLO is responsible for ensuring that ETPL's and the Contractor(s) workers and subcontractors receive adequate training in project-specific community relations, so as to be aware of health, safety and security issues as well as the standard of conduct expected when engaging with the community. Induction training for all new workers shall be provided and will cover at a minimum:

- General liaison and interaction with communities;
- Cultural sensitivities;
- Awareness-raising on health, safety and security considerations;
- Project Code of Conduct.

Additional training on community relations will be delivered through:

- Tool Box Meetings;
- Safety, Security, Health and Environment Safety Committee Meetings;
- In-House Training / Seminars;
- Notice Boards; and
- Newsletters.

7.8 GRIEVANCE MANAGEMENT

ETPL has adopted the Community Grievance Procedure outlined below, which requires interaction, consultation, targeted information and timely resolution of legitimate grievances. This approach is aimed at building a reputation of responsiveness, concern and responsibility among the community, with a view to building and

sustaining acceptance and support for the construction and operation of the project.

ETPL and its Contractor(s) shall foster a sense of working with the local community and demonstrate that the Project takes a proactive stance to grievances.

ETPL's grievance management system and database will comply with and has the flexibility to feed information into the Community Grievance Procedure. ETPL will also provide all Contractor(s) teams with training in Community Grievance Procedures.

In implementing ETPL's Community Grievance Procedure, the Contractor(s) shall:

- Record all grievances using the template Grievance Form given at the end of this section;
- Assess and advise the resolution of the grievance in the time frame required by the assessment.

All grievances will be investigated and a response (outlining a resolution) provided by ETPL/Contractor(s) as soon as possible and not more than 30 days after receiving the grievance. If more time is required for resolution, the person raising the grievance and ETPL shall be kept informed.

While the Contractor(s) is not prevented from initiating the grievance resolution, any corrective action taken must be in coordination with ETPL.

ETPL, through the CLO, will ensure that the details of the Community Grievance Procedure are publicized at community meetings and via posters and other means to all communities in the vicinity of the project.

In addition, ETPL and its Contractor(s) shall ensure that the local populations working/residing in the macroenvironment of the project area receive necessary information for contacting and initiating a grievance through meetings, pamphlets and similar community outreach programs under the direction of the CLO.

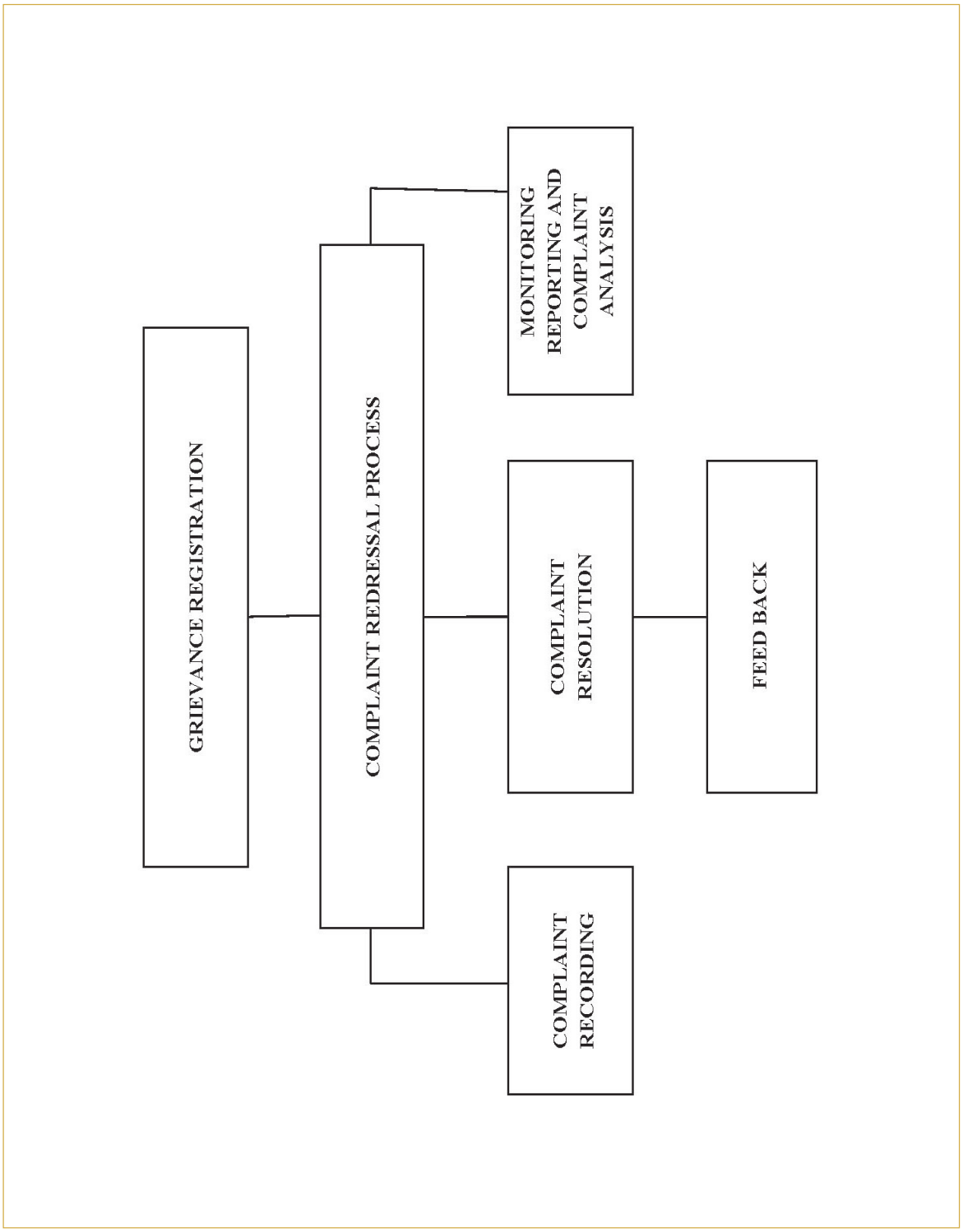
ETPL and its Contractor(s) shall ensure sufficient resources are allocated on an ongoing basis to achieve effective implementation of this Plan. The Contractor Plan shall describe the resources allocated to and responsibility for the execution of each task and requirement contained therein, and shall describe how roles and responsibilities are communicated to relevant personnel.

7.9 PERFORMANCE INDICATORS

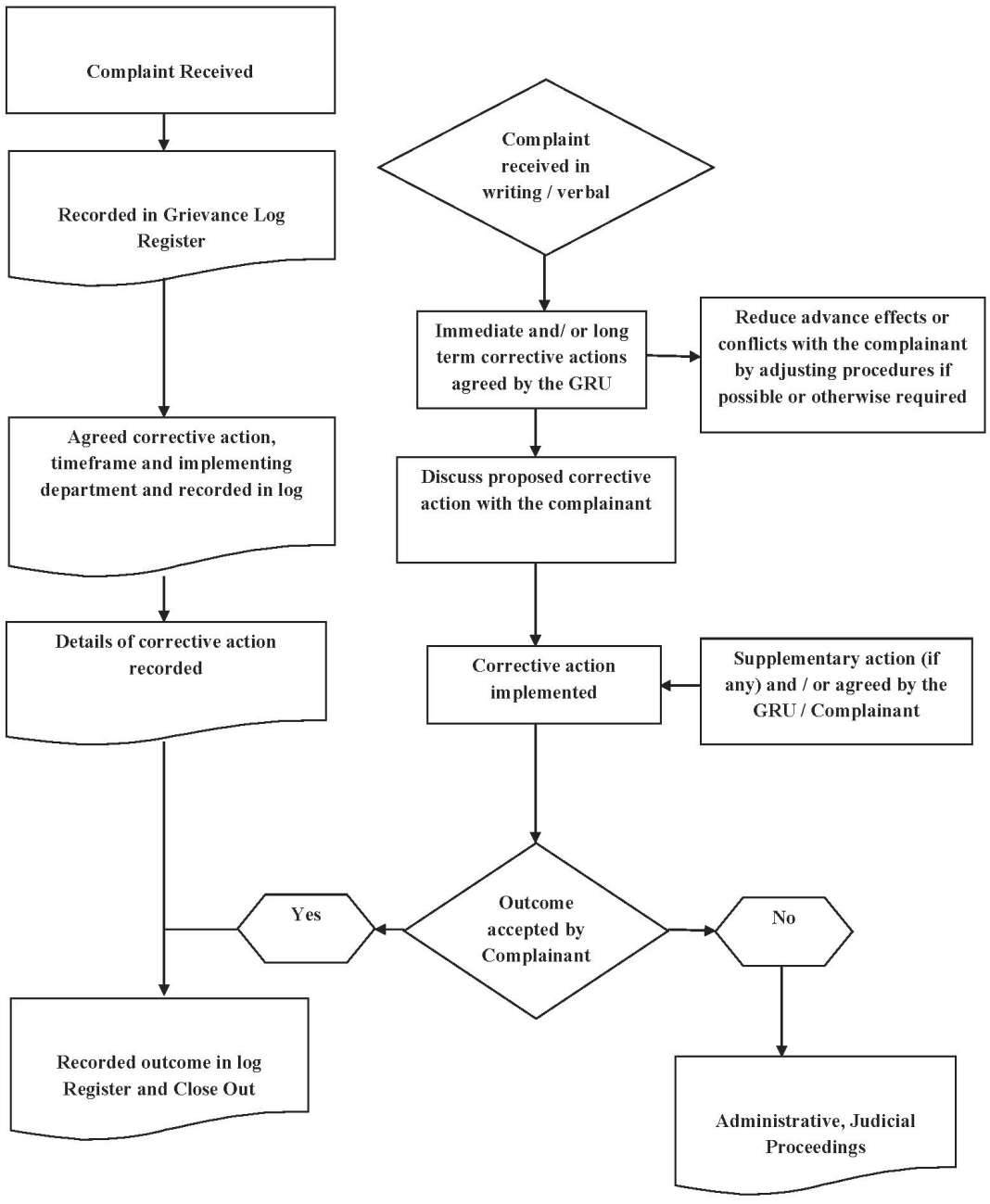
Table 7.3 outlines the indicators used for measuring and verifying performance in relation to community engagement. However ETPL may modify or add to these indicators to enhance the Plan based on learning from the performance indicators.

Table 7.5: Performance Indicators

ID No.	Performance Indicator	Measurement	Internal Assessment Frequency
1	Maximize use of the Project Community Grievance Procedure.	100% of grievances (except those related to worker issues) channeled through the Community Grievance Procedure.	Monthly
2	Resolution of Community Grievances.	75% of grievances resolved (from the Project perspective) within 30 days, categorized according to cause of grievance.	Monthly
3	Disruptions to work.	Number of hours lost due to community disruption categorized according to cause of disruption (to be coordinated with Security departments to ensure consistent reports).	Monthly
4	Compensation payments.	Amount of compensation paid as a result of Project impacts	Monthly


GRIEVANCE REGISTRATION
COMPLAINT REDRESSAL PROCESS
MONITORING REPORTING AND COMPLAINT ANALYSIS
COMPLAINT RESOLUTION
FEED BACK
COMPLAINT RECORDING

GRIEVANCE REDRESSEL PLAN



08 POTENTIAL ENVIRONMENTAL IMPACTS OF PROPOSED DEVELOPMENT AND RECOMMENDED MITIGATION MEASURES

8.1 METHODOLOGY FOR IMPACT ASSESSMENT

The environmental and social consequences of construction and operation of proposed project facilities are analyzed in this section. The impacts on environmental resources from the proposed project will vary in duration and significance. Three types of impact duration were considered as part of the evaluation, including short term, long term, and permanent impacts. Short-term impacts are temporary in nature and occur during the construction phase of the project. Short-term impacts diminish to cessation as soon as the construction phase of the project is completed; long-term impacts are those impacts that will be chronic in nature due to ongoing activities in the project area, while permanent impacts are those resulting in a permanent and irreversible change to existing environmental resources and their quality in the vicinity of the project. Impacts may be positive or negative, and are generally identified as such. The specific criteria used for determining the significance of impacts are identified for each resource, and the following assumptions are generally used when evaluating the potential project impacts:

- ETPL as project proponent will comply with all applicable laws and regulations;
- The construction phase of the project will proceed as described in Section 3; and
- ETPL as proponent will implement the mitigation measures and Environmental Management Plan in letter and Spirit.

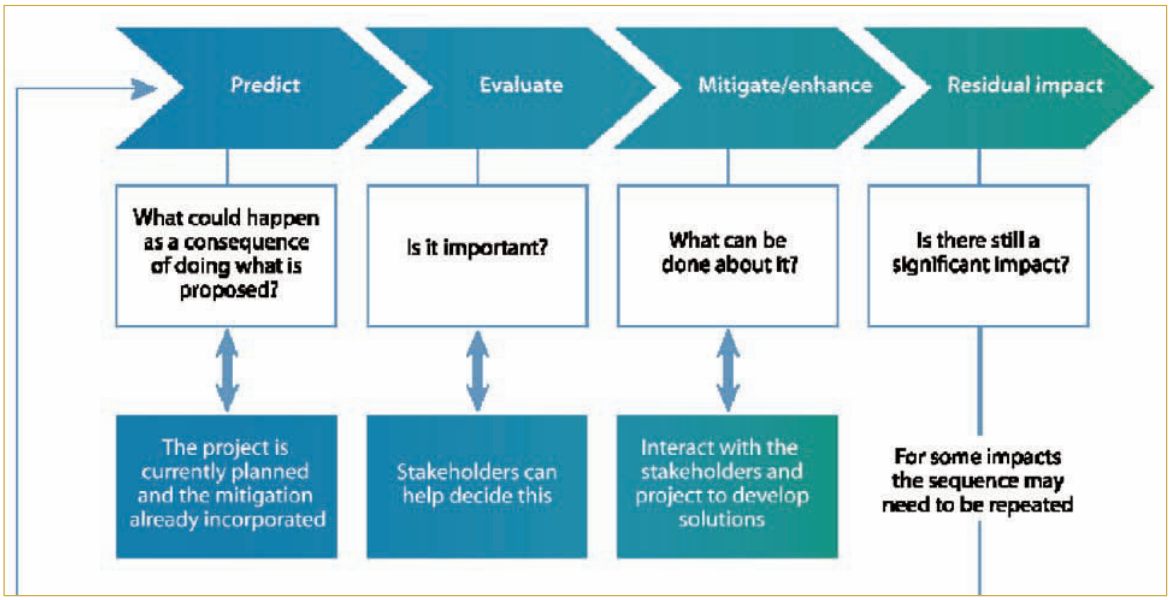


Figure 8.1: Schematic of the Impact Assessment Process

8.2 Screening of Potential Impacts

Screening of potential impacts due to construction and operation stages of proposed LNG import terminal at Port Qasim are related to:

- Site Preparation
- LNG Terminal installation
- Waste Discharges
- Air Quality;
- Noise Level;
- Man Made Hazards;
- Natural Hazards;
- Sensitivity
- Operational Risks and management of Hazards
- Socioeconomic impacts

8.3 Impact Assessment & Proposed Mitigation Measures

The impact assessment and proposed mitigation measures are based on the location of brown field site in the side bay adjacent to ETPL's exiting terminal referred as Option 3.

8.3.1 Site Preparation

8.3.1.1 Dredging and Reclamation Activities

The technology to be adopted for dredging would depend on the geology of the site which will be determined at the detailed design stage. It is estimated that up to 1.6 million cubic meters of material will be dredged at the proposed brown field site. According to the analysis on data of the previous works done in the same area, the main materials to be dredged are clay and sand, which are easily dredgeable. The dredging process has been found to result in loss of the biota located within the dredge area which is a short time activity localized to the environment.

Most of the area to be dredged consists of barren sand/soft bottom or soft bottom/rubble with little or no observed epifaunal communities. The benthic population is restricted to the top 10 cm of the substrate. Once construction is completed, habitats and associated organisms have been found to reestablish/re-colonize themselves quickly as the regeneration time is short (2-3 weeks) within the newly constructed berthing and turning basin (Dr. Shahid Amjad,NIO, 2004).

Siltation and sedimentation impacts at the dredging site are expected to be localized and short-term in duration. Potential impacts will be further reduced through the use of appropriate dredging technique. The increase in local water turbidity levels produced by dredging operations is directly related to the type and quantity of material being dredged. In addition, sloughing of the material along the side slopes of the cut and prop wash from operational tug boats operating in shallow waters alongside the channel can add to localized increase in water turbidity. According to the U.S. Army Corps of Engineers Manual entitled Engineering and Design - Dredging and Dredged Material Disposal (ACOE 1983), the increase in the level of suspended material appears to be concentrated in the immediate vicinity of the dredger. Within 5 m (16 ft) of the cutter head of a dredger, suspended solids concentrations can reach levels on the order of tens of milligrams per liter (mg/l) above background. However, these concentrations decrease exponentially away from the cutter towards the water surface, as well as laterally and in the downstream direction. Typically, near seabed concentrations are reduced to a few tenths of a mg/l within a lateral distance of 300 m (984 ft) from the cutter head of dredger, although these may extend farther in the downstream direction in the presence of a significant mean current to a distance of 1000 m (3280 ft) (Hayes 2000). Other variables, such as particle size, may affect the distribution of suspended

materials, but overall the turbidity effects are expected to be both short-term and localized in nature.

For dredge projects similar to those proposed for ETPL-LNG Project, the typical adopted effluent concentration in the water column is in the order of 30-35 NTU (Nephelometric Turbidity Unit) above background. To ensure that the effluent concentration does not exceed this value during this project, regular turbidity measurements will be carried out and operational procedures modified accordingly. It is envisaged that the excess dredged material will be temporarily placed on the shoal (sandbank). Deposition of this material will impact an area in which the benthic habitat is characterized by soft bottom/sand. Although existing benthic habitat will be lost by placement of dredged material on the bottom, the excess spoils shoal itself will form a foundation for a new benthic habitat till such time the excess spoils are harvested by the dredging operation.

Most dredged material will be transported and deposited directly to reclamation and to the proposed dumping site designated by PQA or temporary at areas on project site. Some sedimentation and temporary turbidity could potentially occur due to transport of fine material into marine habitats during dewatering of dredged material. In order to minimize the impact of sedimentation resulting from dewatering, all dredged material will be deposited within dikes equipped with control weirs. The dikes will contain the discharged dredged material and prevent re-deposition of the material due to waves or overflow. The weirs, used to discharge excess water, will be designed to reduce the discharge of fine sediment including benthic community back into the water column and to moderate the discharge velocity and volume. The benthic community is anticipated to be rehabilitated at the discharge site.

No blasting will be involved during the entire site preparation and development phase as rocks are not envisaged in the area to be dredged.

An additional issue related to the dredging operation is the fueling of dredge barges and associated vessels. It is envisaged that a fuel barge will be used to transport fuel to the dredger. A Spill Control Plan shall be prepared in consultation with Independent Monitoring Consultant (IMC) and be implemented throughout the construction phase of project.

Upon completion of dredging operations, long-term operational impacts to the benthic communities within the approach channel and turning basin have been found to be minimal. Although existing biological habitats will be permanently altered in the short-term, new habitats and organisms have been found to rapidly reestablish themselves in previously disturbed areas. In addition, dredging can also alter the bottom in ways that actually aid in establishing habitats in areas where they did not previously exist. Due to natural current movements, it is not anticipated that there will be any long-term sedimentation impacts during operations. Natural currents and tides are expected to serve to minimize or restrain potential sedimentation to developing biological communities and prevent or minimize the need for additional dredging in this area.

If Land reclamation is conducted, it will occur by placing dredge spoils from the berthing basin and turning basin expansion directly into designated fill and stockpile areas. Placing most dredged material directly into planned reclaim areas avoids the need to rehandle the material, thus minimizing the potential sedimentation impacts from storm water run-off and re-deposition of material. Some sedimentation could potentially occur due to transport of fine material into marine habitats during dewatering of dredged material. It will be minimized using dikes equipped with control weirs or some such technique that will appropriately contain the sediment movement, as discussed earlier.

Dredged spoils not directly placed in areas to be reclaimed will be pumped into PQA-designated site and sediment particles will be allowed to settle prior to discharge of effluent water. Once drained, dredge spoils will be placed using conventional fill placement techniques. Turbidity control booms will be placed as

required around any fill areas not permanently contained. As with the dredging operation, it is expected that these control procedures will minimize adverse impacts on marine resources due to short-term sedimentation and turbidity effects.

8.3.1.2 Maintenance Dredging:

Maintenance dredging is an essential part of operation of all port activities particularly the LNG terminals. PQA need to conduct hydrodynamic and sediment transport modeling to predict frequency of maintenance dredging or the bathymetric surveys being conducted to indicate about the prevailing depths by PQA.

During operation of the proposed Terminal, periodic bathymetric surveys will be conducted by PQA and Terminal Operators within the berthing and turning basin to measure changes in bottom elevation and locate areas of sediment accumulation. As discussed above relative to construction dredging, the primary concerns for dredging are increases in turbidity and suspended sediments, and the loss of benthic organisms in particular. Turbidity will be monitored during each maintenance dredging event to ensure compliance with relevant international standards. If the turbidity standard is exceeded, dredging will be shut down temporarily until modifications can be made to the dredging technique to bring the operation back into compliance.

8.3.1.3 Compaction of Reclaimed Soil

Appropriate compacting technique will be used for improvement of the reclaimed soils. Because many of the near-shore habitats around project site will be undergoing modification due to island expansion and construction of shoreline protection, and because new habitats may still not have established themselves along the shoreline, the impact of compacting process on existing and new habitats will be minimal. The compacting activity would need to be completed prior to the reestablishment of new near shore habitats around project area. When proposed works are complete, no anticipated adverse long-term operational impacts from site filling and soils compacting are expected.

8.3.1.4 Shore Protection

A comprehensive shore protection system around the perimeter of the project site is proposed to prevent coastal erosion and provide protection for project facilities against coastal flooding. The shore protection system will be designed to withstand wave and surge conditions associated with the nominal 100-year frequency hurricane event.

Impacts from construction of the shore protection features could result from related dredging and land reclamation, as well as the actual installation of the shore protection systems. Of the habitats that will be impacted by shore protection system construction, the mangrove habitat is the most sensitive; however, the mangrove habitat on brown field site in the vicinity of ETPL is relatively small. Due to its isolation and small size the overall impact due to loss of the mangroves is minimal.

Mitigation Measures

1) The dredging of berthing pocket at the project site will have a slightly negative impact on the marine habitat and the benthos of the creek; this would adversely affect fisheries reproduction. However, carefully regulated construction program and disposal of spoil at the designated areas would minimize and localize these impacts. The extensive dredging and disposal of spoils carried out for Port Qasim over the last decade or so, has greatly reduced the benthic habitat. ETPL will ensure the adoption of careful methods to reduce the impact of construction on marine ecology of the site;

2) To prevent loss due to erosion, exposed soil materials will be protected by surface treatments such as armoring, pavement and vegetation. No mitigation measures other than those sites above are needed except that the entire operation will be keenly monitored by the proponent and IMC;

3) Any loss of mangrove habitat will be compensated by

plantation/replantation of mangrove of as many mangrove trees as the canopy of the removed trees would require. The number of trees to be planted against the number removed will be determined in consultation with IUCN and IMC;

4) Shore protection along the reclaimed site will consist primarily of concrete caissons or equivalent systems. These shore protection systems will be installed in areas that have already been impacted by prior dredging activities. Therefore, no additional impacts are expected due to the installation of the shore protection structures.

5) Monitoring of all activities related to removal of plantation and the replantation.

8.3.2 LNG Terminal Installations

Impacts related to LNG Terminal are those associated with the construction as well as operational activities at LNG import terminal.

Activities associated with the installation of Jetty for the FSRA/LNGC will involve construction of loading platforms, breasting dolphins, mooring points, access trestles, and walkways. Construction of the loading platforms and breasting dolphins will require installation of drilled steel piles. Pilings will be installed in previously dredged areas, no benthic habitats will be present at the time of borehole installation; and hence no direct impact from pile installation is expected to benthic habitats. Potential impacts during pile installation will be further reduced a) by the use of non-toxic, clay free, biodegradable drilling fluid, b) Mooring points, access trestles and walkways will be installed above the water surface thus reducing direct impacts to marine communities as a result of these construction activities.

Construction activities and vessel traffic have the potential to interfere with local fishing activity by temporarily obstructing access of fishermen to their fishing grounds.

The entire Kadiro-Phitti-Gharo Creek ecosystem is only sparsely vegetated with a few plant species, which are otherwise prevalent in the Karachi region. Construction of the proposed LNG Terminal and associated activities will not result in significant damage to this sparsely vegetated system. It is estimated that on shore ecology will not be much affected. No unique habitat has been identified and it will be ensured that any unique habitat if identified will not be lost. Similarly, during operation phase terrestrial ecology will remain unaffected. No rare or endangered species of plants or animals are reported in the area. Removal of the scrub may have some negative impact on the birds and aquatic animals which would migrate to the more dense adjacent bushes.

There will be no anticipated impacts to marine mammals once the facility is operational; therefore, mitigation measures will not be required. With the exception of marine mammals, no other at-risk marine species are known to occur or to utilize the habitats within the project area; mitigation measures will therefore not be necessary.

The operation of the LNG terminals has an excellent safety record world-wide and is not likely to affect the terrestrial ecology of the area. LNG after its re-gasification will be NG and its fugitive emissions or spillage will not need special remedial measures other than proper ventilation and diffusion in the atmosphere which is an integral part of the project design. Hazards of any accidental release of LNG are discussed in subsequent section on Risk Assessment (QRA study is also being conducted by the proponent). No impacts on the terrestrial ecology are likely from the normal operation of the LNG Terminal.

The tie in to the gas distribution system would be provided with the consent of SSGC through PQA approved ROW. For the construction of sub-sea delivery pipeline, "No" mangrove plants will need removal along the alignment of the pipeline. The proposed design ensures that no major damage to this important asset is caused. The technique employed for laying of the pipeline underneath the sea bed shall be environment friendly causing minimal disturbance to ecology particularly relating to mangroves and benthos.

Mitigation Measures

1) Advance notices on upcoming construction activities will be provided to local fishermen, in order to mitigate possible obstruction of potential fishing areas during construction. Pakistan Fisherfolk Form being the main stakeholder will be kept informed of all activities that could have negative impact on the fisheries operations.

2) The construction contract should include provisions to limit the removal of bushes and mangrove to the bare minimum and restricted to the land area identified by PQA. The bushes and mangrove seedlings may, as far as possible be saved and transferred to the adjacent area. Other plants in the vicinity will need to be protected against damage by construction operations. The areas beyond the limits of site shall not be disturbed or otherwise damaged. Trees and shrubs will be planted in consultation with PQA and monitored by IMC.

3) Once construction activities are completed, there are no anticipated long-term impacts that will occur as a direct result of installation of berthing facilities. Given appropriate substrate, sunlight, and temperature, benthic communities will be able to reestablish within the vicinity of the LNG terminal site. There is the potential for long-term impacts due to increased ship traffic, particularly as a result of accumulation of pollutants in the water column and sediment, which is known to adversely affect biological communities. In order to minimize and avoid impacts related to introduction of pollutants and invasive species all bilge discharge procedures will follow standard MARPOL regulations.

4) Mitigation of potential impacts to benthic habitats is anticipated to occur through natural reestablishment of bottom conditions and resettlement of associated faunas. Natural forces of currents and tides should restore the pre-construction distribution of soft bottom sediments that will be recolonized by infaunal organisms.

5) Any loss of mangrove habitat will be compensated by plantation/replantation of mangrove of as many mangrove trees as the canopy of the removed trees would require. **The number of trees to be planted against the number removed will be determined in consultation with IUCN and IMC.**

8.3.3 Waste Discharges

Water withdrawals and discharges due to operation of the proposed Terminal will include the following:

- Ballast water withdrawals

During the offloading of LNG, the LNGCs take on ballast water to offset the tonnage of LNG. The ballast water is used to correct for trim, list, and structural items. In addition to taking on ballast water, the LNGCs will utilize sea water for cooling while at dock. The amount of cooling water required varies, depending on several factors such as ship size, propulsion system.

- Ballast water discharge

The proposed Project will increase ship traffic into the PQA channel by around one ship per week in the first phase. However, LNGC ships will enter the channel with a full load and will not need to discharge ballast water into the channel. Therefore, there are no anticipated impacts from ballast water discharge into the main channel.

- Condensate water discharges from submerged condensate vaporizers

Controlled vaporization of the LNG within the FSRA will produce condensate from the ambient air vaporizers if considered (decision on the open/closed loop system would be taken at the time of FEED). After passing through the treatment system of the FSRA which will comply with MARPOL convention, the water will be discharged back into the sea.

- Discharges from ship engine cooling systems

The cooling water at discharge is 3 degrees Celsius (^{o}C) warmer (at most) than at intake. According to National Environmental Quality Standards (NEQS) the change in discharge temperature is required to be lower than 3^{o}C over

ambient. The FSRA will be adequately equipped to deal with the temperature differences to respond to the national and international standards. The effects of cooling water discharge are expected to be biologically insignificant in view of the small temperature difference between the discharged cooling water and ambient conditions. However, water temperature and diffusion modeling to be considered in detail design to better evaluate the mixing of the cooling water with receiving water.

Discharges from the FSRA would be at approximately the ambient temperature of the Sea. Water discharges for the LNG carriers, primarily associated with cooling onboard machinery, would cool to within 1.5°F of ambient temperature within 75 feet of the discharge point. These discharges would not raise the overall temperature of the Sound or aggravate conditions that contribute to hypoxia. Temperature-related impacts associated with operation of the FSRA and LNG carriers would be localized and minor.

- Storm water discharges from developed shore-side facilities

The designing stage will take care of the appropriate site for storm water discharges from the facility. Care would be taken that the storm water is not mixed with other effluents.

- Sewage Discharge

The crew will generate grey water (from showers, sinks laundry, etc.) at the rate of approximately 150 liters per person per day and sewage (from toilets) at the rate of 50 liters per person per day. This will generate 2000 cubic meters per year of grey water and about 650 cubic meters per year of sewage, which will be treated before discharge and expected to be catered for during the design stage.

Mitigation Measures

1) The proposed operations are not expected to affect either the hydrology or currents of the channel. Discharges of water from the site to the channel are too small to have a measurable effect on hydrology or current patterns that could affect fishery resources.

2) Automatic biocide dosing, quality control and feedback systems will be incorporated into the FLNG facility design.

3) Screens will be installed on the cooling water riser inlets and inlet current speeds will be low (estimated at 0.5 m/s) to prevent the ingress of large marine fauna into the cooling water system.

4) Heat recovery measures from the FSRA will be considered in the detailed design stage.

8.3.4 Air Quality

Project related air quality impacts during construction are expected to include fugitive dust emissions at the project site from ground excavation, fill operations, and removal of debris, as well as construction vehicle emissions, marine vessel emissions and portable generators. Typical practice for fugitive dust control is to treat land disturbed during construction and grading, if necessary, in a way that minimizes visible airborne particulates. Because the construction period is limited and activities change during the construction phases, these emissions are only temporary and vary throughout this period.

Potential emissions of fugitive dust will depend on such factors as soil properties (i.e., moisture content, volume of spoils, and soil silt content), meteorological variables (wind speed and precipitation), and construction practices employed.

Air emissions from the FSRA are generally generated by burning natural gas to heat the LNG during the vaporization process. Ships may have heavy fuel driven engines which may emit high levels of SOx and NOx. In case of Gas turbine driven ships or Gas generators located on shore the levels would be lower. The potential air emissions would mainly be NOx. Oxides of nitrogen emissions can be of concern for three reasons:

- Human health effects, including those associated with photochemical smog;
- Generation of photochemical smog or acid rain in air sheds with high levels of nitrogen oxides; and

- Nitrous oxide (N_2O), an oxide of nitrogen, is a greenhouse gas with a very high GHG warming potential of about 300 times that of CO_2.

Once liquefied, LNG is stored at atmospheric pressure and at its boiling point temperature of -161°C. With such a huge difference in the temperature of LNG compared to the outside ambient temperature, significant efforts are made to insulate the pipes and tanks in which LNG is stored to limit the amount of heat in-leak (absorption) and hence reduce the rate of boil-off of the LNG product. LNG loading lines, when not in use, are maintained at a cryogenic temperature by recirculating LNG from the LNG storage tanks through the dual line system. This is necessary to avoid repeated thermal expansion and contraction which can damage bellows and pipe supports. The main parameter impacting boil-off gas rates of storage tanks is the extent of heat in-leak through the layers of insulation into the LNG tanks, not tank motions. LNG carriers typically have boil-off rates of their LNG cargo of about 0.15% per day. Newer designs are reducing this to 0.1% per day.

The air dispersion models have been prepared for LNG vapor emissions considering two scenarios viz. Normal and Emergency. The detailed report of Air Dispersion Modelling has been provided as Annex-I to this ESIA report. Detailed QRA studies will further evaluate the risks associated with LNG transfer, regasification, handling and storage.

Mitigation Measures

1) Construction impacts on air quality will be mitigated through construction management practices, including the use of appropriate dust suppression measures. Air quality impacts from operation of the project's power production system will be minimized by appropriate technology to reduce the impact of emissions to confirm to World Bank standards. The power production system will be designed for high-efficiency with advanced combustion controls to minimize fuel consumption and pollutant emissions.

2) FSRUs generally have emission monitoring system. However, it is recommended that ETPL would conduct regular emission monitoring to supplement the data generated offshore.

3) Fugitive dust emissions will be minimized through the use of dredged fill material, which will be pumped in a slurry form through pipeline into dewatering basins located near the final reclamation areas. Construction equipment used for final grading will handle fill material with high moisture contents and minimal potential to generate fugitive dust. To further minimize emissions of airborne particulates, fugitive dust will be mitigated using the following measures, as necessary:

- The use of water on areas of exposed soils, if necessary; and
- Final grading and landscaping of exposed areas as soon as possible.

4) Emissions from vehicles and other engine-driven construction equipment will be temporary and cease once the project is completed. Nevertheless, mitigation measures including proper maintenance of construction equipment and controlling unnecessary idling of equipment will be implemented.

5) It is envisaged that Selective Catalytic Reduction or any other alternative systems would be incorporated on board the ships to reduce NOx emissions.

6) All emissions from construction and operation must be in compliance with air quality standards in vogue. With adherence to the applicable legal requirements, impacts to regional air quality during operation of the Project would be insignificant but would continue for the life of the Project. Regular monitoring and evaluation is recommended.

7) The lack of other cumulative sources of NOx emissions within the region also protects against the potential for photochemical smog or acid rain generation.

7.3.5 Noise

LNG terminal construction and associated activities may raise the ambient noise levels in the microenvironment. In particular, works such as pile driving, dredging, drilling,

earthworks, etc. as well as site plant such as compressors, would contribute to noise pollution. The duration of the construction work is anticipated not to exceed one year. The assessment of noise emissions from project site during the construction phase of the project is based on review of the similar construction activities in PQA where construction equipments used are very similar to the equipment planned for the construction phase activities, which include diesel engine driven electric generators and earthmoving equipment. Thus, it is valid to extrapolate the expected noise emissions for the construction phase of the project from the previously calculated baseline noise assessment.

The diesel engine driven equipment will comprise most of the construction tools needed for this project. These include the dredging barges and pumps, winches for cranes and pipe shore pulling, power for dredged spoil compaction system and pile driving, concrete batching, sand pumping, jetting equipment, pipe compression test equipment, welding generators, power for the temporary fuel, water and sewer systems, and the engines for the tugs, launches and ferries. The total noise level that may be expected due to diesel engine driven construction phase operations would be well below both the daytime limit of 55 dB(A) and the nighttime limit of 45 dB(A) required by World Bank Guidelines through appropriate mitigation measures.

Wind speed and direction data reveal that winds blow from the southwest. Offshore winds are also generated by convection changes as the land warms during the day. It is considered likely that there would be regular occasions when the prevailing wind would direct the acoustic waves towards the land. The acoustic effect at the creeks would be to echo the noise especially during low tides. This may be more pronounced in case of sharp burst of noise such as during pile driving. However, the open land would dissipate the acoustic waves from noise emission activities and the impact of noise emission would be only feebly reaching the shore line. There are no noteworthy structures, buildings or topographic features in the proximity of Project site and thus there would be no necessity for further shielding or damping of the noise.

There are no developed residential areas close to the proposed LNG terminal site. There is no school, hospital or library, however some human settlements mostly comprising earthen dwellings are scattered. It is unlikely that noise from the construction phase activity would be noticed audibly at the microenvironment of the project area. Based on the review of data for similar activities performed for other projects of similar nature the expected noise levels would be well below both the daytime limit of 55 dB(A) and the nighttime limit of 45 dB(A) required by World Bank Guidelines. If the noise emitted from construction operations reaches levels which exceed the World Bank Guidelines then modest noise control measures can be employed that will reduce the noise by 5 to 10 dB. The construction workers who may be exposed to high noise would be provided ear plugs to be worne as protective measures.

There are several factors that would affect the potential impact of noise emission from the LNG terminal operation. Such factors include the distance between the terminal and the residential areas, local acoustic barriers, and the limits of tolerance of the local population. The operation of LNG cargo unloading, storage and re-gasification etc. are low impact activities. Noise emissions during project operation is expected to be much lower and generally derived from facility operations such as pumps, engines, other on-site machinery, and from LNG Carriers unloading LNG at the jetties.

LNG Terminal and storage facilities are not particularly noisy. Noise level immediately outside these facilities is generally reduced to acceptable level of 70 dB(A) required by World Bank guidelines for noise emissions .There are no continuously noisy systems around the facility, while the noisy standby power generator would be housed in its own building, and its occasional use inside an adequately sealed structure would reduce the emission level from almost 90 to 105 dB(A) to less than 70 dB(A) at the boundary wall of the facility.

Noise emissions from the marine vessels would mainly be

generated by the operation of the vessel's engines. The noise emissions from vessel engines are substantially attenuated by their placement deep within the confines of the vessel. Only one vessel will be using the berth at any point of time. The increase in noise emissions from marine vessels using the berth is not expected to result in significant increase in level (< 3dBA). Additionally, sound emissions from marine vessels will occur on an intermittent and infrequent basis.

Cumulative Impact: Including the proposed LNG import terminal, there are number of industrial facilities that are proposed to be established in the vicinity of the project site. There is limited information available as to the planned development of these proposed projects or the scale and timing of their development. The cumulative effect of the noise emission from LNG facility and any other proposed industrial developments (including any other proposed LNG facilities) is assessed not to exceed the recommended ambient noise levels, on the basis that any other proposed industrial development would be required to achieve the same noise criteria which are acceptable for the proposed Engro-LNG project. In some circumstances, the existing ambient noise level may already be above the recommended noise levels. In such cases, noise generated by the LNG facility will be maintained below the existing ambient noise levels. This should ensure that ambient cumulative noise impacts of the project will be negligible. Also other proposed industrial developments (including potential LNG facilities) are likely to include some or all of the proposed mitigation measures outlined within, thereby minimizing cumulative impact on the receiving environment.

Mitigation Measures

No additional mitigation measures are required other than following standard operating procedures which require regular maintenance of equipment and providing PPEs to the workers at stressed sites.

8.3.6 Manmade Hazards

The manmade hazards that may potentially occur during the construction and operation of the LNG import terminal project will be minimized to the extent practically possible through the use of automated systems and controls, environmental management system plans for spill and fire response, as well as worker health and safety, and designated work practices required during construction and operation. The manmade hazards considered for impact include the following:

1) Fuel Spills

2) Fire and explosion

3) Marine Hazard

4) Workplace Hazard

8.3.6.1 Fuel Spills:

Spills of fuel oil can have a potential impact on soil, groundwater and particularly surface water during both the construction and operational phases of the project. During construction fuel will be distributed over water to several types of vessels, including the dredge barges, the pipe lay barges, the water treatment barge, the concrete batch plant barge, and the quarters barges or cruise ship. Fueling will be conducted in a manner consistent with the spill prevention and response plan prepared by the construction contractor. In addition to construction barge fueling operations, fuel oil will be transferred from oil delivery barges to tanks. These operations will be managed in a manner consistent with the requirements of the spill plan. Impacts of a very limited nature are anticipated from occasional equipment leaks from fuel and hydraulic systems. The potential area of impact will be minimized by implementing a schedule of mechanical preventative maintenance for equipment and by instructing construction personnel of the importance of controlling the area potentially impacted by a release and providing immediate spill response and cleanup measures.

Mitigation Measures

1) The potential for equipment leaks from fuel and hydraulic systems will be avoided and/or reduced by implementing a scheduled mechanical preventive maintenance for equipment.

