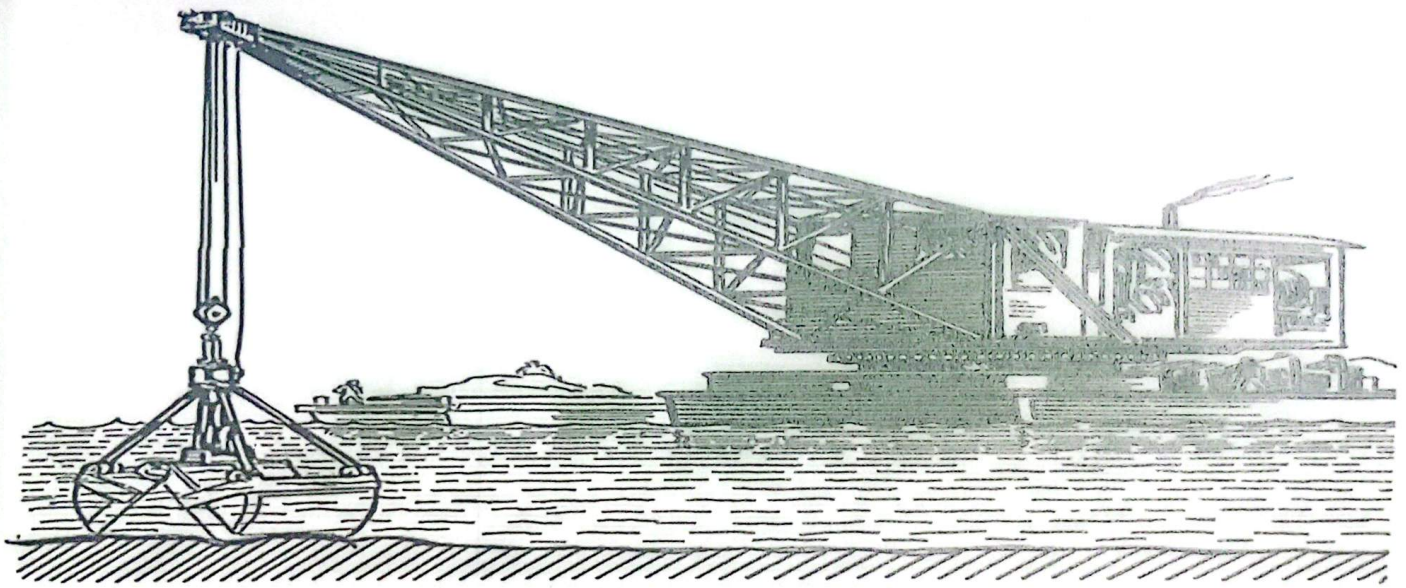


Environmental Impact Assessment (EIA) Report

KARAMAT ULLAH & BROTHERS DREDGER



Report Submitted By: Mr. Karamt Ullah

Near River Chenab (MG/SAND/RIVER CHENAB/ZONE-1
& BLOCK-3), District Muzaffargarh

Consulting Organization



Safe EnviroSolutions

Save The Planet

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Executive Summary

Title and Location of the Project:

The project under consideration of this Environmental Impact Assessment (EIA) Report is Sand extraction with Dredger Machine from River Chenab District Muzaffargarh (MG/SAND/RIVER CHENAB/ZONE-1 & Block 3).

Proponent of the Project:

Mr. Karamat Ullah S/O Inayat Ullah R/O Jahaniyan Road House No: 3, Tariq Abad Khanewal is the proponent of this project.

Report Preparation:

To comply with IEE/EIA regulations 2000 as per Punjab Environmental Protection (Amendment) Act (PEPA) 2012, the proponent of Karamt Ullah & Brothers Dredger has entrusted the *Safe Enviro Solutions*.

Company office address: 99/Burj-Al-Saeed building Room #110, Main Ferozepur Road Ichra, Lahore.

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Description of the Project

Nature of the Project: Sand extraction with Dredger Machine from River Chenab District Muzaffargarh.

ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIA)

Zone No.	MGT/SAND/RIVER CHENAI ZONE-1	
Points	Easting (M)	Northing (M)
A	30754000	06751000
B	58100	50700
C	57000	49100
D	58900	47750
E	57900	42350
F	47650	42000
G	47800	48150
Total Area:	20357.80	Acres

Total cost of the project: PKR 7 Million (Excluding lease)

Environmental Budget: Environmental budget of the project is 0.2 million.

Magnitude of the Project:

4-5 persons will perform their duties during operation of the Project.

Depth: The sand mining will be in 1 meter depth layer by layer the overall mining depth will be 5 meters

Storage area: stockpile area will be limited to 0.5 hacters and will be located on even surface.



Loading and unloading and transportation detail: the sand placed on the stockpile and will be loaded to transport trucks with front end loaders for sale to the local market

Water consumption:

1-2 gallon water will be used

Duration of lease: area is on lease.

(Lease agreement is attached in annexure)

Total Area: 20357.80 Acres **ZONE-1 &**

246.25 Acres BLOCK-3

Category of the Project

This project falls in the Schedule I (List of projects requiring IEE), Category D (Commercial extraction of Sand, Gravel, limestone, clay, Sulphur and other minerals not included in Schedule II with total cost less than Rs. 100 million)

Objective of the Project:

- To fulfill the market demand of sand.
- To get the best quality of sand for construction purpose.
- Positive impacts on local communities in terms of employment and local economic development.

Benefits of the project

- Being based on the use of submersible pump dredge is more efficient and it drastically reduces the fuel consumption
- The particular design of dredge allows to get only good quality of material avoiding waste of energy and granting to the end user to work with high quality of sand for construction purpose.
- To Reduce Damages From Future Flood Disasters
- Increase Flow Carrying Capacity



Comparison of Dredger Machine and Excavator

Sand dredger	Excavator
Sand excavation strategy in-stream using modern technology has not serious impacts on river banks. Sand extraction of river bed recommended from more than 50 m away of river bank, and the part of river where straight, it will be restored as meander to bring the river natural shape and it will increase the river beauty, reduce the water velocity in main channel also reduce the velocity left and right bank in channel. So the lower velocity of water in channel will not affect the River bank. Riparian buffer zone widths more than 30 m are very useful for bank stabilization and aquatic food web.	Excavator only has a limited access along the river shore line causing higher risks of cave in shore land and river widening which may not be desirable. Excavator damage the river bank.
Extraction with dredger will lower river bed will increase flow carrying capacity during high flood period, it will also reduce the flood risk in that area.	Excavator cause erosion at the river banks, resulting in eroding river banks and at the time of high rainfall causing flood to the area
Turbidity can cause serious damage to the ecosystem to prevent serious damage to the ecosystem. This problem will be solved by Drag flow by the production of a bell to limit water turbidity.	Increase the turbidity of water
Due to the particular design it will allow getting only good quality of material avoiding waste of energy and provide the good quality of sand for construction purpose.	
Being based on submersible pump it is more efficient and it drastically reduces the fuel consumption compared to the other old technologies.	
Most of the developed countries are using this technology.	Old Conventional method

Dredger can target the desired or planned area anywhere in the river and provides better selective and design capabilities

Excavator only has a limited access to the river bed only along the river shore line causing higher risks of cave in shore land and river widening which may not be desirable.

The Proponent will follow the following mitigation measures

Parts of the river reach that experience deposition will be identified first. The Lease holder and Environmental NOC holder may be allowed to extract the sand deposit in these locations.

Equipment must be regularly serviced and inspected to make sure there are no leaks of oil, diesel, fuel, detergents or hydraulic fluids. Servicing and maintenance of vehicles as far as possible must occur outside of the boundaries of permit area. If maintenance does occur on site due to breakdown, all steps must be undertaken to avoid hydrocarbon spills/leakages. Diesel will be stored on site, secondary containment will be provided. Spilled hydrocarbon must be treated as a hazardous waste and needs to be disposed off in appropriate hazardous waste containers and removed off site as soon as possible. No washing of equipment or machinery may occur on the permit site or in the watercourse. Spill kit will be used in case of any spill. The hydrology of the landscape will be maintained by ensuring that extraction takes place away from the riparian zone and the stockpile area drainage is monitored. The extraction of sand must not exceed the replenishment rate of sand during the rainy season. HEC-RAS model is used for computation of cross-section hydraulic parameters and river discharge capacity. The Environment Officer and Project Manager must establish working and no-go areas, which need to be strictly adhered to. Keep surrounding vegetation, especially larger trees and shrubs, to create a screen that reduces flood impacts. Protected trees must be marked, their location recorded and must be avoided as best as possible. Bank erosion can be controlled with re-plantation. No trapping, snaring, hunting, fishing or killing of any animal may occur on the permit site.

Vehicle access must be strictly contained onsite. Vehicles may only use designated roads and access points as determined by the Environment officer and project Manager before operations commence.

During transporting sand on public roads, these will be kept clear of spills, leaks, mud and sand. There is not any worth mentioning waste will generate at project site. If any solid waste

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will generate on site it will be disposed of in clearly marked bins and solid waste will be handover to the contractor

Mixed/generals waste and hazardous waste must be separated and disposed off in clearly marked bins. No waste may be buried or burned. Empty fuel storage drums will be handover to the authorized contractor. No disposal of sewage will occur on or near the site. Septic tanks will be available. Rehabilitation will ensure good vegetative cover which will reduce dust creation. Dust fallout monitoring will be introduced if dust becomes an on-going problem. Water will be sprinkled to minimize the dust. Hearing protection will be provided for employees operating machinery.

Site access, including stockpile areas and loading areas will be fenced off to prevent unauthorized access. Correct signage must be available at the main access road and entrance of haul road to areas – includes authorization, access authorization, warning activity, safety and warning signs (protective equipment, fire & medical equipment) and contact numbers. No open fires shall be allowed on site under any circumstances.

Turbidity can cause serious damage to the ecosystem; this problem will be solved by Drag flow by the production of a bell to limit water turbidity.

Due to the particular design it will allow getting only good quality of material avoiding waste of energy and provide the good quality of sand for construction purpose. Use of advance technology for sand removing in the river bed and minimized the environment impacts on river banks. Sand mining in river bed will be one meter depth layer by layer the overall mining depth will be 05 meters. Maintain the river flow carrying capacity in active channel without any serious activities.

Being based on submersible pump it is more efficient and it drastically reduces the fuel consumption compared to the other old technologies.

The project potential impacts will be mitigated by adopting all suggested technical/ engineering best practices and measures.

The Acker-White and Engelund-Hansen method was used for calculation of sediment transport and sediment rating curve the result obtained from Acker-White equation considered more reliable for sand volume extraction and replenishment. The sediment rating curve was developed. Hydraulic characteristic of river cross-section such; hydraulic depth (H_d), cross-section area (A), top width (B), and Wetted Perimeter was estimated with HEC-RAS 5.0.3



using steady and value of manning's (n) is adopted 0.033 on the bases of field investigation and river morphology. The basic characteristics of river cross-section, computed velocity and computed river flow discharge. The detail is given in chapter 3.

The sand extraction in River must be away 1000 m to 1500 m away from civil structure 500 m to 1000 m away from water intake points, fish breeding areas, irrigation areas riverine settlement. To avoid the sand extraction at riffle and straight channel cross-section due to high velocity it causes rapid bed and bank erosion.

The width of a buffer depends greatly on what resource you are trying to protect. Scientific studies have shown that efficient buffer widths vary for bank stabilization and stream shading, for wildlife habitat based on catchment characteristic and geometry. Furthermore, the necessary width for an individual site may be less or more than the average recommendations, depending on soil type, slope, land use and other factors. An ordinary planting adjustment to consider is the inconstancy in the width of land accessible for planting inside the riparian zone. The width of a riparian buffer is a key factor in the general outline of the planting (Agriculture and Agri-Food Canada, 2018). Cross-section of a stream and the adjacent riparian area.

Detailed mitigation measures are given in Chapter 3 & 5.

Proposed Monitoring: The EMP is prepared to ensure that the activities are undertaken in a responsible non-detrimental manner with the objectives of: (i) providing a pro-active, feasible and practical working tool to enable them ensure and monitoring of environmental performance on site; (ii) guiding and controlling the implementation of findings and recommendations of the environmental assessment (iii) detailing specifications deemed necessary to estimating the environmental impact (iv) ensuring that safety recommendations are complied with detailed Environmental Management Plan (EMP) is presented in Chapter 6.

1 CHAPTER 1: INTRODUCTION

1.1 Purpose of Report

Environmental Impact Assessment is the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made. The purpose of conducting an EIA was to:

1. To ensure that environmental considerations are explicitly addressed and incorporated into the development decision making process;
2. To avoid and minimize the adverse significant biophysical, social and other relevant effects of the proposed project;
3. To promote development that is sustainable and optimizes resource use and management opportunities.

This EIA study was conducted according to the newly issued standard guidelines and principles available from Punjab-EPA. This EIA report is structured in (9) chapters;

Chapter 1 is the introductory chapter describing purpose of report, identification of project and proponent, details of consultant and location of project.

Chapter 2 describes the type of project, its objectives, considered alternatives, site layout, land use, road access, vegetation, cost, process flow chart and rehabilitation plan.

Chapter 3: Feasibility Study

Chapter 4 presents the Legislative and Regulatory framework.

Chapter 5 details the baseline data of the project site,

Chapter 6 identifies and assesses the predicted impacts of the proposed project, the methodology for impact assessment and their mitigation measures.

Chapter 7 presents the Environmental Management and Monitoring Plan (EMP)

Chapter 8 public consultation

And lastly, Chapter 9 gives conclusions and recommendations of the EIA study.

The project lies under the categories of the projects requiring detailed EIA as per Pakistan Environmental Protection Agency (Punjab-EPA) (2000) regulations.

1.2 Scope of EIA Study

The purpose of this EIA study is identification of key environmental impacts which will likely arise during construction and operational phase along with the assessment of the significant negative impacts and mitigation measures to be adopted for their minimization.

The ultimate goal of this EIA report, among others, is to produce an Environmental Management Plan (EMP) for the proposed project. Compliance of EMP together with the provisions for mitigation measures for the significant negative impacts will ensure the implementation of this project in an environmentally sustainable manner both at construction as well as operation stages of the Project.

The EIA report ensures compliance to all national and local regulations enforced in Pakistan such as requirements of section 12 of Punjab Environmental Protection (Amendment) Act, 2012.

This EIA report also discusses the legal and administrative framework within which the EIA is prepared. A detailed project description is included in the EIA report together with a description of the baseline environmental conditions and the actual environmental situation at the proposed site for the project.

