Hagler Bailly Pakistan

Expansion of Engro Polymer and Chemicals Limited's PVC and VCM Manufacturing Plant

Environmental Impact Assessment

Final Report

HBP Ref.: R8E02FIQ

September 6, 2018

Engro Polymer and Chemicals Limited

Karachi

Executive Summary

Engro Polymer & Chemicals Limited (EPCL), a subsidiary of Engro Corporation (EC) operates a polymer and chemicals production plant (the Plant, or the Site) in Port Qasim (PQ). EPCL is planning an expansion of the Plant. Under this expansion, the production capacity of PVC will be increased from 195 ktpy to 295 ktpy and that of VCM will be increased from 195 ktpy to 245 ktpy. The Project will also include other modifications including the addition of an import line for EDC and installation of another VCM storage tank.

EPCL is involved in the manufacturing, marketing and distribution of chlor-vinyl allied products and PVC. It is the only fully integrated chlor-vinyl chemical complex in Pakistan. It produces PVC, caustic soda, sodium hypochlorite, hydrochloric acid and EDC/VCM. It markets a total of five products under the brand name 'SABZ'.

EPCL has acquired the services of Hagler Bailly Pakistan (Pvt.) Limited for undertaking Environmental Impact Assessment (EIA) of the proposed Project. This report documents the EIA process and its results.

Project Location

The Site is located in the Eastern Industrial Zone of Port Qasim (the Port or PQ), located in Bin Qasim Town, in the southern part of the Malir District, Karachi. Adjacent to the Site in the east is Engro Zarkhez fertilizer plant, and to the direct west, a liquefied natural gas (LNG) facility of Sui Southern Gas Company (SSGC). To the south is a road beyond which is an under-construction thermal (coal-fired) power plant. To the north is vacant, undeveloped land.

Exhibit I shows the location of the Project.

Exhibit I: Location of Proposed Project

Project Outline

EPCL will increase its production of PVC and VCM by 100 ktpy and 50 ktpy respectively. It will do so by establishing another PVC plant (PVC-III Plant) within the boundaries of the existing facility.

The new plant will comprise the following process units:

- Feedstock section
- Polymerization section including chemicals preparation
- Slurry stripping section
- Drying section
- VCM recovery section
- PVC packaging and storage
- EDC Import Pipeline

It will also include the following new utilities' facilities:

- New MCC
- New CCR
- Catalyst storage
- Pipe rack

- Underground piping
- High-pressure nitrogen gas

VCM is produced through the cracking of EDC, which is produced from ethylene and chlorine. The chlor-alkali plant is used to produce and supply chlorine. The ethylene is imported through Engro Vopak Terminal Limited (EVTL).

PVC polymer is made by forming vinyl chloride droplets in water by vigorous agitation. Polymerization is started using monomer-soluble initiators or catalysts that break down to give the free radicals and hence initiate a free radical polymerization of vinyl chloride. During the reaction the monomer droplets are allowed to coalesce in a controlled manner to give solid particles with the required particle size and structure.

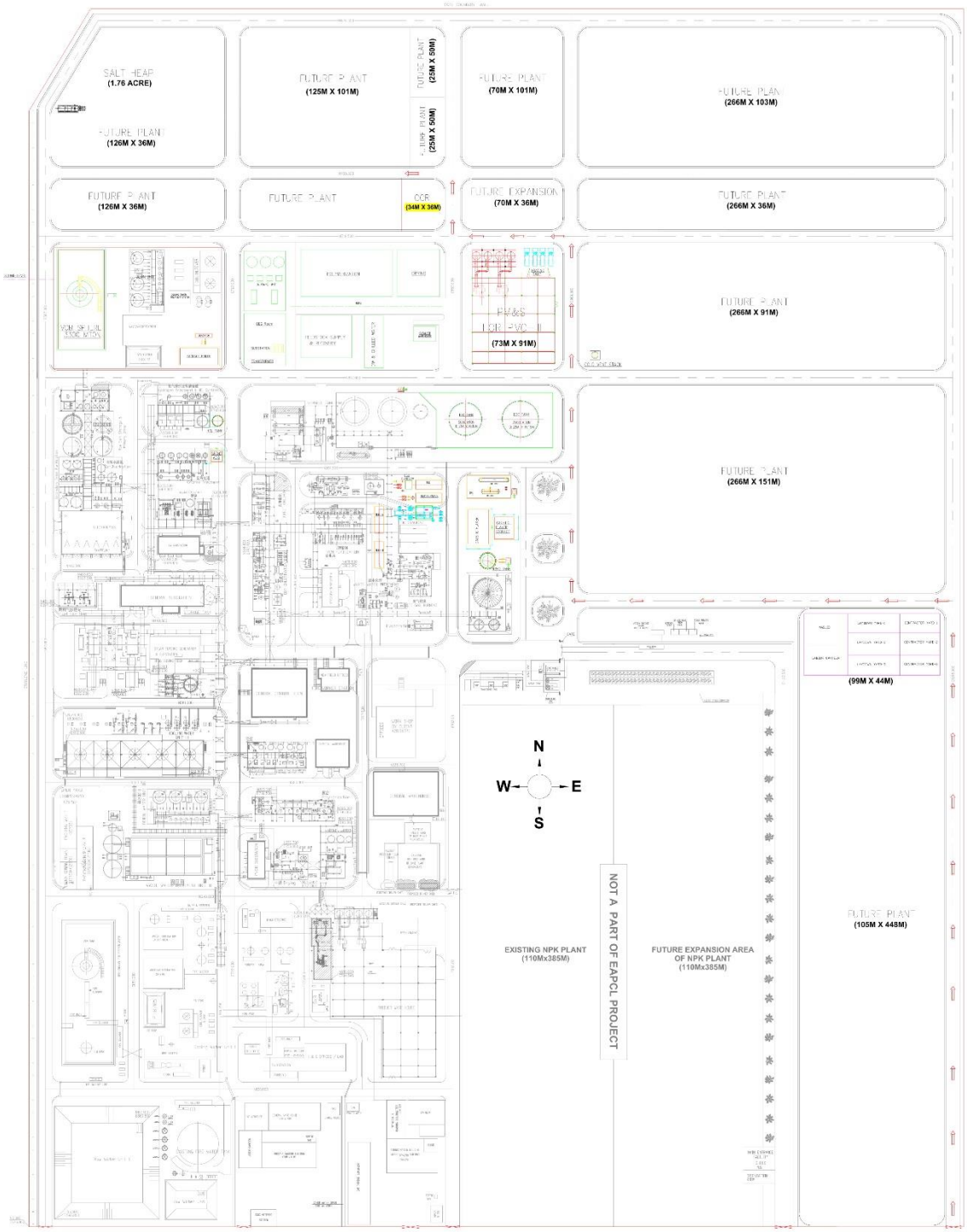
Reactions are carried out at different temperatures to give different grades of product with the required molecular weight. Following the reaction stage, the untreated monomer is recovered from PVC slurry and the slurry is dried to produce a dry powder final product.

The major stages of the process include reception and storage of raw materials, polymerization, polymer drying, polymer storage, mixing of recovered and fresh VCM, VCM recovery, wastewater stripping, and demineralization of water.

The Project will be installed in EPCL's existing plant site in the industrial estate of Port Qasim.

Exhibit II shows the layout of the Project including the existing facilities and the planned facilities.

Exhibit II: Layout of Project



Description of the Environment

The existing physical, biological and socioeconomic conditions of the surrounding areas of the Project are described in the EIA report. For describing each type of conditions a

study area around the Project footprint was delineated. The delineation is based on the physical environmental, biological and socioeconomic environment's receptors. This was used to assess the baseline conditions in the areas likely to be affected by the Project. Baseline information was collected from field surveys, previous EIAs conducted in the Project area and other published literature.

Physical Environment

The topography, geology, climate, traffic, water resources and seismicity of the Study Area are described below. In addition results of sampling for ambient air quality, water quality and noise levels are also included.

Climate

The climate at Port Qasim is characterized as hot and dry during summer, and mild during winter with heavy, sporadic, rainfall during the monsoon. The southwest monsoon prevails from April to October in the Study Area. The monsoon is characterized by a reversal in wind direction during the remaining months; and, heavy rainfall over most of the Indian Subcontinent.

Topography, Geology and Seismic Hazards

The topographic relief in the Study Area is relatively gentle, increasing in elevation at approximately 10 meters (m) per km towards the north of the Study Area. The proposed plant site is flat and there is no natural vegetation on the site.

Port Qasim is located adjacent to an active tectonic setting and is approximately 190 km east of the triple continental junction between the Arabian, Eurasian and Indian plates. The area has a moderate level of seismic activity.

Air Quality

Ambient air quality sampling was carried out from April 12 to May 4, 2018. The sampling results show that NO_2, NO, VCM, SO_2, PM_{10} and $PM_{2.5}$ concentrations comply with SEQS at all sampling locations. However, SO_2 concentrations comply with both 24-hour SEQS however, the concentrations exceed the annual SEQS at A1. The maximum concentration is also observed at A1. Traffic on Port Qasim access roads and combustion points where coal, petrol and diesel being used as fuel are major sources of SO_2 emissions. This point is in the downwind direction of K-Electric and PQEPC power stations which are the biggest sources of SO_2 in the vicinity of the Project. A2 is located in an open area and does not have much influence on the existing plant. Also, this point is free from the influence of the existing plant as operations of the PVC plant does not result in such emissions.

Water Resources

There is no significant natural freshwater source in the Project area. The Indus River about 120 km to the east of Karachi city and the Hub River, a perennial stream that originates in Baluchistan and marks the boundary between Karachi Division and Balochistan are the sources of water in Karachi.

The main surface-water resources in the vicinity of the Project are the creeks of the Arabian Sea, namely, Gharo Creek at the south of the Project site. The Arabian Sea is the only major surface water body in the region.

The industrial and municipal discharges contribute different types of pollutants to the creeks. These include acids, heavy metals, organochlorines, organo-phosphorous, alum, arsenic, benzene, calcium, chlorides, magnesium, potassium, sodium, sulfates, toluene and suspended matter. The water that enters the creeks at high tide and leaves at low tide is the only source flushing the pollutants to the open sea.

Water Quality

Water quality was tested at two locations; one at the existing plant wastewater treatment facility (W1) and the other at Badal Nullah Drain (W2). The sampling results showed that the parameters; pH, conductivity, temperature, DO, BOD, COD, TSS, sulfates, fluorides and metals are in compliance with standards at all sampling locations whereas the parameters; oil and grease, phenol, cyanide, anionic detergents, sulfide, ammonia and chlorine were not detected at any of the sampling locations. Chloride and TDS concentrations at W1 complies with SEQS however, Chloride and TDS concentrations at W2 exceed the SEQS as well as the typical seawater concentration of 19,353 and 35,000 mg/L respectively. Pollution concentrations in excess of SEQS observed in Badal Nullah Drain (W2) may be due to contribution by other industries.

Waste

Hazardous solid waste comprises heavies and coke. Liquid heavies are disposed of in an on-site incinerator. Coke and solid heavies are collected in drums and polypropylene bags and transported by dumper truck off-site by third-party contract and disposed of through incineration. Offsite incineration for these solid hazardous wastes is managed by Zephyr Waste Solutions, Karachi.

There is also a scrapyard and salvage yard for waste disposal and recovery for non-hazardous waste.

Noise

The Project site is located within an industrial area that has relaxed limits. Noise levels at all sampling sites comply with SEQS.

Traffic

The Average Daily Traffic (ADT) for light vehicles (motorcycles, cars and pickups) and heavy vehicles (buses and trucks) as per previous study estimates are well over 60,000 that pass through or near Port Qasim Industrial Zone every day.[1]

Ecology

Data collection for ecology was carried out on May 1, 2018. The surveys included terrestrial ecology and coastal macro-invertebrate fauna. In addition to these surveys,

[1] Environmental Impact Assessment of Bin Qasim Coal Conversion Project. September 2013.

literature reviews were carried out and information from the most recent past surveys was used. Members of the local community were also consulted regarding species observations. The results are presented below.

Habitat

A review of the Study Area using the latest ***Google Earth™*** Imagery shows that, based on differences in land use, the following habitat classifications can be determined:

- Coastal Habitat
- Vegetation Cluster

Flora

The vegetation is characteristics of xerophytic[2] plant communities. During the May 2018 survey, a total of five plant species were observed in the terrestrial habitat.

Fauna

During the survey conducted in May 2018 evidence of Indian Hare *Lepus nigricollis* was observed. Pugmarks of both species were observed at Sampling Location E3. There was anecdotal evidence of locals sighting and hearing sounds of Wild Boar *Sus scrofa*, Asiatic Jackal *Canis aureus*, Fox *Vulpes vulpes* and Indian Hare at the Sampling Location E2.

Birds can travel long distances especially compared to mammals and reptiles. Furthermore, a number of bird species use both terrestrial and marine habitats. A total of three bird species were observed in the terrestrial habitat including the Common Myna *Acridotheres tristis*, Laughing Dove *Spilopelia senegalensis* and House Sparrow *Passer domesticus*.

A single reptile species, Indian Fringe-toed Sand Lizard *Acanthodactylus cantoris*, was observed at Sampling Location E4.

Macro-invertebrates are coastal organisms that are an essential part of the food chain for coastal biodiversity. Their abundance and diversity is an indicator of the level of disturbance of the coastal habitat. The abundance and diversity of coastal macro-invertebrates in at the outfall where EPCL's effluent is discharged into the Arabian Sea is less than that of areas further away from the coastline but more than that of coastal areas away from EPCL. This is because EPCL is discharging effluent that meets SEQS and not allowing disturbance to that area, thereby preserving conditions for the survival of macro-invertebrates, while other areas of the coastline are more disturbed due to extensive construction activity along the coast.

Other coastal fauna includes coastal marine fisheries and marine mammals and reptiles. Coastal marine fisheries show higher abundance and diversify away from the coastline as the coastal areas are already disturbed due to industrial activity.

None of the species observed in the area of conservation importance based on both the IUCN Red List and on national listings.

[2] Any plant adapted to life in a dry or physiologically dry habitat (salt marsh, saline soil, or acid bog) by means of mechanisms to prevent water loss or to store available water (from Encyclopedia Britannica)

Protected Area

The Study Area is located well within a developed area and the nearest Protected Area, the Keti Bandar North Wildlife Sanctuary, is more than 20 km away.

Social and Cultural Characteristics

The socioeconomic setting of the settlements and communities that may be potentially impacted by the Project is provided below.

Current Land-Use

The majority of the Study Area falls under a notified industrial area – the Port Qasim Industrial Zone. The Study Area covers a total of 3.4 square km. Major land uses in the Study Area consist of an industrial area (44%), vegetation cluster (26%), barren land (23%), drainage/wetland (5%) roads (1%) and Gharo Creek (1%).

Demography

The total population of the surveyed settlements is estimated to be around 59,000. The largest settlement in the Study Area is Pipri, with an estimated population of 45,000 individuals, whereas Ameen Muhammad Baloch is the smallest settlement with an estimated population of 125 persons. Pipri is a semi-urban settlement whereas all other settlements are rural settlements. The average size of the household in the Study Area was 5.21 persons.

Ethnology and Religion

Out of the total estimated population in the Study Area, 99.8% are Muslims. The other 0.2% of the population comprises Hindus and Christians.

The ethnic makeup of the population within the Study Area comprises mainly the Kalmati caste, followed by Baloch, Khosa and Zoharani. The main languages spoken in the area are Sindhi and Urdu.

Cultural Heritage

There is one heritage site within the Study Area. It is a shrine of Hazrat Syed Shah Hassan. Not much is known about this shrine however people believe that Hazrat Syed Shah Hassan is one of the seven famous saints protecting Karachi from cyclones. People occasionally visit the shrine and pray there. Most of the population in the Study Area is Muslim. A large influx of laborers from across the country which live in the Study Area has resulted in a mixed identity of the community.

Physical Infrastructure

The condition of the infrastructure in the settlements of the Study Area is poor. None of the rural settlements have reported having police stations, police check-posts and natural gas facilities. However, Pipri has basic urban infrastructure like road network water supply and power supply system.

Health

In the settlements of the Study Area settlement, Haji Ghulam Muhammad has a hospital, whereas a dispensary is functioning in Railway Colony with a visiting lady doctor. The hospital and clinic at Pipri and Gulshan-e-Hadeed are the main health facilities located in the area which are accessible from the Study Area.

The most common ailments reported are respiratory issues, cough and flu, followed by Hepatitis C and eye problems among men and women.

Malaria and diarrhea are common among children with the lack of sanitation being the main cause of diseases.

Education

Education facilities in the Study Area are provided by primary, middle and secondary schools run by the provincial education department. Primary schools were reported in 80%, middle schools in 5% and high schools in only 7% of the settlements in the Study Area. A middle school is also functioning under the Sindh Madarsatul Islam located at Morand Khan Qaserani Baloch settlement and another primary school is functioning under the Sindh Education Foundation, located at Natho Tando Khoso settlement. Most of the schools are co-educational.

The literacy rate for both males and females is reported at 36%. The literate people have mostly attained education up to primary (5th grade) and matriculate levels (10th grade).

EPCL is involved in activities to contribute to underprivileged communities of Ghagar Pattak, located near Port Qasim. Their contributions are mainly in the areas of education, health and safe drinking water. Environmental Impacts Identification

An in-depth assessment of the following potential impacts was carried out. These were identified as having medium or high significance in a scoping exercise carried out and included in the EIA report.

- **Construction Activities:** Potential environmental impacts of construction activities include: pollution due to improper disposal of camp waste and wastewater; spills and leakages of oil and contamination of soil and potentially surface water; increase in risk to workers related to occupational health and safety; disturbance to the communities nearby due to noise and dust emissions.
- **Transport of equipment and materials:** an increase in congestion on roads and inconvenience to road users; air and noise emissions; community safety issues.
- **Air emissions:** risk to workers due to the emission of harmful chemicals such as EDC/VCM, CO, SO_2, NOx etc.
- **Noise emissions:** disturbances to the local community; disturbances to workers.
- **Water resources and consumption:** increased stress on the local community's water needs.
- **Effluent discharge:** soil contamination; surface and groundwater contamination; contamination of the coastal areas.

- **Accidental releases and spills:** increase risks to human health; soil contamination; surface and groundwater contamination; contamination of the coastal areas.

Construction Activities

Construction activities if not managed properly can lead to a significant, albeit temporary, disturbance of the local environment. However, if measures presented in the Environmental Management and Monitoring Plan (**Section 8**) are followed construction impacts will be mitigated to acceptable levels.

Accidental Spills and Releases

Project operations will involve the use of three hazardous material ethylene, VCM, and chlorine in large quantities. These chemicals have a potential to harm human health and the environment around it if released accidentally into the atmosphere.

A detailed risk assessment has been carried out for the existing plant for the release of potentially hazardous gases from the plant. In consideration of this, all risk management processes and emergency response plan are in place to cater to this situation to avoid accidental release of gases and to minimize the impacts. Standard Operating Procedures (SOP) has been developed and training conducted for various emergency scenarios at the plant, including vapor release incidents. These procedures provide guidelines on minimizing the volume of the system from which release has occurred. Exercises and drills to monitor the effectiveness of the program are done regularly to ensure that our emergency squad members are well prepared to tackle emergency situations. The same measures will be used and where needed, modified, to cater to the expansion.

Liquid Effluents

The discharge of increased and untreated wastewater and sewerage can impact soil, water resources and aquatic biodiversity. A number of processes during the operation phase will generate wastewater.

Based upon the above analysis, the following mitigation measures will be adopted:

- Any significant impact on the surface and groundwater will be averted by treating the water as per SEQS.
- Periodic monitoring will be done to include discharge rate of overall wastewater as well as conducting the chemical analysis of the wastewater streams, so that relevant remedial measures can be employed

Analysis of Alternatives

A comparison of alternatives for project management and design alternatives was carried out as part of the ESIA.

Alternative Site Options

There are no feasible location alternatives for the Project as the proposed activity is located within the existing facility of EPCL. In addition proximity to EVTL is vital to

supply the raw material ethylene required for the Project. An alternative, un-used location will result in additional operational and management costs and increase the risk of leakage of hazardous chemicals due to additional pipeline used for transfer of raw material. In addition, the current option does not require any further resettlement and the nearest community is located at least 6 km away.

Power Supply Alternatives

The Project can source power from the KESC grid or it can generate its own power in-house. The latter option is preferred because it will reduce the burden on the already strained KESC grid and will provide a dedicated power source for the Project.

Effluent Disposal Alternatives

EPCL will ensure that the effluent being discharged from its facility will meet SEQS prior to disposal. Previously EPCL was channeling the effluent to mangrove plantations to help support them. However, these plantations have been cleared for other industries not under Engro Corporation. Therefore, the only option is to dispose the effluent into the Arabian Sea after ensuring its compliance with SEQS.

No-Action

The 'no-action' option if taken will prevent the country from increasing its production of PVC and result in greater imports to meet the growing demands of PVC in the country. The proposed activity offers a chance to improve Pakistan's trade deficit and offer a reliable and economical supply of PVC to Pakistan's industry. Therefore, this option is not feasible.

Environmental Management and Monitoring Plan

A detailed Environmental Management and Monitoring Plan (EMMP) is developed and is presented in the EIA. It presents mitigation measures for construction and operational impacts of the Project. In addition to the EMMP, specific management plans have been developed for areas of concern, including the following:

- Waste Management Plan
- Construction Management Plan
- Spill Prevention and Management Plan

The EMMP also describes a framework for developing a grievance redress mechanism for the Project.

Public Consultations and Disclosure

As part of the Environmental Impact Assessment process, consultations were undertaken with institutions that may have an interest in the proposed project or may be affected by it.

As the Project is located in an industrial area there are no communities in close proximity to it. Therefore, only institutional stakeholders were consulted.

A summary of the concerns raised in the consultations is presented below.

- How will the Project deal with additional wastewater generated due to the expansion?
- How will solid waste be handled?
- Will there be changes to emergency preparedness and are there any inherent safety measures being developed as part of the Project?
- How is the analysis of issues due to leakages being carried out?
- Are there flammable chemicals on site?
- Will gaseous emissions increase?
- Will manpower requirement increase?
- Will additional power be required? If so, how will this be supplied?
- Will more water be consumed?
- Will there be an increase in by-products?
- Will there be increased traffic due to the Project?

Conclusion

The proposed expansion project entails the construction and operation of a PVC and VCM production facilities that will increase the capacity of EPCL to produce PVC and VCM by 100 ktpy and 50 ktpy respectively. The Project will also include other modifications including the addition of an import line for EDC and installation of additional tanks for VCM and EDC

Among the potential negative impacts of the Project, the main concerns include discharge of effluent that does not meet SEQS resulting in contamination of the coastline, accidental spills and releases of hazardous chemicals such as EDC and occupational health and safety of workers. All impacts including these main ones are considered as part of the assessment and mitigation and management measures are recommended to reduce their impacts to acceptable levels. The Project will ensure that it is compliant with all national standards.

The EIA includes mitigation measures and monitoring requirements which are outlined in the Environmental Management and Monitoring Plan (**Section 8**). If these are implemented the anticipated impact of the Project on the area's natural and socioeconomic environment will be well within acceptable limits. The project will also comply with all the statutory requirements and standards listed in **Section 2** of this report.

Contents

Appendices:

Table

List of Abbreviations

ASG	Abbas Steel Group
BID	Background Information Document
BOD	Biochemical Oxygen Demand
BQATI	Bin Qasim Association of Trade & Industry
CA	Chlor Alkali
CEA	Cumulative Effects Assessment
CMP	Construction Management Plan
COD	Chemical Oxygen Demand
CR	Critically Endangered
EDC	Ethylene Dichloride
EHS	Environment Health and Safety
EIA	Environmental Impact Assessment
EMMP	Environment Management and Monitoring Plan
EN	Endangered
EPA	Environmental Protection Agency
EPCL	Engro Polymer and Chemicals Limited
ERSP	Environmental and Review Procedure
EVTL	Engro Vopak Terminal Limited
GFPs	Grievance Focal Points
GoP	The Government of Pakistan
GRC	Grievance Redress Committee
GSHAP	Global Seismic Hazard Map Project
HBP	Hagler Bailly Pakistan
HCL	Hydrogen Chlroride
HTV	Heavy Traffic Vehicle
IEE	Initial environmental examinations
IUCN	International Union for Conservation of Nature
KESC	Karachi Electric Supply Company
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas

LTV	Light Transport Vehicle
MBIs	Marine benthic invertebrates
MC	Mitsubishi Corporation
MW	megawatt
NaCl	Sodium Chloride
NEQS	National Environmental Quality Standards
NS	Anti-fouling agent
NWIZ	North Western Industrial Zone
OSHA	Occupational Safety and Health Administration
Pak–EPA	Pakistan Environmental Protection Agency
PCU	passenger car units
PCU	Public Complaints Unit
PEPA	Pakistan Environmental Protection Act
PGA	peak ground acceleration
PM	Particulate Matter
PPE	Personal Protective Equipment
PQ	Port Qasim
PQA	Port Qasim Authority
PQEPC	Port Qasim Electric Power Company
PVC	Poly Vinyl Chloride
QRA	Quantitative Risk Assessment
RoW	Right of Way
SEPA	Sindh Environmental Protection Agency
SEQS	Sindh Environmental Quality Standards
SMP	Spill Management Plan
SOP	Standard Operating Procedure
SPMP	Spill Prevention and Mitigation Plan
SSGC	Sui Southern Gas Company
TDS	Total Dissolved Solids
TSP	Total Suspended Particles
TSS	Total Suspended Solids
UC	Union Council

US	United States
USA	United States of America
VCM	Vinyl Chloride
WMP	Waste Management Plan
WWF	World Wide Fund for Nature

Units

µg/m^3	Microgram per cubic meter
Cm	Centimeter
Cumec	Cubic meter per second
dB A	Decibel on 'A' scale
ha	Hectare
kg/h	kilogram per hour
km	Kilometer
ktpy	kilo tonnes per year
kW	Kilo-Watt
LAeq	Level of Equivalent on 'A' scale
m	Meter
m/s	meters per second
m^3/h	Meter cube per hour
mg/kg	Milligram per kilogram
mg/l	Milligram per liter
mg/Nm^3	milligram per nanometer cube
mm	Millimeter
MPaG	MegaPascal
mS/cm	Millisiemen per centimeter
Nm^3/h	Normal cubic meters per hour
NTU	Nephelometric Turbidity Unit
^oC	Centigrade Celsius

1. Introduction

Engro Polymer & Chemicals Limited (EPCL), a subsidiary of Engro Corporation (EC) operates a polymer and chemicals production plant (the Plant, or the Site) in Port Qasim (PQ). Initially, the Plant was a joint venture by the name of Engro Asahi Polymer and Chemical Ltd. The installed capacity was 100 kilo ton per year (kty), and it was solely a Polyvinyl Chloride (PVC) Plant. The Plant came into commercial operation in 1999. The Plant was then expanded to 150 kty PVC along with a backward-integration project[3] in addition to PVC production, 230 kty Ethylene Dichloride (EDC), 204 kty Vinyl Chloride Monomer (VCM), 107 kty caustic, 20 kty Hypochlorite, 60 kty Hydrochloric Acid (HCl). A 3 kty Hydrogen production was also added, and commissioned by 2010. In 2010, a combined cycle 65 MW power plant was also established to meet the power requirements of the Plant. Diesel generators were available on standby mode for backup power production. EPCL is an ISO certified organization.

Engro Polymer & Chemicals Limited (EPCL) is planning another expansion in production of existing Plant. Under the expansion Project, the production capacity of the PVC plant will be expanded from 195 ktpy to 295 ktpy and the VCM plant will be expanded from 195 ktpy to 245 ktpy. The Project will also include other modifications including the addition of an import line for EDC and installation of another VCM storage tank, EDC Storage Tank, Caustic Flaker unit, additional tank for HCl and recovery of Sulfuric Acid from spent Acid. EPCL has contracted the services of Hagler Bailly Pakistan (Pvt.) Limited for carrying out Environmental Impact Assessment (EIA) in compliance with the applicable prevailing national laws, as well as the subsequent submission to Sindh Environmental Protection Agency (SEPA) for getting the environmental approval for the Project.

1.1 Project Location

The Site is located in the Eastern Industrial Zone of Port Qasim (the Port or PQ), located in Bin Qasim Town, in the southern part of the Malir District, Karachi. The Port Qasim Authority (PQA) is the federal government agency mandated to manage the port and associated industrial developments. PQ was built in the 1970's to relieve pressure on the Karachi Port and is today the second largest port of Pakistan handling about 35% of the nation's cargo imported by sea. The Port covers a large industrial area built over 11,000 acres surrounding the Port. The 65-acre land parcel that constitutes the subject Site is part of the larger 300-acre plot leased by the PQA to Engro Corporation for 50 years in February 1998.

Adjacent to the Site in the east is Engro Zarkhez fertilizer plant, and to the direct west, a liquefied natural gas (LNG) facility of Sui Southern Gas Company (SSGC). To the south

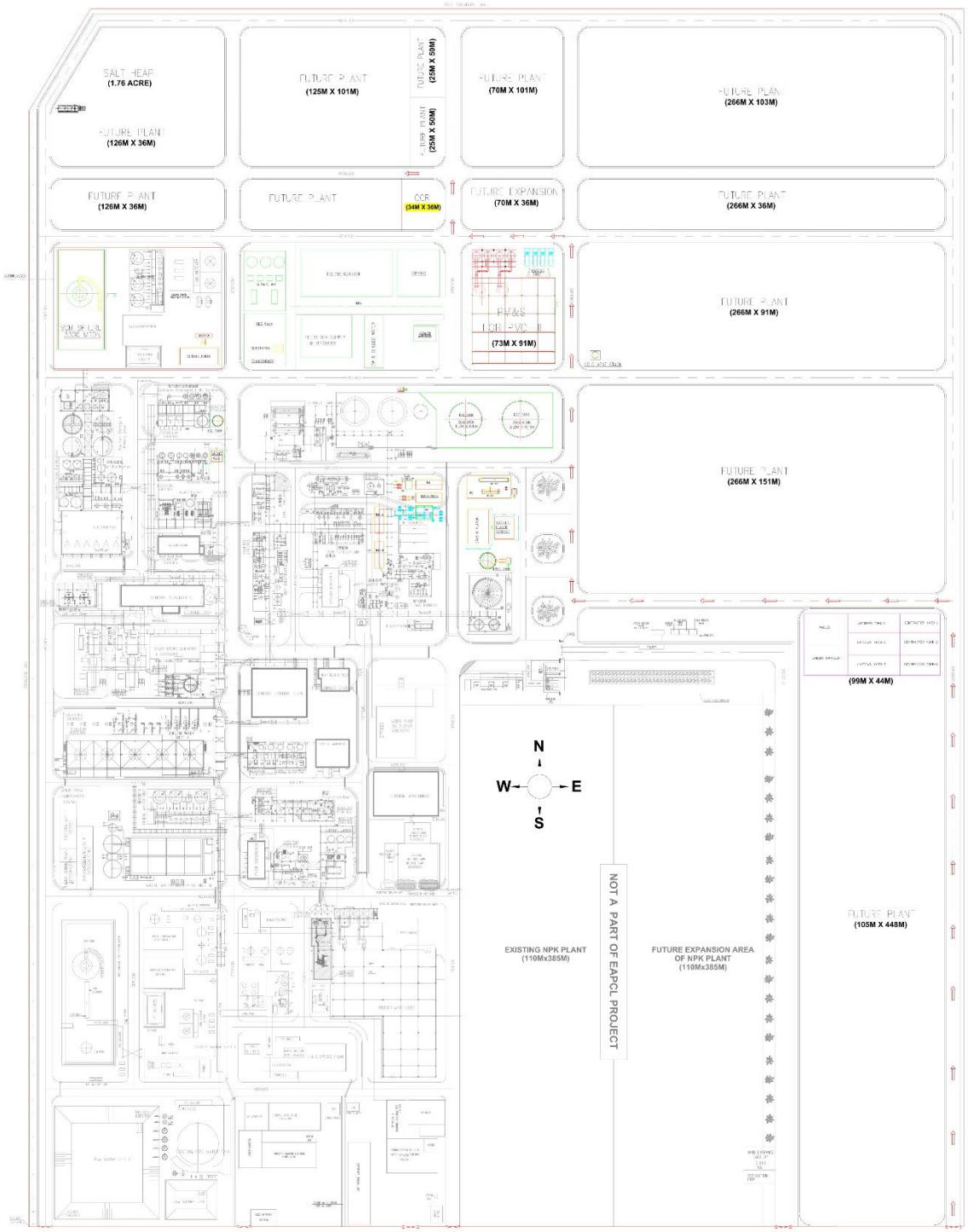
[3] VCM production is technically called backward integration while forward integration involves production of PVC products like pipes

is a road beyond which is an under-construction thermal (coal-fired) power plant. To the north is vacant, undeveloped land.

Exhibit 1.1 shows the location of the Project and **Exhibit 1.2** shows the layout of the Plant.

Exhibit 1.1: Location of Proposed Project

Exhibit 1.2: Project Layout



1.2 Objectives of the Project

The primary objective of the Project is to achieve expansion of the existing facility whilst complying with national laws for environmental management for the economically viable production of PVC and VCM.

1.3 Introduction to the EIA

This Environmental Impact Assessment (EIA) was conducted to meet the regulatory requirements of Pakistan contained in the Pakistan Environmental Protection Act, 1997 and its associated rules and regulations, rules and regulations of the Sindh Environmental Protection Act 2014.

1.4 Project Category

In the Sindh province of Pakistan, the *Sindh Environmental Protection Agency (Review of Initial Environmental Examination and Environmental Impact Assessment) Regulations, 2014* provides the project categorization. The regulations classified industry involved in the chemical production business, in Schedule II projects which requires an EIA.

1.5 Scope of the EIA

The aspects of the expansion included and excluded from the scope of the EIA are as follows:

1.5.1 Within Scope of the EIA

The scope of the EIA will include assessing the environmental and social impacts of the expansion and the facility as a whole, after expansion. This consists of the addition of units to increase the capacity. The proposed expansion includes the following:

- PVC Production increase from 195 ktpy to 295 ktpy
- VCM Production increase from 195 ktpy to 245 ktpy
- EDC Import line
- VCM Storage Tank
- VCM additional sphere
- EDC Storage Tank
- Caustic Flaker Unit
- Additional Tank for HCL and recovery of Sulfuric Acid from Spent Acid

The activities that will be covered as part of the EIA will be divided into construction and operation activities. Under construction activities, those related to site preparation, expansion in existing facilities such as import pipelines, construction camps, equipment, waste streams, site restoration will be included. Under operational activities, it will include all activities associated with PVC-III Plant, and EDC-VCM Plant as well as the

ethylene import pipeline and utilities associated with processing such as raw water treatment, cooling water system, etc.

EPCL is separately conducting a Quantitative Risk Assessment (QRA) study for the Project which will be available later. All safety hazards will be addressed in the QRA. A QRA was conducted for the PVC-II Plant. The same standards are being followed for the PVC-III Plant.

1.6 The Project Proponent

The Project proponent is Engro Polymer & Chemicals Limited (EPCL) which is a subsidiary of Engro Corporation, involved in the production of quality Chlor-Vinyl allied products and PVC. It is the only fully integrated Chlor-Vinyl chemical complex in Pakistan. Currently, it has a capacity to produce 195 ktpy of PVC and 195 ktpy of VCM.

It produces the following:

- PVC
- Caustic Soda
- Sodium Hypochlorite
- Hydrochloric Acid
- EDC/VCM
- Hydrogen

It markets the following products under the brand name 'SABZ':

- AU 67 S Film, Sheet, Artificial Leather, Wire Coating, Hoses
- AU 72 Film, Sheet, Artificial Leather, Wire Coating, Hoses
- AU 67 R Pipe, Sheet, Window Profiles
- AU 60 Films, Sheet, Bottle, Window Profiles
- AU 58 Films, Sheet

1.7 Organization of the Report

The EIA report contains 9 sections as follows: After the *Executive Summary* and *Introduction* (this section), the *Regulatory and Administrative Framework* (**Section 2**) discusses the environmental laws of the country. The project is described in *Project Description* (**Section 3**). The physical, ecological and socioeconomic baseline is presented in *Existing Environment of the Project Area* (**Section 4**). The outcome of public disclosure and stakeholder engagement is provided in *Information Disclosure, Consultation and Participation* (**Section 5**). The core of the EIA is the *Environmental Impacts Identification* (**Section 6**) which identifies the potential environmental and social impacts of the proposed Project, predicts their magnitude, evaluates the significance of impacts, and proposes mitigation measures, where required. This section is followed by the *Analysis of Alternatives* (**Section 7**). The *Environmental Management and Monitoring Plan* (**Section 8**) identifies various implementing mechanisms, institutional arrangements, monitoring mechanisms, and other plans to ensure effective

implementation of the proposed mitigation measures. Finally, *Conclusions* (**Section 9**) concludes the report. The background information and detailed data are provided in the appendices.

2. Regulatory and Administrative Framework

In Pakistan, the history of legislation drafted specifically to protect the environment dates back to the 1980s. This section provides a brief historical and constitutional context followed by a detailed discussion of relevant laws.

2.1 Historical and Constitutional Context

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 (Pak–EPA), the primary government institution at that time 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 (NEQS) were established in 1993. In 1997, the Pakistan Environmental Protection Act (PEPA) 1997 was enacted to replace the 1930 Ordinance. PEPA conferred broad-based enforcement powers to the environmental protection agencies. This was followed by the publication of the *Pakistan Environmental Protection Agency Review of Initial Environmental Examination and Environmental Impact Assessment Regulations 2000* which provided the necessary details on the preparation, submission, and review of initial environmental examinations (IEE) and environmental impact assessments (EIA).

Prior to the 18th Amendment to the Constitution of Pakistan in 2010, the legislative powers were distributed between the federal and provincial governments through two 'lists' attached to the Constitution as Schedules. The Federal list covered the subjects over which the federal government had exclusive legislative power, while the 'Concurrent List' contained subjects regarding which both the federal and provincial governments could enact laws. The subject of 'environmental pollution and ecology' was included in the Concurrent List and hence allowed both the national and provincial governments to enact laws on the subject. However, as a result of the 18th Amendment, this subject is now in the exclusive domain of the provincial government. The main consequences of this change were as follows:

- The Ministry of Environment at the federal level was abolished. Its functions related to the national environmental management were transferred to the provinces. To manage the international obligations in the context of the environment, a new ministry—the Ministry of Climate Change—was created at the federal level.
- The PEPA 1997 was technically no longer applicable to the provinces. The provinces were required to enact their own legislation for environmental protection. However, to ensure legal continuity PEPA 1997 continued to be the

legal instrument for environmental protection in the provinces till enactment of the provincial law.