2) Each fuel transfer will be visually monitored for the potential of release. Furthermore, the plan will require fuel tender personnel to be instructed in the means of stopping, minimizing and responding all leaks and spills (if any) using spill containment/cleanup equipment maintained on each vessel. The construction contractor will be required to have active contracts in place with third party emergency response/cleanup companies to provide additional assistance if necessary.

3) Given these management controls, the potential impact from a fuel oil spill on water would be restricted to the small area within the deployed booms. Within this area, oil will be removed from the surface of the water, to the extent possible, using equipment and materials maintained adjacent to the location of fueling operations or supplied by the third party response contractor (depending in the size of the release). In addition to construction barge fueling operations, it is envisaged that fuel oil will be transferred from oil delivery barges to tanks during both the construction and operational phases. These operations will be managed in a manner consistent with the requirements of the spill response plans. As with barge refueling operations, barge to tank transfer procedures will require the barge and onshore crew to visually monitor every fuel transfer to the onshore tanks. Tank volumes, which will be monitored by level sensing devices, will be checked prior to the start of transfer to ensure that there is sufficient volume to receive the delivery. The spill plans will require documentation of volume readings before and after the transfer, as well as other important control measures such as inspections of hoses and mooring lines, verification of communications equipment and signals, and pre-transfer conferences.

4) Fuel tanks will be provided with a secondary containment system that will limit the potential impact of releases due to tank failure. The area impacted by a worst case tank failure would be limited to the area of the secondary containment, which will be impervious to the fuel oil and sized to contain the entire contents of the tank. Operators will be provided with spill response materials and training to adequately respond to a pipe leak and minimize the land area potentially impacted by the release. Following transfer, the lines will be blown through to the tanks to minimize potential releases from the piping system between delivery operations.

5) The potential impacts from spills of materials other than fuel oil will be minimized and controlled in a similar manner. Portable secondary containment will be used to the degree possible during construction to store drums of chemicals. During the operational phase, chemicals will be stored in a secure warehouse provided with secondary containment arrangements. The warehouse will be supplied with sorbent and other materials appropriate to minimizing the area impacted during a release and clean up of the spill.

8.3.6.2 Fire and explosion:

Fire and explosion hazard impacts to surrounding islands, inhabitants, workers, and marine resources are not expected during the construction phase due to the limited quantities of flammable and combustible materials to be provided/transported to the site. The availability and use of portable extinguishing systems would limit the impacts of small fires, and personnel will receive training on the proper use and locations of this equipment.

Releases of cryogenic or low temperature liquid (e.g., LNG) due to spills, leaks, or intentional draining can expose facility personnel to several hazards. These hazards include oxygen deficiency, freezing injuries, fire hazards, and explosive air-gas mixtures.

Fire and explosion hazards at LNG Terminal from the receiving, transfer and regasification of LNG and natural gas are detailed in separate heading as "Risks". The Hazard/Risk Analysis considers the various hazards and potential effects on public safety that could occur in the operation of the LNG Import Terminal in Port Qasim with respect to siting and the operating procedures at the terminal.

Mitigation Measures

1) Potential impacts due to fire and explosion will be minimized through use of gas detection systems and a fire

suppression system consistent with the international guidelines.

2) Control Systems and Operational Procedures will be in place to minimize the potential for a fire or explosion and the resultant impacts to the operation, island and personnel.

3) A detailed risk assessment is being conducted to determine if a LNG facility of a specific design and layout can be located on a site without causing an unacceptable impact to the safety of the public who live or work near the site. In this study the requirements of NFPA 59A (2009) for LNG Facilities shall be followed. It is expected that hazard zones would lie within the property of the LNG terminal site or over adjacent water, these requirements are met.

4) As required by NFPA 59A and to minimize impacts to personnel and facilities, Impoundment areas (secondary containment) will be provided.

8.3.6.3 Marine Hazard:

Shipments of LNG received at the LNG facility/terminal will transit to the project site through the PQA navigational channel. Volume of shipping traffic will increase during the construction phase and would taper-off during the operation of the project. Ships contracted for the movement of the LNG will be equipped with the safety devices and the crews will be trained in safe handling and emergency response procedures. Shipments of LNG will comply with International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code), International Maritime Organization 1993.Coordination of ship arrivals and departures will be controlled by the Port Qasim Authority.

Mitigation Measures

1) LNG Shipment will comply with the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code), International Maritime Organization 1993. Procedures for inspection and safety checks will be performed on each shipment, prior to the unloading/loading operations and before the vessel is released from the terminal.

2) Worldwide there is no record of serious incident of an LNG carrier involved in product transport as envisioned for the ETPL-LNG project. By implementing the management controls and following internationally accepted codes and standards, ETPL expects no marine safety-related impacts due to the shipments of LNG.

8.3.6.4 Workplace Hazard:

There are potential impacts to worker safety during the construction and operation phase due to the increased activities on the island and over water, the higher risk associated with handling LNG and the higher population of workers. During construction, the potential impacts to worker safety include construction related hazards from working at elevation above deep sea water, within confined spaces, and near hydraulic and heavy equipment. The potential impacts to worker safety during operation include extremely low temperature material exposure and oxygen depletion hazards, increased fire hazards, and hazards associated with high-pressure systems.

Mitigation Measures

A Health and Safety Plan for construction and operations will be implemented and monitored with emphasis on personal protective equipment and inherently safe equipment.

8.3.7 Natural Hazards

Natural disasters may occur in the vicinity of the project area; these include severe storms and tropical hurricanes, flooding, and earthquakes. The impacts are expected to be much severe in case of siting the LNG terminal in the main channel critically exposed to open sea as compared with its location away from the navigation channel (proposed Brown Field site).

Mitigation Measures

The mitigation strategies for each of the aforementioned natural hazards are discussed below.

1) Natural hazards associated with storm events include those arising from storm waves/surges, high winds, and torrential rainfall. For protection against wave run-up and over topping, shore protection features will be constructed to protect the proposed island footprint. The LNG facility will be designed to withstand a Category 5 hurricane and the remaining components of the facility will be designed for a Category 4 hurricane. These design parameters will protect against high winds, as well as storm surge and wave effects, associated with these relatively infrequent meteorological events.

2) Shore protection structures will be designed to withstand the impacts from a 100-year storm. Based on design evaluations, shore protection features will be incorporated to further stabilize the island and its operational features.

3) The Geological Survey of Pakistan has, however, defined the area of Port Qasim, where the site under study is located, to fall in a Seismic Zone 2B region. This suggests the possibility of moderate to major seismic hazard i.e. probability of earthquakes of intensity VI to VIII MM scale and 5.6 to 6.6 on Richter scale. From the charts published (such as Figure 8.2), the peak ground level acceleration (PGA) for this zone is 28%. The seismic risk factor of 0.3 is advisable and will need to be incorporated in the design for constructions and installations in the coastal zone, for operational basis earthquakes (OBE) pertaining to damage due to moderate level earthquakes (MM-VI to VIII). The seismicity in the Karachi and at Project site is considered to be low. According to the published data the Project area lies in zone of low seismic activity, with acceleration ranging from 1.6 to 2.8 m/sec^2. A factor of 2.8 m/sec^2 will, on the other hand, have to be taken for a maximum credible earthquake (MCE). The design of the LNG terminal should take these values into consideration.

4) Major damages done by Tsunamis, the impulsively generated seawater waves that are a result of underwater earthquakes, have not been recorded for the coastal area south of Karachi. There are, however, evidences of a 1.2 m

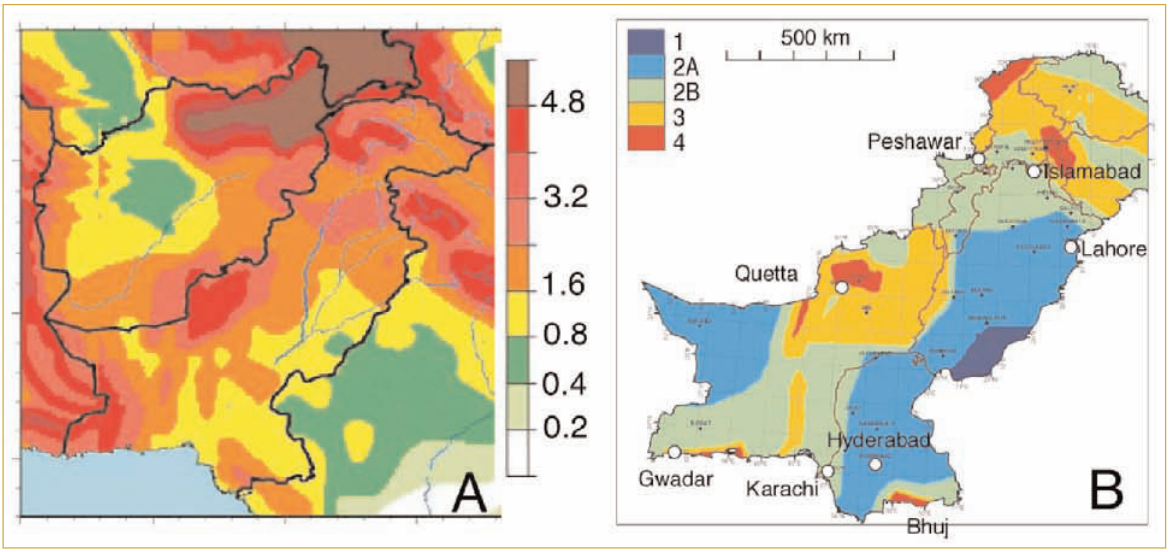


Figure 8.2: (A) GSHAP hazard map of Pakistan (Giardini et al. 1999; color scale indicates peak ground acceleration (m/s/s) with 10% probability of exceedance in 50 years) compared to (B) a recently revised hazard map following the 2005 earthquake (working group on Pakistan Hazard 2006; zonation 4 is most hazardous, 1 is least hazardous).

tsunami generated by an offshore earthquake of intensity 8 M in 1945, which caused only minor damages in Port Qasim area. This event was followed by another Tidal wave that was recorded in 1953. The Tsunami of December 26, 2004 had no impact on the macroenvironment of the Port Qasim area.

5) Tsunamis are not expected to occur in the vicinity of the project area; yet, the mitigation strategies proposed to deal with hurricanes and surges of category 5 are considered sufficient to deal with tsunamis of high order.

8.3.8 Protected Areas & Heritage Sites

There are no designated Protected Areas in the vicinity of the project area. Similarly, this ESIA study has not found any antiquity artifact in the microenvironment of area concerned. No sites of cultural heritage are known to exist at or in the immediate vicinity of the LNG Project location. There are also no indications of any old settlement in the area, nor is there any site covered under the listing of cultural heritage sites. Therefore, there will be no impacts from the construction and operation of the facilities; as such, no mitigation will be required.

8.3.9 Operational Risk and Hazards

The risks unique to LNG projects include operational risks arising from gas tanker and terminal operations involving transport, storage and the transfer of LNG. In particular, many gas terminals are located within the environs of established ports. So their operations and those of the tankers serving them share a common operational environment with other port users. The management of gas shipping operations within ports is therefore a matter of some importance, and needs to be taken into account by those who administer ports and provide essential services in port areas (This is well-known within the LNG industry: see for example the manual, 'LNG Operations in Port Areas: Recommendations for the Management of Operational Risk Attaching to Liquefied Gas Tanker and Terminal Operations in Port Areas', written by SIGTTO, the Society of International Gas Tanker and Terminal Operators (Witherbys Publishing, 2003, first edition). SIGTTO has a membership of over 100 companies who own or operate over 95% of the world's LNG tankers and terminals and over 55% of the world's LPG tankers and terminals.). As a protective device, the industry body, SIGTTO, has argued for the elimination of major risk elements by locating gas operations in places where they are unlikely to be vulnerable to uncontrolled threats from outside their own operating environments. (SIGTTO Information Paper 14: Site Selection and Design for LNG Ports and Jetties, 1997.)

There is also a dynamic factor affecting risk in LNG operating environments. Ports tend to be competitive and seek to grow their businesses. Over time the promise of new business or the demands of other users will have an impact, and therefore the prospects of a changing risk profile should be anticipated from the outset. As a result, the cooperation of port authorities with the gas businesses becomes important if the required degree of safety is to be achieved. This is particularly true of risks arising from the movement of gas tankers in port areas and from other activities carried out in the vicinity of gas tankers and terminals.

There has never been a catastrophic failure of an LNG tanker's hull and containment system so it is not possible to draw on data that would permit the construction of scenarios following the release of large quantities of LNG into the atmosphere. Controlled releases of LNG however show that a cloud will develop and travel horizontally from the spill point under prevailing winds. The flammable volumes of gas will eventually disperse in the atmosphere. However, the SIGTTO manual notes that in spite of an exemplary safety record:

"The risk profile of LNG tankers presents a very serious residual hazard in port areas if the vital structure of the tanker is penetrated… Thus the paramount objective in managing LNG shipping operations in port areas is the elimination of any credible risk of a tanker's containment system being breached" (11 SIGTTO, LNG Operations in Port Areas, section 1, at 3.).

It also notes that:

"If very large quantities of LNG were released into the atmosphere the resulting gas cloud could extend beyond the terminal area, or the immediate vicinity of a tanker in transit through to a port, to affect adjacent port areas up to several hundred meters from the source of the escape".

(SIGTTO, at 5. It recommends the use of a Quantitative Risk Assessment study as a decision tool to satisfy company safety policy and the authorities that the risk is acceptable.)

Further, there is a lack of data on the consequences of a large-scale and sudden confluence of LNG and sea water, although it appears likely that it too would generate a gas cloud in the atmosphere similar to that described above. There have been incidents recorded of LNG escaping during cargo transfer at loading and receiving terminals. However, the volumes have been very small and the effects confined to the immediate environment of the terminals involved.

The likelihood of the above events is customarily minimized by stringent application of rigorous standards in the design and operation of the terminal. In the event of their occurrence the adverse consequences are minimized through appropriate siting of facilities, and institutionalizing standard emergency response plan (ERP) and disaster management plan (DMP). The ships that transport LNG are specially designed and constructed to carry LNG for long distances. Construction of LNG ships is highly regulated and comprises a combination of conventional ship design and equipment, with specialized materials and system designed to safely contain liquids stored at temperatures of -260ºF.

We addressed potential environmental impacts in the unlikely event that an incident involving the FSRA or an LNG carrier released LNG. Because LNG is a cryogenic liquid, the greatest threat to aquatic life from an unignited LNG spill would be thermal stress. Any aquatic life directly contacting the LNG would experience a sudden cold shock that could be lethal, although it is expected that most motile underwater organisms would detect the temperature change and avoid the area. Aquatic fauna on the surface near the release could be surrounded by the vapor cloud and suffer asphyxiation. However, because the LNG would quickly vaporize and disperse, the likely duration of such exposure would be short. Impacts to shoreline habitats and associated fauna could occur in the unlikely event of an unignited vapor cloud of natural gas from an LNG release reached land and ignited onshore. Potential damage could involve the combustion of both vegetation and wildlife as the fire burned back toward the location of the release.

8.3.9.1 LEAKAGE OF LNG

The available literature on LNG emphasizes a number of positive features of this form of gas. Since LNG is odorless, colorless, non-flammable, non-corrosive and non-toxic, it will not pollute land or water resources. If it is released on water, it evaporates with no residual trace

Table 8.1: Estimated Impact of International LNG Breaches, Spills on Public Safety and Property

Event	Problem ship damage, spill	Potential Hazard	Potential Impact on public spill safety [1]		
			-500m	500-1,600 m >	1,600 m
Insider threat or hijacking	International, 2-7 sq m breach and medium-to-large spill	Large fire Damage to ship Fireball.	High High Medium	Medium Medium Low	Low Low Very low
Attack on ship	International, large release of LNG	Large fire Damage to ship Vapor cloud fire	High High High	Medium Medium High-	Low Low Medium
	International, 2-12 sq m breach and medium-to-large spill	Large fire Damage to ship fireball	High High Medium	medium Medium Medium Low	Low Low Very low

[1] *Distance to spill origin, varies according to site*
Source: Sandia Report, p, 54

(although the pool will simultaneously spread and evaporate and is able to sustain a fire if a source of ignition exists). LNG is stored at ambient pressure so that a tank rupture will not cause an explosion. LNG (Liquefied Natural Gas) vapors (primarily methane) are harder to ignite than other types of flammable liquid fuels. If LNG spills on the ground or on water, it will warm, rise and dissipate into the atmosphere. However, potential hazards include fire, in case if an ignition source is near LNG vapors and frost bite because of the risk of contact with an extremely cold substance such as any direct exposure of skin or equipment.

Mitigation Measures include the use of double hull features in LNG tankers to provide a built-in form of secondary containment. According to the Centre for Energy Economics *(October 2003.)*, there has been no off-site property injury or damage over 30 years as a result of the mitigation measures taken (including appropriate and modern equipment, facility design, safety and emergency systems, operational procedures and personnel training). In the EU technical risks that may lead to leaks or other forms of accident can be mitigated by adhering to the approved technical standards such as the BS EN 1473: 1977 on 'Installation and Equipment for Liquefied Natural Gas - Design of Onshore Installations' (This European industry standard was prepared by Technical Committee CEN/TC 282 (AFNOR)). This gives functional guidelines for LNG installations and recommends procedures and practices which will result in a safe and environmentally

8.3.9.2 Accidents only at Liquefaction Plants

There appear two exceptions to track record of no accidents. 1) The accident which occurred at the world's first commercial liquefaction plant in Cleveland, Ohio (USA), in 1944. The plant liquefied natural gas and stored the LNG in tanks which was vaporized later for use during heavy demand periods. An LNG storage tank ruptured and spilled the uncontained liquid into storm drains, followed by a large fire, which killed 128 people and injured more than 200. Tanks were subsequently redesigned for the cold temperatures required by LNG and no further tank failure has resulted since in the USA. However, the accident was probably responsible for the dearth of construction of LNG facilities over the next 20 years. It may be noted that the LNG tankers currently used carry five times the amount of LNG stored in the Cleveland plant in only one of their four or five shipboard tanks. 2) An explosion occurred at the Skikda LNG plant in Algeria on 19 January 2003, killing 27 people and injuring 80. This was also an accident involving a liquefaction plant.

However both the above referred accidents occurred at the liquefaction plants. No significant incident has occurred at the receiving terminal anywhere in the world.

Australia has been supplying LNG since 1989 and has an enviable record for safety and reliability. Over 2,200 shipments have been dispatched without incident. (Source: Australian Department of Resources, Energy and Tourism)

As of February 2009, the global LNG industry comprises 27 export (liquefaction) facilities, 64 receiving (regasification) terminals, and 298 ships, altogether handling more than 175 million metric tons of LNG every year. LNG has been safely delivered via ocean-going transport for more than 50 years. During that time there have been more than 46,000 LNG ship voyages, covering more than 100 million miles, without any major incidents involving a major release of LNG either in port or on the high seas. LNG ships frequently transit high traffic density areas. For example, in 2000, one LNG cargo entered Tokyo Bay every 20 hours, on average, and one LNG cargo a week entered Boston harbor. Overall, LNG safety is inherent in the properties of LNG, the technologies and operating practices that have evolved on the basis of understanding these properties, and regulatory requirements.

Mitigation Measures:

To a large extent, the overall positive safety record is rooted in the limited risks arising from LNG itself. Because LNG is stored at atmospheric pressure the major hazard is fire, rather than explosion. Hence the need for

emergency fire detection and response is a way of combating this risk.

8.3.9.3 Terrorism

Independently of the typical industry-generated risks, there are increased risks from terrorist attacks, which may also have important and highly damaging environmental consequences. Prior to September 11, 2001, the major security issue concerning LNG infrastructure was accidental leakage from LNG storage and processing facilities. Residents of densely populated areas where LNG plants were planned tended to express their concerns that gas might escape, congeal and possibly ignite. Discussions on risk and the likelihood of accidents in LNG transport have focused on how to deal with human errors. The current context is very different. One study has stated that the international gas transport infrastructure seems to be "increasingly susceptible to risks of accidents or even attacks of transport bottlenecks or other supply interruptions" (C Jepma and N Nakicenovic, Sustainable Development and the Role of Gas, May 2006 (Energy Delta Institute Report for the European Gas Union Congress 2006)).

In 2002 there was a suicide boat attack on a tanker off the coast of Yemen. Such events have contributed to public concerns about safety post 9/11. Facilities that handle large amounts of hazardous materials like LNG terminals and ships have been thought to be attractive targets for terrorists. The ships themselves could be perceived as potentially 'floating bombs'. The fear has been a scenario involving a terrorist using an explosive charge like a rocket or flying an airplane to breach and probably detonate one or more storage tanks on an LNG ship at or near a populated port area. A similar scenario is envisaged when LNG storage facilities are considered.

In January 2008 a US Government Accountability Office study concluded that "the threat of seaboard terrorist attacks on maritime energy tankers and infrastructure is likely to persist" (GAO, Maritime Security, December 2007). It may be noted that LNG is flammable but not explodable. Therefore, the greatest risk to the public from a suicide attack on a tanker ship carrying LNG was deemed to be from fire, not an explosion. The ferocity of such a fire could, according to some US Government studies, cause burns to persons standing more than one kilometer away from the ship. LNG in its liquid form does not burn and is inherently less volatile than many petrochemical products. The US report did however note that plans for responding to a spill and to a terrorist threat are generally separate from each other; ports have rarely tested these plans simultaneously to see if they work effectively with each other. This particular risk factor can be expected to be reviewed from time to time and to vary in the weight attached to it.

LNG facilities and ships require a higher degree of planning, resources, knowledge, and risk to attack than softer targets. Terrorists want to be successful, so they look for ways to execute crimes that will have a desired impact with a high likelihood of success. Lastly, they work with the resources they can acquire to conduct their acts so they are less likely to attack assets requiring sophisticated and complex methods as is evidenced by the vast majority of events. Their strategic objectives are sometimes profound, but their weapons, tactics, and choice of targets tend to be common.

Existing ETPL terminal at PQA is ISPS certified and regular drills are carried out. ETPL have their own contingency plan which will be supplemented with the comprehensive contingency plan being proposed for all port terminals at PQA. All the relevant safety protocols would be followed by ETPL; however, "no one can guarantee that a terrorist incident can't happen."

Mitigation Measures:

Maritime Agency and PQA have an enviable security record and are committed to maintain the same. No additional mitigation measures are required.

8.3.9.4 Explosion

LNG tanks store natural gas in liquid form at a temperature of about -160°C, which does not require pressure to maintain its liquid state. Sophisticated

containment systems prevent ignition sources from coming in contact with the liquid. Since LNG is stored at atmospheric pressure, a crack or puncture of the container will not create an immediate explosion.

Mitigation Measures

No mitigation measures are required because LNG is stored at atmospheric pressure, a crack or puncture of the container will not create an immediate explosion.

8.3.9.5 Vapor Clouds

As LNG leaves a temperature-controlled container, it begins to warm up, returning the liquid to a vapor. Initially, the liquefying gas is colder and heavier than the surrounding air. In the liquid/liquefying stage it creates a fog which is a vapor cloud above the released liquid. As the gas warms up, it mixes with the surrounding air and begins to disperse. The vapor cloud will only ignite if it encounters an ignition source while concentrated within its flammability range.

Mitigation Measures

Safety devices and operational procedures are intended to minimize the probability of a release and subsequent vapor cloud having an effect outside the facility boundary.

8.3.9.6 Freezing Liquid

If LNG is released, direct human contact with the cryogenic liquid will freeze the point of contact and can damage the tissues.

Mitigation Measures

Appropriate containment systems surrounding an LNG storage tank on ship are designed to contain the tank's contents. Containment systems would also separate the tank from other equipment. Moreover, all facility personnel must wear gloves, face masks and other protective clothing as a protection from the freezing liquid when entering potentially hazardous areas. This potential hazard is restricted within the facility boundaries and does not affect neighboring communities.

8.3.9.7 Rapid Phase Transition

When released on water, LNG floats being less dense than water - and vaporizes. If large volumes of LNG are released on water, it may vaporize too quickly causing a rapid phase transition (RPT). Water temperature and the presence of substances other than methane also affect the likelihood of an RPT. An RPT can only occur if there is mixing between the LNG and water. RPT ranges from small pops to blasts large enough to potentially damage light weight structures. Other liquids with widely differing temperatures and boiling points can create similar incidents when they come in contact with each other.

Mitigation Measures

Safety devices and operational procedures are intended to minimize the probability of a release of LNG.

8.3.9.8 Flammable Gas Dispersion

US Federal regulation 49CFR193.2059, Flammable vapor-gas dispersion protection, provides for protection of the public from flammable gas clouds that could result from an LNG spill. When spilled, LNG vaporizes, releasing cold natural gas. Natural gas mixed with air is flammable in concentrations of approximately 5-15% by volume (LFL and HFL for LNG is 5% to 15% respectively). Very close to a spill, the natural gas concentration is too rich to burn, but further away from the spill, additional mixing with air produces a flammable cloud of natural gas. Natural gas formed by vaporization of LNG is initially very cold and thus much denser than the surrounding air. The resulting vapor cloud therefore spreads out close to the surface near the spill. As the cloud moves downwind, mixing with air and heat transfer with the ground warm the vapor cloud. At some distance from the spill, the cloud becomes lighter than air and it lifts off. Ultimately, mixing with air dilutes the cloud below the flammable range.

The US federal regulation and NFPA 59A both require that flammable gas dispersion from potential LNG spills not extend beyond the property line of the LNG facility. More specifically, the regulation calls for an average flammable gas concentration of no greater than 2.5% (one half of the lower flammable limit [LFL] of methane in air) at a receptor height of 0.5 m. Using one half LFL of methane is a safety factor that accounts for the lower LFL's of C2+ hydrocarbons which may be present, as well as the limitations of atmospheric dispersion.

Mitigation Measures

The flammability risk would be taken into consideration during the detailed QRA. The recommendations of QRA shall be implemented as mitigation measures for flammability risk.

8.3.9.9 Likelihood of Tanker Collisions

An offshore terminal has the added risks of ship collision, varying degrees of movement during unloading, and less protected areas during extreme weather. Aside from safe docking, an onshore terminal has no ship movement to worry about. Many ship designs are not able to sail with a partial cargo. An unberthed LNG carrier with partially filled cargo tanks might be unstable and might flounder in rough seas. An offshore facility would be more vulnerable to having the unloading operation interrupted than an onshore terminal.

A traffic control scheme, such as segregation of lanes with adequate separation distances and constant monitoring physically or through remotely operated devices, is evolved to minimize the risk of tanker encounters. Further, adequate navigational aids are installed to indicate channels, as well as separation distances. Their positions are marked clearly on the charts. Proper policing is enforced to prevent vessels from discharging bilge, tanker washings, oily slop, etc. into the marine waters, as a part of the environmental management strategy. Collision risks have also been considered by SIGGTO.

Mitigation Measures

The risk of a significant collision between the stationary ETPL-LNG facility and a LNG Carrier, sufficient to cause a breach of an LNG tank on either the LNG Facility or the LNG carrier is extremely low given that:

- Safety zone requirement would be followed as per the results of the QRA. Detailed risk analysis would be conducted in the QRA study, recommendations of which will be followed in the design of the project.
- LNG import facility is fitted with thrusters to maintain a fixed bearing and position during berthing operations;
- LNG import facility is fitted with very robust fenders to protect both the facility and LNG carriers during berthing;
- FSRA and LNG Carriers both have double hulls and, for a spill to occur, both hulls on either the FSRA or LNG Carrier as well as the LNG tank linings would need to be breached;
- ETPL intends to place the LNG carrier inside a berthing pocket, dimensions of which will be confirmed in the FEED, so that the risk of collision between berthed LNG carrier and passing by Vessel is minimized and heavy displacement ships can also pass by in the main channel. Moreover; the Jetty arrangement would be designed to minimize/sustain the surge loads due to large ships passing by LNG ships.

Such an eventuality would have a lesser probability at the proposed Brown Field site.

8.3.9.10 Potential Impacts on Assets in Neighborhood

The NFPA59A guidelines and the 49CFR193 Federal regulations of the USA consider proximity of the site to populated areas and to buildings and other industrial facilities to have a direct impact on potential risks. The

criteria that must be considered for siting an LNG facility in the USA have as large or greater impact on the surrounding area than any credible terrorist attack.

Facilities should provide limited access and constant surveillance to keep away the people who have no business near the terminal.

The US regulations on chemical and hydrocarbon processing plant security (6 CFR Part 27, 2007) will apply to LNG regasification terminals and will require each such facility to assess vulnerabilities and to develop adequate Site Security Plans (SSPs). Pakistan will have to frame similar regulations at each LNG facility to assess vulnerabilities and to develop adequate Site Security Plans (SSPs).

Potential risks from a large aircraft being hijacked and used as a weapon to crash into an LNG tank or an LNG ship is not considered realistic. This is because of:

- Increased security measures being taken after September 11, 2001, and
- Most LNG tanks or LNG ships in service generally do not meet the criteria for being an attractive terrorist target.
- Although a small aircraft would be more easily obtained, it would not have the combination of mass and speed necessary to create the impact energy required to cause either a cargo release from a ship or an LNG release from a tank.

Furthermore

- LNG Terminal and LNG ships being assets critical to public safety, have little potential for a significant release in the event of any credible terrorist attack.
- There are several levels of security that would have to be overcome in order for an attack to be successful in circumventing the basic design, emergency shutdown mechanisms, facility security and PQA oversight.
- All of the consequences of a credible terrorist attack produce exclusion zones that fall within the code-required consequence criteria, which are used to permit a facility. These exclusion zones will have to be established and analyzed as part of the siting and permitting process.
- The US Department of Homeland Security sets requirements for facility security measures as regulated per the Marine Transport Security Act (MTSA) and the Chemical Facility Anti-Terrorism Standards (CFATS), and Port Qasim Authority will act in similar manner. Sites will differ in methods of providing security which include CCTV cameras, fencing, intrusion detection and communications to protect the LNG terminal and associated facilities.
- The proposed ETPL-LNG terminal will obtain ISPS certification and shall comply with the conditions set out in the permission.
- The risk would be taken into consideration during the detailed QRA.

8.3.9.11 Safety and Risk Management of Large LNG Spills Over Water

While standard procedures and techniques exist for the analysis of the potential hazards from an LNG spill over land, no equivalent set of standards currently exists for LNG spills over water. This is due in part to the lack of large-scale data of LNG spills onto water, as well as the much more complicated physical and dispersion phenomena that occur when a very cold liquid such as LNG is spilled onto water. For that reason, the U.S. Department of Energy (DOE) requested that Sandia National Laboratories (Sandia) develop guidance on a risk-based analysis approach to assess and quantify potential threats to an LNG ship, the potential hazards and consequences of a large spill from an LNG ship, and review prevention and mitigation strategies that could be implemented to help reduce the possibility and risks to people and property of an LNG spill over water.

To support this effort, Sandia worked with the DOE, the U.S. Coast Guard, LNG industry and ship management agencies, LNG shipping consultants, and government

intelligence agencies to collect background information on ship and LNG cargo tank designs, accident and threat scenarios, and standard LNG ship safety and risk management operations. Sandia developed a report, "Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water", SAND2004-6258, that provides communities and agencies dealing with the marine import of LNG on the general scale of safety, security, and hazard issues of a large spill and how to focus risk prevention and risk management efforts[Hightower 2004].

The information and results presented in the Sandia LNG safety and risk analysis report are intended to be used as guidance for conducting site-specific hazard and risk analyses. The results of the Sandia report are not a prescription but need to be considered in the context of siting LNG terminals in Pakistan. Furthermore, the report has been recommended as guideline for using performance-based approaches to analyze and responsibly manage risks to the public and property from potential LNG spills over water. The following is an overview of the guidance to assess and manage site-specific hazards and risks from marine LNG imports.

I Factors that Influence an LNG Spill

Figure 8.3 presents a pictorial view of the various factors or events that can occur during an LNG spill over water. First, an LNG cargo tank must be breached, either from an accidental event such as a collision or grounding or possibly from a malevolent or intentional event. Quantifying the likelihood and results of such events are very important because they influence the size and location of a possible breach, the potential volume of a spill, and the associated hazards. Many site-specific, and system-specific variables must be considered including; the LNG vessel size and design type, cargo tank geometry and construction materials, potential ignition sources, site-specific environmental factors such as waves, wind, and terrain, safety and security measures and operations, and emergency response plans and initiatives.

Depending on the size and location of an LNG cargo tank breach, LNG could spill onto or into the LNG ship, flow from the breach onto the water surface, or both. Depending on whether there is early or late ignition, LNG dispersion will occur through volatilization of the LNG from contact with water and be transported as a vapor cloud in the air or as a liquid on the water surface. The timing of a potential ignition will determine whether the LNG will disperse without a fire, burn as a pool fire, or burn as a vapor fire.

These factors can each significantly influence the estimates of the hazard distances and hazard levels for an LNG spill and each should be carefully assessed for each site. For example, an evaluation of several recent LNG spill studies showed significant differences in thermal hazard estimates due to differences in assumptions and modeling approaches used in each analysis [Lehr and Simecek-Beatty 2003][Fay 2003][Quest 2003][Vallejo 2003][Pitblado 2004].

II Example of Potential Hazards from Large LNG Spills over Water

Sandia used the general scale of the potential hazards of a large LNG spill over water, and used the existing experimental data to evaluate and analyze by modeling to assess several potential spill hazards including; asphyxiation, cryogenic burns and cryogenic damage to the ship from the very cold LNG, dispersion, fires, and explosions. Available accidental and intentional threat information was used to identify possible breaching scenarios. Based on this review, the most likely hazards to people and property included thermal hazards from an LNG fire. Cryogenic and fire damage to an LNG ship were also identified as concerns that could cause additional damage to LNG cargo tanks following an initial cargo tank breach.

To help the public get a feeling of the expected scale and range of the hazards from a large LNG spill over water, the hazard distances for several possible accidental and intentional breach scenarios of a standard LNG vessel, holding 125,000 - 140,000 m^3 of LNG, for generally stable

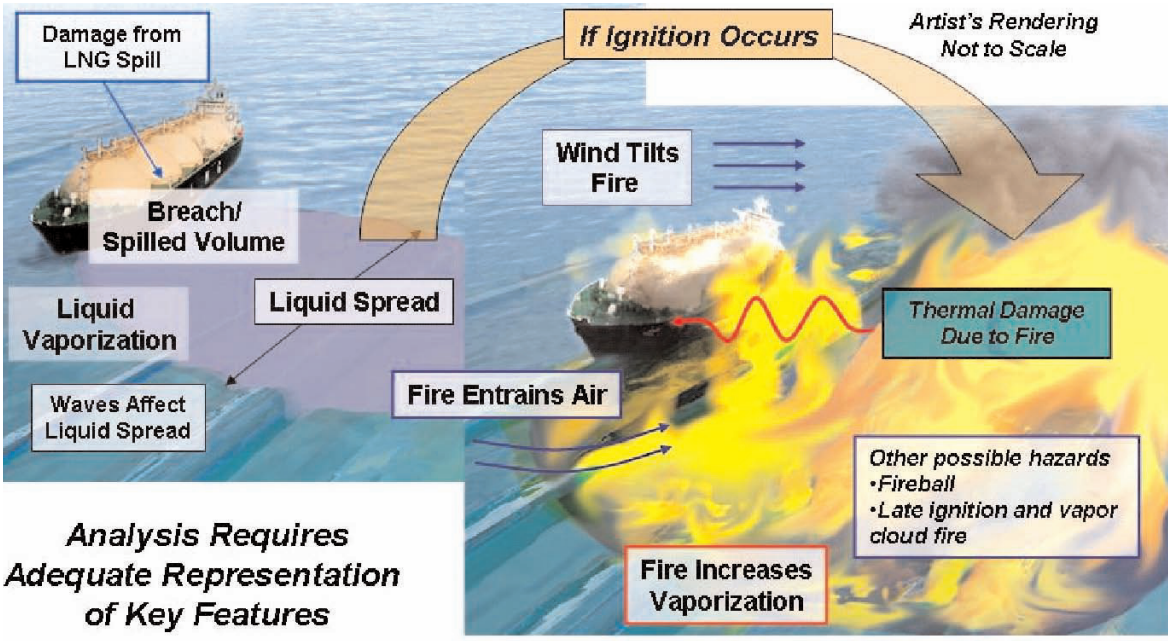


Figure 8.3: Key factors that influence an LNG vessel spill over water

atmospheric conditions were evaluated by Sandia and are presented in the guidance report. The results consider spill volumes of one-half the contents of a standard LNG cargo tank, approximately 12,500 m^3, for each LNG cargo tank breached. The range of the results, based on different assumptions and various spill parameters, are presented in Table 8.2 for thermal fire hazards. Most intentional events are expected to provide an ignition source such that a pool fire occurs and the likelihood of a large unignited release of LNG is unlikely. The 37.5 kW/m^2 and 5 kW/m^2 values shown in Table 8.2 are thermal flux values commonly recognized for defining hazard distances for LNG [NFPA 2001]. The 37.5 kW/m^2 is a level suggesting severe structural damage and major injuries if expected for over 10 minutes. The 5 kW/m^2 is a level suggesting second-degree skin burns on exposed skin if expected for periods of over about 20 seconds, and is the value suggested as the protection standard for people in open spaces.

While these results show the general range of hazards for spills from common LNG vessels, larger vessels are being considered for offshore ports, and larger spills could occur. Examples of hazard distances for spills from larger vessels are presented in a Sandia report [Hightower 2006]. The results show the scale of the concerns, but actual hazard distances will vary based on site-specific environmental conditions, fire dynamics, terrain, ship sizes, and safety and emergency response measures in place.

III Mitigation measues/Risk Management for LNG Operations over Water

While it is important to assess the possible hazards from a large LNG spill over water, it should be noted that the risks and hazards from a potential LNG spill can be reduced in many cases through a combination of safety and risk mitigation approaches, including:

1) Reducing the potential for a spill,

2) Reducing the consequences of a spill, or

3) Improving LNG transportation safety equipment, security, or operations to prevent or mitigate a spill.

For example, a number of international and U.S. safety and design standards have been developed for LNG ships

Table 8.2: Potential Thermal Hazard Distances for Possible Breaching Events of a Standard LNG Vessel

HOLE SIZE(m^2)	TANKS BREACHED	DISCHARGE COEFFICIENT	BURN RATE(m/s)	SURFACE EMISSIVE POWER (kW/m2)	POOL DIAMETER(m)	BURN TIME(min)	DISTANCE TO 37.5 kW/m2(m)	DISTANCE TO 5 kW/m2(m)
			ACCIDENTAL EVENTS					
1	1	.6	3X10-4	220	148	40	177	554
2	1	.6	3X10-4	220	209	20	250	784
			INTENTIONAL EVENTS					
5	3	.6	3 x 10-4	220	572	8.1	630	2118
5*	1	.6	3 x 10-4	220	330	8.1	391	1305
5	1	.9	3 x 10-4	220	405	5.4	478	1579
5	1	.6	8 x 10-4	220	202	8.1	253	810
12	1	.6	3 x 10-4	220	512	3.4	602	1920

** nominal case considered*

to prevent or mitigate an accidental LNG spill over water. These standards are designed to prevent groundings, collisions, and steering or propulsion failures. They include traffic control, safety zones around the vessel while in transit within a port, escort by Coast Guard vessels, and coordination with local law enforcement and public safety agencies. These efforts have been exemplary, and in over 40 years of LNG marine transport operations there have been no major accidents or safety problems either in port or on the high seas [Pitblado 2004]. In addition, since September 11, 2001, additional security measures have been implemented to reduce the potential for intentional LNG spills over water. They include earlier notice of a ship's arrival (from 24 hours to 96 hours), investigation of crew backgrounds, at-sea boardings of LNG ships, special security sweeps, and positive control of an LNG ship during port transit.

It is also to be noted that Milford Haven in UK has successfully operated at criteria much more stringent than those indicated here.

Milford Haven Port Authority notifies two zones for safe navigation of vessels within the port jurisdiction as follows:

- Controlled Zones

Controlled Zone is extending 1 mile ahead and astern of the specified vessel and within the main channel. No commercial vessel of 20 meters or more may navigate within the controlled zone except astern of the specified vessel where such navigation is away from it and provided that prior permission has been sought from and granted by Port control.

- Exclusion Zones

Exclusion zone is extending ahead to the limit of the line of sight from the bridge of the specified vessel within the confines of the channel; no vessel is permitted to navigate within this zone at any time. Such limit will be determined by a patrol vessel stationed ahead. The zone astern will extend to the stern of an escort tug, when provided, or 100 meters where it is not.