The technical section of the report and the environmental baseline situation form the basis for the detailed impact assessment during replacement and operation phases of the project. Based on the findings of this report, an environmental management system has been devised, outlining necessary mitigation and compensation measures together with monitoring practices.

1.3 Approach & Methodology

The key steps followed while conducting EIA are briefly described below.

1.3.1 Review of Project Documents

Previous feasibility report has been reviewed for getting insight into the project area and related issues. Some offices and organizations were also visited for acquisition of published reports and data.

1.3.2 Reconnaissance Survey of the Project Area

The reconnaissance survey under this study was conducted by an interdisciplinary team to conceptualize the project and understand the potential environmental and social impacts associated with the proposed project. During the field reconnaissance, the main information regarding the topography, soils, land use, surface water, groundwater, flora, fauna, social setting, villages/ towns, in the surroundings of proposed project was examined.

1.3.3 Data Collection

Both primary and secondary data were collected to accomplish the objectives of the study. The primary data was collected by conducting field surveys through individual interviews of local population, focus group discussions and consultations with local community, while secondary data was collected from the published Government documents, i.e. Economic Survey of Pakistan, District Population Census, Weather data, Government Acts, Laws and Regulations.

1.3.4 Data Processing and Analysis

After collecting all above data from different sources including interviews from communities, consultations, physical observations, and data compiled from other documents was analyzed. Accordingly, the results were presented through tables, graphical/ pictorial illustrations.

1.4 Identification of the Project and the Proponent

1.4.1 Project

The project is Sand extraction with Dredger Machine from River Chenab District Muzaffargarh.

1.4.2 Proponent

Mr. Karamat Ullah is proponent of this project.

1.5 Details of Consultant

The services of Safe-Enviro Solutions (99-Durj Al Saeed, Room#110, Techno Lahore) have been engaged to carry out An Environmental Impact Assessment (EIA) for Sand extraction with Dredger Machine.

1.5.1 EIA Team

A core team of qualified professionals having relevant experience of conducting environmental and social assessments contributes to preparation of an Environmental Impact Assessment (EIA) shown in Table 1.1

Table 1-1 EIA Study Team

Detail of team conducting IEE study with qualification and position in team.

Name	Qualification	Position in the EIA/IEE Team
Muhammad Rehman Majeed	M.Phil (Environmental Science) GCU Lahore	Project Incharge And Supervisor
Ammara Anwar	M.S (Environmental Science) PU-Lahore	Team Leader and Coordinator (Author of the Report)
Mohsin Ali	M.Phil Environmental Science GCU Lahore	Senior Environmentalist (Field Analyst)
Tazneen Husnain	M.sc Environmental Engineering (UET Lahore)	Environmental Engineer
Anum Waheed	BS (Hons) Environmental Science (GCU Lahore)	Research Associate (Author of the Report)

the main roles of the team members are given. However, their role was not restricted to these, rather includes many other studies in their respective fields in the context of this IEE studies.

Chapter 10: The Nervous System and Behavior

Neuroscience: The Study of the Nervous System and Behavior

10.1: Basic Organization of the Nervous System and Functions of Neurons

10.1.1: Neurons

The nervous system is the body's communication system. It is made up of neurons, which are specialized cells that transmit information throughout the body. Neurons are the basic units of the nervous system, and they are responsible for processing and transmitting information. The nervous system is divided into the central nervous system (CNS) and the peripheral nervous system (PNS). The CNS is located in the brain and spinal cord, while the PNS is located in the rest of the body. The PNS is responsible for carrying information between the CNS and the rest of the body.

2 CHAPTER 2: DESCRIPTION OF THE PROJECT

2.1 Type and category of the Project

According to environmental laws of the country developmental projects have to undergo the process of Environmental Impact Assessment (EIA) or Initial Environmental Examination (IEE) in order to predict and mitigate the impacts of the development at an early stage. Based on nature, size, cost and associated impacts, the project under consideration has been categorized for Study according to the regulation 3 of Statutory Notification issued on June 13, 2000 s(S.R.O.339 (1) /2001). The Project is a Sand Extraction falls under Schedule 1 (List of projects requiring IEE), Category D (Commercial extraction of Sand, Gravel, limestone, clay, Sulphur and other minerals not included in Schedule II with total cost less than Rs. 100 million) of the IEE / EIA Regulations 2000 made under section 12 of Punjab Environment Protection Act 1997 (Amended 2012) under which the study is mandatory for getting Environmental Approval. The Director General, EPA Punjab is the authority to issue the requisite Environmental Approval after proper review of the project.

2.2 Objective of the Project:

- To fulfill the market demand of sand.
- To get the best quality of sand for construction purpose.
- Positive impacts on local communities in terms of employment and local economic development.

2.3 Analysis of Alternatives

2.3.1 General

The main objective of this section is to consider various alternatives to make the project more environmental friendly and sustainable with respect to the location and layout of the whole project. For the selection of appropriate layout, under existing site conditions, following environmental and social precautions were considered:

- Minimum environmental adverse impacts
- Minimum resettlement and land acquisition
- Cost effective solution

The important factors taken into consideration for selection of site for the project include:

- (i) Location
- (ii) Technology Option

2.3.2 Location

The sand will be extracted with Dredger Machine from Sand extraction with Dredger Machine from River Chenab District Muzaffargarh. The project site is acquired on lease for two years from mines and mineral department. The Dredger Machine will be used to extract mixture of water and sand from river.

In comparison with conventional sand removal method, dredger may actually have an edge over excavator and provides a better sustained and safer sand removal. Excavator only has a limited access to the river bed only along the river shore line causing higher risks of cave in shore land and river widening which may not be desirable.

Dredger in comparison can target the desired or planned area anywhere in the river and provides better selective and design capabilities.

2.3.3 Technology Option

Sand extraction by Sand Dredger Machine from River, because being based on the use of submersible pump dredger is more efficient and it drastically reduces the fuel consumption. The particular design of dredger allows to get only good quality of material avoiding waste of energy and granting to the end user to work with high quality of sand for construction purpose. Technology used in the most developed countries.

2.4 Location and the site layout of the Project

Sand extraction with Dredger Machine from River Chenab District Muzaffargarh.

2.5 Land use on the site

The land is acquired on lease. Lease agreement is attached in annexure. The project site located at River Chenab District Muzaffargarh.

The Dredger Machine will be used to extract mixture of water and sand from river bed.

2.6 Vegetation features of the site

Some wild grasses grown with few low bushes and thorny shrubs which have no medicinal value or considered endangered.

2.7 Cost and the magnitude of the operation

Total cost of the project is PKR 7 Million Rupees, excluding Lease cost Breakup of health and safety and environmental budget.

Health and Safety Budget of the project is 0.1 million	Ten Thousand rupees for Safety Signs
	Forty Thousand Rupees for Fire Fighting Equipment
	Forty Thousand Rupees for Personal Protective Equipment (PPEs), First Aid Boxes
	Ten Thousand Rupees for bins for solid waste
Environmental budget of the project is 0.2 million.	Two lac Rupees for plantation.

2.8 Magnitude of the Project

4-5 persons will perform their duties during operation of the Project.

2.9 Schedule of implementation

Project will be executed as soon as the no objection certificate from the environmental protection agency, Punjab will be issued, as the proponent has applied for other mandatory approvals from concerned departments The Project will be implemented in 1 week after the issuance of the EPA NOC.

2.10 Description of the Project

Nature of the Project: Sand extraction with Dredger Machine from River Chasab District Almarfargach.

Zone No.	North East / South West / River Chasab District	North East / South West / River Chasab District
Plot No.	North East / South West / River Chasab District	North East / South West / River Chasab District
1	30' x 4000'	400' x 1000'
2	30' x 100'	30' x 100'
3	30' x 100'	30' x 100'
4	30' x 100'	30' x 100'
5	30' x 100'	30' x 100'
6	30' x 100'	30' x 100'
7	30' x 100'	30' x 100'
8	30' x 100'	30' x 100'
Total Area	20357.80	Acres

Depth: The sand mining will be in 1 meter depth layer by layer the overall mining depth will be 5 meters

Storage area: stockpile area will be limited to 0.5 hectares and will be located on even surface.

Loading and unloading and transportation detail: the sand placed on the stockpile and will be loaded to transport trucks with front end loaders for sale to the local market

Water consumption:

1-2 gallon water will be used

Duration of lease: area is on lease for two years.

(Lease agreement is attached in annexure)

Total Area: 20357.80 Acres

246.25 Acres BLOCK-3

Category of the Project

This project falls in the Schedule I (List of projects requiring IEE), Category D (Commercial extraction of Sand, Gravel, limestone, clay, Sulphur and other minerals not included in Schedule II with total cost less than Rs. 100 million)

benefits of the project

- Being based on the use of submersible pump dredge is more efficient and it drastically reduces the fuel consumption.
- The particular design of dredge allows to get only good quality of material avoiding waste of energy and granting to the end user to work with high quality of sand for construction purpose.
- To Reduce Damages From Future Flood Disasters
- Increase Flow Carrying Capacity

3 CHAPTER 3: FEASIBILITY STUDY OF THE PROJECT

3.1 Introduction

Economic development is one of the main objectives of developed and developing nations worldwide. Development comes with growth of urban areas. Urban growth is achieved through sand and gravel mining for construction of modern, attractive and durable structures. Today, the demand for sand materials in Pakistan continues to rise. Ensuring their availability is vital for the development of the infrastructure in the country. There are many different sources of sand and gravel, the most important among them is the river. As the requirement of these construction materials is on rise, they also are very vital for the health, physical character of the river and the different important functions of the river. The extraction of sand and gravel from the river bodies has to be regulated and done with adoption of required environmental safeguards.

The Chenab River is a trans boundary river crossing northwestern India and eastern Pakistan. It is one of river of the Indus System in Punjab region

The length of river is about 1,180 km (730 mi) approx.

The constant deposit of sediment raises the surface of river channel when river enters the plain area. Heavy sediment loads from huge catchment area and garbage dumps are the main hurdles to block the holding capacity of water during monsoons and flash floods.

HEC-RAS model was used for computation of cross-section hydraulic parameters and river discharge capacity. Sediment transport computation and deposition study of project area performed at river cross-section by using Acker-White and Engelund-Hansen equations. The sediment rating equation was developed by Acker –White equation to determination of sediment flow rate at other cross-section in project areas. Daily river discharges measured, used to computation of time frame for sand mining in dry season. River morphology at project area reach in last few years was computed with GIS. Average River riparian buffer zone width was computed using statically approach employing spatial analysis tool of Geographic information system. The statistical model input parameters such as slope and overland flow length was

computed from digital elevation model of 30 m resolution. Bank erosion of river can be controlled with re-plantation, brush, grass and small trees.

3.2 Purpose of the Study

The purpose of the study to develop Best Management Tools (BMT) for sand mining and guideline:

The main aim of this study

- ✓ To guide river management authority, water resources management department, irrigation department, government agencies and local development and management department in minimizing and monitoring impacts of in-stream sand extraction on the quality of River in Pakistan.
- ✓ To develop the best sand mining guide tools for sand mining operators in implementing Best Management Practices (BMPs) and appropriate in-stream sand extraction techniques by carrying out field investigation and community engagement as well as undertaking closing plans and rehabilitation work in mining areas.
- ✓ To address the advanced and modeling exercise to determine how much sediment is moving into and through a reach, and how this affects channel hydraulics.
- ✓ To guide the sand mining operators and river management authority with basic modeling exercise to determine how sediment is moving into and through a reach and how much volume they will extract.

3.3 Background

The rapid construction for economic development in worldwide especially in developing countries are required sand mining from pit; river and agricultural land have positive and negative impacts to the environment. Sand and gravel have long been used as basic aggregate for construction of urban infrastructure, roads and building. Today, the demand for sand materials in Pakistan continues to rise. Sand and other sediments are generated from rock

weathering and erosion from topsoil layer, with a yield that depends on the soil composition, the vegetation cover, the intensity of rainfall, and the slope of the terrain. Soil is a slowly regular asset made up of rock, sand, dirt, topsoil which constitutes the diverse kinds. Pit sand, stream sand and rock are parts of soil which take a very long time to be shaped yet separated in a matter of days. Sand and rock are underground topographical assets framed from dissolving mountain rocks conveyed by streams and waterways. Soil has much utilization, it is required for horticulture, as a territory and in development yet the beginning of money economy brought many benefit driven organizations to be associated with its mining both legitimately and illicitly with some having no respect for the earth. Soil mining and reaping has both positive and negative ecological effects (Mwangi, 2007).

Sand and rock are essential assets to monetary improvement exercises in created and creating countries. Recuperation from stream channels, surge fields and glacial stores and additionally handling of these assets is expensive yet significant in development and industry (Draggan, 2008). Improvement is a procedure of step by step getting to be plainly greater, better, further developed in business, exchange and mechanical exercises. Development of towns and urban areas requests substantially more foundation and development of solid structures, for example, tarred streets, business shopping centers and settlement for the consistently expanding populace (Draggan, 2008). Effects of sand mining and rock extraction can be arranged into three classes as introduced (Stebbins, 2006). There are physical effects which are an aftereffect of mining from streambed causing modification of direct slant and changes in channel morphology. Water quality effects are caused by sand mining and digging exercises, lessening water quality for downstream clients and increment treatment costs. Environmental effects, for example, loss of territories and species unsettling influence are an aftereffect of mining rock and sand persistently prompting expulsion of channel substrate, suspension of silt and leeway of vegetation. Uncovered illicit sand mining going ahead in India, is generally done on streams. The ecological effects noted were changes in fluvial morphology, profound passages on stream overnight boardinghouses in speed of streaming water bringing about disintegration on waterway banks. At times there is exhaustion of water assets prompting sustenance deficiencies and hardships for individuals (Bagchi, 2010).

Understood that sand mining is done and essential in South Africa for development purposes yet forms included have incredible potential in upsetting the regular habitat. They noticed that

inordinate soil mining cause antagonistic effects to biota and their living spaces. Extraction in close stream bed harms vegetation and sea-going environments (Hill & Kleynrans, 1999). In-stream sand mining can harm private and open properties and additionally sea-going environments. Inordinate expulsion of sand may altogether contort the regular harmony of a stream channel. By expelling silt from the dynamic channel bed, in-stream mines interfere with the progression of dregs transport through the waterway framework, disturbing the residue mass adjust in the waterway downstream and inciting channel changes (generally entry point) expanding impressive separations (usually 1 km or more) past the extraction site itself. The extent of the effect essentially relies upon the sizes of the extraction with respect to bed stack residue supply and transport through the reach (Kondolf, Smeltzer, & Kimball, 2001). The magnitude of the impact basically depends on the magnitudes of the extraction relative to bed load sediment supply and transport through the reach. Implementation of the principles and processes outlined in these Guidelines will limit the negative externalities of sand and gravel mining.