All four provinces have enacted their own environmental protection laws. These provincial laws are largely based on PEPA 1997 and, hence, provide the same level of environmental protection as the parent law.

2.2 Sindh Environmental Protection Act 2014

The Sindh Environmental Protection Act 2014 (Sindh Act 2014) is the basic legislative tool empowering the government to frame regulations for the protection of the environment. As per the law, the Sindh Environmental Protection Agency (SEPA) is responsible to implement the provisions of this Act in Sindh. The Sindh Act 2014 is applicable to a broad range of issues and extends to air, water, industrial liquid effluent, marine, and noise pollution, as well as to the handling of hazardous wastes. The articles of Sindh Act 2014 that have a direct bearing on the proposed Project are listed below. The details are discussed in the following sections.

- Article 11 that deals with the Sindh environmental quality standards (SEQS) and its application
- Article 13 that deals with hazardous substances
- Article 14 that prohibits various acts detrimental to the environment
- Article 17 that establishes the requirement for environmental impact assessment.
- To implement the provisions of the Sindh Act 2014, *rules* and *regulations* are required.[4] The key rules and regulations are:
  - National Environmental Quality Standards (Self–Monitoring and Reporting by Industries) Rules, 2001
  - Environmental Samples Rules, 2001
  - Sindh Environmental Protection Agency Review of Initial Environmental Examination and Environmental Impact Assessment Regulations, 2014 (IEE–EIA Regulations 2014)

Guidelines are issued by the Pak–EPA for preparation of environmental assessment. The relevant guidelines are discussed in **Section 2.3**. All the rules, regulations, and guidelines issued under PEPA 1997 and discussed above remain valid after promulgation of Sindh Act 2014.

[4] Rules and regulations are similar instruments but differ in their hierarchy. The power to make rules and regulations is given in the enabling law, PEPA 1997 and Sindh Act 2014 in this case. The rules are made by the government (federal or provincial, as the case may be) and require publication in the official gazette. Regulations are made by the government agency which is empowered by the law, environmental protection agencies in this case, and are not always published in the official gazette. Rules deal with relatively important matters such as delegation of powers and authorities, whereas regulations usually deal with procedural matters.

2.3 Requirements for Environmental Impact Assessment

The articles of Sindh Act 2014 that have a direct bearing on the environmental assessment of the proposed Project are:

- Article 17(1): 'No proponent of a project shall commence construction or operation unless he has filed with the Agency[5] an initial environmental examination or an environmental impact assessment, and has obtained from the Agency approval in respect thereof.'
- Article 17(3): 'Every review of an environmental impact assessment shall be carried out with public participation…'

The IEE-EIA Regulations 2014 provides the necessary details on the preparation, submission, and review of the IEE and the EIA. Categorization of projects for IEE and EIA is one of the main components of the IEE-EIA Regulations 2014. Projects have been classified on the basis of the expected degree of adverse environmental impact. Project types included in Schedule II of the regulations those that are likely to have a potentially significant impact on the environment and thus an EIA is required for such projects, whereas those included in Schedule I as having potentially less adverse effects and therefore require an IEE. The regulations classified industry that involves in chemical production business, in Schedule II projects which requires an EIA.

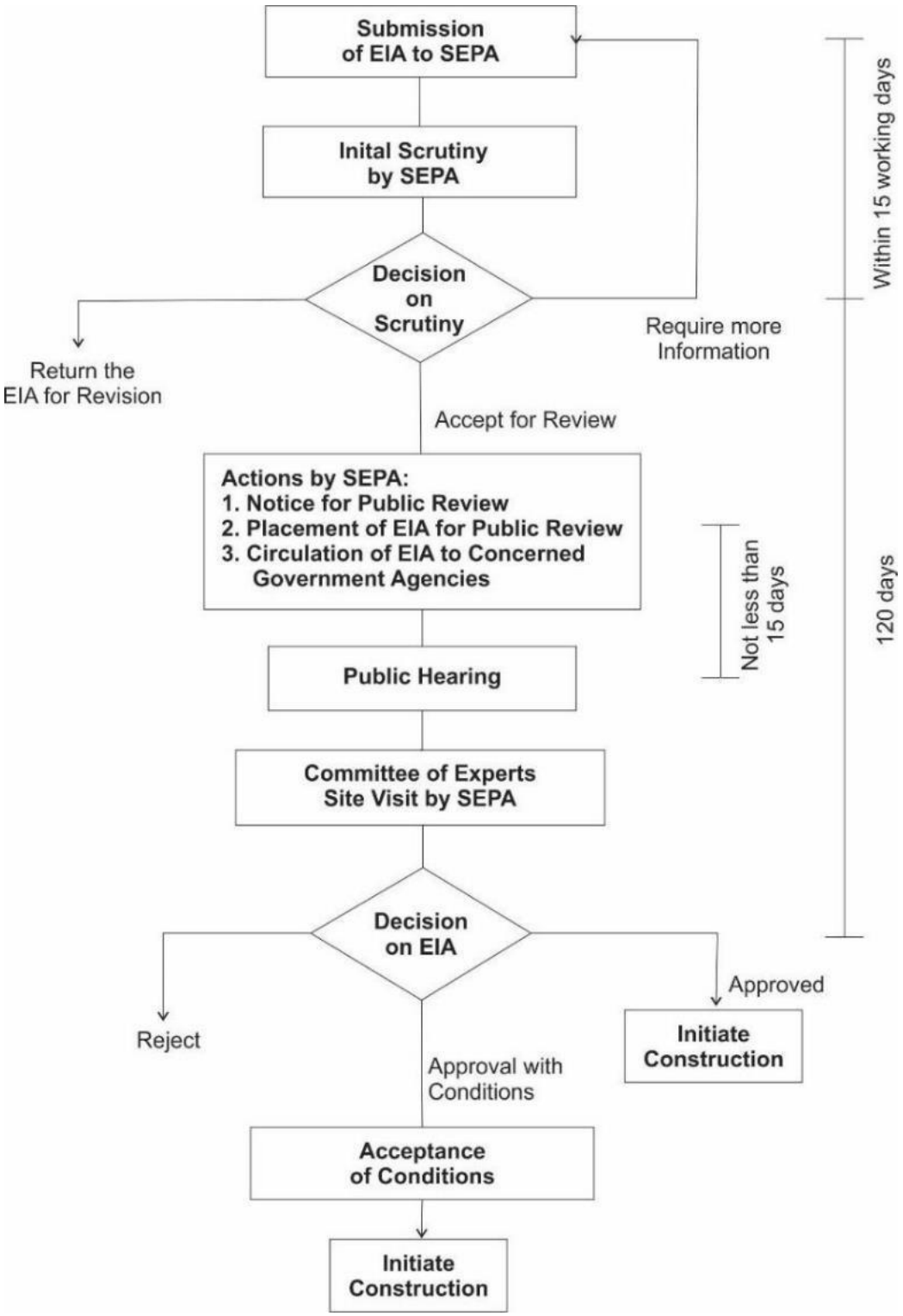
Regulation 9 of the IEE-EIA Regulations 2014 requires that '(1) Ten paper copies and two electronic copies of an lEE or EIA shall be filed with the Federal Agency; (2) Every lEE and EIA shall be accompanied by (a) an application, in the form set out in Schedule V; (b) copy of receipt showing payment of the review fee; (c) no objection certificates from the relevant departments in case of EIA shall be the part of reports; and (d) the environmental checklist as per its guidelines.

Exhibit 2.1 shows the prescribed procedure for review of EIA by the EPA which is contained in Regulations 10–17. The key features are:

- On acceptance of the EIA for review, EPA will place a public notice in national English and Urdu newspapers and in local language newspaper informing the public about the project and where it's EIA can be accessed. It will also set a date for a public hearing which shall be at least 30 days after the publication of the notice.
- If it considers necessary, the EPA can form a Committee of Experts to assist the EPA in the review of the EIA. The EPA may also decide to inspect the project site.

Exhibit 2.1: EIA Review and Approval Procedure

[5] The term 'Agency' refers to the Sindh Environmental Protection Agency.



Article 17(4) of SEPA Act 2014 binds the SEPA to 'communicate its approval or otherwise … within a period of four months from the date the environmental impact assessment is filed complete in all respects in accordance with the regulations, failing which … the environmental impact assessment shall be deemed to have been approved,

to the extent to which it does not contravene the provisions of this Act and the rules and regulations'.

Regulation 7 of the IEE-EIA Regulations 2014 pertains to the guidelines. It states that: '(1) The Agency may issue guidelines for preparation of an lEE or EIA or an environmental checklist, including guidelines of general applicability and sectoral guidelines indicating specific assessment requirements for planning, construction and operation of projects relating to a particular sector. (2) where guidelines have been issued under sub-regulation (1), an lEE or EIA shall be prepared, to the extent practicable, in accordance therewith and the proponent shall justify in the lEE or EIA or in environmental checklist any departure therefrom.'

The relevant guidelines are the follows:

- Policy and Procedures for the filling, review, and approval of environmental assessments set out the key policy and procedural requirement. It contains a brief policy statement on the purpose of environmental assessment and the goal of sustainable development and also states that environmental assessment is integrated with feasibility studies.
- Guidelines for the preparation and review of environmental reports which cover the following:
  - Scoping, alternatives, site selection, and format of environmental reports;
  - Identification, analysis and prediction, baseline data, and significance of impacts;
  - Mitigation and impact management and preparing an environmental management plan;
  - Reporting;
  - Review and decision making;
  - Monitoring and auditing;
  - Project management.
- Guidelines for Public Consultation which covers the following:
  - Consultation, involvement and participation;
  - Identifying stakeholders;
  - Techniques for public consultation (principles, levels of involvement, tools, building trust);
  - Effective public consultation (planning, stages of EIA where consultation is appropriate);
  - Consensus building and dispute resolution;
  - Facilitating involvement (including the poor, women, building community, and NGO capacity)
- Guidelines for sensitive areas which identifies the sensitive areas

2.3.1 Environmental Standards

Article 11(1) of the Sindh Act 2014 states that: 'Subject to the provisions of this Act and the rules and regulations, no person shall discharge or emit or allow the discharge or emission of any effluent, waste, pollutant, noise or any other matter that may cause or likely to cause pollution or adverse environmental effects, as defined in Section 2 of this Act, in an amount, concentration or level which is in excess to that specified in Sindh Environmental Quality Standards…'

The Sindh EPA has promulgated several standards, the SEQS, which were applicable to the entire province of Sindh. These include:

- Ambient air quality (9 parameters)
- Drinking water (32 parameters)
- Ambient noise
- Industrial effluents (32 parameters)
- Industrial gaseous emissions (18 parameters).

2.4 Administrative Framework on Environmental Issues

The proposed project is legally required to comply with the SEQS. The environmental standards applicable in Sindh are NEQS as developed by Pakistan Environmental Protection Agency prior to 18th Amendment. The only exception is the ambient air quality standards which Sindh Environmental Protection Agency has notified separately. **Exhibit 2.2** to **Exhibit 2.4** provide SEQS Guidelines for key parameters of ambient air quality, effluents and noise for reference.

Exhibit 2.2: SEQS Limits for Ambient Air Quality

Pollutants	*Time–weighted Average*	*Sindh Standards (µg/m3)*
Sulfur Dioxide (SO_2)	Annual	80
	24 hours	120
Oxide of Nitrogen as (NO)	Annual	40
	24 hours	40
Oxide of Nitrogen as (NO_2)	Annual	40
	24 hours	80
Ozone (O_3)	1 hour	130
Suspended Particulate Matter (SPM)	Annual	360
	24 hours	500
Respirable particulate Matter. PM_{10}	Annual	120
	24 hours	150
Respirable Particulate Matter. $PM_{2.5}$	24 hours	75

Pollutants	*Time–weighted Average*	*Sindh Standards (µg/m3)*
	Annual Average	40
Lead (Pb)	Annual Average	1
	24 hours	1.5
Carbon Monoxide (CO)	8 hours	5,000
	1 hour	10,000

Exhibit 2.3: SEQS Limits for Effluents (mg/l, unless otherwise defined)

Parameter	*SEQS (Into Sea)*
Temperature increase*	40°C or increase less than 3°C
pH value	6 to 9
Five–day bio–chemical oxygen demand (BOD) at 20°C	80**
Chemical oxygen demand (COD)	400
Total suspended solids (TSS)	200
Total dissolved solids (TDS)	3,500
Grease and oil	10
Phenolic compounds (as phenol)	0.3
Chlorides (as Cl')	SC*** (19,353)[a]
Fluorides (as F')	10
Cyanide total (as CN')	1.0
Anionic detergents (as MBAS)	20
Sulfates (SO_4)	SC*** (2,712)[a]
Sulfides (s')	1.0
Ammonia (NH_3)	40
Pesticides	0.15
Cadmium	0.1
Chromium (trivalent and hexavalent)	1.0
Copper	1.0
Lead	0.5
Mercury	0.01
Selenium	0.5
Nickel	1.0
Silver	1.0
Total toxic metals	2.0

Parameter	*SEQS (Into Sea)*
Zinc	5.0
Arsenic	1.0
Barium	1.5
Iron	8.0
Manganese	1.5
Boron]	6.0
Chlorine	1.0

Exhibit 2.4: Sindh Environmental Quality Standards for Noise

No.	*Category of Area/Zone*	*Effective from 1st July, 2010*		*Effective from 1st July, 2012*	
		*Limit in dB(A) Leq**			
		Day Time	*Night Time*	*Day Time*	*Night Time*
1.	Residential are (A)	65	50	55	45
2.	Commercial are (B)	70	60	65	55
3.	Industrial area (C)	80	75	75	65
4.	Silence zone (D)	55	45	50	45

Note:

1. Day time hours: 6 .00 am to 10.00 pm
2. Night Time hours: 10.00 pm to 6.00 am
3. Silence zone: Zones which are declared as such by the competent authority. An area comprising not less than 100 meters around hospitals, educational institutions and courts and courts.
4. Mixed categories of areas may be declared as one of the four above-mentioned categories by the competent authority.
5. dB(A) Leq: time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

3. Project Description

EPCL intends to expand its existing PVC and VCM production facility in Port Qasim. The expansion will include the following:

- Increase in production of PVC from 195 ktpy to 295 ktpy and
- Increase in production of VCM from 195 ktpy to 245 ktpy

A brief description of the existing facility and the expansion project is provided in this section.

3.1 Project Background

Two Japanese companies, the Asahi Glass Company Limited and the Mitsubishi Corporation (MC), and Engro Chemical Pakistan Limited, a major fertilizer company of Pakistan, concluded a joint venture agreement at Karachi in October 1997 to establish a joint venture company to establish the first major PVC manufacturing plant in Pakistan.

The plant was established with the realization that although the demand for PVC stood at 90,000 tons in 1996 and was increasing at a rate of about 10% annually, there was no PVC manufacturing plant in the country. The country was meeting its PVC demand through imports from Saudi Arabia, Iran, Thailand, and other countries.

Engro is the second largest fertilizer company in Pakistan. Asahi Glass is one of the largest chlor-alkali manufacturers in Asia, having its chlor-alkali business in Indonesia and Thailand in addition to its own operation in Japan. MC has polyester fiber and polypropylene film businesses in Pakistan. The total investment in the existing project was approximately US$83 million. Engro, Asahi Glass, and MC were equity partners in the ratio of 50%, 30% and 20%, respectively, in the joint venture company called Engro Asahi Polymer & Chemicals Ltd. Asahi Glass divested its shares in the company in 2006 and the current shareholding includes 56% ownership by Engro, 34% ownership by the public and 10% ownership by MC.

The plant went into operations in November 1999. Its average production annually in the six-year period since it started operation (2000-2005) is 81,000 tons. The production peaked in 2005 at 91,200 tons.

From 2006 to 2010 the plant underwent expansion. In 2008 construction and commissioning of a PVC II plant, an EDC/VCM and Chlor Alkali production facility was completed. In 2009 a combined cycle power plant of 65 MW was commissioned, a caustic plant with EDC was commissioned and back integration was completed with the VCM plant commissioned in 2009.

3.2 Operating Strategy

EPCL now plans to expand its existing PVC resin production facility of 195 kpty and its existing VCM production facility of 195 kpty by 100 kpty of PVC and 50 kpty of VCM respectively.

VCM is produced through the cracking of EDC, which is produced from ethylene and chlorine. The Chlor Alkali plant is used to produce and supply chlorine. The ethylene required for the production of EDC is imported.

3.3 Project Location

The Project will be installed in EPCL's existing plant site in the industrial estate at Port Qasim in Bin Qasim Town. Bin Qasim is the easternmost town of the 18 constituent towns of greater metropolitan Karachi. The Gadap Town borders Bin Qasim to the north, Thatta district and the Indus River to the east, the Arabian Sea to the south, and the Malir River and the towns of Landhi, Malir, and Korangi Cantonment to the west. Port Qasim was built in the 1970's to relieve pressure on Karachi Port and is today the second largest port of Pakistan handling about 35% of the nation's cargo imported by sea. A large industrial area, built over an area of 4,500 hectares (11,000 acres) surrounds the port. Major industrial units in the vicinity of the existing plant include Pakistan Steel, Pakistan PTA plant, BOC Gas, KESC power plant, and the Engro Zarkhez fertilizer blending plant. The Project is located in the Eastern Zone (Plot EZ/I/P-II-I) of BQIZ. The 65-acre land parcel that constitutes the subject Site is part of the larger 300-acre plot leased by the PQA to Engro Corporation for 50 years in February 1998. **Exhibit 3.1** shows the Project Location.

Exhibit 3.1: Project Location

3.4 Overview of the Process

PVC polymer is made by forming vinyl chloride droplets in water by vigorous agitation. Maintenance of the droplets in suspension may be achieved using surface active agents that control the rate of coalescence of monomer droplets.

Polymerization is started using monomer-soluble initiators or catalysts that break down to give the free radicals and hence initiate a free radical polymerization of vinyl chloride. During the reaction, the monomer droplets are allowed to coalesce in a controlled manner to give solid particles with the required particle size and structure.

Reactions are carried out at different temperatures to give different grades of product with the required molecular weight. Following the reaction stage, the untreated monomer is recovered from PVC slurry and the slurry is dried to produce a dry powder final product. The major stages of the processing include the following:

- Reception and storage of raw materials (VCM, initiators and additives)
- Polymerization
- Polymer drying
- Polymer storage

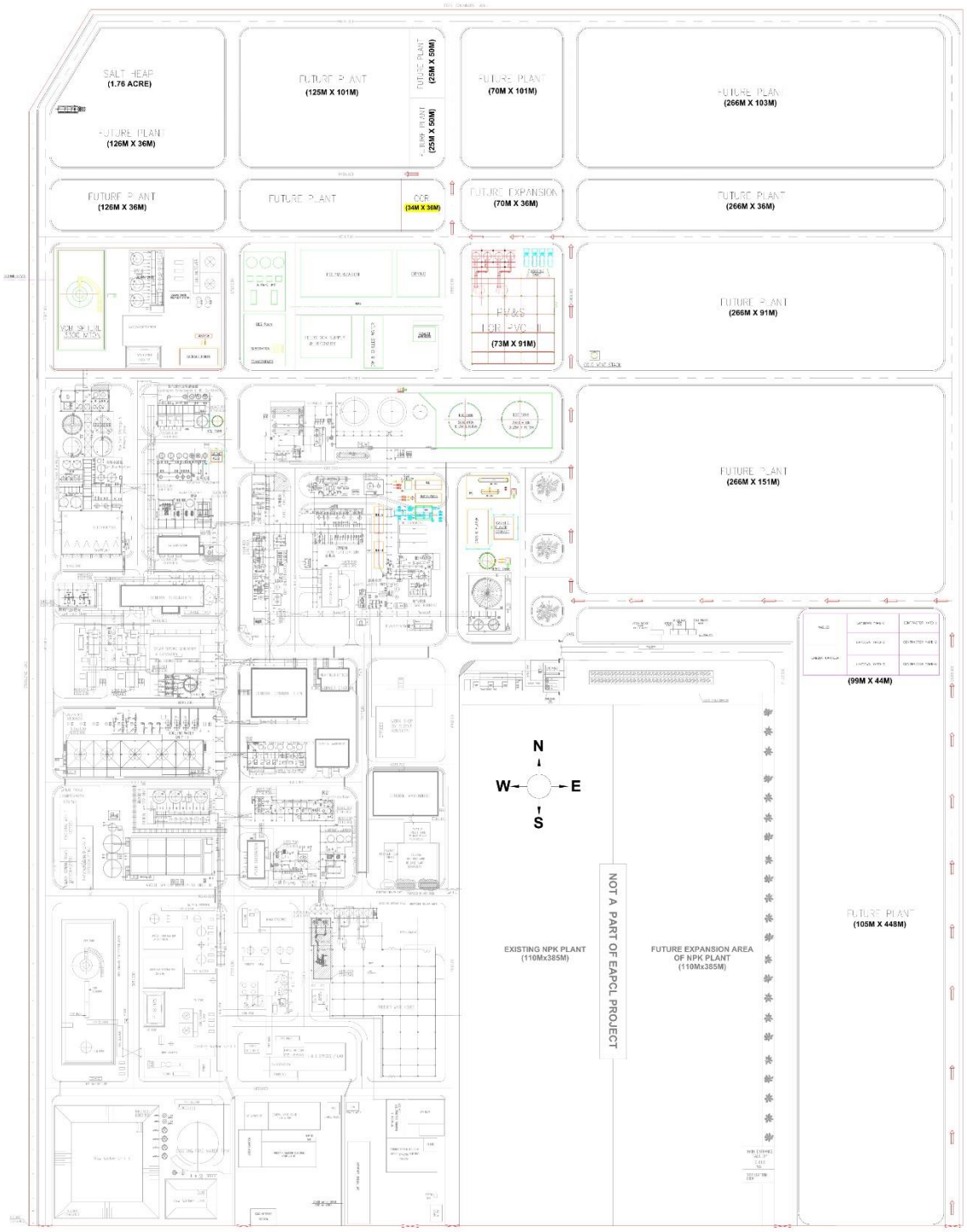
Other processes run parallel to the above include:

- Mixing of recovered VCM with fresh VCM
- VCM recovery
- Wastewater striping
- Demineralised water

3.4.1 Existing Plant Layout

Exhibit 3.2 shows the layout of the existing plant as well as with the planned developments.

Exhibit 3.2: Project Layout



Surface Cover

Of the 65 acres covered by the Site, 32 acres (49%) is either sealed with concrete or occupied by paved roads, plant machinery, utilities, and buildings. 33 acres (51%) of the

land is unsealed open areas including salt yard, open areas around the evaporation pond, scrap yard, unpaved track and green areas.

Site Buildings

There are several buildings at the Site for offices, laboratory and warehouses. These include:

- Administration, technical and canteen building
- General warehouse, labor canteen and offices building
- Laboratory, substation, main control room and field offices building
- Residential Area

Current Operations

The annual Plant production is 150 -kilotons (kt) of PVC, 230 kt of EDC, 204 kt of VCM, 107 kt of caustic soda, 20 kt of Hypochlorite, 60 kt of Hydrochloric acid (HCl), and 3 kt of Hydrogen. The product development processes are described below:

- Chlorine is obtained by electrolysis of sodium chloride (NaCl), the by-products of this process are caustic soda, sodium hypochlorite, hydrochloric acid, and Hydrogen gas. On-site gas turbines (described below) provide electricity for the electrolysis process.
- Through direct chlorination, Chlorine is reacted with Ethylene (obtained as raw material import) within a catalyst containing reactor to form the intermediate material EDC.
- EDC is thermally cracked to produce VCM.
- VCM is passed through the polymerization reactor in presence of water and suspending agents, and high-speed agitation produces small droplets of VCM. The VCM droplets form PVC under set pressure and temperature.

3.4.2 Transfer pipeline from Storage Facility to PVC Plant

The VCM in the existing setup is transported from storage facility at Port Qasim to the PVC plant through a six-inch diameter pipeline. The approximate length of the line is six kilometers. The right of way (RoW) is assigned by Port Qasim Authority (PQA) for all chemical and utility lines running between western zone and eastern zone of the Port Qasim. A 40 meters wide zone of RoW has been spared for this purpose. Most of the lines are buried except while crossings of marshy land, seawater intake channel of the Pakistan Steel and Pipri and Badal nullahs. The capacity of the line is more than 300 tons per day. Safety factors like the risk of fire, external corrosion, accessibility for maintenance and inspection, minimization of risk during accidental leakages, and isolation valves were evaluated and incorporated in the design at the time of construction.

3.4.3 VCM Storage at VCM Plant

Approximately 300 tons per day of VCM is delivered to the plant. The VCM is stored in a single pressurized, spherical tank with a capacity of 3,500 cubic meters (m^3). The tank is designed for a pressure of 8.5 kg per cm^2 G and temperature of up to 50 °C.

3.4.4 Operational Controls

Majority of the operations are centrally controlled and connected to computers and alarm systems in the control room. Manual operating procedures are also available for dealing with emergencies.

3.4.5 Power Supply

Electrical power is primarily supplied by in-house power generators.

3.4.6 Storage Facilities

There are two types of storage facilities associated with the plant. These include raw material storage facilities and product storage facilities.

Raw material storage facilities are located at the site and at Engro Vopak Terminal Limited (EVTL). EVTL supplies EPCL with ethylene. The storage facilities are as follows:

- 7.5 kT Ethylene cryogenic storage at EVTL
- 5 kT EDC storage at EPCL plant site
- 7 kT EDC storage at EVTL
- 3 kT VCM storage at EPCL plant site
- 3 kT VCM storage at EVTL
- 100 kT Salt storage at EPCL plant site

Product storage is entirely at the site. The storage facilities are as follows:

- 5 kT PVC storage at EPCL plant site
- 3.5 kT Caustic Soda storage at EPCL plant site
- 0.3 kT Sodium Hypo Chlorite storage at EPCL plant site
- 0.3 kT HCl storage at EPCL plant site

3.4.7 PVC-II Plant

The PVC-II plant was commissioned in 2008. Details of its design and operation are provided in this section.

Design

The plant produces 50,000 metric tpy of polyvinyl chloride resin. The annual operational hours of the plant are 8,000. VCM is used as raw material. The plant includes the following:

- VCM Service Tank
- Polymerization
- VCM Stripping
- Drying
- Storage and Bagging
- VCM Recovery
- Catalyst Preparation and Storage
- Well Coating System and Wastewater Treatment
- Refrigeration

Utilities

The following utilities are used:

- Freshwater
- Pure water
- Fire water
- Circulation cooling water
- Chilling water
- Instrument air
- Plant air
- Nitrogen
- Low pressure steam
- Steam
- Electricity

Storage and Charging of VCM and Water

Fresh VCM is stored in the VCM tank. The recovered VCM from the VCM recovery unit is stored in a separate tank, the Recovered VCM tank. Cold de-ionized water is used for polymerization charging. It is also used for injection of water for shaft sealing, pipeline flushing, flushing of discharge filter and injection of water for the polymerization reaction. Cold de-ionized water is stored in a cold deionized water tank while hot de-ionized water, after heating with steam, is stored in a hot deionized water tank.

Polymerization

Polymerization is carried out in an autoclave with an agitator. The heat is removed using cooling water. This is a batch process with a volume of 70 m^3. The following procedures are involved:

- Feeding of VCM and de-ionized water
- Feeding of initiator, dispersant and other chemicals
- Polymerization reaction
- Addition of terminator when polymerization reaction ends
- Discharge of PVC slurry
- Autoclave flushing and liquid spray
- Preparation for the next production cycle

VCM Recovery

The un-reacted VCM comes from the Polymerization Autoclave Discharge Tank, Foam Separator and Stripping Tower boosted by the Compressor System. It is stored in condensate tank for use in polymerization.

Alarm and Interlock System

In order to avoid incidents such as overpressurization, release, fires or run away reactions, necessary alarms and interlock systems are installed. Flammable gas detectors are installed in areas where flammable gases exist. Alarms will sound in the emergency panels within the control room.

Waste Gas

The waste gas emission in this plant is dryer vent. The flow rate of drying waste gas is 75,000 Normal cubic meters per hour (Nm^3/h) at a height of 30 meters (m) and temperature at the source of 100 °C. The waste contains water vapors, VCM (1.3 kg/h or 18mg/Nm^3) and PVC powder (maximum 100/Nm^3).

Wastewater

The wastewater includes centrifugal mother liquor, stripping wastewater and flushing water from equipment and the ground. The normal amount of wastewater is 38-41 m^3/h. It is treated in the wastewater pre-treatment facility and discharged after satisfying SEQS.

Solid Waste

Solid dry sludge is produced from the wastewater pre-treatment plant. The quantity is 25 tpy.

Noise

The main source of noise in the plant is the blower, compressor and pumps. The majority of equipment produces noise less than 85 dB (A), with some exceptions producing nose of 100 dB (A).

3.4.8 Chlor-alkali Plant

The Chlor-alkali plant was commissioned in 2008. The plant produces about 107,000 tpy of caustic soda and 91,600 tpy of chlorine. Details of its operations are described in this section.

Process

The ion membrane caustic soda process includes the following:

- Primary brine and crude salt storage
- Secondary brine and electrolysis
- Secondary brine purification
- Electrolysis
- Depleted brine de-chlorination
- Chlorine and hydrogen gases treatment and chlorine absorption
- Chlorine gas treatment
- Hydrogen treatment
- Chlorine absorption
- High purity hydrochloric acid production
- Evaporation
- Tank farm building of dilute sulfuric acid and other acids.

Wastewater Treatment

The main sources of wastewater include equipment and floor washing water, which contains CL^-, Na^+ and SO_4^{2-}. Except for treatment in the septic tank the waste domestic water is mixed with the waste production water and discharged from the plant. The flow rate is between 6-12m^3/h and the quality is as follows:

- pH: 6.0-9.0
- Chemical Oxygen Demand (COD): Maximum 150 mg/l
- Biological Oxygen Demand (BOD): 50mg/l
- Suspended Solids (SS): 150-180 mg/l

Emissions

The Chlor-alkali plant emissions mainly consist of hydrogen, nitrogen, and water vapor. It contains about 10 ppm of HCL vapors.

3.4.9 EDC-VCM Plant

The EDC-VCM plant was commissioned in 2008. Details of its operations are provided in this section.

Direct Chlorination

Ethylene and chlorine combine in a homogeneous catalytic reaction to form EDC. Ferric chloride is used as the catalyst. The reaction takes place at a temperature of 49ºC and 345 kilo-pascal of pressure. This is an exothermic reaction and heat removal is accomplished using cooling water. The equation for the reaction is as follows:

$$C_2H_4 + CL_2 \rightarrow C_2H_4CL_2 + 218 \text{ kJ/mole}$$

Ethylene is fed in slight excess to the stoichiometric ratio to ensure complete utilization of chlorine and maximum yield of EDC. The reaction products are 99% liquid EDC and 1% chlorinated hydrocarbon gases. The gases are sent to the incinerator via EDC recovery and the liquid is pumped to crude EDC storage after water and caustic wash. Natural gas is added into the gaseous stream which dilutes chlorine bound oxygen below explosive limits.

Oxy Chlorination

Ethylene is reacted with hydrochloric acid, recycled from EDC cracking to produce more EDC thereby consuming every molecule of chlorine. Air is also injected as a source of oxygen. The reaction takes place in the gaseous phase in a fluidized bed reactor charged with cupric chloride ($CuCl_2$) catalyst at about 400°F and 80 psig. Heat from the reaction is removed by generating low pressure and saturated steam at 150 psig. The equation for the reaction is as follows:

$$C_2H_4 + HCL + ½\ O_2 \rightarrow C_2H_4Cl_2 + H_2O + 238kJ/mole$$

Water is separated from EDC and sent to wastewater treatment via stripping to recover EDC. Crude EDC is sent to storage. Gaseous streams containing chlorinated hydrocarbons are sent to the incinerator prior to their emission into the atmosphere. Crude EDC is purified in a series of distillation processes where water, light-ends, and heavies are separated. Dry purified EDC is then fed to the cracking unit for VCM production.

EDC Cracking

Purified EDC is fed to cracking furnaces where it decomposes into VCM and hydrochloric acid as follows:

$$C_2H_4CL_2 \rightarrow C_2H_3CL + HCL - 71kJ/mole$$

Cracking temperature is ≤1,000ºC. Conversion efficiency is 56-60%. Reaction products and un-reacted EDC are cooled immediately in the Quench Section to minimize coking and reaction reversal. Hydrochloric acid (HCL) is separated from EDC and VCM and sent to the Oxy Chlorination Unit. Subsequently, EDC is separated from VCM and recycled. VCM is sent to storage.

Emission and Effluent

The effluent of the EDC-VCM plant has the following characteristics:

- Flow rate: 35 m^3/h
- pH: 7.18

- DO: 4.39 ppm
- BOD: 43.47 ppm
- COD: 127.40 ppm
- TSS: 13.75 ppm
- TDS: 2,620.00 ppm
- Chloride: 1,270.88 ppm
- Fluoride: 0.50 ppm
- Sulfate: 287.23 ppm
- Copper: 0.04 ppm
- Lead: 0.02 ppm
- Nickel: 0.06 ppm
- Barium: 0.53 ppm
- Boron: 1.20 ppm

The wastewater is treated in a wastewater pre-treatment facility and discharged after ensuring compliance with SEQS.

An incinerator is installed at the EDC-VCM plant to burn all the potentially hazardous gases emitted from the plant. The maximum emission level from the incinerator is as follows:

- Flow rate: 12,700m^3/h
- CO_2: 2.85t/hr
- CO: 800µg/m^3
- CL_2: 150µg/m^3
- NO_x: 400µg/m^3
- SO_2: 1,700µg/m^3
- HCl: 400µg/m^3

3.4.10 Ethylene Import Pipeline

Ethylene is transferred to the direct chlorinator through a 6–inch diameter, 6 km long line from Engro Vopak Terminal Limited (EVTL) where it is stored at -103°C at atmospheric pressure. It is vaporized and transferred to the plant in gaseous form. The line follows the same route as the existing VCM line. It has a Cathodic Protection (CP) system, and emergency isolations, pressure and temperature indications. Exposed portions of the line are insulated to avoid external corrosion and exposure to sunlight. A pressure relief valve is installed on the line to release excess pressure in any contingency. The line is painted and best inspection practices are followed to ensure integrity.

The line is under continuous operation during normal operations. It provides identical flow metering systems at EVTL and EPCL. The differential in flow identifies any leaks from the line.

3.4.11 Utilities

Utilities consumed by the Plant include electricity, water and natural gas.

Electricity

The Plant meets its electricity requirements from its own generation. A 65 MW combined cycle power plant is operational at the Site. The power plant is normally run with natural gas (methane) and occasionally on diesel fuel when the gas pressure is low or when there are other emergency needs.

The power consumption is estimated to be 200 kW.

Raw Water Supply

The total water requirement of the plant, depending on the load, is 3 million gallons per day and is supplied by the Karachi Water and Sewerage Board.

Natural Gas Supply

The natural gas requirement of the Plant is fulfilled through Sui Southern Gas Company supply lines. The daily requirement of natural gas, depending on load, is between 8 and 0.354 million standard cubic meters per day.

The consumption is estimated at 75 m^3/hour (2,348,250 Kcal/hr).

Firefighting

The following arrangements are there for firefighting:

- Outdoor hydrants
- Fixed fire water monitor
- Indoor hydrants and firefighting vertical pipe
- Fire extinguishers

3.5 Proposed Development Project

Expansion of the existing PVC and VCM plant will include the installation of new units and the addition of processes to generate the required quantities of PVC and VCM.

3.5.1 Plant Configuration

The PVC-III plant will comprise the following process units:

- Feedstock section
- Polymerization section including chemicals preparation
- Slurry stripping section

- Drying section
- VCM recovery section
- PVC packaging and storage

It will also include the following new utilities' facilities:

- New MCC
- New CCR
- Catalyst storage
- Pipe rack
- Underground piping
- High pressure nitrogen gas

The activities involved in the PVC-III plant are described below.

Caustic Flaker Unit

The 50% caustic feed already available as a final product at the CA plant will be fed to the facility where it will be concentrated up to 98 % in nickel-based two stage pre and final falling film concentrators. The unit uses natural gas to further increase the Caustic Concentration to 99% melt. There is no toxic release expected from this unit. The effluent of the unit will go to the main effluent along with others and will comply with SEQS at the boundary wall after treatment.

Feedstock Section

In the feedstock section, various raw materials and chemicals together with demineralized water will be stored and fed to their consumer points.

VCM

Fresh VCM will be transferred from outside the Battery Limit to the VCM Service Tank and then fed to the Reactor through the VCM Charge Pump.

EDC

An EDC storage tank will be set up as part of the proposed Project. It will have a capacity of 5,000 tons and will be provided with nitrogen blanketing and diluge/sprinkler systems to ensure safe and environmentally friendly operations.

An EDC import pipeline of length 7,000 m and flow capacity of 150 TPH will be established as part of the Project. It will run from EVTL and EPCL with storage of 6,900 MTons at EVTL.

Demineralized Water

Demineralized water, supplied from the Battery Limit, will be fed to the Degassing Unit where oxygen content dissolved in demineralized water will be less than 1 ppm. The

demineralized water will be discharged from the Degassing Unit and sent to the Pure Water Tank through the Pure Water Cooler to cool down to 30ºC and will be stored here.

It will then be charged to the Reactor using the Pure Water Charge Pump. The pump will be operated continuously to supply and/or clean various points of the PVC-III plant. Demineralized water in the Injection Water Tank will be used for sealing the mechanical seal of machinery such as the Slurry Pump and Agitator.

Regarding the Hot Charge System, the demineralized water will be supplied to the Hot Pure Water Tank and then circulated by the Hot PW Circulation Pump through Pure Water Heater for heating. The hot demineralized water will be charged to the Reactor by the Hot Pure Water Pump for heating up the content of Reactor to polymerization temperature.

Catalyst Storage

Catalysts will be stored in the Catalyst Warehouse outside the Battery Limit at -20ºC where refrigerators will be furnished to provide the required temperature conditions.

Polymerization Section

Suspension polymerization of VCM will be carried out in batch operation under pressure.

Chemical Preparation

The Suspension Agent (SA) in powder form will be charged after being weight-measured manually and stored in the SA Hopper. It will be transferred into an SA Solution Tank where it will be dissolved in pure water by heating and/or cooling which varies depending on the SA grade. The SA solution will then be transferred to each SA Storage Tank and stored there at about 20ºC. Additives will be dissolved and stored in their respective Additive Tanks.