By specifying these controlled zones the ports is able to handle LNG ships without any issues. The idea is again based on a risk based regime.

Risk prevention and mitigation techniques are important tools in reducing both the potential for and the hazards of a spill, especially in zones where the potential impact on public safety and property can be high. The general risk management process recommended is discussed in detail in the Sandia report and a flow chart of the process is presented in Figure 8.4.

The risk analysis process helps support a program for managing risks to the public of marine LNG imports. The process steps as shown in Figure 8.4 include:

- Evaluating the potential for an event that could cause a breach or loss of LNG from a ship;

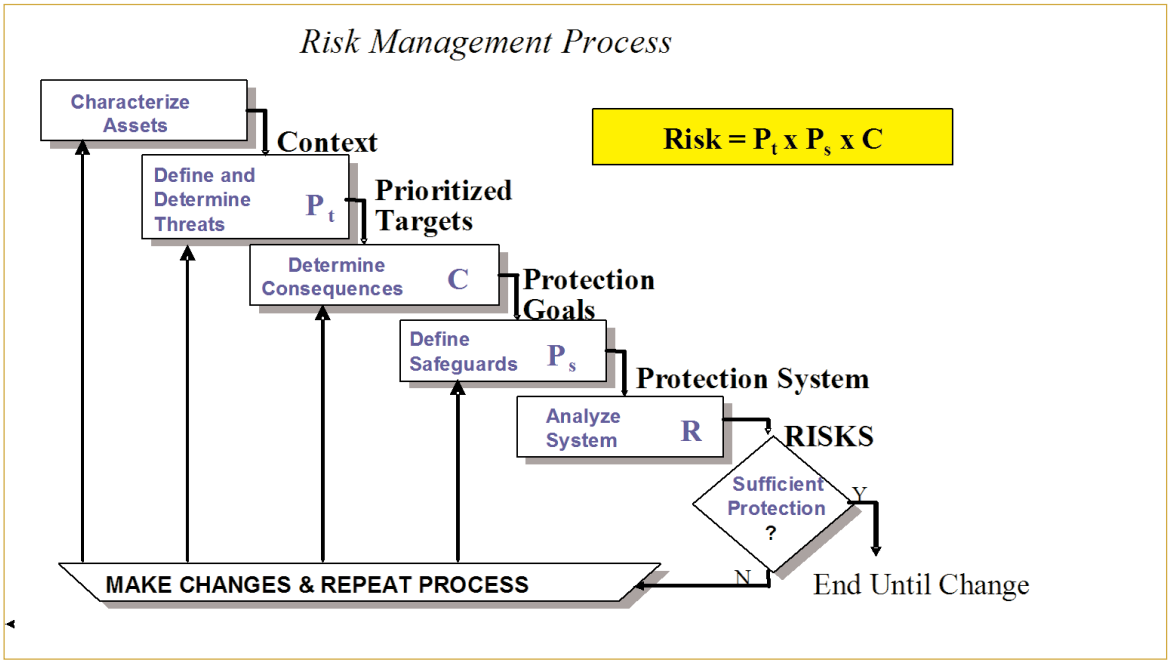


Figure 8.4: Risk Analysis and Risk Management Process Approach

- Establishing the potential damage to a cargo tank or other system from these events and the potential spills that could occur;
- Estimating the volume and rate of a potential LNG spill based on the dimensions and location of the breach, properties and characteristics of the LNG, ship construction and design, and environmental conditions (e.g., wind, waves, currents, etc.);
- Estimating the dispersion, volatilization, and potential hazards of a spill based on site-specific physical and environmental conditions; and
- Identifying prevention and mitigation approaches and strategies to meet identified protection goals and risk management goals.

As illustrated in Figure 8.4, if risks, costs, or operational impacts are deemed to be too high such that sufficient protection cannot be provided to meet defined protection goals for the site, the overall process cycles back through the evaluation to identify alternative approaches for improving system performance and protection.

Proactive risk management approaches can help reduce both the potential for and hazards of such events and include:

- Improvements in ship and terminal safety/security systems - including improved surveillance, tank and insulation upgrades, tanker standoff protection systems,
- Modifications and improvements in LNG tanker escorts, extension of vessel movement control zones, and safety operations near ports and terminals,
- Improved surveillance and searches of tugs, ship crews, and vessels,
- Redundant or offshore mooring and offloading systems, and
- Improved emergency response systems to reduce fire and dispersion hazards and improved emergency response coordination and communication.

The risks can be re-evaluated according to the new approaches to determine if they meet the identified protection and risk goals. If not, then the evaluations are repeated with additional provisions or changes until the

Table 8.3: Potential Lower Flammability Limit (LFL) Distances for Possible Vapor

IMPACT ON PUBLIC SAFETY	REDUCTION IN EVENT POTENTIAL (Prevention)	IMPROVE SYSTEM SECURITY AND SAFETY(Mitigation)	IMPROVED HAZARD ANALYSIS(Reduce Analytical	RESULTANT RISK REDUCTION Uncertainties)
High and Medium Low	■ Early off-shore interdiction ■ Ship inspection ■ Control of ship, tug and other vessel escorts ■ Vessel movement control zones (safety/security zones) ■ One-way traffic ■ LNG offloading system security interlocks	■ Harbor pilots ■ Ship and terminal safety and security upgrades ■ Expanded emergency response and fire fighting to address fires, vapor clouds, and damaged vessels	■ Use of validated CFD models for LNG spill and thermal consequence analysis for site specific conditions ■ Use of CFD and structural dynamic models for spill/structure interactions	Combination of approaches to reduce risks to acceptable levels
	Use of existing best risk management practices on traffic control, monitoring & safety zones	Use of existing best risk mitigation practices to ensure risks remain low	Use of appropriate models to ensure hazards are low for site-specific conditions	Combination of approaches to ensure risks are maintained at acceptable levels

protection and risk goals are reached. The potential alternatives, changes, and/or upgrades can be compared through the process to identify the most appropriate and cost-effective approaches for improving overall system safety and security. Deciding on the sufficiency of protection measures to meet risk management goals is often aided by a benefit-cost evaluation, with measures matched to risk levels as shown in Table 8.3. For most locations and operations, some level of risk is common and, therefore, a "residual" risk often remains.

The risk management approach presented is performance-based and should include identification of site-specific hazards and risks and site-specific public and property protection goals. What might be applicable for effective risk reduction in one location might not be appropriate in another. Therefore, risk management must be balanced between public protection goals, emergency management capabilities and other resources, and overall hazards relative to other local industrial operations and activities. For this reason, risk identification and risk management processes should be conducted in cooperation with appropriate stakeholders, including public safety officials and elected public officials. Considerations should include site-specific conditions and needs, available intelligence, threat assessments, safety and security operations, and available resources.

ETPL has carried out a detailed QRA which highlights mitigation measures to the probable risks pertaining to the sites being considered for successful commissioning of project.

8.3.10 INSTALLATION OF PIPELINE

The installation of the pipeline underground will involve alteration of land surface. Environmental issues may arise during land preparation, improper backfilling, dumping of excess soil and surface erosion. Environmental issues emanating from project activities will be as follows:

- The right of way (RoW) of the proposed route for pipeline will run in the terrestrial environment along existing roads which are fairly level and covered with loamy saline soils. The land area along the existing roads has already been utilized for industrial development and for providing infrastructure facilities. Since no significant land use change is envisaged no mitigation measure would be necessary.
- The high pressure 600mm-pipeline would be buried under ground by conventional burying method. A trench of about 1.2 m depth will be excavated to bury the pipeline. After laying of pipeline the trench will be backfilled and compacted and the RoW will be

restored to its original condition.

- The RoW will be restored to its original condition after commissioning of the pipeline. The operation phase of the project will therefore not contribute to soil erosion.
- The RoW, campsites and other construction sites will be restored to the original conditions to the extent possible. The photographs taken prior to commencement of construction will be used for this purpose. The land will be re-contoured, debris and excess construction material will be removed, surplus soil will be disposed of, damaged/blocked drainage will be restored, ditches and pits will be backfilled, all concrete structures will be dismantled, and re-vegetation measures will be implemented, wherever required.

The following mitigatory and preventive measures will be adopted to minimize the potential adverse impacts on marine and terrestrial environments during land preparation activities for laying pipeline:

- Unnecessary damage to the ground surface and blockage of natural drainage will be avoided.
- Leakages from the system and rupture of the pipeline will be mitigated through the contingency plan discussed in the detailed EMP at chapter 6.
- Equipment will be maintained properly to minimize oil or fuel leakages from construction machinery. Clean-up will be undertaken in the event of an oil spill larger than half a liter. This will include removal of contaminated soil from the area and disposal at proper location.
- After laying the pipeline, the disturbed surface will be restored as much as possible to its pre-project conditions. The ditch will be backfilled and the RoW graded in a manner that restores the natural contour of the ground and allows natural surface drainage. The backfill will be crowned to a height of not less than 200 mm and not more than 300 mm above and at the adjacent ground surface.
- The backfilled trench will be kept compacted with a low crown of subsoil.
- Excavated material will be placed within the corridor of the pipeline.
- Excavated material from ditching operations will not be placed where there is a chance of impairment of natural drainage system.
- Soil that cannot be used will be considered surplus and will be removed from the pipeline corridor.
- Steep cut and fill will be avoided in all such cases where the risk of slope failure is high.
- The RoW will be cleaned of all remaining debris after the backfilling operation and all holes, ruts, and depressions will be filled in order to leave the RoW in an acceptable condition.
- The contractor will dispose of unusable soil spoils at the location specified by PQA & SSGCL. These locations shall be selected to avoid slopes, watercourses, water ponds, or any area where the dumping of waste soil may cause adverse effect on the terrain.
- Removal of debris, cast-off cables, machinery parts, timber, and all other waste from the RoW will be ensured.
- Fuels, oils, and other hazardous substances will be handled and stored according to standard safety practices.
- The fuel tanks will be appropriately marked with regard to their contents.
- Fuels, oils, and chemicals will be stored in areas lined by an impervious base and containing dykes.
- The construction contract should include provisions to limit the removal of bushes and mangrove to the bare minimum and restricted to the area identified by PQA. The bushes and mangrove seedlings may, as far as possible be saved and transferred to the adjacent area. Other plants in the vicinity will need to be protected against damage by appropriate burying

operations. The areas beyond the limits of site shall not be disturbed or damaged otherwise. Mangrove trees will be planted at 1:5 in consultation with an Independent Monitoring Consultant (IMC) at an area identified by PQA.

- Spill prevention and response plan will be prepared by ETPL in consultation with IMC and the same shall be implemented in case of any such incident.
- Soil contaminated with minor, moderate or major oil spills will be removed and suitably disposed of by incineration or bioremediation.
- The acceptable limit of 2,000 mg/l suspended sediment concentration of the World Bank guidelines should be adopted (World Bank Technical Paper 140).
- Careful and regulated excavation, back filling and quality assured construction methods will be adopted by the contractors. The foreign material for filling purposes should be contaminant free.
- No endangered species are reported to exist in the area. The impact of construction activity on the marine ecology will therefore be small, temporary and localized to the microenvironment.
- Photographs of the RoW and other project sites taken prior to commencement of field activity will be used for reference when restoring the site.
- The leakages will have to be keenly monitored

Emissions from the pipeline or its transmission systems are not likely. The leakages from the pipeline and rupture during the operation phase cannot be ruled out because of the hazards that such incidents can create. The incident would alter the air quality in terms of increase in the concentration of green house gases in the microenvironment, will create fire hazards because of the combustible nature of the NG and the scare that may be created because of the incident.

8.3.10.1 Impact on Air Quality

Construction activities related to laying of NG pipeline in the terrestrial environment could entail from emission of dust during trenching, leveling, and backfilling, in addition to operation of vehicular traffic on unpaved roads, emission of combustion gases from construction machinery and equipment.

The emission of pollutants during the construction phase is not likely to be significant due to their rapid dispersion resulting from high wind velocity in the coastal area. As a result the severity of impact of the emission will be low, of short term duration, and can be minimized by appropriate mitigation measures. Furthermore, the activity will be limited to the microenvironment and hence will have insignificant impact on the communities in the distant locations. The dust emissions from traffic on unpaved roads are likely to be a nuisance to residents living close to the RoW of the NG pipeline.

Emissions from the pipeline or its transmission systems are not likely. The leakages from the pipeline and rupture during the operation phase cannot be ruled out because of the hazards that such incidents can create. The incident would alter the air quality in terms of increase in the concentration of green house gases in the microenvironment, will create fire hazards because of the combustible nature of the NG and the scare that may be created because of the incident.

NG transmission in Pakistan has the track record of safety as observed elsewhere in the world. Incidence of injury due leakages, pipe fracture or any element of operation has not been reported by SSGCL or SNGPL for employees and contractors engaged by the organization. This is because the work practice and the standard operating procedures adopted by SSGCL or SNGPL have been implemented with dedication. As for the world scenario the United States has reported injuries that total at less than 1 injury in the year 2000 and less than 2 in the year 2001 for every 200,000 hours worked (the equivalent of 100 full time workers). This is a low rate of injury but, necessary measures, such as the Worker Health and Safety Plan and Safe Operating Procedures, will have to be employed to reduce risk of occupational hazards.

Mitigation Measures

Adopting the following measures will further reduce the severity if any, of the impacts:

- Dirt road routinely used by a community for accessing the project site, will be sprinkled with water regularly to reduce fugitive dust emissions resulting from heavy vehicular traffic.
- Dust emission while digging close to residential areas, will be suppressed by sprinkling water or else an alternative-digging method will be explored.
- Personal Protective Equipments (PPEs) will be provided to the workers involved in construction activities to safe-guard the health of the workers.
- Transportation of construction materials will be in covered vehicles.
- Regular maintenance of construction machinery and auxiliary equipment will be the contractor's responsibility.
- All equipment, generators, and vehicles used during the project will be properly tuned and maintained in good working condition, in order to minimize exhaust emission levels.
- pipeline fracture may occur at any point along the RoW. Periodical pipe inspections will be undertaken to identify and register possible pipe fractures.
- Leak detection systems will be installed at strategic locations.
- In the event of a pipe fracture, the fracture location will be isolated according to the ESD (Emergency Shut Down) procedure.

8.3.10.2 Noise Emissions

Pipeline laying activities may raise the ambient noise emission level particularly in the residential and commercial areas. The duration of the pipeline laying activity is anticipated not to exceed 15 months. The assessment of noise emissions from project site during the construction phase of the project is based on review of the similar construction activities in Port Qasim where construction equipments used are very similar to the equipment planned for the construction phase activities of NG pipeline, which include diesel engine driven electric generators and earthmoving equipment. Thus, it would be appropriate to assume that the expected noise emission level during the construction activity period will be of low intensity besides being contained in the microenvironment.

The construction equipment will be diesel engine driven and will include the barges and pumps, winches for cranes and pipe shore pulling, soil compaction systems and pile driving, concrete batching and pumping, jetting, pipe compression testing, welding generators, temporary fuel, water and sewer systems, and the engines for the tugs, launches and ferries. The total ambient noise level that may be expected due to diesel engine driven construction phase operations would be well below both the daytime limit of 70dB(A) and the nighttime limit of 60 dB(A) required by National Environmental Quality Standards (NEQS).

There are no developed residential areas close to the preferred route of pipeline. It is unlikely that noise from the construction phase activity would be noticed audibly at the immediate outside of the operation area. The construction workers who may be exposed to high noise would be provided ear plugs to be worne as protective measures.

Mitigation Measures

- All equipment, generators, and vehicles used during the project will be properly tuned and maintained in good working condition, in order to minimize noise emission levels.
- The company should plan to mitigate the adverse impact of noise on the receptors in general and construction workers in particular. The vehicles and equipment will be regularly monitored for the performance of the noise reducing equipments.

Vehicles whose noise levels exceed the minimum required level would be restricted for use in the construction activity area.

- All work will be carried out during day time.
- Operators will be instructed keep the noise level at acceptable limits so that the marine fauna is disturbed to the least.
- A speed limit of 25km/hr will be enforced for project vehicles passing through populated areas.

8.3.10.3 Impact on Water Resources

The activities related to NG Pipeline laying may affect the water resources and lead to groundwater pollution, seawater contamination, and soil erosion. The pipeline will be laid at a depth of 1.2-2m in the terrestrial environment and up to 2 to 3m at sub-sea level. The risk from exposure to sea water will be high at the coastline, the creeks and the mangrove area. The coastal and the creek area are both under high stress due to indiscriminate discharge of untreated wastewater from cattle colony, residential areas in Bin Qasim town and the industrial areas of Korangi and Landhi besides the industrial zones of Port Qasim.

Construction activities along the coastline, especially excavation, trenching, and backfilling, pose the greatest threat to the marine ecosystem.

Mitigation Measures

To reduce the risk to the quality of marine ecosystem, special attention will be paid to reduce the impact that may be by introducing the following mitigation measures:

- Freshwater will be used for hydro-testing, after which oil-contaminated water will be properly disposed of. Appropriate size of mesh will be used to filter out debris including metallic residues. Efforts will be made to reuse this filtered water as far as possible.
- Sewage generated from construction camps will be appropriately treated before being discharged into the existing sewerage system.
- Heavy construction machinery will be kept off the waterfront to the extent possible.
- The RoW including the coastline will be regularly inspected to monitor erosion and spills.
- Erosion- and sediment-control measures will be employed and maintained where necessary.
- All the disturbed areas including the pipeline trench, the storage and work place will be restored to the original contour as far as possible.
- The backfill will be stabilized and consolidated into layers not exceeding a depth of 25 cm.
- Washing vehicles near the working area and any other natural water source will be prohibited.
- Equipment will be maintained properly to minimize oil or fuel leakages from construction machinery.

8.3.10.4 Wildlife

Under the existing environmental setting of the study area, no significant impact on wildlife is expected, nor is any serious wildlife issue anticipated. There is no protected, endangered, or endemic species in the project area. There are 1) No threatened species inhabiting the area, 2)No animal dens and burrows along the pipeline route, 3) Foxes and jackals, the common nocturnal carnivores in the study area, are not likely to be impacted during the construction period which will be of short duration and will be confined to day time activity, 4) Birds being mobile species are not likely to be easily impacted since they have the capacity to avoid area under disturbance, 5) No endemic species are reported in the study area.

Mitigation Measures

The following measures will further minimize any impact on the wildlife during the construction of the proposed project:

- A No Hunting, No Trapping and No Capturing policy will be enforced by the contractor and monitored by supervision consultant.
- Project personnel will be prohibited from buying wild animals or birds.
- Waste of any kind will not be discharged into the sea, and leftover food will be disposed of appropriately.
- Nighttime construction and vehicular traffic will be avoided as much as possible.

8.10.3.5 Damage to Existing Infrastructure

The total length of proposed pipeline right of way is 40.09 km. The right of way runs along existing roads and crosses number of physical structures including, major roads, Highway N-5, Pakistan Railway Mainline and the steel mill drainage system. Furthermore the pipeline RoW would pass through buried utility lines. The construction activities may accidentally damage these lines and all such systems will have to be identified before start of excavation for laying the pipeline.

Mitigation Measures

- Existing buried pipelines will be identified in the project area through a detailed topographic survey to set the boundary of RoW.
- Prior approval for right of way will have to be obtained from relevant authorities before the start of pipeline laying activities.
- Damage to existing infrastructure will be avoided as far as possible. Ditch burying along the RoW and horizontal thrust boring under the roads will be employed to avoid damage to the existing infrastructure. Any damage caused to the infrastructure due to construction activities will be promptly repaired.

8.3.10.6 Disruption to Traffic and Access

The proposed pipeline parallels major roads for a significant proportion of its length. Most construction traffic will follow the access road along the RoW and is not expected to cause significant disruption on the public highway. Line pipe will be transported on normal size trailers and no heavy equipment will be required for construction. There may be some traffic disruption associated with construction traffic using the existing roads.

Mitigation Measures

Crossings of major highways and busy roads shall be performed with thrust boring which would not involve any disruption or diversion of normal traffic.

IMPACT RATING

Overall Impact Rating	Impact Priority
≤ 3	Catastrophic
4 ~ 6	High Significance
7 ~ 9	Medium Significance
10 ~ 16	Low Significance
> 16	Insignificance

		Likelihood/Frequency				
		Very High (1)	High (2)	Medium (3)	Low (4)	Very Low (7)
Consequence / Severity	Very High (1)	VH X VH (1)	H X VH (2)	M X VH (3)	L X VH (4)	VL X VH (7)
	High (2)	VH X H (2)	H X H (4)	M X H (6)	L X H (8)	VL X H (14)
	Medium (3)	VH X M (3)	H X M (6)	M X M (9)	L X M (12)	VL X M (21)
	Low (4)	VH X L (4)	H X L (8)	M X L (12)	L X L (16)	VL X L (28)
	Very Low (7)	VH X VL (7)	H X VL (14)	M X VL (21)	L X VL (28)	VL X VL (49)

	Very High	High	Medium	Low	Very Low
Likelihood / Probability	• The occurrence during abnormal / unplanned event on monthly basis; or • during normal activity, the aspect occurs continuously as a normal operating condition	• The occurrence during abnormal / unplanned event is once per quarter; or • during normal activity, the aspect occurs twice a month	• The probability of occurrence during abnormal / unplanned event events, is once in six months, or • during normal activity, the aspect occurs once in a month	• The occurrence of aspect is during abnormal or unplanned event with the probability of occurrence once per year or • during normal activity, the aspect occurs once in six months	• The occurrence of aspect is only during abnormal or unplanned event with the probability of occurrence less than once per year.

Severity	Very High	High	Medium	Low	Very Low
Environment	• Extensive and long term impacts causing irreversible damage to all components of environment including land, water and air as a result of hazardous releases. Examples include: Leakage of large quantity of LNG, Emissions of air pollutant responsible for global impacts (e.g. CFC, GHG) in large quantities, long-term impacts to water bodies from wastewater discharges, extensive areas of ground damage, or large spills affecting waterway ecosystem.	• Severe impacts to habitat or extensive impact to wildlife or fisheries or agricultural lands or potential for regional or global environmental impacts. Examples include: Emissions of air pollutant responsible for global impacts (e.g. CFC, GHG) in significant quantities, long-term impacts to water bodies from wastewater discharges, extensive areas of ground damage, or large spills affecting waterway ecosystem.	• Local environmental impacts with degradation of sensitive habitat or potential impact to wildlife or fisheries or agricultural lands. Examples include: Emission of air pollutants in moderate quantity altering air quality in the immediate surrounding, discharges of concentrated contaminants to water, localized areas of ground damage, or medium size spills of hydrocarbon (>= one bbl and < 100 bbl) in less sensitive areas.	• Local environmental impacts with degradation of habitat or low impact to wildlife or fisheries or agricultural lands. Examples include: Emission of air pollutants in low quantity which may effect air quality in the immediate surrounding, discharges of concentrated contaminants to water, localized areas of ground damage, or medium size spills of hydrocarbon (less than one bbl) in less sensitive areas, or physical impacts to ground directly adjacent to a facility or low consumption of natural resources.	• Environmental impacts are not existent, are transitory, or are limited to a relatively small area where there is no impact on flora or fauna or for very small duration. Examples include: well-dispersed atmospheric emissions (below NEQS), dilute aqueous discharges to water, small spills of hydrocarbon (negligible amount)
	• Large uncontrolled release of hazardous material / NG e.g. >100,000 m3, 10,000 m3 in sensitive area.	• Uncontrolled release of reportable quantity. e.g. >1000 m3.	• Uncontained release of minimum reportable quantity.	• Release contained to site.	• Contained releases of hazardous material. No off site impact.
	• Impact for beyond the Terrminal boundary.	• Impact on immediate neighborhood beyond facility boundary.	• No long term impact beyond facility boundary.	• No prolonged damage.	• Minor damage/ quick clean-up
	• Long term damage affecting extensive area off site and prolonged clean-up.	• Long term damage affecting limited area off site and prolonged clean-up..	• Prolonged damage on site.		
Occupational Health	• Multiple deaths or multiple persons on-site with onset of severe or life-threatening health effects alleged to be due to exposure arising from EVTL's activities.	• Death or onset of severe or life-threatening health effect to single person on-site alleged to be due to exposure arising from EVTL's activities.	• Single person on-site with onset of irreversible health effect alleged to be due to exposure arising from EVTL's activities.	• Single person on-site, with moderate short term reversible health effect resulting in DAFWC and alleged to be due to EVTL's activities.	• Over-exposure to single person on site, but no reported ill-health effect e.g. monitoring result shows occupational exposure limit has been exceeded, or one-off event such as failure of local controls or PPE
	• Death or onset of severe or life-threatening health effects to single person off-site alleged to be due to exposure arising from EVTL'S activities.	• Multiple persons on-site with onset of irreversible health effects alleged to be due to exposure arising from EVTL's activities.	• Multiple persons on-site with mild to moderate short term reversible health effects resulting in DAFWC and alleged to be due to EVTL's activities.	• Over exposure to multiple persons on-site but no reported health effects.	
	• Multiple persons off-site with onset of irreversible health effects alleged to be due to exposure arising from EVTL'S activities	• Single person off-site with onset of irreversible health effect alleged to be due to exposure arising from EVTL's activities.	• Single person off-site, with mild to moderate reversible short term health effects alleged to be due to EVTL's activities.	• Off-site exposure likely, but no effects identified	
		• Multiple persons off-site with mild to moderate reversible short term health effects alleged to be due to exposure arising from EVTL's activities.			

PROPOSED LNG IMPORT TERMINAL PROJECT

ESH Aspect/Issue	Summary of Relevant Data	Impact Source	Project Phase: Pre-construction	Project Phase: Construction	Project Phase: Operation	Project Phase: Post Operation	Potential Impact Description	Management from the EVTL	Inherent Risk Ranking: Likelihood	Inherent Risk Ranking: Severity	Inherent Risk Ranking: Risk Ranking	Proposed Mitigation and Follow-up Actions	Residual Risk Ranking: Likelihood	Residual Risk Ranking: Impact	Residual Risk Ranking: Risk Ranking
SITE Preparation															
Loss of the biota	Most of the area to be dredged consists of barren sand/soft bottom or soft bottom/mobile with little or no observed epifaunal communities. The benthic community is restricted to the top 10 cm of the substrate.	Dredging and Reclamation Activities		x			loss of the biota located within the dredge area which is a short time scale, localized impact. Once construction is completed, habitats and associated organisms have been found to reestablish/re-colonize themselves quickly as the regeneration time is short (2-3 weeks) within the newly constructed berthing and turning basin	HSE Dept. to monitor vegetation, benthic community on continous basis.	Low	Medium	Low Significance (12)	1) The dredging of berthing pocket at the project site will have a slightly negative impact on the marine habitat and the benthos of the creek; this would adversely affect fisheries reproduction. However, carefully regulated construction program and disposal of spoil at the designated areas would minimize and localize these impacts. The localized benthic habitat and disposal of spoils carried out for Port Qasim over the last decade or so, has greatly reduced the benthic biomass. EVTL will ensure the adoption of careful methods to reduce the impact of construction on marine ecology of the site; 2) To prevent loss due to erosion, exposed soil materials will be protected by surface treatments such as armoring, pavement and vegetation. No mitigation measures other than those sites above are needed except that the entire operation will be keenly monitored by the proponent and IMC; 3) Any loss of mangrove habitat will be compensated by plantation/replantation of mangrove of as many mangrove trees as the canopy of the removed trees would require. The number of trees to be planted against the number removed will be determined in consultation with IUCN and IMC; 4) Use of protection along the reclaimed land areas primarily of concrete caissons or equivalent systems; 5) Slope protection along the reclaimed land areas that have already been impacted by prior dredging activities. Therefore, no additional impacts are expected due to the installation of the shore protection structures. 6) Monitoring of all activities related to removal of plantation and the replantation. 6) The construction contract should include provisions to limit the removal of bushes and mangrove to the bare minimum and restricted to the land area identified by PQA. The bushes and mangrove seedlings may, as far as possible be saved and transferred to the adjacent area. Other plants in the vicinity will need to be protected against damage by construction operations. The areas beyond the limits of site shall not be disturbed or otherwise damaged. Trees and shrubs will be planted in consultation with PQA and monitored by IMC; 7) Construction of berthing facilities, dredging, reclamation and land development will occur as a direct result of installation of berthing facilities. Given these activities, changes in substrate, sunlight, and temperature, benthic communities will be able to reestablish within the vicinity of the LNG terminal site. There is the potential for long-term impacts due to increased ship traffic, particularly as a result of accumulation of pollutants in the water columns and sediment, which is known to adversely affect biological communities. In order to minimize and avoid impacts related to introduction of pollutants and invasive species all bilge discharge procedures will follow standard MARPOL regulations. 8)Mitigation of potential impacts to benthic habitats is anticipated to occur through natural reestablishment of bottom conditions and resettlement of associated faunas. Natural forces of currents and tides should restore the bottom conditions to pre-disturbance conditions. Any loss of mangrove habitat will be compensated by plantation/replantation of mangrove trees as the canopy of the removed trees would require. The number of trees to be planted against the number removed will be determined in consultation with IUCN and IMC.	Very Low	Very Low	Insignificance (2fl)
Creek Bed	The suspended matter in the creek areas has an annual range of 25-170 ppm. The highest values were observed during the southwest monsoon period (usually May-August). The average suspended load during June-July was between 80-115 ppm.	Maintenance Dredging			x		Increases in turbidity and suspended sediments, and the loss of benthic organisms in particular.	POA need to conduct hydrodynamic and sediment transport modeling to predict frequency of maintenance dredging or the bathymetric surveys being conducted to indicate about the dredging depths by PQA. Turbidity to be monitored during each maintenance dredging event to ensure compliance with relevant international standards.	High	Low	Medium Significance (8)		Low	Very Low	Insignificance (2fl)
Near-shore habitats	the Phiti Creek has faunal community characteristic of very fine sediments from muddy to clayey. The animal communities are not very abundant except mudskipper, fiddler crabs and the snail Cerithidea cingulata a pollution indicator species.	Compaction of Reclaimed Soil		x			Because many of the near-shore habitats around project site will be undergoing modification due to island expansion and construction of shoreline protection, and because new habitats may also be established, the overall impact is minimal.	The compacting activity would need to be completed prior to the construction of new assets/structures around project area.	Low	Low	Low Significance (16)		Very Low	Very Low	Insignificance (4fl)
Mangroves	The density of mangrove trees is between 50-60 / 100 m2. The height of the individual tree within the established Avicennia marina habitats were between 2-3 m. However, the mangrove habitat on green field project site option 1 (75 to 100 acres land on Khipiranwala Island) or on brown field site Option 3 in the vicinity of EVTL is relatively small.	Shore Protection resulting in Land reclamation		x			Of the habitats that will be impacted by shore protection system construction, the mangrove habitat is the most sensitive; however, the mangrove habitat on green field project site option 1 (75 to 100 acres land on Khipiranwala Island) or on brown field site Option 3 in the vicinity of EVTL is relatively small. Due to its isolation and small size the overall impact due to loss of the mangroves is minimal.	HSE Dept. to monitor Mangroves disturbance / replantation on continous basis.	Medium	Low	Low Significance (12)		Low	Low	Insignificance (2fl)

PROPOSED LNG IMPORT TERMINAL PROJECT

ESH Aspect/Issue	Summary of Relevant Data	Impact Source	Project Phase: Pre-construction	Project Phase: Construction	Project Phase: Operation	Project Phase: Post Operation	Potential Impact Description	Management from the EVTL	Inherent Risk Ranking: Likelihood	Inherent Risk Ranking: Severity	Inherent Risk Ranking: Risk Ranking	Proposed Mitigation and Follow-up Actions	Residual Risk Ranking: Likelihood	Residual Risk Ranking: Impact	Residual Risk Ranking: Risk Ranking
Local fishing activity	Residents of Ibrahim Haidery and Rehri were traditional fishermen involved in fishing business since the last five centuries.	LNG Terminal Installations Impacts related to LNG Terminal are those associated with the construction as well as operational activities at LNG import terminal.		x			Construction activities and vessel traffic have the potential to interfere with local fishing activity by temporarily obstructing access of fishermen to their local fishing grounds.	Advance Notices to be issued for every activity to alerts local fisherman	High	Low	Medium Significance (8)	1) Advance notices on upcoming construction activities will be provided to local fishermen, in order to mitigate possible obstruction of potential fishing areas during construction. Pakistan Fisherfolk Form being the main stakeholder will be kept informed of all activities that could have negative impact on the fisheries operations.	Low	Very Low	Insignificance (28)
Sea water temperature	Sea water temperature measured were 22.7°C.	Waste Discharges			x		The cooling water at discharge is 3 degrees Celsius (°C) warmer (at most) than at intake. Ship crew will generate 2000 cubic meters per year of grey water and about 650 cubic meters per year of sewage, which will be treated before discharge and expected to be catered for during the design stage.	Monthly monitoring	High	Low	Medium Significance (8)	1) The proposed operations are not expected to affect either the hydrology or currents of the channel. Discharges of water from the site to the channel are too small to have a measurable effect on hydrology or current patterns that could affect fishery resources. 2) Automatic biocide dosing, quality control and feedback systems will be incorporated into the FLNG facility design 3) Screens will be installed on the cooling water riser inlets and inlet current speeds will be low (estimated at 0.5 m/s) to prevent the ingress of large marine fauna into the cooling water system 4) Heat recovery measures from the FSRA will be considered in the detailed design stage	Low	Very Low	Insignificance (28)
Air Quality	The measured mean concentrations of gaseous pollutants were; 93.3 µg/m3 for PM10, 0.9 ppm for CO, 8.1 ppb for SO2, 11.9 ppb for NOx and 300.8 ppm CO2. All these levels of gaseous pollutants were well within limits of USEPA	Fugitive dust emissions		x			Air quality impacts during construction are expected to include fugitive dust emissions at the project site from ground excavation, fill operations, and removal of debris, as well as construction vehicle emissions, marine vessel emissions and portable generators	Monthly monitoring during construction	High	Very Low	Low Significance (14)	1) Construction impacts on air quality will be mitigated through construction management practices, including the use of appropriate dust suppression measures. Air quality impacts from operation of the project's power production system will be minimized by appropriate technology to reduce the impact of emissions to confirm to World Bank standards. The power production system will be designed for high-efficiency with advanced combustion controls to minimize fuel consumption and pollutant emissions. 2) Fugitive dust emissions will be minimized through the use of dredged fill material, which will be pumped in a slurry form through pipeline into dewatering basins located near the final reclamation areas. Construction equipment used for final grading will handle fill material with high moisture contents and minimal potential to generate fugitive dust. To further minimize emissions of airborne particulates, fugitive dust will be mitigated using the following measures, as necessary: • The use of water on areas of exposed soils, if necessary; and • Final grading and landscaping of exposed areas as soon as possible. 3) Emissions from vehicles and other engine-driven construction equipment will be temporary and cease once the project is completed. Nevertheless, mitigation measures including proper maintenance of construction equipment and controlling unnecessary idling of equipment will be implemented. 4) It is envisaged that Selective Catalytic Reduction or any other alternative systems would be incorporated on board the ships to reduce NOx emissions. 5) All emissions from construction and operation must be in compliance with air quality standards in vogue. With adherence to the applicable legal requirements, impacts to regional air quality during operation of the Project would be insignificant but would continue for the life of the Project. Regular monitoring and evaluation is proposed. 6) The lack of other cumulative sources of NOx emissions within the region also protects against the potential for photochemical smog or acid rain generation.	Very Low	Very Low	Insignificance (28)
Air Quality	The measured mean concentrations of gaseous pollutants were; 93.3 µg/m3 for PM10, 0.9 ppm for CO, 8.1 ppb for SO2, 11.9 ppb for NOx and 300.8 ppm CO2. All these levels of gaseous pollutants were well within limits of USEPA	LNG Vapour Emissions			x		LNG carriers typically have boil-off rates of their LNG cargo of about 0.15% per day.	Monthly monitoring	High	Very Low	Low Significance (14)	FSRUs generally have emission monitoring system. However, it is recommended that EVTL would conduct regular emission monitoring to supplement the data generated offshore.	Low	Very Low	Insignificance (28)
Noise	The mean noise level at the site was 54 dB(A)	Construction and associated activities		x			LNG terminal construction may raise the ambient noise levels in the microenvironment. In particular, works such as pile driving, dredging, drilling, earthworks would contribute to noise pollution.	Monthly monitoring	Medium	Low	Low Significance (12)	No additional mitigation measures are required other than following standard operating procedures which require regular maintenance of equipment and providing PPEs to the workers at stressed sites	Very Low	Very Low	Insignificance (49)
Manmade Hazards															

PROPOSED LNG IMPORT TERMINAL PROJECT

ESH Aspect/Issue	Summary of Relevant Data	Impact Source	Project Phase					Potential Impact Description	Management from the EVTL	Inherent Risk Ranking			Proposed Mitigation and Follow-up Actions	Residual Risk Ranking		
			Pre-construction	Construction	Operation	Post Operation				Likelihood	Severity	Risk Ranking		Likelihood	Impact	Risk Ranking
Sea water contamination	Concentration of Oil & grease in marine sediments in Phitti Korangi Creek is 16.25 mg/kg.	Fuel Spills		x	x			Spills of fuel oil can have a potential impact on soil, groundwater and particularly surface water during both the construction and operational phases of the project. Impacts of a very limited nature are anticipated from occasional equipment leaks from fuel and hydraulic systems.	Sea water quality to be recorded weekly to observe any change due to construction activity.	Medium	Very Low	Insignificance (49)	1) The potential for equipment leaks from fuel and hydraulic systems will be avoided and/or reduced by implementing a scheduled mechanical preventive maintenance for equipment. 2) Each fuel transfer will be visually monitored for the potential of release. Furthermore, the plan will require fuel tender personnel to be instructed in the means of stopping, minimizing and responding all leaks and spills (if any) using spill containment/cleanup equipment maintained on each vessel. The construction contractor will be required to have active contracts in place with third party emergency response/cleanup companies to provide additional assistance if necessary. 3) Given these management controls, the potential impact from a fuel oil spill on water would be restricted to the small area within the deployed booms. Within this area, oil will be removed from the surface of the water, to the extent possible, using equipment and materials maintained adjacent to the location of fueling operations or supplied by the third party response contractor (depending in the size of the release). In addition to construction barge fueling operations, it is envisaged that fuel oil will be transferred from oil delivery barges to tanks during both the construction and operational phases. These operations will be managed in a manner consistent with the requirements of the spill response plans. As with barge refueling operations, barge to tank transfer procedures will require the barge and onshore crew to visually monitor every fuel transfer to the onshore tanks. Tank volumes, which will be monitored by level sensing devices, will be checked prior to the start of transfer to ensure that there is sufficient volume to receive the delivery. The spill plans will require documentation of volume readings before and after the transfer, as well as other important control measures such as inspections of hoses and mooring lines, verification of communications equipment and signals, and pre-transfer conferences. 4) Fuel tanks will be provided with a secondary containment system that will limit the potential impact of releases due to tank failure. The area impacted by a worst case tank failure would be limited to the area of the secondary containment, which will be impervious to the fuel oil and sized to contain the entire contents of the tank. Operators will be provided with spill response materials and training to adequately respond to a pipe leak and minimize the land area potentially impacted by the release. Following transfer, the lines will be blown through to the tanks to minimize potential releases from the piping system between delivery operations. 5) The potential impacts from spills of materials other than fuel oil will be minimized and controlled in a similar manner. Portable secondary containment will be used to the degree possible during construction to store drums of chemicals. During the operational phase, chemicals will be stored in a secure warehouse provided with secondary containment arrangements. The warehouse will be provided with contact and other materials appropriate to	Insignificance (49)	Very Low	Very Low
Effect on human health/ Public Safety		Fire and Explosion			x			Impacts include oxygen deficiency, freezing injuries, fire hazards, and explosive air/gas mixtures.	Detailed Fire contingency Plan to be developed.	Low	Very High	High Significance (4)	1) Potential impacts due to fire and explosion will be minimized through use of gas detection systems and a fire suppression system consistent with the international guidelines. 2) Control Systems and Operational Procedures will be in place to minimize the potential for a fire or explosion and the resultant impacts to the operation, island and personnel. 3) A detailed risk assessment is being conducted to determine if a LNG facility of a specific design and layout can be located on a site without causing an unacceptable impact to the safety of the public who live or work near the site. In this study the requirements of NFPA 59A (2009) for LNG Facilities shall be followed. It is expected that hazard zones would lie within the property of the LNG terminal site or over adjacent water, these requirements are met. 4) As required by NFPA 59A and to minimize impacts to personnel and facilities, Impoundment areas (secondary containment) will be provided.	Insignificance (21)	Very Low	Very Low
Marine Hazard	The maximum frequency of ship arrival with a FSRA of 150,000 m3 storage and an LNG carrier of 135,000 m3 considering per day consumption of NG at 500 MMSCFD would be after approximately 4 to 5 days.	Volume of Shipping Traffic			x	x		Ships contracted for the movement of the LNG will be equipped with the safety devices and the crews will be trained in safe handling and emergency response procedures.		Very Low	Very Low	Low Significance (14)	1) LNG Shipment will comply with the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code), International Maritime Organization 1993. Procedures for inspection and safety checks will be performed on each shipment, prior to the unloading/loading operations and before the vessel is released from the terminal. 2) Worldwide there is no record of serious incident of an LNG carrier involved in product transport as envisioned for the EVTL-LNG project. By implementing the management controls and following internationally accepted codes and standards, EVTL expects no marine safety-related impacts due to the shipments of LNG.	Insignificance (28)	Very Low	Low
Workplace Hazard		Overall construction and operation activities			x	x		There are potential impacts to worker safety during the construction and operation phase due to the increased activities on the island and over water, the higher risk associated with handling LNG and the higher population of workers.	Workplace hazards will be managed by strong OH&S management system.	Medium	Low	Low Significance (12)	A Health and Safety Plan for construction and operations will be implemented and monitored with emphasis on personal protective equipment and inherently safe equipment.	Insignificance (49)	Very Low	Very Low