3.4 Sand Mining Effect

EPA Punjab (2017) summarized the following effects of sand and gravel mining as listed below

- I. Extraction of bed material in excess of replenishment by transport from upstream causes the bed to lower (degrade) upstream and downstream of the site of removal of sand.
- II. Degradation may change the morphology of the river bed, which constitutes one aspect of the aquatic habitat.
- III. Lowering of the water table can destroy riparian vegetation.
- IV. Rapid bed degradation may induce bank collapse and erosion by increasing the heights of banks.

3.5 Sand Mining Guideline

EPA Punjab (2017) summarized following Guideline after studying relevant literature for sand mining projects

- I. There is need to ensure conservation of the river equilibrium and its natural environment.

- II. There is need to ensure that the rivers are protected from bank and bed erosion beyond its stable profile.
- III. No obstruction to the river flow and water transport is necessary.
- IV. There is need to avoid pollution of river water leading to water quality deterioration.
- V. There is need to avoid aggradation at the downstream reach especially those with hydraulic structures such as jetties, water intake etc.
- VI. The distance between sites for sand and gravel mining should be depends on the replenishment rate of the river. Sediment rating curve for the potential sites shall be developed and checked against the extracted volumes of sand and gravel.
- VII. Layers of sand and gravel which could be removed from the river bed shall depend on the width of the river and replenishment rate of the river.
- VIII. Sand should not be extracted within 1000 meter from any crucial hydraulic structure such as pumping station, water intakes, bridges, buildings and such structures.

3.6 Impacts of Sand Mining

Ministry of Environment, Forest and Climate Change India (2016) summarized the following the impacts of sand mining can be categorized as follows shown **Table 3-1**:

Table 3-1 Impacts of Sand Mining and Description

Sr. #	IMPACTS ON	DESCRIPTION
1	Biodiversity	Impact on related ecosystems (for example: fisheries)
2	Land losses	Both inland and coastal through erosion
3	Hydrological functions	Change in water flows, flood regulation and marine currents
4	Water supply	Through lowering of the water table and pollution
5	Infrastructures	Damages to bridges, river embankments and coastal infrastructures
6	Climate	Directly through transport emissions
7	Landscape	Coastal erosion, changes in deltaic structures, quarries, pollution of rivers
8	Extreme events	Decline of protection against extreme events (flood, drought, storm surge)

3.7 Site Selection and Limitations

3.7.1 Introduction

River flows carries sediment from steep slope and high elevation catchment which is naturally erodes sediment from the bed, banks of rivers in steep mountain areas and move toward downstream gradually over time, particularly during high flows and floods. Extensive volumes of sediment can be moved rapidly in extreme high floods and deposited at near flat valley and river meanders on a temporary basis then moved along to another location during the next high flood event. In determining suitable sites for in-stream sand mining extraction the following factors should be considered:

- I. Select the sites if sand removal reduce the risk of flooding and investigate how much it and sediment deposition continue to increase or will it reach a stable state that will not increase flood risk.
- II. Minimize the sand lease area affected: If possible, extract sand only from the dry deposits (evade working in the low flow channel (see **FIGURE 3-1**). Do not extract excess sand in anticipation of future floods.
- III. Only remove sand from dry un-vegetated deposits such as gravel bars and islands.
- IV. Sand Removing areas must be away from the river reserve.
- V. Sand mining at the concave side of the river channel should be eschewed to obviate bank erosion. Similarly meandering segment of a river should be culled for mining in such a way as to eschew natural eroding banks and to promote mining on naturally building (aggrading) meander components(EPA Sabah, 2011)
- VI. Sand mining should be avoided at V-shaped and fast flowing river sections with steep channel slopes and high risk river bank erosion sites.
- VII. When sand extraction is being carried out, measures should be taken to reduce the peril of fine sediments causing pollution of other sections of the river.

Ideally sand should be extracted from a depositional area as it accumulates, commensurable to the natural rate of sediment movement.

Figure 2. Typical channel reach and cross section for measurement of channel features (USGS, 2004)

3.8 Sand Mining Recommendations from Civil Structure

Sand volume abstraction should only be considered if there is a peril to infrastructure (outfalls, intakes, bridges) or other sustainable activity (navigation, flood risk management, water supply) because it also plays crucial role to improve country economic activities. If there is no consequential risk to these activities then the requisite for sand abstraction should be reconsidered. There are studying literatures relevant to the sand mining projects following limitation was workout.

- I. Sand and gravel shall not be extracted within 1,000 m from any crucial hydraulic structure such as pumping stations, water intakes, bridges, buildings and such structures (DHD, 2009).
- II. The site must be at least 500 m away from the nearest sensitive civil structure such as water intake points, fish breeding areas, irrigation areas and river sections used for navigation, recreational areas or riverine settlement (EPA Sabah, 2011)
- III. Mining shall not be undertaken in a mining lease located in 200-500meter of bridge, 200 meter upstream and downstream of water supply /irrigation scheme, 100 meters from the edge of National Highway and railway line, 50 meters from a reservoir, canal or building, 25 meter from the edge of State Highway and 10 meters from the edge of

other. For carrying out mining in proximity to any bridge or embankment, appropriate safety zone (not less than 200 meters) should be worked out on case to case basis, taking into account the structural parameters, location aspects and flow rate, and no mining should be carried out in the safety zone so worked out. Mining activities shall not be done for mine lease where mining can cause danger to site of flood protection works, places of cultural, religious, historical, and archeological importance (MEFACC, 2016).

- IV. According assistant director mines and minerals, Pakistan lease (2017), Sanding mining not is undertaken in a mining lease area located in 200 meter of railway line, roads, water reservoir, electricity transmission line, pipe line of Sui gas, historical places and others important civil structure.

3.9 Guideline and Sand Extraction Limitation from Civil structure in Project Area

The Chenab River is formed by the union of two headwaters, Chandra and Bhaga, which rise in the upper Himalayas in the Lahaul and Spiti district of Himachal Pradesh state, India.

The length of river is about 720 km (450 mi).

The sand extraction in River must be away at least 1500 m from the Barrage, 1000 m to 1500 m away from civil structure such as railway bridge, road bridge and 500 m to 1000 m away from water intake points, fish breeding areas, irrigation areas riverine settlement.

3.10 Setback and Sand Mining in River Bed

Besides, expelling riparian vegetation from the banks of little, intensely shaded streams will have a significantly more prominent effect on stream temperature and amphibian territory all through the watershed than expelling vegetation from larger waterways, where just a small amount of the water is shaded. As opposed to overlooking these streams totally, a tradeoff is making a littler setback. Guidelines issue by Ministry of Environment, Forest and Climate Change India (2016) the maximum depth in-stream mining.

- I. In the case of mining leases for riverbed sand mining, concrete river stretches should be identified and mining sanctions/lease should be granted stretch sagacious, so that the

requisite safeguard measures are duly implemented and are efficaciously monitored by the respective Regulatory Ascendant entities.

- II. Mining depth should be restricted to 3 meter and distance from the bank should be 3 meter or 10 percent of the river width whichever less.
- III. For carrying out mining in proximity to any bridge and / or embankment, congruous safety zone should be worked out on case to case substratum, taking into account the structural parameters, locational aspects, flow rate etc. and no mining should be carried out in the safety zone so worked out.

Guidelines issue by Sabah State DID the maximum depth in-sin-stream mining

- I. Sabah State DID in its guidelines for river sand mining has mentioned that extraction of sand can only be carried out on 1/3 of the river and the allowable portion of extraction is the middle third of the river.
- II. The depth of extraction from the base of the river is dependent on the width of the river and the amount to be extracted as well as the replenishment rate of the sand. Figure 3-2, illustrates the width of river in relation to its allowable depth of extraction.

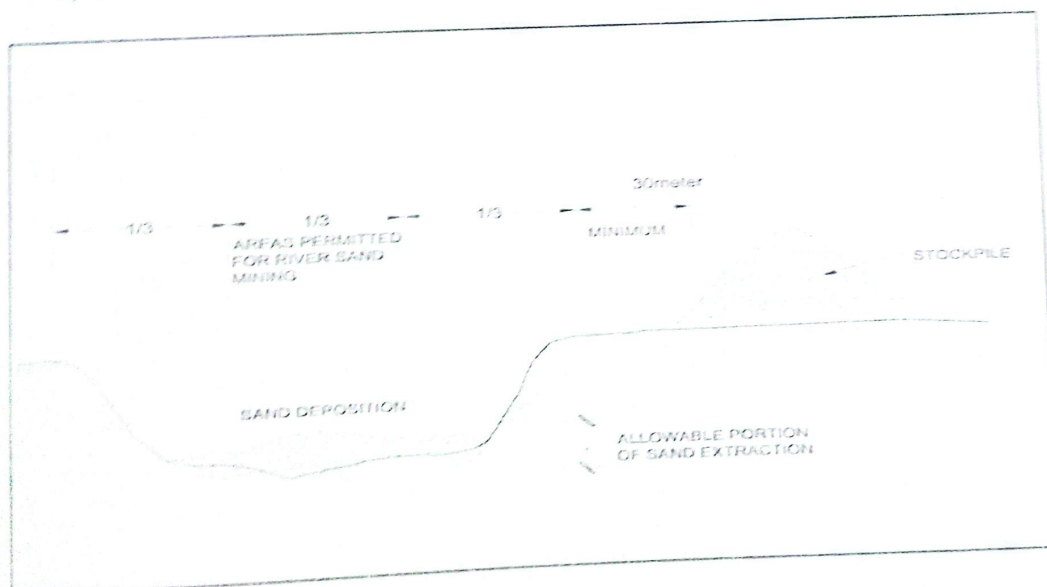


Figure 3-2 Setback, Allowable Mining Portion for In-Stream Mining by the State DID, Sabah (EPA Sabah, 2011)

Guidelines issue by (SEPA, 2010) sediment removing in River the based on the following option:

- i. Minimize the area affected; only abstract sediment from less than 50% of the surface area of individual dry deposits. The total length of sediment abstraction should not exceed 30m when quantified along the bank.
- ii. Do not remove sediment more than once every three years within a distance equal to the average river width multiplied by 25 (eg if average river width is 5m the operation cannot be repeated within a distance of $(5 * 25) = 125\text{m}$).
- iii. Maintain a distance of at least 2m between the wet edge of the low-flow channel and the area of removal.
- iv. Removed sediment should not be used to form bank-top embankments.
- v. Consider reintroducing removed sediment downstream

Determining the sand budget for a particular stream reach requires site-specific topographic, hydrologic, and hydraulic information. This information is utilized to determine the amount of sand that can be abstracted from the area without causing undue erosion or degradation, either at the site or at a nearby location; upstream or downstream (see Figure 3.3).

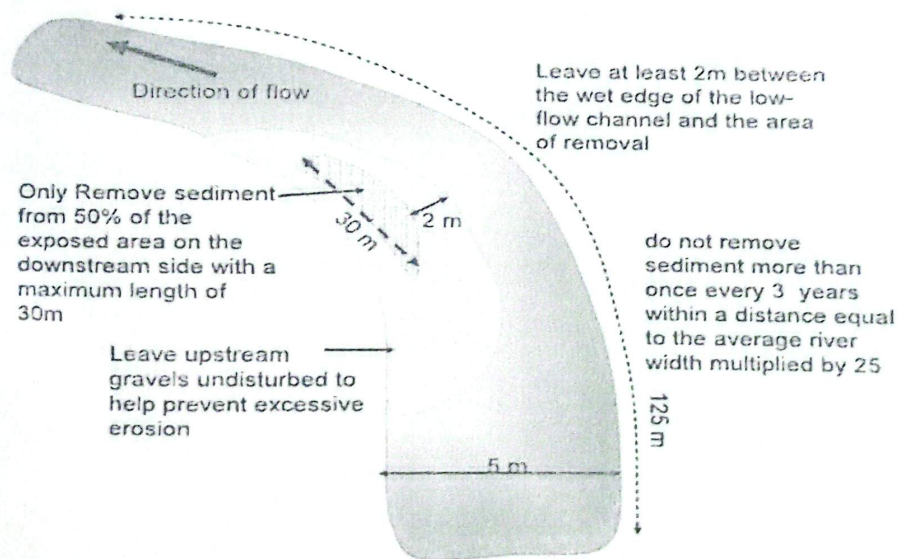


Figure 3-3: Good practice, small scale sediment removal from dry un-vegetated deposits (SEPA, 2010).

Sand is major requirement for construction of road, building, bridge and much other structure and it play crucial role country economic. River bring sediment from steep slope area during high flood and deposited it in or near river and it can be remove these sediment with next coming flood event. The extraction sediment/sand from subsisting pools: do not engender pools

where none have subsisted anteriorly. Pools should not be incremented significantly in size or over-deepened; this could increment the peril of destabilizing the channel leading to incremented erosion. Do not transmute pools in size (width, length, depth) or frequency. **Figure 3-4**, illustrates the Good practice sand/sediment extraction in river pool.

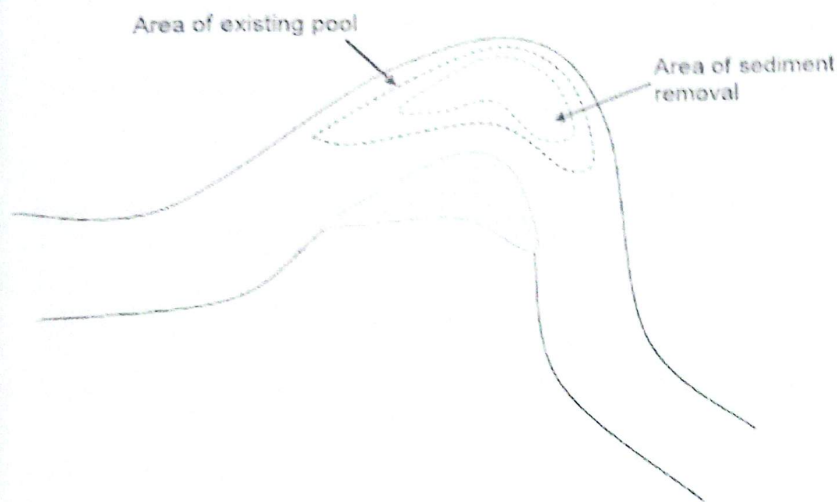


Figure 3-4 Good practice. Do not increase the area of the original pool

The all above guideline of sand extraction is mostly demonstrated for small watershed and based on sediment replenishment. The watershed area of river is large the average width of the active river.