Poison will be stocked in the Poison Tank. It will be used only for emergency-stop of polymerization in cases such as complete power failure. Anti-fouling agent (NS) will be stored in the NS Tank and will be used as an agent promoting the close-manhole operation of Reactors for coating on inside surface of Reactors.

Catalyst Storage

Three kinds of catalysts will be used in the PVC-III plant with a Catalyst Stock Tank for each type. All catalysts will be stored at under -20ºC using a Brine Circulation System.

The control of catalysts charged to Reactors will be carried out automatically by a central DCS control. The necessary catalysts will be selected and each kind will be fed to the Catalyst Measuring Tank in order after which it will be fed to the Reactor using pressurized nitrogen and demineralized water. Solvents will not be used to feed catalysts.

Polymerization Operation

Polymerization consists of a combination of VCM, demineralized water, catalysts, suspending agents and other chemicals, and operational parameters.

A specified amount of cooled demineralized water, sealed with nitrogen gas in the tank, will be charged into the Reactor through a batch meter. The specified amount of aqueous SA solution, stored in an SA Storage Tank, will automatically be poured into the Reactor by a batch meter during charging by the demineralized water. The demineralized water and SA solution will be held in the Reactor and mixed.

A measured quantity of catalyst solution will be fed into the Reactor. A specified amount of VCM will also be fed into the Reactor through a batch meter and VCM Charge Filter. Demineralized water will also be injected from the bottom of the Reactor at a constant rate. The contents of the Reactor will be violently stirred to maintain good suspension conditions.

During the charging of VCM, a specified amount of hot demineralized water will be charged into the Reactor to bring and maintain the contents of the Reactor at the set polymerization temperature. The temperature of the Reactor will automatically be controlled so as to be constant by adjusting the flow rate of the cooling water. All heat generated from the reaction will be removed by cooling through the Reactor Jacket, Baffles and Reflux Condenser. The drop in pressure in the Reactor signals the end point of the reaction.

After the end of the reaction, a neutralizer and additive will be charged into the Reactor through the Additive Measuring Tank using pressurized nitrogen and demineralized water, after measuring through a Neutralizer Tank and Additive Tank, one by one. The additive will be used to obtain higher quality PVC product.

Discharge of Slurry

The PVC slurry in the Reactor will be blown down through the Slurry Discharge Pump into a High Pressure Blowdown Tank. The unreacted VCM will be recovered through a VCM Recovery Compressor.

After recovering VCM the slurry will be transferred to the Blowdown Tank by a Slurry Transfer Pump. The slurry in the Blowdown Tank will be fed to the Slurry Stripping Section through a Stripping Slurry Feed Pump.

After completion of the slurry discharge step, anti-fouling agent (NS) will be sprayed through a spray head fixed inside the Reactor. It will be fed under pressure to spray nozzles directly from the NS Tank. Before spraying of NS, gas will be sucked from the Reactor using the Reactor Evacuation Blower. In this way both NS and steam will enter the Reactor and condense on the Reactor internals flowing down to the bottom.

Considerable care will be taken in selecting a polymerization recipe because the amount and type of chemicals and operational parameters significantly affect the stability of the reaction, reaction rate and the quality of product. All operational data is maintained in the DCS for every PVC grade.

Slurry Stripping Section

In this section, the residual VCM in the PVC particles will be stripped out of the PVC slurry with steam and recovered to the VCM Recovery Section.

After polymerization, the PVC slurry in the Blowdown Tank will contain 10,000 to 30,000 ppm of VCM (based on dry PVC). The PVC slurry in the Blowdown Tank will be pumped up by the Stripping Slurry Feed Pump and fed to the top zone of the Stripping Column at a specified rate, while being heated up by the de-monomered slurry, which will be discharged from the bottom of Stripping Column, through a Slurry Heat Exchanger.

Steam will be fed into the bottom of Stripping Column. The PVC slurry fed to the Stripping Column will be heated up with rising steam and will flow down to the bottom while liberating VCM contained in it.

The PVC slurry will be kept on trays inside the Stripping Column, being in good contact with steam and keeping it in boiling condition. The standard temperature of steam stripping in the process will be around 100ºC and the column pressure will be that of a slight vacuum.

The hot PVC slurry, which will by now be practically free from VCM, will be continuously charged from the bottom section of the Stripping Column and sent to the Slurry Tank after being cooled by the feed slurry through the Slurry Heat Exchanger.

The overhead vapor consisting of steam and VCM stripped out of the PVC slurry will be cooled by condensers. Steam will be condensed in the Condensers to be separated from the VCM and the separated VCM gas will be recovered to the VCM Recovery section through a Stripping Vacuum Pump. Meanwhile, hot demineralized water, prepared in a Stripping Hot Water Tank, will be intermittently injected into the Stripping Column at a fixed rate in order to rinse away the PVC powder stuck to the inside of the column.

VCM Recovery Section

In this section, the unreacted VCM will be recovered and treated for re-use. This VCM will be compressed by R-VCM Compressors in series up to about 0.7 MegaPascal (MPaG). The inhibitor will be injected into the VCM gas to prevent VCM from polymerizing. The compressed VCM gas will be condensed in the R-VCM condenser and R-VCM Vent Condenser from where the inert gas containing VCM will be fed to the Waste VCM Gas Tank. The condensate will be introduced into the R-VCM Decanter in order to separate accompanying water. This separated water will be drained into a Waste Water Tank. The liquefied VCM will be cooled down through a VCM Cooler with chilled water below 20ºC and will automatically be sent to the R-VCM Tank. The recovered liquefied VCM will be re-used as feedstock for the succeeding polymerization reaction.

Wastewater containing VCM will be collected from various parts of the PVC-III Plant into the Waste Water Tank. This wastewater will be pumped up by a Waste Water Pump and fed to a Waste Water Stripping Column after being pre-heated through a Waste Water Heat Exchanger by VCM stripped wastewater discharged from the bottom of the Column.

The VCM dissolved in wastewater will be stripped out by means of stream-stripping using steam fed to the bottom of the Stripping Column. Waste vapor and VCM leaving from the top of the Column will be condensed in the Waste Water Condenser. Uncondensed VCM will be recovered and returned to the VCM Gas Buffer Tank. The

VCM stripped wastewater will be sent from the bottom of the Column to a Waste Water Treatment Unit by a Waste Water Discharge Pump after being cooled through a Waste Water Heat Exchanger.

Waste VCM gas discharged from the Waste Gas Tank will be sent to the Waste VCM Recovery Unit. The separated VCM will be recovered to the VCM Gas Buffer Tank and the remaining waste gas will be purged to the atmosphere.

Drying Section

In this section, the wet PVC cake will be separated from the PVC slurry and dried to obtain the PVC product. After VCM stripping the PVC slurry will be fed to a centrifuge continuously in order to separate the wet cake from the PVC slurry. The wet cake contains 18 ~ 27 wt. by percentage of water (based on wet base). The wet PVC cake discharged from the centrifuge will be dropped into fluidized bed dryers, where the moisture will be removed from the PVC powder to below 0.3 wt. by percentage. The necessary heat for drying will be supplied by hot air from steam through the heating tubes installed in fluidizing zones.

The dried PVC powder will be discharged from the Dryer through a Rotary Feeder and transferred to the Product Sieve where PVC powder will be screened and oversized materials separated from undersized products.

An Exhaust Scrubber will be available to prevent dust-pollution. Wastewater separated from the PVC slurry in centrifuges will be recovered into a Spent Pure Water Tank. A part of this spent pure water will be recycled to the PVC Plant by a Spent SP Pump, to be re-utilized for washing/cleaning of Reactors.

The SP Pump will be re-utilized for washing of the Blowdown Tank, Slurry Tank and other PVC-slurry handling portions. Another part of the spent pure water will be utilized for pre-heating of air used for Dryers, which is very effective for saving of steam consumption, especially in winter. The remaining spent water will be discharged to the Wastewater Pond.

PVC Packaging and Storage Section

There will be a single PVC packaging system which will include two sets of packaging machines and a set of palletizer.

The PVC powder, stored in silos (200 tonnes/per silo) in advance will be used for packaging. It will enter the Charge Hopper located at the bottom of the silo. There will be a DCS-25 packaging machine in the bottom of the Charge Hopper that will be used to scale the powder of PVC. The PVC powder will flow from the Charge Hopper to the DCS-25 packaging machine using gravity. The Gravity Feeder will be used to ensure packaging to high precision.

After the PVC powder has moved through the DCS-25 packaging machine, it will go into the Discharge Hopper. The Discharge Hopper will be fixed with a net weight weigher (load cells, digital weighing controller). When packing begins, one person will be needed to open and embed the bag outlet of the Discharge Hopper. The PVC powder will then flow into the packaging bag from the Discharge Hopper. The bags which are filled with

the PVC powder will be transmitted to sewing machines, using a sewing conveyor (belt). Each bag will be turned down by a bag-tipping conveyor and be flattened by bag flattening conveyor. The belt conveyor will convey the full bag to a metal detector and weight-checking scale. Bags that pass quality control will move through an ink-jet printer, lifting conveyor, bag-feeding conveyor and enter a palletizing unit. Bags that do not pass this control will be rejected.

Finally, in the palletizing unit, the palletizer will take the PVC powder bag to a stack-packing machine. After stack-packing the palletizing conveyor will feed the pallet bag to a stack buffer conveyor and a forklift will convey the pallet bag from the stack buffer conveyor to storage.

Other Storage

Storage tanks for Sodium Hypochlorite and Hydrochloric Acid will be established.

Sodium Hypochlorite

This tank will have a capacity of 431 m^3. It will be FRP and PVC lined.

Hydrochloric Acid

This tank will have a capacity of 287 m^3. It will also FRP and PVC lined. It will be nitrogen blanketed and vapors from the tank will be connected to the existing scrubber system to avoid releases to the atmosphere.

MTPD Spent Sulfuric Acid Recovery Plant

98% sulfuric acid is currently being used at the CA plant to dry chlorine gas for compression in a 3-stage countercurrent process. The purpose of this plant will be to concentrate & recycle the resulting 78% spent sulfuric acid back to 96~98% for re-use in the chlorine drying process. There is no emission from this equipment. The water from this unit, if any will go to the existing wastewater system and be discharged to the sea along with effluent from rest of the site.

4. Existing Environment of the Project Area

This section describes the baseline environmental conditions in the Area of Influence of the Project. Physical, Ecological and Socioeconomic conditions of the area are discussed.

4.1 Area of Influence

The potential impacts of the Project on its surrounding physical and biological environments include air and water quality impacts, noise generation and land transformation. These are expected to reduce with increased distance from the Project facilities. For assessment of impacts on the physical environment, on ecology and on the socioeconomic environment different Study Areas have been selected due to differences in receptors. These Study Areas are shown in their respective sections.

This section defines the prevailing physical, ecological and socioeconomic conditions in the area.

4.2 Physical Environment

The baseline for physical environment includes a description of topography, geology, seismicity, climate, air quality, water resources and quality, noise levels, and traffic.

4.2.1 Study Area

The physical environment Study Area, depicted in **Exhibit 4.1,** includes an area within a 1 km radius around the center of the Project. This accounts for an area in which the physical environment may be impacted by the Project related activities. The discussion on topography, climate and geology, extends further than this Study Area as described in the respective sections.

4.2.2 Scope and Methodology

The specific tasks covered under the physical baseline study included:

- Review and analysis of secondary information to characterize baselines, particularly topography, geology, climate, traffic, water resources and seismicity.
- Field surveys for characterization of Study Area - specifically: ambient air quality, water quality, and noise levels.

4.2.3 Topography

The topographic relief in the Study Area is relatively gentle, increasing in elevation at approximately 10 meters (m) per km towards the north of the Study Area. The proposed plant site is flat and there is no natural vegetation on the site. **Exhibit 4.2** shows the regional topography. The topography in the Study Area is between 5 m and 20 m above mean sea level.

4.2.4 Geology

The lithological units within the Study Area, and in the region, are shown in **Exhibit 4.3**.[6] According to the geological map of Pakistan, the Study Area is uniformly TPM (Tertiary, Pliocene, and Miocene) sedimentary rocks associated with the southern extension of the Kirthar Range. It is in Manchar formation, mostly Pliocene in age consisting of shale, sandstone, and conglomerate with thickness up to 1,372 m.

4.2.5 Seismicity

Port Qasim is located adjacent to an active tectonic setting and is approximately 190 km east of the triple continental junction between the Arabian, Eurasian and Indian plates. The proposed project is located in the seismotectonic region of the Kirthar Ranges, where a moderate level of seismic activity is believed to exist, but large magnitude earthquakes are rare. **Exhibit 4.4** shows the Global Seismic Hazard Map of Pakistan (GSHAP).[7] According to this, the peak ground acceleration (PGA) with a 10% probability of exceedance in 50 years is between 0.8 and 1.6 m/s^2.

4.2.6 Climate

The climate at Port Qasim is characterized as hot and dry during summer, and mild during winter with heavy, sporadic, rainfall during the monsoon. The southwest monsoon prevails from April to October in the Study Area. The monsoon is characterized by a reversal in wind direction during the remaining months; and, heavy rainfall over most of the Indian Subcontinent.

The hottest months are from mid - March to June. The winters are mild with the temperature dropping to 10 degrees (^{0}C) in January. Karachi receives approximately 217.3 millimeters (mm) of rain annually. Almost 80% of the rain is concentrated in the monsoon season. **Exhibit 4.5, Exhibit 4.6** and **Exhibit 4.7** shows the monthly weather parameters and recorded mean monthly rainfall and precipitation, respectively, based on the long-term data (1961-1990) measured at Karachi Airport Meteorological Station,[8] 26 kilometers (km) from the Project Site.

The general characteristics of the seasons based on this data are described as follows:

Summer (mid-March to mid-June)

Characterized by high temperatures, moderate rainfalls with moderate atmospheric humidity and high speed-winds that blow from southwest towards northeast.

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6 Geological Survey of Pakistan (GSoP) and United States Geological Survey (USGS). "Geological Map of Pakistan [Scale: 1:2,000,000]" (1964)

7 Giardini, D., Grünthal, G., Shedlock, K. M. and Zhang, P.: The GSHAP Global Seismic Hazard Map. Annali di Geofisica 42 (6), 1225-1228, 1999.

8 Station: Karachi Airport, Location: 24d 54m N, 67d 08m E, Elevation (barometer): 22m Data Coverage 1961 – 1990 (30 years) for temperature, humidity and rainfall, 1975-1978 (4 years) for wind **Source:** Pakistan Meteorological Department

Summer Monsoon (mid-June to mid-September)

Characterized by high temperatures, high rainfalls with high atmospheric humidity and high speed-winds that blow from southwest towards northeast.

Post-Monsoon summer (mid-September to mid-November)

Characterized by moderate temperatures, low rainfalls and low speed-winds that normally blow from southwest towards northeast with the direction of wind changing at the end of post-monsoon summer from northeast to southwest.

Winter (mid-November to mid-March)

Characterized by low temperatures, dry conditions with low atmospheric humidity and a significant reduction in wind speeds that blows from northeast to southwest with the direction of wind changing at the end of winter from northwest to southeast.

Exhibit 4.1: Study Area

Exhibit 4.2: Topography in the Study Area

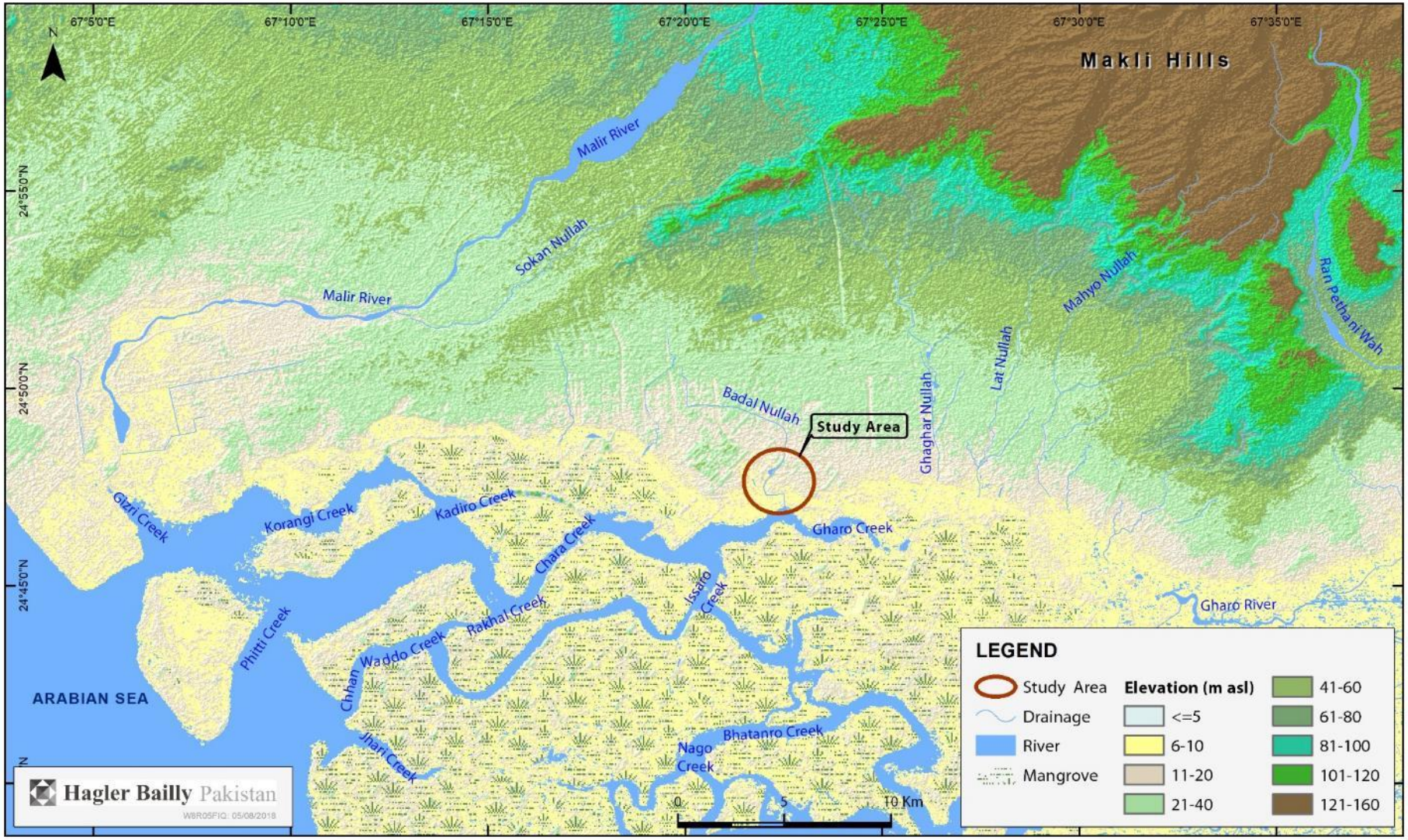


Exhibit 4.3: Geology in Study Area

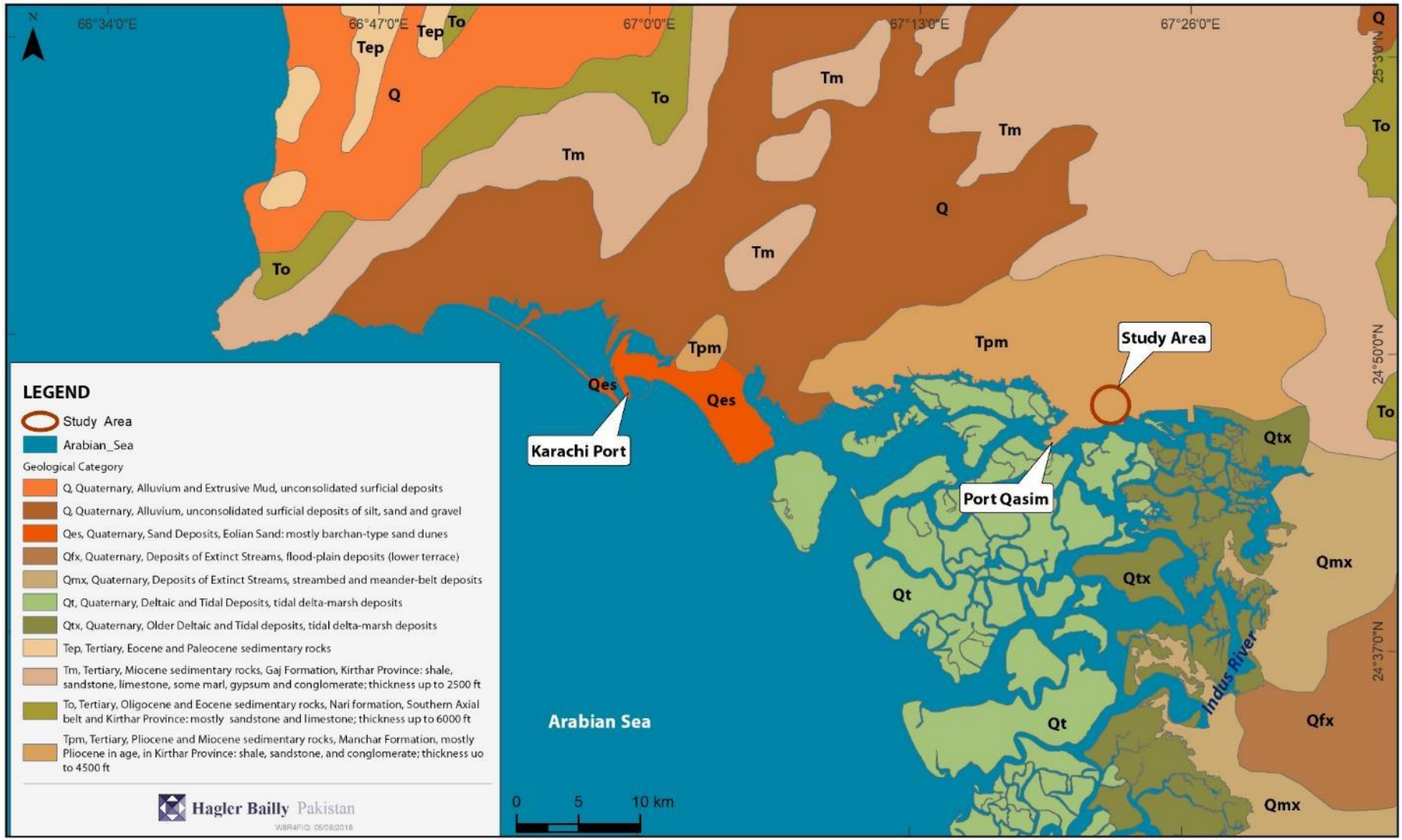


Exhibit 4.4: Seismic Hazard Map of Pakistan

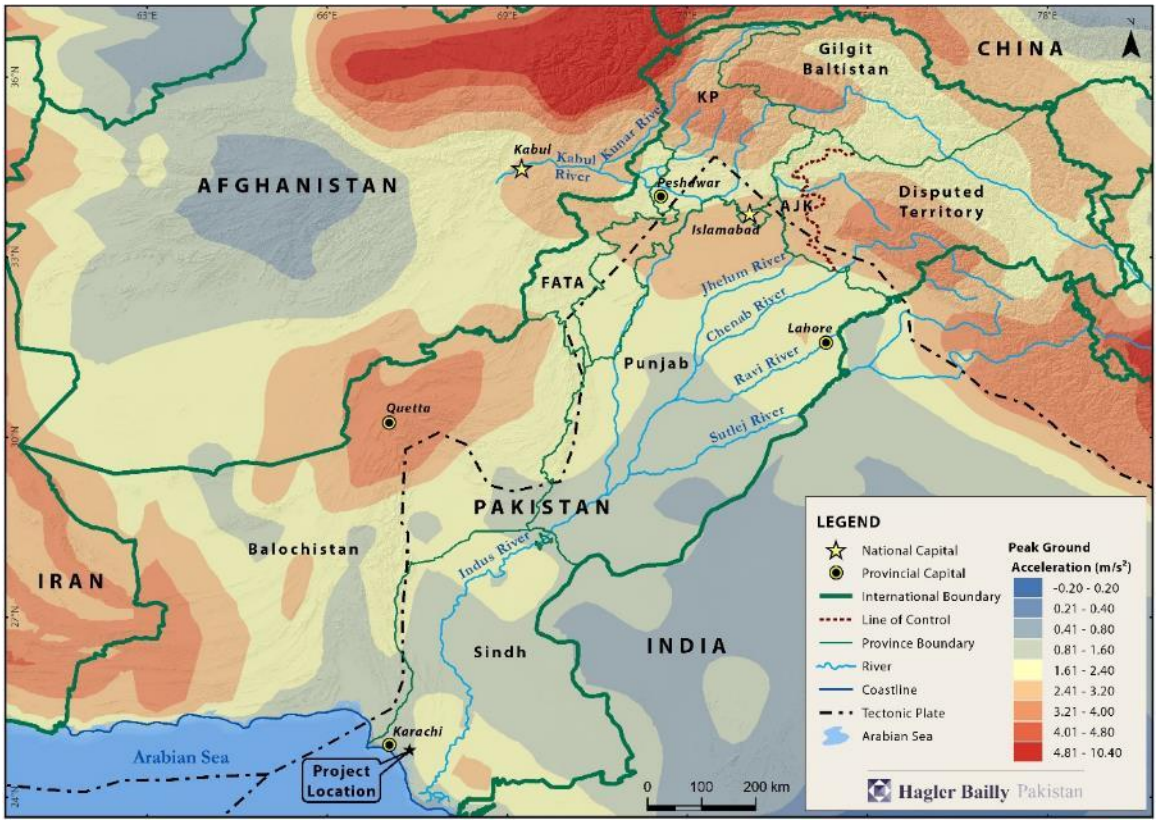


Exhibit 4.5: Mean Climatic Data of Karachi Airport Meteorological Station

Month	*Temperature (°C)*			*Relative Humidity*		*Rainfall*	*Mean Wind*	
	Mean	*Max*	*Min*	*5:00 AM*	*5:00 PM*	*(mm)*	*Speed (m/s)*	*Direction (degree)*
Jan.	18.1	25.8	10.4	66	36	6.0	1.3	36
Feb.	20.2	27.7	12.7	71	39	9.8	1.6	320
Mar.	24.5	31.5	17.6	78	44	11.7	2.0	263
Apr.	28.3	34.3	22.3	83	49	4.4	3.0	259
May	30.5	35.2	25.9	84	60	0.0	4.4	256
Jun.	31.4	34.8	27.9	83	65	5.5	4.2	249
Jul.	30.3	33.1	27.4	82	71	85.5	4.0	255
Aug.	28.9	31.7	26.1	86	73	67.4	4.3	263
Sep.	28.9	32.6	25.2	85	66	19.9	3.5	265
Oct.	27.9	34.7	21.0	80	48	10.0	1.6	259
Nov.	23.9	31.9	15.9	70	40	1.8	1.4	34
Dec.	19.5	27.4	11.6	66	38	4.4	1.0	47

Exhibit 4.6: Temperatures (°C) Recorded at Karachi Airport Meteorological Station

Month	*Mean of Monthly*		*Highest Recorded**		*Lowest Recorded**	
	Maximum	*Minimum*	*Value*	*Date*	*Value*	*Date*
Jan.	29.1	6.1	32.8	16/1/1965	0	21/1/1934
Feb.	32.0	7.7	35.0	29/2/1960	2	11/2/1950
Mar.	36.1	12.2	39.0	26/3/1977	8	2//31939
Apr.	40.1	17.7	44.0	16/4/1947	13	5/4/1940
May	41.5	22.2	48.0	9/5/1938	18	9/5/1960
Jun.	40.1	25.4	47.0	18/6/1979	22	3/6/1940
Jul.	37.5	25.0	42.0	3/7/1958	22	22/7/1938
Aug.	35.5	23.9	41.7	9/8/1964	23	12/8/1933
Sep.	37.4	22.7	43.0	30/9/1951	18	30/9/1950
Oct.	39.3	16.1	43.0	1/10/1951	10	30/10/1949
Nov.	35.6	11.2	38.5	1/11/1986	6	29/11/1938
Dec.	31.0	6.8	33.9	8/12/1963	2	30/12/1932
Annual	36.3	16.4	48.0	9/5/1938	0	21/1/1934

* Highest and lowest recorded temperatures are based on data collected at the Karachi meteorological station since it was established in 1928-1990

Source: Pakistan Meteorological Department

Exhibit 4.7: Rainfall (mm) Measured at Karachi Airport Meteorological Station

Month	*Mean Monthly (mm)*	*Wettest Month**		*Mean Number of Rainy Days*
		Value (mm)	*Year*	
Jan.	6.0	66.8	1976	0.5
Feb.	9.8	96.0	1979	0.6
Mar.	11.7	130.0	1967	0.4
Apr.	4.4	52.8	1935	0.3
May	0.0	33.3	1933	0.0
Jun.	5.5	85.9	1936	0.7
Jul.	85.5	429.3	1967	2.6
Aug.	67.4	359.4	1944	2.5
Sep.	19.9	315.7	1959	0.7
Oct.	10.0	98.0	1956	0.1
Nov.	1.8	83.1	1959	0.2
Dec.	4.4	63.6	1980	0.7
Annual	217.3	745.5	1944	9.4

* Based on data collected at the Karachi Airport Meteorological Station since it was established in 1928-1990

** 'Rainy day' is defined as a day on which at least 0.1 mm of rain is recorded

Source: Pakistan Meteorological Department

Storms and Cyclones

Severe storms and cyclones seldom cross the coast of Pakistan. **Exhibit 4.8** shows the monthly intensity and location of cyclonic activities. 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. 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.

Exhibit 4.8: Month-wise Intensity and Location of Storms in Arabian Sea

Month	*Intensity of Storms on an arbitrary scale of 0-4*	*Primary Area of Activity*
Jan.	0 (No Storms)	–
Feb.	0 (No Storms)	–
Mar.	0 (No Storms)	–
Apr.	2	Southern Arabian Sea
May	3	Southern Arabian Sea
Jun.	3	Northern Arabian Sea
Jul.	1	Northern Arabian Sea
Aug.	1	Northern Arabian Sea
Sep.	2	Northern and Central Arabian Sea
Oct.	4 (Severe)	Southern and Eastern Arabian Sea
Nov.	4 (Severe)	Southern and Eastern Arabian Sea
Dec.	1	Southern and Eastern Arabian Sea

Source: Marine Investigators, Report on Arabian Sea for Hagler Bailly Pakistan (1998)

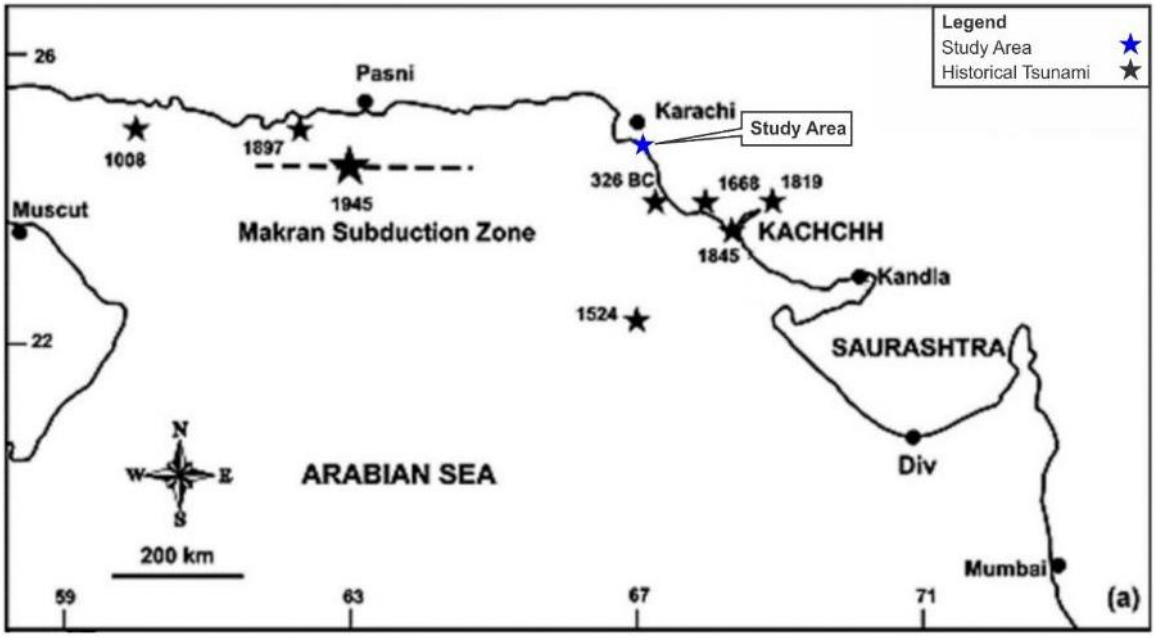
Tsunamis

The coast of Pakistan is in an area of a potential tsunami. While large tsunamigenic earthquakes have been relatively rare, there is potential for a tsunami associated with the Makran Subduction Zone (MSZ) or smaller localized tsunamis associated with several smaller thrust faults around Karachi[9].

A map of historical tsunamis that have been generated, some in close proximity to the Port Qasim Area, is shown in **Exhibit 4.9**. These are associated with both the MSZ, as well as localized and smaller faults along the Karachi coast extending east towards India.

[9] Pararas-Carayannis. "The potential of tsunami generation along the Makran Subduction Zone in the northern Arabian Sea. Case study: the earthquake and tsunami of November 28, 1945", Science of Tsunami Hazards 24 (2006).

Exhibit 4.9: Historical Tsunamis Generated in the Region (up to 1945)



Source: Shukla et al. "Coastal Geomorphology and tsunami hazard scenario along the Kachch coast, western India" (2010)

The relatively recent tsunami generated along the MSZ in 1945 was responsible for the loss of life, approximately 4000 deaths, and destruction along the sparsely populated coast of Pakistan. It is reported that this tsunami was around 1.5 m at Karachi[10] and the associated earthquake of intensity was 8.1 M_w. The 1945 event was followed by another tsunami-related tidal wave in 1953.

Other than tsunamigenic earthquakes along the MSZ, the smaller localized faults extending from Karachi to India can cause "localized" tsunamis[11]. Smaller faults east of Karachi have potential to generate localized tsunamis that may impact Port Qasim.[12]

4.2.7 Air Quality

This section describes the current ambient air quality in the area where Project activities are proposed. The pollutants selected for evaluation, based on the expected emissions from the Project activities and the level of risk to human health posed by these pollutants, are as follows:

- Respirable particulate matter; coarse (PM_{10})[13] and fine ($PM_{2.5}$)[14]
- Sulfur dioxide (SO_2)

[10] Active Faults of the World.

[11] Billham et al. " Southern Pakistan Geology and Tectonics" (2007)

[12] Billham et al. " Southern Pakistan Geology and Tectonics" (2007)

[13] PM_{10} is particulate matter 10 micrometers or less in diameter

[14] $PM_{2.5}$ is particulate matter 2.5 micrometers or less in diameter

- Oxides of nitrogen (NO_X); nitrogen dioxide (NO_2) and nitric oxide (NO)
- Vinyl Chloride Monomer (VCM)

Methodology and Sampling Locations

Air quality sampling was carried out at five different locations in the Study Area between April 12 and May 4, 2018. A description of sampling locations is given in **Exhibit 4.10**.

Exhibit 4.10: Details of Air Quality Sampling Locations

Sample ID	*Coordinates*	*Pollutants Sampled*	*Description*
A1	24° 47' 36.4" N 67° 22' 09.5" E	PM_{10}, $PM_{2.5}$, NO_x, SO_2, VCM	Upwind and outside plant boundary at its west direction.
A2	24° 47' 43.9" N 67° 22' 40.9" E	PM_{10}, $PM_{2.5}$, NO_x, SO_2, VCM	Downwind and outside plant boundary at its east direction.
A3	24° 47' 47.8" N 67° 22' 12.2" E	PM_{10}, $PM_{2.5}$, VCM	Upwind and outside plant boundary at its north direction.
A4	24° 47' 42.1" N 67° 22' 23.8" E	VCM	Downwind and inside plant boundary near EDC/VCM plant
A5	24° 47' 22.5" N 67° 22' 23.4" E	PM_{10}, $PM_{2.5}$	Upwind and inside plant boundary near raw water and existing fire water plant

Particulate matter was sampled using Airmetrics MiniVol Portable Air Samplers. This equipment draws an air sample through an inlet by a vacuum pump at a fixed flow rate. The sampling is normally carried out for 24-hours duration. The particulates are filtered using an impactor and collected on a filter paper which is dried and weighed after the sampling to obtain the weight of particulates in the sampled volume of air.

NO, NO_2 and SO_2 were measured using Gradko diffusion tubes. These tubes passively uptake pollutants via diffusion and hence, require longer sampling of durations of between 2-4 weeks. The collected pollutants are quantified using ion chromatography.

Photographs of the particulate matter and diffusion tube sampling sites are shown in **Exhibit 4.11**. The sampling locations along with nearby settlements and roads are shown in **Exhibit 4.12**.

Exhibit 4.11: Air Quality Sampling Site Photographs

Low volume samplers at A1

Low volume samplers at A2

Low volume samplers at A3

Low volume samplers at A5

Diffusion tubes at A1

Diffusion tubes at A2

Diffusion tubes at A3

Diffusion tubes at A4

Exhibit 4.12: Air Quality Sampling Locations

Emission Sources

From the field survey, the following sources of emissions in the vicinity of the Project were identified and listed as below.

1. The Pakistan Steel Mill complex and its ancillary processes (not in operational condition today, however, can be a possible source of NOx, SO_2, and PM)
2. The K-electric Power Station
3. The Port Qasim Electric Power Company (PQEPC)
4. Traffic on Port Qasim access roads: combustion of coal, petrol and diesel is a source of NO_x and SO_2 emissions with diesel burnt in heavy transport vehicles is the main source of SO_2. Vehicle exhaust results in $PM_{2.5}$ emissions whereas tire movement, especially on tracks and unsealed road result in dust emissions (PM_{10} and $PM_{2.5}$).

Results and Analysis

Exhibit 4.13 presents the air quality sampling results are summarized. The complete results from the lab are given in **Appendix A**.