PROPOSED LNG IMPORT TERMINAL PROJECT

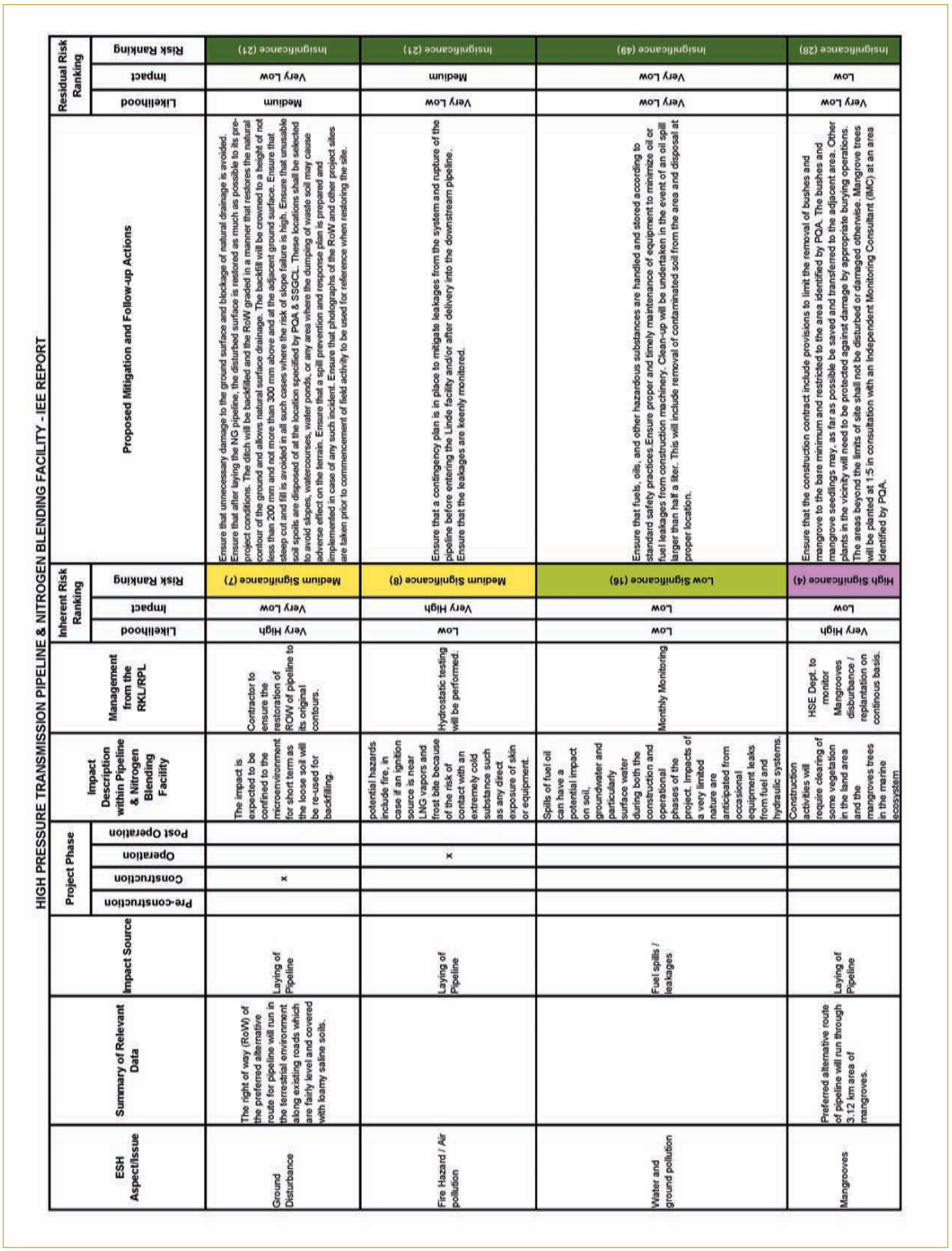
ESH Aspect/Issue	Summary of Relevant Data	Impact Source	Project Phase					Potential Impact Description	Management from the EVTL	Inherent Risk Ranking			Proposed Mitigation and Follow-up Actions	Residual Risk Ranking		
			Pre-construction	Construction	Operation	Post Operation				Likelihood	Severity	Risk Ranking		Likelihood	Impact	Risk Ranking
Natural Hazards	Tsunamis have not been recorded for the coastal area south of Karachi. Tropical cyclones that come near the proximity of Karachi are generally not severe. The coastal topography being gentle and flat, even a surge of 2.0 feet during spring tide can create flooding. In Sindh Coastal belt, frequency of the storm striking the coast is low (for once a 75 year period) and four storms struck the coast between 18 and 19o. N and only three of these struck between 19 and 20o N).	Extreme weather conditions		x	x			The impacts are expected to be much severe in case of siting the LNG terminal in the main channel (Option 2) as compared with its location away from the navigation channel (Option 1 & Option 3).	Natural hazards will be managed by strong Emergency preparedness and response.	Very Low	Very High	Medium Significance (7)	1) Natural hazards associated with storm events include those arising from storm waves/surges, high winds, and torrential rainfall. For protection against wave run-up and over topping, shore protection features will be constructed to protect the proposed island footprint. The LNG facility will be designed to withstand a Category 5 hurricane and the remaining components of the facility will be designed for a Category 4 hurricane. These design parameters will protect against high winds, as well as storm surge and wave effects, associated with these storm events. Shore protection structures will be designed to withstand the impacts from a 100-year storm. Based on design evaluations, shore protection features will be incorporated to further stabilize the island and its operational features. 3) The Geological Survey of Pakistan has, however, defined the area of Port Qasim, where the site under study is located, to fall in a Seismic Zone 2B region. This suggests the possibility of moderate to major seismic hazard i.e probability of earthquakes of intensity VI to VIII MM scale and 5.6 to 6.6 on Richter scale. From the charts published (such as Figure XXX), the peak ground level acceleration (PGA) for this zone is 25%. The seismic risk factor of 0.3 is advisable and need to be incorporated in the design for close by zone and 1 level earlier in the zone 2. For operating basis earthquake (OBE) peak ground acceleration is 50% of MCE and corresponds to level earlier in the zone (MM-VI to VIII). The seismicity in the Karachi and at Project site is considered to be low. According to the published data the Project area lies in zone of low seismic activity, with acceleration ranging from 1.5 to 2.8 m/sec2. A factor of 2.8 m/sec2 will, on the other hand, have to be taken for a maximum credible earthquake (MCE). The design of the LNG terminal should take these values into consideration. 4) Major damages done by Tsunamis, the impulsively generated seawater waves that are a result of underwater earthquakes, have not been recorded for the coastal area south of Karachi. There are, however, evidences of a 1.2 m tsunami generated by an offshore earthquake of intensity 8 M in 1945, which caused only minor damages in Dec 1945. Other tsunami was recorded in the Arabian Sea in 1983 and 1999. The Tsunami of December 26, 2004 had no impact on the coastline of the Port Qasim as recorded in 1853. The Tsunami of October 28, 2010 has no impact on the coastline of the Port Qasim. 5) Tsunamis are not expected to occur in the vicinity of the project area; yet, the mitigation strategies proposed to deal with hurricanes and surges of category 5 are considered sufficient to deal with tsunamis of high order.	Insignificance (28)	Very Low	Low	Insignificance (28)
Protected Areas	There are no designated Protected Areas in the vicinity of the project area. Similarly, this ESIA study has not found any antiquity artifact in the microenvironment of area concerned. No sites of cultural heritage are located in and around the immediate vicinity of the LNG Project location. There are also no indications of any old settlement in the area, nor is there any site covered under the listing of cultural heritage sites.	Construction and operational activities associated activities		x	x			There will be no impacts from the construction and operation of the facility, as such, no mitigation will be required.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Operational Risk and Hazards																
Fire hazard		Leakage of LNG			x			potential hazards include fire, in case if an ignition source is near LNG vapors and frost bite because of the risk of contact with an extremely cold substance such as any direct exposure of skin or equipment.	Detailed Fire contingency Plan to be developed.	Very Low	Very High	Medium Significance (7)	Mitigation measures include the use of double hull features in LNG tankers to provide a built-in form of secondary containment. According to the Centre for Energy Economics (October 2003), there has been no off-site property injury or damage over 30 years as a result of the mitigation measures taken (including appropriate and modern equipment, facility design, safety and emergency systems, operational procedures and personnel training). In the EU technical risks that may lead to leaks or other forms of accident can be mitigated by adhering to the approved technical standards such as the BS EN 1473: 1997 on 'Installation and Equipment for Liquefied Natural Gas – Design of Onshore Plants'. The plans for LNG facilities for Pakistan was prepared by Technical Consultee CENTO 282 (APMOR). The plans for LNG facilities for LNG installations and recommends procedures and practices which will result in a safe and environmentally	Very Low	Medium	Insignificance (21)
Public Safety	The accident which occurred at the world's first commercial liquefaction plant in Cleveland, Ohio (USA), in 1944. An explosion occurred at the Skikda LNG plant in Algeria on 19 January 2004, killing 27 people and injuring 80.	Liquefaction Plants		x				storage tank can rupture and spill the uncontained liquid into storm drains, followed by a large fire	Detailed Spill contingency Plan to be developed.	Very Low	Very High	Medium Significance (7)	To a large extent, the overall positive safety record is rooted in the limited risks arising from LNG itself. Because LNG is stored at atmospheric pressure the major hazard is fire,, rather than explosion. Hence the need for emergency fire detection and response is a way of combating this risk	Very Low	Medium	Insignificance (21)

PROPOSED LNG IMPORT TERMINAL PROJECT

ESH Aspect/Issue	Summary of Relevant Data	Impact Source	Project Phase: Pre-construction	Project Phase: Construction	Project Phase: Operation	Project Phase: Post Operation	Potential Impact Description	Management from the EVTL	Inherent Risk Ranking: Likelihood	Inherent Risk Ranking: Severity	Inherent Risk Ranking: Risk Ranking	Proposed Mitigation and Follow-up Actions	Residual Risk Ranking: Likelihood	Residual Risk Ranking: Impact	Residual Risk Ranking: Risk Ranking
Terrorism	In 2002 there was a suicide boat attack on a tanker off the coast of Yemen.	Unavailability of security			x		Facilities that handle large amounts of hazardous materials like LNG terminals and ships have been thought to be attractive targets for terrorists.	Detailed Security Plan to be developed.	Very Low	Very High	Medium Significance (7)	Maritime Agency and PQA have an enviable security record and are committed to maintain the same. No additional mitigation measures are required	Very Low	Low	Insignificance (28)
Vapor Clouds	As LNG leaves a temperature-controlled container, it begins to warm up, returning the liquid to a vapor. Initially, the liquefying gas is colder and heavier than the surrounding air. In the liquid/liquefying stage it creates a fog which is a vapor cloud above the released liquid.	Release of LNG			x		As the gas warms up, it mixes with the surrounding air and begins to disperse. The vapor cloud will only ignite if it encounters an ignition source while concentrated within its flammability range.	Detailed Spill contingency Plan to be developed.	Low	High	Medium Significance (8)	Safety devices and operational procedures are intended to minimize the probability of a release and subsequent vapor cloud having an effect outside the facility boundary	Very Low	Low	Insignificance (28)
Freezing Liquid		Release of LNG			x		If LNG is released, direct human contact with the cryogenic liquid will freeze the point of contact and can damage the tissues.	Detailed Spill contingency Plan to be developed.	Low	High	Medium Significance (8)	Appropriate containment systems surrounding an LNG storage tank on ship are designed to contain the tank's contents. Containment systems would also separate the tank from other equipment. Moreover, all facility personnel must wear gloves, face masks and other protective clothing as a protection from the freezing liquid when entering potentially hazardous areas. This potential hazard is restricted within the facility boundaries and does not affect neighboring communities	Very Low	Very Low	Insignificance (49)
Rapid Phase Transition	If large volumes of LNG are released on water, it may vaporize too quickly causing a rapid phase transition (RPT).	Release of LNG			x		RPT ranges from small pops to blasts large enough to potentially damage light weight structures.	Detailed Spill contingency Plan to be developed.	Low	High	Medium Significance (8)	Safety devices and operational procedures are intended to minimize the probability of a release of LNG.	Very Low	Low	Insignificance (28)
Flammable Gas Dispersion	US Federal regulation 49CFR193.2059, Flammable vapor-gas dispersion protection, provides for protection of the public from flammable gas clouds that could result from an LNG spill.	Flammable Gas Dispersion			x		Very close to a spill, the natural gas concentration is too rich to burn, but further away from the spill, additional mixing with air produces a flammable cloud of natural gas.	Detailed Spill contingency Plan to be developed.	Low	High	Medium Significance (8)	The flammability risk would be taken into consideration during the detailed QRA shall be implemented as mitigation measures for flammability risk	Low	Low	Insignificance (28)
Likelihood of Tanker Collisions	The maximum frequency of ship arrival with a FSRA of 150,000 m3 storage and an LNG carrier of 135,000 m3 considering per day consumption of NG at 500 MMSCFD would be after approximately 4 to 5 days.	Likelihood of Tanker Collisions			x		An offshore terminal has the added risks of ship collision, varying degrees of movement during unloading, and less protected areas during extreme weather.	QRA to identify safety zones.	Medium	Very High	Catastrophic (3)	• Safety zone requirement would be followed as per the results of the QRA. Detailed risk analysis would be conducted in the QRA study, recommendations of which will be followed in the design of the project. • LNG import facility is fitted with thrusters to maintain a fixed bearing and position during berthing operations; • LNG import facility is fitted with very robust fenders to protect both the facility and LNG carriers during berthing; •FSRA and LNG Carriers both have double hulls and, for a spill to occur, both hulls on either the FSRA or LNG Carrier as well as the LNG tank linings would need to be breached; • EVTL intends to place the LNG carrier inside a berthing pocket, dimensions of which will be confirmed in the FEED, so that the risk of collision between berthed LNG carrier and passing by Vessel is minimized and heavy displacement ships can also pass by in the main channel. Moreover, the Jetty arrangement would be designed to minimize/sustain the surge loads due to large ships passing by LNG ships.	Very Low	High	Low Significance(14)

PROPOSED LNG IMPORT TERMINAL PROJECT

ESH Aspect/Issue	Summary of Relevant Data	Impact Source	Project Phase				Potential Impact Description	Management from the EVTL	Inherent Risk Ranking			Proposed Mitigation and Follow-up Actions	Residual Risk Ranking		
			Pre-construction	Construction	Operation	Post Operation			Likelihood	Severity	Risk Ranking		Likelihood	Impact	Risk Ranking
Soil	Sand formation is brown in color and the grain size ranges from fine to medium. Normally sand thrown by sea waves on the coast are carried inwards, work-up into dunes by wind action. Beach and sea bottom material in the vicinity of Phitti mouth is predominantly composed of Micaceous, very well sorted fine sand.	Construction and associated activities		x			Contamination of Soil	Monthly Monitoring	Low	Very Low	Insignificance (28)	• Construction activities should not be extended beyond designated buffer zones • Natural and existing clearings should be used to the extent possible • Fuel, oil and other hazardous materials if stored on land area, should be provided with impervious lining • Combustible and explosive material should not be stored in storage area • Fuel tanks and hazardous material should be marked appropriately Fuel storage areas should be checked regularly to identify leakage • Safety equipments and utensils should be available at site at all times Vehicle Maintenance Yard should be developed at a designated location during construction work • Where possible, segregation of solid waste during handling should be followed to manage it effectively • Contractor should follow EVTL 's emergency response plan •Machinery movement should be restricted to the construction corridor Restoration of sites after completion of project should be mandatory	Very Low	Very Low	Insignificance (49)
Water Quality	The coastline of Karachi is highly polluted with a variety of hazardous substances of industrial, municipal and agriculture origin.	Construction and associated activities		x			Contamination of water followed by effect on marine biota	Monthly Monitoring	Low	Very Low	Insignificance (28)	• Temporary latrines should be located at a suitable distance from water bodies • Sewage should be treated appropriately at each unit • Vehicle cleaning should be prohibited near water bodies • Construction machinery should be kept off the water resources to the extent possible • Weekly/monthly water/wastewater/groundwater quality monitoring should be conducted throughout construction/operation • Treated wastewater of acceptable quality, may be reused for processing construction material	Very Low	Very Low	Insignificance (49)
Solid Waste		Construction and associated activities		x			Contamination of Soil, surface and ground water	Segregation and proper disposal being part of waste management plan.	Low	Very Low	Insignificance (28)	• Solid waste should be collected and stored in environmental friendly manner • Certified solid waste contractor should be hired for disposal of waste •Solid waste should be kept in closed container	Very Low	Very Low	Insignificance (49)



HIGH PRESSURE TRANSMISSION PIPELINE & NITROGEN BLENDING FACILITY - IEE REPORT

ESH Aspect/Issue	Summary of Relevant Data	Impact Source	Project Phase: Pre-construction	Project Phase: Construction	Project Phase: Operation	Project Phase: Post Operation	Impact Description within Pipeline & Nitrogen Blending Facility	Management from the RKL/RPL	Inherent Risk Ranking: Likelihood	Inherent Risk Ranking: Impact	Inherent Risk Ranking: Risk Ranking	Proposed Mitigation and Follow-up Actions	Residual Risk Ranking: Likelihood	Residual Risk Ranking: Impact	Residual Risk Ranking: Risk Ranking
Ground Disturbance	The right of way (RoW) of the preferred alternative route for pipeline will run in the terrestrial environment along existing roads which are fairly level and covered with loamy saline soils.	Laying of Pipeline		x			The impact is expected to be confined to the microenvironment for short term as the loose soil will be re-used for backfilling.	Contractor to ensure the restoration of ROW of pipeline to its original contours.	Very High	Very Low	Medium Significance (7)	Ensure that unnecessary damage to the ground surface and blockage of natural drainage is avoided. Ensure that after laying the NG pipeline, the disturbed surface is restored as much as possible to its pre-project conditions. The ditch will be backfilled and the RoW graded in a manner that restores the natural contour of the ground and allows natural surface drainage. The backfill will be crowned to a height of not less than 200 mm and not more than 300 mm above and at the adjacent ground surface. Ensure that steep cut and fill is avoided in all such cases where the risk of slope failure is high. Ensure that unusable soil spoils are disposed of at the location specified by PQA & SSGCL. These locations shall be selected to avoid slopes, watercourses, water ponds, or any area where the dumping of waste soil may cause adverse effect on the terrain. Ensure that a spill prevention and response plan is prepared and implemented in case of any such incident. Ensure that photographs of the RoW and other project sites are taken prior to commencement of field activity to be used for reference when restoring the site.	Medium	Very Low	Insignificance (21)
Fire Hazard / Air pollution	Laying of Pipeline			x			potential hazards include fire, in case if an ignition source is near LNG vapors and frost bite because of the risk of contact with an extremely cold substance such as any direct exposure of skin or equipment.	Hydrostatic testing will be performed.	Low	Very High	Medium Significance (8)	Ensure that a contingency plan is in place to mitigate leakages from the system and rupture of the pipeline before entering the Linde facility and/or after delivery into the downstream pipeline. Ensure that the leakages are keenly monitored.	Very Low	Medium	Insignificance (21)
Water and ground pollution	Fuel spills / leakages						Spills of fuel oil can have a potential impact on soil, groundwater and particularly surface water during both the construction and operational phases of the project. Impacts of a very limited nature are anticipated from occasional equipment leaks from fuel and hydraulic systems.	Monthly Monitoring	Low	Low	Low Significance (16)	Ensure that fuels, oils, and other hazardous substances are handled and stored according to standard safety practices.Ensure proper and timely maintenance of equipment to minimize oil or fuel leakages from construction machinery. Clean-up will be undertaken in the event of an oil spill larger than half a liter. This will include removal of contaminated soil from the area and disposal at proper location.	Very Low	Very Low	Insignificance (49)
Mangrooves	Preferred alternative route of pipeline will run through 3.12 km area of mangroves.	Laying of Pipeline					Construction activities will require clearing of some vegetation in the land area and the mangroves trees in the marine ecosystem	HSE Dept. to monitor Mangrooves disturbance / replantation on continous basis.	Very High	Low	High Significance (4)	Ensure that the construction contract include provisions to limit the removal of bushes and mangrove to the bare minimum and restricted to the area identified by PQA. The bushes and mangrove seedlings may, as far as possible be saved and transferred to the adjacent area. Other plants in the vicinity will need to be protected against damage by appropriate burying operations. The areas beyond the limits of site shall not be disturbed or damaged otherwise. Mangrove trees will be planted at 1:5 in consultation with an Independent Monitoring Consultant (IMC) at an area identified by PQA.	Very Low	Low	Insignificance (28)

HIGH PRESSURE TRANSMISSION PIPELINE & NITROGEN BLENDING FACILITY - IEE REPORT

ESH Aspect/Issue	Summary of Relevant Data	Impact Source	Project Phase				Impact Description within Pipeline & Nitrogen Blending Facility	Management from the RKL/RPL	Inherent Risk Ranking			Proposed Mitigation and Follow-up Actions	Residual Risk Ranking		
			Pre-construction	Construction	Operation	Post Operation			Likelihood	Impact	Risk Ranking		Likelihood	Impact	Risk Ranking
Historical / monuments / cultural values	Historical and cultural sites are not located on the RoW of the project.	Laying of Pipeline		x			Loss of precious values	Continous monitoring during construction phase	Very low	High	Low Significance (14)	Careful planning to minimize/offset problem. Any finding of archaeological or historical importance will be immediately brought to the notice of the relevant department.	Very Low	Low	Insignificance (28)
Health and Safety	Linde Pakistan will implement Standard Operating Procedures (SOPs) for the production of Liquid Nitrogen and its blending with NG in pipeline followed by metering and conveying the gas to the downstream NG pipeline.	Nitrogen Blending Facility			x		Health and Safety hazards will exist during operation of Nitrogen blending facility.	OH&S hazards will be managed by strong OH&S management system.	High	Low	Medium Significance (8)	Linde currently has nitrogen production facilities and operating standards, albeit at a smaller magnitude, therefore possesses experience and expertise to built and operate the mentioned blending facility.	Very Low	Low	Insignificance (28)
Natural drainage streams	The pipeline RoW crosses a few narrow channels and dry stream beds. The Sindh Irrigation Act 1879 under section 61 also prohibits the damaging, altering, enlarging or obstructing the canals without proper authority.	laying of Pipeline		x			Construction activities within the natural drainage streams may cause their blockage, especially if RoW is not properly restored to its original contours.	Contractor to ensure the restoration of ROW	High	Low	Medium Significance (8)	The RoW will be restored to its original condition after commissioning of the pipeline. The operation phase of the project will therefore not contribute to soil erosion.	Low	Very Low	Insignificance (28)
Mangrooves	There will be an estimated loss of about 100-150 mature trees.	Land Preparations		x			Land preparation in tidal mudflat and along the coastline will involve removal of mangroves and some sparse vegetation.	Replantation	Very High	Low	High Significance (4)	Mangrove trees will be planted at 1:5 in consultation with an Independent Monitoring Consultant (IMC) at an area identified by PQA.	Very Low	Low	Insignificance (28)
Marine benthos	Most of the area to be dig consists of barren sand/soft bottom or soft bottom/rubble with little or no observed epifaunal communities. The benthic population is restricted to the top 10 cm of the substrate.	Ditch burying		x			Most studies on the impact of ditch burying on marine benthos show that this activity can result in a 30 to 70% reduction in species variety; some 40 to 95% reduction in the number of individual species and a similar reduction in biomass in burying areas.	HSE Dept. to monitor vegetation, benthic community on continous basis.	High	Low	Medium Significance (8)	It is estimated that in stable environments the lost benthos are replaced and supplemented by a wider species diversity of slow-growing (equilibrium) species after cessation of burial activity.	Very Low	Low	Insignificance (28)

HIGH PRESSURE TRANSMISSION PIPELINE & NITROGEN BLENDING FACILITY - IEE REPORT

ESH Aspect/Issue	Summary of Relevant Data	Impact Source	Project Phase				Impact Description within Pipeline & Nitrogen Blending Facility	Management from the RKL/RPL	Inherent Risk Ranking			Proposed Mitigation and Follow-up Actions	Residual Risk Ranking		
			Pre-construction	Construction	Operation	Post Operation			Likelihood	Impact	Risk Ranking		Likelihood	Impact	Risk Ranking
Air Quality	The general air quality data for the major pollutants was carried out by EMC in 2007 and the mean concentrations of gaseous pollutants were, 238 µg/m3 for PM10, 3.0 ppm for CO, 14 ppb for SO2, 20 ppb for NOx and 321 ppm CO2.	Laying of NG pipeline		x			Emission of dust during trenching, leveling, and backfilling, in addition to operation of vehicular traffic on unpaved roads, emission of combustion gases from construction machinery and equipment.	Monthly Monitoring	High	Very Low	Low Significance (14)	• Ensure that the dirt road routinely used by a community for accessing the project site, is sprinkled with water regularly to reduce fugitive dust emissions resulting from heavy vehicular traffic. •Ensure that Personal Protective Equipments (PPEs) are provided to the workers involved in construction activities to safe-guard the health of the workers. •Ensure that construction materials are transported in covered vehicles. •Ensure that all equipment, generators, and vehicles used during the project are properly tuned and maintained in good working condition, in order to minimize exhaust emission levels. •Ensure that periodical pipe inspections are undertaken to identify and register possible pipe fractures. •Ensure that leak detection systems are installed at strategic locations.	Low	Very Low	Insignificance (28)
Noise	There are no developed residential areas close to the preferred route of pipeline.	Laying of NG pipeline		x			Increased ambient noise emission level particularly in the residential and commercial areas.	Monthly Monitoring	Medium	Low	Low Significance (12)	• Ensure that all equipment, generators, and vehicles used during the project are properly tuned and maintained in good working condition, in order to minimize noise emission levels. •Ensure that the vehicles and equipment are regularly monitored for the performance of the noise reducing equipments. Vehicles whose noise levels exceed the minimum required level must be restricted for use in the construction activity area. •Ensure that all work is carried out during day time. •Ensure that operators are instructed to keep the noise level at acceptable limits so that the marine fauna is disturbed to the least. •Ensure that a speed limit of 25km/hr is enforced for project vehicles passing through populated areas.	Very Low	Very Low	Insignificance (49)
Water Resources	The coastal and the creek area are both under high stress due to indiscriminate discharge of untreated wastewater from cattle colony, residential areas in Bin Qasim town and the industrial areas of Korangi and Landhi besides the industrial zones of Port Qasim.	Laying of NG pipeline		x			groundwater pollution, seawater contamination, and soil erosion.	Monthly Monitoring	Medium	Very Low	Insignificance (21)	• Ensure that the oil-contaminated water (after hydro-testing) is properly disposed of. Appropriate size of mesh will be used to filter out debris including metallic residues. Efforts will be made to reuse this filtered water as far as possible. •Ensure that sewage generated from construction camps is appropriately treated before being discharged into the existing sewerage system. •Ensure that heavy construction machinery is kept off the waterfront to the extent possible. •Ensure that the RoW including the coastline is regularly inspected to monitor erosion and spills. •Ensure that erosion and sediment-control measures are employed where necessary. •Ensure that all the disturbed areas including the pipeline trench, the storage and work place are restored to the original contour as far as possible.	Very Low	Very Low	Insignificance (49)
Wildlife	There are no threatened species inhabiting the area	Laying of NG pipeline		x	x		No significant impact on wildlife is expected, nor is any serious wildlife issue anticipated.	Monthly Monitoring	Very Low	Very Low	Insignificance (49)	Ensure that a No Hunting, No Trapping and No Capturing policy is enforced by the contractor and monitored by supervision consultant.	Very Low	Very Low	Insignificance (49)
Existing Infrastructure	The right of way runs along existing roads and crosses number of physical structures including, major roads, Highway N-5, Pakistan Railway Mainline and the steel mill drainage system. Furthermore the pipeline RoW would pass through buried utility lines.	Laying of NG pipeline	x				The construction activities may accidentally damage these lines and all such systems will have to be identified before start of excavation for laying the pipeline.	Identification of Existing facilities and their plans during preconstruction stage.	Medium	Medium	Medium Significance (9)	• Ensure that existing buried pipelines are identified in the project area through a detailed topographic survey to set the boundary of RoW. • Ensure that prior approval for right of way is obtained from relevant authorities before the start of pipeline laying activities. •Ensure that damage to existing infrastructure is avoided as far as possible and any damage caused to the infrastructure due to construction activities is promptly repaired.	Low	Very Low	Insignificance (28)

HIGH PRESSURE TRANSMISSION PIPELINE & NITROGEN BLENDING FACILITY - IEE REPORT

ESH Aspect/Issue	Summary of Relevant Data	Impact Source	Project Phase				Impact Description within Pipeline & Nitrogen Blending Facility	Management from the RKL/RPL	Inherent Risk Ranking			Proposed Mitigation and Follow-up Actions	Residual Risk Ranking		
			Pre-construction	Construction	Operation	Post Operation			Likelihood	Impact	Risk Ranking		Likelihood	Impact	Risk Ranking
Socioeconomic Impacts		Laying of NG pipeline		x			project related traffic and operation of the construction machinery can be hazardous to the population when the work is being conducted in the vicinity of settlements. Open trench can also be a potential source of accidents.	Continous monitoring	High	Low	Medium Significance (8)	•Ensure that the RoW is aligned to avoid residential areas, settlements, houses and buildings. • Ensure that the land ownership is, if necessary, determined with extreme care. • Ensure that written agreements are made for any temporary or permanent land acquisition. • Ensure that compensation is paid according to the written agreements. • Ensure that the acquired land is clearly marked and the actual land take is limited to the agreed limits. • Ensure that continuous liaison is maintained with the affected community and their concerns are addressed appropriately, if necessary. • Ensure that noise from campsites and construction sites is minimized using appropriate means (silencers, barriers, etc.) as required and noise levels is checked regularly at the campsite and construction sites. • Ensure that the camps are constructed at least 500 m from any settlement. • Ensure that no construction works is carried out during the night. • Ensure that the construction activities should not block the existing roads and tracks. If unavoidable, alternate routes will be provided in consultation with the affected people and concerned department. • Ensure that the liaison with local community is maintained by project proponent and contractor and the communities are informed of the construction activities well in advance. • Ensure that the construction area is cordoned off, and no irrelevant personnel are allowed inside. • Ensure that safe driving practice is enforced for the project vehicles. A speed limit of 25 km/hr will be enforced for the project vehicles passing through settlements. • Ensure that all supplies (water, fuel, construction materials, camp supplies, etc.) are sourced in a manner not adversely affecting the local population. The capacity and existing demand on the sources will be estimated, and these will be used for the project needs only when surplus capacity is available. •Ensure that the construction crew undergoes medical screening before being deployed in the field. • Ensure that all sites of archaeological, historical, cultural and religious significance are avoided and if any artifacts are discovered during the excavation, the relevant authorities (Department of Archaeology and Museums, Government of Pakistan, Karachi) will be contacted.	Low	Very Low	Insignificance (28)

09 Potential Social Impacts of Proposed Development and Recommended Mitigation Measures

9.1 Socioeconomic Impacts

There are undoubted positive impacts of an expanding gas sector on employment, competitiveness and sustainable development. However, the gas sector is a relatively modest creator of employment, and has contributed mostly as a substitute for coal in power generation. However NG is being used in the transport sector as CNG and also for cooking and heating. It is the main raw material for fertilizer production. These uses have modest impacts on competitiveness but have clear environmental benefits. In the drive to a low carbon economy, gas is a transitional fuel rather than the ideal fuel of the low-carbon economy. It nonetheless contributes to policies of sustainable development.

Natural gas is generally considered to make a positive contribution to sustainable development because it has been responsible for a declining reliance on coal in power generation, at least in the European context. Natural gas is the cleanest of all hydrocarbon energy sources, but virtue of emitting very low amounts of key pollutants such as sulphur and nitrogen oxide and emitting less than half of the CO_2 emitted by burning coal. However, the greater weight given to climate change mitigation in public policy means that the CH_4 emissions from methane take the shine off natural gas as 'the fuel of the future' or even as a transitional fuel to a low carbon economy.

The link between LNG and sustainability is rather different. There are at least four positive connections between LNG and the notion of sustainability. These are:

- It provides clean natural gas supplies;
- Liquefaction technology is an efficient way to monetise stranded gas reserves and create benefits for the developing countries that seek to export them;
- LNG is a relatively safe and secure fuel with an excellent track record in safety and environmental respects, and
- LNG solutions are flexible and scalable: small scale distributed LNG offers supplies to remote areas while liquefaction technology can capture waste streams from flare gas and landfills;

It is estimated that a maximum of 200 to 300 full time construction jobs will be created during the construction phase of the project. EVTL will use good faith efforts to employ qualified Pakistani citizens in the construction and operation of the proposed project. A training program will also be established by EVTL to recruit and train suitable citizens with the skills required during the project's construction and operational phases. Based on local populations and the potential number of available workers it is expected that up to 50 percent of the construction work force personnel will be hired from Sindh. The remainder of the construction and supervisory positions will be filled with experienced workers that will temporarily relocate to the area. Thus, construction activities will provide numerous new, temporary and permanent, work opportunities for both skilled and unskilled labor, as well as contribute significantly to the national economy. Because of the available labor pool, particularly of unskilled workers, and the diminishing needs of other large construction projects currently underway in the Sindh, the demand for labor for this project is not expected to compete with or impede other ongoing development projects in the area.

In addition to creating construction jobs for an extended period (estimated at 2 years), job training will be made available to provide the appropriate personnel for civil, mechanical and other positions required by the

construction. This action is consistent with the national goals of advancing both training and employment of its citizens in the high technology sector, and is particularly important to the young population of the Country as they emerge from school into the workforce.

It is estimated that 100 to 150 permanent full time jobs will result from on-going operations and maintenance of the facility with a permanent annual payroll.

The majority of the raw materials to be used during construction are expected to be purchased from the local market since significant amount of cement, aggregate or ready mix concrete, and miscellaneous fabricated material may be sourced from different parts of country. Other required materials may also be purchased locally, and include such items as food, housing materials, ferries and other small marine vessels, household and office supplies, oils, chemicals and cleaning supplies. These purchases are projected to infuse the local economy with additional revenues over the estimated 2-year construction period.

Natural gas accounts for the largest share of Pakistan's energy use, amounting to almost 45 percent of total energy consumption. Pakistan currently consumes all of its domestic natural gas production. Limited new gas discoveries and ever increasing demand has resulted in widening the gap between (demand and supply), and (supply and availability).

The projected demand/supply/availability analysis had indicated a shortfall of 3.0 MTOE in 2010 and the gap is expected to reach 19.9 MTOE in 2015 and 85.3 MTOE in 2030. Pakistan is exploring all possible avenues for cheap, abundant and environment-friendly sources of gas in order to continue with sustained economic growth in the coming years.

The gap between supply and demand of natural gas (NG) emerged in 2007- 08 and was projected to build up to 2,100 MMCFD by 2015, as the current gas fields gradually go off plateau. The demand and supply projections had indicated a widening gap of approximately 500 million cubic feet per day (MMFCD) by the year 2010. Winter of 2010-11has actually shown higher shortage then envisaged.

The existing demand of NG in the country is 5190.5 MMCFD, out of which 3895.5MMCFD is met by internal sources. As of June 30, 2010 the NG reserves were 28.90 trillion cubic feet. With no external source of NG available, Pakistan meets the demand from internal sources only. The increasing demand of NG has created a shortfall of 1,295 MMCFD and is expected to increase further. Gas load shedding has become a phenomenon with industry being forced to shut down for five days in a week in Punjab and fertilizer industry for 30-45 days. KESC and other IPPs had their gas allocations curtailed significantly resulting in gas load shedding of over 6-8 hours in the country. Industry running boilers to generate steam is being forced to use coal, furnace oil or diesel and diesel for power generation, with households utilizing charcoal and firewood, thus inducing rapid deforestation and warming of their microenvironment

The present requirement of oil in the country is around 19 million tons per annum, out of which about three million tons (15%) is met from internal sources. The oil reserves being only 314.39 million barrels, the balance demand is met through imports of crude oil and other petroleum products.

Oil imports cost $ 32.26 billion for 58.64 million tons oil during last four years (2006-2009). In order to attract local and multi-national companies for investment in oil and gas sectors and in aggressive exploration, the government has given incentives in new Petroleum Policy 2009.

Since inception, exploration and production companies made 223 oil and gas discoveries in the country and that so far cumulative production from these discoveries is 543 million barrels oil and 24.433 trillion cubic feet of gas having worth of about Rs 27000 billion and Rs. 4930 billion respectively at an average international market price of oil and average wellhead value of gas for 2009.

In order to explore more oil and gas reserves the government granted 115 exploration licenses. Presently, 16 foreign companies are operating in 44 blocks in Pakistan for the purpose.

To fill the growing energy supply deficit, GOP is in earnest implementing a multi-pronged strategy which includes: (i) increasing domestic oil & gas exploration and production, (ii) fast track utilization of hydro power potential, (iii) expediting the development of vast local coal reserves, (iv) importing piped natural gas from neighboring countries, (v) importing LNG, (vi) setting-up new nuclear power plants, and (vii) exploiting affordable alternate energy resources.

Any commitment of additional gas supplies to industries, power and fertilizer production on a long term basis have not been possible, without confirmation of additional sources of gas supply. This may, however, have been possible through:

1) Gas pipeline import which at the earliest could come on-stream by 2017 as per the Gap Coverage Strategy from Iran or Turkmenistan,

2) A major on-shore/off-shore gas field discovery in the current year (the gas to market period being five years), or

3) LNG import which by current assessment could provide gas by the year 2012-13. It was supposed to have started by 2010-11 under the Mashaal Project.

The GOP had mandated SSGC to develop a project for the import of LNG. The first supply of LNG of 3.5 million tons per annum (equivalent to 500MMCFD of gas) was targeted for the year 2011; followed by another for supply of 2.0mtpa by the year 2013. The projects stand delayed, while the shortage keeps multiplying.

EVTL intends to follow a fast track approach towards developing the LNG import terminal in order to bridge the gap between supply and demand of energy. The Project is primarily based on developing the required infrastructure so that LNG can be brought into the Natural Gas (NG) market, which has witnessed phenomenal growth in the energy sector in Pakistan. In the first stage, the focus is on the fastest method to facilitate LNG flow into the NG pipeline network in Pakistan.

The proponent is best placed in the energy sector, particularly in handling about 70% of LPG imports into Pakistan and cryogenic product ethylene. EVTL operates a state of the art LPG and chemical terminal in south western zone of Port Qasim. The terminal consists of a jetty, suitable for handling ships up to 75,000 DWT and houses storage tanks with a storage capacity of 10,100 cubic meters of LPG and balance for chemicals for a total storage capacity of EVTL 84,000 cbm.

The proposed site at Port Qasim is a dedicated area for Oil and Gas development and is promoting local energy supply system. FOTCO is utilized for oil imports and PRO-GAS for LPG in addition to EVTL. Proposed EVTL-LNG terminal for import of NG will also be located in the same zone but at Khiprianwala Island. It will thus be integrated into the infrastructure of Oil & Gas sector being developed.