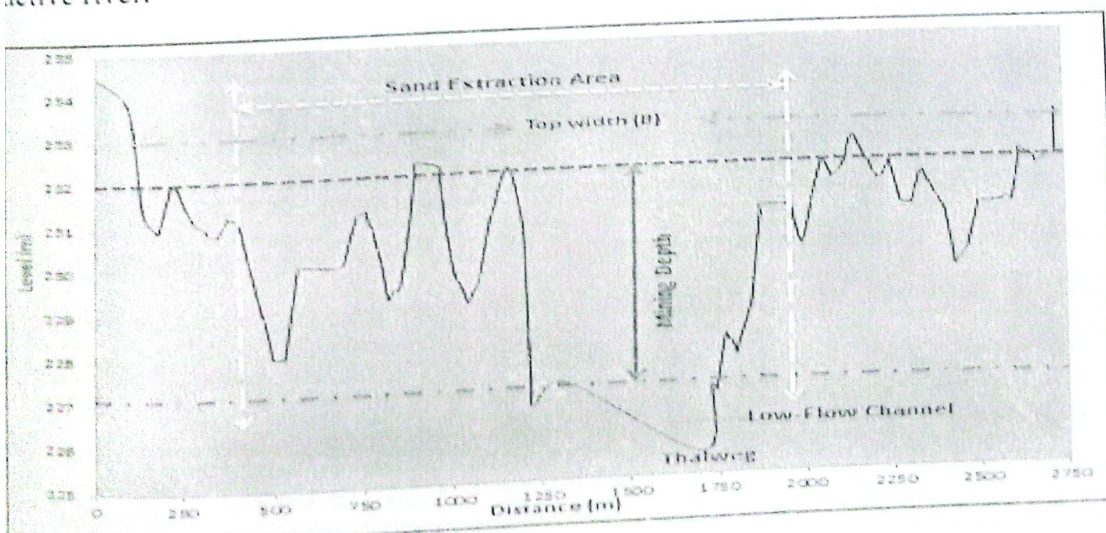


Figure 3-5 Guideline sand extraction depth, redline low-flow channel divide

If average river width is greater than 1500 meter operation cannot be repeated within a distance of $(5 * 25) / 500 = 2.5 * \text{Average Width (m)}$. The total length of pool in that section is 3.5 km and the area of actual pool 2 Km² and the area of sediment removing is 1.53 Km² (see Figure 3-6)

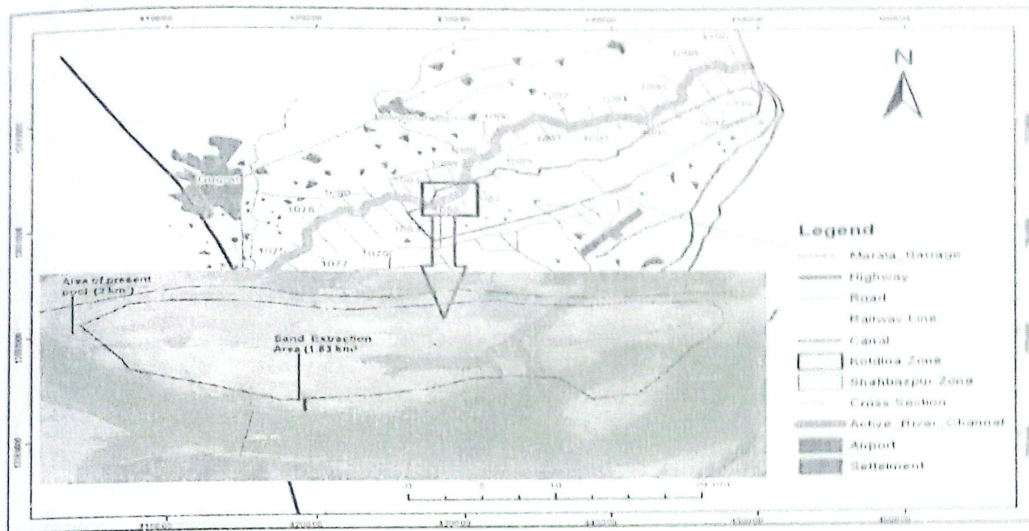


Figure 3-6 Good practice sand extraction in-stream

Setbacks need, for instance, insurance of surface waters from contamination, security of structures from flooding or disintegration, and safeguarding of riparian natural surroundings and shoreline comforts. The sand excavation must be setback for distance 10% total width of cross-section from the both side of main channel bank toward the flow channel.

3.11 Stockpiling and Management Practice

For thousands of years, sand have been utilized in the construction of roads and buildings. Today, demand for sand perpetuates to increment. Mining operators, in conjunction with cognizant resource agencies, must work to ascertain that sand mining is conducted in a responsible manner.

Sand stockpiles must be located more than 30m away from the river bank to avert the sand stockpile from being washed away if the river water level elevates or during hefty rain (DID, 2009).

Sand stockpiles must be located more than 30m away from the river bank to prevent the sand stockpile from being washed away if the river water level rises or during heavy rain (EPA Sabah, 2011):

Direct release fine sediments discharge into river has wide-ranging impacts on aquatic biota, both when in suspension and when they are deposited on the river-bed. The effect that a sediment load has on an aquatic community is dependent on few factors, including the biological community and life stage in relation to sediment grain size, concentration, and transport method. But it can be controlled by using proper management tools a basic outline is given below:

River sand mining activities currently result in silt run-off and discharge into the river. This silted run-off water contributes to better total suspended particulates inside the river thereby growing its turbidity. Sand mining operators should be build ponds to contain their wash- out water or proper drainage to channel their run-off. Sedimentation ponds and siltation structures are used to minimize sediment contributions to surface waters but sediment ponds need to not be constructed on pinnacle of natural waterways or streams. Discharge silted water into river with proper drainage design where outfalls of the drainage have to be located with riprap to prevent scouring of river banks.

3.12 Operational Guide Line

According to (DID, 2009) in-stream operation should be limited during low flow season and Sand may be extracted across the entire active channel during the dry season (May to September).

Mining operation in active river channel should be limited during low-flow Season (Feb and October to December).

3.13 SEDIMENT TRANSPORT FUNCTION AND METHODOLOGY

3.13.1 Sediment Transport in Rivers

The free limit (comprising of mobile material) of an alluvial channel misshapes under the activity of streaming water and the twisted bed with its evolving harshness (bed frames) collaborates with the stream (Nalluri & Featherstone, 2001). The subsequent development of the bed material (residue) toward stream is called silt transport and a basic bed shear pressure must be surpassed to begin the molecule development. Such a basic shear pressure is alluded

as early (limit) movement condition, underneath which the particles will be very still and the stream is like that on an unbending limit. Some dregs particles roll or slide along the bed irregularly and some others saltate (jumping or skipping along the bed). The material transported in either of these modes is called 'bed stack'. Better particles (with low fall speeds) are entrained in suspension by the liquid turbulence and transported along the direct in suspension. This method of transport is called 'suspended load'. At times better particles from upland catchment (sizes which are absent in the bed material), called 'wash stack', are likewise transported in suspension. The consolidated bed material and wash stack is called total load. Bed stack ranges from a couple of percent of aggregate load in marsh streams to maybe 15% in Mountain Rivers to more than 60% in some bone-dry catchments. Despite the fact that a moderately little piece of the aggregate dregs stack, the course of action of bed stack silt constitutes the design of sand, and rock bed channels. The rate of residue transport normally increments as a power capacity of stream; that is, a multiplying of stream commonly creates more than a multiplying in dregs transport and most silt transport toward flood plan and mostly sediment deposited in river meander or where river flat (see figure). The natural effects from in-stream mining can be kept away from, if the yearly bed stack is figured and total extraction is limited to that esteem or some bit of it. As far as possible extraction to some segment of bed stack, the measure of residue that passes the in-stream mining site amid a given timeframe must be computed. The river sediment flow and deposition system was shown **Figure 3-7**.

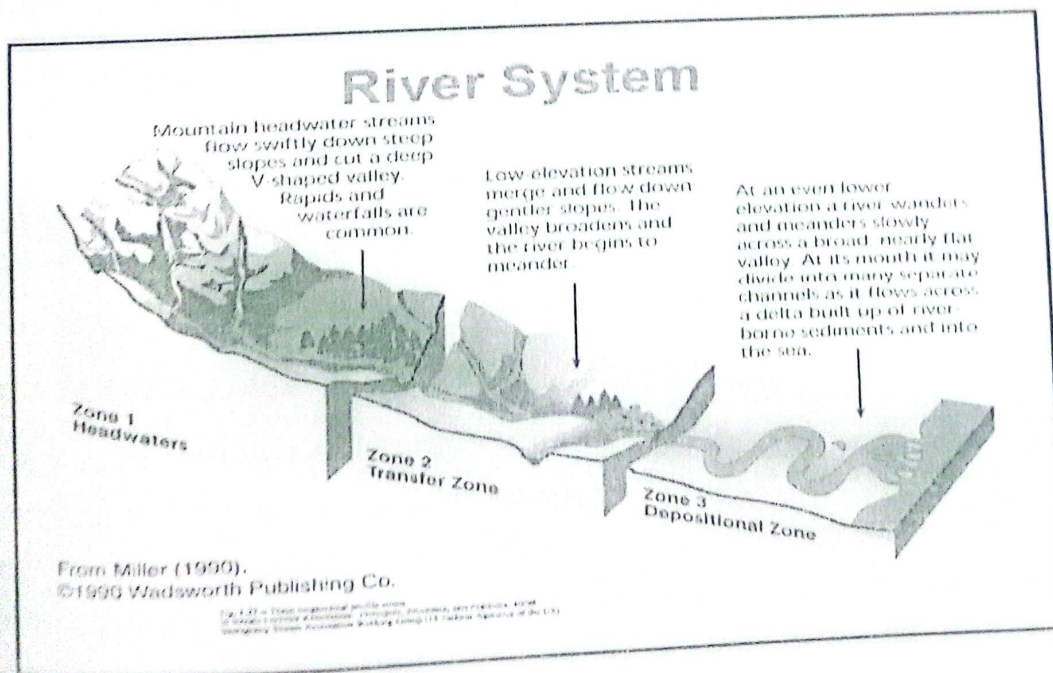


Figure 3-7 The river sediment flow and deposition system

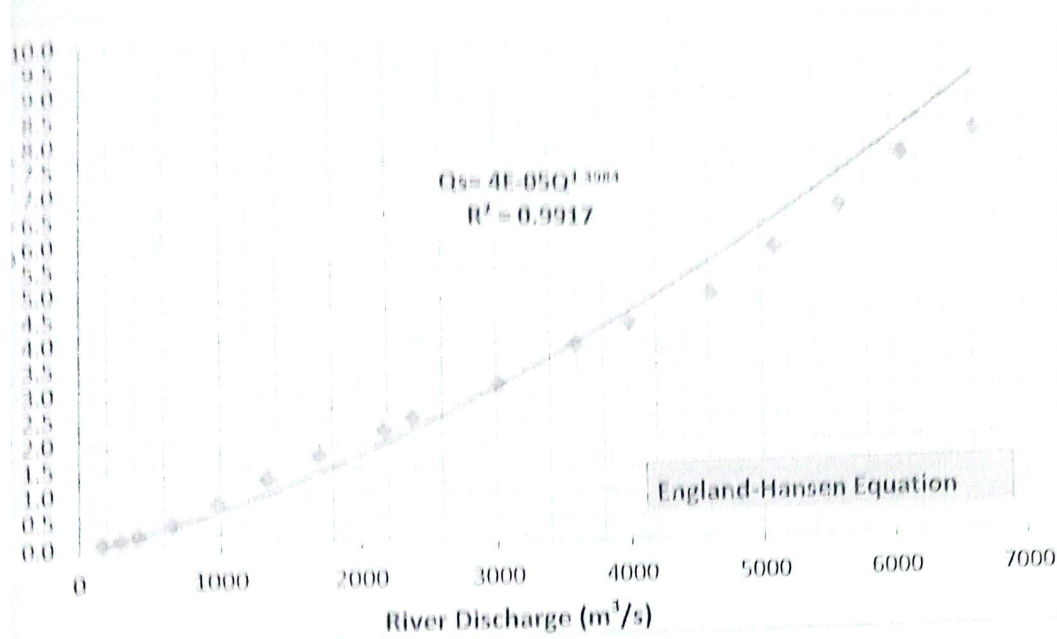


Figure 3-10 Sediment Rating Curve at Cross-Section # 1085 River

In a plot between discharge and sediment concentration there is not large scatter in points. One reason behind this scatter is that soil erosion rates in a watershed are not the same during different seasons of the days, month or year. If the scatter is large, it might be necessary to develop separate rating curves for different seasons or according to stream flow generation mechanisms, such as rainfall, snowmelt, etc. A sediment rating curve is mainly applied to obtain the value of sediment concentration for a given discharge. Along with the flow duration curve at a given location, the sediment rating curve can also be used to estimate the amount of sediment transport over a period of time. Another important use of sediment rating curve is in estimation of the effect of land use changes at river boundary and watershed management on sediment yield. The equation developed by Acker-White method can be used for sediment discharge computation of different river flow discharge.

$$Q_s = 0.2093 \cdot Q^{0.2518}$$

Whereas the above parameter can be described as Q_s , sediment discharge (m³/s) and Q river discharge (m³/s).