Exhibit 4.13: Results of Ambient Air Quality Sampling

Sample ID	*NO_2*	*NO*	*VCM*	*SO_2*	*PM_{10}*	*$PM_{2.5}$*
	µg/m³	*µg/m³*	*ppm*	*µg/m³*	*µg/m³*	*µg/m³*
A1	14.8	<0.4	<0.0001	107.08	102.1	38.3
A2	24.6	0.9	0.003	44.47	116.8	51.9
A3	–	–	<0.0001	–	87.6	37.5
A4	–	–	0.002	–	–	–
A5	–	–		–	107.3	39.1
SEQS (annual)	**40**	**40**	–	**80**	**120[a]**	**40[a]**
SEQS (24–hour)	**80**	**40**	–	**120**	**150**	**75**
CAAQS (24-hour)[15]	–	–	**0.01**	–	–	–

Notes:

- means either the standard is not defined for the specific averaging period or the measurements were not taken at that point.

[a] means the annual standards do not apply to PM_{10} and $PM_{2.5}$ as these were 24-hours reading.

The following analysis of results are presented:

- NO_2 and NO concentrations comply with both 24-hour and annual SEQS at both locations. The maximum concentration was observed at A2. This point is downwind of K-Electric and PQEPC power stations which are the biggest sources

[15] https://www.arb.ca.gov/research/aaqs/common-pollutants/vc/vc.htm, https://www.arb.ca.gov/research/aaqs/caaqs/vc/vc.htm

of NOx (NO_2 and NO) in the vicinity of the Project. Also, this point is free from the influence of the existing plant as the operation of the PVC plant does not result in such emissions.

- VCM concentrations at A1 and A3 are <0.0001 i.e. below the level of reporting whereas at A2 and A4 they are 0.003 and 0.002 ppm, respectively. It can be seen that VCM concentrations at all sampling locations are below standards and the existing plant is only emitting 30% of the standards.
- SO_2 concentrations comply with both 24-hour SEQS however, the concentrations exceed the annual SEQS at A1. The maximum concentration is also observed at A1. Traffic on Port Qasim access roads and combustion points where coal, petrol and diesel being used as fuel are major sources of SO_2 emissions. This point is in the downwind direction of K-Electric and PQEPC power stations which are the biggest sources of SO_2 in the vicinity of the Project. A2 is located in an open area and does not have much influence on the existing plant.
- The PM_{10} and $PM_{2.5}$ concentrations comply with SEQS at all sampling locations. The lowest PM_{10} and $PM_{2.5}$ concentrations as 87.6 and 37.5 µg/m^3, respectively, are observed at a sampling location (A3) located at the north and upwind of the existing plant. The highest PM_{10} and $PM_{2.5}$ concentrations as 116.8 and 51.9 µg/m^3, respectively, are observed at sampling location (A2) located at east and downwind of existing plant. This point is also in downwind direction of K-electric and PQEPC power station.

4.2.8 Water Resources

There is no significant natural freshwater source in the Project area. The Indus River about 120 km to the east of Karachi city and the Hub River, a perennial stream that originates in Baluchistan and marks the boundary between Karachi Division and Baluchistan are the sources of water in Karachi.

The main surface-water resources in the vicinity of the Project are the creeks of the Arabian Sea, namely, Gharo Creek at the south of the Project site. The Arabian Sea is the only major surface water body in the region. It is bordered on the north by Pakistan and Iran, on the west by the Arabian Peninsula, and on the east by the western coast of India. The industrial and municipal discharges contribute different types of pollutants to the creeks. These include acids, heavy metals, organochlorines, organo-phosphorous, alum, arsenic, benzene, calcium, chlorides, magnesium, potassium, sodium, sulfates, toluene and suspended matter. The water that enters the creeks at high tide and leaves at low tide is the only source flushing the pollutants to the open sea.

There is also a natural rainwater drain running through the Project site – Badal Nullah – which ultimately falls into the Gharo Creek located in the south of the proposed site (**Exhibit 4.14**).

Exhibit 4.14: The Badal Nullah

4.2.9 Water Quality

This section describes the wastewater quality at plant outlet and at Badal Nullah Drain. The parameters selected for evaluation, based on the expected discharge from the plant and the level of risk to human health posed by the presence of these parameters, are as follows:

- On-site Testing:

  pH, electrical conductivity (EC), dissolved oxygen (DO), temperature

- Lab Analysis:

  Total suspended solids (TSS), total dissolved solids (TDS), biological oxygen demand $(BOD)_5$, chemical oxygen demand (COD), oil and grease, phenol, chloride, fluoride, sulfate, sulfide, ammonia, cyanide, anionic detergents as methylene blue active substances (MBAS), chlorine, cadmium, chromium, copper, lead, mercury, selenium, nickel, silver, arsenic, zinc, barium, iron, manganese, boron

Methodology and Sampling Locations

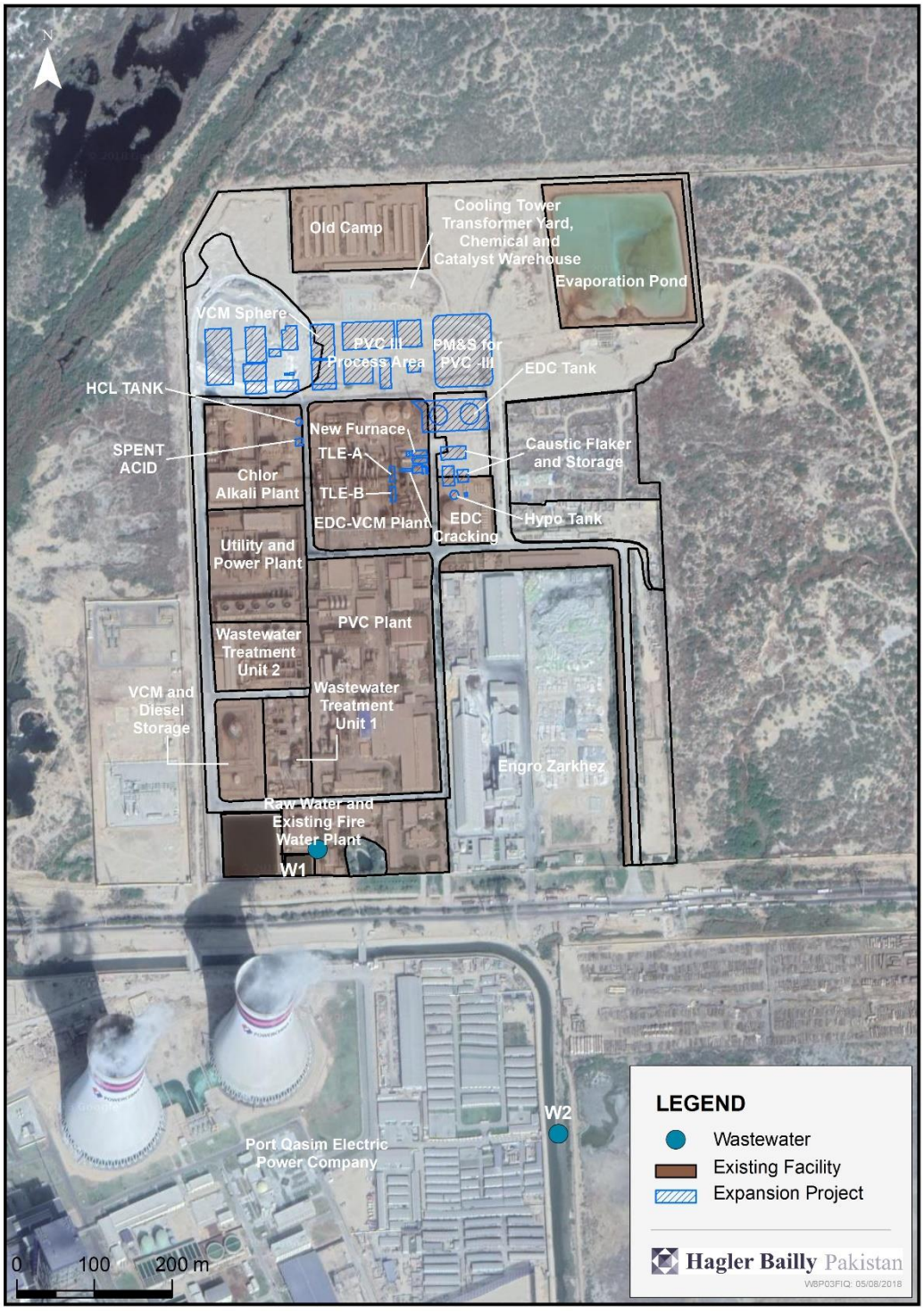
Wastewater was sampled on April 16, 2018. Samples were sent to HBP lab for general physical parameters and PINSTECH, Islamabad for metals and major ions and the remaining parameters. On-site testing was also carried out with the hand-held meters for pH, EC, DO and temperature.

Exhibit 4.15 provides a description of sampling locations. **Exhibit 4.16** shows the sampling locations.

Exhibit 4.15: Sampling Locations for Wastewater Quality

Sample ID	Coordinates	Description
W1	24° 47' 22.9" N 67° 22' 19.3" E	Wastewater quality at the Plant outlet to check compliance with SEQS
W1-D	24° 47' 22.9" N 67° 22' 19.3" E	Duplicate of W1 (quality control sample)
W2	24° 47' 11.1" N 67° 22' 30.5" E	Wastewater quality at Badal Nullah before mixing to sea water to check for flow of pollutants into sea that could harm marine life on the shore.

Exhibit 4.16: Wastewater Quality Sampling Locations



Wastewater Sources

There are three streams of wastewater at the Site premises. These include:

1. Removal of domestic sewage by tractor trollies,

2. Release to on-site evaporation pond for low pH or EDC containing wastewater, and
3. Release to offsite wastewater channel after treatment.

Results and Analysis

The wastewater quality sampling results are summarized in **Exhibit 4.17**. The complete results from the lab are given in **Appendix B**. The results are discussed below and are highlighted where exceeds the standards.

- Field Test Parameters
  - All samples are within the 6.0 to 9.0 pH range as prescribed by the SEQS.
  - Conductivity levels are quite higher at W2 than at W1. This is due to the mixing with sea water through Gharo Creek that has high conductivity levels due to the presence of high salt concentration.
  - Temperatures at both sampling locations are in compliance with SEQS. However, the temperature at W2 is lower than W1 which may be due to the dilution effect with Gharo Creek at W2.
  - DO at W2 is higher than at W1. This is because of; aeration process which brings water and air in close contact as the water flows over the rocks and lower temperatures at W2 as the cooler water have a greater capacity to dissolve oxygen than warmer water.
- General Parameters
  - BOD and COD are in compliance with SEQS at both sampling locations (W1 and W2). BOD and COD levels come out to be lower in the sample taken from Badal Nullah Drain (W2) falling into the Gharo Creek than the sample taken at plant discharge (W1) that contains chemical and biological pollution. This is likely due to the dilution of sea water from Gharo Creek that reduces the concentration of both BOD and COD that are at higher levels at W1; direct discharge of the Plant and no dilution.
  - Solids: TSS at all sampling points are in compliance with SEQS. TDS at W1 (the Plant outlet) are in compliance with SEQS however, exceeds at W2 (Badal Nullah) by about 10 times. This may be because of the mixing of sea water through Gharo Creek that has high TDS content (typically >35,000 mg/L).[16].
  - Chlorides and Fluorides comply with SEQS at the Plant Outlet (W1) but Chlorides exceed in a sample collected from Badal Nullah (W2). The high concentration of Chlorides may be contributed from effluent added to Badal Nullah from other industries.

[16] http://www.twdb.texas.gov/innovativewater/desal/faqseawater.asp

- ▷ Sulfates at both locations are in compliance with SEQS. However, sulfates at W2 (Badal Nullah) are higher than at W1 (the Plant Outlet). At W2 seawater intrusion takes place which is naturally high in sulfates.
- ▷ Of the general parameters, the compounds like oil and grease, phenol, cyanide, anionic detergents, sulfide, ammonia, and chlorine are not detected at any of the sampling locations.

- ▶ Metals
  - ▷ All the metals tested are either in compliance with SEQS or not detected (in lower quantities than the level of reporting) in both samples, W1 and W2. Of the metals, iron, manganese, zinc, cadmium, silver, mercury and selenium are not detected in the wastewater samples however, iron was observed at a very low concentration in Badal Nullah drain due to its mixing with sea water from Gharo Creek at W2.

Exhibit 4.17: Wastewater Quality Results

	Units	*Analytical Method/ Technique*	*LOR*	*SEQS (into Sea)*	*W1*	*W1-D*	*W2*
Field Tests							
pH		US EPA 150.1	0.1	6.0–9.0	7.18	7.20	7.40
Conductivity	µS/cm	US EPA 120.1	1.0	–	4,580	4,570	46,500
Temperature*	°C	US EPA 170.1	0.1	40°C or increase less than 3°C	30.7	30.7	28.0
DO	mg/l	US EPA 360.1	0.1	–	4.39	4.38	5.84
General							
BOD	mg/l	US EPA 405.1	5	80**	43.47	44.10	22.98
COD	mg/l	US EPA 410.3	4	400	127.40	127.40	78.40
TSS	mg/l	US EPA 160.2	4	200	13.75	15.25	6.75
TDS	mg/l	US EPA 160.1	10	3,500	2,620.00	2,623.00	35,338.00
Oil and Grease	mg/l	US EPA 413.1	5	10	ND	ND	ND
Phenol	mg/l	US EPA 420.1	0.05	0.3	ND	ND	ND
Chloride	mg/l	SMEW	5	SC*** (19,353)[a]	1,270.88	1,269.11	19,905.17
Fluoride	mg/l	US EPA 340.1	0.1	10	0.50	0.50	1.00
Cyanide	mg/l	US EPA 335.2	0.1	1	ND	ND	ND
MBAS	mg/l	US EPA 425.1	0.1	20	ND	ND	ND
Sulfate	mg/l	US EPA 375.3	10	SC*** (2,712)[a]	287.23	289.70	2,579.28
Sulfide	mg/l	US EPA 376.1	0.5	1	ND	ND	ND
Ammonia	mg/l	SMEW	0.5	40	ND	ND	ND
Chlorine	mg/l	SMEW	0.1	1.0	ND	ND	ND

	Units	*Analytical Method/ Technique*	*LOR*	*SEQS (into Sea)*	*W1*	*W1-D*	*W2*
Metals							
Iron	mg/l	SMEW	0.1	8.0	ND	ND	0.30
Manganese	mg/l	SMEW	0.1	1.5	ND	ND	ND
Zinc	mg/l	SMEW	0.1	5.0	ND	ND	ND
Cadmium	mg/l	US-EPA 7000B	0.01	0.1	ND	ND	ND
Chromium (trivalent and hexavalent)	mg/l	HACH 8023	0.01	1.0	0.10	0.06	0.06
Copper	mg/l	US-EPA 7000B	0.01	1.0	0.04	0.02	0.01
Lead	mg/l	US-EPA 7000B	0.01	0.5	0.02	0.01	0.02
Nickel	mg/l	US-EPA 7000B	0.01	1.0	0.06	0.03	0.02
Silver	mg/l	HACH 8027	0.05	1.0	ND	ND	ND
Barium	mg/l	US-EPA 7000B	0.01	1.5	0.53	0.20	0.24
Boron	mg/l	HACH 8015	0.01	6.0	1.20	0.82	0.71
Mercury	µg/l	HGAAS	0.52	10	ND	ND	ND
Selenium	µg/l	HGAAS	0.78	500	ND	ND	ND
Arsenic	µg/l	HGAAS	0.52	1000	2.77	2.27	2.52

Notes:

ND: Not Detected, DO: Dissolved Oxygen, BOD: Biochemical Oxygen Demand

COD: Chemical Oxygen Demand, TSS: Total Suspended Solids, TDS: Total Dissolved Solids

mS/cm: milli Siemen per centimeter, mg/l: milligram per liter, µg/l: microgram per liter, MBAS: Methylene Blue Active Substances

*The effluent should not result in temperature increase of more than 3 ^{0}C at the edge of the zone where initial mixing and dilution take place in the receiving body. In case zone is not defined use 100 meters from the point of discharge.

**The value for industry is 200 mg/L

SC**Discharge concentration at or below sea concentrations (SC).

[a] seawater concentration of chloride and sulfate is taken as 19,353 and 2,712 mg/L. This is taken and confirmed from two online sources:

http://ocean.stanford.edu/courses/bomc/chem/lecture_04.pdf

https://www.ocean.washington.edu/courses/oc400/Lecture_Notes/CHPT4.pdf

Originally the values for chloride and sulfate as reported in the above sources are 19.353 and 2.712 g/kg. One liter of pure water weighs exactly 1000 grams (one kilogram). Also, the grams are multiplied by 1000 to get in milligrams.

4.2.10 Waste

Solid waste is disposed of on barren lands at designated areas separated from each other with labels (**Exhibit 4.18**). The several types of waste being generated and handled which classified according to the classification of the waste as hazardous and non-hazardous.

Hazardous Waste

Hazardous waste production consists of the following:

- **Heavies** (EDC waste) is generated at VCM plant in purification area. It consists of those hydrocarbons (HCs) whose boiling point is higher than EDC. Heavies come out from the bottom of the vacuum column.
- **Coke** (EDC waste) is generated in VCM fumes at the VCM plant cracking area. It is produced by the cracking of EDC and comes out in solid form from the quench filters and furnace.

There are two onsite incinerators built in the EDC-VCM plant area. One incinerator incinerates liquid heavies and other flue gases. Liquid heavies from vacuum column bottom are incinerated which consists of Triane (75%), EDC (20%) and Tetrane (5%). Flue gases pass through two scrubbers (HCl and caustic scrubber) which remove HCl and Cl_2. Incinerator temperature is maintained above 850 ^{0}C which degrades chlorinated hydrocarbons.

Coke and solid heavies are collected in drums and polypropylene bags and transported by dumper truck off-site by third-party contract and disposed of through incineration. Offsite incineration for these solid hazardous waste is managed by Zephyr Waste Solutions, Karachi. Offsite incinerators used by Zephyr Waste Solutions include the City District Government Karachi incinerator in Shershah and Fashmi International incinerator located in Sindh Industrial Trading Estate (SITE), Karachi. Incineration certificates provided by Zephyr Waste Solutions (that indicate the quantity and type of hazardous waste removed, disposal method, and location) for offsite incineration are available with the site management.

Non-Hazardous Waste

Non-hazardous waste production consists of the following:

- Paper waste (papers, bags and cartons)
- Empty oil/grease drums
- Empty chemical drums- plastic and metallic
- Empty chemical cans
- Wooden pallets
- Plastic bags
- Metallic waste (from piping, valves and sheets)
- Non-metallic waste (PVC and other plastics)
- Biological waste (food waste from canteen)

Salt sludge is generated at Chlor Alkali (CA) Plant brine area. It consists of Magnesium, Calcium and Sulphate. This sludge is taken out from clarifiers and filters). Salt sludge is placed on the ground in an open area and is also shifted through the dumper truck through a contractor.

Scrapyard

Solid waste materials are regularly collected from the site, sorted, and stored in demarcated spaces at the scrapyard. The area of scrapyard is 2.8 acre. Waste from scrapyard is transported on a regular basis for recycling, disposal, or incineration. Photographs of the scrapyard including are shown in **Exhibit 4.18**.

Exhibit 4.18: Sorted and Temporarily Stored Waste at the Scrapyard

Garbage

Scrap material

Gas containers

Empty catalyst containers

Discarded pallets

Empty large metal canister

Empty plastic drums

Empty metal drums

Empty suspending agent containers

Salvage Yard

The solid waste materials from the site are dumped in an unregulated unsorted manner at the salvage yard. The area is 5.8 acres. Photographs of the salvage yard are shown in **Exhibit 4.19**.

Exhibit 4.19: Unsorted and Long-Term Stored Waste at the Salvage Yard

Discarded cooling fins from the cooling tower

Plastic drums filled with unidentified material

Improper oil storage with visible staining on pallet

Improper oil storage in plastic canisters with visible staining on cardboard containers

Mixed unsorted waste

View of the salvage yard

4.2.11 Noise

This section defines the baseline ambient noise levels in the Study Area in a manner that can be used for the assessment of the noise impact of the proposed Project. The Study Area falls under the PQ NWIZ, which is a designated industrial area.

Methodology and Sampling Locations

Exhibit 4.20 provides the details of noise sampling locations. Noise measurements were taken at four locations in the vicinity of the Project. Noise readings were taken for 24 hours at each site. A sound level survey was conducted between April 12 and April 19, 2018, at four locations for 24 hours at each location.

Exhibit 4.20: Noise Sampling Locations

ID	*Coordinates*	*Description*
N1	24° 47' 35.2" N 67° 22' 08.1" E	Outside plant boundary on its west side
N2	24° 47' 45.4" N 67° 22' 39.4" E	Outside plant boundary on its east side
N3	24° 47' 48.4" N 67° 22' 12.6" E	Outside plant boundary on its north side

ID	*Coordinates*	*Description*
N4	24° 47' 22.6" N 67° 22' 23.9" E	Inside plant boundary and near admin building

The noise levels were measured using portable Cirrus Research plc.'s sound level meter, Model CR:1720. The instrument meets the International standards IEC 61672-1:2002, IEC 660651:1979, IEC 60804:2001, IEC 61260:1995, IEC 60942:1997, IEC 61252:1993, ANSI S1.4-1983, ANSI S1.11-1986, and ANSI S1.43-1997 where applicable. The instruments have a resolution of 0.1 dB.

The meter was calibrated at the start of measurement at each site, using Cirrus Research plc.'s acoustic calibrator, Model: CR:514. The sound meter and calibrator were factory calibrated on September 28, 2015. The instrument was mounted on a tripod, to avoid interference from reflecting surfaces within the immediate neighborhood, and a windshield was used in all measurements. Photographs of the sampling equipment setup are provided in **Exhibit 4.21. Exhibit 4.22** shows the noise sampling locations.

Exhibit 4.21: Noise Sampling Site Photographs

Sound meter at N1

Sound meter at N2

Sound meter at N3

Sound meter at N4

Results and Analysis

The Project site is located within an industrial area and therefore the industrial limits are applicable. A summary of the sampling results and comparison with SEQS are provided in **Exhibit 4.23**. Analysis of the summary statistics is as follows:

- Noise levels at all sampling sites comply with SEQS. Noise levels around the Project are from 54.7 and 59.5 dBA during daytime and from 52.2 to 57.7 dBA during nighttime.
- Maximum day and nighttime noise levels are observed at N4 which are 59.5 and 57.7 dBA, respectively. This is because the point receives noise mainly from the movement of vehicles on PQ Road (approx. 50 m from N4) and from the operation of existing plant and PQEPC which is located at the south of the plant (approx. 100 m from N4).
- Minimum day and nighttime noise levels are observed at N2 which are 54.7 and 52.2 dBA, respectively. This is because the point is at open barren land where it receives noise from the operation of existing plant only and it is approximately 1 km far away from the road and other industries located at the south (PQEPC) and east (Lotte Pakistan Limited) of the plant.

The complete results are presented in **Appendix C**.

Exhibit 4.22: Noise Sampling Locations

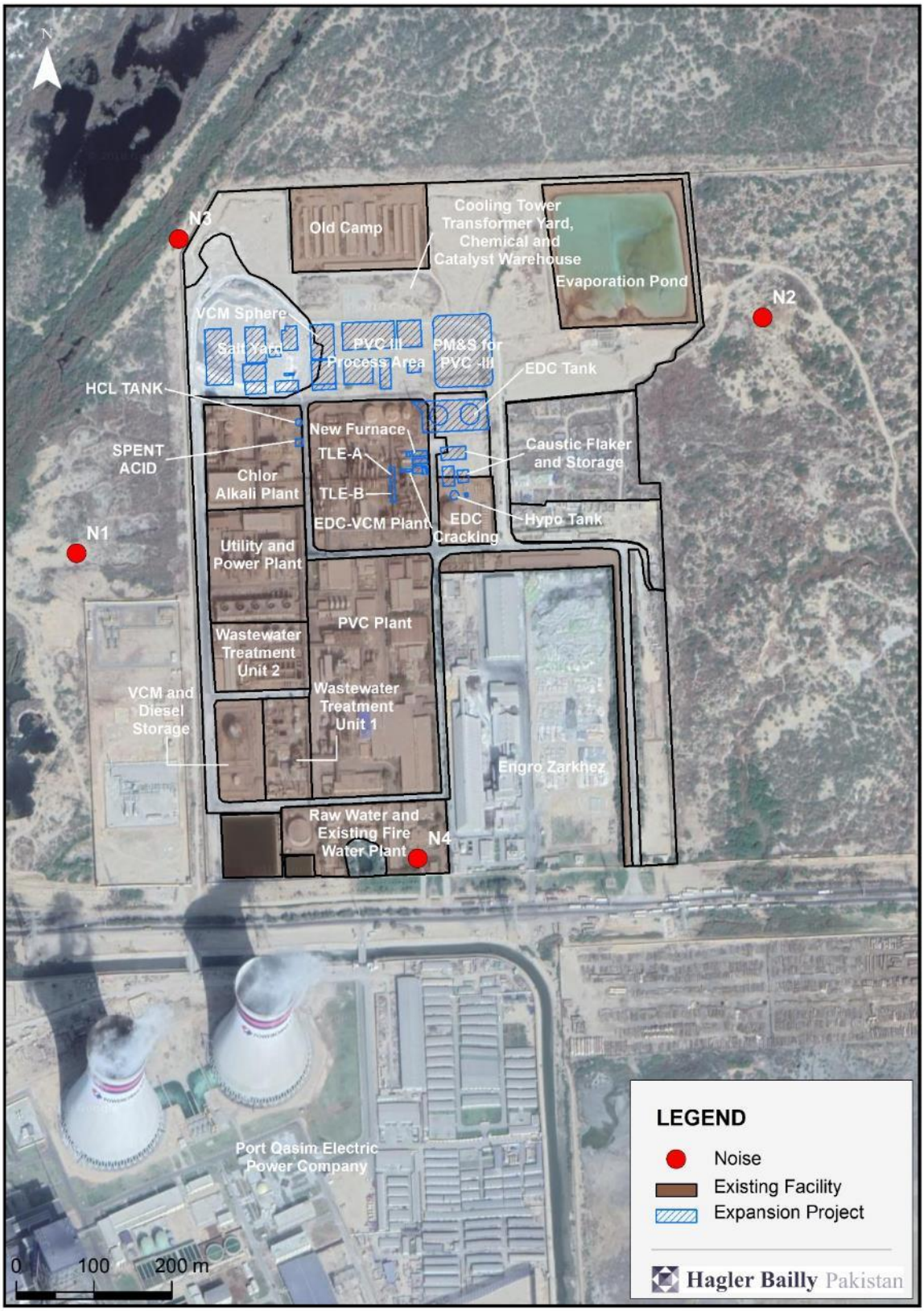


Exhibit 4.23: Noise Sampling Results (dBA) and Comparison with SEQS

Sample ID	*Day*	*Night*
N1	55.1	56.4
N2	54.7	52.2
N3	54.7	54.2
N4	59.5	57.7
SEQS for industry	75	65

4.2.12 Traffic

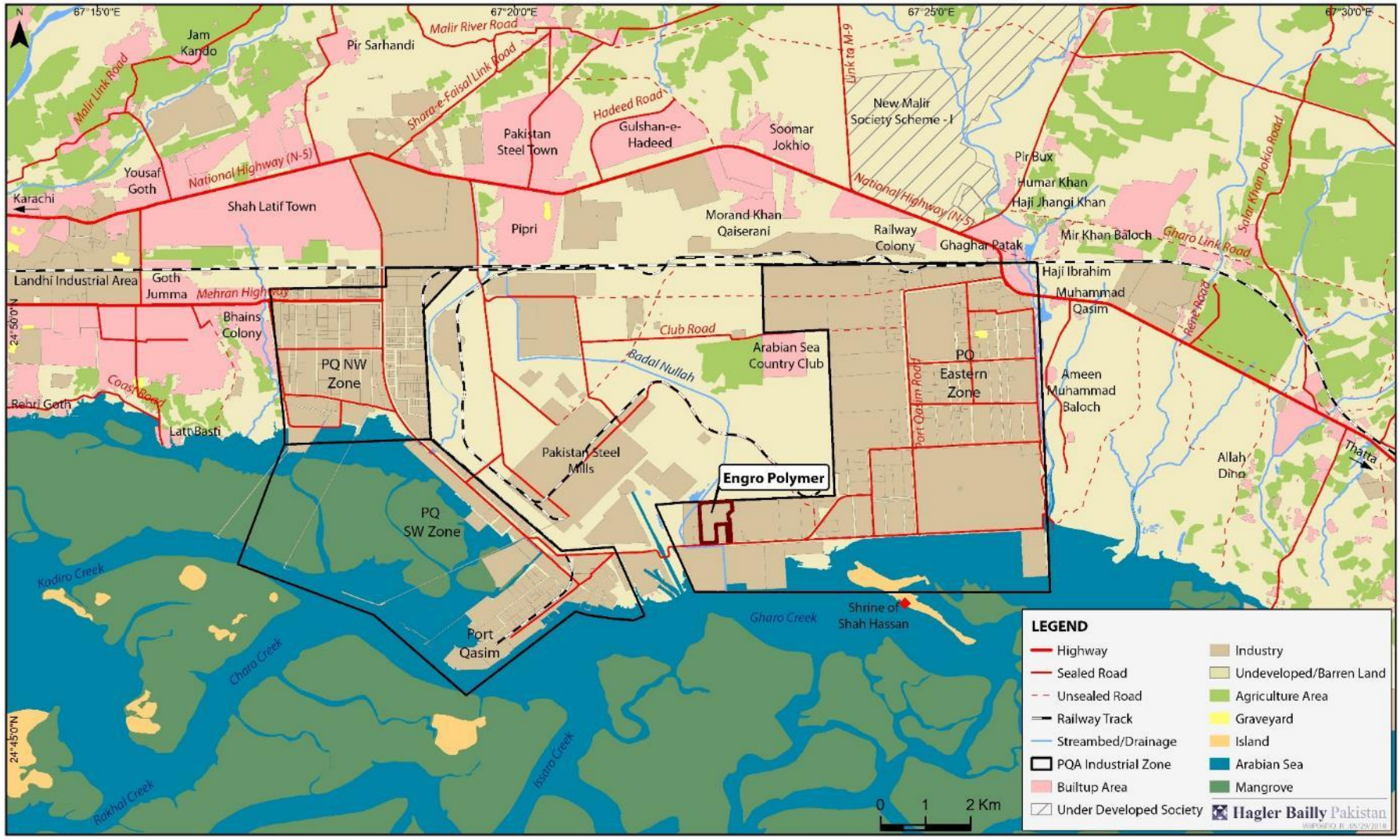
Exhibit 4.24 shows the access to Project site. The Average Daily Traffic (ADT) for light vehicles (motorcycles, cars and pickups) and heavy vehicles (buses and trucks), in both direction are as follows:[17]

- Between Karachi and Port Qasim: 9,700 light; 6,600 heavy (16,300 total)
- Between Port Qasim and location to the east: 1,800 light; 2,400 heavy (4,200 total)
- On N-5: 31,600 light; 8,500 heavy (40,100 total)

Therefore, well over 60,000 vehicles pass through or near Port Qasim Industrial Zone every day.

[17] Environmental Impact Assessment of Bin Qasim Coal Conversion Project. September 2013.

Exhibit 4.24: Access to Project Site



4.3 Ecology

The objective of the ecological baseline is to provide an overview of the ecological conditions in the Project site and vicinity.

Data collection for ecology was carried out at selected sampling locations within the Study Area (see **Section 4.3.4**) on May 1, 2018. In addition to these surveys, literature reviews were carried out. Local communities were also consulted regarding species observations.

4.3.1 Scope

The specific objectives of the ecological baseline study are as follows:

- A review of the available literature on the biodiversity of the Project site and vicinity
- Qualitative assessment of terrestrial ecological resources including vegetation, mammals, reptiles, and birds
- Qualitative assessment of marine ecological habitats
- Reports of wildlife sightings in the Study Area and vicinity by the resident communities.
- Identification of key species and determination if there are any potential critical habitat and ecosystem services in the Project facility and surroundings.

4.3.2 Literature Reviews

The most recent past surveys conducted in areas which overlap with the Study Area were used to supplement the ecological surveys carried out within the Study Area. This included the Ecosystem Services Review and Cumulative Impact Assessment for Industrial and Port Development at Port Qasim for the International Finance Corporation, on January 7, 2016.[18]

4.3.3 Habitat Classification and Description of the Study Area

The use of the term habitat, in the most general sense for animals, is where an animal can live.[19] As this is a highly modified environment, mainly in terms of land use; habitats have been classified mainly based on land use.

Habitat classification approaches are subjective in nature, devised to assist in the understanding of ecological systems, the functions of those systems, and the interrelationship with species. Classically, wildlife habitat is described as containing three

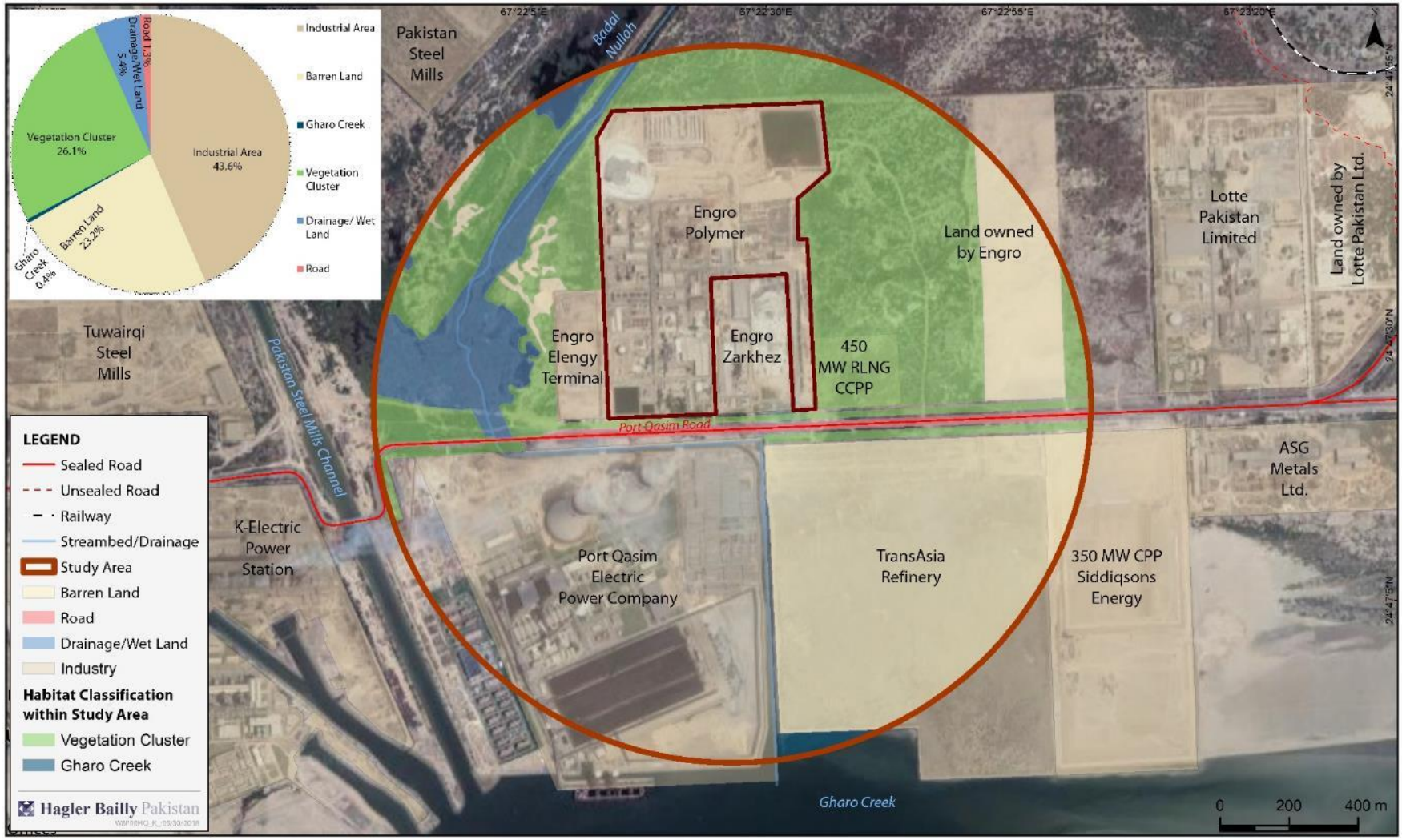
[18] Hagler Bailly Pakistan, Ecosystem Services Review and Cumulative Impact Assessment of Port and Industrial Developments at Port Qasim, for the International Finance Corporation, January 2016

[19] Morrison, M.L, Marcot, B., Mannan, W. Wildlife-Habitat Relationships: Concepts and Applications. Island Press, Washington, D.C., 2006

basic components: cover, food, and water (Morrison et al 2006) with vegetation as the core descriptive component.

Habitats in the Terrestrial Study Area were classified relying primarily upon vegetation type. Satellite imagery from ***Google Earth™*** was used to initially delineate the spatial distribution of habitat types within the Terrestrial Study Area and this habitat characterization was confirmed during the field surveys. Following this classification approach, two types of habitats were defined: Coastal Habitat and Vegetation Clusters. **Exhibit 4.25** shows these habitats.

Exhibit 4.25: Habitat Classification



4.3.4 Sampling Locations for Ecological Surveys

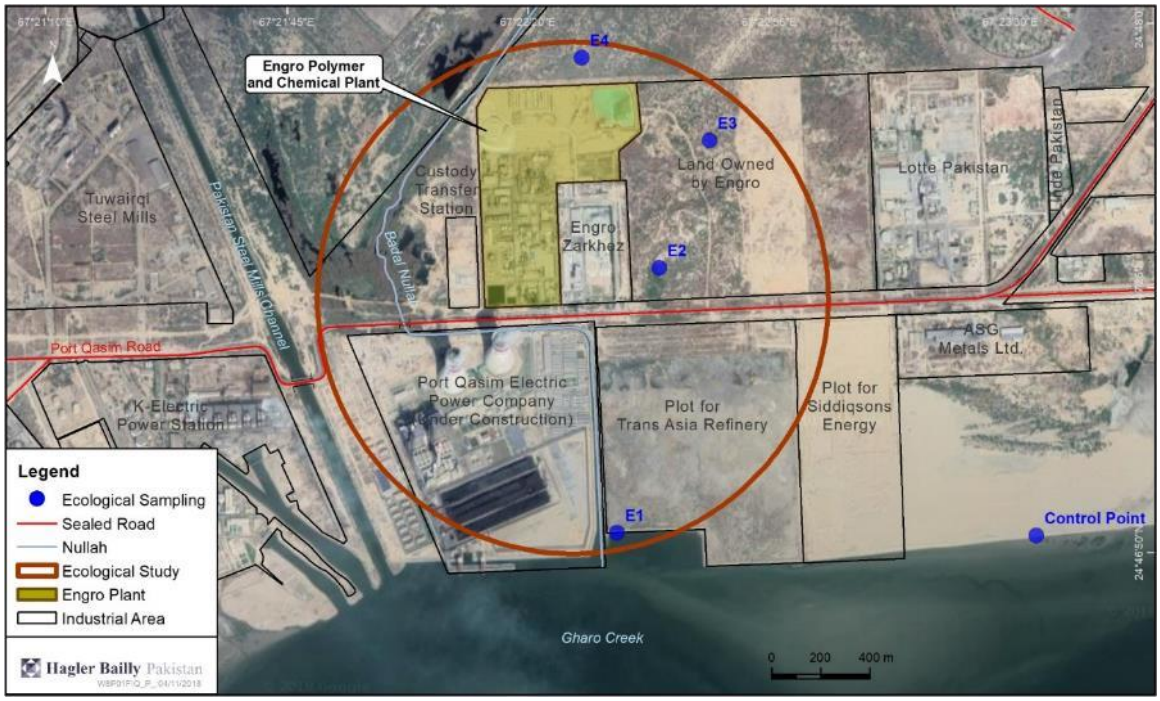
Sampling locations for ecological surveys were selected based on coverage of the different types of habitats. The focus was on locations where Project-related impacts are most likely to take place. These areas include the drain outfall and associated coastal habitat and the vegetation surrounding the Plant.