In short, the cumulative impact on the National economy will be a strongly positive one. Significant additional resources will be realized by the nation as a result of this project, which is consistent with the government's long-term development plan. The additional licensing income, among other sources of additional income, will add to the government revenues and economic growth resulting from expanded and diversified business development in Pakistan in future.

The proposed development will also not cause any displacement of population in the microenvironment of any of the site(s) under consideration.

9.2 Interaction with Local Population

Construction activities are frequently conducted with a minimum level of interaction with the local population at the construction site. This will be a short term activity that will shift from site to site and hence it is more than likely that the interaction with the community will be of short term duration. However relationship with the local communities will be established prior to and during the construction work to ensure that their natural concern about possible socio-economic impacts is taken into account.

9.3 Employment Opportunities

The project will provide unskilled and semiskilled

employment opportunities, although temporary, during the construction phase. Preference will be given to those who are resident near the corridor of impact and are likely to be directly affected by construction activities.

9.4 Safety Hazards for Local Population

The project related traffic and operation of the construction machinery can be hazardous to the population when the work is being conducted in the vicinity of settlements. Open trench can also be a potential source of accidents.

9.5 Resource Utilization

The sourcing of supplies such as water, fuel, camp supplies, etc., required during the construction phase can adversely affect the available resources. The demands induced by the needs of the project will be fulfilled by the proponent who area already located in the industrial zone of Port Qasim.

9.6 Impacts on Historical and Cultural Sites

Historical and cultural s ites are not located on the RoW of the project. However the standard form of contract for such projects specifies that any finding of archaeological or historical importance will be immediately brought to the notice of the relevant department.

Mitigation Measures

The following mitigation measures will be implemented during construction phase of the pipeline project to minimize the impacts.

- The RoW will be aligned to avoid residential areas, settlements, houses and buildings. There will be no displacement of population and no loss of business. Hence no mitigation measure required.
- Land ownership will, if necessary, be determined with extreme care.
- Written agreements will be made for any temporary or permanent land acquisition.
- Compensation will be paid according to the written agreements.
- The acquired land will be clearly marked and the actual land take will be limited to the agreed limits.
- Continuous liaison will be maintained with the affected community and their concerns addressed appropriately, if necessary.
- Noise from campsites and construction sites will be minimized using appropriate means (silencers, barriers, etc.) as required. Noise levels will be checked regularly at the campsite and construction sites.
- Camps will be constructed at least 500 m from any settlement.
- No construction works will be carried out during the night.
- The construction activities will not block the existing roads and tracks. If unavoidable, alternate routes will be provided in consultation with the affected people and concerned department.
- Construction crew's interaction with local population will be minimized. Liaison with local community will be maintained by project proponent and contractor. The communities will be informed of the construction activities well in advance.
- The construction area will be cordoned off, and no irrelevant personnel will be allowed inside. The construction machinery will not be left un-attended. The trench will not be left open for extended period, appropriate crossover passages will be provided in consultation with the local population.
- Safe driving practice will be enforced for the project vehicles. A speed limit of 25 km/hr will be enforced for the project vehicles passing through settlements.
- It will be ensured that the supplies (water, fuel, construction materials, camp supplies, etc.) are

sourced in a manner not adversely affecting the local population. The capacity and existing demand on the sources will be estimated, and these will be used for the project needs only when surplus capacity is available.

- The construction crew will undergo medical screening before being deployed in the field.
- All sites of archaeological, historical, cultural and religious significance will be avoided. If any artifacts are discovered during the excavation, the relevant authorities (Department of Archaeology and Museums, Government of Pakistan, Karachi) will be contacted.

10 Preliminary Cumulative Impact assessment

The section presents the assessment of Cumulative Impacts of proposed ETPL LNG Terminal Project on the microenvironment and macroenvironment during the construction and operation stages. It may be stated that the microenvironment comprises the onshore installations including the Terminals and the handling of cargo at Port Qasim. The following terminals form the main components of the microenvironment:

1. PIBT – Pakistan International Bulk Terminal (handling Coal, Cement & Clinker) (under construction)

2. FOTCO LNG Terminal – Handling LNG (proposed)

3. Progas – Handling LPG (Operational)

4. FOTCO Oil terminal – Handling Oil (Operational)

5. IOCB (PSM) – Pakistan Steel Mill Iron Ore and Coal Berth (Operational)

6. FAP – Fauji Akber Portia Grain Terminal – Handling grains (Operational)

7. QICT – Qasim International Container Terminal (handling cargo) (Operational)

The macroenvironment on the other hand comprises the Industrial and Urban area on the coastline that forms the hinterland of Port Qasim. Relevant IFC guidelines have been followed for the assessment of each environmental aspect. Figure 10.1 shows the location of different installations in the microenvironment and macroenvironment.



Figure 10.1 Location Map of Terminals in PQA

10.1 Assessment Scenario (i): Cumulative Impacts from ETPL in Operation with two terminal Facilities (FOTCO LNG & PIBT) under Construction

10.1.1 Impacts on Air Quality

The ambient air quality in the project area was found to be within allowable limits. The operation of the LNG terminal projects will emit exhaust and potentially leak Boil-off gas. The significant components of combustion emissions are NOx, SO_2, CO and fine particulate matter less than 10 microns (PM10).

A general air dispersion study was carried out for the ETPL LNG terminal Project and indicated there is a potential for significant air quality impacts if stack emissions from the FSU/Power Generation Unit during operation are not maintained within NEQS. However, some of the predicted discharges exceed international (WHO) standards for emission. Modelling of emissions from the operation of ETPL LNG Terminal suggested the highest 24-hour average concentrations of NOx would be 19.13 mg/m^3, SO_2 would be 94.83 mg/m^3 and PM10 would be 3.55 mg/m^3. The highest annual mean for ground level NOx was 4.72 mg/m^3, 23.41 mg/m^3 for SO_2, and 0.627 mg/m^3 for PM10.Predicted emissions and the relevant NEQS and WHO guidelines for ambient air quality are summarized in Table 10.1 below.

Also the cumulative effect of these emissions coupled with those from the construction of the FOTCO LNG Terminal & PIBT and from operation of FOTCO Oil, FAP, QICT, Pro-Gas and IOCB needs to be considered. Air quality impacts from the construction of the other terminal facility is expected to come from fugitive dust emissions from excavation and fill operations, and emissions from construction equipment/ vehicles, marine vessels and portable generators. Of these, emissions from ships, vehicles and generators would likely contribute emissions similar to those from the operation of ETPL LNG Terminal and are considered in the cumulative impacts. Ships may have heavy fuel-driven engines that emit high levels of SOx and NOx. Gas turbine-driven ships and onshore gas generators emit primarily NOx, but at lower levels than heavy fuel-driven ships, and construction equipment and vehicles may emit NOx and CO. However, these emissions would be limited to the construction period and in the vicinity of the construction works areas.

Existing/In-Place Controls

The ETPL LNG Terminal facility will use natural gas for its main fuel source, thereby reducing significant emissions compared to other fuels. Construction impacts to air quality at the FOTCO and ETPL LNG Terminal sites will be mitigated through construction management practices such as the implementation of suppression measures for fugitive dust and gaseous emissions. Mitigation of emissions from vehicles and other engine-driven construction equipment will include proper maintenance and controlling unnecessary idling of equipment. Selective Catalytic Reduction or alternative systems would be incorporated onboard ships associated with construction of this project to reduce NOx emissions.

Table 10.1 Predicted Emissions for Operation of ETPL LNG and Ambient Air Quality Standards and Guidelines

Emission	Predicted Stack Emission Levels	NEQS (Ambient)	NEQS (Stack Emissions)	WHO Ambient Air Standard
NOx (Max. 24-hour concentration)	19.13 mg/m^3	--	NOx=400mg/Nm^3	--
SO2 (Max. 24-hour concentration)	94.83 mg/m^3	50 µg/m^3	SOx=400mg/Nm^3	20 µg/m^3
PM10 (Max. 24-hourconcentration)	3.55 mg/m^3	--		50 µg/
NOx (Max. annual mean)	4.72 mg/m^3	100 µg/m^3		40 µg/m^3 (NO_2)
SO2 (Max. annual mean)	23.41 mg/m^3	200 µg/m^3		--
PM10 (Max. annual mean)	0.627 mg/m^3	--	Doesn't give for LNG	20 µg/m^3

Significance of Impacts

Given the spatial distribution of vapour emissions from ETPL LNG Terminal during operation, as shown in Figure 10.1 below,

these emissions are expected to have limited overlapping with those emitted from the construction of the FOTCO LNG Terminal & PIBT and from operation of FOTCO Oil, FAP, QICT, Pro-Gas and IOCB, and construction-related air quality impacts are expected to be temporary and localized. Also, given that the predicted emissions are expected to fall within allowable limits according to NEQS and IFC emission standards, the cumulative air quality impacts from operation of the ETPL LNG Terminal Project concurrently with the construction of FOTCO project are considered to be minor. An evaluation of impacts is summarized in Table 10.2.

Additional Mitigation Measures, Management and Monitoring

It is recommended that further controls, such as those listed in the IFC EHS General Guidelines for air emissions and ambient air quality, be implemented during operation of the ETPL LNG terminal facility to reduce and maintain levels of emissions within applicable standards.

Significance of Residual Impacts

With the implementation of the proposed further controls and if all emissions are controlled to within applicable standards, residual impacts on air quality would be considered of negligible significance.

10.1.1 IMPACTS FROM NOISE EMISSIONS

The main sources of noise generated in LNG facilities include pumps, generators, compressors, recycle piping, air dryers, heaters, air coolers at liquefaction facilities, vaporizers used during re-gasification, and loading/unloading of vessels.

The main sources of noise generated from Container terminals are the maneuvering of container trailers, stacking of containers, loading and unloading of containers.

The main sources of noise generated from Oil terminal are

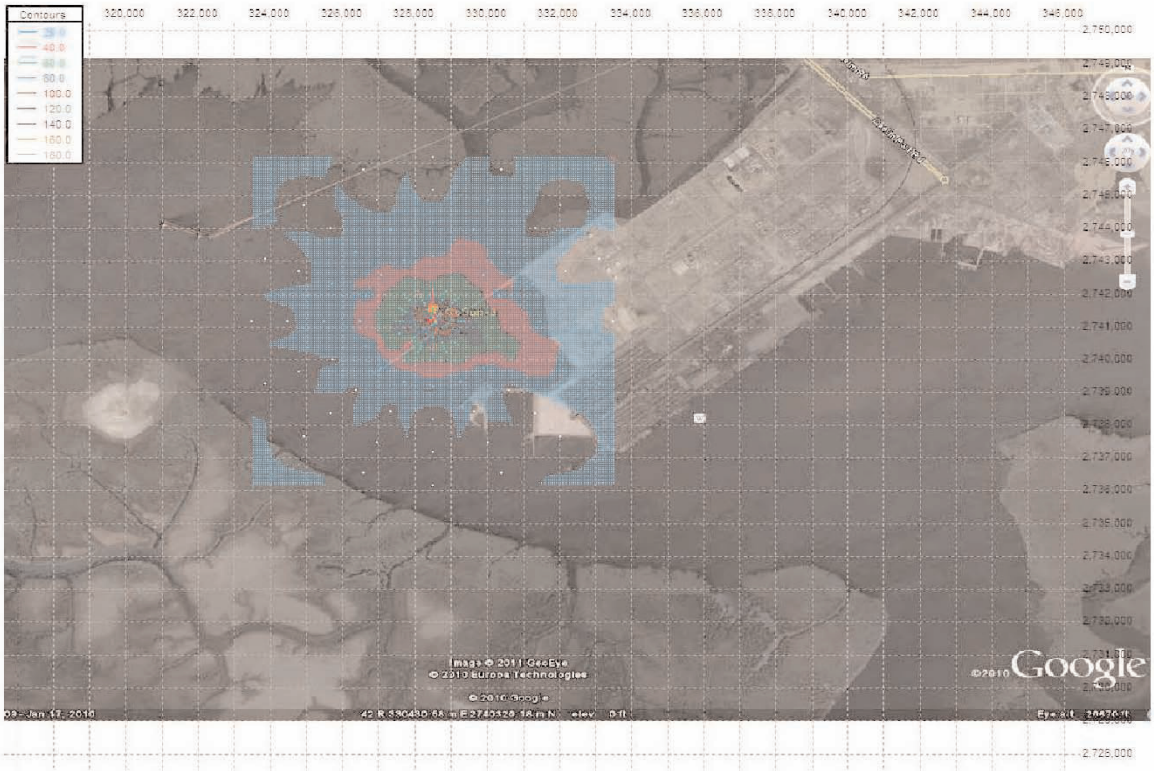


Figure 10.2 Color Average 24-hourly Contour Map for Vapor Emission at Normal Scenario. Yellow circle indicate the location of the FOTCO LNG terminal construction sites.

Table 10.2 Evaluation of Cumulative Impacts to Air Quality from Operation of ETPL LNG terminal during Construction of FOTCO LNG projects.

Impact	Emissions from operation of ETPL LNG Terminal (NOx, SO2, CO, PM10) in combination with emissions from ships and equipment associated with the construction of FOTCO LNG Terminal & PIBT.				
Impact Magnitude	The magnitude of operations emissions from ETPL LNG Terminal is shown in Figure 10.1 above. Emissions from construction of FOTCO LNG site and PIBT would be small and localized to the construction areas.				
Receptor Sensitivity	**Low**	Low Medium	Medium	Medium High	High
	The project locations are far from developed urban areas; however, mangroves and mudflats are the primary habitat in the vicinity and support a variety of fauna, including migratory birds.				
Impact Nature	**Negative Imp**	Positive	Neutral		
	Impacts to air quality are considered to be negative impacts				
Impact Type	Direct	Secondary	Indirect	**Cumulative**	Residual
	Cumulative impacts are considered.				
Impact Duration	Temporary	**Short-term**	Long-term	Permanent	
	Cumulative impacts will only last for the duration of construction of the FOTCO floating LNG facility, expected to 24 months respectively				
Impact Extent	**Local**	Regional	Global		
	Impacts would be limited to the area immediately around the two project sites.				
Impact Severity	No Change	Slight	**Low**	Medium	High
	Severity is ranked as Low-Medium. Though emissions from construction will be short-term and localized, the current predicted emissions from operation of ETPL LNG Terminal exhibit some exceedence which need to be addressed. Suggested mitigation measures will be adopted.				
Significance	Negligible	**Minor**	Moderate	Major	Critical
	The combination of a Low-Medium Receptor Sensitivity and Low-Medium Impact Severity results in an overall Minor significance.				

pumps, oil suction machinery, generators etc.

The main sources of noise generated from grain terminal are suction of grains from ships, pumps, generators, conveyor belts noise etc.

Noise will also be generated during construction works such as pile-driving, dredging, drilling, earthworks, etc. Acoustic effects at the creeks are expected to echo the noise, especially at low tide during activities with sharp bursts of noise such as those emitted during piling.

The NEQS stipulate that noise levels should not exceed 85dBA at 7.5 m from the sound source. World Bank Guidelines stipulate noise levels should not exceed 70 dBA day or night at industrial or commercial sites, or 55 and 45 one hour dBA for day and night, respectively, at residential sites, or result in background levels of 3dB at the nearest receptor location off-site. The ambient noise levels measured at the ETPL LNG terminal site were well within World Bank Guideline.

There are no developed residential areas close to the Projects. However, construction noise has the potential to disturb wildlife, in particular birds which may be roosting, foraging or breeding in the area, and marine mammals which may be affected by underwater noise generation. But as the types of noise will differ during construction and operation (loud, percussive versus low, continuous noise), it is not expected that the suite of sensitive receivers affected will be the same for two activities. For example, marine mammals may be negatively affected by underwater piling activities associated with construction but may not be disturbed by the much lower noise generated by operation of the LNG facility.

The operations involving FAP grain and fertilizer cargo unloading, rice loading and handling of storage facilities are low impact activities with respect to noise pollution. Operations involving container handling are also medium impact activities with respect to noise pollution. But the noise is localized inside the terminal and due to non-development of residential areas, the noise effect is minimal. Operations involving unloading of oil and gas are very low noise activities.

As such, noise impacts are expected to be associated more with construction rather than operation of the facilities.

Existing/In-Place Controls

During operation of the ETPL LNG facility, periodic monitoring of noise at the nearest receptors will be carried out. If noise levels exceed guidelines, the equipment suppliers will be required to reduce noise at the source in order to meet ambient noise targets. Additionally, noise-producing equipment will be placed inside acoustic enclosures to reduce noise at the source. During construction of the FOTCO facility, if noise levels exceed World Bank limits, noise control measures will be implanted to reduce the noise by 5 to 10 dBA.

Significance of Impacts

Significance of impacts is expected to be minor. An evaluation of impacts is summarized in Table 10.3.

of the projects to identify the extent of the potential cumulative noise impacts to sensitive receivers are recommended to confirmation compliance of relevant NEQS and World Bank Guidelines at sensitive receivers.

Significance of Residual Impacts

Residual noise impacts will remain minor.

10.1.2 IMPACTS ON WATER QUALITY

Sediment Dispersion

Dredging is expected to occur during the operation of the ETPL LNG facility along with 5 terminals (FOTCO Oil, FAP, QICT, Pro-Gas, IOCB) as periodic maintenance to maintain safe navigable depths for the vessels. This will result in periodic

Table 10.3 Evaluation of Cumulative Impacts from Noise Emissions from Operation of ETPL LNG in Operation with two terminal Facilities (FOTCO LNG & PIBT) under Construction.

Impact	Noise from operation of ETPL LNG in combination with noise generated by the operation of two terminal Facilities (FOTCO LNG & PIBT) under Construction.				
Impact Magnitude	The magnitude of noise emissions is higher for construction than for operation. However, only the immediate industrial vicinity will be affected.				
Receptor Sensitivity	**Low**	Low Medium	Medium	Medium High	High
	The project locations are far from developed urban areas; however, fauna, particularly birds which may use the area for roosting, foraging or breeding, and marine mammals, may be affected.				
Impact Nature	**Negative Imp**	Positive	Neutral		
	Impacts from noise emissions are considered to be negative impacts				
Impact Type	Direct	Secondary	Indirect	**Cumulative**	Residual
	Cumulative impacts are considered.				
Impact Duration	Temporary	**Short-term**	Long-term	Permanent	
	Cumulative impacts will only last for the duration of construction of FOTCO & PIBT facilities.				
Impact Extent	**Local**	Regional	Global		
	Impacts would be limited to the industrial area around the eight project sites				
Impact Severity	No Change	Slight	Low	**Medium**	High
	Severity is ranked as Medium due to the potential for disturbance to wildlife, particularly birds and marine mammals.				
Significance	Negligible	**Minor**	Moderate	Major	Critical
	The combination of a Medium Receptor Sensitivity and Medium Impact Severity results in an overall Minor significance.				

Additional Mitigation Measures, Management and Monitoring

Although the ESIAs state that in-place controls are expected to maintain noise levels within acceptable limits, quantitative noise impact assessments for the construction- and operation-phase

increases in turbidity in the local waterways. The extent of impact of increased turbidity and suspended sediment depends on several factors including the duration of dredging, dredging plant used, type and volume of material being dredged, tides, and current speeds. Sloughing may occur along

the sides of dredged channels, which contributes to turbidity. In addition to causing increased turbidity and suspended sediment loads, dredging may also release toxins and heavy metals contained in contaminated bottom sediments.

Extensive dredging will also occur during the construction of the FOTCO and PIBT facilities, resulting in localized and short-term siltation and sedimentation. Disposal of dredged material into the aquatic environment will also result in elevated turbidity and suspended sediment around the disposal site and potentially at downstream areas. Construction dredging will be much more extensive than maintenance dredging with regard to volume, but will be shorter in duration (i.e. will only occur once). Although both construction and maintenance dredging by themselves can be considered short-term, continual periodic dredging, as may occur as one project completes dredging and another begins, may not allow the system to fully recover between each dredge period, and turbidity and sedimentation levels may remain elevated.

Wastes and Pollutants

At present, approximately 65 million gallons per day (mgd) of untreated industrial wastewater and over 400 mgd of untreated domestic sewage is discharged into the sea from the city of Karachi, resulting in extremely poor sea water quality in the area. The ETPL LNG project will produce liquid sewage effluent which will be discharged into the sea, in much lower quantities, and will be treated prior to discharge. Crews typically generate around 150 liters of grey water per person per day and around 50 liters of sewage per person per day. Given the small number of workers expected for operation of the ETPL LNG facility, and as the wastewater produced will also be treated, the impact to water quality from sewage and grey water is not considered to be unacceptable.

The construction of the other terminal facilities is expected to generate sewage, wastewater, deck drainage, site run-off, etc., which may result in contamination and affect water quality upon discharge. Construction activities also have the potential to release contaminating substances from spillage of construction materials, wastes, fuels and oils. Although each spill contributes little on an individual basis, many spills over the long term can cause chronic concentrations of contaminants and degradation of water quality.

Existing/In-Place Controls

For dredging projects such as these, the typical adopted range of turbidity during dredging is in the order of 30-35 Nephelometric Turbidity Units (NTU) above background. Water quality will be measured to ensure compliance with adopted standards.

The ETPL LNG project will implement several mitigation measures for management of liquid effluent streams. Toilet wastewater will be treated in an on-site sewerage treatment plant before mixing with the main wastewater stream. Effluent will be treated to meet NEQS. This treated effluent will also be recycled in flushing water to reduce freshwater consumption. The discharge rate and chemical quality of the wastewater effluent will be monitored to comply with NEQS.

Pollution prevention and cleanup measures are generally included in project Environmental Management Plans (EMPs).

Significance of Impacts

Significance of impacts is expected to be moderate. An evaluation of impacts is summarized in Table 10.4.

Additional Mitigation Measures, Management and Monitoring

As Moderate impacts are deemed to be "Significant", additional mitigation is considered necessary.

Water quality modeling is recommended to be conducted to characterize local hydrodynamic conditions and to act as a tool to predict impacts to water quality due to sediment dispersion associated with marine dredging. The model would allow the assessment to be conducted in a quantitative manner and allow any unacceptable construction and operational environmental impacts to be identified to IFC Standards. Modeling will also be conducted to address concerns related to any overlapping construction periods with regard to dredging of sediments. A review of construction schedules will be undertaken and appropriate scenarios developed to address cumulative sediment transport concerns. Further mitigation measures would be developed based on the results.

In addition, it is recommended that best practice procedures are

Table 10.4 Evaluation of Cumulative Impacts to Water Quality from Operation of ETPL LNG facility in Operation with two terminal Facilities (FOTCO LNG & PIBT) under Construction.

Impact	Impacts to water quality from operation of ETPL LNG in Operation with two terminal Facilities (FOTCO LNG & PIBT) under Construction.				
Impact Magnitude	The magnitude of water quality impacts includes the immediate project areas as well as affected downstream water bodies.				
Receptor Sensitivity	Low	Low Medium	Medium	**Medium High**	High
	Estuarine and marine ecosystems are sensitive to water quality. Inputs of effluent and sediment can change water quality characteristics of aquatic habitats that are vital to biota living there. Changes in temperature can also detrimentally affect the ecosystem.				
Impact Nature	**Negative Imp**	Positive	Neutral		
	Impacts to water quality are considered to be negative impacts.				
Impact Type	Direct	Secondary	Indirect	**Cumulative**	Residual
	Cumulative impacts are considered.				
Impact Duration	Temporary	**Short-term**	Long-term	Permanent	
	Cumulative impacts will only last for the duration of construction of the FOTCO & PIBT facilities.				
Impact Extent	**Local**	Regional	Global		
	Impacts would be limited to the area around two project sites as well as nearby downstream areas and local tidal creeks.				
Impact Severity	No Change	Slight	Low	**Medium**	High
	Severity is ranked as Medium due to the potential for adverse effects on the sensitive aquatic ecosystem.				
Significance	Negligible	Minor	**Moderate**	Major	Critical
	The combination of a Medium-High Receptor Sensitivity and Medium Impact Severity results in an overall Moderate significance.				

implemented during maintenance dredging such as the installation of silt curtains, the use of dredgers that result in lower turbidity (e.g. cutter-head dredges over hopper dredges and clam shells), etc.

Project EMP should provide procedures for contractors to ensure minimization of untreated operational discharge, and spills and release and a monitoring program that maintains compliance with applicable standards.

Significance of Residual Impacts

Upon confirmation of compliance with applicable standards by modeling results, and if effluents are controlled to within applicable standards and turbidity from dredging is controlled to the maximum extent practicable through the use of best practices and feedback monitoring, residual impacts may be reduced to minor.

10.1.3 IMPACTS ON COMMUNITY HEALTH, SAFETY & SECURITY

Boating Accidents & Injuries

Traffic accidents involving fishing boats and Project vessels (including LNG, Oil and Containers carriers and transport boats of supplies and workers) have the potential to result in minor to serious injury or, in rare instances, death. During the operation of ETPL LNG terminal, local fishermen will be allowed to access their normal fishing areas beyond the Project's security buffer zone. However, the fishing boat traffic may increase in this unrestricted area as a result of reduced fishing areas during the construction of the 02 LNG terminal Projects. This can increase the risk of accidents and injuries. While the magnitude of the change in vessel traffic from these two new projects has not been quantified, the obstruction to maritime navigation is anticipated to be short-term, lasting during the construction periods of the PIBT and FOTCO Project.

Exposure to Environmental Contaminants

Residents, particularly fishermen that come within closer distance to the project activities, are at risk for exposure to project emissions and discharges to the air and water.

Considering the cumulative air quality impacts from emissions from the three projects (e.g., exhaust emissions and gas leakages) is anticipated to be minor, the potential for health

effects associated with exposure to air contaminants is anticipated to be low. It is important to note the most sensitive receptors are residents and fishermen with existing respiratory illness conditions (TB and asthma) where their conditions can be exacerbated from exposure to air contaminants.

Cumulative water quality impacts (including associated with wastes and pollutants) is anticipated to be moderate. No information is available on the communities' use of the local waterways, other than for fishing. If the residents and fishermen also use the waterways for recreational, swimming or domestic uses (e.g., laundering), then these activities can expose them to potential project-related water quality contaminants (e.g., accidental spills, waste discharge, etc.). In addition, project contaminants that have the potential to bioaccumulation in fish can create another potential pathway for community exposure. A more detailed health baseline study is recommended to fully assess the potential cumulative impacts via these exposure pathways.

Spread of Infectious Diseases

The potential for transmission of infectious diseases (including TB) may occur through direct worker-community interactions, such as during rotation of crews between onshore locations to and from the offshore Project site; or indirectly through the influx of new comers (e.g., jobseekers) into the local communities. Population influx can lead to potential water and sanitation related diseases (e.g. diarrhea) associated with increased pressures on inadequate community sewage and wastewater systems.

The ETPL LNG operational workforce will primarily be housed offshore on self-contained accommodation barges with food, clothing and medicine and/or housed away from the Project site and commute daily by boat to and from the Project site. Workforce housing plans are not known for the other project. Nevertheless, ETPL's workforce housing arrangements will limit worker-community interactions, reducing the risk of infectious disease transmission. Furthermore, the offshore barge accommodations will meet international standards, thereby reducing the potential for outbreaks (e.g., food-borne illnesses and respiratory infections) associated with overcrowded and unhygienic living quarters that can spread to the surrounding communities.

Population-Influx Related Health Issues

An assessment on the potential for population influx (i.e., newcomers moving into the local communities seeking to gain jobs or provide good and services to the two projects) is needed to assess the cumulative impacts from influx-related health issues (e.g., spread of infectious diseases, psycho-social well-being and effects on public health infrastructure).

Existing/In-Place Controls

During the operation of the ETPL LNG facility, environmental pollution controls will be in placed to limit harmful air emissions and water quality impacts (see discussion for Air Quality and Water Quality). In addition, the Project will implement a Hazardous Materials Management Plan, which includes procedures for proper storage, transport and safe disposal of medical/ clinical wastes and hazardous wastes.

To reduce the risk of accidents and injuries involving fishing boats and shipping vessels, ETPL will employ a Safety Exclusion Zone along the pipeline route throughout its operation. This zone will be marked on the relevant navigation charts. Furthermore, ETPL suggests hiring locals to monitor the waterways in the vicinity of the Project for movements of local fishing boats to avoid hindrance by Project activities.

These three projects recognize the importance of the Pakistan Fisher folk Forum and will keep them informed of all activities that could have negative impact on the fisheries operations.

Significance of Impacts

Significance of impacts is expected to be Moderate. An evaluation of impacts is summarized in Table 10.5.

Additional Mitigation Measures, Management and Monitoring

As Moderate impacts are deemed to be "Significant", additional mitigation is considered necessary.

Community Health Baseline Study

Table 10.5 Evaluation of Cumulative Impacts to Community Health, Safety and Security from Operation of ETPL LNG terminal in Operation with two terminal Facilities (FOTCO LNG & PIBT) under Construction.

Impact	Impacts to community health, safety and security from operation of ETPL LNG in Operation with two terminal Facilities (FOTCO LNG & PIBT) under Construction.				
Impact Magnitude	The magnitude of the impact encompasses all local people (residents and fishermen) that use the waterways in the Project area and communities that house workers (if planned).				
Receptor Sensitivity	Low	Low Medium	Medium	Medium High	**High**
	The sensitivity of the local people to health impacts is considered high due to the limited access to emergency medical care in the event of an injury or illness				
Impact Nature	**Negative Imp**	Positive	Neutral		
	Impacts to community health are considered to be negative impacts.				
Impact Type	Direct	Secondary	Indirect	**Cumulative**	Residual
	Cumulative impacts are considered.				
Impact Duration	Temporary	**Short-term**	Long-term	Permanent	
	The cumulative impacts, particularly the increased risk of boating accidents and injuries, will be heightened during the construction of the two LNG projects. The impact is anticipated to be short-term with fishermen adapting to alternate travel routes around exclusion zones over the long-term.				
Impact Extent	**Local**	Regional	Global		
	Impacts would be limited to the area around the two project sites, including the popular fishermen's transit locations around the Buddo and Bundal islands.				
Impact Severity	No Change	Slight	**Low**	Medium	High
	Local fishermen may adjust travel routes to accommodate change in boating traffic over the long-term, while increasing their familiarity with safety precautions around safety exclusion zones at the three project sites.				
Significance	Negligible	Minor	**Moderate**	Major	Critical
	The combination of a High Receptor Sensitivity and Medium Impact Severity results in an overall Moderate significance.				

A detailed community health baseline study is needed to better understand the community's current uses of the local waterways that could potentially expose them to water quality discharges; current levels of boating/vessel traffic and accident rates; and other community health vulnerabilities (such as psycho-social well-being or mental stress/anxiety associated with industrial development and social disruption).

Population Influx Assessment and Management

An assessment for the potential for population influx into the communities within the Project is recommended. If identified as a significant cumulative impact, consider preparing an influx management plan to address potential related health issues (e.g., infectious disease transmission, psycho-social wellbeing and effects on public health infrastructure).

Workforce Trainings & Code of Conduct

The following aspects are recommended for inclusion in the Health, Safety and Environmental Management Program:

- Provide safety training for vessel captains, particularly outlining local fishing areas and the need for precaution in particular with small-scale fishermen.
- Develop and enforce a worker code of conduct regarding respect for local communities and worker-community conflict management, particularly for locals hired for watch and ward of exclusion zones.
- Design worker living quarters to prevent over-crowding and unhygienic conditions (e.g., proper sewer waste disposal facilities) following industry best practices, such as Workers Accommodations: Processes and Standards (IFC and EBRD, August 2009).
- Integrate hygiene trainings (e.g., hand washing) in worker health and safety induction programs and as a regular part of continuous trainings for workers. Establish Standard Operating Procedures for Food Preparation and Handling to ensure all food handlers are medically screened on a routine basis (e.g., semi-annual medical exams) and vaccinated.
- Conduct regular TB screenings of workers and contractors, while ensuring the protection of employee rights and confidentiality.

Significance of Residual Impacts

Depending on the outcome of the additional study, and with the implementation of the recommended additional mitigation, management and monitoring measures, residual impacts on Community Health, Safety & Security may be considered minor-to-moderate.

10.1.4 IMPACTS ON FISHERIES

The majority of people living in the project area rely on fishing and other related professions to earn a living. Impacts to local fisheries may occur indirectly through impacts to habitat (disturbance and loss of fishing grounds) and water quality, thereby impacting fishing stocks and important nursery grounds for commercial species, and through physical restriction of fishing by construction and operation of the facilities within local fishing grounds and by increased marine traffic through the area. Fishermen would be excluded from PIBT & FOTCO sites during construction, and fishing activities would likely decrease in the vicinity of the two terminal sites and Phitti Creek due to vessel traffic, essentially removing a large block of intertidal and mangrove creek fishing grounds.

Existing/In-Place Controls

The ETPL LNG ESIA states that the disposal of solid or untreated liquid wastes into waterways will be prohibited, and suggests locals should be hired to monitor the waterways in the vicinity of the Project for movements of local fishing boats to avoid hindrance by Project activities. Periodic sampling of water quality will occur to ensure compliance with NEQS. Any impacts on the local fishing community determined will be compensated, if warranted, under the Community Grievance Procedure, though no in-place controls are currently provided.

Significance of Impacts

Significance of impacts is expected to be moderate. An evaluation of impacts is summarized in Table 10.6.

Additional Mitigation Measures, Management and Monitoring

As Moderate impacts are deemed to be "Significant", additional mitigation is considered necessary.

Table 10.6 Evaluation of Cumulative Impacts to Fisheries from Operation of ETPL LNG terminal in Operation with two terminal Facilities (FOTCO LNG & PIBT) under Construction.

Impact	Impacts to local fisheries from operation of ETPL LNG terminal in Operation with two terminal Facilities (FOTCO LNG & PIBT) under Construction.				
Impact Magnitude	The magnitude of the impact encompasses all local people who are dependent on fisheries for sustenance and/or livelihood.				
Receptor Sensitivity	Low	Low Medium	**Medium**	Medium High	High
	For the local people whose livelihoods depend on fishing, their sensitivity to impacts to fisheries is considered high.				
Impact Nature	**Negative Imp**	Positive	Neutral		
	Impacts to fisheries are considered to be negative impacts.				
Impact Type	Direct	Secondary	Indirect	**Cumulative**	Residual
	Cumulative impacts from three concurrent projects are considered.				
Impact Duration	Temporary	**Short-term**	Long-term	Permanent	
	Although cumulative impacts generally last for the duration of construction of PIBT & FOTCO LNG project during the operation of the ETPL LNG terminal project, the impact will not abate when construction is completed. Those fishing grounds will remain impacted and fishing efforts impeded in the vicinity of the projects.				
Impact Extent	**Local**	Regional	Global		
	Impacts would be limited to the area around the 03 project sites as well as nearby downstream areas and local tidal creeks.				
Impact Severity	No Change	Slight	Low	**Medium**	High
	Severity is ranked as Medium. Although some fishing areas will be removed or fishing efforts hampered, other areas will still remain available to local fishers.				
Significance	Negligible	Minor	**Moderate**	Major	Critical
	The combination of a High Receptor Sensitivity and Medium Impact Severity results in an overall Moderate significance.				

A detailed fisheries study is recommended to be conducted to characterize the existing condition of fisheries in the area prior to the construction of the project(s) for an accurate determination of potential impacts to fisheries resources and fishing operations. The study shall include not only desktop review of recent data to identify fisheries resources and composition of commercially important species in relation to the project area as well as sites of importance such as nurseries and spawning grounds, but also field studies to determine fisheries abundance, identify nursery and spawning grounds of commercially important species, and seasonal occurrence of juvenile and spawning fisheries (fish eggs and larvae) in relation to the intake. Further mitigation measures would be developed based on the results.

Consultation with local fishing groups is also recommended to be carried out throughout the project phases to determine who may operate within the project area to capture their local knowledge of fisheries resources, spawning grounds etc. A Community Grievance Mechanism shall be developed. If significant impacts are determined, a system of compensation should be developed.

Significance of Residual Impacts

Depending on the outcome of the additional study, and with the implementation of the recommended additional mitigation, management and monitoring measures, residual impacts on fisheries may be reduced to minor to moderate.

10.1.5 Impacts on Ecology

Mangroves will be removed cleared for the construction of PIBT and FOTCO LNG facilities and were cleared during construction of remaining 06 projects in operation. Mangroves provide multiple important ecological functions such as shoreline protection and erosion control, water filtration and nutrient sink, nursery habitat for commercially important fish species, and feeding, roosting and breeding habitat for birds.

The mangroves are an overvalued environmental and social component of the projects in Port Qasim area. True that they are important in protecting the land area and its ecology from natural disasters such as storms. However this important aspect is taken care of by the Mangrove Forest on the ocean front lined along Bundal and Buddo Islands and the creeks as such the mangrove trees lining the Port side are unimportant. Furthermore the entire Phitti-Kadiro-Gharo creek system is designated for development of the Port related infrastructure and industries. The development activities in the Port area and along the creeks facing the Port are mandated to protect the mangrove area. Every tree that may be felled is compensated by plantation of 3-10 trees depending on the canopy lost. Institutions such as IUCN and WWF Pakistan are actively engaged in protection of the mangrove forest area and afforestation wherever needed. As such i) loss of mangrove trees on a small area of 50 hectares will not constitute any adverse impact on the ecology of the micro and macroenvironment, ii) The 50 ha of mangroves forest to be removed does not provide any "priority ecosystem services" because the area is demarcated for development and operation of Port activities under PQA Master plan.

The benthic habitat and communities within the Port Qasim area have also been substantially impacted over the years. Continuous dredging for construction of projects and maintenance of channels, as well as contamination has led to degradation of benthic sediments and the communities that live in them. Although benthic fauna are generally considered to recover rapidly, continued dredging as described above may not leave enough recovery time between dredging periods, leading to permanent or long-term impacts to these communities. This can, in turn, impact higher species that depend on in fauna for food. In addition to removal of benthic in fauna through dredging, placement of dredges spoil can also bury existing benthic fauna, and continued placement in the same area can lead to extirpation of the benthic community there.

Additionally, dredging can negatively affect water quality by re-suspending toxins and heavy metals in bottom sediments, and increasing turbidity which can clog fish gills and lower BOD (see Impacts on Water Quality above). Again, although water quality can quickly recover after dredging, continuous or multiple dredging periods by multiple projects in a single area may not allow time for recovery, leading to chronic turbidity and degradation of water quality.

The noise caused by construction of the other LNG facilities during the operation of ETPL LNG terminal, which will increase large vessel traffic in the area, may also disturb local wildlife, including migratory birds which may require mangroves for foraging and resting; disruption of this behavior may cause them to expend energy necessary for the long flights during migration. Construction noise and vessel activity may also disturb marine mammals in the area. Though dolphins are known to frequent areas with high marine traffic, construction noise in addition to vessel movement may provide enough disturbances to cause movement away from the area.

Existing/In-Place Controls

The two projects under construction claim they will plant/transplant mangroves to replace those removed from the project sites. ETPL states that any loss of mangrove habitat will be compensated by plantation/replantation of mangrove of as many mangrove trees as the canopy of the removed trees would require. The number of trees to be planted against the number removed will be determined in consultation with IUCN and Independent Monitoring Consultant (IMC).

Water quality monitoring and controls will be implemented as described under Impacts to Water Quality above.

Screens will be installed on the FOTCO cooling water riser inlets and inlet current speed will remain low (estimated at 0.5m/s) to prevent the ingress of large marine fauna into the cooling water system.

Significance of Impacts

Significance of impacts is expected to be moderate. An evaluation of impacts is summarized in Table 10.7.

Additional Mitigation Measures, Management and Monitoring

As Moderate impacts are deemed to be "Significant", additional mitigation is considered necessary.

The ETPL LNG facility should include structural measures such as screens to prevent the intake of marine organisms. See Impacts to Water Quality above for additional mitigation

Table 10.7 Evaluation of Cumulative Ecological Impacts from Operation of ETPL LNG terminal in Operation with two terminal Facilities (FOTCO LNG & PIBT) under Construction.