3.17 Extraction Volume Computation Techniques

The average river flow at downstream in month July is estimated 1060.3 m³/s

$$Q_s = 0.6043 * Q^{0.2518}$$

$$Q_s = 0.2093 * (1060.3)^{0.2518}$$

$$Q_s = 1.209 \text{ m}^3/\text{s}$$

$$\text{Total replenishment volume} = Q_s * \text{Flow period} * \text{area}$$

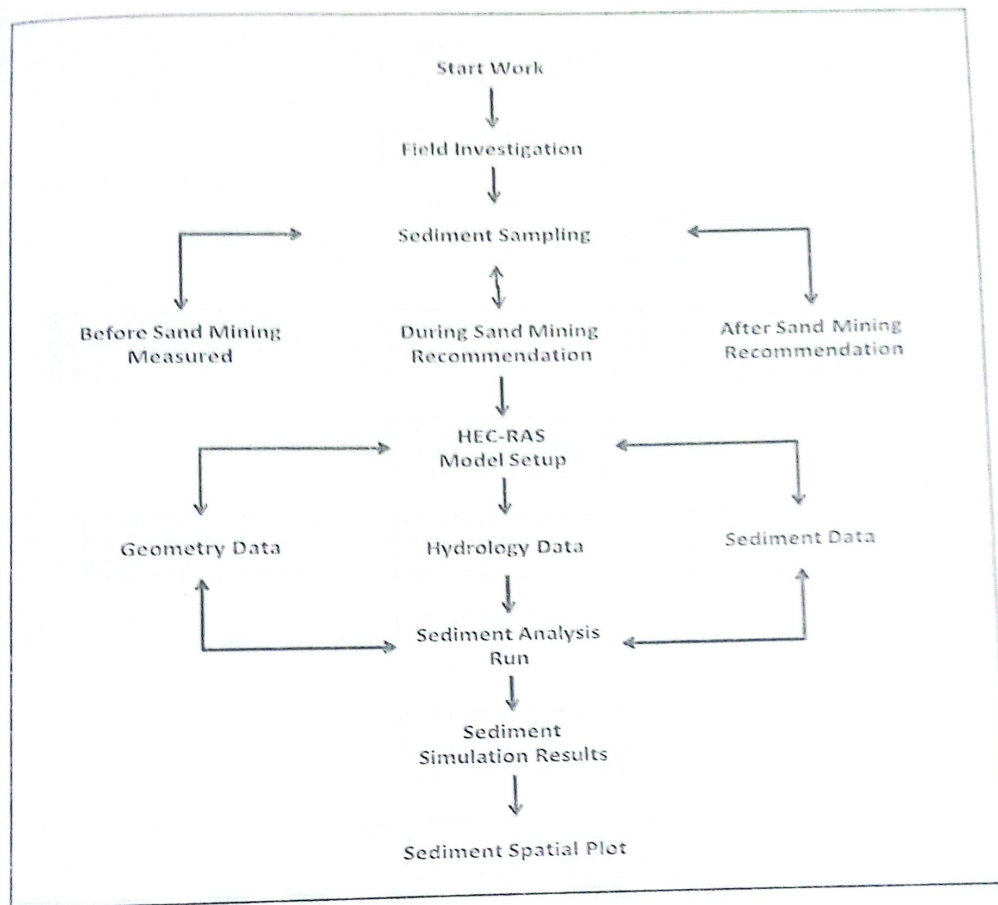
$$\text{Total replenishment volume} = 1.209 * 31 * 24 * 1530000$$

$$\text{Total replenishment volume} = 1376228880 \text{ m}^3$$

The sand extraction and replenishment analysis was performed on cross-section # 1085 it is clear rate of replenishment volume greater than volume extraction.

For the evaluation of in-stream volume extraction and replenishment a 1-D/2-D Quasi Unsteady Flow and sediment model was built for this study area using the Hydraulic Engineering Center – River Analysis System (HEC-RAS) Version 5.0.3. The current HEC RAS is capable of performing steady and unsteady flow water surface profile calculations, and sediment modeling.

Figure 3-11 Working Flow Chart



3.18 Model Input Data

3.18.1 Geometry Data

Information needs to be input by the user regarding the geometry of the study site, the hydrology data being used, and the sediment data for the site. For HEC-RAS, the geometry file requires a river path with cross sections along it. For this project, the cross-sections with 100 meter intervals were created using the HEC-GeoRAS model embedded in ArcGIS 10.3 and the 30 m resolution using shuttle radar topography mission (SRTM). Digital elevation Model data from 2005, obtained from the earth explorer. Shape files were created in ArcGIS from using shuttle radar topography mission (SRTM) data with a resolution of 30 m. Cross-sections were cut from these shape files, and oriented along a stream pathway (see Figure 3-12).

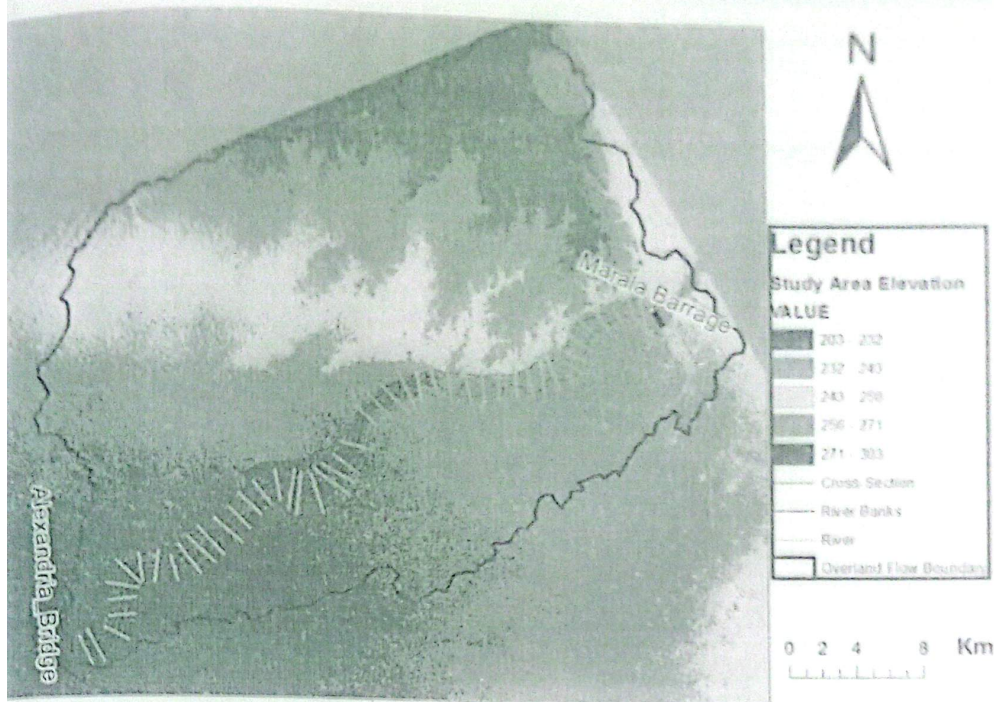


Figure 3-12 River Cross-Section and Elevation Map

Bank stations at each cross-section were set at the elevations of bank full flow, at which the river would be full of water to the bank height. Areas of the cross-section outside the bank stations were defined as the floodplains. HEC-GeoRAS allows creating the geometry files in AutoCAD, and then be exported to HEC-RAS. After being exported, the geometry file can be opened in HEC-RAS with the flow paths, cross-section locations and elevations, and bank stations. Colored images from Google Earth were used to classify the land uses, and then these classes were used for the estimation of Manning's n values, which were needed by HEC-RAS for performing hydraulic computations in model. The Manning's roughness values within cross-sections are allowed to be varied, so the roughness was set as 0.033 for the main channel nearly free of vegetation, and 0.04 for the channel floodplain with shrubs.

18.2 Schematic River System

The schematic river system defined in the HEC-RAS show the simplified plan view and locations of the cross section data from upstream to downstream of the study site. The setting up of the model was carried out by considering 49 km river length as shown in Figure 3-13 with 25 cross-sections. The study site is situated at section number 1100 to at section number

0 RIVER DISCHARGE CAPACITY AND MANAGEMENT OPTION

1 Flood Risk and Management

General Rivers encompass channel, bank and overbank or floodplain deposits and are accountable for transporting sediment from upstream, overflow land to lowland and the oceans. The quantity of abrasion, transport and deposition of sediment inside a river is determined by means of the interplay among stream glide and channel slope ('movement power'). Stream flow/velocity varies from supply to outlet however is generally maximum in the center sections of the river in which tributaries converge and the channel gradient is better (SEPA, 15).

Floods in river end result from heavy rainfall inside the upper drainage basin and excessive deposition of sediment in lowland is a particular problem for flood, whereas snowmelt contributions are on the average forty% of the whole waft in July, while the height softens fees attained. For this reason, it synchronizes with the early monsoon in July, however not with the height values going on in August and September at some stage in the monsoon; the tributaries flowing into the River can aggravate the floods.

Flood shows that more excessive deposition of sediment is a in that area is particular problem for flood risk management and it reduces the capacity of the river to transport river flow rapidly and may cause river bank overtopping and flooding. Flood risk may also be increased in areas of due to overland high erosion where banks are retreating towards receptors such as property. River restoration increases natural storage capacity and reduces flood risk. Excess water is stored in a timely and natural manner in areas where values such as attractive landscape and biodiversity are improved and opportunities for recreation can be enhanced.

The most common reason for carrying out works to rivers is to increase their capacity to carry flood flows. There are a number of ways that to increase flood carrying capacity in that part of reach, but the two commonest are channel maintained and enlarging the channel cross section typically by widening or deepening.

3.22 How to increase river (channel) capacity

The most common reason for carrying out works to rivers is to increase their capacity to carry flood flows. There are a number of ways that to increase flood carrying capacity in that part of reach, but the two commonest are channel maintained and enlarging the channel cross section (typically by widening or deepening. There are a few outline also given below

- Considering river channel together with inundation(s) (flood plain) as one water body“(diking, pondering in open landscape environment.
- Necessity to dredging bottom in narrow profiles?
- River restoration increases natural storage capacity and reduces flood risk.
- Restoring meanders to rivers that have been straightened not only restores river habitat degraded by past flood management projects, but also increases the in stream storage capacity and slows the downstream propagation of the flood peak, thereby decreasing downstream flood risk and the need for flood management dams.

3.23 Discharge Flow Capacity Management Method

The main objective is usually the maintenance of channel capacity to ensure it is adequate for flood conveyance. In the past, rivers were left much sediment deposited. This led to the need for a regular programme of sediment to maintain the depth of the reach, and this is still an important activity on some other rivers, especially in the vicinity of lock structures. The discharge of each river cross-section carryout by using HEC-RAS based on manning equation. The most familiar Manning equation which was introduced by Engineer Robert Manning in 1889 M can be used to estimate the river inflow capacity using basic hydraulic characteristic of selected cross-section. It is a useful way of obtaining a rough idea of flow capacity and of checking the impact of maintenance works. Manning equation was used in many researches and project would be written as:

$$v = \frac{1.486}{n} R^{\frac{2}{3}} S^{\frac{1}{2}}$$

And

$$Q = AV$$

For design of composite drain roughness coefficient was calculated by using following expression:

$$n_w = \frac{P_1 n_1 + P_2 n_2 + \dots + P_m n_m}{P}$$

Where:

v = Flow velocity (m/s)

Q = discharge in m^3/s

n = Roughness coefficient (dimensionless)

R = Hydraulic Radius (m) (A/P)

S = Slope of drains gradient

A = area of cross section of flow (m^2)

n_w = Weighted coefficient of roughness for the drains

$P_1, P_2, \& P_m$ = Wetted perimeter in meter for each side of roughness

$n_1, n_2, \& n_m$ = Roughness coefficients corresponding to each wetted perimeter

P = the total wetted perimeter, in meter, for the River.

The flood conveyance capacity of River was computed using normal and high flood measured at Marala Barrage downstream as shown below **Figure 3-18 to 3-23**.

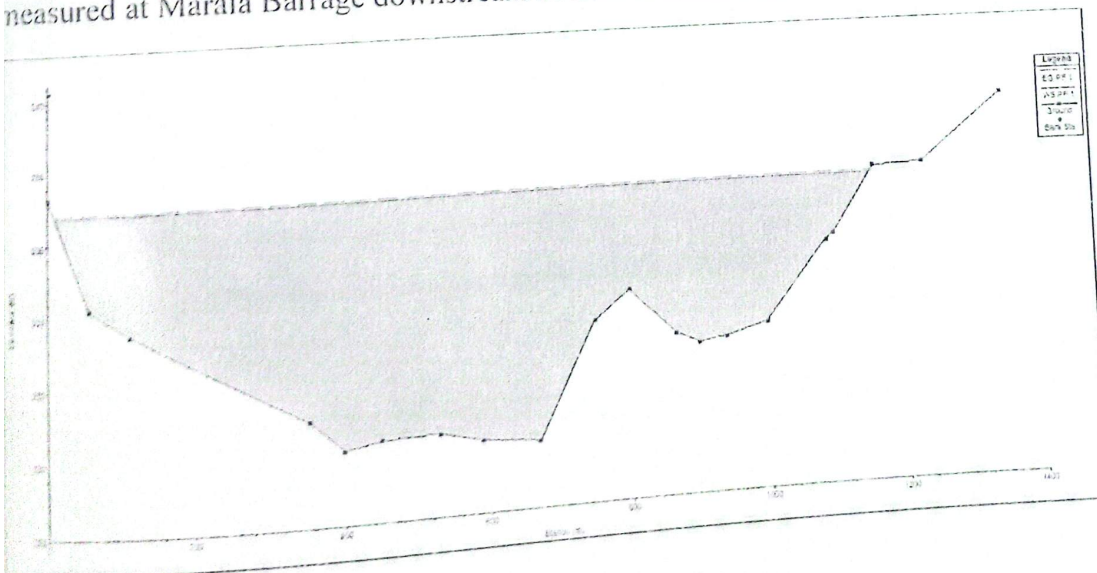


Figure 3-18 5000 m^3/s Flow discharge conveyance capacity of River (XS 1092)

3.27 Statistical and Scientific Applications for Riparian Buffer Width

i. Variable Width

Several models have been created to consider individual site factors in determining buffer width. These range from the complex to the relatively simple. The more complex models take into account multiple factors, such as slope, erodibility and infiltration rates. Examples of such models include Brown et al. (1987),

$$B_{ww} = \left(\frac{S_a}{K} \right)^n$$

Whereas

B_w = width of riparian buffer zone

S_a = average slope (%)

K = erodibility factor

The erodibility factor (K) requires long-term data and time consuming of using direct measurement method. There are as several methods was developed to estimate the value of K-factor from readily available data on soil properties (Manyiwa & Dikinya, 2013). The high value K-factor in eroded soils was primarily due to low organic matter content (0.75%) because organic matter has the capacity to bind soil particles together (Brady & Weil, 2008). Other than relatively low clay and organic matter in non-eroded areas, the high K-factor value is a result of granular soil structure since it is generally more stable than and crumb structure (Daum, 1996). The nomograph (which relates K to soil properties) was developed by (Wischmeier, Johnson, & Cross, 1971) with the following equation form:

$$K = \frac{2.1 \times 10^4 \times (2 - OM) \times M^{1.14} + 3.25 \times (St - 2) + 2.5 \times (Pt - 2)}{100}$$

Where as

K = erodibility factor

OM = Organic matter content (%).

$M = \text{Silt (\%)} * (100 - \text{Sand \%})$,

S_t = Soil structure code (very fine granular = 1, fine granular = 2, coarse granular = 3, blocky, platy or massive = 4),

P_t = Permeability class (rapid = 1, moderate to rapid = 2, moderate = 3, slow to moderate = 4, slow = 5, very slow = 6).