A total of five sampling locations were identified. **Exhibit 4.26** provides the land use classification, coordinates and justification for selection of each sampling location. **Exhibit 4.27** shows the sampling locations.

Exhibit 4.26: Sampling Points, Associated Habitat Classifications and Justifications for Selection

Sampling Location ID	*Classification by Land Use*	*Coordinates*	*Justification for Selection*
E-1	Coastal Habitat	67° 22' 34.1"E 24° 46' 51.8"N	Effluent from the Project can contaminate coastal areas located within its vicinity
E2	Vegetation Clusters	67° 22' 39.7"E 24° 47' 26.8"N	Presence of wild plants and limited disturbance provides habitat for wildlife which may be affected due to increased activity of the Project
E3		67° 22' 46.8"E 24° 47' 43.8"N	
E4		67° 22' 28.1"E 24° 47' 54.5"N	
Control Location	Coastal Habitat	67° 23' 34.9"E 24° 46' 52.1"N	Coastal location away from effluent discharge to check for the difference in macroinvertebrate fauna

Exhibit 4.27: Sampling Locations



4.3.5 Survey Methodology

The ecological resources within the Study Area have been divided into two categories, terrestrial and marine. For terrestrial ecological resources, further surveys were carried out focusing on vegetation, mammals, birds and herpetofauna.

At each sampling location, the information collected included general site information as well as surveys for vegetation, mammals, reptiles and birds.

Terrestrial Ecological Resources

Terrestrial ecological resources were surveyed including vegetation, mammals, reptiles and birds. The methodologies used have been presented below.

Vegetation: The quadrate method was used to survey vegetation. A total of 3 quadrats of 10m x 10m were used at each sampling location. Vegetation species observed in the quadrats were counted and noted.

Mammals and Reptiles: Line transects of 200 m by 20 m were used at each sampling location to record mammal signs (footmarks, droppings, dens).

Birds: Line transects of 200 m by 50 m were used at each sampling location. All bird species observed were recorded.

In all cases, the most recent keys available in the literature were used to identify the species.

Marine Ecological Resources

Detailed sampling exercises for the marine ecological resources in the area, covering mangrove habitat, mudflats, marine benthic invertebrates, burrowing forms and the fish fauna were carried out in June and September 2015 for the CEA of Port Qasim. Furthermore, extensive literature reviews for the presence and behavior of migratory and congregatory bird species, fish species of conservation importance which have been reported from or may occur in the Study Area (as well as the wider marine environment) were carried out in the latter half of 2015 (as part of the CEA of Port Qasim). Therefore, up to date information on the marine ecological resources within the Study Area is available. Primary data was collected for macro-invertebrates from the area directly exposed to the effluent discharge of the Plant.

Near the outfall used by the Project, soil samples were collected for coastal macro-invertebrates. They were stored in plastic jars with formaldehyde. The samples were transported to a laboratory in Karachi University where they were analyzed. A sample for macro-invertebrates was also be collected from a point further away from the outfall as a control point.

4.3.6 Ecological Survey Results and Discussion

This section summarizes the results and discussion of the May 2018 ecological survey as well as the information gathered from the most recent past ecological surveys, literature sources and anecdotal evidence from members of the local community.

Terrestrial Ecology

The Study Area comprises almost entirely of terrestrial habitat. It is composed mainly of dry plain land covered with xerophytic plants. The results of the information collected for terrestrial vegetation, mammals, reptiles and amphibians and birds is presented below.

Vegetation: The vegetation is characteristics of xerophytic[20] plant communities. During the May 2018 survey a total of 5 plant species were observed in the terrestrial habitat. Of these the species Mesquite was the most abundant. Of the other four plant species one was identified as *Euphorbia prostrata* while the remaining three could not be identified. **Exhibit 4.28** shows photographs of the plant species.

[20] Any plant adapted to life in a dry or physiologically dry habitat (salt marsh, saline soil, or acid bog) by means of mechanisms to prevent water loss or to store available water (from Encyclopedia Britannica)

Exhibit 4.28: Plant Species

Prosopis juliflora at Sampling Locations E2 and E4

Unidentified species at Sampling Location E2

Euphorbia prostrata at Sampling Location E2

Source: Survey carried out in the current Study, May 2018

No threatened or endemic terrestrial plant species have been reported from this area during the May 2018 survey. The distribution of these plant species is not limited to any specific site or habitat type and they are widespread.

***Mammals*:** During the survey conducted in May 2018 evidence of Indian Hare *Lepus nigricollis* was observed. Pugmarks of this species were observed at Sampling Location E3. Anecdotal evidence of the Wild Boar *Sus scrofa,* Asiatic Jackal *Canis aureus,* Fox *Vulpes vulpes* and Indian Hare was recorded at the Sampling Location E2.

There is anecdotal evidence of small mammals such as rodents, hare and squirrels in the area. Small mammal burrows were observed during at Sampling Location E2 (**Exhibit 4.29**).

Exhibit 4.29: Small mammal burrows

Small mammal burrows at Sampling Locations E2

None of the mammals reported from the Study Area are of conservation importance based on the IUCN Red List of Threatened.[21] The Asiatic Jackal and the Fox are included in Appendix III of the CITES Species List and listed as Near Threatened in Pakistan Mammals National Red List 2005.[22] None of the mammal species reported to be present in the area are endemic and their distribution is widespread.

Birds: Birds can travel long distances especially compared to mammals and reptiles. Furthermore, a number of bird species use both terrestrial and coastal habitats.

During the survey conducted in May 2018 three bird species were observed, including the Common Myna *Acridotheres tristis*, Laughing Dove *Spilopelia senegalensis* and House Sparrow *Passer domesticus*.

Birds generally have relatively large ranges compared to mammals and reptiles, therefore, it is possible that part of the Study Area is used by bird species of the wider Indus Delta. The Indus Delta consists of both resident and migratory bird species, some of which show congregatory behavior[23] as well. Based on an analysis carried out for the Cumulative Impact Assessment of Port Qasim in November 2015[24], it was found that a total of 65 bird species known to occur in the Indus Delta show congregatory behavior while 62 of these showing both migratory and congregatory behavior. However, considering that the entire Study Area comprises habitat which is extremely disturbed by human activity it is highly unlikely that any congregatory sites will be affected by the Project and Project-related activities.

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21 The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. accessed 14 January 2015

22 Sheikh, K.M. & Molur, S. (Eds.) Status and Red List of Pakistan's Mammals. Based on Pakistan's Conservation Assessment and Management Plan for Mammals. 344 pp. IUCN, Pakistan. 2005.

23 Congregatory behavior is a feature of many bird families and often occurs at particular stages of the life-cycle. It occurs across a wide taxonomic range. Conservation of each congregatory site is vital for the species' continued survival. Destruction or degradation of key sites can have serious impacts on congregatory birds at the population level.

24 Hagler Bailly Pakistan (HBP), Cumulative Effects Assessment of Industrial and Port Developments at Port Qasim for the International Finance Corporation (IFC), Washington D.C, January 2016

Pakistan is host to a large number of guest birds from Europe, Central Asian States and India every year. These birds originally reside in the northern states and spend winters in various wetlands and deserts of Pakistan from the high Himalayas to coastal mangroves and mud flats in the Indus delta. After the winter season, they go back to their native habitats.

This famous route from Siberia to various destinations in Pakistan over the Karakorum, Hindu Kush, and Suleiman Ranges along Indus River down to the delta is known as International Migratory Bird Route Number 4. It is also known as the Green Route or, more commonly, as the Indus Flyway and is one of the important migratory routes in the Central Asian - Indian Flyway [25] (**Exhibit 4.30**). As per an estimate based on regular counts at different Pakistani wetlands, between 700,000 and 1,200,000 birds arrive in Pakistan through Indus Flyway every year.[26] Some of these birds stay in the lakes but majority migrate to coastal areas.

Exhibit 4.30: Asian Migratory Bird Flyways

Source: U.S. Fish and Wildlife Service 2008. Available at:http://alaska.fws.gov/media/avian influenza/ak-flyway2.gif U.S. Fish and Wildlife Service/Alaska

Of the bird species observed in the Study Area, none are of conservation importance based on the IUCN Red List of Threatened Species.

Reptiles and Amphibians: During the survey conducted in May 2018 a single reptile species were observed in the Study Area, the Indian Fringe-toed Sand Lizard *Acanthodactylus cantoris* (**Exhibit 4.31**). No amphibian species were observed.

[25] Convention on the Conservation of Migratory Species. Central Asian Flyway Action Plan for the Conservation of Migratory Waterbirds and their Habitats. New Delhi, 10-12 June 2005: UNEP/CMS Secretariat, 1 February 2006.

[26] Pakistan Wetlands Programme, Migratory Birds Census Report, 2012

Commonly observed terrestrial reptiles include the Short-toed Sand Swimmer *Ophiomorus brevipes* and Sindh Gecko *Crossobamon orientalis*.

Exhibit 4.31: Indian Fringe-toed Sand Lizard *Acanthodactylus cantoris* at Sampling Locations E4

Based on a literature review as well as information from past ESIAs none of the reptile species reported from the Study Area and its vicinity are of conservation importance. This conclusion is based on information available on the IUCN Red List of Threatened Species[27] as well as information on endemism of reptile species in Pakistan.

Coastal Ecology

The Study Area does not include mangrove habitat. A very small part of the Study Area consists of coastal habitat. This is mostly composed of sandy shores and mudflats. The results of the information collected relevant to the coastal ecology within the Study Area has been presented below.

Coastal intertidal areas have a diverse range of conditions. The substrate has very fine sediments (mud, clay and silt) and the faunal communities present are dominated by faunal assemblages representing soft sediments. The sediment substrates are generally found to be high in organic content and with black mud just below the substrate.[28] Coastal invertebrate fauna and marine benthic invertebrates (MBIs) makes up most of the biodiversity present within the marine habitat part of this Study Area.

Coastal Invertebrate Fauna: The surface and burrowing marine invertebrates play an important role in mixing the organically enriched bottom sediments and are the key

[27] The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. accessed 14 January 2015

[28] Akhter, N Sustainable Fisheries The Pakistan National Conservation Strategy, Government of Pakistan Environment and Urban Affairs Division in collaboration with IUCN – The World Conservation Union, 1995

linkages in transferring the energy from lower trophic level to the next higher trophic level in the food chain.

The marine benthic invertebrate community includes the microbes: detritus feeders, small and large herbivores, and small and large carnivores. The marine invertebrates play an important role in mixing the organically enriched bottom sediments and are the key linkages in transferring the energy from the lower trophic level to the next higher trophic level in the food chain.

MBI organisms (like those shown in **Exhibit 4.34**) are a good indicator of ecological disturbances. Sampling for Marine Benthic Invertebrates carried out in June 2015 for the Cumulative Effects Assessment of Port Qasim was used for the application of the Shannon Weiner diversity index, to measure the health of the ecosystem. The results showed that higher MBI biodiversity was found away from the mainland where impacts of pollution from industrial and residential areas are expected to be low. The species showed a relatively uneven distribution at the Sampling Location closest to the present Study Area. The conclusions of the study carried out in June 2015[29] were that overall the Port Qasim Area creeks are a disturbed area, and therefore both species diversity and species richness are relatively low. It was not possible to conclusively establish any relationship of MBI biodiversity with dredging activities, as with other factors such as turbidity and pollution.

Based on information available in previous ESIAs and secondary literature, none of the marine invertebrates species reported from the Study Area are threatened according to the IUCN Red List of Threatened Species.[30] Moreover, their distribution is not limited to any specific site or habitat type and are widespread.

Results of Sampling

Sampling for MBI was conducted at two sampling locations (see **Exhibit 4.27**). Sampling Location E1 is located at the outfall of the drain used to discharge effluent from EPCL. Sampling Location C1 is located further away from the drain where currently there is no discharge.

The macro-invertebrate samples collected from the soil at the outfall showed a higher diversity and abundance of benthic fauna compared to the one located further away from the outfall. Foraminifera, bivalve, and nematode were dominant in the sample from Sampling Location E1. The abundance of macro-invertebrates collected from the sampling location further away from the drain showed lower diversity and abundance and higher levels of disturbance. The coastal area of Port Qasim is highly disturbed by construction activity which decreases the abundance of macro-invertebrate fauna. The area at and around the outfall is relatively undisturbed. In addition, the effluent being discharged from EPCL meets SEQS guidelines.

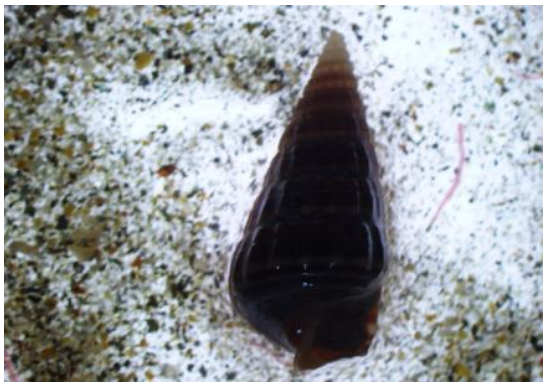
[29] Hagler Bailly Pakistan (HBP), Cumulative Effects Assessment of Industrial and Port Developments at Port Qasim for the International Finance Corporation (IFC), Washington D.C, January 2016

[30] The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. accessed 02 May 2015

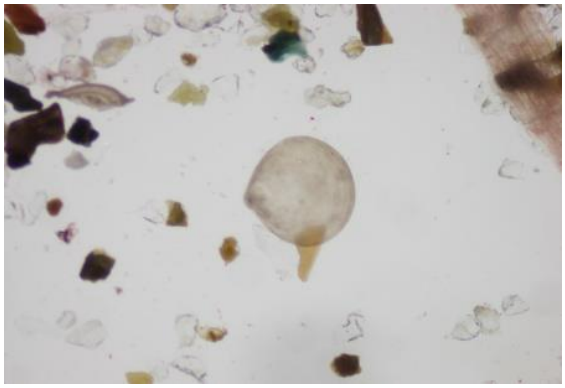
Exhibit 4.32 shows photographs of the macro-invertebrate fauna collected during sampling in May 2018.

Exhibit 4.32: Macro-invertebrates, Sampling May 2018

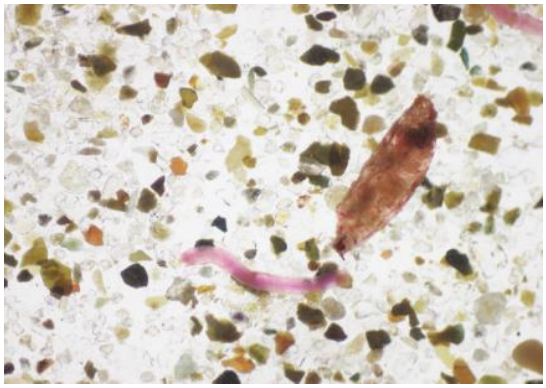
Bivalve shell (broken)



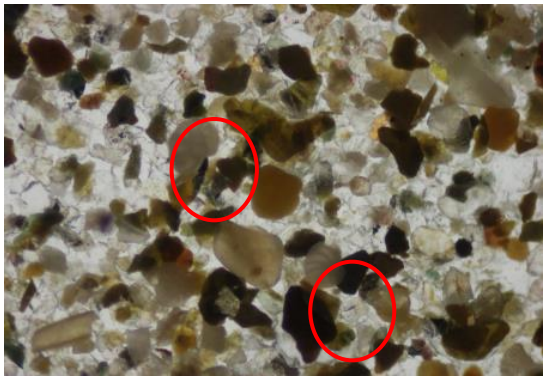
Gastropod



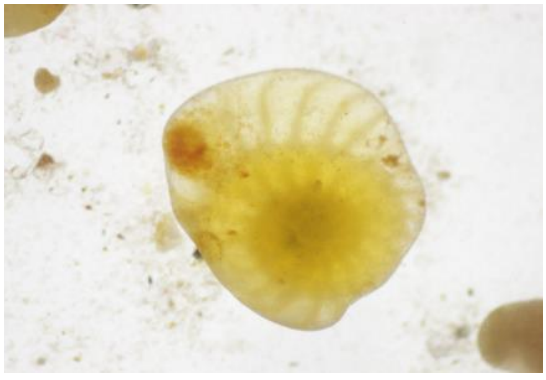
Bivalve shell



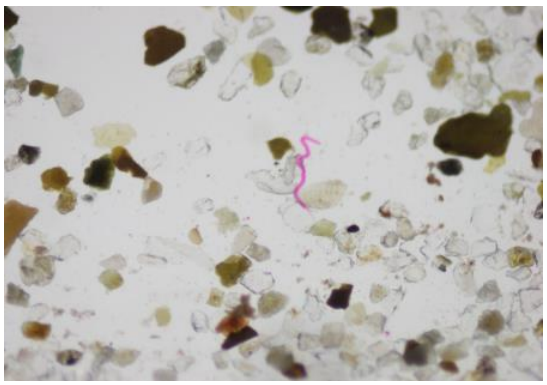
Copepod



Foraminifera in E1 sample



Foraminifera in C1 sample

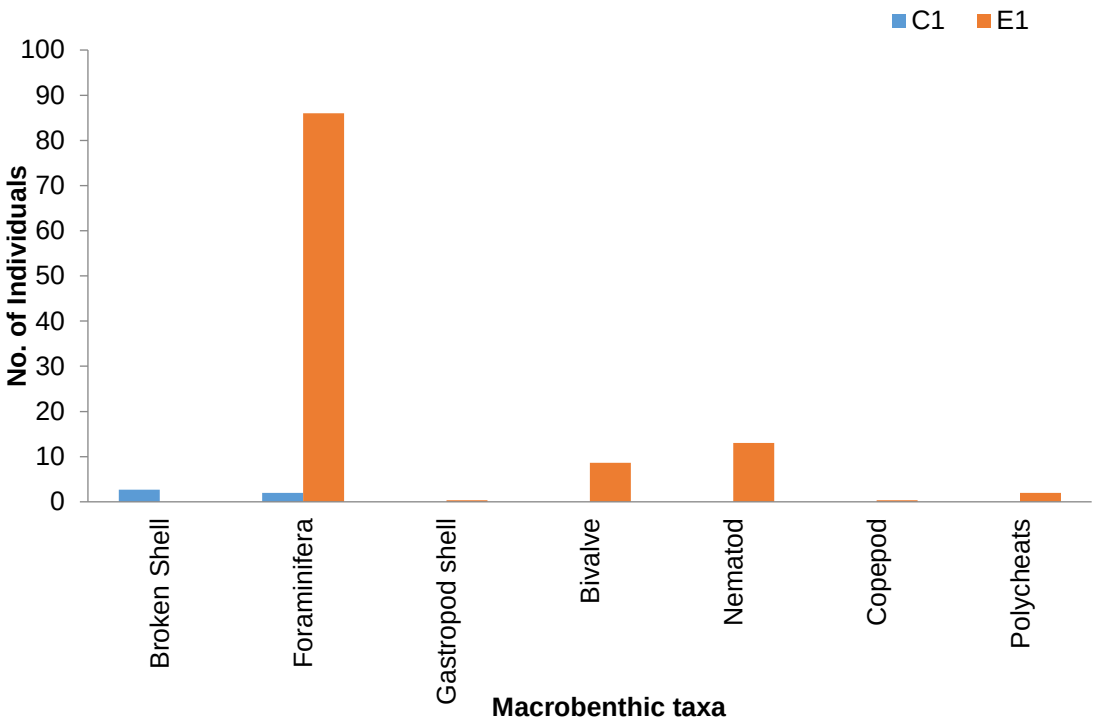


Nematode

Polychaete

Exhibit 4.33 shows a graph with the abundance of different forms.

Exhibit 4.33: Abundance of different forms of macro-invertebrates



The results indicate that the macroinvertebrate fauna at the outfall which is exposed to effluent discharge from EPCL is healthier relative to the fauna distal from it. This is probably due to the relatively low levels of disturbance at the outfall compared to disturbances due to construction activities at other sites along the coast of Port Qasim as well as the fact that the area at and near the outfall is exposed to effluent that meets SEQS and is, therefore, not polluted as defined by national laws. Furthermore, fish were also observed in the drain used for effluent discharge indicating that conditions for the persistence of aquatic life exist in the drain and the outfall.

While conditions for MBI distal from the coastline are better than along the coastal areas,[31] the conditions near the outfall are not worse than the conditions along the rest of the coastline. The results suggest that the conditions at and near the outfall are more stable than the rest of the coastal area of Port Qasim and that the conditions are suitable for the persistence of aquatic life. In addition, fish were also observed in the drain near the outfall indicating that the effluent is not destroying fauna.

Coastal Marine Fisheries: A very high diversity of fish species (approximately 200) has been recorded from the Indus Delta region.[32] Common larvae of fish described for Korangi Creek (located at a distance of 7.5 km west of sampling point E-1) and adjoining creeks in Indus Delta belong to the families Mugilidae, Gerreidae, Clupeidae, Nemipteridae, Gobiidae, Sciaenidae, Engraulidae, Sillaginidae and Lutjanidae.[33] Some juvenile sharks have been reported from Issaro Creek.[34]

Sampling for fish was carried out within the Port Qasim Area as part of the Cumulative Impact Assessment of Port Qasim.[35] The results of the sampling exercise showed a lower number of species at the two sampling locations close to the coastal areas. This can be attributed to more pollution, a higher level of disturbance, and industrial and domestic sewerage at sampling locations proximal to the coastline compared to those distal from it.

Heavy Metal Contamination: Based on three separate surveys carried out in 2008, 2014 and 2015, heavy metal contamination was detected in fish, shrimp and crab species. The heavy metals of concern included arsenic, cadmium, zinc and copper, as they were found to be above the permissible limits. In the most recent survey carried out in June 2015, only arsenic was found to be above the permissible limit; concentrations of other heavy metals including copper, lead, mercury and zinc were found to be below the permissible limits.

Marine Mammals and Reptiles: There is very little published information available on the number of cetaceans that visit the Port Qasim Area. Anecdotal evidence suggests that they have been observed in the shallow waters of creeks within the study area, but very rarely.

Among the reptiles, Beaked Sea Snake *Enhydrina schistose*, Annulated Sea Snake, *Hydrophis cyanocinctus,* Yellow Sea Snake *Hydrophis spiralis*, Dwarf Sea Snake *Hydrophis caerulescens,* Small headed Sea Snake *Hydrophis fasciatus* and Pelagic Sea

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31 Hagler Bailly Pakistan, Ecosystem Service Review and Cumulative Impact Assessment for Port and Industrial Developments at Port Qasim for the International Finance Corporation, January 2016

32 WWF. Indus Delta: A Vanishing Ecosystem. Indus for All Programme. Programme Management Unit, WWF [not dated]

33 Ibid

34 Based on surveys carried out by WWF Pakistan and Marine Fisheries Department and as reported by WWF and MFD.

35 Hagler Bailly Pakistan (HBP), Cumulative Effects Assessment of Industrial and Port Developments at Port Qasim for the International Finance Corporation (IFC), Washington D.C, January 2016

Snake *Pelamis platurus* have been recorded from the mangroves in the Indus Delta.[36] All of these species are listed as Least Concern in the IUCN Red List of Threatened Species.

Based on the information above these marine mammal and reptile species of conservation importance are not normally present in Gharo Creek which is the only habitat exposed to potential impacts of the Project.

4.3.7 Protected Area

Exhibit 4.34 shows the Protected Areas around the Study Area. It can be observed that the Study Area is located well within a developed area. The nearest Protected Area, the Keti Bandar North Wildlife Sanctuary, is more than 20 km away from the Study Area.

[36] Ahmad, MF.,Ghalib, SA., Niazi, MS., Perveen Z. and Hassan, A. Study of the Vertebrate Fauna of Mangrove Swamps of Sindh Coast. PARC Final Report Zoological Survey Department, Karachi, 1989 (Unpublished Report).

Exhibit 4.34: Relative Locations of Protected Areas and the Study Area

4.4 Social and Cultural Characteristics

The socioeconomic baseline study for the Project presents the socioeconomic conditions of the communities located within 8 km of the EPCL Complex.

Data Sources

The main data source was information from secondary sources consisting mainly of previous ESIAs conducted by HBP and the Cumulative Impact Assessment for Port Qasim.[37]

Other key secondary sources of information include official statistics, such as maps, census reports and other available documentation on the history of the people and the area from a broad selection of recent and reliable sources, both published and unpublished.

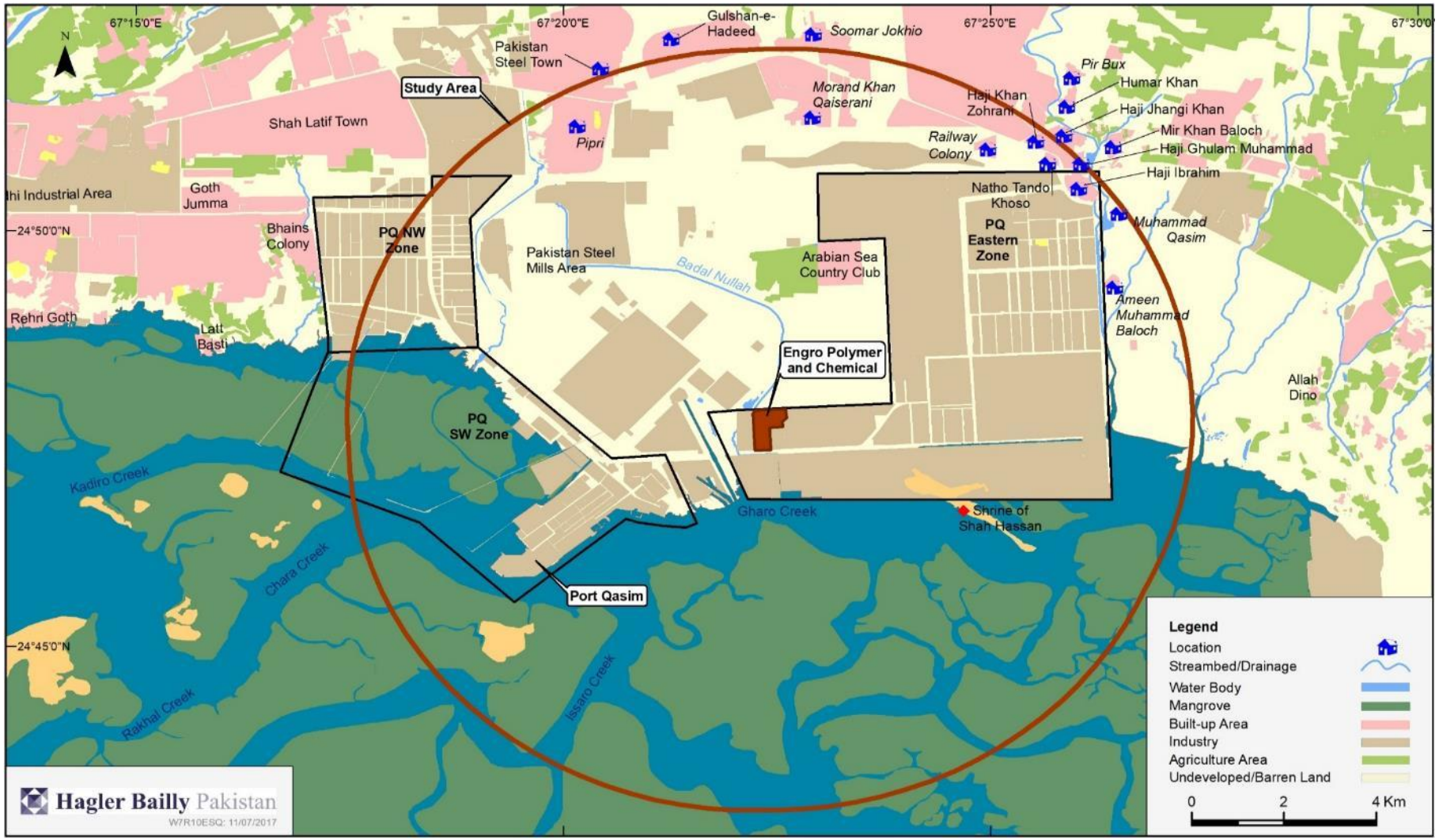
The list of settlements located within an 8 km radius of the EPCL Complex along with their coordinates is shown in **Exhibit 4.35** whereas the locations of the surveyed settlements are shown in **Exhibit 4.36**.

Exhibit 4.35: List of Settlements in Study Area

No	*Location*	*Coordinates*	
1	Railway Colony	24°51'03.9"N	67°24'57.9"E
2	Haji Ibrahim	24°50'33.1"N	67°25'59.6"E
3	Natho Tando Khoso	24°50'49.0"N	67°25'40.0"E
4	Haji Khan Zohrani	24°51'03.3"N	67°25'38.7"E
5	Haji Ghulam Muhammad	24°51'11.8"N	64°26'39.8"E
6	Ameen Muhammad Baloch	24°49'24.4"N	67°26'22.7"E
7	Muhammad Qasim Baloch	24°50'11.3"N	67°26'24.0"E
8	Morand Khan Qaiserani	24°51'30.1"N	67°23'02.2"E
9	Pipri	24°51'15.2"N	67°20'09.6"E

[37] Hagler Bailly Pakistan, Ecosystem Services Review and Cumulative Impact Assessment for Industrial and Port Developments at Port Qasim for the International Finance Corporation, January 2016

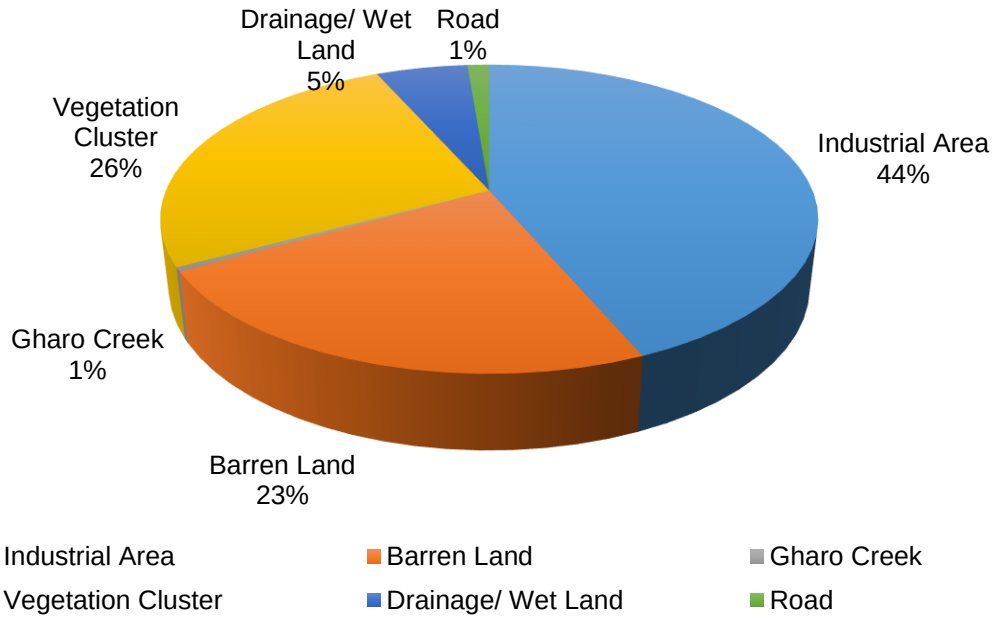
Exhibit 4.36: Location of Surveyed Settlements



4.4.1 Land-Use

The Study Area covers 3.4 square km. Major land uses in the Study Area consist of an industrial area (44%), vegetation cluster (26%), barren land (23%), drainage/wetland (5%) roads (1%) and Gharo Creek (1%). **Exhibit 4.37** shows the distribution.

Exhibit 4.37: Land Use Distribution



4.4.2 Demography

The total population of the surveyed settlements is estimated to be around 59,000. The largest settlement in the Study Area is Pipri, with an estimated population of 45,000 individuals, whereas Ameen Muhammad Baloch is the smallest settlement with an estimated population of 125 persons. Pipri is a semi-urban settlement whereas all other settlements are rural settlements. **Exhibit 4.38** lists the number of households, population of the settlements and average household size.

Exhibit 4.38: Demographic Profile of the Project Site Surroundings

Settlement	*Population*	*No. of Households*	*Average Household Size*
Railway Colony	1,800	292	6.16
Haji Ibrahim Goth	2,300	350	6.57
Natho Tando Khoso	1,900	270	7.04
Haji Khan Zohrani	2,000	250	8.00
Haji Ghulam Muhammad	4,700	950	4.95

Settlement	*Population*	*No. of Households*	*Average Household Size*
Ameen Muhammad Baloch	125	25	5.00
Muhammad Qasim Baloch	420	70	6.00
Morand Khan Qaserani Baloch	700	100	7.00
Pipri	45000	9000	5.00
Total	**58,945**	**11,307**	5.21

4.4.3 Household Size

A household may either be a single person or a multi-person household. Household members may be related or un-related and essentially include people who make common provisions for food and other essentials of living and have no usual place of residence elsewhere. The average size of the household in the Study Area was 5.21 persons. The maximum and minimum household sizes, recorded in the surveyed population were 10 and 5, respectively. The population residing in the area is largely semi-urban and rural.

4.4.4 Ethnology and Religion

Out of the total estimated population in the Study Area, 99.8% are Muslims. The other 0.2% of the population comprises Hindus and Christians.

The ethnic makeup of the population within the Study Area comprises mainly the Kalmati caste, followed by Baloch, Khosa and Zoharani. The main languages spoken in the area are Sindhi and Urdu.

4.4.5 Cultural Heritage

There is one heritage site within the Study Area. It is a shrine of Hazrat Syed Shah Hassan. Not much is known about this shrine however people believe that Hazrat Syed Shah Hassan is one of the seven famous saints protecting Karachi from cyclones. People occasionally visit the shrine and pray there. Most of the population in the Study Area is Muslim. A large influx of laborers from across the country which live in the Study Area has resulted in a mixed identity of the community.

4.4.6 Livelihoods

Labor work is the main occupation in the area. This is mainly due to low literacy levels because of which the labor-force residing in the area are largely unskilled. Up to five percent of the employed were government employees and an equal proportion is employed in the private sector, mainly the nearby industries, where they work as peons, telephone operators and security guards.

Unemployment and under-employment are common issues reported in the area. There is high competition for the daily-labor opportunities in the nearby industrial zone as labor supply exceeds labor demand. In the Study Area, most laborers are out of work for half

the time in a year. The rate of daily wage labor is around PKR 400 to 600 per day. Labor work includes work as masons, whitewashing, bagging and gardeners.

4.4.7 Governance and Administration

The Study Area falls within the Malir District. There is a single local government at the District level called the District Government. The District Government consists of an elected District (*Zila*) Council Chairman. The District administration comprises District offices including sub-offices at union council (UC) and town levels (includes municipal and town committees).

4.4.8 Physical Infrastructure

The condition of infrastructure in the settlements of the Study Area is poor. None of the rural settlements in the Study Area reported having police stations, police check-posts and natural gas facilities. However, Pipri has basic urban infrastructure like road network water supply and power supply system.

Housing and Other Structures

Over 62% of the living structures in the villages surveyed for the socioeconomic baseline were of masonry construction, while the remaining were of adobe construction. The main market in the area is located in Pipri. The market contains general stores, grocery shops, food-stores, mechanics and other service shops. Smaller shops for basic supplies exist in other settlements in the Study Area. Pictures showing these structures in the Study Area are shown in **Exhibit 4.39**.

Exhibit 4.39: Houses and Shops in the Study Area

Masonry Construction Houses in the Study Area

Adobe Construction Houses in the Study Area

Shops and hotel in study area.

Hotel at Railway Colony

Every settlement in the Study Area has at least one mosque. The mosques are of masonry construction, consisting of a single large prayer room or hall. The male population of a settlement congregates for prayers.

Exhibit 4.40: View of Mosques in the Study Area

Mosque at Railway Colony

Mosque and Shrine in the study area

Roads and Transport

Seven villages of the Study Area (see **Exhibit 4.41**) are connected by blacktop roads, whereas the remaining settlements are connected by unsealed road. Regular transport facilities to the inhabitants of the Study Area are in the form of taxis and buses. The inhabitants can easily access the public transport from the national highway.

Electricity and Fuelwoods

Electricity is available in nine of the thirteen settlements in Study Area, supplied through the K-Electric grid. Findings of the socioeconomic baseline survey show that fuelwood is generally used for cooking in settlement houses, whereas battery-operated torches are used for lighting. This wood is usually collected from surrounding areas. Mesquite bushes locally known as *keekar*, growing in the nearby lands, are the main source of fuelwood. These are used in combination with larger logs. The logs are available at a price of 400 to 500 per *mund* (mund is a local unit that equals 40 kg). LPG, being an expensive fuel alternative, is rarely used.

Water Supply

Water supply is one of the major problems faced by inhabitants living in the Study Area (see **Exhibit 4.41**). Most of the underground water is brackish and saline. Up to 57% of the settlements in Study Area have access to potable water supplied and managed by the Karachi Development Authority (KDA) through pipelines, while the rest of the settlements purchase water from private tankers. The price of water per tanker varies between PKR 500 to 1,500, depending on the size of the tanker. One tanker meets six to eight days of water requirement of an average household. FFBL has also established a reverse osmosis (RO) plant in Natho Tando Khoso, which supplies water mainly to the Natho Tando Khoso community and nearby residents.