Impact	Impacts to local ecology from operation of ETPL LNG terminal in Operation with two terminal Facilities (FOTCO LNG & PIBT) under Construction.				
Impact Magnitude	The magnitude of the impact encompasses the local terrestrial and mangrove areas that will be cleared and reclaimed, connected waterways that may experience impacts in water quality, and species that depend on the area (some local, others migratory).				
Receptor Sensitivity	Low	**Low Medium**	Medium	Medium High	High
	Mangroves, estuarine and marine ecosystems are considered sensitive to habitat clearing and water quality degradation.				
Impact Nature	**Negative Imp**	Positive	Neutral		
	Impacts to ecology are considered to be negative impacts.				
Impact Type	Direct	Secondary	Indirect	**Cumulative**	Residual
	Cumulative impacts from three concurrent projects are considered.				
Impact Duration	**Temporary**	Short-term	Long-term	Permanent	
	Some impacts, such as noise and turbidity and other disturbance generated during construction, will be temporary. However, the clearing of mangroves and terrestrial habitat is permanent as facilities will be constructed over the areas.				
Impact Extent	**Local**	Regional	Global		
	Although most impacts would be considered local, cumulative impacts to migratory species could have a regional extent. The cumulative destruction of the Indus Delta habitats would also be considered regional.				
Impact Severity	No Change	Slight	Low	**Medium**	High
	Severity is ranked as Medium. The area is already degraded. Mangrove habitat will be mitigated through off-site plantation.				
Significance	Negligible	Minor	**Moderate**	Major	Critical
	The combination of a Medium-High Receptor Sensitivity and Medium Impact Severity results in an overall Moderate significance.				

measures for water quality.

An ecological survey comprising both terrestrial and marine survey is recommended to be undertaken to determine the ecological sensitivity of the area, and include mapping habitats and identification of flora and fauna. This would help determine the quality and extent of the habitat lost due to the ETPL LNG terminal and other one project. Further mitigation measures would be developed based on the results.

Significance of Residual Impacts

Depending on the outcome of the additional study, residual impacts to ecology may be reduced minor to moderate if ecological assemblages of high sensitivity or large areas of habitats are not significantly affected.

10.2 Assessment Scenario (ii): Cumulative Impacts from Operation of ETPL LNG terminal with seven additional facilities (FOTCO LNG, PIBT, FOTCO Oil, FAP, QICT, Pro-Gas, IOCB) in operation

10.2.1 Impacts on Air Quality

World Bank Guidelines(1) suggest that plans for the establishment of a project should not lead to either the air shed dropping into "poor air quality", or to an increase of more than 5 µg/m3 in the annual mean level of SOx, NOx or PM for the entire air shed.

ESIAs provide modelling for overall dispersion of LNG vapour emissions. After LNG liquefaction, stored LNG emits methane gas vapour known as "boil-off" gas. Examination of the average 24-hourly contour maps for dispersion plumes modelled for the "normal" scenario shows that LNG vapour emissions from each project may overlap at times. Though urban centers are mostly outside the modelled extent of the vapour plumes, workers, fishers, or other people travelling through the area would be subject to the extent of the vapour cloud and its hazards.

(1) World Bank Group (1998) Thermal Power: Guidelines for New Plants, In: Pollution Prevention Handbook. Effective July 1998.

Existing/In-Place Controls

In place controls for the ETPL LNG facility are provided above under Section 10.1.1. The FOTCO ESIA states that air quality impacts from the Project's power production system will be minimized by appropriate technology to reduce the emissions to conform NEQS and applicable international standards. The power production system will be designed for high-efficiency with advanced combustion controls to minimize fuel consumption and pollutant emissions.

Significance of Impacts

Assuming emissions will be maintained within applicable standards for the duration of operation of each of the projects, impacts from these emissions are expected to be minor. An evaluation of impacts is summarized in Table 10.8.

Additional Mitigation Measures, Management and Monitoring

Operation-phase quantitative air dispersion modeling is recommended to confirm whether potential air quality impacts would be acceptable as per applicable standards. If operation-phase modeling confirms this, it is recommended that further controls, such as those listed in the IFC EHS General Guidelines for air emissions and ambient air quality, be implemented during operation of the ETPL LNG facility to reduce and maintain levels of emissions within applicable standards.

According to World Bank recommendations, facilities should be designed so that boil-off gas is collected using an appropriate vapor recovery system. For LNG plants, the vapor should be returned to the process for liquefaction or used on-site as a fuel; boil-off gas from on-board carriers should be reliquefied and returned to the process system to be used as fuel on-site, compressed and placed into the pipeline, or flared.

Other terminal operators are also committed to control air emissions from their facilities through adoption of mitigation measures as per their commitment with EPA. EPA Sindh also monitors the compliance of Environmental Management Plan

Table 10.8 Evaluation of Cumulative Impacts to Air Quality from Operation of ETPL LNG with seven additional facilities (FOTCO LNG, PIBT, FOTCO Oil, FAP, QICT, Pro-Gas, IOCB) in operation.

Impact	Emissions from operation of ETPL LNG Terminal (NOx, SO2, CO, PM) in combination with operation of seven additional facilities (FOTCO LNG, PIBT, FOTCO Oil, FAP, QICT, Pro-Gas, IOCB) as well as leakage of LNG vapour.				
Impact Magnitude	The magnitude of emissions from operation is localized, extending around the three sites from Port Qasim west to the shoreline.				
Receptor Sensitivity	Low	**Low Medium**	Medium	Medium High	High
	The project locations are far from developed urban areas; however, mangroves and mudflats are the primary habitat in the vicinity and support a variety of fauna, including migratory birds.				
Impact Nature	**Negative Imp**	Positive	Neutral		
	Impacts to air quality are considered to be negative impacts				
Impact Type	Direct	Secondary	Indirect	**Cumulative**	Residual
	Cumulative impacts from eight concurrent projects are considered.				
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
	Cumulative impacts will last as long as these eight or more of the facilities remain in operation at the same time.				
Impact Extent	**Local**	Regional	Global		
	Impacts would be limited to the area immediately around the eight project sites.				
Impact Severity	No Change	Slight	Low	**Medium**	High
	Severity is ranked as Medium. The current predicted emissions from operation of ETPL LNG terminal exhibit some exceedence which need to be addressed. Vapour emissions from three LNG facilities will cover an extensive area and will produce emissions in the long-term.				
Significance	Negligible	**Minor**	Moderate	Major	Critical
	The combination of a Low-Medium Receptor Sensitivity and Medium Impact Severity results in an overall Minor significance.				

through inspections.

Significance of Residual Impacts

With the implementation of the proposed further controls and if all emissions are controlled to within applicable standards, residual impacts of air emissions would be considered of Negligible to Minor significance.

10.2.2 IMPACTS FROM NOISE EMISSIONS

Sources of noise during operation of eight terminal facilities are described in section 10.1.1. Several factors affect the potential impacts of these sources such as the distance between the terminal and sensitive receivers, acoustic barriers, and limits of tolerance. Noise emitted during operation of the facilities is expected to be lower than noise generated during construction. Noise levels immediately outside the facilities, once in operation, are expected to be controlled within acceptable limits through the in-place controls described below.

Existing/In-Place Controls

Noisy equipment, such as power generators, will be housed in sound dampening structures. The engines of marine vessels are attenuated by placement deep within the vessel. Sounds levels will be monitored for compliance.

The sources of noise during operation of the project include vehicular movements, ships offloading operations, intermittent sounding of horns by the ships etc. The noise emitting from these sources will not be significantly higher than the background noise level.

Significance of Impacts

Given that each facility will adhere to the same stringent standards and the distance of the facilities from major urban centers, it is not considered likely that there will be significant increases (>3dBA) in ambient noise levels at sensitive receivers. As such, sensitive receivers (urban centers, wildlife) are not expected to be significantly affected. Significance of the impact is considered minor. An evaluation of impacts is summarized in Table 10.9.

Additional Mitigation Measures, Management and Monitoring

Table 10.9 Evaluation of Cumulative Impacts from Noise Emissions from Operation of ETPL LNG with seven additional facilities (FOTCO LNG, PIBT, FOTCO Oil, FAP, QICT, Pro-Gas, IOCB) in operation.

Impact	Noise from operation of ETPL LNG in combination with operation of seven additional facilities (FOTCO LNG, PIBT, FOTCO Oil, FAP, QICT, Pro-Gas, IOCB).				
Impact Magnitude	The magnitude of noise emissions is substantially lower for operation than for construction. Impacts will be limited to the immediate vicinity of the project and waterways of shipping vessels.				
Receptor Sensitivity	Low	**Low Medium**	Medium	Medium High	High
	The project locations are far from developed urban areas; however, fauna, particularly birds and marine mammals, may be affected.				
Impact Nature	**Negative Imp**	Positive	Neutral		
	ImpaImpacts from noise emissions are considered to be negative.				
Impact Type	Direct	Secondary	Indirect	**Cumulative**	Residual
	Cumulative impacts from three concurrent projects are considered.				
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
	Cumulative impacts will last as long as these eight or more of the facilities remain in operation				
Impact Extent	**Local**	Regional	Global		
	Impacts would be limited to the industrial area around the eight project sites.				
Impact Severity	No Change	Slight	**Low**	Medium	High
	Severity is ranked as Low due to low noise generation during operation.				
Significance	Negligible	**Minor**	Moderate	Major	Critical
	The combination of a Medium Receptor Sensitivity and Slight Impact Severity results in an overall Minor significance.				

Quantitative noise impact assessments for the operation phase of the projects to identify the extent of the potential cumulative noise impacts to sensitive receivers are recommended to confirmation compliance of relevant NEQS and World Bank Guidelines at sensitive receivers.

Significance of Residual Impacts

Residual noise impacts will remain negligible.

10.2.3 IMPACTS ON WATER QUALITY

Thermal Discharges

The cooling water used for heating the LNG at the ETPL LNG terminal at discharge is 3 degrees Celsius (ºC) warmer (at most) than at intake. This discharged heating water will be mixed with cooling water from power generation so that the temperature difference when discharged will be smaller. For the ETPL LNG Project the temperature of the discharged water shall be adjusted so that temperature discharges of more than 3ºC at the edge of a 100m mixing zone from the point of discharge will be avoided.

Discharges from ship engine cooling water at the FOTCO facility will be, at most, 3ºC warmer than intake. According to World Bank guidelines, discharge is required to be less than 3ºC above ambient. Discharges from the FOTCO FSRA would be approximately the same temperature as ambient. Water used for cooling machinery onboard the LNG carriers is expected to cool to within 1.5ºF (0.83ºC) of ambient temperature within 75 feet of the discharge point.

Sediment Dispersion

Maintenance dredging is part of the long-term operational plan for the eight terminal projects, as it is essential to maintain safe navigable depths for vessels transporting products (Oil, LNG, LPG, grains, containers etc.). Although elevated turbidity and sedimentation resulting from the dredging is considered short-term and localized, cumulative effects may occur from multiple projects conducting maintenance dredging in the same area.

Wastes and Pollutants

Like the ETPL LNG facility, grey water will be generated by operations of eight terminal facilities, which will be treated before discharge. All facilities have the potential for spillage and accidental release of fuels and oily wastes, and to produce

contaminated run-off during day-to-day operation. Although each spill contributes little on an individual basis, many spills over the long term can cause chronic concentrations of contaminants and degradation of water quality.

Existing/In-Place Controls

Dredging operations at the facilities will be monitored to ensure compliance with accepted standards.

The FOTCO LNG facility will treat its grey water using automatic biocide dosing, quality control and feedback systems. All sewage will be treated to NEQS prior to discharge. Discharges from ships will adhere to MARPOL 73/78 regulations.

Operation of the FAP terminal will not generate industrial effluents or solid wastes and hence no such waste will be discharged from the facility.

Other Terminal Operators (PIBT, Progas, QICT, IOCB, and FOTCO) are also bound to comply National Environmental Quality Standards (NEQS).

Periodic monitoring of water quality will be undertaken at each site to ensure compliance with applicable water quality standards.

Significance of Impacts

Significance of the impacts is considered moderate. An evaluation of impacts is summarized in Table 10.10.

Additional Mitigation Measures, Management and Monitoring

As Moderate impacts are deemed to be "Significant", additional mitigation is considered necessary.

For the Operational phase, quantitative thermal plume discharge modeling is recommended to determine the area/extent of mixing zone and confirm whether potential water quality impacts associated with the combined heating water discharges would be acceptable as per the applicable standards. Since the ETPL LNG Terminal ESIA states that there are no

Table 10.10 Evaluation of Cumulative Impacts to Water Quality from Operation of ETPL LNG with seven additional facilities (FOTCO LNG, PIBT, FOTCO Oil, FAP, QICT, Pro-Gas, IOCB) in operation.

Impact	Impacts to water quality from operation of ETPL LNG with seven additional facilities (FOTCO LNG, PIBT, FOTCO Oil, FAP, QICT, Pro-Gas, IOCB) in operation.				
Impact Magnitude	The magnitude of water quality impacts includes the immediate project areas as well as affected downstream water bodies				
Receptor Sensitivity	Low	Low Medium	**Medium**	Medium High	High
	Estuarine and marine ecosystems are sensitive to water quality. Inputs of effluent and sediment can change water quality characteristics of aquatic habitats that are vital to biota living there. Changes in temperature can also detrimentally affect the ecosystem.				
Impact Nature	**Negative Imp**	Positive	Neutral		
	Impacts to water quality are considered to be negative impacts				
Impact Type	Direct	Secondary	Indirect	**Cumulative**	Residual
	Cumulative impacts from eight concurrent projects are considered.				
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
	Cumulative impacts will last as long as these eight or more of the facilities remain in operation				
Impact Extent	**Local**	Regional	Global		
	Impacts would be limited to the area around the eight project sites as well as nearby downstream areas and local tidal creeks				
Impact Severity	No Change	Slight	Low	**Medium**	High
	Severity is ranked as Medium due to the potential for adverse effects on the sensitive aquatic ecosystem.				
Significance	Negligible	Minor	**Moderate**	Major	Critical
	The combination of a Medium-High Receptor Sensitivity and Medium Impact Severity results in an overall Moderate significance.				

NEQS with regard to temperature decreases in the aquatic environment, World Bank standards should be adopted to maintain the limits of discharge temperature within 3ºC of ambient. Further mitigation measures would be developed based on the results.

Water quality modeling is also recommended to characterize local hydrodynamic conditions and to act as a tool to predict impacts to water quality due to sediment dispersion associated with maintenance dredging works. The model would allow the assessment to be conducted in a quantitative manner and allow any unacceptable environmental impacts to be identified to IFC Standards. Further mitigation measures would be developed based on the results.

In addition, best practice procedures are recommended for dredging operations, such as the installation of silt curtains, the use of dredgers that result in lower turbidity (e.g. cutter-head dredges over hopper dredges and clam shells), etc.

The Project EMP should provide procedures for contractors to ensure minimization of untreated operational discharge, and spills and release and a monitoring program that maintains compliance with applicable standards.

Significance of Residual Impacts

Upon confirmation of compliance with applicable standards by modeling results, and if effluents are controlled to within applicable standards and turbidity from dredging is controlled to the maximum extent practicable through the use of best practices and feedback monitoring, residual impacts to water quality may be reduced to minor.

10.2.4 Impacts on Community Health, Safety & Security

Impacts to community health, safety and security during operation of all eight projects would be similar to those described in above section 10.1.1. The risk of accidents and injuries is associated with increase in vessel traffic from the operation of eight facilities. Overall, the workforce size will, however, be reduced during the operation of three LNG facilities as compared to the construction stages. However, the long-term operation of the three projects may attract newcomers seeking jobs and/or opportunities to provide goods and services. An assessment on the potential for population influx is needed to better understand the potential for impacts on disease transmission, psycho-social well-being, and public health infrastructure (including drinking water and sanitation services, health care services, etc.).

Existing/In-Place Controls

Existing controls and mitigation measures for impacts to community health will be adopted.

Significance of Impacts

Significance of impacts is expected to be Moderate. An evaluation of impacts is summarized in Table 10.11.

Additional Mitigation Measures, Management and Monitoring

As Moderate impacts are deemed to be "Significant", additional mitigation is considered necessary.

The additional studies, mitigation, management and mitigation measures recommended are also applicable and are recommended to be implemented.

Significance of Residual Impacts

Depending on the outcome of the additional studies, and with the implementation of the recommended additional mitigation, management and monitoring measures, residual impacts on community health, safety and security may be considered minor-to-moderate.

10.2.5 Impacts on Fisheries

Impacts to fisheries during operation of all three projects would be similar to those described under Section 10.1.1. Additionally, cumulative impacts would occur from vessel traffic and impingement and entrainment of fish and crustacean at the seawater intakes associated with the operation of all three facilities.

Existing/In-Place Controls

Existing controls and mitigation measures for impacts to fisheries are described under Section 10.1.1.

Significance of Impacts

Table 10.11 Evaluation of Cumulative Impacts to Community Health, Safety and Security from Operation of ETPL LNG with seven additional facilities (FOTCO LNG, PIBT, FOTCO Oil, FAP, QICT, Pro-Gas, IOCB) in operation.

Impact	Impacts to community health, safety and security from operation of ETPL LNG with seven additional facilities (FOTCO LNG, PIBT, FOTCO Oil, FAP, QICT, Pro-Gas, IOCB) in operation.				
Impact Magnitude	The magnitude of the impact encompasses all local people (residents and fishermen) that use the waterways in the Project area and communities that house workers (if planned).				
Receptor Sensitivity	Low	Low Medium	Medium	**Medium High**	High
	The sensitivity of the local people to health impacts is considered Medium-high due to the limited access to emergency medical care in the event of an injury or illness				
Impact Nature	**Negative Imp**	Positive	Neutral		
	Impacts to community health are considered to be negative impacts				
Impact Type	Direct	Secondary	Indirect	**Cumulative**	Residual
	Cumulative impacts from eight concurrent projects are considered.				
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
	Cumulative impacts, particularly the potential for accidents and injuries, will last as long as eight or more of the facilities remain in operation.				
Impact Extent	**Local**	Regional	Global		
	Impacts would be limited to the area around the eight project sites, including the popular fishermen's transit locations around the Buddo and Bundal islands.				
Impact Severity	No Change	Slight	**Low**	Medium	High
	Over the long-term, local fishermen may adjust travel routes to accommodate change in boating traffic, while increasing their familiarity with safety precautions around safety exclusion zones at the three new LNG project sites.				
Significance	Negligible	Minor	**Moderate**	Major	Critical
	The combination of a High Receptor Sensitivity and Low Impact Severity results in an overall Moderate significance				

Significance of impacts is expected to be moderate. An evaluation of impacts is summarized in Table 10.12.

Additional Mitigation Measures, Management and Monitoring

As Moderate impacts are deemed to be "Significant", additional mitigation is considered necessary.

A detailed fisheries study is recommended to be conducted to accurately determine impacts to fisheries resources and fishing operations. Consultation with local fishing groups is also recommended to be carried out throughout the project phases and included in the Community Grievance Mechanism. Further mitigation measures would be developed based on the results of the detailed study and local consultation.

Significance of Residual Impacts

Depending on the outcome of the additional study, and with the implementation of the recommended additional mitigation, management and monitoring measures, residual impacts may be reduced to minor to moderate.

10.2.6 IMPACTS ON ECOLOGY

As described under Section 10.1.1 above, the benthic habitat and communities within the Port Qasim area have been substantially impacted over the years. Continuous dredging for construction of projects and maintenance of channels, as well as contamination has led to degradation of benthic sediments and the communities that live in them. Although benthic in fauna are generally considered to recover rapidly, continual, periodic maintenance dredging of navigation channels during operation of the eight terminal facilities may not leave enough recovery time between dredging periods, leading to permanent or long-term impacts to these communities. See Section 10.1.1 for impacts on ecology from dredging.

The increase in large marine vessel traffic in the area may disturb local wildlife, particularly marine mammals. Though dolphins are known to frequent areas with marine traffic, high vessel traffic may cause movement away from the area. In the worst case, vessel strike may actually occur, though the likelihood is low due to the evasive maneuverings of dolphins.

Table 10.12 Evaluation of Cumulative Impacts to Fisheries from Operation of ETPL LNG with seven additional facilities (FOTCO LNG, PIBT, FOTCO Oil, FAP, QICT, Pro-Gas, IOCB) in operation.

Impact	Impacts to local fisheries from operation of ETPL LNG with seven additional facilities (FOTCO LNG, PIBT, FOTCO Oil, FAP, QICT, Pro-Gas, IOCB) in operation				
Impact Magnitude	The magnitude of the impact encompasses all local people who are dependent on fisheries for sustenance and/or livelihood.				
Receptor Sensitivity	Low	Low Medium	Medium	**Medium High**	High
	For the local people whose livelihoods depend on fishing, their sensitivity to impacts to fisheries is considered Medium-high.				
Impact Nature	**Negative Imp**	Positive	Neutral		
	Impacts to fisheries are considered to be negative impacts.				
Impact Type	Direct	Secondary	Indirect	**Cumulative**	Residual
	Cumulative impacts from eight concurrent projects are considered.				
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
	Cumulative impacts will last as long as eight or more of the facilities remain in operation.				
Impact Extent	**Local**	Regional	Global		
	Impacts would be limited to the area around the eight project sites as well as nearby downstream areas and local tidal creeks.				
Impact Severity	No Change	Slight	Low	**Medium**	High
	Severity is ranked as Medium. Although some fishing areas will be removed or fishing efforts hampered, other areas will still remain available to local fishers.				
Significance	Negligible	Minor	**Moderate**	Major	Critical
	The combination of a High Receptor Sensitivity and Medium Impact Severity results in an overall Moderate significance.				

Changes in water temperature at the discharge of the LNG facilities may also detrimentally affect marine fauna such as plankton, the base of the food chain.

Existing/In-Place Controls

Water quality monitoring and controls will be implemented as described under Impacts to Water Quality above.

Screens will be installed on the FOTCO cooling water riser inlets and inlet current speed will remain low to prevent the ingress of large marine fauna into the cooling water system.

Significance of Impacts

Significance of impacts is expected to be minor. An evaluation of impacts is summarized in Table 10.13.

Additional Mitigation Measures, Management and Monitoring

The additional studies, mitigation, management and mitigation measures recommended in Section 10.1.1 are also applicable and are recommended to be implemented.

Significance of Residual Impacts

Residual ecological impacts would be expected to remain minor.

10.2.7 UNPLANNED EVENTS

Impacts may also occur from unplanned, accidental, or natural disaster events or even acts of terrorism, resulting in spills, explosions, or large-scale leakages. The cumulative impacts from loss of containment from two or more of the LNG facilities due to an unplanned event such as those mentioned above is considered here. Each of the projects conducted dispersion modeling for emission of LNG vapors resulting from an emergency scenario such as failure of temperature control system due to collision, tsunami, or other unplanned emergency events.

LNG tanks store natural gas in liquid form at -160ºC at atmospheric pressure. Therefore, a crack of puncture of the container will not create an immediate explosion. Vapour clouds would form as the liquid warms and gas is released. The cloud would ignite only if it encounters an ignition source while concentrated within its flammability range. If released over

Table 10.13 Evaluation of Cumulative Ecological Impacts from Operation of ETPL LNG with seven additional facilities (FOTCO LNG, PIBT, FOTCO Oil, FAP, QICT, Pro-Gas, IOCB) in operation.

Impact	Impacts to local ecology from operation of ETPL LNG terminal with seven additional facilities (FOTCO LNG, PIBT, FOTCO Oil, FAP, QICT, Pro-Gas, IOCB) in operation.				
Impact Magnitude	The magnitude of the impact encompasses the local connected waterways that may experience impacts in water quality, and species that utilize the area (some local, others migratory).				
Receptor Sensitivity	Low	**Low Medium**	Medium	Medium High	High
	Estuarine and marine ecosystems are considered sensitive to water quality degradation. Marine mammals are sensitive to marine traffic activity and associated noise.				
Impact Nature	**Negative Imp**	Positive	Neutral		
	Impacts to ecology are considered to be negative impacts				
Impact Type	Direct	Secondary	Indirect	**Cumulative**	Residual
	Cumulative impacts from eight concurrent projects are considered.				
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
	Cumulative impacts will last as long as eight or more of the facilities remain in operation.				
Impact Extent	**Local**	Regional	Global		
	Although most impacts would be considered local, cumulative impacts to migratory species could have a regional extent.				
Impact Severity	No Change	Slight	**Low**	Medium	High
	Severity is ranked as Low. Ecological impacts are considered greater during construction.				
Significance	Negligible	**Minor**	Moderate	Major	Critical
	The combination of a Medium Receptor Sensitivity and Low Impact Severity results in an overall Minor significance.				

water, the LNG will typically float and then vaporize and dissipate. However, if large volumes are released on water, the LNG may vaporize too quickly, causing a rapid phase transition (RPT) which can range from a small pop to blasts large enough to potentially damage light-weight structures.

Cumulative impacts could occur (very large vapor cloud resulting in large fires or RPTs) if an unplanned caused loss of containment from two of more of the LNG facilities.

Existing/In-Place Controls

Appropriate separation distances will be implemented for the terminals and vessels. The facilities will be constructed away from adjacent industrial and residential areas. Safety zones will be established around LNG ships while underway based on vapour dispersion data and thermal radiation contours.

Fuelling operations will be conducted in a manner consistent with spill prevention and response plans, including visual monitoring. Fuel tenders will be instructed on the procedure for stopping, minimizing and cleaning up spills. The potential for spills and leaks will be reduced by implementing scheduled preventative maintenance for equipment. Fuel tanks will be provided with a secondary containment system (such as double hulls in tankers) to limit the potential impact of releases due to tank failure. Other safeguard systems using technologies such as alarms and back-up systems, and emergency shut-down systems may be used to control containment.

Fire and explosion risks will be minimized through use of gas detection and fire suppression systems.

To partially protect from storm hazards, the facilities will be constructed inland, away from the open shoreline. Shore hardening/protection features will also be installed.

Significance of Impacts

Although the event is considered unlikely to occur, the severity would be high if it did indeed happen. Therefore, the significance of impacts is expected to be moderate. An evaluation of impacts is summarized in Table 10.14.

Additional Mitigation Measures, Management and Monitoring

Table 10.14: Evaluation of Cumulative Impacts resulting from an Unplanned Event.

Impact	Impacts from major loss of containment from three or more LNG facilities as a result of an unplanned event.				
Impact Magnitude	The magnitude of the impact encompasses the area between Port Qasim west to the waters edge over the three facilities.				
Receptor Sensitivity	Low	**Low Medium**	Medium	Medium High	High
	The facilities will be constructed a safe distance from urban centers in case of explosive loss of containment. However, port infrastructure lies adjacent to the sites and the area contains sensitive habitats.				
Impact Nature	**Negative Imp**	Positive	Neutral		
	Impacts to ecology are considered to be negative impacts				
Impact Type	Direct	Secondary	Indirect	**Cumulative**	Residual
	Cumulative impacts from three concurrent projects are considered.				
Impact Duration	Temporary	**Short-term**	**Long-term**	Permanent	
	Cumulative impacts would range from short-term (explosion and fire) to longer term as habitats would take time to recover and developments would be financially affected for some time.				
Impact Extent	Local	Regional	Global		
	Impacts would be limited to the extent illustrated by the dispersion modeling for each project.				
Impact Severity	No Change	Slight	Low	Medium	**High**
	Assuming explosive loss of containment, impact severity would be considered high.				
Likelihood	Extremely Unlikely	**Unlikely**	Low Likelihood	Medium Likelihood	High Likelihood/Inevitable
	The potential for two or more plants to experience a major loss of containment at once due to an unplanned event is considered unlikely				
Significance	Negligible	Minor	**Moderate**	Major	Critical
	The combination of a Medium Receptor Sensitivity and Low Impact Severity results in an overall Moderate to Major significance.				

Primary, secondary and tertiary containment measures should be ensured through the implementation of appropriate designs, safety procedures and safeguard systems. Stringent safety zones should be strictly maintained and appropriate contingency, emergency and spill response, and evacuation plans be developed and implemented.

Significance of Residual Impacts

Though the implementation of appropriate mitigation measures and safeguards will greatly reduce the likelihood of the event occurring, the significance of residual impacts is still considered moderate to major as major explosive loss of containment will be severe in impact if it does happen.

11 Environmental Management and Monitoring Plan

11.1 Introduction

This section lays out the Environmental Management Plan (EMP) for the works concerning the Construction and Post-Construction including the Operation stages of ETPL LNG Terminal. The EMP is meant to provide an overall approach for managing and monitoring environment-related issues and to describe the institutional framework for implementing the EMP. The rationale of this EMP is to propose environmental protection commitments to protect the environmental values that may be affected by the development of the project and to assist the administering authorities to decide the appropriate approval conditions for the project.

The previous sections identified the environmental impacts of different activities during the construction and operation stages of the ETPL LNG terminal and mitigation measures to reduce the severity of the impacts. For successful environmental practices an essential requirement of the PEPA 1997 is to develop an environmental management plan (EMP) to guide through the procedures to the management and employees of the organization for continual improvement.

11.2 Need for EMP

The EMP is required to achieve the following objectives:

- Outlining measures to be taken during the implementation and operation of the ETPL LNG Terminal to eliminate or offset adverse environmental impacts, or reduce them to acceptable levels.
- Taking actions such as defining roles and responsibilities of the project proponent for implementation of EMP and identification of areas where these roles and responsibilities can be shared with other stakeholders.
- Defining the requirements for communication, documentation, training and management and implementation of mitigation measures.
- Taking actions required for assessing the effectiveness of mitigation measures employing the monitoring mechanism and identifying related parameters to confirm the effective implementation of these measures.

11.3 Scope of the EMP

The initial focus of the EMP is the protection of aquatic habitat and traffic management due to increase in visiting people as well as those activities under the direct control of ETPL management where activities may give rise to significant environmental impacts, the EMP includes a number of priority strategies and actions relating to these locations. The EMP also supports collaboration and joint actions with affiliated organizations, tenants and contractors within the ETPL's sphere of influence.

In line with the Provisions of Pakistan Environmental Protection Act, 1997 and rules and regulations framed there under, the following criteria will be used to determine priorities for attention:

- Impact on the physical and biological environment;
- Contribution to innovation and definition of best environmental practice;
- Compliance with statutory requirements and other environmental commitments;
- Availability of resources.

The EMP acknowledges the social and cultural dimensions of responsible environmental management alongside the biological and physical, reflecting a holistic view of the ETPL as a "human ecosystem".

The scope of the EMP includes the following functional areas:

- Management systems: Those systems employed in the management of the ETPL's operational activities. It will include financial systems; engagement and supervision of contractors; purchasing policies, etc.
- Knowledge systems: Those processes which build knowledge and capacity on environmental issues, principles and sustainable behaviors. It will include training; communications; campaigns; links with operational departments, etc.
- Energy management: The energy related aspects of the planning, design, construction, operation and maintenance of the ETPL's facilities.
- Water management: Aspects of supply, usage and disposal of water pertinent to the planning, design, construction, operation and maintenance of the ETPL's facilities.
- Materials management: Those services and activities which support the avoidance, resource recovery (e.g. reuse and recycling) and environmentally responsible disposal of solid and liquid waste materials.
- Planning, design and development: The planning, design and development of the ETPL's built form and associated infrastructure.
- Pollution prevention: Those aspects of planning and management which support minimization of air and water pollution and contamination of land resulting from daily routine activities.
- Transport: Programs, projects, systems and procedures which promote and support walking, cycling and public transport for trip-to-work, accommodation and other related travel.
- Biodiversity and open space: Those aspects of management and maintenance which support conservation and enhancement of biodiversity and environmentally sustainable use of open space across ETPL and other properties.

The proposed scope of the Project subject to the EMP includes all the main components of the Project

- Marine facilities and vessel approach lane out to existing shipping channel;
- LNG terminal, storage and re-gasification unit facilities;
- Pipeline lateral and directly associated facilities (natural gas and natural gas liquid laterals);
- Supporting facilities and infrastructure

11.4 EMP Process

The EMP consists of the following areas and defines the methods and procedures for its implementation.

- Organizational structure; roles and responsibilities of project personnel;
- Specific requirements of implementation of EMP;
- Mitigation or impact management matrix;
- Monitoring plan with emphasis on specific parameters to monitor.

In the preparation of this plan several aspects concerning the siting, designing, construction and operation of LNG terminal have been taken into consideration. Additionally management related issues have been provided to guide through the procedures.

11.5 ETPL's Commitment to Environment, Health and Safety

ETPL is committed to manage and operate its assets in a manner consistent with its core values to protect the health and safety of people and the environment and to comply with applicable Environment Health and Safety (SHE) laws, regulations and internal SHE standards.

The ETPL will establish environment, health & safety (SHE) department which will handle all environment related concerns and issues. The SHE manager will be the Head of SHE department and will be responsible for reporting to Chief Executive Officer. To support SHE management system, an SHE officer will be appointed to coordinate with the contractor during construction process and also monitor the activities at all the sensitive areas during the construction and operations stages of the terminal.

In this regard ETPL's Safety, Health and Environmental policy is being given here:



SAFETY HEALTH & ENVIRONMENTAL POLICY

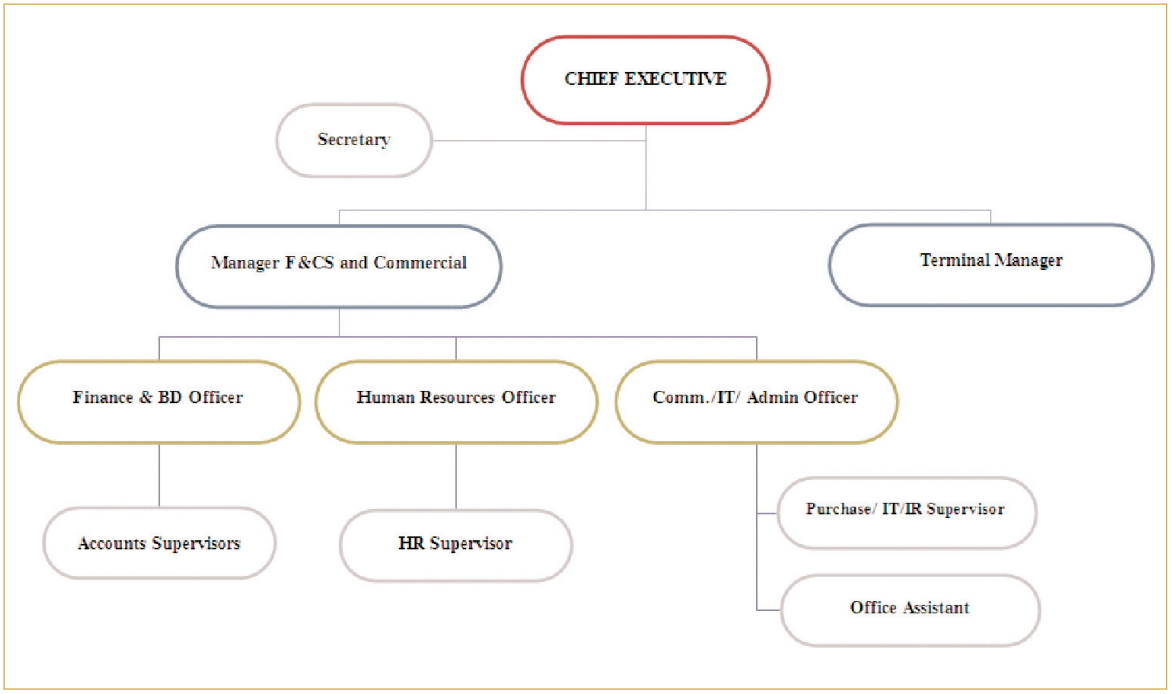
Engro Vopak Terminal Limited is firmly committed to protect the environment, the safety & health of its employees, customers, contractors, interested parties and the community while providing storage and handling services of bulk liquid and gaseous products.

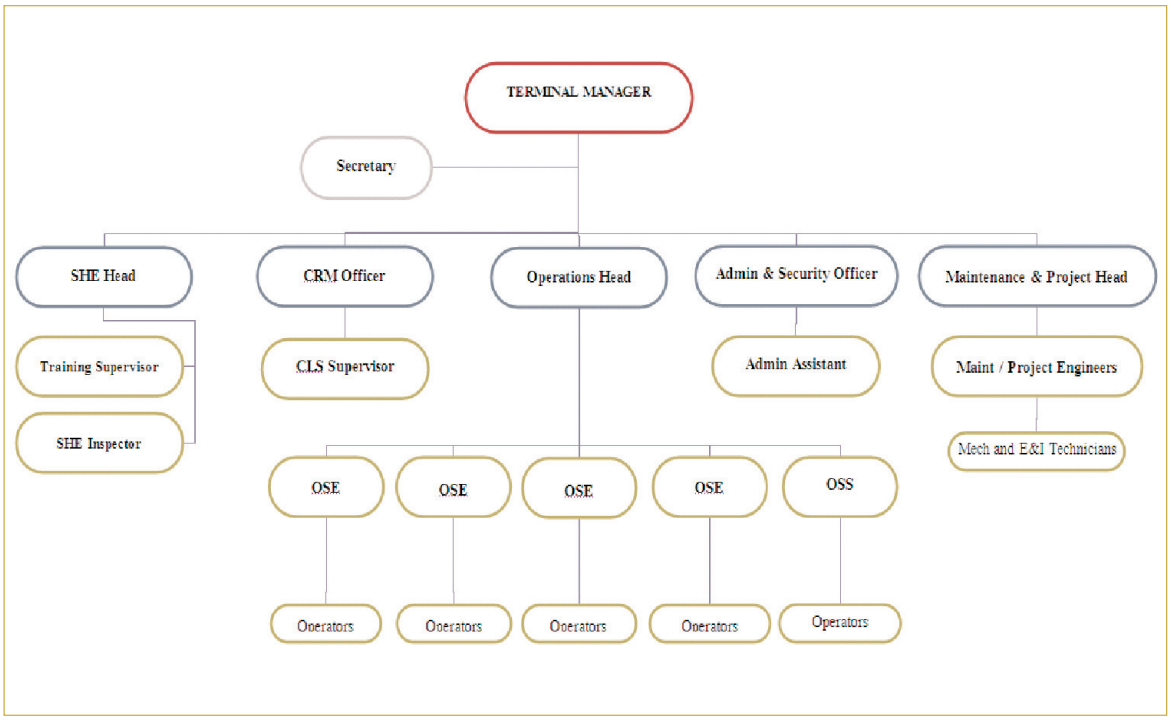
- We will continually improve our processes to manage safety, health & environmental performance and to prevent pollution to air, land and water.
- We will continuously work towards our goals of zero incidents and no damage to environment .
- We will strictly adhere to safety, health and environmental governing regulations as a minimum.
- We consider safety, health and environment a line management responsibility. Every manager will provide visible commitment and resources necessary to support the implementation of safety, health & environmental policies & its objectives.
- Every employee will contribute to the prevention of incidents by identifying, reporting, analyzing and controlling safety, health and environmental hazards. This will be supported by training programs adapted to their functions.

Issue: 02, July 2010

Sheikh Imran-ul-Haque
Chief Executive

11.6 ETPL ORGANIZATION STRUCTURE





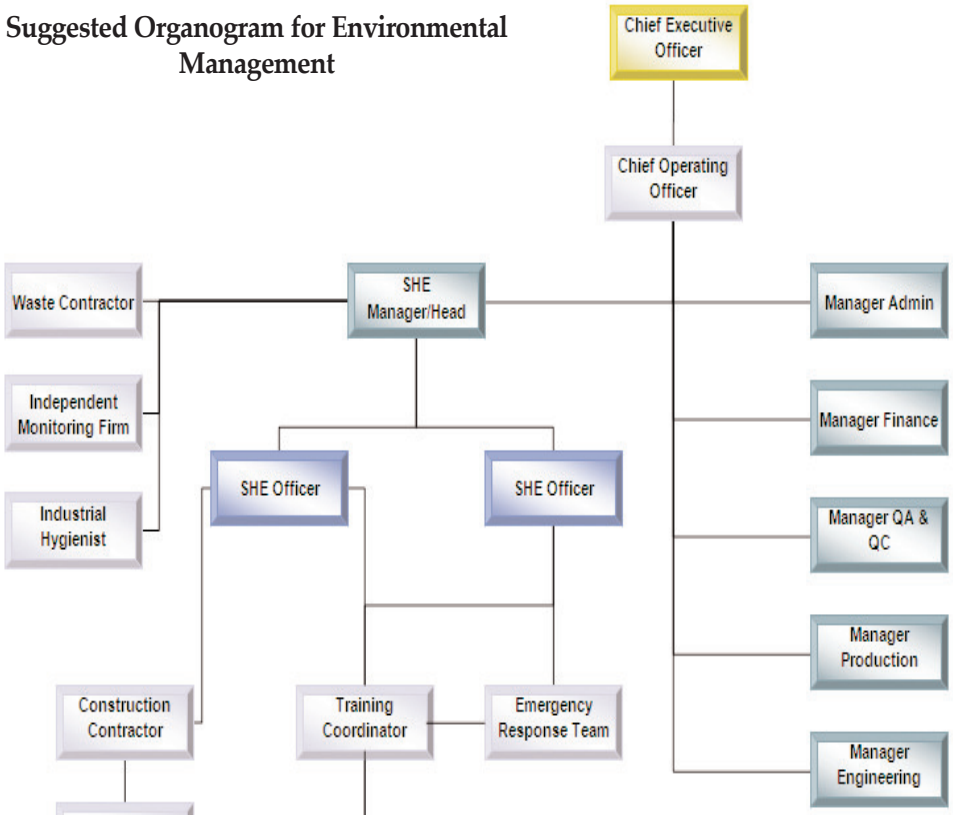
11.7 MANAGEMENT APPROACH

The environmental management will require specific approach in order to handle the issues effectively. SHE Head/Manager will assign the roles and responsibilities to be performed during the construction and operations stages of terminal. It is expected that a certain degree of redundancy is inevitable across all management levels, but should be in the order to ensure that compliance with the environmental management plan can be cross-checked.