According to (Trimble, & Sartz, , 1957) buffer widths can be determined based on a simple formula, $W = 8 + 0.6S$, where W is the buffer width and S the slope in %

3.28 Riparian Buffer Zone Determination River Study Reach

There are many theoretical Riparian buffer width was recommended in literature based on its function, but statistical and satellite approaches was adopted for evaluation buffer width for both banks of river. Digital elevation model SRTM of 30 m resolution was used with spatial applications of ArcGIS 10.3. Because GIS-based methodologies make utilization of accessible scene data to survey the joined impact of various factors on riparian capacity. These are regularly used to organize destinations for reclamation to meet a give administration objective, for instance, disintegration control. They may likewise utilize scene data to build up a record of execution or quality, which is hence converted into a misfortune width identified with the size of the index. An empirical equation proposed by Brown et al. (1987) are modified with overland flow surfaces length and it can be expressed as

$$B_w = \left(\frac{S_a}{K} \right)^2 * FL_o$$

Whereas

B_w = width of riparian buffer zone

S_a = average slope (%)

K = erodibility factor

FL_o = flow length of over land flow

There is the slope should be depended on the paths of flow of selected overland flow block, and it measured from each raster cell after running the flow direction cell by cell using ArcGIS

application. The slope of each block area only considering over land flow was characterized and computed from raster based on spatial analysis tools of geographic information. The Zonal Statistical tool (Esri, 2013) was used and calculated the zonal sum of specific block from raster. The weighted slopes were obtained for all sub-catchment after dividing zonal sum obtained after multiplication with flow accumulation zonal sum. The final slope map for selected reach of catchment are presented in Figure 3-26.

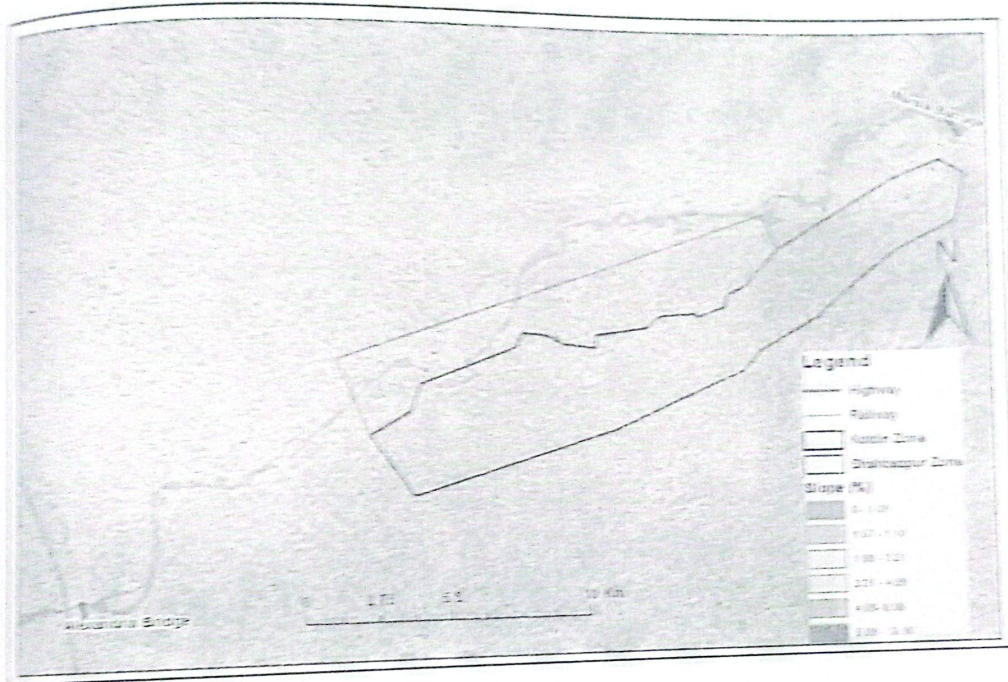


Figure 3-26 Slope map of project area

Soil samples were collected from eroded surface soils that is, from sampling points: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, and 15, respectively whereas the sample locations, slope, and soil particle distribution presented in Table 3-9. Sampling depth was 0-30 cm and 30-100 cm. Samples from the eroded sites were collected to the slope direction. Soil morphological properties including soil structure type, class and permeability class were also collected using The Harmonized World Soil Database based viewer software (FAO, 2012)

Table 3-9 Soil Particle size distribution with location coordinate and Slope

ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIA)

SR. #	Latitude	Longitude	sand %	Silt %	Clay %	Organic Matter OM %	Slope %
1	32.694310°	74.358101°	42	36	22	0.7	17
2	32.715862°	74.269403°	42	36	22	0.7	14.6
3	32.658689°	74.227108°	34	47	18	0.8	13.5
4	32.605684°	74.213997°	34	47	18	0.8	12.9
5	32.616078°	74.117873°	35	47	18	0.75	10.2
6	32.551671°	74.132052°	35	47	18	0.8	11
7	32.514883°	74.109910°	35	47	18	0.8	15.3
8	32.621069°	74.452809°	46	39	15	0.75	8
9	32.613429°	74.399649°	35	47	18	0.8	6.7
10	32.603429°	74.319649°	35	47	18	0.8	3.3
11	32.575476°	74.358917°	35	47	18	0.8	2.9
12	32.591813°	74.308079°	35	47	18	0.8	1.9
13	32.547809°	74.286914°	42	36	22	0.69	3.1
14	32.521737°	74.215303°	35	47	18	0.8	2.2
15	32.499363°	74.153716°	35	47	18	0.8	2.4

Longest overland flow path lengths were also computed with ArcGIS spatial tools (concept of over land flow **Figure 3-27** and study area overland flow map was shown **Figure 3-28**) based on given below methodology.

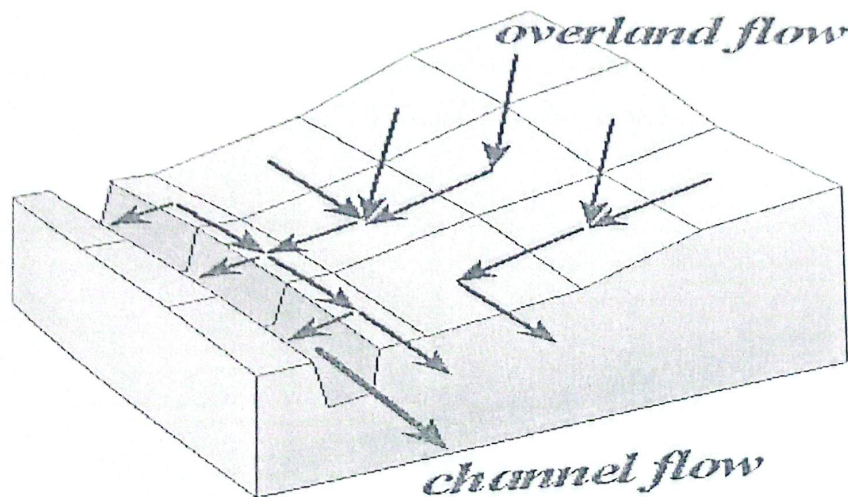


Figure 3-27 : Concept of overland flow

- I. Spatial analyst Tools
- II. flow direction cell by cell using Flow Length Tools
- III. Flow direction was used as input raster
- IV. Zonal Statistics as Table tool

ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIA)

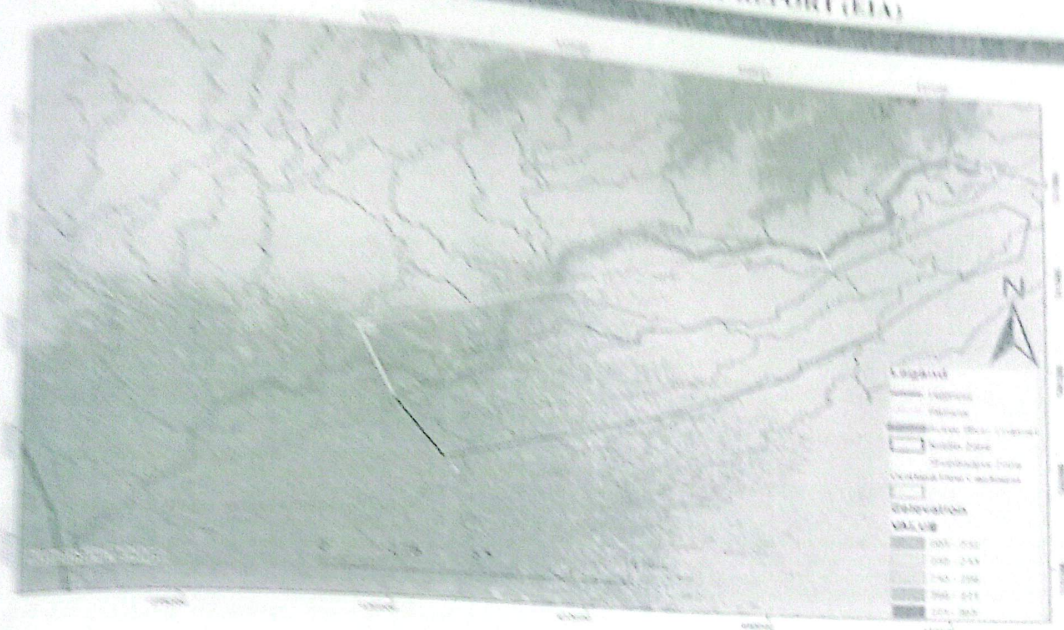


Figure 3-25 Overland flow catchment boundary and Elevation Map of Project Area

The buffer zone width was computed using equation 32 there are soil sample 1 to 7 was taken left bank side of Study river and soil sample 8 to 15 was collected left bank side of the river reach. Permeability Class according (FAO, 2012) is to moderately well, soil structure class 1 and soil structure "granular". The computed buffer with for river reach is shown in Table-3-10 below:

Table 3-10 Computed Buffer zone width for river reach

Reaches	Left bank	Right bank	Area (m ²)	Area (m ²)	Area (m ²)	Organic Matter (%)	Slope (%)	Overland Flow Length (m)	K-Factor	Buffer Width (m)
1	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
2	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
3	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
4	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
5	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
6	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
7	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
8	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
9	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
10	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
11	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
12	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
13	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
14	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
15	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
16	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
17	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
18	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
19	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
20	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
21	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
22	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
23	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
24	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
25	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
26	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
27	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
28	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
29	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
30	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
31	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
32	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
33	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
34	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
35	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
36	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
37	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
38	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
39	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
40	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
41	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
42	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
43	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
44	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
45	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
46	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
47	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
48	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
49	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
50	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
51	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
52	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
53	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
54	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
55	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
56	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
57	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
58	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
59	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
60	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
61	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
62	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
63	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
64	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
65	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
66	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
67	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
68	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
69	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
70	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
71	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
72	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
73	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
74	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
75	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
76	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
77	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
78	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
79	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
80	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
81	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
82	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
83	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
84	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
85	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
86	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
87	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
88	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
89	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
90	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
91	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
92	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
93	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
94	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
95	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
96	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
97	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
98	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
99	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10
100	10.1234567	10.1234567	10	10	10	1.5	1.5	10	0.1234567	10

3.29 RIVER MORPHOLOGY

3.29.1 Background

Three simple channel patterns are detected in alluvial plains. They are braided, meandering and straight. River morphology is defined via channel patterns and channel characteristics π , and is decided by such factors as discharge, water surface slope, water velocity, depth and width of the channel, and river mattress materials, and so on. These factors aren't independent but inter-associated with every different. A river channel consists of water, sediment and solute from the drainage vicinity to the ocean and is for that reason of interest to hydraulic engineers, geomorphologists and sedimentologists, that is critical to engineers because water is used for a diffusion of purposes with the aid of humanity; water courses are used as navigation channels, and additionally erosion, transportation and deposition of sediment motive some of troubles in the river and within the catchment that should be solved pragmatically. The direct impact of transportation of sediment and water from the geologist's and geomorphologies' point of view is that the structure and shape of the river and adjacent regions are constantly modified due to erosion and sedimentation (Grade, 2006). The geologists and geomorphologists are concerned approximately river channel changes taking place in 10^4 to 10^6 years or extra, engineers are concerned with modifications in a river during a particularly short duration, say 10–20 years to possibly 50–one hundred years. Those channel changes may be in the shape of length, form, composition of mattress material, slope and plan-shape (Grade, 2006).

3.30 Impact on River Morphology

One of the principal reasons of environmental impacts from in-stream mining is the elimination of extra sediment than replenishments.

3.31 Streambed erosion

There are four fundamental procedures that add to bed disintegration (DIRM, 2009):

- Diminish in sediment supply. This can happen when the characteristic section of sediment through the system is hindered by upstream dams, weirs, catchment disintegration control works, or excavations in the streambed
- increment in bed incline. This can be because of fixing the waterway, expelling a bed control, for example, a stone bar, weir or crossing, or excavations the bed of the stream for extractive ventures, amusement or substantial pump openings
- increment in speed (not related with an expansion in incline). This can be because of a channel

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increasing, for example, deforestation and erosion, deforestation and vegetation on the riverbed or siltation
increasing or increments in release. This can be because of expanded urban run-off, catchment
water system supplies.

3.2 Basic river typology (BRT)

The first simple level of morphological classification of river reaches, derived from (Rinaldi, Surian, Corniti, & Bussanini, 2013), is based on river channel plan form character (number of threads and plan form pattern) in the context of valley setting (confinement). This basic river typology (BRT) defines seven river types (plus a type 0 for highly altered reaches) using readily available information, mainly remotely sensed imagery (Figure 3-29). Different types are associated with two broad categories of valley confinement (1) confined reaches, and (2) unconfined and partly confined reaches. Confined reaches are divided into three morphological types based on the number of threads, i.e. single-thread; transitional (wandering); multi-thread. The broad types of unconfined and partly confined reaches are distinguished (2, single-thread; anastomosing; 3, single-thread; sinuous; 4, single-thread; meandering; 5, transitional; wandering; 6, multi-thread; braided; 7, multi-thread; anabranching) using a plan form assessment of sinuosity, braiding, and anabranching indices. The sinuosity index (S_i) is the ratio of reach length measured along the (main) channel and measured following the direction of the overall plan metric course (or 'meander belt axis' for single thread rivers (Rinaldi, Gurnell, Gonzalez de la Haza, Bussanini, & Hendriks, 2016)).