Exhibit 4.41: Roads and Water Sources in the Study Area

Road in study area

Road in study area

Water storage tank in Pipri

Water Supply from Private Tankers

4.4.9 Social Infrastructure

Improved socioeconomic conditions tie in with higher education levels and good health of the people. An educated and skilled labor-force is more productive and contributes to economic growth. Health is the basic right of every human and improved nutrition and healthcare also contributes to bolstering the productivity of the human capital.

Education

Education facilities in the Study Area are provided by primary, middle and secondary schools run by the provincial education department. Primary schools were reported in 80%, middle schools in 5% and high schools in only 7% of the settlements in the Study Area. A middle school is also functioning under the Sindh Madarsatul Islam located at Morand Khan Qaserani Baloch settlement and another primary school is functioning under the Sindh Education Foundation[38], located at Natho Tando Khoso settlement.

Most of the schools are co-educational.

The literacy rate for both males and females was reported at 36%. The literate people have mostly attained education up to primary (5th grade) and matriculate levels (10th grade). Pictures showing the education institutions in the Study Area are presented in **Exhibit 4.42**.

Exhibit 4.42: Education Institutions in the Study Area

Government Primary School at Morand Khan Qaserani Baloch

Government Boys Secondary School at Khan Muhammad Baloch

EPCL established a primary school with The Citizen's Foundation (TCF) in 2013 at Gaghar Pattak. The school has grown over the past 5 years and currently, more than 450 students are receiving education from it. EPCL has provided the school with a solar powered system to ensure an uninterrupted supply of electricity. There are plans to expand the organization's contribution to education by setting up two more primary schools in the area as well as a secondary school.

Health

In the settlements of the Study Area settlement, Haji Ghulam Muhammad has a hospital, whereas, a dispensary is functioning in Railway Colony with a visiting lady doctor. The hospital and clinic at Pipri and Gulshan-e-Hadeed are the main health facilities located in the area which are accessible from the Study Area.

[38] The Sindh Education Foundation (SEF) was established in 1992 as a semi-autonomous organization to undertake educational initiatives in the disadvantaged areas of Sindh. SEF provides communities with direct access to educational facilities by opening schools through its various endeavors.

The most common ailments reported are respiratory issues, cough and flu, followed by Hepatitis C and eye problems among men and women.

Malaria and diarrhea are common among children with the lack of sanitation being the main cause of diseases.

In 2017 EPCL launched Community Health Campaigns for the community at Gaghar Pattak. Free medical camps were provided on a monthly basis throughout the year. These included free checkups, free medicines and free food supplements. More than 5,000 patients were treated free of cost for diseases such as hepatitis, bone mass density, diabetes, hypertension, skin diseases, eye screening & General OPD. Based on the performance of this initiative EPCL is now considering setting up a Primary Healthcare Unit in the area.

EPCL has planned to set up five water filtration plants within the community of Gaghar Patak in the period of 2018-2019. This will provide safe drinking water to the people, will be free of cost to the community and will help in the prevention of water-borne diseases.

5. Information Disclosure, Consultations and Participation

As part of the Environmental Impact Assessment process, consultations were undertaken with institutions that may have interest in the proposed project or may be affected by it. This section documents the consultation process for the EIA of the proposed Project.

5.1 Objectives of Stakeholder Consultations

The objectives of the stakeholder consultations during the EIA process are to:

- Ensure involvement of the affected and interested public in the project planning and EIA decision making processes;
- Inform the stakeholders on the proposed activities and its consequences;
- Gather data and information from the public about their human and biophysical environment, as well as about the relations they have with their environment;
- Seek input from the public on the planned activities to increase its positive outcomes and avoid or mitigate negative impacts.

The views, interests and concerns of Project stakeholders are taken into account in the following decisions:

- Planning, design and implementation of the Project;
- During the assessment of the potential impacts of the Project and the identification of appropriate mitigation measures;
- Decisions by the regulatory authorities on whether to approve the Project and corresponding conditions of approval.

5.2 Good Practice Principles

The consultations should be undertaken in good faith while remaining impartial. The good practice principles that should be observed during the consultations are listed below:

- *Cultural sensitivity* – this requires understanding and appreciation of the social institutions, values, and culture of the communities in the project area and respect for the historical, cultural, environmental, political and social backgrounds of the communities which are affected by a proposal;
- *Interactive approach* – consultation should not be limited to one–way dissemination of information. Stakeholder comments should be fed into the EIA process and proposed project design;

- *Open, transparent and informative* – People who are affected by the Project and are interested in participating should be given access to relevant information, in a simple and understandable format;
- *Inclusive and equitable* – It should be ensured that all stakeholder groups are represented, including less represented groups such as women, children, elderly and poor people;
- *Appropriateness and flexibility* – Consultation methodologies should be appropriate to the specific phase of the EIA process and the stakeholder groups identified. The consultation should be adjusted according to the resources available;
- *Capacity building* – Capacity building should be part of consultation interaction wherever appropriate and practicable.

5.3 Framework for Consultations

The EIA of the proposed Project is undertaken in compliance with relevant national legislation.

Public consultation is mandated under Sindh's environmental law. Regulation 6 of the IEE-EIA Regulations 2000 provides the general requirements whereas the sectoral guidelines indicating specific assessment requirements are provided in the Guidelines for Public Consultation 1997 (the 'Guidelines'). These are summarized below.

- **Objectives of Public Involvement:** 'To inform stakeholders about the proposed project, to provide an opportunity for those otherwise unrepresented to present their views and values, providing better transparency and accountability in decision making, creating a sense of ownership with the stakeholders';
- **Stakeholders:** 'People who may be directly or indirectly affected by a proposal will clearly be the focus of public involvement. Those who are directly affected may be project beneficiaries, those likely to be adversely affected, or other stakeholders. The identification of those indirectly affected is more difficult, and to some extent it will be a subjective judgment. For this reason, it is good practice to have a very wide definition of who should be involved and to include any person or group who thinks that they have an interest. Sometimes it may be necessary to consult with a representative from a particular interest group. In such cases the choice of representative should be left to the group itself. Consultation should include not only those likely to be affected, positively or negatively, by the outcome of a proposal, but should also include those who can affect the outcome of a proposal';
- **Mechanism of consultations:** 'Provide sufficient relevant information in a form that is easily understood by non-experts (without being simplistic or insulting), allow sufficient time for stakeholders to read, discuss, consider the information and its implications and to present their views, responses should be provided to issues and problems raised or comments made by stakeholders, selection of venues and timings of events should encourage maximum attendance';

- **Timing and Frequency:** Planning for the public consultation program needs to begin at a very early stage; ideally, it should commence at the screening stage of the proposal and continue throughout the EIA process;
- **Consultation Tools:** Some specific consultation tools that can be used for conducting consultations include; focus group meetings, needs assessment, semi-structured interviews; village meetings and workshops;
- **Other Important Considerations:** 'The development of a public involvement program would typically involve consideration of the following issues; objectives of the proposal and the study; identification of stakeholders; identification of appropriate techniques to consult with the stakeholders; identification of approaches to ensure feedback to involved stakeholders; and mechanisms to ensure stakeholders' consideration are taken into account'.

5.4 Project Stakeholders

Project stakeholders are defined as those groups or individuals that 'are directly or indirectly affected, positively or negatively, by the project and who can contribute to or hinder its success'. The identification of stakeholders is an ongoing and iterative process and more stakeholders are normally identified as the project develops.

5.4.1 Stakeholder Identification and Analysis

As mentioned earlier, stakeholders include individuals and groups that can affect or take effect from a project's outcome. In case of the Project, these include:

- Industries and factories located in areas that are affected by Project activities;
- Government and regulatory authorities directly or indirectly connected to or overseeing, the activities of the Project;
- Non–governmental organizations working in areas that can be affected by the Project;
- Academia that can be interested in the Project from the transfer of skill and knowledge point–of–view.

The list of identified stakeholders is included in **Section 5.5.**

5.4.2 Consultation Material

The main documents for distribution to stakeholders during the consultation are the Background Information Document (BID). The BID informed the stakeholders about the EIA process and on how they can participate in it. In addition, it contained Project details. The BID for the Project is included as **Appendix D**.

The consultation material was prepared and issued by HBP for information of consultation team members in advance of the process.

5.5 Consultation Methodology

A transparent and effective consultation mechanism was adopted for the Project, which ensured that the consultation objectives were met. Representatives of client and HBP were present during the consultation meeting with the stakeholders.

As there are no communities directly affected by the Project, they were not consulted. Consultation was only carried out with institutions.

HBP dispatched the BID to the identified industrial stakeholder that may be affected by the Project activities and asked for their opinions and concerns on the potential environmental and social impacts of the proposed Project. HBP also conducted a consultation meeting with the selected industrial stakeholders for which letters to inform about the objective of the consultation process and the meeting date, time and venue were dispatched in advance. The meetings progressed in the following manner:

- An overview of the Project description was provided;
- Briefly described the EIA process that was undertaken for the Project and presented the structure of the EIA report to facilitate understanding of the report;
- Concerns were recorded, queries were addressed;

The team from HBP provided information related to the Project EIA via letters to all the institutional stakeholders.

The list of identified institutional stakeholders is given in **Exhibit 5.1.**

Exhibit 5.1: List of Institutional Stakeholders

Stakeholder	*Attended*
Industrial Stakeholders	
Pakistan Steel Mills	×
Tuwairqi Steel Mills	✓
Engro Zarkhez	✓
Lotte Pakistan Limited	✓
TransAsia Refinery	×
Port Qasim Electric Power Company	✓
K-Electric Power Station	×
World Wide Fund for Nature (WWF)	×
International Union for Conservation of Nature (IUCN)	✓
Bin Qasim Association of Trade & Industry (BQATI)	✓
Engro Vopak Terminal, Port Qasim	✓
Arabian Sea and Country Club	×
Abbas Steel Group (ASG)	×

Stakeholder	*Attended*
Government Stakeholders	
Port Qasim Authority (PQA)	×
Pakistan Steel Mill	×
Sindh Environmental Protection Agency (SEPA)	×

5.6 Documentation and Reporting

The HBP team kept a record of all discussions during the meeting. An attendance record was maintained and photographs were taken. Photographs of the session consultations are provided in **Exhibit 5.2**. Summary of concerns raised during institutional stakeholder consultations is provided in **Exhibit 5.3.**

Exhibit 5.2: Institutional Consultation Photographs

Exhibit 5.3: Summary of Institutional Consultation

Aspect	*Concerns*	*Responses*
Wastewater related impacts	Will wastewater generation increase? If so how will this be handled?	▶ The plant has the capacity to deal with the additional wastewater to be generated. However, EPCL has allocated funds for increasing capacity to handle wastewater as well. ▶ EPCL will ensure that the effluent discharging from the wastewater treatment plant is SEQS compliant.
Solid waste disposal arrangements	How will solid waste be handled?	▶ Solid waste includes PVC resin which is sold in the market. Other solids are non-toxics including salts that are disposed of in landfills. ▶ On an aside liquid waste is disposed of using a SEPA approved incinerator. ▶ Solid waste both hazardous and non-hazardous will be managed through a waste management plan as discussed in **Section 8.3**.
Coke	Will coke be generated and if so how will it be handled?	▶ The expansion will not result in the addition of coke.
Emergency procedures	Will there be any changes to emergency procedures? And is there any inherent safety plan built into the expansion?	▶ The current systems for handling emergencies are well-established and regularly audited. EPCL also conducts drills to ensure emergency preparedness. In addition, EPCL has active and passive mitigation systems. ▶ The risk is mainly from PVC III and from storage. EPCL has conducted an internal study and is satisfied that all safety arrangements are adequate. A third party has been contracted to carry out an independent evaluation. ▶ The technology EPCL is using is from a globally known licenser with a reputation for manufacturing safe technology.
Leakage issues	What is the analysis regarding leakage issues?	▶ EPCL has mitigation measures in place to prevent leakages and to deal with them. ▶ Bolts, nuts and studs, other pipe connections of proper material specification strictly be used where there is a chance of leakage. ▶ An emergency response and a comprehensive system for coordination with public authorities are already in place to control such situations. However, the plan will be

Aspect	*Concerns*	*Responses*
		modified to have all the measures as suggested in **Section 6.3.5** and **Section 6.3.6** to avoid accidental release of gases and to minimize the impacts.
Flammable chemicals	Are there flammable chemicals on site?	▶ All chemicals on site are flammable. ▶ Fire systems and fire emergency response are in place for the expansion. ▶ All chemicals will be marked first and separated and provided with the proper storage based on their risk to the environment.
Gaseous emissions	Will gaseous emissions increase?	▶ There will be an overall increase but these will be lower than that for the current plant because the technology is better. ▶ EPCL has a standby adsorption unit for the current plant. ▶ The ambient air quality will be periodically monitored in the vicinity of the plant to ensure that the concentration levels of the gases are within the permissible limits. ▶ Several different types of cleaning systems will be employed such as complex multi-stage systems comprising adsorbent injection and/or catalytical devices for pollution abatement.
Timing of other studies	Will other studies such as QRA, FSS be done by the time of the public hearing?	▶ These will be ready by the time of the public hearing.
Manpower	Will manpower increase due to expansion?	▶ Yes, PVC III will have its own shifts and staff. The load on the lab will also increase.
Additional power	Will additional power be required?	▶ EPCL currently has additional power and is also looking to rehabilitate its Tornado technology for power generation.
Gas consumption	Will gas consumption increase?	▶ Gas consumption will increase. EPCL is working to minimize its environmental footprint in this regard. ▶ The EPCL expansion Project envisages utilizing hydrogen gas from the chlor-alkali plant to supplement the natural gas-fired in the ethyl dichloride cracking furnace. It is expected that hydrogen will result in savings of 0.8-1.0 MMSCFD of natural gas.

Aspect	*Concerns*	*Responses*
Water requirement	Will more water be required? And if so how will this be managed from an environmental perspective?	▶ Water requirement will increase. EPCL will invest more in cooling towers and reduction of losses. Over the past 5 years, EPCL has reduced its water usage and will continue to do so. ▶ EPCL is also considering becoming a zero discharge facility but this is not part of the expansion. ▶ The incremental impact from the Project on water resources will be minor and is unlikely to have significant impacts on creek ecology downstream. ▶ The Project water requirement will be met by water supply from Karachi Water and Sewerage Board, therefore, the risk of water crisis due to the Project for local communities is low.
By-products	Will there be an increase in by-products?	▶ No. Outputs of caustic, hypochlorite and other by-products will remain the same.
Traffic	Will there be impacts on traffic?	The construction traffic will be increased slightly however, this will be in a few trucks. Also, these will use the national highways that have the capacity to deal with such a slight increase.
Soil and water	Impacts on soil and water are important to consider.	All the Project construction and operation activities will take place within the plant premises and in proper designated and lined areas that will reduce the impact of soil and water contamination. Further mitigation measures are discussed in **Section 6**.

6. Environmental Impacts Identification

This section discusses the potential environmental and social impacts of the proposed Project. It predicts the magnitude of the impacts, assesses their significance, identifies mitigation measures to minimize adverse impacts, and evaluates the residual impacts, if any, of the Project.

Risk is defined qualitatively in terms of consequence and probability. Consequence is defined in terms of magnitude, duration, and spatial scale. Thus, the three categories are defined as follows:

- H—Definite impact, major deterioration and/or long–term impact and/or large footprint
- M—Possible impact, moderate deterioration and/or medium–term impact and/or intermediate footprint
- L—Unlikely (or low likelihood) impact, minor deterioration and/or short–term impact and/or small footprint

The significant issues are then further discussed in the following sections.

6.1 Impact Identification and Scoping Matrix

Impacts are identified using a scoping matrix presented in **Exhibit 6.1**. Major impacts are discussed in detail and depth further in this section.

Exhibit 6.1: Screening of Environmental and Social Impacts of the Proposed Activities

Project Activity	*Description*	*Initial Impact*	*Initial Risk*	*Mitigation Measure*	*Residual Risk*
Construction Phase					
Site construction activity	Construction activities include construction and operation of staff camp and equipment, storage of equipment, civil works, and installation of equipment, refueling and maintenance of vehicles. During the construction phase, the proposed Project can also increase the risk of exposing the workers and employees of the construction team and their contractors to occupational and safety hazards. Pipeline construction will include activities such as, leveling, and trenching that will result in loosening up of soil making the surface prone to erosion from wind and water.	▶ Water and wastewater from staff camp ▶ Spills and leakages of oil from equipment ▶ Contamination of soil and surface water ▶ Air and noise emissions ▶ Occupational health and safety risk to the workers ▶ Soil erosion	M	Construction related impacts can be kept low if managed properly. ▶ A construction management plan (CMP), spill management plan (SMP) and waste management plan (WMP) are included in **Section 8** (Environmental Management and Monitoring Plan). ▶ Personal protective equipment will be used to avoid occupational health and safety risk to the workers. ▶ Noise mufflers will be installed in construction machinery to reduce noise emission. ▶ Water sprinkling will be frequently carried out for dust suppression. ▶ Detailed mitigation measures are provided below.	L
Transportation of equipment and material	Part of the equipment will be imported via Karachi Port or Port Qasim. Other equipment and material will be procured from local sources. The equipment and material will then be moved to the project site using the main highways, such as M–9 or N–5.	Following are the impacts due to Project generated traffic: ▶ Road congestion and inconvenience to existing road users	M	All the roads that will be used for the transportation of project material and equipment are national highways, and in most cases have at least 4 lanes. The current volume of traffic on any of the highways ranges from 8,000 to 21,000 vehicles per day. In comparison, the	L

Project Activity	*Description*	*Initial Impact*	*Initial Risk*	*Mitigation Measure*	*Residual Risk*
		▶ Air and noise emissions ▶ Community safety issues		volume of traffic generated by the movement of Project material and equipment is likely to be less than a few trucks, spread over several weeks. The incremental traffic and consequently the impact will, therefore, be insignificant. Mitigation measures are provided below.	
Operation Phase					
Air emissions	On-site emission sources include PVC plant, EDC/VCM plant, generators and Chlor Alkali plant which results in the emissions of pollutants such as VCM, PVC powder, CO, SO_2, NOx, PM, HCl, Cl_2 and H_2	▶ Health issues of the surrounding community ▶ Occupational health and safety risk to the workers	M	Maximum achievable control technology (MACT) will be applied for emissions sources including PVC process vents, resin processing, equipment leaks, wastewater, heat exchangers, and storage vessels. VCM and EDC production from the operation of the Project will be higher than the existing situation still its emissions will be within standards as the existing situation which is well below the standards. Detailed mitigation measures are provided below in **Section 6.3.1**.	L
Noise emissions	Installation and operation of new facilities will add to the existing noise levels.	▶ Disturbance to the community ▶ Disturbance to the workers employed in the Project	M	The noise levels of the existing plant are already in compliance with SEQS and also the Project is located in a designated industrial zone which has relaxed standards. Mitigation measures are discussed in **Section 6.3.2** which include protective measures for workers.	L

Project Activity	*Description*	*Initial Impact*	*Initial Risk*	*Mitigation Measure*	*Residual Risk*
Water resources and consumption	Project water consumption from local water resources	Stress on community water needs	M	The Project water requirement will be met by water supply from Karachi Water and Sewerage Board, therefore, risk of water crisis due to the Project for local communities is low.	L
Effluent discharge	Operation of the Project will result in wastewater generation from the following sources: ▶ Incinerator ▶ Stormwater pit ▶ EDC wastewater stripper ▶ Chlor alkali wastewater ▶ PVC plant wastewater	▶ Soil contamination ▶ Water contamination	M	The wastewater generated by the Project activities will be treated in the wastewater pre-treatment facility and discharged after satisfying SEQS. Mitigation measures are discussed in **Section 6.3.4.**	L
Accidental releases and spills	Project operations will involve the use of three hazardous material ethylene, VCM, and chlorine in large quantities. Spills from the pipeline, storage tanks and during other transportation will pose risk to public health.	▶ Risk to human health ▶ Soil contamination ▶ Water contamination	H	A detailed risk assessment will be carried out for the release of potentially hazardous gases from the plant. An emergency response plan is to be prepared to avoid accidental release of gases and to minimize the impacts. Detailed mitigation measures are provided in **Section 6.3.5** and **6.3.6**.	L
Solid waste	Project operation will result in an increased quantity of generated waste as a result of expansion. Also, the Project operations will involve use of three hazardous material ethylene, VCM, and chlorine in large quantities.	▶ Risk to human health ▶ Soil contamination ▶ Water contamination	M	A Hazardous Materials Management Plan will be prepared in accordance to the points discussed in **Section 6.3.7.** A WMP is included in **Section 8.**	L

Project Activity	*Description*	*Initial Impact*	*Initial Risk*	*Mitigation Measure*	*Residual Risk*
Traffic	Operation of the Project will result in an increase in staff traffic mainly in form of passenger cars.	▶ Traffic accidents ▶ Air emissions ▶ Deterioration of access roads	L	Project related traffic will be very insignificant as compared to the total traffic already on the PQ access roads. Trainings will be given to the drivers to avoid risk of accidents. Mitigation measures are discussed in **Section 6.3.8**.	L
Greenhouse gas emissions (GHGs)	Combustion of natural gas to fulfill the Project requirement.	CO_2 emissions	L	Tree plantation will be done in order to reduce the CO_2 emissions.	L
Occupational health and safety	Production process of PVC and EDC will result in an exposure of hazardous material to the workers.	Risk to workers	M	A Hazardous Materials Management Plan will be prepared in accordance to the points discussed in **Section 6.3.7**. Personal protective measures will be taken to reduce risk of accidents to workers (**Section 6.3.10**).	L

6.2 Possible Impacts in Construction Phase

Impacts associated with construction along with their mitigation measures are presented in the sections below.

6.2.1 Site Construction Activity

Some of the environmental and social impacts of construction activities relate to activities at the construction site whereas others relate to the setting up and operation of the construction crew camp. Typical issues include:

- Site clearance leading to dust emission
- Removal of vegetation leading to loss of vegetation cover
- Erosion and sedimentation due to earthworks
- Deterioration of air quality from the operation of construction machinery and earthwork and movement of construction vehicles
- Noise and vibration from machinery and construction work
- Generation of waste and its disposal
- Disposal of wastewater from the construction camp
- Cultural impact related to the presence of non-local workers

Typically, the construction impacts are temporary and end with the completion of the construction activity. However, poor management can result in long-term residual impacts. To avoid the adverse impact of the construction activities on the environment, the following measures are proposed:

- To the extent possible, the camp of the construction contractor(s) will be located within the premises of Project site.
- The construction contractor will develop a specific construction management plan (CMP) based on the CMP included in the EMMP (**Section 8**). The CMP will be submitted to Port Qasim Authority (PQA) and Project Implementation Consultant (PIC) for approval.
- The CMP will clearly identify all areas that will be utilized during construction for various purposes using a site plan.

Solid Waste

Assessment

The construction activities may generate a considerable amount of waste. A detailed inventory of the waste will be prepared. The waste will include metals (mainly iron and copper), concrete, wood, cotton, plastic, packing materials, electronic, and insulation material. Several types of hazards are associated with the solid wastes. For example:

- Sharp edges in metals

- Tripping hazards if material is left in the pathways
- Soil contamination from leaking oil from equipment
- Slipping hazard from oil on floors
- Potentially toxic content
- Respiratory disorders due to dust and fumes

Mitigation Measures

The following mitigation measures will be applied on-site:

- A comprehensive waste management plan (**Section 8**) will be instituted during which re–use opportunities for waste generated from the project will be actively investigated. Used oil and other waste will be identified, and if any, it will be stored in separate designated and contained facility.
- As a standard practice, all metal (mainly iron and copper) or wooden parts generated as waste during the construction of new project will be recycled or stored in a dedicated existing scrap yard for auction.
- Even after the implementation of the control measures, it is possible that some littering may take place. Periodic monitoring and cleanup will be undertaken to minimize the residual impact.

Effluent

The staff and labor camps for construction of the Project will be a source of wastewater generated from the toilets, washrooms, and the kitchen, etc. All sanitary discharge effluent will, however, be routed to the existing system of PQA after passing through septic tanks and soakage pits.

Soil erosion

Erosion of soil along the right of way (RoW) caused by wind or storm water run-off can affect the land. A significant impact on soil stability will be interpreted if, after completion of the construction activities, the construction corridor is left with unsealed surfaces or surfaces devoid of vegetation and without compaction. Secondly, the land is not graded on its natural or pre-project condition and drainage.

Assessment

Pipeline construction will include activities such as leveling, and trenching that will result in loosening up of soil making the surface prone to erosion from wind and water. Erosion control measures are part of good engineering practice that if employed will prevent any erosion-related problems in the future. The mitigation measures that are required are presented in the next section.

Mitigation Measures

Following measures will be employed to minimize soil erosion:

- The corridor that is disturbed during pipeline construction will be kept to a minimum.
- The construction corridor along the pipeline's RoW will be properly marked.
- The movement of machinery will be restricted to the construction corridor.
- Excavated material will be placed within the pipeline work corridor.
- The topsoil along the trench will be stockpiled separately and will be used as the uppermost soil layer during the backfilling of the trench.
- The backfill will be crowned to a height of about 200 mm above the adjacent ground surface to allow for settling.
- Soil erosion control measures (e.g. silt fences, rip rap) will be undertaken where necessary during construction.
- The RoW, campsites and other construction sites will be restored as close as possible to their pre-project conditions after the installation of the pipeline is completed. For this purpose a Reinstatement Plan will be prepared that may include the following:
    a. Removal of debris, excess construction material, cable, machinery parts or timber
    b. Disposal of surplus soil
    c. Repair to damaged or blocked drainage
    d. Filling of all ditches and pits
    e. Soil erosion control measures where necessary
    f. Grading of the RoW to restore the natural contour of the ground and allow natural surface drainage

Implementation of the proposed mitigation measures is likely to leave an insignificant residual impact on the soil stability of the project area. To ensure this, the pipeline RoW will be regularly inspected after the completion of construction work. The monitoring measures will include:

- Post-reinstatement record of the condition of the RoW
- Inspection for signs or erosion during and after the construction

Soil and Water Contamination

The existing sources of soil contamination in the area include the industrial units, commercial activities, port related activities and vehicles and maintenance.

Assessment

Spills during refueling, discharge during vehicle and equipment maintenance, traffic accidents and leakages from equipment/vehicles often result in contamination of soil and potentially that of surface water bodies at the construction site.

Possible sources of soil and water impacts include:

- Spills during refueling, discharges during vehicle and equipment maintenance, traffic accidents, handling of chemicals and leakages from equipment and vehicles often result in contamination of soil during construction;
- Runoff after a storm from the construction site may contain oil that may pollute the surrounding lands. Earthwork may also alter the drainage pattern and affect the stormwater flow and result in possible flooding of sections of surrounding land;
- Various types of wastes such as packing waste, metal scrap, excess materials, uprooted vegetation, and excess soil will be generated during the construction phase. Besides being an eyesore, the waste can be a health hazard and pollute waterways, if disposed of improperly.

During a typical construction project spill of fuel, lubricants, and chemicals take place:

- During transfer from one container to another or during refueling
- During maintenance of equipment and vehicles
- Due to leakages from equipment and containers, and
- As a result of traffic accidents.

Depending on the nature of the material, location of spill and quantity of spill, soil can get contaminated.

Mitigation Measures

The following control measures are proposed to mitigate the impact on soil resources:

- Spill prevention trays will be provided and used at refueling locations
- On-site maintenance of construction vehicles and equipment will be avoided as far as possible. In case on-site maintenance is unavoidable, tarpaulin or other impermeable material will be spread on the ground to prevent contamination of soil.
- Regular inspections will be carried out to detect leakages in construction vehicles and equipment.
- All vehicles will be washed in external commercial facilities.
- Fuels, lubricants, and chemicals will be stored in covered bounded areas, underlain with impervious lining.
- Appropriate arrangements, including shovels, plastic bags and absorbent materials, will be available near fuel and oil storage areas.
- Contaminated soil will be removed from the site and taken to the incineration.
- Emergency plan for spill management will be prepared and inducted to the staff for any incident of spill.

Detailed mitigation measures are provided in waste management plan (WMP), construction management plan (CMP) and spill management plan (SMP) included in **Section 8**.

Implementation of the proposed mitigation measures is not likely to leave any long-term residual impact on the soil, however, insignificant amount of hydrocarbon may be left in the soil due to minor spills where remedial measures are not possible. No long-term residual impacts are expected if the above-listed measures implemented.

To ensure compliance:

- Regular inspection of the soil in the Project area will be undertaken.
- Incident record of all moderate and major spills will be maintained. The record will include the location of the spill; estimated quantity; spill material; restoration measures; photographs; description of any damage to vegetation, water resource, or community asset; and corrective measures taken.

Noise

Construction noise is a component of environmental noise associated with construction activities. Construction noise arises from an activity at a construction site. It includes:

- noise from operation of construction machinery and equipment for the construction activities including site preparation work, foundations and concrete placement, erection of metal structures, installation of mechanical and electrical equipment and building maintenance or repair work; and
- noise from movement of vehicles within, entering or leaving a construction site.

Construction noise emanates from the source and propagates through the atmosphere. There are numerous factors influencing the noise level received at a sensitive receptor including:

- The degree to which the radiation emitted is concentrated in a single direction.
- Atmospheric absorption (i.e. attenuation which is a function of temperature, humidity, and frequency within the atmosphere).
- Meteorological influences (attenuation or enhancement due to surface temperature and humidity, vertical temperature profile, wind speed, and direction).
- Ground absorption (influence of hard or soft ground types on propagation).
- Topography and structures (attenuation due to intervening buildings and terrain features.

Depending on the construction equipment used and its distance, the receptors may typically be exposed to intermittent and variable noise levels. During the day such noise results in general annoyance and can interfere with sleep during the night. In general, human sound perception is such that a change in sound level of 3 dBA is just noticeable, a change of 5 dBA is clearly noticeable, and a change of 10 dB is perceived as a doubling or halving of sound level.

Assessment

The analysis presented in this section is based on the approach recommended by the Federal Highway Administration of the US Department of Transportation for assessment of construction noise.[39]

Construction noise levels at the nearest receptor in the nearby village, located approximately at 6,000 m from the boundary of the construction site, would fluctuate depending on the type, number and duration of use of various pieces of construction equipment and distance from the receptor.

In this analysis, first, the noise level due to each piece of equipment, which is likely to be used in the construction, is calculated. The peak noise levels of construction equipment mainly used at a typical construction site, are shown in **Exhibit 6.2**. The list includes all equipment except vehicles.

The predicted noise level at 6,000 m from the source with the noisiest equipment say drilling machine, working is 40 dBA. When more than one piece of equipment is working simultaneously, the noise level at the receptor will increase. Generally speaking, the noise level will increase by 3 dBA due to the first equipment. Increase due to subsequent addition of equipment will gradually decrease from 3 dBA. So if five equipment, each producing 52 dBA at the receptor, are working simultaneously, the resulting noise level will be around 59 dBA. The attenuation due to topographic factors could be up to 5 dBA. Good maintenance of equipment with the installation of noise mufflers can reduce the noise by another 5 dBA.

Column 1: The list of all equipment that is typically used on a construction site.

Column 2: The peak noise level range of the construction equipment at a reference distance of 15.2 m (50 ft) from the source.

Column 3: The typical peak noise level in a typical work cycle.

Column 4: The 'quieted' noise level. This is the noise level that is easily achieved by proper maintenance of equipment and use of simple noise reducing features such as enclosures and mufflers.

Column 5: Piece of equipment used in each specific type of construction phase.

Exhibit 6.2: Construction Equipment Noise Ranges (dBA)

Equipment	*Peak Noise Range at 15.2 m*	*Typical Peak Sound Level in a Work Cycle*[a]	*Typical 'Quieted Equipment' Sound Level*[b]	*Construction Phase*		
				Earthworks	*Structures*	*Installation*
Batching plant	82-86	84	81		Y	
Concrete mixers	76-86	85	82		Y	
Cranes	70-94	83	80		Y	Y

[39] Highway Construction Noise: Measurement, Prediction, and Mitigation, Reagan, J. A. and C. A. Grant, Special Report. US. Department of Transportation, Federal Highway Administration.

Equipment	*Peak Noise Range at 15.2 m*	*Typical Peak Sound Level in a Work Cycle*[a]	*Typical 'Quieted Equipment' Sound Level*[b]	*Construction Phase*		
				Earthworks	*Structures*	*Installation*
Excavators	74-92	85	82	Y		
Tractors and trolleys	77-94	88	85	Y	Y	Y
Water bowsers	85-93	88	85	Y	Y	Y
Graders	72-92	85	82	Y		
Bulldozers	65-95	80	75	Y		
Paver	87-89	88	80	Y		
Pumps	68-72	76	75	Y	Y	Y
Diesel generators	72-82	78	75	Y	Y	Y
Vibrators	68-82	76	75	Y	Y	
Drilling machines	82-98	90	87		Y	Y
Compressors	74-84	81	71		Y	
Dumpers	77-96	88	83	Y	Y	Y
Road rollers	73-77	75	72	Y		

Sources: Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances. USEPA; Bolt, Beranek, and Newman, 1971.

Notes:

[a] Where typical value is not cited in literature, mean of the peak noise range is assumed

[b] Quieted equipment can be designed with enclosures, mufflers, or other noise-reducing features. Where data is not available, a 3 dB reduction is assumed

Current ambient noise levels in the area were observed to be well below SEQS limits. A slight increase in ambient noise conditions is expected due to the construction activities and increased traffic for transportation of construction materials and supplies.

Mitigation

The general mitigation measures are discussed below.

- Noise survey of all construction equipment will be conducted prior to their deployment. The survey will be repeated periodically. For this purpose, each piece will be tagged and the following data will be recorded:
  - Survey date, surveyor, and noise meter ID
  - Equipment ID, type, and make
  - Noise levels at reference distance(s) in idling conditions, in all four directions

  - ▷ Noise levels at reference distance(s) in full throttle conditions, in all four directions
- Based on the above survey, equipment emitting excessive noise in comparison with other similar equipment will not be allowed to operate.
- Equipment under use will be regularly maintained, tuned, and provided with mufflers to minimize noise levels.
- Equipment in a poor state of maintenance, particularly without effective noise control will be checked to determine if it can be improved, and replaced with less noisy equipment as soon as practicable.
- Quietest available equipment will be selected that can economically undertake the work required.
- Equipment or the work area will be modified to make it quieter by substituting existing equipment with quieter equipment; retrofitting existing equipment with damping materials, mufflers, or enclosures; erecting barriers; and maintenance.
- Special noise reduction measures, such as erecting purpose-built acoustic barriers, restricting opening hours and maintaining transport vehicle will be implemented.
- Noisy operations will be combined to occur in the same time period. The total noise level produced will not be significantly greater than the level produced if the operations were performed separately.
- Workers' exposure to high noise levels will be reduced by keeping moving workers away from the noise source; restricting access to areas; rotating workers performing noisy tasks, and shutting down noisy equipment when not needed.

Given the residual impacts, periodic monitoring of noise at source, at the construction site, and at the receptors level will be undertaken.

Dust Emission

Dust emission from construction sites is a concern particularly if the site is near residential areas. Dust or the equivalent technical term 'particulate matter', is generally defined as any airborne finely divided solid or liquid material up to the size of about 100 microns (micrometers or one-millionth of a meter). The main health hazards are the particles smaller than 10 microns (designated as 'PM_{10}') as they are respirable. Larger particles also tend to settle rapidly and often do not reach receptors. In cases where they reach the receptors, the dust is considered a nuisance as it may soil property and affect visibility.

Assessment

Potential sources of particulate matter emission during construction activities include earthworks (preparation of RoW, dirt or debris pushing and grading), exposed surfaces, exposed storage piles, truck dumping, hauling, vehicle movement on unpaved land, combustion of fuel in equipment and vehicles.

There are no settlements within 6 km of the plant area. The environmental issue related to dust emission is the potential nuisance to the people working and using the commercial area near the Port Qasim entrance.

For the construction activity in RoW of the ethylene pipeline, a significant effect on the environment will be interpreted if there is an increase in visible dust beyond the limits of the construction RoW.

Mitigation Measures

If standard dust control techniques are used the emissions can be reduced significantly. The methods proposed to mitigate the potential sources of particulate emissions are given as below.

- Vehicle speeds to be controlled in the vicinity of the community,
- Road surfaces to be cleaned or kept damp when required. The most effective means of reducing the dust emission is wet suppression. Watering exposed surfaces and soil with adequate frequency to keep soil moist at all times can reduce the total dust emission from the project by as much as 75%.[40]
- Dust control is achieved by dust suppression and extraction system. Dust suppression is achieved by two methods; Plain Water Dust Suppression System and Dry Fog Type Dust Suppression System. Design and construction features of Dust control system shall be generally in conformity with the recommendation of "American Conference of Governmental Industrial Hygienists" or applicable international standards.

If the mitigation measures proposed above are set in place, there is no significant risk to the environment. In view of the residual impacts, the following monitoring measures will be undertaken:

- Ambient air concentration of the pollutants will be periodically monitored in the areas around the plants.
- Dust emission from the construction activity will be visually monitored, particularly when activity is undertaken close to the receptors, to prevent visible dust beyond the plant property lines.

6.2.2 Transportation of Equipment

The maximum traffic load is expected during the construction phase.

[40] El Dorado County Air Pollution Control District. 2002. Guide to Air Quality Assessment: Determining Significance of Air Quality Impacts Under the California Environmental Quality Act. First Edition. http://co.el-dorado.ca.us/emd/apcd. As there are no local standards of VCM therefore Canadian Ambient Air Quality Standards for VCM have been applied to the Project. The standard is 0.01 parts per million (ppm) for 24-hours averaging period.

Assessment

Impacts of transportation of construction equipment and plant machinery on the Project site are:

- Queueing and longer commute times
- Safety hazards especially for pedestrians and livestock due to the increased volume of traffic on the roads;
- Deterioration of ambient air quality and increase in noise levels in settlements located alongside the route selected for transportation; and
- Degradation of the existing roads.