Contractor and sub-contractor will work in environment friendly manner under the supervision of SHE department of ETPL. All the regulatory agencies including EPA will be contacted as and when required to get advice for environmental management and they will be kept informed of the environmental conditions of the area periodically by ETPL management and their contractors/sub-contractors.

Some of the approaches to be followed during the environmental management practices are given below:

Suggested Organogram for Environmental Management



Compliance with EMP will be the responsibility of ETPL Management at each stage of project. ETPL Management will ensure that all executive activities during construction stage do not create adverse environmental effects.

- Complying with the relevant legislation and regulations;
- Regularly reviewing of the impacts on the environment;

- Developing appropriate indicators to monitor core impacts;
- Setting appropriate annual objective, targets and publicly reporting on progress;
- Monitoring supplier's environmental management arrangements;
- Using sustainable materials (e.g. recycled paper and water based inks) for office supplies and environmentally safe raw materials with recycling options where appropriate;
- Communicating openly with internal and external stakeholder on environmental issues.

11.8 Roles & Responsibilities

Environmental management will be the integral part of corporate policy of ETPL. Therefore, committing to reduce the environmental impacts will reflect the management approach and belief that good governance and performance in this area is synonymous with running a well managed efficient business. Overall responsibility for environmental performance rests with the Chief Executive Officer of ETPL while the daily management will be performed under the direction of Manager SHE. SHE officer and contractor will execute environmental management under the supervision of Manager SHE during construction and operations. A brief make-up of the roles and responsibilities of the system is given below:

11.8.1 Chief Executive Officer

The Chief Executive Officer (CEO) will regulate environmental management plan. Some of the key roles and responsibilities of CEO are given below.

- To consider and react to issues and solutions proposed by the SHE Department;
- To cooperate and consult the relevant environmental agency to perform better;
- To evaluate the progress of development and implementation of EMP;
- To approve any change in decision-making and authorities in consultation with SHE Head/Manager, if appropriate.

11.8.2 SHE Head/Manager

The success of EMP depends on proper and effective management provided by SHE manager. Following are some of the roles and responsibilities assigned to Manager SHE.

- To ensure that the points of views of staff, contractors and SHE officers are considered and placed likewise in the EMP;
- To identify issues and propose solutions for inclusion in the EMP review process;
- To improve coordination and exchange of information between top management, employees, and contractors;
- To contribute to actions required to deliver the management plan and ensure its continued development;
- To review EMP every year, tracking issues and changing EMP in accord with the solutions and suggestions;
- To monitor the progress of development and implementation of the EMP.

11.8.3 SHE Officer

The role of SHE officer will be authorized by SHE Head/Manager. The responsibilities of SHE officer will include:

- To integrate, as far as possible, the aims and objectives of different users within an agreed plan;
- To maintain a balanced, holistic approach to the solution of concerned issues in accordance with and compliance of legislative requirements;
- To provide professional guidance on questions relating to the environment management and issues raised by contractors/relevant personals;

- To develop the EMP process by its implementation.

11.9.4 Contractor

The contractor will carry out field activities as part of the proposed LNG terminal project that includes relevant and subsidiary construction work. The contractor will have certain liabilities under the environmental laws of the country, which will be specified in the contract document with the ETPL Management.

The overall responsibility for all matters pertaining to environment will be that of the organisational head of assigned contractor. The role and responsibilities of the contractor consist of the following:

- To carry out construction activities in environmentally sound manner;
- To coordinate with the SHE officer to resolve issues arising during construction phase;
- To manage and implement environmental management practices as given in the impact assessment report as well as SHE polices adopted/prepared by ETPL;
- To administer construction crew and reduce the environmental risks;
- To appoint a dedicated environment officer to understand and handle environmental issues more easily in coordination with SHE officer.

11.10 Training

All employees will be trained appropriately to work on EMP effectively. Employees training will provide workers with information on minimising waste generation. The SHE Head/Manager will determine the training requirements in consultation with contractor among the staff of both construction contractor, supervision consultant, Environment Specialist and ETPL's Manager SHE.

- Trainings identified in EMP are given below,
- Site induction course
- Training for emergency response and preparedness
- Training for familiarization with site environmental controls
- Specific environmental training for relevant employees e.g. installing erosion and sedimentation controls, daily checks to maintain controls, cleaning up pills, waste minimization.

The Plant and Terminal will have

(i) Distributed Control System to monitor and control the plant process and operation,

(ii) Fire and gas detection and alarm system, and

(iii) An emergency shut off system. Each of these systems will be separated from each other, to provide data and communication transmission.

11.11 Communications

For effective monitoring, management and documentation of the environmental performance during the operation, the Health, Safety and Environmental (SHE) matters will be discussed during daily meetings held on site. Environmental concerns raised during the meetings will be mitigated after discussions between the SHE officer and the contractor. Any issues that require attention of higher management of ETPL will be communicated to them for action. The SHE department and the contractor will also prepare a weekly environmental report. Duplicates of the report will be provided to the higher managements of ETPL and of the contractor. Communication will play a vital role in good management practices. Steps given below will assist in effective communication and documentation.

A. Kick-off Meeting

The aim of organizing the kick-off meeting is to define the environmental responsibilities, awareness to EMP to the managing staff and to streamline the work plan according to the EMP. This meeting will be arranged prior to commencement of activities.

B. Quarterly Meetings

Initially quarterly meetings will be held after kick-off meeting however if situation demands for monthly meetings, it will be rearranged accordingly. Aim of this meeting is to review the progress of activities performed, explore ideas and problems, and discuss about the progress in acquisition and analysis of information. Deadlines are re-evaluated in it and if necessary, the project program is revised in these meetings.

C. Peer Review

The aim of this review is to predict and modify the conclusions and interpretation of assessment phases in the light of other professional opinions that mainly not involved in the proposed project, but just for the provision of a critical appraisal of the style and expression of documentation produced.

D. Minutes of Meetings

In the end of quarterly meetings, minutes will be issued which comprises of the discussion made in the meeting, issues discussed and decisions taken with the time frame for their implementation. Main points of minutes for general employees may be incorporated in the record register. These meeting minutes will also be provided to the higher authorities of ETPL and the contractor for their own record.

E. Management, Co-ordination and Information

Although ETPL is keen in environmental management practices and already have plans to adopt preventive measures with environmental considerations, it can be said that any weakness in organisational structure, management, communication, lack of information and coordination may lead to environmental risk. The following are some of the guidelines to handle the risks:

- Ensure that management authorities have access to high quality, up-to-date and relevant data for decision-making.
- Ensure that staff associated with implementation work and SHE department have access to relevant data for implementation of EMP.
- Ensure involvement of all associated groups, management authorities and associated staff in the management plan process.
- Ensure highest-level liaison and co-ordination between contractor and ETPL staff.
- Ensure that HAZOP study has been conducted

HAZOP will be conducted to ensure safety of operations and the HAZOP will be attended by FSRU owner, LNGC Owner, ETPL, etc. Furthermore operating and commissioning procedures will be prepared in line with the industry and with the aid of FSRU owners who have ample experience of LNG Handling and operations.

11.12 Implementation Stages of EMP

Success of EMP will rest with its implementation. For that matter it will be necessary to establish an SHE department and organise a team with direct responsibility for putting the plan into practice. This set-up needs to be provided with adequate resources and an office base to execute the EMP in three stages, which include planning and designing; construction and operation.

11.12.1 Planning and Design of ETPL LNG Terminal

Implementation of EMP needs to take a start at the inception stage to handle the environmental issues much before they arise. The following are the three main components to consider in an EMP prior to start of construction:

A- Design of ETPL LNG Jetty

It describes the ETPL project in terms of location, geology, seismicity, magnitude; infrastructure facilities available and their deficiencies; along with the mechanism for doing so. If any design parameter changes at the time of approval, ETPL will assess the environmental impacts

Table 11.1: Specific Responsibilities for Management & Coordination

S.No	Strategic Objective	Proposed Implementation Process	SuggestedIn-charge	Suggested Priorit
01	To ensure high level of necessary information exchange.	■ Make review document available to interested parties. ■ Disseminate relevant information held by SHE department among the staff. ■ Produce newsletter for publication annually for general awareness in all staff. ■ Meetings using input from previous reports, advices receive from Stakeholders	■ SHE Head/Manager ■ SHE Officer ■ SHE Head/Manager ■ SHE Head/Manager	■ High ■ High ■ On-going ■ High
02	To ensure management plan is implemented, monitored and reviewed.	■ Adopt management structure as proposed. ■ Appoint full-time officer(s) with responsibility for long term management and accurate monitoring. ■ Examine annual progress report and review with respect to the monitoring progress. ■ Conduct self-monitoring regularly.	■ SHE Head/Manager ■ SHE Manager ■ CEO and SHE Head/ Manager ■ SHE Head/Manager	■ High ■ High ■ On-going ■ High
03	To improve decision-making process for management.	■ Develop an appropriate form of management process, specific to the environmental issues ■ Develop a fully comprehensive database of impact and mitigation understandable for the management.	■ SHE Officer ■ SHE Manager/ SHE officer	■ High ■ High
04	To ensure co-ordination between contractor and ETPL.	■ Obtain support for a Memorandum-of-Understanding between management and Contractor for the implementation of ■ EPA Requirements ■ EMP ■ Continue regular liaison between management of ETPL and contractor.	■ SHE Head/Manager ■ SHE Officer	■ High ■ On-going
05	To develop strategic policies for better environmental management.	Develop strong coordination between SHE department and top management.	■ SHE Head/Manager	■ High

that may arise from such changes. If the impacts are found to be different and in excess of those mentioned in the report, they will develop effective mitigation measures to address the changes to minimise the residual impacts and seek approval for the required change from SEPA as well as PQA and any other regulatory authority, if required.

B- APPROVALS

ETPL and contractor will, besides obtaining NOC from SEPA obtain relevant clearance and necessary approval from

the government and other agencies (Explosives Dept. etc) prior to commencing construction and operation. Furthermore, issuance of NOC will require the ETPL to plan for undertaking continuous monitoring, including self-monitoring and reporting. ROW for laying the Pipeline should be acquired from PQA, NHA and Railways where appropriate after a detailed route alignment survey.

C- Contractual Provisions

The requirements of environmental impact assessment with respect to mitigation measures shall be incorporated in the construction and operations plans and procedures. This will make it mandatory for the contractor to follow procedures and comply with environmental regulations.

11.12.2 Construction and Operation Phase

In order to implement EMP successfully during the construction and operation phase, it is necessary to adopt mitigation measures, monitoring plan and emergency procedures in letter and spirit. Training will be required at each step and phase. Changes in management processes will be documented and made available to the employees.

A- Mitigation Plan

The environmental impacts and remedial measures, as well as responsible persons designated to ensure adoption of the mitigation measures are given in the mitigation matrix Table 11.2. Mitigation matrix is basically a mitigation plan. These impacts and mitigation measures have already been given in detail in the earlier chapters. The matrix presented here additionally provides the responsibility clause for contractor and proponent for adoption of mitigation measures throughout the project.

B- Emergency response plan

A Project-specific Emergency Response Plan will be developed which primarily relates to the different construction activities of the Project. It supports the EMP and addresses actions and required responses all ETPL personnel, employees and contractors.

Emergency response management will be provided by a small team of senior managers (the control committee) who in turn will direct all response activities through the Emergency response unit, plant security, communications, public relations, safety and environmental affairs and material procurement departments. Each of these departments will have specific responsibilities to perform in the event of an emergency.

C- Possible Risk

I. Internal Risks arising from operational conditions or human error that could result in personal accidents, spills or fires, such as:

- Uncontrolled gas leak (RLNG and liquefied natural gas) into the atmosphere.
- Fire/explosions.
- Hydrocarbon (gasoline, diesel).
- Chemical product spills, which may or may not be present at site.
- Occupational accidents (serious or fatal), due to product contamination, failure to comply with operating rules and procedures, negligence of the personnel, falls, internal traffic accidents, burns, acts of God, bad use of equipment and personal protection items.
- Environmental Contamination (due to gas leaks into the environment, product spills on land and in the sea).

II. Natural Risks that may affect the facilities and their resulting damage to property and the personnel.

- Strong earthquake
- Tsunamis (flood)
- Typhoon/Cyclone
- Lightening

III. External risks arising from delinquent actions, terrorism or vandalism.

IV. Personnel Transportation Risks

All personnel of the Plant must be instructed that in the event of automobile/barges/boat accidents while the personnel is being transported to/from the Plant, using own or third-party transportation contracted by the

Table 11.2 (a): Mitigation Matrix (Overall)

S.No	Affected areas	Possible mitigation measures	Responsibility	Monitoring Frequency
1		Smoking should be prohibited at all sites	SHE Officer	Continuous Monitoring
2		Proper servicing of vehicles, provision of exhaust mufflers	Contractor	Weekly Monitoring
3	Air Quality	All equipment should be properly tuned	SHE Officer and Contractor	Monthly Monitoring
4		Fire-fighting equipment should be available in all activity areas at all times	SHE Manager	Weekly Monitoring
5		Staff should be provided with personal protective equipments	SHE Manager	Continuous Monitoring
6		Safety valves should be provided with silencers	Managers (Engg. & SHE)	Continuous Monitoring
7		Machinery and equipment should be housed in separate enclosures	Managers (. & SHE)	Continuous Monitoring
8	Noise	Working hours should be adjusted so as not to exceed 8 hours exposure in a single shift.	SHE Officer	When it is required
9		Earthmoving equipment should be kept in good condition by proper maintenance and servicing	SHE Officer	Weekly Monitoring
10		Use of horns should be prohibited within the activity area	SHE Officer and Contractor	Continuous Monitoring
11		Construction activities should not be extended beyond designated buffer zones	SHE Officer and Contractor	Continuous Monitoring
12		Natural and existing clearings should be used to the extent possible	SHE Officer and Contractor	Continuous during Construction
13		Fuel, oil and other hazardous materials if stored on land area, should be provided with impervious lining	SHE Manager SHE Manager	When required
14		Combustible and explosive material should not be stored in storage area	SHE Officer	Continuous Monitoring
15		Fuel tanks and hazardous material should be marked appropriately		Continuous Monitoring
16	Soil	Fuel storage areas should be checked regularly to identify leakage	SHE Officer	Continuous Monitoring
17		Safety equipments and utensils should be available at site at all times	SHE Manager	Weekly Monitoring
18		Vehicle Maintenance Yard should be developed at a designated location during construction work	SHE Officer and Contractor SHE Manager and Officer	Continuous upto Construction Completion
19		Where possible, segregation of solid waste during handling should be followed to manage it effectively	Contractor	Weekly Monitoring
20		Contractor should follow ETPL's emergency response plan		Continuous Monitoring
21		Machinery movement should be restricted to the construction corridor	Contractor	
22		Restoration of sites after completion of project should be mandatory	Contractor	

Table 11.2 (a): Mitigation Matrix (Overall) [Continued…]

S.No	Affected areas	Possible mitigation measures	Responsibility	Monitoring Frequency
23	Water Quality	Temporary latrines should be located at a suitable distance from water bodies	Contractor	At times of placement of latrines
24		Sewage should be treated appropriately at each unit	SHE Manager	Monthly Monitoring
25		Vehicle cleaning should be prohibited near water bodies	SHE Manager	Continuous Monitoring
26		Construction machinery should be kept off the water resources to the extent possible	SHE Officer	Continuous Monitoring
27		Weekly/monthly water/wastewater/groundwater quality monitoring should be conducted throughout construction/operation	SHE Officer	Weekly (Construction) Monthly (Operation)
28		Treated wastewater of acceptable quality, may be reused for processing construction material	SHE Officer and Contractor	Monitoring if required
29	Solid Waste	Solid waste should be collected and stored in environmental friendly manner	SHE Manager	Weekly Monitoring
30		Certified solid waste contractor should be hired for disposal of waste	SHE Manager	Weekly, if required
31		Solid waste should be kept in closed container	SHE Officer	Weekly Monitoring

Table 11.2(b): Mitigation Matrix (Pipeline)

No.	Project Component or Impact	Action	Responsibility	Timing
1.	Laying of Pipeline	Ensure that unnecessary damage to the ground surface and blockage of natural drainage is avoided.	Contractor	Construction Phase
		Ensure that a contingency plan is in place to mitigate leakages from the system and rupture of the pipeline after exiting ETPL boundary limits	SSGC	Operation Phase
		Ensure proper and timely maintenance of equipment to minimize oil or fuel leakages from construction machinery. Clean-up will be undertaken in the event of an oil spill larger than half a liter. This will include removal of contaminated soil from the area and disposal at proper location.	Contractor	Construction Phase
		Ensure that after laying the NG pipeline, the disturbed surface is restored as much as possible to its pre-project conditions. The ditch will be backfilled and the RoW graded in a manner that restores the natural contour of the ground and allows natural surface drainage. The backfill will be crowned to a height of not less than 200 mm and not more than 300 mm above and at the adjacent ground surface.	Contractor, ETPL/ SSGC	Post Construction Phase
		Ensure that steep cut and fill is avoided in all such cases where the risk of slope failure is high.	Contractor, SSGC	Construction Phase
		Ensure that unusable soil spoils are disposed of at the location specified by PQA & SSGCL. These locations shall be selected to avoid slopes, watercourses, water ponds, or any area where the dumping of waste soil may cause adverse effect on the terrain.	Contractor, SSGC	Post Construction Phase

Table 11.2 (b): Mitigation Matrix (Pipeline)

No.	Project Component or Impact	Action	Responsibility	Timing
1.	Laying of Pipeline	Ensure that fuels, oils, and other hazardous substances are handled and stored according to standard safety practices.	Contractor, SSGC	Construction & Operation Phase
		Ensure that the construction contract include provisions to limit the removal of trees/plantation to the bare minimum. Trees will be planted at 1:5 in consultation with an Independent Monitoring Consultant (IMC) at an area identified by PQA.	ETPL/SSGC, IMC	Construction and Post Construction Phase
		Ensure that a spill prevention and response plan is prepared and implemented in case of any such incident.	ETPL / SSGC	Construction & Post Construction Phase
		Ensure that photographs of the RoW and other project sites are taken prior to commencement of field activity to be used for reference when restoring the site. Ensure that the leakages are keenly monitored.	ETPL /SSGC IMC	Before and after Construction Phase Construction Phase
2	Impact on Air Quality	Ensure that the dirt road routinely used by a community for accessing the project site, is sprinkled with water regularly to reduce fugitive dust emissions resulting from heavy vehicular traffic.	Contractor	Construction Phase
		Ensure that Personal Protective Equipments (PPEs) are provided to the workers involved in construction activities to safe-guard the health of the workers.	Contractor, ETPL / SSGC	Construction Phase
		Ensure that construction materials are transported in covered vehicles.	Contractor	Construction Phase
		Ensure that all equipment, generators, and vehicles used during the project are properly tuned and maintained in good working condition, in order to minimize exhaust emission levels.	Contractor	Construction Phase
		Ensure that periodical pipe inspections are undertaken to identify and register possible pipe fractures.	ETPL / SSGC	Operation Phase
		Ensure that leak detection systems are installed at strategic locations.	ETPL / SSGC	Operation
3	Impact due to high Noise	Ensure that all equipment, generators, and vehicles used during the project are properly tuned and maintained in good working condition, in order to minimize noise emission levels.	ETPL / SSGC, IMC	Construction Phase
		Ensure that the vehicles and equipment are regularly monitored for the performance of the noise reducing equipments. Vehicles whose noise levels exceed the minimum required level must be restricted for use in the construction activity area.	Contractor	Construction Phase
		Ensure that all work is carried out during day time.	ETPL / SSGC	Construction Phase
		Ensure that operators are instructed to keep the noise level at acceptable limits so that the marine fauna is disturbed to the least. Ensure that a speed limit of 25km/hr is enforced for project vehicles passing through populated areas.	ETPL / SSGC	Construction Phase
4	Impact on Water Resources	Ensure that the oil-contaminated water (after hydro-testing) is properly disposed of. Appropriate size of mesh will be used to filter out debris including metallic residues. Efforts will be made to reuse this filtered water as far as possible.	Contractor	Post Construction Phase

Table 11.2 (b): Mitigation Matrix (Pipeline)

No.	Project Component or Impact	Action	Responsibility	Timing
4	Impact on Water Resources	Ensure that sewage generated from construction camps is appropriately treated before being discharged into the existing sewerage system.	Contractor	Construction Phase
		Ensure that heavy construction machinery is kept off the waterfront to the extent possible.	Contractor	Construction Phase
		Ensure that the RoW including the coastline is regularly inspected to monitor erosion and spills.	IMC	Construction Phase
		Ensure that erosion and sediment-control measures are employed where necessary.	Contractor, ETPL / SSGC	Construction Phase
		Ensure that all the disturbed areas including the pipeline trench, the storage and work place are restored to the original contour as far as possible.	Contractor	Post Construction Phase
5	Impact on Wildlife	Ensure that a No Hunting, No Trapping and No Capturing policy is enforced by the contractor and monitored by supervision consultant.	Contractor, Supervision Consultant	Construction Phase
6	Impact on Existing Infrastructure	Ensure that existing buried pipelines are identified in the project area through a detailed topographic survey to set the boundary of RoW.	Contractor, ETPL / SSGC	Before Construction Phase
		Ensure that prior approval for right of way is obtained from relevant authorities before the start of pipeline laying activities.	ETPL / SSGC	Before Contractor, Supervision Consultant Construction Phase
		Ensure that damage to existing infrastructure is avoided as far as possible and any damage caused to the infrastructure due to construction activities is promptly repaired.	ETPL / SSGC	Construction Phase
7	Socioeconomic Impacts	Ensure that the RoW is aligned to avoid residential areas, settlements, houses and buildings.	ETPL / SSGC	Design Phase
		Ensure that the land ownership is, if necessary, determined with extreme care.	ETPL / SSGC	Before Construction Phase
		Ensure that written agreements are made for any temporary or permanent land acquisition.	ETPL / SSGC	Before Construction Phase
		Ensure that compensation is paid according to the written agreements. Ensure that the acquired land is clearly marked and the actual land take is limited to the agreed limits.	ETPL / SSGC	Before Construction Phase
		Ensure that continuous liaison is maintained with the affected community and their concerns are addressed appropriately, if necessary.	ETPL / SSGC	Before and during Construction Phase
		Ensure that noise from campsites and construction sites is minimized using appropriate means (silencers, barriers, etc.) as required and noise levels is checked regularly at the campsite and construction sites.	Contractor, IMC	Construction Phase
		Ensure that the camps are constructed at least 500 m from any settlement.	Contractor	Construction Phase
		Ensure that no construction works is carried out during the night.	Contractor	Construction Phase

Table 11.2 (b): Mitigation Matrix (Pipeline)

No.	Project Component or Impact	Action	Responsibility	Timing
7	Socioeconomic Impacts	Ensure that the construction activities should not block the existing roads and tracks. If unavoidable, alternate routes will be provided in consultation with the affected people and concerned department.	Contractor	Construction Phase
		Ensure that the liaison with local community is maintained by project proponent and contractor and the communities are informed of the construction activities well in advance.	ETPL / SSGC	Construction Phase
		Ensure that the construction area is cordoned off, and no irrelevant personnel are allowed inside.	Contractor, ETPL / SSGC	Construction Phase
		Ensure that safe driving practice is enforced for the project vehicles. A speed limit of 25 km/hr will be enforced for the project vehicles passing through settlements.	Contractor, ETPL / SSGC	Construction Phase
		Ensure that all supplies (water, fuel, construction materials, camp supplies, etc.) are sourced in a manner not adversely affecting the local population. The capacity and existing demand on the sources will be estimated, and these will be used for the project needs only when surplus capacity is available.	Contractor, ETPL / SSGC	Construction Phase
		Ensure that the construction crew undergoes medical screening before being deployed in the field.	Contractor,	Construction Phase
		Ensure that all sites of archaeological, historical, cultural and religious significance are avoided and if any artifacts are discovered during the excavation, the relevant authorities (Department of Archaeology and Museums, Government of Pakistan, Karachi) will be contacted.	Contractor, ETPL / SSGC	Construction Phase

D- Risk management

The management of contingencies at the natural gas re-gasification LNG import terminal plant is based on:

- Early detection (alarms, detectors, setting off of safety elements);
- Immediate automatic reaction (feed shut-off valves, either of the fluid, electric process or other).
- Confinement of emergency area.
- Application of the adequate response procedure
- Follow-up and monitoring

I. Evacuation Plan

The following alarm signal(s) will be used to begin evacuation of the facility (check all which applies):

- Bells/Horns/Sirens
- Verbal Public address system

Emergency Contacts	Phone No.	Address
Fire/Police/Ambulance		
State Office of Emergency Services		
National Response Centre		
Post-Incident Contacts		
Fire Department Hazardous Materials Program		
EPA Department of Toxic Substances Control		
Cal-OSHA Division of Occupational Safety and Health		
Bay Area Air Quality Management District		
Regional Water Quality Control Board		
Emergency Resources:		
Poison Control Centre		
Nearest Hospital		

company, they must immediately notify the Environment, Health and Safety Environment Department (SHE) so that it will provide the necessary assistance for the injured, and proceed to issue notices not only to the health care centres but also to external support institutions (National Civil Defence, Police, Fire, Fighters, etc).

- Other (specify)
- Evacuation map is prominently displayed throughout the facility with assembly point(s), routes and roles and responsibilities for all employees.

Note: A properly completed Site Plan satisfies contingency plan map requirements. This drawing (or any other drawing that shows primary and alternate evacuation routes, emergency exits, and primary and alternate staging areas) must be prominently posted throughout the facility in locations where it will be visible to employees and visitors.

II. Emergency Equipment

The Hazardous Materials Storage Ordinance requires that emergency equipment at the facility be listed.Table 11.3 meets this requirement.

III. Trainings

a. Personnel Trainings General workers will be trained as per following procedures:

Personnel Training Procedures

- Internal alarm/notification
- Evacuation/re-entry procedures & assembly point locations
- Emergency incident reporting
- External emergency response organization notification
- Location(s) and contents of Emergency

b. LNG Handlers will be annually trained in the following manner:

- LNG Handling Training Procedures
- Safe method for handling and storage of LNG
- Location(s) and proper use of fire and spill control equipment
- Spill procedures/emergency procedures

c. Emergency Response Team members are capable of and engaged in the following:

Emergency Response Training Procedures

- Personnel rescue procedures
- Shutdown of operations
- Use, maintenance, and replacement of emergency response equipment
- Refresher training which is provided annually
- Emergency response drills which are conducted at least quarterly

IV. Emergency Response training

Develop and practice a spill clean-up procedure including where to find emergency equipment and how to use it. Make sure all people on site are aware of emergency telephone numbers to call in the case of a large spill. Spill kit equipment on site should include: booms to contain liquids, material to prevent spills into drains, and material to absorb spills. Keep this absorbent material in a clearly labeled and easily accessible place.

a. Response Strategy

Upon the occurrence of the emergency, the Plan will be developed under the following conditions:

- First Stage: Notification
- Second Stage: Initial assistance/rescue
- Third Stage: Response operations
- Fourth Stage: Evaluation of the Plan and damages

a. First Stage: Notification

Internal Communication: Radio communication systems, channels and frequencies will be established for the

Table 11.3: Emergency Equipment Inventory

Equipment Category	Equipment Type	Location	Description
Personal Protective Equipment, Safety, and First Aid Equipment	• Cartridge Respirators • Chemical Monitoring Equipment (describe) • Chemical Protective Aprons/Coats • Chemical Protective Boots • Chemical Protective Gloves • Chemical Protective Suits (describe) • Face Shields • First Aid Kits/Stations (describe) • Hard Hats • Plumbed Eye Wash Stations • Portable Eye Wash Kits (i.e. bottle type) • Respirator Cartridges (describe) • Safety Glasses / Splash Goggles • Safety Showers • Self-Contained Breathing Apparatuses (SCBA) • Other (describe)		
Fire Extinguishing Systems	• Automatic Fire Sprinkler Systems • Fire Alarm Boxes / Stations • Fire Extinguisher Systems (describe) • Other (describe)		
Spill Control Equipment and Decontamination Equipment	• Absorbents (describe) • Berms / Dikes (describe) • Decontamination (describe) • Emergency Tanks (describe) • Exhaust Hoods • Gas Cylinder Leak Repair Kits (describe) • Neutralizer (describe) • Over-pack Drums • Sumps (describe) • Other (describe		
Communications and Alarm Systems	• Chemical Alarms (describe) • Intercoms / PA Systems • Portable Radios • Telephones • Underground Tank Leak Detection Monitors • Other (describe)		
Additional Equipment (Use Additional Pages if Needed)			

command post, alternative posts and for the personnel that forms part of the response Brigade.

Furthermore, message forms will be established to record at least the following information: Name of informant, location and place of the emergency, number of people affected and, if possible, an estimate of the type of injuries and/or damages, among others.

External Communication: In the event of spills, leaks or discharges into the sea or the beach, the Harbour Master's Office of the area of influence must be informed through the fastest means: telephone and fax; and also using the forms of the General Harbour Master's and Coast Guard Bureau.

- Local Authorities will be advised by telephone.
- In the case of serious or fatal accidents, the Government Attorney General's Office and the National Police will be notified in coordination with the Legal Counsel.
- The relatives of the injured person, as soon as he is evacuated to a hospital.
- To the extent possible, the press will be notified after the accident has been investigated and by the person designated by Management.
- In the case of an accident that has affected the facilities; the Insurance Company will be notified in Coordination with the Administration and Finance Management.

b. Second Stage: initial assistance/rescue

A joint evaluation will be made of the status of the event, the conditions of the site, the environmental characteristics that warrant a safe development of rescue actions, first aid and transportation of the injured to a medical unit.

Trained emergency teams must be prepared to act as required, and a reserve team must be available. All personnel who are not essential to fight the emergency must be evacuated to a safe place where there must be communication equipment available to count the number and condition of the personnel. In the event of fire, the execution or fighting phase will be implemented immediately.

c. Third stage: Response Operations

Response Operations refer to:

- Fire fighting using extinguishers or pressure water network or foam.
- Spill control (of lubricants or fuel using absorbing material) or confinement.
- Dispersion of gas clouds. Access control to affected area.
- Medical assistance and evacuation of injured personnel.
- Evacuation of all personnel if their lives are in danger (in the event of earthquakes, tsunamis or other factors).
- Application of a monitoring program and a mitigation plan.

d. Fourth Stage: Evaluation of the Plan and of damages

Once response operations have concluded, the development and results of the Plan must be evaluated in order to issue recommendations that allow correcting deficiencies for the purpose of improving response operations. These recommendations will then form part of revision and subsequent annual approval of the Contingency and Risk Prevention Manual. A record of damages will be prepared as part of the final emergency report. The resources used, lost and recovered will be detailed in said register.

B. EMERGENCY RESPONSE MANUALS

Including the proponent's commitment to prepare written emergency plans for the pipeline, plant and marine terminal to cover emergency situations that could occur, based on the results of a Quantitative Hazard and Risk Assessment. It was agreed that Emergency Response Manuals will be developed for:

- LNG Plant Accident Response;
- FSRA, Loading Facility and LNGC Accident Response;
- Pipeline Rupture Contingency Plan; and
- Platform or Jetty Emergency Response.

E- Monitoring and Review

Monitoring of different activities will be required to analyse the impacts of construction and operation on the environment. Self-monitoring and reporting tools will be adopted to carry out monitoring as per EPA rules and regulations.

SHE officer will coordinate with manager SHE, who will be the in-charge of monitoring procedures. Monitoring techniques will be identified and the frequency of selected parameters for monitoring will be followed as per the monitoring plan given Table 11.4. SHE Head/Manager will keep a record of all non-conformities observed and report them along with actions to CEO for further action. SHE Head/Manager will also report any impact anticipated along with his recommendations for further action.

The contractor shall take note of the recommendations relating to issues arising during monitoring of construction activities.

Review: Environmental assessment of the proposed project has been made on the basis of the project description, site visits, existing environmental conditions and expected changes in environmental parameters due to construction activities as well as during operation of the LNG terminal. Review of activities will take place after conceding changes in project design, record keeping and management plans subsequent to impact assessment study.

11.13. Standard Operating Procedures

11.13.1 Wastewater/Storm

water management

A. Purpose of Wastewater/storm water Management

The purpose of the adopted procedure is to provide guidelines and simplify the process of categorizing, quantifying, managing, and disposing of wastewater wherever and whenever arising during the project's construction and operation phase. Wastewater management is a critical component of company's operating policies. Wastewater management includes the proper disposal/recycling and reuse of the wastewater generated during construction and operation phase. The procedure is designed to assist in a company's wide effort to provide protection for the environment and to comply with company's corporate requirement, environmental laws and regulations regarding proper wastewater management.

B. Scope

Wastewater as part of construction and operational stages shall be managed as per this procedure. An integrated wastewater management system for the LNG jetty and storage terminal is essential to reduce wastewater; this will be provided as a design input.

Substitute techniques must be investigated, including source reduction, recycling and reuse wherever possible with a view towards maximizing the benefits and minimizing the cost of each method of wastewater management.

Guidelines for proper handling, categorization, recording, minimization, and disposal of all types of wastewater associated with company operations and projects are part of this procedure that need to be documented.

This procedure shall be followed at all construction sites by all company personnel and contractors working for this proposed project.

Table 11.4: Environmental Monitoring Plan

Stage	Monitoring areas	Parameters and techniques to monitor	Monitoring frequency	Reason to monitor parameter	Responsibility
Construction	Dredging	• Benthic Community • Erosion and Sedimentation • Vegetation • Disposal of Dredge Material	Continuous	• Dredging results in disturbance of benthic community. • Causes soil erosion and sedimentation.	Health, Safety & Environment Department.
	Marine Ecology	• Biodiversity	Continuous	Unmitigated operations may result in loss of biodiversity	Health, Safety & Environment Department
	Air Emissions	• CO • SO_x • NO_x • PM_{10} • $PM_{2.5}$ • SPM	• Before start of construction activity • Monthly monitoring during construction and operation	Emissions from construction machinery and power production and operation of FSRU may result in deterioration of air quality	Health, Safety & Environment Department
	Solid Waste	Solid waste quality and quantity	Continuous	Improper disposal may result in deterioration of marine ecology	Health Safety & Environment Department
	Wastewater	Primary Pollutants of NEQS	Monthly	Improper disposal may result in deterioration of marine ecology	Health, Safety & Environment Department
	Noise	Noise Intensity	• Start of construction • Monthly	Uncontrolled noise may cause nuisance	Health, Safety & Environment Department
	Soil	• Soil contamination • Soil erosion • Soil sedimentation	Monthly	Surface and sea water pollution	Health, Safety & Environment Department
	Occupational Safety	• Accidents • PPEs • Annoyance	Continuous	Occupational safety and legal obligations	Health, Safety & Environment Department
	Land reclamation	• Soil Quality	Continuous	Legal obligations and structure protections. Prevention of soil erosion and sedimentation to the port.	Health, Safety & Environment Department

Table 11.4: Environmental Monitoring Plan

Stage	Monitoring areas	Parameters and techniques to monitor	Monitoring frequency	Reason to monitor parameter	Responsibility
End of construction	Restoration of sites	• Visual analysis • Photographic records	End of construction	Compliance of Environmental Approval Conditions	Health, Safety & Environment Department.
Operations	Waste water	• Waste water minimisation • Storage and handling • Recycling and reuse • Treatment before disposal • Primary Pollutants of NEQS	Monthly	Compliance of Environmental Approval Conditions	Health, Safety & Environment Department
	Solid waste	• Solid waste quality and quantity • Solid waste disposal	Monthly	Compliance of Environmental Approval Conditions	Health, Safety & Environment Department
	Fire & Safety	• Fire Hazards & • Safety Protocols	Continuous	Compliance of Environmental Approval Conditions	Health, Safety & Environment Department
	Air Emissions	• CO • SOX • NOX • PM10 • PM2.5 • SPM	Monthly	Compliance of Environmental Approval Conditions	Health, Safety & Environment Department
	Noise	Noise intensity measurement	Monthly	Compliance of Environmental Approval Conditions	Health, Safety & Environment Department
	Hazardous spill	• Spill on Land • Spill on Water	Continuous	Compliance of Environmental Approval Conditions	Health, Safety & Environment Department
	Traffic management	Standard Operating Procedures	Continuous	Compliance of Environmental Approval Conditions	Health, Safety & Environment Department
	Compliance monitoring	• EIA Commitments • Mitigation Measures • Conditions of Environmental Approval • SOPs	Monthly	• EIA Commitments • Mitigation Measures • Conditions of Environmental Approval • SOPs	Independent Monitoring Consultant (IMC)

C. Definitions

I. Wastewater

Any water arising after use/consumption shall be including of liquid waste discharged by domestic residences, commercial properties, industry, and/or agriculture and can encompass a wide range of potential contaminants and concentrations. In the most general terms, it refers to the municipal wastewater that contains a wider range of pollutants arising due to the mixing of wastewaters from different sources.

II. Hazardous Wastewater

Plant wastewater comes in the category of hazardous wastewater. If it has one or more of the following properties:

- Oily water
- Toxicity (may cause risk of injury to health of organisms or the environment)
- Concentration of contaminants too high above safe acceptable limits

III. Non-hazardous Waste:

The wastes are categorized as nonhazardous wastes, if they do not possess any of the hazardous contaminant mainly comprising of consumed water arising from washing area and sanitary wastewater.

D. Procedure

Main concern to manage the wastewater is listed below:

- Eliminate wastewater production wherever possible.
- Minimize wastewater production.
- Recycle or Reuse
- Wastewater disposal in an environmentally safe manner through adequately designed facility

I. Wastewater Minimization

Generation of wastewater will be minimized through the following steps taken by working personnel at the facility:

- Through efficient use of raw water (minimizing the wastewater).
- Extensive management schemes will be formulated for both phases during construction and operations (water management).
- It is expected that segregated and /or treated wastewater will be made available for subsequent use during operations phase (recycling and reuse).

II. Storage and Handling

Wastewater shall be stored/retained in lined ponds or storage tanks till proper onsite treatment or remote disposal.

III. Recycling

Reuse of wastewater is a best way to reduce the quantity of the wastewater that requires subsequent treatment and disposal.

IV. Treatment

- Biological treatment of wastewater through retention in septic tanks prior to disposal
- Sludge produced as a by-product of biological treatment be disposed off properly through burial pits
- Some of the wastewater will be reused for cleaning or washing purpose. The treated water should comply with National Environmental Quality Standards (NEQS).

V. Disposal

Proper disposal should be done following the treatment through discharge into water bodies or sewerage system where available.

E. WASTE MANAGEMENT OPTIONS

- All storm water run-off and pump-out from facility construction-sites will be inspected and directed to sedimentation basins to remove suspended solids (e.g., silt);
- Sewage will be collected and temporarily stored in tank(s) until it is transported to a designated wastewater treatment facility;
- Standard mobile sewage tankers should be engaged to collect and transport sewage from portable latrines and temporary storage tanks
- Oil spills in port waters could result from a variety of sources including on-shore industries; unsupervised bilge pump-outs; collisions and sinking of vessels; illegal discharges from vessels; accidents when transferring waste oil to storage facilities and accidents when refuelling vessels.
- To reduce the risk of oil spills occurring from a vessel, Maritime Safety Regulations ensure the safety of navigation, including the provision of navigation aids is maintained.
- Direct discharge will only be considered as a contingency option.