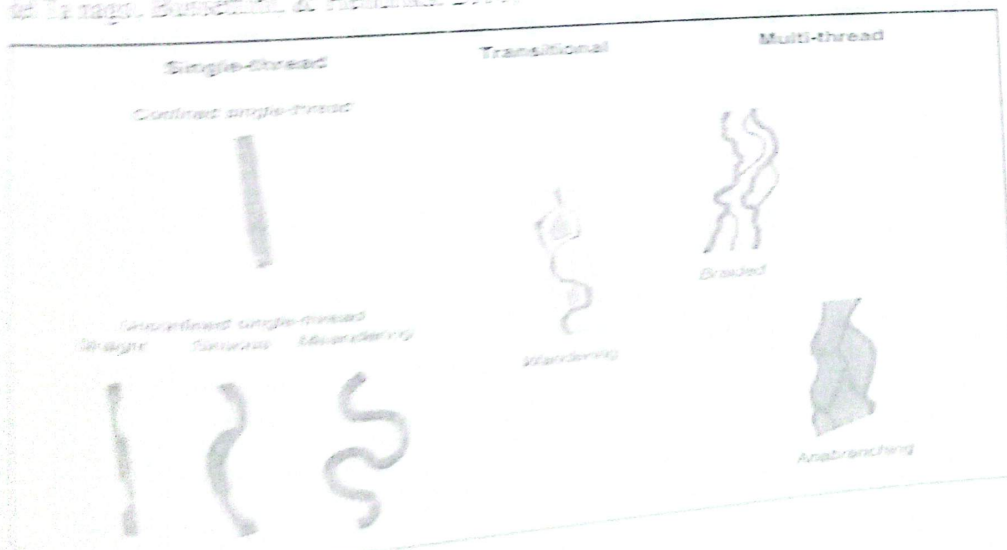


Figure 3-29 The seven river types of the basic river typology

3.33 Active channel

The active channel of the River is a dynamic system where flood events and sediment movement regularly cause changes in the channel morphology. Changes in the longitudinal profile are constantly occurring, due to aggradation and degradation along the channel and lateral bank erosion.

3.34 Historic change

The historical Changes in the river morphology over time can be attributed to several factors such as the presence of bedrock, sediment supply, frequency and magnitude of flood events, and human intervention.

3.35 Longitudinal profile

River selected reach generally increase or decrease in size (width/depth) as they flow in a downstream direction as they receive additional flow from overland due to heavy rainfall. This is the case for the River during normal and flood flow conditions, however during low flow conditions the River (upstream flow recorder) is subject to flow losses due to irrigation abstraction. Longitudinal profiles change over time in response to several factors including: river flow behavior, sediment size and location, flow resistance, velocity, width, depth, and slope (Leopold, , Wolman , & Miller, 1964). The longitudinal profile of the River will change over time in response to changes in the factors discussed above; it displays a typical concave shape with steeper areas in the 1500 m downstream

3.36 Hydrology and flood hazard

Changes in the morphology of the River are in part driven by the hydrological characteristics of the river including the magnitude and frequency of flood flows.

3.5 Bank erosion

Bank disintegration is a characteristic and fundamental process that happens in all stream networks. Without it, waterways would have no width, there would be no supply of new sediments. Bank erosion is considered to be the erosion of the margins of the active channel survey and not the erosion of the low flow channel or channel bank migration.

3.5.1 Sand Mining Management Plan

Physical checking prerequisites of sand extraction exercises ought to incorporate studied channel cross-sections, longitudinal profiles, bed material estimations, geomorphic maps, and release and sediment transport estimations. The physical information will outline bar renewal and any adjustments in channel morphology, bank disintegration, or particle size measure. Notwithstanding checking for replenishment at particular mining locales, observing of the whole reach to the estuary will give data on the aggregate reaction of the framework to sand extraction. For instance, it is imperative for downstream bars and the estuary to get adequate and to keep up estuarine structure and capacity. Since the height of the bed of the channel is variable from year to year, an achieve based way to deal with observing will give a bigger setting to site-particular changes. If long-term monitoring data show that there is a reach-scale trend of bed lowering (on bars or in the thalweg), the extraction should be limited.

3.5.2 River Cross-sections

Overlaid channel cross-section ought to be situated at for all three observed destinations upstream, downstream and inside the extraction region. Cross-section proposed to demonstrate achieve scale changes ought to be suitably situated over geomorphic highlights, for example, at the head of riffles, over the most profound piece of pools, or crosswise over specific kinds of channel bars. Cross-section area dividing ought to be sufficiently close to characterizing the morphology of the stream channel. Cross-section information ought to be overlaid after the first season to assess changes that may have happened. Cross-section data should be collected over the reach to the estuary, and locally upstream, downstream, and within each mining site (RPA, 2003).

3.40 Mining Site Cross-sections

According to (EPA Sabah, 2011) given below information should be follow during sand extraction and River Morphology

- i. One set of cross-sections at each extraction site to illustrate local changes related to specific in-stream extraction activities.
- ii. At least 10 survey points to be measured for each cross-section at 20 to 30 m interval.
- iii. Cross-sections should illustrate the upstream, mid-, and downstream portion of the site being excavated, and at least one cross-section upstream and one cross section downstream of the bar.
- iv. Thus, at least five (5) cross-sections should be located at every extraction site to illustrate local changes. Cross-sections should be oriented perpendicular to the channel, extend from the top of bank to the opposite top of bank, and show the morphology of the channel (including the portion below the water surface).

3.41 Riparian vegetation and River Morphology

The riparian zone forms the link between the environments of water and land. The structure, species creation and degree of riparian vegetation all have an essential influence in the nature of the water condition. The riparian zone has numerous essential advantages counting:

3.41.1 Rivers bank Protection

The riparian vegetation can tie stream banks together, forestalling disintegration and ensuring critical farmland or house for instance. Without vegetation, waterway banks are a considerable measure weaker and there is a far more prominent shot that the bank will be too much disintegrated by the stream; it can likewise be vulnerable to disintegration by rain. Materials washed into the stream because of the bank disintegration can present unnecessary supplements and furthermore cover natural surroundings in stream that plants and creatures rely upon. Channel frame and habitat is controlled by numerous variables, one of which is bank quality. Riparian vegetation is a key factor in deciding bank quality and along these lines has a noteworthy part in deciding channel frame and living spaces; for instance weaker banks can prompt more extensive shallower channels with more extreme bed inclines, which can influence the nature of in-stream living spaces (SEPA, 2009). During sand mining operation, operator should be harvest small trees and grass along the river bank.

3.4.1.2 Habitat and habitat connectivity

Numerous types of plants and creatures use riparian vegetation; for instance, otters utilize tree roots as spots for rest and safety, and bats utilize trees as perches. Species in the water condition can be exceptionally reliant on riparian vegetation; for instance, creepy crawlies tumbling off plant foliage can frame a huge part of the nourishment for salmon and trout. For sure, leaves and other plant materials falling into conduits from riparian vegetation can shape the reason for the whole natural way of life in the water condition. Woody garbage, regularly sourced from the riparian zone, assumes a critical part in putting away/reusing natural material in waterways, which thusly nourishes spineless creatures. It likewise gives asylum to angle. The shade and cover which riparian vegetation makes can likewise be essential for amphibian living beings. What's more, the segments of riparian territory along conduits are frequently the main semi-common natural surroundings show in a zone (SEPA, 2009).

3.4.2 Recommendation

- I. Before sand removing must be checked it that there increase in sediment due to a rare flood event.
- II. Only sand Remove from dry or un-vegetated deposit such as sand bars and island in very low season. The total length of sand extraction should not exceed 20-30m toward the river banks.
- III. Minimize the area affected
- IV. Use advance technology for sand removing in the river bed and minimized the environment impacts on river banks.
- V. Follow the river flow discharge chart throughout the year of sand removing during high rain and very low-flow season.
- VI. At sand mining sites/cross-section brush, grass or small trees simply put in place in front of the eroding bank.
- VII. Avoid sand manning below redline
- VIII. Sand mining in river bed will be one meter depth layer by layer
- IX. Maintained the river flow carrying capacity in active channel without any serious activities.

4 CHAPTER 4: DESCRIPTION OF THE ENVIRONMENT

4.1 General

Sheikhupura district is a district of Punjab province, Pakistan. Sheikhupura is bounded by 6 other districts of Pakistani Punjab Namely: Lahore, Nankana Sahib, Narowal, Hafizabad, Faisalabad and Gujrawanwala.

Agriculture is unquestionably important in the economy of Sheikhupura. While the main crops of Sheikhupura are wheat and rice. While main fruits are Guavas and citrus and vegetables are potatoes, carrots, cauliflower, tomato, onion, turnip, peas and okra.

The Pertaining physical and environmental conditions of the project area are described in this section. Data/Information for this section was collected from a variety of sources, included published literature (Secondary data), and surveys conducted for other studies in the area, and those that were conducted specifically for this study (*Primary data*).

Most of the information on geology and climate was collected from published literature and previously conducted studies. Samples were taken for ambient air quality, water and wastewater quality. The information given in the sections on vegetation and wildlife was taken from the concerned departments. Information on water resources came from both secondary sources as well as data that were collected specifically for the study.

Checklist methodology was used to establish the environmental profile of the proposed site.

The Project area lies in the District of Sheikhupura.

4.2 Description of Environment

Based on the environmental checklist, socioeconomic questionnaires for consultations, field surveys were carried out to collect data on the physical, ecological and socioeconomic environmental aspect of the project site.

i) Physical Environment

The physical aspects of the project site covered the following:

- Soils - type of soils, erosion, stability
- Land use pattern of the area including agriculture crops, barren lands, industrial and residential use

- Affected buildings - residential, industrial, commercial, and structures of buildings (if any)
- Drainage pattern
- Available energy source(s)
- Other private/ public infrastructure/ utilities like pipelines, electric poles
- Water resources available both surface and groundwater
- Air quality and noise level in the project area

Ecological Environment

In consideration of ecological environment, the following main aspects were studied:

- Existing vegetation along the project area
- Trees likely to be affected due to the project implementation (if any)
- Migratory species especially migratory birds
- Endangered species both flora and fauna
- Wildlife in the project area
- Forests and game reserves existing along the project area
- Beneficial plants and animals in the project area
- Aquatic life including fish resources
- Wetlands within the vicinity of the project area

Socioeconomic Environment

Social assessment has attempted to determine the social implications in terms of assumed positive and negative impacts as a result of the implementation of the proposed project. The socioeconomic baseline data covered the following major aspects:

- Demographic profile
- Population
- Number of households
- Literacy status

- Nature of business/ occupations
- Livelihood/ income
- Living standard of the population
- Social infrastructure available
- Community perceptions about the Project

4.3 Physical Environment

4.3.1 Geomorphology and Geology

Muzaffargarh spreads over an area of 3,249 km² and forms a strip between the Chenab River on its east and Indus River on its west, which pass along the Eastern and Western boundaries respectively of the district and a triangle of Rajpur tehsil of the district. The district is bounded on the north by district Layyah, on the south by Bahawalpur and Bahawalpur Khan districts across the river Chenab. District Multan and Khanewal are on the eastern side of district Muzaffargarh, across the river Chenab. District Sanghar touches it on the northeast. District Tarn Taran and Jalandhar district are on the western side across the river Indus. It is one of oldest districts of Punjab. According to the 1991 census of Pakistan, the population of the district was 2,635,903, of which 12.75% were urban. Muzaffargarh is one of oldest districts of Punjab.

Based on geography, topography and geology, the project area is briefly described below:

4.1.1 Geography

Muzaffargarh is located between 29° 58' 39.612" N, 71° 12' 25.164" E. The city of Muzaffargarh is located in southern Punjab almost the exact centre of

The closest major city is Multan. The area around the city is a flat, alluvial plain and is ideal for agriculture, with wheat and mango farms. There are many canals that cut across the Muzaffargarh District, providing water from nearby rivers. This makes the land very fertile. However usually land close to the Chenab are usually flooded in the monsoon season.

4.1.2 Seismic Zone

According to seismic zoning of Pakistan the project area lies in seismic zone 2A and represents minor damage. Seismic zoning of Pakistan is given in Figure 4-2.

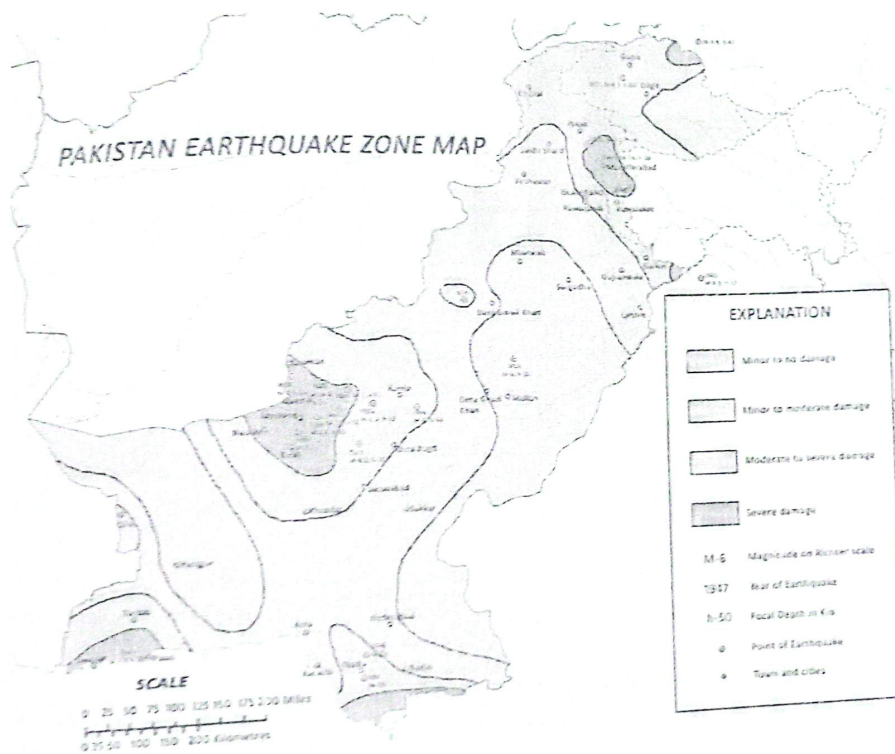


Figure 4-1: Seismic Zoning Map of Pakistan

4.1.3 Clim

ate

Muzaffargarh lies on 118 m above sea level. Muzaffargarh is considered to have a desert climate. During the year, there is no rainfall in Muzaffargarh. The climate here is classified as BWh by the Köppen-Geiger system. The average annual temperature is 25.6 °C (78.1 °F) in Muzaffargarh. The annual rainfall is 157 mm (6.2 inch).

provide raw material in abundance for the manufacture of Munj, Ban, ropes and mats, etc., which are the well-known cottage industries in the district.