Mitigation Measures

- Heavy transport vehicles in use by the Project during the construction phase may damage the local roads. In case of any damage by Project activities, these roads should be promptly and properly repaired and maintained.
- Make sure all drivers comply with the traffic codes concerning maximum speed limit, driving hours, etc.
- Keep speeds slow (30 km/hr) on unsealed roads to avoid windblown dust.
- Sprinkle water on unsealed roads that are used for construction traffic.
- Promptly and properly repair and maintain roads that are subject to damage by Project construction activities.
- Identify suitable times to transport equipment.
- Train drivers to move along long transport route to keep their vehicle speed in limits and consider traffic signs and boards.
- Construction traffic will not travel during school starting and ending hours on designated road segments in front of schools on the transport route.
- Maintain vehicles, especially brakes.
- All vehicles, generators and other equipment used during the construction will be properly tuned and maintained in good working condition in order to minimize emission of pollutants

Implementation of the proposed mitigation measures is likely to leave no long-term residual impact on the ambient air. To ensure compliance, regular inspection of equipment and vehicles will be undertaken.

6.3 Possible Impacts in Operation Phase

Major environmental impacts during operations will result from the operation of the Project, which includes air and noise emissions, wastewater discharges and the risk of accidental spills and releases. All major potential environmental impacts during operation phase are discussed in this section.

6.3.1 Air Emissions

The operation of the proposed Project will result in an increase in air emissions that can potentially affect the ambient air quality.

Assessment

The pollutants selected for evaluation; sulfur dioxide, nitrogen oxides and particulate matter (PM_{10} and $PM_{2.5}$) are not Project specific and their concentration in ambient air also gets affected by the nearby operating power stations; K-electric and Port Qasim electric power stations, whereas the pollutant VCM is Project specific and its concentration is only dependent on the production of PVC. However, as discussed in **Section 4**, the concentration of SO_2, NO_2, NO, PM_{10}, $PM_{2.5}$ and VCM are within the standards. The proposed expansion will cause an in an increase in the above pollutant concentration. However, considering the existing plant situation and measures in place this increase will be marginal and still be in standards.

PVC production process is also known to be a source of dioxin emission. Dioxin is a general term that describes a group of hundreds of compounds. The common elements in these compounds are the presence of chlorine and their highly persistent nature in the environment. The chemical is an unwanted byproduct of the combustion process in which chlorine is present. The most common compound is 2,3,7,8-tetrachlorodibenzo-p-dioxin or TCDD. The toxicity of other dioxins and chemicals that act like dioxin is measured in relation to TCDD.

The estimates of dioxin emission during PVC production as compared to total dioxin emission in the world are not readily available. An indication can be obtained from the national inventories. The total dioxin emission to air from PVC production as compared to the national emission ranges between 0.01% to 0.69% for Belgium, Canada, Germany, Holland, and USA—the countries for which information is available (UNEP, 1999). This indicates that PVC production is likely to be a very small contributor to the total dioxin emission to the air from anthropogenic sources. The most important route for human exposure to dioxins is food consumption, contributing 95-98% of total exposure (UKDETR, 1999). It is therefore concluded that although dioxin emission from the proposed facility does not appear to be a significant source of dioxin, there is a need to control the emission due to the toxic nature of dioxin.

Mitigation Measures

The mitigation measures that can be applied to control the emissions of pollutants are described below.

- The ambient air quality will be periodically monitored in the vicinity of the plant to ensure that the concentration levels of the gases are within the permissible limits.
- Several different types of cleaning systems will be employed such as complex multi-stage systems comprising adsorbent injection and/or catalytical devices for dioxin abatement.

- Dioxins are mostly produced as a consequence of de novo synthesis, which occurs at a temperature range of 300-350 °C. Usually, dioxins are produced when the temperature cools from 700 °C to 200 °C. The number of dioxins produced in this process are inversely proportional to the rate of cooling of the gas. Therefore, very efficient heat recovery systems must be developed, such as heat exchangers, and the gases should eventually be cooled by quenching (Grzegorz Wielgosiński, 2011).

6.3.2 Noise Emissions

The plant noise will increase after installation of new facilities to meet the expansion requirement that may result in disturbance to the receptors.

Assessment

The Project is located in a designated industrial area where noise limits are relaxed. Also, the ambient noise levels are well within the standards as discussed in **Section 4**. Noise generated due to Project operation will be 62.5 dBA and 60.7 dBA during day and night, respectively.[41] These noise levels still within the levels prescribed in SEQS. Furthermore, there are no sensitive receptors located within 6.5 km radius near the Project that could be disturbed due to increase in noise levels. Noise during operation is, therefore, not a major concern for the Project. Although the details of the noise levels for the proposed Project are not available at this time, it is expected that the noise levels of the new facilities will be similar or lower to that of the existing plant.

Mitigation

The noise levels will be in compliance of the SEQS however, the following mitigation measures will be adopted for the workers and for the community to further drop the noise levels:

- Occupational noise exposure to workers in the form of 8–hourly time-weighted average will be maintained well within the applicable SEQS limits.
- Acoustic enclosures will be provided wherever required to control the noise level.
- Personal protection equipment (including earmuffs, earplugs) will be provided and made mandatory for the workers.
- Equipment under use will be regularly maintained, tuned, and provided with mufflers to minimize noise levels.
- Muffled breakers and silenced diesel generators and compressors will be used to reduce equipment noise.
- Other than the provision of personal protective equipment, it will be ensured that when possible, the workers maintain sufficient safe distance from the noisy equipment

[41] The maximum noise levels are observed at N4 which takes into account the noise generated by the plant operations. The day and nighttime noise levels are taken as a conservative approach to be additional noise levels due to operation of the proposed Project.

- Build an enclosure around the noise source so that noise is contained. The enclosure should be free from gaps and made of dense material and be lined with noise-absorbing material like glass or polyester batts.
- Design and built acoustic barriers if needed. Vegetated buffer zones can also be planted to mitigate noise from operations using suitably selected native plantings local to the area.
- Equipment or the work area will be modified to make it quieter by substituting existing equipment with quieter equipment; retrofitting existing equipment with damping materials, mufflers, or enclosures; erecting barriers; and maintenance.
- Noisy operations will be combined to occur in the same time period. The total noise level produced will not be significantly greater than the level produced if the operations were performed separately.
- Workers' exposure to high noise levels will be reduced by keeping moving workers away from the noise source; restricting access to areas; rotating workers performing noisy tasks, and shutting down noisy equipment when not needed.

6.3.3 Water Resources

Project water consumption from local water resources may compromise the requirement of local community needs. However, the following mitigation measures will be adopted:

- The possibility of using recycled water for dust suppression will be explored.
- The incremental impact from the Project on water resources will be minor and is unlikely to have significant impacts on creek ecology downstream.
- The operational water requirements for the Project will be met by a supply connection provided by PQA.

6.3.4 Effluents

The discharge of increased and untreated sewerage can impact soil, water resources and aquatic biodiversity, fish and human.

Assessment

The wastewater includes centrifugal mother liquor, stripping wastewater and flushing water from equipment and the ground. The expected amount of wastewater generation is assumed to be equal to the existing plant i.e. 38-41 m^3/h. the wastewater generated will be first treated in the wastewater pre-treatment facility and then discharged to the Badal Nullah after satisfying SEQS.

Wastewater is also produced from caustic evaporation in the chlor-alkali (CA) plant which is a condensate and does not have a significant impact in deteriorating the effluent quality. Most of the process chemicals being used in the CA plant are inorganic. Therefore, the effluent is not a major concern.

Chemical sewer from the Project will also be connected to the wastewater treatment unit to ensure that no contaminated effluent flows out of the plant without treatment.

The current concentration of metals is low and within standards in the Badal Nullah draining into the sea indicates that marine life is not likely to be impacted by pollutants in this drain. Also, the project will not result in an exceedance of the standards.

Mitigation Measures

- Any significant impact on the surface and groundwater will be averted by treating the water as per SEQS.
- Periodic monitoring will be done to include discharge rate of overall wastewater as well as conducting the chemical analysis of the wastewater streams so that relevant remedial measures can be employed

6.3.5 Accidental Releases

Project operations will involve the use of three hazardous materials including ethylene, VCM, and chlorine in large quantities. These chemicals have a potential to harm human health and the environment around it if released accidentally into the atmosphere.

Assessment

Main gases which can affect the neighboring receptors in case of heavy leaks are:

- Vinyl Chloride
- Ethylene

Vinyl chloride will be stored in the storage tanks whereas ethylene will be supplied through a 6-inches diameter pipeline. In all the cases the spill source type is a horizontal jet with the source plane perpendicular to the ambient wind direction and the source velocity pointing downward. The consequence of an accidental release may include damage to the EPCL plant and the operators, in case of an explosion, fatalities in case of severe short-term exposure, and various diseases such as cancer, disruption of the endocrine system, neurotoxicity, and immune system suppression.

Mitigation Measures

A detailed risk assessment has been carried out for the existing plant for the release of potentially hazardous gases from the plant. In consideration of this, all risk management processes and an emergency response plan are in place to avoid accidental release of gases and to minimize the impacts. Standard Operating Procedures (SOP) have been developed and training conducted for various emergency scenarios at the Plant, including vapor release incidents. These procedures provide guidelines on minimizing the volume of the system from which release has occurred. Exercises and drills to monitor the effectiveness of the program are done regularly to ensure that our emergency squad members are well prepared to tackle emergency situations. The same measures will be modified if needed, for the expansion.

An on-site emergency response plan will include the following to minimize the impacts of the proposed Project:

- Identification of hazardous chemicals, processes and the operations

- Release scenarios, consequences in terms of heat generation, overpressure and toxic release etc.
- Preparation of site plan for damage control
- Identification of the vulnerable zones
- Classification of unit or units which have the most potential for creating on-site as well as off-site emergency
- Identification of the important facilities available in the vulnerable zone
- Identification of the requirements of various departments in-site as well as out-site the process plant for coping emergency situation

VCM plant vapors will be scrubbed of all undesirable constituents to make the vapors compliant with target standards. In case of contingencies, hydrocarbon releases are of potentially low magnitude and not expected to impact aquatic life at all. The EPCL Plant safety management system comprises of a comprehensive risk management program to ensure that the vapor release incidents do not take place at all. Operations staff will also be provided more training to ensure that the impact to the neighboring community is minimized in case of a release. It is anticipated that the impact to the aquatic life in case of a vapor release will be minimal as due to in place SOPs. However, the monitoring will be required to reduce the risk and will involve:

- Bolts, nuts and studs, other pipe connections of proper material specification strictly be used where there is a chance of leakage.
- A proper system of periodic inspection of all plants and equipment including cocks, valves and pipelines and the degassing system should be introduced and followed jointly by the process and maintenance department. Preventive maintenance should be planned in a manner to synchronize gradually with periodic routine shut down of equipment and plant.
- A complete register for recording the periodic testing should be maintained.
- A control room equipped with the instruments for automatic detection of small amount of gas releases and their location.
- Process flow, temperature, instrumentation control, pressure relief, safety and general operating condition should be examined to ensure that the plant would not only operate safely but should also fail safely if it is going to fail at all.
- Periodic safety audit by both internal and external audit team should be undertaken by the management.

6.3.6 Accidental Spills

Assessment

Spills from the pipeline, storage tanks and during other transportation, can potentially affect the soil, water resources, flora and human being.

A significant impact will be interpreted if there is any discharge of oil or any other chemical from the storage tanks, import pipeline, accidents and any equipment breakdown.

Accidental discharge and leakages of oil or any chemical are technically possible. Safety measures that will be the part of the Project design to minimize the occurrence of such events are already in place for the existing plant.

Major hydrocarbon storage at the site will be at the VCM storage area which is the largest hydrocarbon storage at the site with a current capacity of around 3,500 m^3 VCM. For the expansion project, an additional storage tank for VCM is designed. Some quantity of the hydrocarbons such as the EDC storages are envisaged in the expansion project, these tanks will be designed with over flow dikes having adequate capacities to hold the full volume of the vessel. These dikes will be kept isolated from the normal sewer and plant effluent channels hence there is no chance of mixing of effluent with these hydrocarbons. To keep control on evaporation rate from the liquid pool inside the dike, foam systems will be installed at each dike, which is already present at the existing plant, which will cover the surface of the liquid pool to minimize vapor release to air.

Mitigation Measures

An emergency response and a comprehensive system for coordination with public authorities are already in place to control such situations. Exercises and drills to monitor the effectiveness of the program are done regularly to ensure that EPCL's emergency squad members are well prepared to tackle emergency situations. A comprehensive contingency plan includes the following:

- Identification of potential sources of the event
- Risk minimization
- Action plan for spill response
- Designation of personnel and training
- Disposal options of contaminated material

Key monitoring includes the regular inspection of the plants and import pipeline, particularly where there is a high risk to water resources, workers, or any other receptors.

6.3.7 Solid Waste

Assessment

The increased waste generated due to the proposed expansion can potentially affect the environment. The expected increase in solid dry sludge from the wastewater pre-treatment plant is assumed to be equal to the existing plant i.e. 25 tpy as discussed in **Section 3**.

As no regulations for waste handling and disposal exist, an adverse impact on the environment will be interpreted if,

- Any person is exposed to potentially hazardous waste generated by the project

- Project generates waste that can be avoided through practicable means (waste minimization)
- Reusable waste generated by the project is discarded
- Recyclable waste instead of separation at the source is dumped at the trash bins
- Any waste generated by the project is scattered at any place outside the designated bins, or
- Non-recyclable and non-reusable waste ends up at any place other than the designated landfill site.

Mitigation Measures

To avoid any potential issue, EPCL's project management has imposed internal controls for the existing plants. These measures will be continued in the proposed expansion plan as well.

Non-hazardous Wates

EDC-VCM Plant

- The high COD or BOD in effluent will generate activated sludge in the wastewater treatment units which will be separated in the wastewater treatment unit and can be used as a nutrient for soil.
- To make sure that the sludge does not contain any heavy metals, analysis of cake sample will be carried out periodically. It will be sent to municipal landfill sites only if shown to be non-hazardous.
- In the unlikely event that the cake is found to be hazardous, it will be stored at the plant site in water-tight sludge ponds until a suitable treatment of disposal means are found.

PVC Plant

- High COD and BOD in effluent water will generate activated sludge in the wastewater treatment plant which will be separated and will be used as a nutrient for soil within the Plant or will be sent to government-approved landfill sites after necessary analysis for toxins.

New Utility Plants

- Wastewater sludge from secondary wastewater treatment will be separated and will be used as a nutrient for soil. Also, the sludge generated might contain some metals that make them hazardous and so it will be stored at the plant site in water-tight sludge ponds until a suitable treatment of disposal means are found. If in the unlikely even might contain some metals.

Solid waste materials are regularly collected from the site, sorted, and stored in demarcated spaces at the scrapyard. The area of scrapyard is 2.8 acre. Waste from scrapyard is transported on a regular basis for recycling, disposal, or incineration.

Hazardous Wastes

As discussed in **Section 4**, there are two on-site incinerators for hazardous waste (coke, and solid heavies) and off-site incinerators for solid hazardous waste, solid material left after on-site incineration process. The same exercise will be carried out for the proposed Project.

A Hazardous Materials Management Plan will also make sure that it includes the following management and mitigation measures:

- Storage and handling of hazardous materials will be in accordance with international standards and appropriate to their hazard characteristics. Storage and liquid impoundment areas for fuels and hazardous process chemicals will be designed with secondary containment to prevent spills and contamination of soil and groundwater. The secondary containment will be impervious with a capacity of at least 110% of the largest single container.
- Labeling will be placed on all storage vessels as appropriate to national and international standards. The labeling will clearly identify the stored materials.
- Supporting information such as MSDS will be available for all hazardous materials.
- A Hazardous Materials Register will be in place that covers:
  - Hazardous Material name
  - HAZCHEM/United Nations Code
  - MSDS
  - Summary of maximum inventory
  - Storage requirements and precautions
  - Location, physical properties of the materials where they are used
  - Approved disposal methods

General Mitigation Measures

In addition of above measures following general management level mitigation measures will be ensured:

1. On-site handling
   a. Recyclable material will be separated at source. Separate bins will be placed at each site for different types of materials—plastic, paper, metal, glass, wood, and cotton etc. The recyclable waste will be delivered to approved waste contractors.
   b. All hazardous waste will be separated from other wastes.
   c. Hazardous waste that cannot be disposed of through acceptable means will be stored in on-site storage facility until an off-site hazardous waste disposal facility is available.

2. Audits
    a. On-site audits of waste management will be undertaken on a regular basis.
    b. Audits of the waste disposal contractors and waste disposal facilities will be undertaken on a regular basis to check that procedures are being followed.
3. Records
    a. Records of all waste generated will be maintained. Quantities of waste disposed of, recycled, or reused will be logged on a Waste Tracking Register.
4. Disposal
    a. All non-hazardous waste material that cannot be recycled or reused will be transferred to approved landfill sites in Karachi.
    b. Depending on the nature and quantity of the hazardous waste, it will either be disposed of by licensed hazardous waste contractors or will be incinerated at an incineration facility equipped to handle hazardous waste.
    c. The possibility of returning the packaging to the manufacturers for reuse will be explored.
    d. Recyclable waste will be disposed of via approved waste contractors.
    e. Chemical containers (including partially full containers) will be returned to vendors.
5. Other management measures
    a. The existing emergency response plan will be modified to deal with the hazardous waste (and substances) from the proposed Project.
    b. Training will be provided to personnel for identification, segregation, and management of waste.
    c. All containers of hazardous waste will be appropriately labeled.
    d. Equipment and material containing asbestos, poly-chlorinated biphenyls (PCBs), and ozone-depleting substances (ODSs) will not be used.

Monitoring and inspection will be conducted to mitigate the residual impacts if there are any still left despite taking all the necessary steps to minimize the resultant impacts.

6.3.8 Traffic

Assessment

The proposed Project will result in an increase in staff traffic that will mainly consist of passenger cars. This additional traffic and its impact will be very low as compared to the total traffic on PQ access roads.

Mitigation Measures

The following mitigation measures will be adopted:

- Make sure all drivers comply with the traffic codes concerning maximum speed limit, driving hours, etc.
- Keep speeds slow (30 km/hr) on unsealed roads to avoid any windblown dust.
- Plant as many trees as possible to reduce the impact of smoke due to vehicles.
- Identify suitable times to transport equipment.
- Provide training to drivers in order to make them familiar with the common road signs and the types of vehicles and equipment that will be moving through the area.
- Train drivers to move along long transport route to keep their vehicle speed in limits and consider traffic signs and boards.
- Maintain vehicles, especially brakes.

6.3.9 Greenhouse Gas Emission (GHGs)

Combustion of natural gas results in the release of carbon dioxide, carbon monoxide, methane, and oxides of nitrogen (NO_x). Out of these gases, carbon dioxide and methane are GHGs; methane being a much more potent GHG (one ton of methane is equivalent to 21 tons of carbon dioxide in terms of global warming potential).

Assessment

The estimated greenhouse gas emission from the plant will be in the range of 440,960 to 689,000 kg of carbon dioxide per day depending on the CO_2 emission co-efficient of 53 kg per million British Thermal Unit (MMBTU)[42] and natural gas consumption of 0.223 to 0.354 MMSCFD (million standard cubic meters per day) as discussed in **Section 3**.

The EPCL expansion project envisages utilizing hydrogen gas from the chlor-alkali plant to supplement the natural gas-fired in the ethyl dichloride cracking furnace. The combustion of hydrogen gas results in the release of H_2O (water vapor) into the atmosphere. Although water vapor is a greenhouse gas, it is always present in the environment and does not decay, so relative to CO_2, its global warming potential (GWP) is quite difficult to calculate. Therefore, water vapor is not considered a pollutant. It is expected that hydrogen will result in savings of 0.8-1.0 MMSCFD of natural gas.

Mitigation Measures

Trees will be planted to reduce the concentration of CO_2 in the air to overcome this issue.

[42] https://www.eia.gov/environment/emissions/co2_vol_mass.php

6.3.10 Occupational Health and Safety

The proposed Project can also result in the risk of exposing the workers to occupational and safety hazards. Generally, the probability of such risks occurring is much lower than the other impacts discussed above. Identify potential exposure levels in the workplace, including surveys of exposure levels and the use of personal monitors during working activities. The following strategies will be adopted:

- Train workers in the identification of occupational electromagnetic field (EMF)/electromagnetic interference (EMI) levels and hazards.
- Establish and identify safety zones to differentiate between work areas with expected elevated EMF/EMI levels compared to those acceptable for public exposure, and limit access to properly trained workers.
- Implement action plans to address potential or confirmed exposure levels that exceed reference occupational exposure levels developed by international organizations such as the International Commission on Non–Ionizing Radiation Protection (ICNIRP), the Institute of Electrical and Electronics Engineers (IEEE). Personal exposure monitoring equipment will be set to warn of exposure levels that are below occupational exposure reference levels (e.g., 50 percent). Action plans to address occupational exposure may include limiting exposure time through work rotation, increasing the distance between the source and the worker, when feasible, or the use of shielding materials.
- Provide adequate ventilation in work areas to reduce heat and humidity.
- Reduce the time required for work in elevated temperature environments and ensure access to drinking water.
- Regularly inspect and maintain pressure vessels and piping.
- Shield surfaces where workers come in close contact with hot equipment, including generating equipment, pipes etc.
- Use warning signs near high-temperature surfaces and personal protective equipment (PPE) as appropriate, including insulated gloves and shoes.

6.3.11 Impacts on Ecology

The Project is located in an industrial area where the natural habitat is highly disturbed. No terrestrial floral or faunal species listed as Endangered or Critically Endangered in the IUCN Red List of Threatened Species has been reported from the Study Area or vicinity. Furthermore, the Project is not expected to have any significant impact on unmodified habitats.

The impact on the ecology and biodiversity of the Study Area and vicinity is likely to come from effluent discharge that drains into the sea and can impact the coastal fauna. Other impacts on ecology can arise from the improper dumping of waste off-site.

Generation of Pollution from Project-related Activities

Generation of pollution from Project-related activities during both construction and operation phases can result in impacts on the ecological resources. Pollution can be generated from both waste generation and from the operation of the Project via effluent discharge if proper measures to control it are not taken.

The impacts on the coastal ecosystem include a decline in diversity and abundance of coastal macro-invertebrate fauna which acts as a food source for coastal biodiversity. As a result, the food chain of the coastal areas closest to the Project's outfall will be affected and will not be able to provide food for coastal biodiversity of the area or will result in contamination of the food sources. There are no species of conservation importance found in the coastal areas and the biodiversity is low due to anthropogenic disturbances. Therefore, the risk to sensitive ecological receptors is low. The coastal fauna of the Port Qasim's coastline is relatively low in terms of both diversity and abundance as compared to coastal areas further away from industrial zones. This is because the former is more disturbed than the latter. The Project can, however, contribute to the deterioration of the coastline if the effluent discharged from its operations does not meet SEQS. It is of note that the effluent being discharged currently is not resulting in the destruction of the fauna of the coastline as fish were observed in the drain near the outfall during the surveys and the MBI abundance and diversity was higher than other areas of Port Qasim's coastline. The latter is probably because other areas of Port Qasim's coastline are undergoing disturbance due to construction activities while the area near the outfall is relatively undisturbed.

Use of the Chosen Dumping Site

The site chosen for waste a disposal will be unavailable for wildlife. However, if waste disposal is carried out at a designated site it is likely to be in an area already disturbed by human activity and not likely to be habitat for any species of conservation importance. Therefore, the impacts on ecology will not be significant.

6.4 Socioeconomic Impact

The Project activities will result in a positive impact on the existing socioeconomic environment of the area covered in the socioeconomic study as well as the rest of the country. These impacts are further discussed below.

6.4.1 Employment Opportunities

The Project will create additional job opportunities in the area. During the construction period several thousand people will be hired. To maximize the benefits to the local community the following mitigation, enhancement and good-practice measures are suggested:

- Explain the recruitment process to local communities;
- Preferentially recruit local candidates provided they have the required skills and qualifications for the announced positions;

- Coordinate efforts to recruit unskilled labor, if any are required under the Project, from the adjacent rural areas.
- Include an assessment of the contractor's demonstrated commitment to local procurement and local hiring in the tender evaluation process.
- Maintain a recruitment database that contains information on local candidates and offer these candidates to contractors for consideration.
- Support the training of local people to increase their potential for indirect employment.
- Maximize the benefits of indirect and induced impacts on local communities and businesses by implementing the community development initiatives pertaining to education, training and skill development of the local people.
- Assist employees, local communities and vulnerable groups in improving basic personal financial life skills through training and awareness campaigns.
- Determine what is considered to be 'fair and transparent' in recruitment and in the distribution of jobs between different community groups in consultation with local communities and their leaders.
- Set long-term (10 to 15 year) targets for local representation at the managerial level. Implement training and development to meet these targets.
- Promote mechanisms to increase the access of vulnerable groups to Project opportunities through small business development.

7. Analysis of Alternatives

This section describes the various project management and design alternatives that were examined during the preparation of the environmental and social impact assessment reports.

7.1 Management Options

The management alternative examines the 'no-action' option which means not installing the proposed plant, thereby bringing no change to the baseline scenario. This option is discussed below.

7.1.1 No-Action

The 'no-action' option if taken will prevent the country from increasing its production of PVC and result in greater imports to meet the growing demand for PVC in the country. The proposed activity offers a chance to improve Pakistan's trade deficit, offer a reliable and economical supply of PVC to Pakistan's industry and create more employment in the country. The 'no-action' option will result in loss of opportunity for transfer of technology to Pakistan, a loss of opportunity for the economic growth of the country and loss of employment.

7.1.2 Alternative Design Options

The alternative design options discussed in the following sections are of possible location alternatives, alternative power supply i.e. buying electricity from the existing grid, and possible waste disposal alternatives.

7.1.3 Alternative Site Options

There are no feasible location alternatives for the Project because the proposed activity is located on the existing facility and requires the incorporation of the new facilities to the existing facilities in order to increase the production of PVC. Furthermore, proximity to the EVTL terminal is vital for the Project as the raw material ethylene will be transferred to the Plant via a pipeline from the EVTL terminal. An alternate location for the new facilities will result in additional operational and management costs and also increase the risk of leakage of hazardous chemicals due to additional pipelines for transfer of chemicals.

Therefore, installing the new facilities in the EPCL owned land adjacent to the existing plant is the most economical, environmentally friendly, and socially friendly option as it requires the least capital and operating costs, has the least amount of risk of accidental leakage of hazardous chemicals, does not require any land acquisition and compensation. In addition, it will result in minimal social impact as it is located at a distance of at least 6 km from any residential colonies.

7.1.4 Power Supply Alternatives

In order to supply the power required for the operation of both the existing and proposed facilities two options have been considered in the EIA:

- Connecting to the Karachi Electric Supply Corporation (KESC) Grid for the supply of power
- Dedicated in-house power generation

In order to supply electricity from the KESC grid a 6.6 kVA transmission line will be required to transmit the power from the nearest junction to the Project site. Additionally, one motor generator set for frequency conversion from 50 Hz to 60 Hz will be required.

The other option is to set up a dedicated power plant to provide electricity to the plant and its ancillary facilities.

Selected Option

EPCL has captive power capability in-house to supply power for the expansion. This will result in a more reliable and efficient supply of electricity for the proposed Project. This option also results in social benefits as having a dedicated power source the PVC-III Plant will not add to the burden of the KESC grid, which already faces considerable shortfalls in the generation and transmission of electricity for the city of Karachi. Environmentally this is a better option as well because it will result in lower greenhouse gas emissions due to a significant decrease in transmission loses. Also the fact that power production at the EPCL plant will be fired by gas further reduces the carbon intensity of the plant as several power plants connected to the grid are fired by furnace oil or diesel.

7.1.5 Effluent Disposal Alternative

The disposal method being used by EPCL for its existing facilities is to dispose of the liquid effluent, once it meets SEQS having undergone the effluent treatment process at the plant. EPCL will continue this practice with the PVC-III Plant.

Previously EPCL had the option of discharging the effluent into mangrove plantations that the company had established. However, the plantations were cleared for construction of a power plant and therefore EPCL can now only discharge into the Arabian Sea.

8. Environmental Management and Monitoring Plan

This section provides the environmental management and monitoring plan (EMMP) of the proposed project. The primary objectives are to:

- Facilitate the implementation of the identified mitigation measures in the environmental assessment
- Define the responsibilities of the project proponent and contractor, and provide a means of effective communication of environmental issues between them.
- Identify monitoring parameters in order to ensure the effectiveness of the mitigation measures.
- Provide a mechanism for taking timely action in the face of unanticipated environmental situations.
- Identify training requirements at various levels.

In addition to the environmental mitigation plan and environmental monitoring plan, specific management plans have been developed for areas of concern, including the following:

- Waste Management Plan
- Construction Management Plan
- Spill Prevention and Mitigation Plan

8.1 Institutional Framework

The organizational roles and responsibilities of the key players are summarized below:

EPCL: The project proponent will undertake overall responsibility for compliance with the EMMP. They will carry out verification checks to ensure that the contractors are effectively implementing their environmental and social requirements.

Contractors: The contractors will implement the majority of environmental and social mitigations as required by their contract with the Owners. The contractors will carry out field activities as part of the proposed project. The contractors are subject to certain liabilities under the environmental laws of the country, and under their contracts with the Project proponent.

8.1.1 Management Responsibilities

The responsibilities of the client and contractor are briefly described below:

- Primary responsibilities:

- ▷ The Owner's Project Manager will be responsible for environmental assessment and EMMP compliance throughout the Project on behalf of the company itself.
- ▷ The Owners will coordinate with the concerned government departments.

- Project management and quality control:
  - ▷ Carrying out construction activities in an environmentally sound manner during the Project will be the responsibility of the contractor's site manager.
  - ▷ Owner's representative will be responsible for the overall environmental soundness of all field operations.

Specific roles and responsibilities for environmental monitoring are provided in **Exhibit 8.1.**

Exhibit 8.1: Roles and Responsibilities for Environmental Monitoring

Aspect	*The Owners' Responsibilities*	*Contractor's Responsibilities*	*Relevant Documentation*
Contracting	Ensuring that monitoring and mitigation requirements are included in the contract between the Owners and the construction contractor(s).	Understanding the requirements and estimating the required resources	Contract between the Owners and the construction contractor(s)
Monitoring plan	Ensuring finalization of monitoring plan before construction commencement	Prepare a construction management plan	Finalized monitoring plan and Construction Management Plan
Resources	Ensuring availability of resources required for environmental monitoring	Ensuring availability of resources required for environmental monitoring	Project budgets
Environmental staff	Designating an Environmental Manager for the project	Designating an Environmental Manager for the project (may be combined with health and safety)	Job descriptions
Monitoring surveys and inspections	Undertaking regular inspections and carrying out further measurements when necessary	Undertaking regular inspections and collecting data on environmental performance, and carry out surveys	Inspection and survey reports
Environmental audit	Conducting periodic audits of the construction site and commissioning third-party audits	Conducting periodic internal audits	Audit reports
Reporting	Ensuring that periodic environmental monitoring reports are received from the	Producing environmental monitoring reports periodically and distributing those among the Owners	Environmental monitoring reports

Aspect	*The Owners' Responsibilities*	*Contractor's Responsibilities*	*Relevant Documentation*
	construction contractor(s) and reviewing those reports	management and appropriate staff members	
Corrective actions	Verifying that carried out activities comply with the EIA/EMMP and identifying corrective actions if needed	Carrying out corrective actions as required	Corrective action record
Maintenance of record	Maintaining monitoring data and recording all incidents of environmental significance and related corrective measures	Maintaining monitoring data and recording all incidents of environmental significance and related corrective measures	Environmental databases

8.2 Environmental Mitigation and Management Plan

The mitigation and management plan is a key component of the EMMP. It lists all of the mitigation measures identified in the environmental assessment and the associated environmental and social aspects of those measures. The mitigation measures for the proposed project are presented in **Exhibit 8.2.**

Exhibit 8.2: Environmental Mitigation and Management Plan

Project Activity/Aspect	*Impact*	*Mitigation Measure*	*Timing*	*Institutional/Implementation Responsibility*
Construction Phase				
Site construction activity	▶ Water and wastewater from staff camp ▶ Spills and leakages of oil from equipment ▶ Contamination of soil and surface water ▶ Air and noise emissions ▶ Occupational health and safety risk to the workers ▶ Soil erosion	▶ Construction related impacts can be kept low if managed properly. ▶ Construction management plan (CMP), spill management plan (SMP) and waste management plan (WMP) will be prepared in accordance with the guidelines provided in **Section 8**. ▶ Personal protective equipment (PPE) will be used to minimize occupational health and safety risks to workers. ▶ Construction contractor's camp will be located near or within the premises of Project site. ▶ All sanitary discharge effluent will be routed to the existing system of PQA via septic tanks and soakage pits ▶ Disturbance during pipeline construction will be minimized by properly marking and restricting the movement of machinery to the construction corridor ▶ Refueling stations will have spill prevention trays ▶ On-site maintenance of vehicles and equipment will be avoided as much as possible. In case on-site maintenance is unavoidable, tarpaulin or other impermeable material will be used to prevent soil contamination. ▶ Regular inspections will be carried out to detect leakages in construction vehicles and equipment. ▶ All vehicles will be washed in external facilities.	DC	Contractor

Project Activity/Aspect	*Impact*	*Mitigation Measure*	*Timing*	*Institutional/Implementation Responsibility*
		▶ Fuels, lubricants, and chemicals will be stored in covered bounded areas with impervious lining. ▶ Appropriate spill control arrangements, including shovels, plastic bags and absorbent materials, will be available near fuel and oil storage areas. ▶ Contaminated soil will be removed from the site and taken for incineration. ▶ Emergency plan for spill management will be prepared and initiated in an incident of a spill. ▶ Noise survey of all construction equipment will be conducted prior to their deployment. ▶ Equipment will be regularly maintained, tuned, and fitted with mufflers to minimize noise. Noisy equipment will not be allowed to operate and will be replaced with new ones. ▶ Equipment or the work area will be modified to make it quieter by substituting existing equipment with quieter equipment; retrofitting existing equipment with damping materials, mufflers, or enclosures; erecting barriers; and maintenance. ▶ Special noise reduction measures, such as erecting purpose-built acoustic barriers, restricting opening hours and maintaining transport vehicles will be implemented. ▶ Loud operations will be planned concurrently while ensuring the total noise produced will not exceed the level if operations were performed separately. ▶ Exposure to high noise levels will be reduced by keeping moving workers away from the noise source; restricting access; rotating workers, and shutting down noisy equipment when not needed.		