Table 11.5: Wastewater Data Sheets Guidelines for Wastewater Management

FLNG Wastewater	
Description	• General water from washings, etc.
Components	• Water • Total Dissolved Solids (TDS) and total suspended solids • Oil & Grease
Waste Category	Non-hazardous
Analysis	Refer Monitoring procedure for analysis requirements (PRO/ENV/02).
Ownership/Responsibility	SHE Manager/Manager Operations
Accumulation/ Storage	Stored in lined ponds or storage tanks till proper disposal.
Waste Handling	When handling plant wastewater, protect yourself from direct contact by using appropriate personal protective equipment
Waste Reduction	• Reduce water use
Disposal Options	• Recycle free oil back into the production stream • Dispose water into lined evaporation ponds or skim pits • Oily water from yards should be treated in oil/water Separator.
Sanitary Wastewater	
Description	Wastewater from camps.
Waste Category	Non-hazardous
Analysis	Refer Monitoring procedure for analysis requirements (PRO/ENV/02).
Ownership/Responsibility	Camp Administrator / PTLs
Waste Handling	When handling sanitary wastewater/ sludge, protect yourself from direct contact by using appropriate personal protective equipment.
Waste Reduction	Reduce water use.
Disposal Options	• Treat wastewater in Red fox or in septic tanks before disposal • Sludge removed from Red fox or septic tank during cleaning should be buried in burial pits.

- During preparation of the final EMP, ETPL will undertake an evaluation of the proposed release of hydro-test water during construction of the storage tanks for LNG and condensate on-site. This will include an analysis of the additives which will be present, their fate and anticipated environmental effects.

F. Recording & Reporting

Visually acquired wastewater management-related monitoring data will be recorded in field logbooks. These logbooks will be maintained as part of the Construction Spread Wastewater Management Records at each designated area or facility within a spread, wherever the stated wastewater management activities occur.

These monitoring data will include as applicable.

- Time, date and identify of individual performing the monitoring activity.
- Description of the process or activity being monitored.
- Findings or results of the monitoring activity.
- Description of activities to address deficiencies or problems; and
- Problems / Deficiencies, Remedial Measures.
- It is responsibility of the management to identify and implement appropriate remedial measures based on identified problems/deficiencies and to properly record and verify all EMP compliance initiatives

11.13.2. Hydrostatic testing

A. Purpose of Hydrostatic Testing

The objective of performing hydrostatic testing of a pipeline is to check and eliminate any defect that might be potential threat for leaks and bursting of pipeline when sustaining maximum operating pressures or sometimes accidental rise in pressure above normal. The key word is pressure which is regulated and when hydrostatic testing is performed through raising the pressure level above the operating pressure to check for any defects in the joining and failure of material due to excessive pressures above the normal operating pressures. If failure occurs then defects are eliminated or in case of no failure a safe margin of pressure above the operating pressure is demonstrated. Defects adversely affect the pressure-carrying capacity because excessive stress in the material leads to failure.

B. Scope

Primary focus during any pipeline activity, including hydrostatic testing, is public safety and protecting the environment. Also it ensures that the material or substance being transferred from one point to another location is conserved and does not occur as waste from the system.

C. Definitions

Hydrostatic Leak Testing is used to test components for leaks by pressurizing them inside with a liquid. This testing method can be used on piping, tanks, valves and containers with welded or fitted sections.

D. Procedure

Hydrostatic testing of pipelines is one method to identify defects or damage in pipelines that could potentially cause a pipeline leak. A hydrostatic test is a routine test to ensure the integrity of pipelines and distribution network. The information below outlined the hydrostatic testing process.

- The gas inside the pipeline is removed and replaced with water. This water contains an environmentally safe green dye to aid in determining the location of a defect, in the event of leak.
- The water inside the pipeline is pumped up to a pressure much higher than the normal operating procedure of the pipeline (i.e. transporting petroleum while in full operation). This high pressure is typically held for at least 8 hours.
- In the event of sudden leak of water from the

pipeline, the pressure will be reduced rapidly and the green water should be raised to the surface quickly.

- In the event of small leak of water from the pipeline; the pressure will be reduced slowly and the green water may not immediately reach the surface. To locate the leak, excavate the pipeline at determined locations for further investigation and testing.
- In the event that defect in the pipeline is identified, repair will be made as soon as possible and the testing will continue until the pressure remains intact for at least 8 hours.
- The pipeline will be refilled with the gas products and the distribution service to the area will be resumed.
- ETPL is committed to the continued safe operation of its pipelines and ensuring the efficient and reliable transportation of petroleum product.

E. Management Options of Hydrostatic testing

Management of Hydrostatic testing consists of;

- Description of the pipeline to be tested. Include information such as the location, dimensions, and materials of construction, intended use.
- Identify the source of the water to be used for the test. (Should be a good quality water source such as a municipal water supply, drinking water well, irrigation well, clean source of surface water, etc.)
- Note: The use of surface waters may require a temporary water use permit from the Pakistan environmental protection agency.
- Description of any chemicals to be added to the test water, the purpose for using the chemicals, and the concentrations used. Provide product literature and material safety data sheets.
- Estimate total volume of test water to be discharged in gallons and discharge rate.
- Description of how the test water will be settled, filtered, or otherwise treated to prevent erosion and remove suspended solids, oil and grease, and other pollutants.
- A description of how dissolved oxygen will be restored to the test water if it is going to reach any surface water body.
- No hydrostatic test water may be discharged within near drinking water supply intake.
- The operator's representative responsible for ensuring that the hydrostatic test water is disposed of properly.

8.13.3. Noise and air emissions

A. Purpose

The purpose of this guideline is;

- To monitor contents of polluting substances in the atmospheric air;
- To control observance of approved limiting permissible emissions at manmade sources;
- To monitor natural sources and a number of man-made sources of emission at work sites at the construction phase;
- To monitor noise emissions;
- Sources of noise emissions.

B. Scope

Scope of work include

- Evaluation of present ambient air quality and noise level at existing area.
- Evaluation of impact of traffic movement at the proposed site and noise level.
- Evaluation of impacts on roads and in the adjacent area due to construction and operation.
- Recommendations for mitigation techniques to redress the expected impacts both for design phase

and operational phase.

C. Definitions

In common use the word noise means unwanted sound or noise pollution. Excessive noise permanently damages hearing, but a continuous low level sound can be dangerous too.

D. Procedure

Air emissions (continuous or non-continuous) from LNG facilities include combustion sources for power and heat generation (e.g. for dehydration and liquefaction activities at LNG liquefaction terminals, and re-gasification activities at LNG receiving terminals), in addition to the use of compressors, pumps, and reciprocating engines (e.g. boilers, turbines, and other engines).

Emissions resulting from flaring and venting, as well as from fugitive sources, Principal gases from these sources typically include nitrogen oxides (NOX), carbon monoxide (CO), carbon dioxide (CO2), and, in case of sour gases, sulfur dioxide (SO2). For LNG terminal, air quality impacts should be estimated by the use of baseline air quality assessments and atmospheric dispersion models to establish potential ground level ambient air concentrations during facility design and operations planning. These studies should ensure that no adverse impacts to human health and the environment result.

Emissions of green house gases together with NOx and SOx are expected from power generation units. All reasonable attempts should be made to maximize energy efficiency and design facilities to minimize energy use. The overall objective should be to reduce air emissions and evaluate cost effective options for reducing emissions that are technically feasible.

The main noise emission sources in LNG facilities include pumps, compressors, generators compressor suction/ discharge, recycle piping, air dryers, heaters, air coolers at liquefaction facilities, vaporizers used during re-gasification, and general loading / unloading operations of LNG carriers/vessels.

Atmospheric conditions that may affect noise levels include humidity, wind direction, and wind speed. Vegetation, such as trees, and walls can reduce noise levels. Installation of acoustic insulating barriers can be implemented, where necessary.

E. Noise and Air Emissions Management Options

Noise and air emissions monitoring includes;

- Strategic environmental planning (e.g., plant sitting and fatal flaw analyses)
- Pollution control device feasibility, troubleshooting, and cost evaluations
- Innovative solutions and flexible permitting.
- Regulatory tracking and rulemaking negotiation on behalf of corporations and trade associations including New Source Review (NSR) Reform, Maximum Available Control Technology (MACT) standard development
- Enforcement assistance, economic evaluations, expert testimony.
- Environmental Management System (EMS) development
- Air permitting such as Prevention of Significant Deterioration (PSD), New Source Review (NSR),and state construction permits
- Air quality modelling and monitoring of air and noise emissions.
- Risk Management Plans
- Emission release inventories (Toxic Release Inventories, Global Warming and Green House Gas Inventories)
- Leak Detection and Repair
- Pollution control technology assessment,
- emission inventory development,
- capture efficiency,

- control equipment performance and equipment specifications and warrantees,
- compliance assessment,
- non-compliance resolution,
- negotiation of commercial terms for air pollution and control equipment and control systems, and
- Development of parametric monitoring, periodic monitoring, and compliance assurance monitoring.

11.13.4. Erosion protection requirements

A. Purpose Erosion Protection

Erosion control projects protect public and private land value and can help reduce sediment pollution by minimizing the degrading effects of erosion. Erosion control projects utilizing natural materials also conserve plant, fish, and wildlife habitat, as well as wildlife access to the land. Erosion control is necessary at the project sites which are interfacing with land and shore.

B. Scope

Soil erosion by water and wind affects the natural environment. Soil loss, and its associated impacts, is one of the most important, yet probably the least well-known, of today's environmental problems. The scope of this activity is to control the erosion through practice of preventing or controlling wind or water erosion.

C. Definitions

The natural process by which the surface of the land is worn away by the action of water, wind, or chemical action is termed as Erosion.

Shore erosion protection works are structures or measures constructed or installed to prevent or minimize erosion of the shoreline in the critical area i.e. is most likely to be the area influenced by the project.

D. Procedure

The best erosion control methods involve the restoration of natural environments along the shoreline. Replanting bay grasses and shrubs and utilizing biodegradable materials as well as offshore breakwaters can stabilize soil while enhancing habitats at the same time. Structural barriers, such as bulkheads, compact soil, alter the composition of the land, and often undermine natural ecology.

E. Management Options

Adequate management and/or structural best management practices to minimize accelerated erosion prevent sediment pollution to the waters of the coastal area and maintain the resource base. Generally this will require a conservation plan that meets the soil loss tolerance. Soil loss tolerances denote the maximum level of soil erosion that allows high levels of sustainable economic crop productivity.

- Wherever possible, non-structural erosion control measures, such as marsh creation, should be used to stabilize eroding shoreline.
- Where no significant erosion is occurring, structural shore erosion control measures should not be encouraged.
- Structural erosion control measures should only be used in areas designated for this activity and when non-structural measures are impractical or ineffective.
- A conservation plan includes best management practices to address erosion and sedimentation control and protection of the soil resource. In the absence of a complete conservation plan, an erosion and sedimentation control plan consisting of appropriate numbers and locations of sediment removal best management practices, must be developed, installed and maintained.

11.13.5- Cleanup and re-vegetation

A. Purpose

This involves removal of excess excavated material (not used as backfill), restoring the site surface to final contours, and stabilization of slopes. After cleanup, disturbed areas are stabilized, smoothed, mulched, reseeded, and fertilized as required. After construction is complete and cleanup is in progress, temporary erosion controls may be removed and permanent landscaping and erosion control measures installed where required as part of final facility reinstatement.

B. Scope

Topsoil is segregated from sub-soils during this operation. Top soil is stored in temporary topsoil stockpile areas for later use in re-vegetation programs. Regular visual inspection is conducted to monitor the growth of vegetation and to ensure that no erosion occurs on slope areas while the trees and other vegetation get established to protect the slope surfaces. The re-vegetation programs will be continued by the Project.

C. Procedure

To determine the number of protected species if any in or around the construction zone in order to assess damage inflicted on the natural environment through the loss of these species and the damage to their ecotopes in the course of clearing construction sites;

- To determine number of rare species growing within the determined populations in the clearance zone.
- To determine proximity of the rest of the species population to the pipeline route in order to assess the constructions possible impact on the whole of the population.
- To assess the condition of rare species in the impact zone prior to and in the course of the construction, as well as during commissioning of the facilities.

D. Management of Cleanup and revegetation

a) Responsibilities

The site environmental coordinator (SEC) is responsible for verifying that clearing and re-vegetation is performed in compliance with applicable environmental requirements and specifications.

b) Instructions

The site environmental coordinator (SEC) will verify that the layout at the facility work area and temporary use areas conform to project.

- The SEC will verify that clearing and re-vegetation is performed in accordance with construction Specifications, which include requirements for timber removal, slash disposal, and dust control.
- The SEC will verify that any debris resulting from clearing activities that may block stream flow, contribute to flood damage, or result in streambed scour or erosion is immediately removed from the stream area.
- The SEC will verify that all necessary measures are taken to minimise erosion and transport of sediment and silt from graded and disturbed work areas. Erosion control specifications and site specific erosion control plans will be followed to ensure that disturbed areas are stabilised and erosion is minimized to the greatest extent practicable.
- Environmental inspection will be conducted during clearing and grading activities and in coordination with Construction Superintendent.

E. Recording & Reporting

The site environmental coordinator (SEC) will document on a Daily Environmental Inspection Reports (DIR) the progress of clearing and re-vegetation activities and status of compliance.

11.13.6. Waste management plan

A. Purpose of Waste Management

The purpose of this procedure is to provide guidelines and simplify the process of categorizing, quantifying, managing, and disposing of solid wastes. Waste management is a critical component of company's operating policies. Waste management includes the proper handling, collection, storage, manifesting, transportation, and disposal/recycling of the solid waste generated. The procedure is designed to assist in a company wide effort to provide protection to the environment and to comply with company's corporate requirement, environmental laws and regulations regarding proper waste management.

B. Scope

The waste management plan will be been developed by the pipeline / jetty construction contractors to ensure that the Management of solid waste generated as a result of the construction of the pipeline and associated activities is consistent, efficient, and in conformance with the laws and regulations. With respect to monitoring, the waste management sets out the following objective:

- To monitor and inspect waste management-related facilities and activities directly resulting from executing the scope of the contract in order to ensure compliance with the Waste Management Plan (WMP). Guidelines for proper handling, categorization, recording, minimization, recycling and disposal of all types of waste associated with company operations and projects are part of this procedure.

C. Definitions

i. Waste

Any material, for which no further use is intended, is considered a waste. It can be solid, semi solid or liquid. Additionally, abandoned materials and materials intended to be recycled are considered wastes. It is very important to understand this concept, because even though something is going to be recycled, it must be managed as a waste until it is actually recycled.

ii. Hazardous Waste

Waste is categorized as a hazardous waste if it has one or more of the following properties:

- Ignitability (flash point less than 600oC);
- Corrosivity (pH less than or equal to 2.0, or greater than or equal to 12.5);
- Reactivity (inherently unstable under ordinary conditions or when exposed to water);
- Irritability (when in contact with body causes inflammation)
- Toxicity (may cause risk of injury to health of organisms or the environment.)

iii. Non-hazardous Waste:

The wastes are categorized as nonhazardous wastes, if they do not possess any of the hazardous characteristics as defined above. However, non-hazardous waste may still present hazards to employees who handle them. All recommended safety and handling practices must be followed.

D. Procedure

Priorities to manage the waste are listed below:

- Eliminate waste production whenever and wherever possible. Use the material only for its intended purpose on site
- Minimize waste production
- Reuse
- Recycle waste on site.
- Dispose of waste through properly designed waste disposal facility.

i. Waste Minimization

To minimize waste, the following steps shall be taken by all personnel working on project sites:

- Only the needed amount of materials shall be ordered. Before purchasing hazardous material, all alternatives for non-hazardous material should be explored.
- Prior consideration shall be given to the sizes of containers available when ordering products that could potentially generate waste. The intent is to avoid unused products and/or their containers from becoming wastes that require special handling.

II. WASTE CATEGORIZATION

All wastes generated at project facilities shall be categorized in two major categories (i.e. Hazardous wastes and Nonhazardous wastes) as per the definitions in section C. Each category has different types of requirement for handling, storage and disposal.

III. LABELING

- Name of the waste (e.g., waste oil, solvents).
- Waste category (e.g., toxic, ignitable).
- Facility name and address (disposal site, etc.).
- Date of waste accumulation: (date when waste was placed in drum).
- Wastes are segregated and located in designated areas to optimize control; storage areas.

IV. SEGREGATION

Waste management becomes very complicated if different types of waste are mixed together. A small amount of hazardous waste, mixed with a nonhazardous waste or recyclable material, can make the whole mixture a hazardous waste. Disposal costs and liabilities for hazardous waste are very high, so it is extremely important to identify wastes and keep them segregated.

The scheme of segregation is as follow:

- All hazardous waste shall be segregated from other types of hazardous wastes as well as non-hazardous wastes at the point of generation of waste.
- At all facilities, containers, with colour coding for easy identification, shall be kept to collect and segregate common wastes. A proposed scheme is as under:
- Food waste shall be collected in separate containers.
- All containers must be properly and clearly labelled. The label must clearly mention the name or type of waste. Also, if the waste is hazardous, it should be clearly labelled on the container along with its hazardous characteristics (e.g. flammable, toxic, radioactive, etc.). This is important to workers and to emergency response teams, who need to know what they are dealing with. Missing or unreadable labels must be replaced.

Coding system for different type of waste

Waste material	(Color or code)
Glass	(blue);
Metals	(green);
Plastic	(white);
Oily rags	(black);
Used oil	(red);
Rubbish / trash	(yellow)

V. STORAGE AND HANDLING

- Waste that will be sent for recycling or off-site disposal shall be temporarily stored at waste storage facilities available at different sites such as Junkyard, Scrap yard, pits, etc.
- The oily sludge, contaminated soil and other hazardous liquid waste (e.g. rinsate, chemicals, etc.) shall be stored in lined pits with HDPE liner. Liner shall be of sufficient thickness (at least 20mil) and adequate strength to withstand tears and punctures.
- All other wastes awaiting disposal shall be kept in closed containers separately. Care must be taken to prevent wastes giving rise to secondary environmental problems, such as odors or soil and groundwater pollution through rainwater leaching.
- All stored wastes must be clearly labeled with type of waste and warning signs.
- Daily estimates of hazardous and no hazardous

waste and volumes generated on site.

- Waste segregation, waste storage containers, general housekeeping and the provision of adequate resources will be monitored.
- All workers handling wastes shall use proper PPE.

VI. Recycling

Recycling and reuse minimizes the quantity of waste requiring disposal. Some of the wastes can be reused within the facilities while others can only be recycled at off-site recycling centers. For example, recycling of used oil is possible in some of the Lube Oil Recycling companies; batteries may be sent back to manufacturer or distributor for recycling. Waste shall not be sold to the unauthorized contractors/companies, who may not have proper recycling facilities, to avoid misuse and to reduce associated liabilities. The possibilities of recycling of each waste are discussed in relevant documents.

VII. Treatment

Some of the wastes, such as wastewater from camps, oily wastewater from process, etc., require proper treatment before disposal. The treated water should comply with National Environmental Quality Standards (NEQS).

VIII. Disposal

Disposal becomes the only available alternatives, if reuse and recycling options are exhausted. A material should be classified as a waste for disposal only if no other useful purpose can be identified and if the material cannot be beneficially reused or recycled. The choice of a suitable disposal option for any waste depends on both environmental and economic considerations. The final disposal shall be done through EPA approved waste management contractors.

IX. Recording & Reporting

ETPL has to record the information about source, composition, quantity, and final disposal of the waste. This information is needed for regulatory compliance, risk assessment and setting reduction targets and objectives as well as corporate statistics.

The Waste Tracking Form, as shown in the Table 11.6 shall be used to record this information by all ETPL teams, while waste is being dispatched outside facility or ETPL's controlled location. It will be made necessary to sign off the Waste Tracking Form, before the waste is dispatched outside.

11.13.7- Environmental Inspection by SHE department

A. Purpose

This procedure identifies environmental responsibilities for the project offices and for the construction site SHE Incharge. It also provides procedural guidance for environmental training, inspection, monitoring functions during construction.

B. Scope

Primary scope of environmental inspector/monitor is to comply with the environmental requirements of the project. ETPL is also responsible for inspecting, documenting, and ensuring that construction meets environmental responsibilities through an integrated program of personnel orientation and training, and inspection of construction activities. In addition, the company will assist in implementing environmental management plans through its program of construction inspection.

C. Definitions

Consists of examining construction activities in the field to verify and document those activities are carried out in compliance with construction and environmental Permits, specifications relating to environmental protection, and mitigation plans approved for the LNG project.

D. Procedure

The company will establish a plan detailing the procedures and documents required for implementing

Table 11.6: Waste Tracking Form

Location of Generation:
Reporting Team:
Submitted by (Name):
Submitted on (Date):

Waste	Approx. Quantity	Unit	Disposal Location
Aerosol Cans (Empty)			
Asbestos			
Batteries (Dry)			
Batteries (Lead Acid)			
Charcoal from Turk Amine Plant			
Clinical Waste			
Construction Waste			
Crude Oil or Condensate Waste			
Descaling Acids			
Diethanolamine (DEA)			
Drilling Fluids/Solids			
Drums and Containers (Empty)			
Filters			
Fluorescent Light Tubes			
Food Waste			
Glycols			
Laboratory Wastes			
NORM Containing Waste			
Oil Contaminated Soil			
Oily Rags (Used)			
Paint Waste			
Pigging Wastes			
Plant Wastewater			
Produced Water			
Rinsate			
Sanitary Wastewater			
Scale (Pipe and Equipment)			
Sludge			
Trash			
(i) Glass			
(ii) Metal			
(iii) Plastic			
(iv) General Trash			
Used Engine Oil			
Checked and Signed:		**dated:**	

environmental management plan thereby complying to the environmental legislations and regulations during the construction and operational phase of the project.

E. Management Options

Functions and responsibilities that will be assigned to company's SHE department include:

- Orientation of LNG project personnel in environmental requirements and procedures particularly in context to the sensitive resource issues at the construction site.
- Environmental training particularly in environmental monitoring is to be imparted to all project personnel.
- Inspection of facilities construction activities for compliance with environmental regulations,
- Specifications, stipulations, drawings, mitigation plans, and procedures.
- Documentation of all training, inspection, and monitoring activities should be exercised.
- Coordinate with the owner's environmental representatives and management personnel on environmental issues.
- Provide technical support to Owner for obtaining environmental permits or other Authorizations as needed or modified during facilities construction

F. Recording & Reporting

Environmental compliance records will be completed daily (as applicable) on standard reporting forms. Other records may include daily logbooks, meeting notes, correspondence, or records of telephone conversations. Compliance reports and other appropriate records will be logged into the field ES&H office and copies transmitted to the project office.

Forms will be used to document field inspection activities. They become permanent documents when completed by the SHE personnel and reviewed and signed by the appropriate supervisor, as required. Documentation that will be used by field environmental compliance personnel is summarized below.

i Daily Environmental Inspection Checklistt (Any suggested checklist)

The purpose of the checklist (to be prepared by SHE department) is to document the results of the environmental inspection activities conducted during the day with respect to compliance of observed construction activities relative to applicable environmental requirements.

The SHE Head/Manager reviews the report for adequacy and accuracy and identifies potential problem areas. Construction signoff is required only if there is a noncompliance requiring action and/or acknowledgement by Construction. Copies of all checklists are filed in the site SHE files.

ii. Weekly Inspection Report

A weekly inspection report is prepared by the site SHE personnel after completing a general inspection of site and submitted to the field SHE Head/Manager with copies to the Environmental Lead. The report includes:

- Summary of inspection and monitoring efforts on the spread over the past week;
- Identification of any non-compliance and steps taken to correct non-compliance;
- Any other issues or problems encountered in carrying out inspection activities (e.g., schedule delays);
- Government representatives on-site during the week;
- Inspection and monitoring plans and schedules for the upcoming week.
- General site audit and completion of the "Weekly Inspection Checklist".
- The Owner will have a standing invitation to accompany project personnel on this audit. The checklist will be modified over time to reflect pertinent issues related to the phase of construction presently occurring.

11.14. Contingency

PLANNING-ACCIDENTS & MALFUNCTIONS

11.14.1. Fire Contingency Plan

Because flammable/combustible materials are present at this site, fire is an ever-present hazard.

All personnel and subcontractors are not trained professional fire-fighters. Therefore, if there is any doubt that a fire cannot be quickly contained and extinguished, personnel will notify the Site Superintendent by radio and vacate the area. The Site Superintendent will immediately notify the local Fire Department.

The following procedures will be used to prevent the possibility of fires and resulting injuries:

- Sources of ignition will be kept away from where flammable materials are handled or stored.
- The air will be monitored for explosivity before and during hot work and periodically where flammable materials are present. Hot work permits will be required for all such work.
- No Smoking" signs will be conspicuously posted in areas where flammable materials are present.
- Fire extinguishers will be placed in all areas where a fire hazard may exist.
- Before workers begin operations in an area, the foreman will give instruction on egress procedures and assembly points. Egress routes will be posted in work areas and exit points clearly marked.
- The following procedures will be implemented in the event of a fire:
- Anyone who sees a fire will notify their supervisor who will then contact the Site Superintendent and the Health and Safety Officer by radio. The Health and Safety Officer will activate the emergency air horns and contact the local Fire Department.
- When the emergency siren sounds, workers will disconnect electrical equipment in use (if possible) and proceed to the nearest fire exit.
- Work crews will be comprised of pairs of workers (buddy system) who join each other immediately after hearing the fire alarm and remain together throughout the emergency. Workers will assemble at a predetermined rally point for a head count. When a small fire has been extinguished by a worker, the Site Superintendent and the Health and Safety Officer will be notified.

A. Evacuation Procedures

In the event on-site evacuation of remedial action personnel is necessary, the following actions will be taken:

- The emergency signal will be activated (one single long blast on the air horn).
- No further entry of visitors, contractors, or trucks will be permitted. Vehicle traffic within the site will cease in order to allow safe exit of personnel and movement of emergency equipment.
- Shut off all machinery if safe to do so.
- All on-site personnel, visitors, and contractors in the support zone will assemble at the entrance to the site for a head count and await further instruction from the Site Superintendent.
- All persons in the exclusion zone and contamination reduction zone will be accounted for by their immediate crew leaders (e.g., foremen). Crew leaders will determine the safest exits for employees and will choose an alternate exit if the first choice is inaccessible.
- During exit, the crew leader will try to keep the group together. Immediately upon exit, the crew leader will account for all employees in his crew.
- Upon completion of the head count, the crew leader will provide the information to the Site Superintendent.
- Contract personnel and visitors will also be accounted for.

- The names of emergency response team members involved will be reported to the Site Superintendent.
- A final tally of persons will be made by the Site Superintendent or designee. No attempt to find persons not accounted for will involve endangering lives of employees by re-entry into emergency.
- In all questions of accountability, immediate crew leaders will be held responsible for those persons reporting to them. Visitors will be the responsibility of those employees they are seeing. Contractors and truck drivers are the responsibility of the Site Superintendent. The Health and Safety Officer will aid in accounting for visitors, contractors, and truckers by reference to sign-in sheets available from the guard shack.
- Personnel will be assigned by the Site Superintendent to be available at the main gate to direct and brief emergency responders.
- Re-entry into the Site will be made only after clearance is given by the Site Superintendent. At his direction, a signal or other notification will be given for re-entry into the Site.
- Drills will be held periodically to practice all of these procedures and will be treated with the same seriousness as an actual emergency.

11.14.2- Hazardous Spill Contingency Plan

In the event of an emergency involving hazardous material spill or release, the following general procedures will be used for rapid and safe response and control of the situation.

Emergency contacts provide a quick reference guide to follow in the event of a major spill. Hazmat spill responses will be coordinated through the local Emergency Response Centre.

A. Notification Procedures

If an employee discovers a chemical spill or a vapor or material release, he or she will immediately notify the Site SHE personnel.

The Site SHE personnel will obtain information pertaining to the following:

- The material spilled or released.
- Location of the release.
- An estimate of quantity released and the rate at which it is being released.
- The direction in which the spill, vapour or smoke caused by the release is heading.
- Any injuries involved.
- Fire and/or explosion or possibility of these events.
- The area and materials involved and the intensity of the fire or explosion.

This information will help the Site SHE personnel to assess the magnitude and potential Seriousness of the spill or release.

B. Procedure for Containing/ Collecting Spills

The initial response to any hazardous spill or discharge will be to protect human health and safety, and then the environment. Identification, containment, treatment, and disposal assessment will be the secondary response.

If, for some reason, a chemical spill is not contained within a dike or sump area, an area of isolation will be established around the spill. The size of the area will generally depend on the size of the spill and the materials involved. If the spill is large (greater than 55 gallons) and involves a tank or a pipeline rupture, an initial isolation of at least 100 feet in all directions will be used. Small spills (less than or equal to 55 gallons) or leaks from a tank or pipe will require evacuation of at least 50 feet in all directions to allow cleanup and repair and to prevent exposure. When any spill occurs, only response personnel will be allowed within the designated affected area. If possible, the area will be roped or otherwise blocked off.

If the spill results in the formation and release of a toxic vapor cloud, further evacuation will be enforced. In general, an area at least 500 feet wide and 1,000 feet long will be evacuated downwind if volatile materials are spilled.

If an incident may threaten the health or safety of the surrounding community, settlement, etc., it will be consulted and determine if the public will be informed and possibly evacuated from the area. The Site SHE personnel will inform the proper agencies in the event of its being necessary.

The designated Response personnel will take the following measures:

- Avoid breathing vapours of spilled material.
- If possible and safe to do so, turn off any ignition source or gas emergency shutoff valve.
- Make sure all unnecessary persons are evacuated from the hazard area.
- Put on protective clothing and equipment.
- If a flammable material is involved, remove all ignition sources, and use spark and explosion proof equipment for recovery of material.
- Determine the major components in the waste at the time of the spill and remove all surrounding materials that could be reactive with the spilled material.
- If wastes reach a storm sewer; try to dam the outfall by using sand, earth, sand bags, etc. If this is done, pump this material out into a temporary holding tank or drums as soon as possible.
- If volatile emissions may occur, spray the spill area with foam, if available.
- Apply appropriate spill control media to absorb discharged liquids.
- For large spills, establish diking around leading edge of spill using booms, soil or other appropriate material. If possible, use a diaphragm pump to transfer discharged liquid to drums or a holding tank.

C. Emergency spill response cleanup materials and equipment

The supply of appropriate emergency response cleanup and personal protective equipment on hand will be inventoried and visually inspected on a weekly basis.

The materials listed below will be kept onsite for spill control depending on the types of hazardous materials present. The majority of this material will be located in the support zone, in a supply trailer or storage area.

- Activated charcoal (carbon) to adsorb organic solvents (hydrocarbons) and to reduce flammable vapors.
- Appropriate solvents, e.g. CITRIKLEEN, for decontamination of structures or equipment.

The following equipment will be kept onsite and dedicated for spill cleanup:

- Plastic shovels for recovering corrosive and flammable materials.
- Sausage-shaped absorbent booms for diking liquid spills, drains, or sewers.
- Sorbent sheets (diapers) for absorbing liquid spills.
- Over pack drums for containerizing leaking drums.
- 55-gallon open-top drums for containerization of waste materials.

Once a hazard has been recognized, take immediate action to prevent the hazard from becoming an emergency. This may be accomplished by the following:

- Daily safety meeting
- Task-specific training prior to commencement of activity
- Lock-out/tag-out
- Personal protective equipment (PPE) selection/use

- Written and approved permits for hot work, confined space
- Air monitoring
- Following all standard operating procedures
- Practice drills for fire, medical emergency and hazardous substances spills.

11.14.3. Housekeeping

In order to reduce the possibility of accidental spills and safety hazards, good housekeeping practices will be followed. They include prompt removal of small spills, regular maintenance of walking areas, regular removal of refuse, and staging of similar materials together.

11.14.4. Security

All rules and regulations set up by landowner will be followed by all personnel on site.

11.14.5. Training

All site personnel are trained to operate the equipment that is present at the site.

11.14.6. Fire Detection and Warning

Portable Fire extinguishers will be used in buildings and as protection during "Hot Work" activities throughout the site. As construction progresses and systems are commissioned within specific buildings, personnel will be informed of the differential of alarm sounds.

- Large office accommodation will be protected by the use of hard-wired smoke detection devices with battery backup.
- A suitable means of raising the alarm in the event of a fire or other emergency at the LNG terminal will be established.

The alarm system will be appropriate to ensure all personnel can be notified immediately of any emergency situation and evacuation, or other actions required. The alarm system will be tested on a regular basis.

11.14.7. Site accommodation

Site accommodation (all temporary facilities) shall be designed and laid out in such a manner so as to reduce the risk of fire to the minimum.

- Good housekeeping shall be observed at all times throughout buildings with desks cleared at the end of each working day and sensitive documents locked away in flame proof cabinets/ lockers.
- All site accommodation shall have sufficient multipurpose dry powder extinguishers located at the access door with signs indicating their positions.
- Additional CO2 extinguishers shall be provided to cover other electrical equipment.
- All fire extinguishers are visually checked on a regular basis through weekly area inspections and quarterly in accordance with equipment tagging process.

11.14.8. Fire drills

- The Fire Safety Coordinator shall ensure that monthly drills are carried out that ensure all personnel are familiar with the evacuation procedure and their respective muster points.
- Simulated fires shall be carried out to ensure the readiness and competency of the fire brigade to fight a major fire. During the drill equipment shall be tested and shall adequately work. In the event any piece of equipment should fail it shall be immediately replaced.
- Review of brigade competency shall be determined during the drills. Brigade members shall be retrained if any evidence of in-competency exists.

11.14.9. Materials storage

- The Site SHE Head/Manager must be informed of all flammable gases and liquids being brought onto site.
- Oxygen and fuel gas cylinders shall not be stored together. Singular oxygen, acetylene carts will be

acceptable as long as they are in use together.

- No flammable materials including solids, gases or liquids shall be stored next to any temporary facilities.
- Storage of flammable gases shall be a minimum of 5 meters from any occupied building suitably secured and with a prominent sign stating "DANGER HIGHLY FLAMMABLE".
- Storage facilities for flammable gases will be inspected by the Site ES&H Manager prior to being used.
- Material storage within the warehouse facility will maintain an excellent standard of housekeeping at all times. Flammable material packaging shall be removed to a safe location as it becomes redundant. Sprinkler systems shall be investigated in warehousing facilities, and were possible installed.
- Materials shall be stored in compliance with OSHA and SEPA regulations.

11.14.10. Firefighting equipment

The following firefighting equipment shall be maintained in good order at the Project and Equipment will also be suitable for fighting bush fires in and around the LNG Project:

- Fire Extinguishers of adequate size and number
- Fire hose and nozzles
- Bunker gear
- Air packs
- 1 water tank with pumping capabilities
- Fire pumps of sufficient size to fill tank
- Assorted accessories for connecting hoses and fighting fires (wrenches, hose clamps, axes, etc.
- Rescue gear for high level rescue (if this is assigned to this group)
- Equipment shall be maintained and tested to ensure serviceability in the event of a fire.
- Tests shall be conducted monthly.
- A water fill station including a storage tank of adequate size to meet construction fire requirements shall be installed to facilitate the filling of the pumper truck and tanker.
- The plant fire suppression system shall be prioritized and serviceable as soon as practical during construction.

11.14.11. Training

All employees shall receive general fire fighting training (i.e. fire extinguisher use). Employees who are members of the fire brigade shall receive at a minimum the following training:

- Use and limitations of the firefighting equipment
- Fire fighting strategies and methods
- Use of respiratory equipment and its limitations
- Donning bunker gear and its care
- Care and maintenance of firefighting equipment and hoses
- Confined space entry and fire fighting in a confined space
- First aid
- High level rescue (if the site assigns this responsibility to this group)

11.15- Environmental Compliance

As confirmed in the Preliminary EMP, Proponent will be responsible for regular audit and review of environment and safety management of the LNG facility. This will include both on-site auditing and review of performance reports. Additional onsite inspections and investigations will be undertaken in the event of significant environmental incidents. These will be undertaken in conjunction with the relevant government agencies.

Plant management will participate in the audits and inspections and investigations. Plant management will also

be responsible for regular review of the environmental performance of the site and site personnel, and for the reporting on the implementation of commitments made in the EMP.

There is also likely to be some compliance auditing associated with the licensing of the LNG Plant, for each government recommendation and proponent commitment, the following information:

- The recommendation or proponent commitment being addressed;
- The issue to be addressed by the proponent;
- How the issue is to be addressed by the proponent;
- Where the issue is addressed in the EMP;
- When the issue is to be addressed by; and
- To whose satisfaction the issue is to be addressed.

11.15.1- Audits

In particular, there will be:

- Annual audit reports.
- A triennial review and improvement of the EMP.

Proponent recognizes that periodic external compliance audits and inspections will be made to monitor, assess and validate the level of Proponent performance and compliance pursuant to the commitments made in the accepted Environmental Management Plan.

11.15.2- Environmental Management Systems Audit

Environmental Management Systems Audit would be undertaken to assess the implementation and operational success of the EMS at the site. This is achieved by assessing the objectives, organizational structure, responsibilities, procedures, processes and resources available at the site. The EMS Audit is a systems assessment, rather than an audit of environmental compliance, which is assessed through the Site Internal Environmental Audit.

Potential areas of concern for audit during construction of LNG plant mainly include:

- Jetty and unloading arms
- Process Area
- Low Pressure and High Pressure pumping systems
- Vaporizers (Regasification Area)
- Vent or flare systems (low pressure and high pressure)
- Maintenance Workshop
- Administration Building
- Guard House
- Utility Area
- Control Room
- Gas Metering Station
- Gas Receiving Station

12 Conclusion

ETPL intends to follow a phased approach towards developing the LNG import terminal in order to bridge the gap between supply and demand of energy. The Project is primarily based on developing the required infrastructure so that LNG can be brought into the NG market, which has witnessed phenomenal growth in the energy sector in Pakistan. In the first stage, the focus is on the fast track approach to facilitate LNG flow into the NG pipeline network in Pakistan.

This Environmental & Social Impact Assessment (ESIA) evaluates the potential environmental, social, economic, cultural, and natural impacts of the proposed Liquefied Natural Gas (LNG) Import Terminal Project. This assessment has been carried out to fulfill the regulatory requirements of Pakistan Environmental Protection Act, 1997 and to satisfy the evaluation criteria of the International Finance Corporation (IFC).

Baseline environmental and socioeconomic information was collected from a variety of sources, including reports of previous studies, published literature, and field surveys. The information collected was used to compose profiles of the natural, socioeconomic, and cultural environments likely to be affected by the project.

The impact assessment and proposed mitigation measures are based on the brown field site located in the side bay adjacent to EVTL's exiting terminal. The selection of site by the proponent depends on the qualitative / quantitative risk analysis as part of the techno-economic feasibility. EMC has carried out analysis on the siting of the LNG terminal and Laying of HP Transmission Pipeline. Environmentally the proposed Brown Field site has been found feasible provided that the mitigations suggested are carried out. The pipeline route also does not interfere with any mangroves or population centers. It raises minimum social and environmental issues and avoids the laying of pipeline in the sub-sea environment; it additionally is economically more viable than the others.

The risks unique to LNG projects include operational risks arising from gas tanker and terminal operations involving transport, storage and the transfer of LNG. In particular, some gas terminals are located within the environs of established ports. So their operations and those of the tankers serving them share a common operational environment with other port users. The management of gas shipping operations within ports is therefore a matter of some importance, and needs to be taken into account by those who administer ports and provide essential services in port areas. To a large extent, the overall positive safety record is rooted in the limited risks arising from LNG itself. Proactive planning and public private partnership can only make such projects successful.

The specific criteria used for determining the significance of impacts are identified for each resource, and the following assumptions are generally used when evaluating the potential project impacts:

- ETPL as project proponent will comply with all applicable laws and regulations;
- The construction phase of the project will proceed as described in Section 3; and
- ETPL as proponent will implement the mitigation measures and Environmental Management Plan in letter and Spirit.

The cumulative impact of this project on the National economy will be a strongly positive one. Significant additional resources will be realized by the nation as a result of this project, which is consistent with the government's long-term development plan. The additional licensing income, among other sources of additional income, will add to the government revenues

and economic growth resulting from expanded and diversified business development in Pakistan in future.

The ESIA study finds that the ETPL's LNG import terminal project is compatible with the aims and objectives of (a) Sustainable Development in promoting improvement in quality of life, and (b) Energy Sector in making available a sustainable energy source and thus contributing to sustainable economic development in Pakistan.

This ESIA Study concludes that establishment of the LNG-Import Terminal Project at Port Qasim would fulfill the requirements of sustainable development by being socially equitable, and economically viable in improving the quality of life for all citizens of Pakistan, without altering the balance in the resources of the ecosystem of the region.