Project Activity/Aspect	*Impact*	*Mitigation Measure*	*Timing*	*Institutional/Implementation Responsibility*
		▶ Vehicle speeds will be controlled in the community areas ▶ Road surfaces will be cleaned or kept damp when required. ▶ Dust control will be achieved by dust suppression and extraction system. ▶ Periodic monitoring and cleanup will be undertaken to minimize the residual impact after implementation of waste control measures. ▶ Periodic monitoring of noise at source, at the construction site, and at the receptors level will be undertaken. ▶ Ambient air concentration of the pollutants will be periodically monitored in the areas around the plants. ▶ Dust emission from the construction activity will be visually monitored, particularly when activity is undertaken close to the receptors, to prevent visible dust beyond the plant property lines.		
Transportation of equipment and material	▶ Road congestion and inconvenience to existing road users due to Project generated traffic ▶ Air and noise emissions ▶ Community safety issues	▶ Heavy transport vehicles in use by the Project during the construction phase may damage the local roads. In case of any damage by Project activities, these roads should be promptly and properly repaired and maintained. ▶ Make sure all drivers comply with the traffic codes concerning maximum speed limit, driving hours, etc. ▶ Keep speeds slow (30 km/hr) on unsealed roads to avoid windblown dust. ▶ Sprinkle water on unsealed roads that are used for construction traffic. ▶ Identify suitable times to transport equipment.	DC	Contractor

Project Activity/Aspect	*Impact*	*Mitigation Measure*	*Timing*	*Institutional/Implementation Responsibility*
		▶ Train drivers to move along long transport route to keep their vehicle speed in limits and consider traffic signs and boards. ▶ Restricted Construction traffic during school start and end hours in front of schools on the transport route. ▶ Maintain vehicles, especially brakes. ▶ All vehicles, generators and other equipment will be properly tuned and maintained in a good working condition in order to minimize emission of pollutants		
Operation Phase				
Air emissions	▶ Health issues of the surrounding community ▶ Occupational health and safety risk to the workers	Maximum Achievable Control Technology (MACT) will be applied for emissions sources including PVC process vents, resin processing, equipment leaks, wastewater, heat exchangers, and storage vessels. VCM and EDC production from the operation of the Project will be higher, however, still within standards as the existing situation falls well below the standards. Further mitigation of impacts will be achieved by following ▶ Periodic monitoring of ambient air to ensure compliance of the concentration levels with the permissible limits. ▶ Several types of cleaning systems will be installed such as complex multi-stage systems comprising adsorbent injection and/or catalytical devices for dioxin abatement. ▶ The cooling of gas involves the production of Dioxins as a result of de novo synthesis, occurring at a temperature range of 300-350 °C. Usually, dioxins are produced when the temperature cools from 700 °C to 200 °C. The amount of dioxins production is in this process is inversely proportional to the rate of gas cooling. Therefore, very efficient heat recovery systems must be developed, such as heat	DO	Owner

Project Activity/Aspect	*Impact*	*Mitigation Measure*	*Timing*	*Institutional/Implementation Responsibility*
		exchangers, and the gases should eventually be cooled by quenching.		
Noise emissions	▶ Disturbance to the community ▶ Disturbance to the workers employed in the Project	Noise levels of the existing plant are in compliance with the SEQS and the Project is located in a designated industrial zone which has relaxed standards. Mitigation measures are discussed in **Section 6.3.2**, a brief about that is given below: ▶ Occupational noise exposure to workers in the form of 8–hourly time-weighted average will be maintained well within the applicable SEQS limits. ▶ In order to control noise levels, acoustic enclosures will be provided wherever required. ▶ The enclosure should be free from gaps and made of dense material and be lined with noise-absorbing material like glass or polyester batts. ▶ PPE (including earmuffs, earplugs) will be provided and made mandatory for the workers. ▶ Other than the provision of PPE, it will be ensured that when possible, the workers maintain sufficient safe distance from the noisy equipment. ▶ Regular monitoring, tuning, and maintenance of equipment under use must be ensured to minimize noise levels. ▶ Use of muffled breakers and silenced diesel generators and compressors to reduce equipment noise. ▶ Design and build acoustic barriers if needed. Vegetated buffer zones of native plantings should be used to mitigate noise from operations ▶ Noisy work areas and equipment should be modified to reduce noise, examples include substitution of existing equipment with quieter	DO	Owner

Project Activity/Aspect	*Impact*	*Mitigation Measure*	*Timing*	*Institutional/Implementation Responsibility*
		equipment; retrofitting existing equipment with damping materials, mufflers, or enclosures; erection of barriers; and maintenance. ► Workers' exposure to high noise levels will be reduced by keeping moving workers away from the noise source; restricting access to areas; rotating workers performing noisy tasks, and shutting down noisy equipment when not needed ► Noisy operations will be scheduled at the same time period so that the total noise level production may not significantly exceed the level produced if the operations were performed separately.		
Water resources and consumption	Stress on community water needs	Water requirements will be met through water supply from Karachi Water and Sewerage Board, therefore, risk of water crisis due to the Project for local communities is low. The following mitigation measures will be adopted: ► All possible measures will be explored to use recycled water for dust suppression. ► The incremental impact of the Project on water resources will be minor and is unlikely to cause significant impacts on creek ecology downstream. ► The operational water requirements for the Project will be met by a supply connection provided by PQA.	DO	Owner
Effluent discharge	► Soil contamination ► Water contamination	The wastewater generated by the Project activities will be treated in the wastewater pre-treatment facility and discharged after satisfying SEQS. ► Any significant impact on surface and groundwater will be averted by treatment of water as per SEQS. ► Periodic monitoring of overall wastewater and chemical analysis of wastewater streams, so that relevant remedial measures can be employed	DO	Owner

Project Activity/Aspect	*Impact*	*Mitigation Measure*	*Timing*	*Institutional/Implementation Responsibility*
Accidental releases and spills	▶ Risk to human health ▶ Soil contamination ▶ Water contamination	Same risk management processes and response plan will be employed for the proposed Project with more strictness. An emergency response plan, as already in place, will make sure to include the following: ▶ Identification of potentially hazardous chemicals, processes and the operations ▶ Release scenarios, consequences in terms of heat generation, overpressure and toxic release etc. ▶ Site plan preparation for damage control ▶ Identification of the vulnerable zones ▶ Classification of unit or units which have the most potential for creating on-site as well as off-site emergency ▶ Identification of the important facilities available in the vulnerable zone ▶ Identification of the requirements of various departments in-site as well as off-site in coping with an emergency situation ▶ Bolts, nuts and studs, other pipe connections of proper material specification strictly be used where there is chance of leakage. ▶ A proper system of periodic inspection of all plants and equipment including cocks, valves and pipelines and degassing system should be introduced and followed jointly by the process and maintenance department. Preventive maintenance should be planned in a manner to synchronize gradually with periodic routine shut down of equipment and plant. ▶ A complete register for recording the periodic testing should be maintained.	DO	Owner

Project Activity/Aspect	*Impact*	*Mitigation Measure*	*Timing*	*Institutional/Implementation Responsibility*
		► A control room equipped with the instruments for automatic detection of small amount of gas releases and their location. ► Process flow, temperature, instrumentation control, pressure relief, safety and general operating condition should by examined to ensure that the plant would not only operate safely but should also fail safely if it is going to fail at all. ► Periodic safety audit by both internal and external audit team should be undertaken by the management. The key monitoring is the regular inspection of the plants and import pipeline particularly where high risk to effect on water resources, workers, or any other receptors.		
Solid waste	► Risk to human health ► Soil contamination ► Water contamination	A WMP is included in **Section 8** which includes Hazardous and Non-hazardous Materials Management Plan. Monitoring and inspection will be conducted to mitigate the residual impacts, if any , despite taking all the necessary steps to minimize the resultant impacts. Monitoring and inspection will be conducted to mitigate the residual impacts, if there are any still left despite taking all the necessary steps to minimize the resultant impacts.	DO	Owner
Traffic	► Traffic accidents ► Air emissions ► Deterioration of access roads	Project-related traffic will be very insignificant as compared to the total traffic already on the PQ access roads. The following mitigation measures will be adopted: ► Training of drivers on safe driving and how to avoid the risk of accidents. ► Make sure all drivers comply with traffic rules concerning maximum speed limit, driving hours, etc.	DO	Owner

Project Activity/Aspect	*Impact*	*Mitigation Measure*	*Timing*	*Institutional/Implementation Responsibility*
		▶ Keep vehicular speeds slow (30 km/hr) on unsealed roads to avoid any windblown dust. ▶ Plant as many trees as possible to reduce the impact of smoke from vehicles. ▶ Identify suitable times for equipment mobilization. ▶ Train drivers to move along long transport route to keep their vehicle speed in limits and consider traffic signs ▶ Regular monitoring, tuning, and maintenance of vehicles, especially brakes, must be ensured.		
Greenhouse gas emissions (GHGs)	CO_2 emissions	Tree plantation will be done to reduce the CO_2 emissions.	DO	Owner
Occupational health and safety	Risk to workers	A Hazardous Materials Management Plan will be prepared in accordance with the points discussed in **Section 6.3.7**. Personal protective measures will be taken to reduce risk of accidents to workers. Further reduction in impacts will be ensured by the adoption of following measures: ▶ Training of workers on the occupational electromagnetic field (EMF)/electromagnetic interference (EMI) levels and hazards. ▶ Establish and identify safety zones to differentiate between work areas with expected elevated EMF/EMI levels compared to those acceptable for public exposure, and limit access to properly trained workers. ▶ Action plans will be devised to address potential or confirmed exposure levels that exceed reference occupational exposure levels developed by international organizations such as the International Commission on Non–Ionizing Radiation Protection (ICNIRP) and the Institute of Electrical and Electronics Engineers (IEEE).	DO	Owner

Project Activity/Aspect	*Impact*	*Mitigation Measure*	*Timing*	*Institutional/Implementation Responsibility*
		▶ Personal exposure monitoring equipment will be set to warn of exposure levels that are below occupational exposure reference levels. Action plans to address occupational exposure may include limiting exposure time through work rotation, increasing the distance between the source and the worker, when feasible, or the use of shielding materials. ▶ Provision of adequate ventilation to reduce heat and humidity ▶ Reduce the time required for work in elevated temperature environments and ensure access to drinking water. ▶ Ensure regular inspection and maintenance of pressure vessels and piping. ▶ Shield surfaces where workers come in close contact with hot equipment, including generating equipment, pipes etc. ▶ Warning signs near high-temperature surfaces and use of PPE as appropriate, including insulated gloves and shoes for workers awareness.		

8.3 Waste Management Plan

This section provides the waste disposal plan that will be employed during construction and operations of the proposed Project discussed in **Section 6**. The main types of waste that will be generated are hazardous and non-hazardous waste.

8.3.1 Non-hazardous Waste Management Plan

To avoid any potential issue, EPCL's project management has imposed internal controls for the existing plants. These measures will be continued in the proposed expansion plan as well.

Construction Phase

- Re–use opportunities for waste generated from the Project will be actively investigated. Used oil and other waste will be identified, and if any, it will be stored in separate designated and contained facility.
- As a standard practice, all metal (mainly iron and copper) or wooden parts generated as waste during the construction of the new Project will be recycled or stored in a dedicated existing scrap yard for auction.
- Even after the implementation of the control measures, it is possible that some littering may take place. Periodic monitoring and cleanup will be undertaken to minimize the residual impact.

Operation Phase

EDC-VCM Plant

- The high COD or BOD in effluent will generate activated sludge in the wastewater treatment units which will be separated in the wastewater treatment unit and can be used as a nutrient for soil.
- To make sure that the sludge does not contain any heavy metals, analysis of cake sample will be carried out periodically. It will be sent to municipal landfill sites only if shown to be non-hazardous.
- In the unlikely event that the cake is found to be hazardous, it will be stored at the plant site in water-tight sludge ponds until a suitable treatment of disposal means are found.

PVC Plant

- High COD and BOD in effluent water will generate activated sludge in the wastewater treatment plant which will be separated and will be used as a nutrient for soil within the plant or will be sent to government-approved landfill sites after necessary analysis for toxins.

New Utility Plants

- Wastewater sludge from secondary wastewater treatment will be separated and will be used as a nutrient for soil. Also, the sludge generated might contain some

metals that make them hazardous and so it will be stored at the plant site in water-tight sludge ponds until a suitable treatment of disposal means are found. If in the unlikely even might contain some metals.

Solid waste materials are regularly collected from the site, sorted, and stored in demarcated spaces at the scrapyard. The area of scrapyard is 2.8 acre. Waste from scrapyard is transported on a regular basis for recycling, disposal, or incineration.

8.3.2 Hazardous Wates Management Plan

As discussed in **Section 4**, there are two on-site incinerators for hazardous waste (coke and solid heavies) off-site incinerators for solid hazardous waste, solid material left after on-site incineration process. The same exercise will be carried out for the proposed Project.

A Hazardous Materials Management Plan will also include the following management and mitigation measures:

- Storage and handling of hazardous materials will be in accordance with international standards and appropriate to their hazard characteristics. Storage and liquid impoundment areas for fuels and hazardous process chemicals will be designed with secondary containment to prevent spills and contamination of soil and groundwater. The secondary containment will be impervious with a capacity of at least 110% of the largest single container.
- Labeling will be placed on all storage vessels as appropriate to national and international standards. The labeling will clearly identify the stored materials.
- Supporting information such as MSDS will be available for all hazardous materials.
- A Hazardous Materials Register will be in place that covers:
  - Hazardous Material name
  - HAZCHEM/United Nations Code
  - MSDS
  - Summary of maximum inventory
  - Storage requirements and precautions
  - Location, physical properties of the materials where they are used
  - Approved disposal methods

8.3.3 Management Level Mitigation Measures

In addition to the above mentioned assessment and project design measures to minimize the waste, and handling options, following general management level mitigation measures will be taken:

1. On-site handling
    a. Recyclable material will be separated at source. Separate bins will be placed at each site for the different type of materials—plastic, paper, metal, glass, wood, and cotton etc. The recyclable waste will be delivered to approved waste contractors.
    b. All hazardous waste will be separated from other wastes.
    c. Hazardous waste that cannot be disposed of through acceptable means will be stored in an on-site storage facility until an off-site hazardous waste disposal facility is available.
2. Audits
    a. On-site audits of the waste management will be undertaken on a regular basis.
    b. Audits of the waste disposal contractors and waste disposal facilities will be undertaken on a regular basis to check that procedures are being followed.
3. Records
    a. Records of all waste generated will be maintained. Quantities of waste disposed of, recycled, or reused will be logged on a Waste Tracking Register.
4. Disposal
    a. All non-hazardous waste material that cannot be recycled or reused will be transferred to approved landfill sites in Karachi.
    f. Depending on the nature and quantity of the hazardous waste, it will either be disposed of by licensed hazardous waste contractors or will be incinerated at an incineration facility equipped to handle hazardous waste.
    g. The possibility of returning the packaging to the manufacturers for reuse will be explored.
    h. Recyclable waste will be disposed of via approved waste contractors.
    i. Chemical containers (including partially full containers) will be returned to vendors.
5. Other management measures
    a. An emergency response plan will be developed for the hazardous waste (and substances).
    e. Training will be provided to personnel for identification, segregation, and management of waste.
    f. All containers of hazardous waste will be appropriately labeled.
    g. Equipment and material containing asbestos, poly-chlorinated biphenyls (PCBs), and ozone-depleting substances (ODSs) will not be used.

8.4 Construction Management Plan

The Construction Management Plan (CMP) will clearly identify all areas that will be utilized during construction for various purposes. The detailed CMP is provided in **Exhibit 8.3** For example, on a plot plan of the construction site the following will be shown:

- Areas used for camp/site office
- Storage areas for raw material and equipment
- Waste yard
- Location of any potentially hazardous material such as oil
- Parking area
- Loading and unloading of material
- Septic tanks

Other key mitigation measures to be adopted are as follows:

- New equipment will be stored in properly demarcated and identified areas
- Separate storage of each item will be adopted and each area will be marked either on the floor or cordoned off by tapes
- Lifting equipment (cranes) used for the equipment will follow the prescribed safety specification.
- Proper illumination to be provided
- Material Safety Data Sheet (MSDS) for chemicals, if any, will accompany the consignment. A copy of the MSDS will be available near the storage area at all times.
- Appropriate PPE will be provided to the workers and it will be ensured that the PPE is used.
- The staff will be provided with training in the use of PPE.
- Proper scaffolding platforms will be provided for all work areas located more than 1 m above floor level.
- First Aid facilities and fire protection devices will be placed in areas where work activities will be performed.
- Ear protection will be used if the noise level is above 85 dB(A)
- All confined spaces[43] will be identified

[43] "Confined space" means a space that:

(1) Is large enough and so configured that an employee can bodily enter and perform assigned work; and

(2) Has limited or restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry); and

(3) Is not designed for continuous employee occupancy.

- The temperature of the confined space will be in the human tolerance range
- Artificial and intrinsically safe lighting will be provided in the confined spaces
- If there is a risk of gases or fumes in the confined space the provisions for ventilation will be made.

Exhibit 8.3: Construction Management Plan

Aspect	*Objective*	*Mitigation and Management Measure*
Vegetation clearance	Minimize vegetation clearance and felling of trees	▶ Removal of trees should be restricted to the development footprint. ▶ Construction activities shall minimize the loss or disturbance of vegetation ▶ Use clear areas to avoid felling of trees ▶ A procedure shall be prepared to manage vegetation removal, clearance and reuse ▶ Cleared areas will be re-vegetated with each tree curt being replaced by at least 3
Poaching	Avoid illegal poaching	▶ Contractual obligation to avoid illegal poaching ▶ Provide adequate knowledge to the workers relevant government regulations and punishments for illegal poaching
Discharge from construction sites	▶ Minimize surface and ground water contamination ▶ Reduce contaminant and sediment load discharged into water bodies affecting humans and aquatic life	▶ Install temporary drainage works (channels and bunds) in areas required for sediment and erosion control and around storage areas for construction materials ▶ Prevent all solid and liquid wastes entering waterways by collecting waste where possible and transport to approved waste disposal site or recycling depot ▶ Ensure that tires of construction vehicles are cleaned in the washing bay (constructed at the entrance of the construction site) to remove the mud from the wheels. This should be done in every exit of each construction vehicle to ensure the local roads are kept clean.
Soil erosion and siltation	Avoid sediment and contaminant loading of surface water bodies and agricultural lands.	▶ Minimize the length of time an area is left disturbed or exposed. ▶ Reduce length of slope of runoff ▶ Construct temporary cutoff drains across excavated area ▶ Setup check dams along catch drains in order to slow flow and capture sediment ▶ Water the material stockpiles, access roads and bare soils on an as required basis to minimize dust. ▶ Increase the watering frequency during periods of high risk (e.g. high winds)

Aspect	*Objective*	*Mitigation and Management Measure*
		▶ All the work sites (except permanently occupied by the plant and supporting facilities) should be reinstated to its initial conditions (relief, topsoil, vegetation cover).
Excavation, earth works, and construction yards	Proper drainage of rainwater and wastewater to avoid water and soil contamination.	▶ Prepare a program for prevent/avoid standing waters, which Construction Supervision Contractor (CSC) will verify in advance and confirm during implementation ▶ Establish local drainage line with appropriate silt collector and silt screen for rainwater or wastewater connecting to the existing established drainage lines already there
Ponding of water	Prevent mosquito breeding	▶ Do not allow ponding of water especially near the waste storage areas and construction camps ▶ Discard all the storage containers that are capable of storing of water, after use or store them in inverted position ▶ Reinstate relief and landscape.
Storage of hazardous and toxic chemicals	Prevent spillage of hazardous and toxic chemicals	▶ Implement waste management plans ▶ Construct appropriate spill containment facilities for all fuel storage areas ▶ Remediate the contaminated land using the most appropriate available method to achieve required commercial/industrial guideline validation results
Land clearing	Preserve fertile top soils enriched with nutrients required for plant growth or agricultural development.	▶ Strip the top soil to a depth of 15 cm and store in stock piles of height not exceeding 2m and with a slope of 1:2 ▶ Spread the topsoil to maintain the physio–chemical and biological activity of the soil. ▶ The stored top soil will be utilized for covering all disturbed area and along the proposed plantation sites ▶ Topsoil stockpiles will be monitored and should any adverse conditions be identified corrective actions will include: ▷ Anaerobic conditions – turning the stockpile or creating ventilation holes through the stockpile; ▷ Erosion – temporary protective silt fencing will be erected;
	Avoid change in local topography and disturb the	▶ Ensure the topography of the final surface of all raised lands are conducive to enhance natural draining of rainwater/flood water;

Aspect	*Objective*	*Mitigation and Management Measure*
	natural rainwater/ flood water drainage	▶ Reinstate the natural landscape of the ancillary construction sites after completion of works
Construction vehicular traffic	Control vehicle exhaust emissions and combustion of fuels.	▶ Use vehicles with appropriate exhaust systems. ▶ Establish and enforce vehicle speed limits to minimize dust generation ▶ Cover haul vehicles carrying dusty materials (cement, borrow and quarry) moving outside the construction site ▶ Level loads of haul trucks travelling to and from the site to avoid spillage ▶ Use of defined haulage routes and reduce vehicle speed where required. ▶ Regular maintenance of all vehicles ▶ All vehicle exit points from the construction site shall have a wash-down area where mud and earth can be removed from a vehicle before it enters the public road system.
	Minimize nuisance due to noise	▶ Maintain all vehicles in good working order ▶ Make sure all drivers comply with the traffic codes concerning maximum speed limit.
	Avoid impact on existing traffic conditions	▶ Prepare and submit a traffic management plan ▶ Restrict the transport of oversize loads. ▶ Operate transport vehicles, if possible, in non–peak periods to minimize traffic disruptions.
	Prevent accidents and spillage of fuels and chemicals	▶ Restrict the transport of oversize loads. ▶ Operate transport vehicles, if possible, in non–peak periods to minimize traffic disruptions. ▶ Design and implement safety measures and an emergency response plan to contain damages from accidental spills. ▶ Designate special routes for hazardous materials transport.

Aspect	*Objective*	*Mitigation and Management Measure*
Construction machinery	Prevent impact on air quality from emissions	▶ Use machinery with appropriate exhaust systems. ▶ Regular maintenance of all construction machinery ▶ Provide filtering systems, duct collectors or humidification or other techniques (as applicable) to the concrete batching and mixing plant to control the particle emissions in all stages
	Reduce impact of noise and vibration on the surrounding	▶ Appropriately site all noise generating activities to avoid noise pollution to local residents. ▶ Ensure all equipment is in good repair and operated in correct manner. ▶ Install high efficiency mufflers to construction equipment. ▶ Operators of noisy equipment or any other workers in the vicinity of excessively noisy equipment are to be provided with ear protection equipment
Construction activities	Minimize dust generation	▶ Water the material stockpiles, access roads and bare soils on an as required basis to minimize dust. ▶ Increase the watering frequency during periods of high risk (e.g. high winds). ▶ Stored materials such as gravel and sand should be covered and confined ▶ Locate stockpiles away from sensitive receptors
	▶ Reduce impact of noise and vibration on the surrounding ▶ Avoid driving hazard where construction interferes with pre–existing roads.	▶ Notify adjacent landholders or residents prior to noise events during night hours ▶ Install temporary noise control barriers where appropriate ▶ Avoid working during 21:00 to 06:00 within 500m from residences.
	Minimizing impact on water quality	▶ Stockpiles of potential water pollutants (i.e. bitumen, oils, construction materials, fuel, etc.) shall be locate so as to minimize the potential of contaminants to enter local watercourses or storm-water drainage.

Aspect	*Objective*	*Mitigation and Management Measure*
		▶ Storm-water runoff from all fuel and oil storage areas, workshop, and vehicle parking areas is to be directed into an oil and water separator before being discharged to any watercourse. ▶ An Emergency Spills Contingency Plan shall be prepared.
Siting and location of construction camps	Minimize impact from construction footprint	▶ Locate the construction camps at areas which are acceptable from environmental, cultural or social point of view.
Construction Camp Facilities	Minimize pressure on local services	▶ Adequate housing for all workers ▶ Safe and reliable water supply. ▶ Hygienic sanitary facilities and sewerage system. ▶ Treatment facilities for sewerage of toilet and domestic wastes ▶ Storm water drainage facilities. ▶ In–house community entertainment facilities.
Disposal of waste	Minimize impacts on the environment	▶ Ensure proper collection and disposal of solid wastes in the approved disposal sites ▶ Store inorganic wastes in a safe place within the household and clear organic wastes on daily basis to waste collector. ▶ Establish waste collection, transportation and disposal systems ▶ Ensure that materials with the potential to cause land and water contamination or odor problems are not disposed of on the site. ▶ Ensure that all on-site wastes are suitably contained and prevented from escaping into neighboring fields, properties, and waterways, and the waste contained does not contaminate soil, surface or groundwater or create unpleasant odors for neighbors and workers.
Fuel supplies for cooking purposes	Discourage illegal fuel wood consumption	▶ Provide fuel to the construction camps for domestic purpose ▶ Conduct awareness campaigns to educate workers on preserving the biodiversity and wildlife of the project area, and relevant government regulations and punishments on wildlife protection.

Aspect	*Objective*	*Mitigation and Management Measure*
Site Restoration	Restoration of the construction camps to original condition	▶ To the extent possible, restore the camp site and all other areas temporarily used for construction to their conditions that existed prior to commencement of construction work.
Construction activities near religious and cultural sites	Avoid disturbance to cultural and religious sites	▶ Stop work immediately and notify the site manager if, during construction, an archaeological or burial site is discovered. ▶ It is an offence to recommence work in the vicinity of the site until approval to continue is given by the plant management. ▶ Maintain appropriate behavior with all construction workers especially women and elderly people ▶ Resolve cultural issues in consultation with local leaders and supervision consultants
Health and Safety	Minimize health and safety risks	▶ Implement suitable safety standards, ▶ Provide the workers with a safe and healthy work environment, taking into account inherent risks in its particular construction activity and specific classes of hazards in the work areas, ▶ Provide personal protection equipment (PPE) for workers, such as safety boots, helmets, masks, gloves, protective clothing, goggles, full–face eye shields, and ear protection. ▶ Maintain the PPE under a regular checking and replacement program
Water and sanitation facilities at the construction sites	Improve workers' personal hygiene	▶ Provide portable toilets at the construction sites and drinking water facilities. ▶ Portable toilets should be cleaned once a day. ▶ All the sewerage should be pumped from the collection tank once a day into the common septic tank for further treatment.

8.5 Spill Prevention and Mitigation Plan

Liquid waste spills that are not appropriately managed have the potential to harm the environment. By taking certain actions BQPS can ensure that the likelihood of spills occurring is reduced and that the effect of spills is minimized.

To enable spills to be avoided and to help the cleanup process of any spills, the EPC contractors and the management and staff of the Owners should be aware of spill procedures. By formalizing these procedures in writing, staff members can refer to them when required thus avoiding undertaking incorrect spill procedures.

A detailed spill management plan will be prepared for the construction phase. Similar, plan will also be developed for specific areas during plant operation. The plan will contain the following:

- Identification of potential sources of spills and the characterization of spill material and associated hazards.
- Risk assessment (likely magnitude and consequences)
- Steps to be undertaken taken when a spill occurs (stop, contain, report, clean up and record).
- A map showing the locations of spill kits or other cleaning equipment.

8.5.1 Avoiding Spills

By actively working to prevent spills, money and time can be saved by not letting resources go to waste. In addition, the environment is protected from contaminants that can potentially cause harm.

All liquids will be stored in sealed containers that are free of leakage. All containers will be on the sealed ground and in an undercover area. Sharp parts will be kept away from liquid containers to avoid damage and leaks.

Bunding: To prevent spills from having an effect on the Project site operations or the environment, bunding will be placed around contaminant storage areas. A bund can be a low wall, tray, speed bump, iron angle, sloping floor, drain or similar and is used to capture spilled liquid for safe and proper disposal.

8.5.2 Spill Kits

Spill kits are purpose designed units that contain several items used for cleaning up spills that could occur. Typical items are:

- Safety gloves and appropriate protective clothing (depending on the type of chemicals held onsite)
- Absorbent pads, granules and/or pillows
- Booms for larger spills
- Mops, brooms and dustpans.

Spill kits are used to contain and clean up spills in an efficient manner. A sufficient number of spill kits will be provided. Spill kits will be kept in designated areas that are easily accessible to all staff. Staff members will be trained in using the spill kit correctly.

After cleaning up a spill, the materials used to clean up will be disposed of correctly. Depending on the spilled material, the used material may be disposed of in the hazardous waste facility or the landfill site.

8.5.3 Responding to spills

Stop the source: If it is safe to do so, the source of the spill should be stopped immediately. This may be a simple action like upturning a fallen container.

Contain and control the flow: To stop the spill from expanding, absorbent materials and liquid barriers should be placed around the spill. Work from the outside to soak up the spill. It is vital that spilled liquid is not allowed to reach storm water drains, sewer drains, natural waterways or soil.

For large scale spills that involve hazardous materials, authorities may have to be alerted.

Clean up: Using information from Material Safety Data Sheets (MSDS) about the properties of the liquid spilled and the spill equipment available, spills should be cleaned up promptly.

Record the incident: By keeping a simple log of all spills, precautionary measures can be put in place to avoid similar accidents from occurring in the future.

8.5.4 Fire Emergency Response Plan

A firefighting system will be installed with a standard operating procedure considering the potential fire from the sparks in Project operation area.

8.6 Reporting

An effective mechanism to store and communicate environmental information during the Project is an essential requirement of an EMMP. This section covers details of the reporting mechanism for the EMMP.

8.6.1 Meetings

Two kinds of environmental meetings will take place during the Project:

- Kick-off meetings
- Fortnightly meetings

The purpose of the kick-off meeting will be to present the EMMP to Project staff and discuss its implementation.

A fortnightly meeting will be held during the construction phase at the site. The purpose of this meeting will be to discuss the environmental issues and their management. The proceedings of the meeting, the required action, and responsibilities will be recorded in the form of a brief report.

8.6.2 Reports

Environmental reports will be prepared on a bi-monthly basis during construction and quarterly during operation.

8.6.3 Environmental Records

The following environmental records will be maintained:

- Periodic inspection reports of Contractor's Environmental Officer or his designate
- Incident record of all moderate and major spills. The record will include:
  - Location of spill
  - Estimated quantity
  - Spilled material
  - Restoration measures
  - Photographs
  - Description of any damage to vegetation, water resource
  - Corrective measures taken, if any
  - Corrective measures taken, if any
- Waste Tracking Register that will record all waste generated during the construction and operational period. This will include quantities of waste disposed of, recycled, or reused
- Survey reports, in particular, the following:
  - Soil erosion: Baseline survey, including photographs (or video), will be conducted to document the pre-construction condition of the construction corridor
  - Vehicle and equipment noise
  - Ambient noise survey reports

8.6.4 Change-Record Register

A change-record register will be maintained at the site, in order to document any changes in EMMP and procedures related to changes in the Project design, construction plan or external environmental changes affecting the EMMP. These changes will be handled through the change management mechanism discussed later in this section.

8.7 Environmental Training

Environmental training will help to ensure that the requirements of the environmental assessment and EMMP are clearly understood and followed by all Project personnel in the course of the Project. The contractor will be primarily responsible for providing training to all Project personnel. An indicative environmental and social training program

is provided in **Exhibit 8.4**, which will be finalized before the commencement of the Project.

Exhibit 8.4: Training Program

Type of Training	*Training By*	*Personnel to be Trained*	*Training Description*	*Period*	*Duration*
Occupational Health and Safety	External Sources	EHS Manager	Training should be provided to aware staff to conform to safety codes.	Before starting of project activities	Full day (8 hour session)
Occupational Health and Safety	EHS Manager	Workers Staff	Health, safety and hygiene Proper usage of personnel protective gear Precautions to be taken for working in confined areas.	Before starting of project activities During Project Activities	Full day (8 hour session)
Health, Safety and Environmental Auditing	External Sources	Staff responsible for inspection/audits	Procedures to carry out Health, Safety and Environmental Audits Reporting requirements	Before starting of project activities	Full day (8 hour session)
Waste Disposal and Handling	External Sources	Relevant Workers Relevant Staff	Segregation, identification of hazardous waste, use of PPEs, waste handling	Before starting of project activities	Full day (8 hour session)
Social & Environmental laws & regulations, norms, procedures and guidelines of Government	External sources	EHS staff Managers and supervisors	Environmental standards and their compliance Govt. regulations	Before starting the project activities	Full day (8 hour session)
Implementation of environmental management and monitoring	External Sources	EHS staff Responsible supervisory staff Management	Concepts of environmental management and monitoring plan	Once in 3 months during the entire construction period	Full day (8 hour session)

8.8 Budget for EMMP Implementation

Costing considerations are provided for mitigation and monitoring in **Exhibit 8.5**.

Exhibit 8.5: Indicative Budget for EMMP Implementation

Core Activity	*Budgeted Activity*	*Budget Rationale*	*Indicative Budget*	*Funding Source*
Occupational Health and Safety	▶ Purchase of required PPEs'	▶ Should be included in the EPC contract ▶ For Engro management and the environmental team of the Engro, 30 Sets of PPEs' at PKR 15,000 for each	– PKR 450,000	Contractor EPCL
	▶ Proper scaffolding platforms for all work areas located more than 1 m above floor level.	▶ Should be included in the repair and maintenance contract	–	Contractor
	▶ First Aid facilities and fire protection devices	▶ Cost of 5 first aid boxes at PKR 4,000	PKR 20,000	EPCL / Contractor
	▶ Monitoring of noise levels	▶ Purchase of noise meter	PKR 200,000	EPCL / Contractor
Staff Hiring	▶ Recruitment of one EHS Manager	▶ Salary of an EHS Manager at the cost of 70,000/month for 18 months	PKR 1,260,000	Contractor
	▶ Recruitment of Sanitary Workers	▶ Salary of a sanitary worker is estimated at PKR 10,000/month. The project may require two sanitary workers for 18 months	PKR 360,000	Contractor
	▶ Recruitment of one EHS Manager by Engro	▶ Salary of an EHS Manager at the cost of 70,000/month for 18 months and may extends his/her services in operational phase	PKR 1,260,000	EPCL
Waste management	▶ Onsite collection, segregation and storage of wastes	▶ Cost of three waste bins	PKR 15,000	Contractor

Core Activity	*Budgeted Activity*	*Budget Rationale*	*Indicative Budget*	*Funding Source*
Trainings	▶ Occupational Health and Safety	▶ HSE Trainer fee for two days at PKR 40,000 per day; travel and boarding at PKR 60,000 per visit	PKR 140,000	EPCL / Contractor
	▶ HSE Audit	▶ HSE Audit Trainer fee for one day at PKR 40,000 per day; travel and boarding at PKR 40,000 per visit	PKR 80,000	EPCL / Contractor
HSE Audit	▶ Conducting and reporting of HSE audit	▶ HSE Auditor fee for four days for two audits at PKR 40,000 per day; travel and boarding at PKR 60,000 per visit	PKR 280,000	EPCL

8.9 Grievance Redress Mechanism

Timely and effective redress of stakeholder grievances contributes to bringing sustainability to the operations of a project. In particular, it will help advocate the process of forming and strengthening relationships between project management and the stakeholder community groups and bridge any gaps to create a common understanding, providing Project management the 'social license' to operate in the area. The grievance redress mechanism proposed for the Project will help achieve the objectives of sustainability and cooperation by dealing with the environmental and social issues of the Project.

8.9.1 Purpose

The purpose of the Grievance Redress Mechanism is to ensure that complaints from Project affected communities and representatives of their interests are dealt with appropriately, with corrective actions being implemented where needed and the complainants were informed of the outcome.

8.9.2 Establishment of GRC

For this purpose, management of EPCL will establish a Grievance Redress Committee (GRC) to ensure grievances are treated without prejudice. The GRC will be headed by the head of the Environment and Social Cell of EPCL as Chairperson of the GRC. The Chairperson of the GRC will appoint one Secretary and two members of the GRC from the Environment and Social Cell of EPCL. The Chairperson of the GRC will also appoint one Community Focal Point (CFP) in every community within a radius of 8 km from the EPCL.

8.9.3 Responsibilities of GRC

Responsibilities of the GRC will be as below:

1. The GRC will ensure that all grievances related to social and environmental issues are registered, formally recorded, reviewed, resolved and the concerned person is informed in a timely manner.
2. GRC will not consider complaints related to the procurements or with matters pending in the court of law.
3. In resolving the disputes, the GRC will take into consideration the following:

- Merit of the complaints/case received for consideration;
- Evidence to take a decision on the complaint;
- Witness statements;
- Plausibility of the case in the light of related project activity;
- Applicable laws, environmental guidelines of Pakistan, ESIA of the Project;
- Observations made on the field; and

- Available information on previous complaints of similar nature.

8.9.4 Dissemination of Information on GRC

After notification of the GRC, information regarding GRC will be disseminated in all the concerned communities by the Secretary of the GRC. Information dissemination will comprise the following:

- List of GRC members including address and contact numbers.
- List of Community Focal Points (CFPs) of surrounding communities within a radius of 8 km around EPCL including address and contact numbers.
- Mailing address and email address of GRC.
- GRC scope of work.
- Process of submission and resolution of grievances

8.9.5 Selection of GRC Members

GRC members will be selected according to their responsibility and personal integrity. Community members will be selected after consultation with the communities. All GRC members will be approved and notified by the management.

8.9.6 Process of Grievance Redressal

The process of grievance redressal is as below;

Logging Grievances by External Stakeholders

The aggrieved person (or their authorized representatives) may file a grievance with the CFP of the village in one of the following ways:

1. Submit a written complaint to CFP.
2. CFP can write a complaint of any illiterate complainant.
3. Given the local cultural context, any aggrieved women may submit complaints to CFPs directly or through the head of the household.
4. An aggrieved person can also submit complaints to GRC through ordinary mail and email.

For complaints registration, Grievance Redress Form will be available with all the CFPs.

Processing of Grievances by Secretary of GRC

On receipt of a grievance, the Secretary of the GRC will try to resolve it himself by involving the concerned CFP and any other concerned person. If the grievance is resolved according to the satisfaction of the aggrieved person, it will be closed. Otherwise, the grievance will be forwarded to the GRC.

Processing of Grievance by GRC

The procedure for hearing and resolution of the complaint will be as follows:

1. **Upon receipt of a complaint:**

- CFP will log the complaint in a register called Complaint Register.
- Grievance will be included in next monthly meeting of the GRC.
- If needed, CFP will request the complainant or his representative to meet GRC on the appointed date to discuss his complaint.
- CFP will prepare all the relevant information and documents relevant to the complaint prior to the meeting and provide copies to all members.

2. **GRC will meet on the appointed date during which it may:**

- Deliberate on the nature and circumstances of the complaint;
- Investigate the complaint based on evidence provided by the complainant;
- Meet with the complainant and other persons;
- Visit the site; and
- Take a decision.

3. **If the GRC needs extra time to investigate or deliberate on the complaint, the Secretary will inform the complainant of the time when a decision is expected. In any case, all complaints shall be resolved within 30 calendar days after GRC meeting.**

Actions

- Once the analysis of the grievance is complete, the committee or person in charge of resolving the grievance will call the aggrieved person for a meeting.
- Regardless of whether the invitation to the aggrieved person is written or oral, it should communicate:
  - The day of the meeting
  - The place
  - Who else will be present (if applicable)
- The aggrieved person should also be informed of her/his right to come to the meeting with a fellow worker of her/his free choice or the workers representative
- During the meeting, the GRC Secretary/Representative will provide the background and present the reasoning behind the analysis of the case.
- Eventually, the person in charge will present the potential solution and he/she will seek the aggrieved person's reaction and approval. Ideally, after the mediation meeting, an agreement will have been made between both parties and they will have settled on the corrective or remediation measures to be taken as well as the timeframe to implement these measures.

- Make the necessary arrangements to resolve the problem or remediate.

Communications

The invitation to a meeting after the analysis can be extended orally or in writing by the GRC or its representative to the applicant.

1. The communication with grievance person by the GRC may be performed by a representative of the grievance committee.
2. All communication will be recorded whatsoever made between parties.

Review

- In case no decision is finalized or complainant is not satisfied by the decision the issue will be forwarded to GM EPCL for review.
- On receipt of the complaint, VP Manufacturing will review the complaint himself or will forward the case to any other manager or senior staff member for review as per the ISO procedure.
- The decision of the GM EPCL or his designated person will be final within EPCL, however, the complainant will be allowed to contact the court of law.
- If the applicant does not accept the second review, the case (and a legal copy of all the documents connected with it) will be turned over to the claimant.

Total time for the review of the complaint will be 15 days.

Monitoring

A meeting will be held with the aggrieved person within 10 days after resolving the grievance to verify that the situation has been resolved to the satisfaction of all involved. Later, monitoring will be conducted on a regular basis, depending on the case. The data will be described in the Grievance Log attached as **Appendix E**.

8.9.7 Records

A database will be set up to manage and monitor grievances. Good practice will be to log all grievances, even recurrent ones or grievances that will eventually be dismissed as unreasonable. Documentation will include the following:

- The name and contact details of the complainant, if appropriate
- The date and nature of the complaint.
- The name of the technical staff charged with addressing the complaint, if appropriate any follow-up actions taken.
- The proposed resolution of the complaint.
- How and when relevant Project decisions were communicated to the complainant.
- Whether longer-term management actions have been taken to avoid the recurrence of similar grievances in the future, if applicable.

8.9.8 Training

All individuals involved in conducting the above-mentioned activities and implementing this mechanism will be qualified based on education, training, and experience to perform his or her respective task(s). Competence evaluations and repetition of training will be conducted as necessary to ensure the protection and continuance of this mechanism.

9. Conclusion

The proposed expansion project entails the construction and operation of a PVC and VCM production facilities that will increase the capacity of EPCL to produce PVC and VCM by 100 ktpy and 50 ktpy respectively. The Project will also include other modifications including the addition of an import line for EDC and installation of another VCM storage tank and EDC tank.

The Project will increase the production of PVC in the country, thereby, reducing reliance on imports to meet local demand. It offers the country a chance to improve its trade deficit, offers a reliable and economical supply of PVC and creates employment.

The Project can potentially have negative impacts which can be mitigated and reduced to within acceptable limits if mitigation and management measures recommended in the ESIA are implemented. Among the potential negative impacts of the Project, the main concerns include discharge of effluent that does not meet SEQS resulting in contamination of the coastline, accidental spills, and releases of hazardous chemicals such as EDC. All these, as well as other impacts, are considered as part of the assessment and mitigation and management measures are recommended. The Project will ensure that it is compliant with all national standards.

The EIA includes mitigation measures and monitoring requirements which are outlined in the Environmental Management and Monitoring Plan (**Section 8**). If these are implemented the anticipated impact of the Project on the area's natural and socioeconomic environment will be well within acceptable limits. The project will also comply with all the statutory requirements and standards listed in **Section 2** of this report.