4.2.1 Fauna

Wild boars called Nahm, are found in the Sind Riverain. Wild pig is extremely common, especially on the banks of the river. Wild boars are called Mirhon, and wild sows Blwindin. They cause damage to the crops in the riverain tracts. The only deer in the district are Parha, or hog-deer, and the ravine deer, called Haran or Chinkara. Jackals and foxes are common. Hares are numerous but, owing to the annual inundation of the rivers, they are only to be found in the drier and higher regions. They are less common. Others are found in the south of the district. Hedgehogs called jah are common. Mongooses are found everywhere. Pig and hog-deer are occasionally taken by nets and munj rope supported on movable side-strings fastened to bushes. The net is called wanvar. There are hardly ever any deaths from wild beasts. There is a variety of birds found in the district.

4.2.2 Endangered Species

There are no floral or faunal species inhabiting in the project area that are included in RED Data Book of IUCN.

4.2.3 Socioeconomic Environment

Socioeconomic and other relevant information revealed from Multiple Indicator Cluster Survey (MICS) 2007-08. One of the objectives of Multiple Indicator Cluster Survey (MICS) was to establish credible baseline for socio-economic status at District and Tehsil Level.

4.2.3.1 Summary of Socio-Economic Indicators

Socio-economic Indicators	District Muzaffargarh
Number of Households	3114
Number of Under-5 Children	2865
Solid Fuel Used	92.2%
Improved Source of Drinking Water	99.3%
Water Treatment Used in the Household	0.5%
Percentage of Population Using Sanitary Means of Excreta Disposal.	41.9%

ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIA)

Proper Disposal of Solid Waste	
Literacy Rate	2.3%
Percentage of Children for Primary School Entry	45%
Total Child Labor	13.2%
Had cough for more than Last Three Weeks	5.1%
Diagnosed with Tuberculosis during Last One Year	1.5%
Diagnosed with Hepatitis during Last One Year	0.7%
Employed	1.2%
Unemployed and Seeking Job	95.5%
Household Utilities	4.5%
Electricity	
Gas	0.1%
Radio	6.3%
TV	29.2%
Cable TV	36.5%
Telephone	6.9%
Mobile	5.0%
	50.7%
Socio-economic Development	
Livestock	73%
Population	4,322,009 persons
Average Annual Growth Rate (1998-2017)	2.63
Mean Household Size	6.6
Govt. Hospitals	12.4%

4.3 Quality of Life Values

4.3.1 Religious, Ethnic Groups and Languages

The mother tongue of the district is Punjabi. The other important language spoken in the district is Urdu. The people speaking these languages in indicated below:

Language	Percentage
Punjabi	99.99
Urdu	4.92

the leading tribes, especially those who are important as landowners, by position and influence are Sayeds, Qureshis, Rajputs, Pathans, Arains and Gujjars. The number of Arains and Gujjars in this District was quite negligible before Independence, but displaced persons belonging to these tribes have now augmented their strength. From amongst the leading classes, Shaikhs, Kotanas, Jhabels, and Mors are found in appreciable numbers. The Jats own the largest area of land and are spread over the entire district. Prior to Independence Rajputs were concentrated in Alipur and Bahawalpur Tehsils, but now they are also spread over the whole district. The Bilochs are strongest in Alipur Tehsil and Bahawalpur Tehsils. The Pathans have a strong settlement round about Muzaffargarh. Qureshis have a few villages in each tehsil. Sayeds and Qureshis are considered superior castes to others. Sayeds do not, as a rule, give their daughters in marriage to other tribes and still speak Sindhi. Bilochs, Pathans and Jats have a natural aversion to intermarriage. Jhabels originally came from the south of the district.

4.3.2 Social Infrastructure and Facilities

The social and physical infrastructure is up to the mark in the project area. A brief account of the education, health, and markets of the area is as follows:

4.3.2.1 Educational Levels

The educational levels of the literate sections of the population are further analyzed below.

	Total	Male	Female
Post Graduate	210	200	10
Graduate	283	261	22
Under Graduate	682	609	73
Matric	4,812	4,586	226
Middle	12,659	11,650	1,009
Primary	27,245	24,691	2,554
Below Primary	26,509	23,356	3,153

CHAPTER 5: STATUTORY REQUIREMENT & STANDARDS

5.1 General

This Section provides an overview of Policy Framework, Legislation, Acts, Laws and Guidelines relevant for preparation of EIA report of the proposed project. In this context, the Pakistan Environmental Protection Act, Laws, Regulations, Ordinances are discussed in the ensuing Section of the report.

5.2 National Policy and Administration Framework

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

The Government of Pakistan promulgated "Pakistan Environmental Protection Act (PEPA) in 1997. Two organizations, the Pakistan Environmental Protection Council (PEPC) and the Pakistan Environmental Protection Agency (Pak-EPA), are primarily responsible for administering the provisions of the Act at the federal level. The PEPC oversees the functioning of the Pak-EPA. Its members include representative of the government industry, non-governmental organization, and the private sector. The Pak-EPA is required to ensure compliance of the National Environmental Quality Standards (NEQS) and establish monitoring and evaluation systems. As the primary implementing agency in the hierarchy, it is responsible for identifying the need for, as well as initiating legislation whenever necessary. The Pak-EPA is also authorized to delegate powers to its provincial counterparts, the provincial EPAs or EPD (Environmental Protection Department in Punjab). One of the functions delegated by the Punjab-EPA to provincial EPAs/EPD is the review and approval of environmental assessment reports of projects undertaken in their respective jurisdictions.

5.3 Punjab Environmental Protection (Amendment) Act, 2013

The Punjab Environmental Protection (Amendment) Act, 2013, empowers the Punjab-EPA to

- Identify categories of the projects to which the environmental examination/ impact assessment provisions will apply.
- Develop guidelines for conducting IEE/ EIA and procedures for the review and approval of the same.
- Develop environmental emission standards for parameters such as air, water and noise pollutants.
- Enforce the provisions of the Act through environmental protection orders and environmental tribunals headed by magistrates with wide-ranging powers, including the right to fine violators of the Act.

Under the provisions of the 2013 Act, the Punjab-EPA is empowered to manage the environmental concerns of their respective projects. The provincial EPAs/ EPD can frame environmental regulations tailored to the requirements of their province, provided these regulations meet or exceed the minimum standards set by the Pakistan EPA. They are also required to review and approve IEEs/ EIAs of all the developments projects.

5.4 National Environmental Quality Standards, 2000

The NEQS 2000 specify the following standards:

- Maximum allowable concentration of pollutants (32 parameters) in municipal and liquid industrial effluents discharged to in land waters, sewage treatment facilities, and the sea (three separate sets of numbers).
- Allowable concentration of pollutants (16 parameters) in gaseous emissions from industrial sources.
- Allowable noise levels.

5.5 Interaction with Other Agencies

It is the responsibility of project proponent to ensure that project complies with the laws and regulations controlling the environmental impacts at both construction and operation stage of the project and that all pre-construction requisites, such as permits and clearances are met.

Punjab Environmental Protection Department

5.5.1 The Proponent will be responsible for providing the complete documentation required by the Punjab Environmental Protection Department and remain committed to the approved project design. No deviation is permitted during the project implementation without the prior and explicit permission of the Punjab EPA/ EPD.

5.5.2 Provincial Departments of Forest and Wildlife

In case the implementation of the proposed project involves the clearing of vegetation and trees in project area, the project contractor will be responsible for acquiring "No Objection Certificate" (NOC) from concerned provincial Department. The application for NOC will need to be endorsed by the Proponent. Where the construction is to be carried out in close proximity of protected forests and wildlife areas, the Proponent is required to coordinate with the departments to ensure that impact on vegetation and wildlife are minimized.

5.5.3 Provincial Revenue Departments

Under the National laws, the matters relating to land use and ownership are provincial subjects, and the Revenue department of the concerned province is empowered to carry out the acquisition of private land and built-up property for public purposes, including on behalf of another provincial or federal agencies. For those purpose, the lead department must lodge an application with the concerned provincial government to depute a Land Acquisition Collector (LAC) and revenue staff, which will be responsible for handling matters relating to land in case of any issue arises, although the project proponent presently owned the project site.

Furthermore, it also requires a liaison with the provincial departments of agriculture, horticulture and forestry in case of issues associated with these departments. The concerns could be relating to the affected vegetation resources, such as trees and crops. In case of some public buildings/ infrastructure is involved, proponent will approach the building department for relocation/ assessment of compensation.

5.5.4 Coordination with Provincial Governments

The Project Proponent (PP) will coordinate with all concerned government department and ensure that the project meets the criteria of district government/ authorities as related to the establishment of construction camps and plants and the safe disposal of waste, solid waste and

PP will also ensure to periodic monitoring of the EMP during both construction and operation period through deployment an Environment Specialist.

3.6 Other Relevant Acts

3.6.1 Forest Act, 1927

The Forest Act, 1927 establishes the right of the government to designate areas for reserve forest, village forest and protected forest, and may acquire such areas for prohibiting or restricting the public use of the resources or other activities.

3.6.2 Punjab Wildlife Protection Act, 1974

The Punjab Wildlife Protection Act, 1974 was passed by the provincial assembly of Punjab in 1974. This Act is applicable to the whole of the Punjab province for protection, conservation, preservation and management of Wildlife. This Act also designated areas of sanctuaries and protection of rare and endangered species.

3.6.3 Canal and Drainage Act, 1873

The Canal and Drainage Act, 1873 under Section 32 (e and f), elucidate that: unless with the permission of the Superintending Canal Officer, no person is entitled to use the water of any canal, or any work, building or land appearing to any canal, shall sell or sublet or otherwise transfer his right to such use and no right to the use of the water of a canal shall be, or be deemed to have been, acquired under the Indian Limitation Act, (XV of 1877), Part IV, nor shall (the Provincial Government) be bound to supply any person with water except in accordance with the terms of a contract in writing.

3.6.4 Local Government Act 2001 and Amended in 2003

These ordinances, issued following the devolution process, establish regulations for land use, the conservation of natural vegetation, air, water, and land pollution, the disposal of solid waste and wastewater effluents, as well as matters related to public health and safety.

3.6.5 Land Acquisition Act, 1894

The land acquisition Act 1894 is a law for the acquisition of land and implemented to fulfill the needs of government and companies for land required by them for their projects, and secondly, to determine and pay compensation to those private persons or bodies whose land is to be acquired. The experience of the power of acquisition has been limited to a cash

compensation policy purposes. The LAA is limited to a cash compensation policy for the acquisition of land and built-up property, and damage to other assets such as, crops, trees and infrastructure. The LAA does not take into account the rehabilitation and settlement of displaced population and restoration of their livelihoods. Presently, the requisite land for the proposed project is already owned by the project proponent, so that no additional private or government land will need to be acquired for the project.

5.6.6 Protection of Trees and Brushwood Act, 1979

This Act prohibits cutting or lopping of trees and brushwood without permission of the concerned Forest Department as a no objection certificate needs to be acquired from Forest Department for cutting of trees.

5.6.7 Alternative Energy Development Board Act, 2010

The Alternative Energy Development Board (AEDB) Act, 2010 refers to the objective of the Alternative Energy Development Board is to assist and facilitate development and generation of Alternative/Renewable Energy in order to achieve sustainable economic growth with transfer of technology for development of an indigenous technological base through a diversified energy generation, the elected government intends to substitute the Alternative Energy Development Board Ordinance, 2007 (LVI of 2007) by a democratic and people friendly Act of the Parliament, "Alternative Energy Development Board Act, 2009" to ensure generation of Alternative/ Renewable Energy keeping in view its potential in the country.

5.6.8 Industrial Relation Ordinance, 2002

The ordinance has been promulgated to amend, consolidate and rationalize the law relating to formation of trade unions, regulation and improvement of relations between employers and workmen and avoidance and settlement of any differences or disputes arising between them. Pakistan's labour laws trace their origination to legislation inherited from India at the time of partition of the Indo-Pak subcontinent. The laws have evolved through a continuous process of effort to meet the socio-economic conditions, state of industrial development, population and labour force explosion, growth of trade unions, level of literacy, Government's commitment to development and social welfare. To meet the above named objectives, the government of the Islamic Republic of Pakistan has introduced a number of labour policies, since its independence to mirror the shifts in governance from martial law to democratic governance.

while Article 18 of the Constitution affords every citizen with the right to enter upon any lawful profession or occupation, and to conduct any lawful trade or business, the Industrial and Commercial Employment (Standing Orders) Ordinance was enacted in 1968 to address the relationship between employer and employee and the contract of employment. The Ordinance applies to all industrial and commercial establishments throughout the country employing 20 or more workers and provides for security of employment. In the case of workers in other establishments, domestic servants, farm workers or casual labour engaged by contractors, their labour contracts are generally unwritten and can be enforced through the courts on the basis of oral evidence or past practice.

The Constitution of Pakistan contains a range of provisions with regards to labour rights found in Part II: Fundamental Rights and Principles of Policy.

5.7 International Environmental & OSH Laws and Regulations

5.7.1 International and National NGOs

International and national Non-Government Organizations (NGOs), such as the International Union for Conservation of Nature and Natural Resources (IUCN) and the World Wide Fund for Nature (WWF), have been active in Pakistan for some time. Both of these NGOs have worked closely with the governments at the federal as well as provincial levels and have positively contributed to the cause of environment. They have played significant role with regard to the formulation of environmental and conservation policies. And last but not the least, another the most prominent NGO namely "Sustainable Development Policy Institute (SDPI)" has also played very significant role in upholding the cause of environmental protection in Pakistan.

Environmental NGOs have been particularly active in the advocacy for promoting sustainable development approaches. Most of the government's environmental and conservation policies, even at the provincial and federal levels, has been formulated in consultation with these leading NGOs, who have also been involved in drafting new legislation on conservation.

5.7.2 International Framework

For the assessment of the environmental impacts of the proposed project on air, water and noise according to the international legal framework, this report has also incorporated the requirements of the IFC EHS Guidelines for Thermal Power Plants (Dec. 19, 2008) and the

"Pollution Prevention and Abatement Handbook" by the World Bank Group, effective July 1985

Within this handbook, different guidelines are mentioned for the purpose of assessing industrial activities with respect to their environmental compliance. In the present case, the guidelines for the thermal power plants are applicable for the preparation of the environmental impact assessment.

3.8 Relevant International Agreements in Pakistan's Context

Pakistan is a party to the following treaties and agreements in furtherance of its environmental goals and programmes:

Treaty	Pakistan Status
Convention on the Protection of Ozone Layer on Dec 18, 1992.	Ratified
The Amendment to Montreal Protocol on Substance that Depleting Ozone layer	Signed
UN Framework Convention on Climate Change on June 13, 1992	Signed
Convention on the Continental Shelf on October 31, 1958	Signed
The Convention on High Seas on October 31, 1958	Signed
Convention on the Fishing and Conservation of the living Resources of the High Seas on October 1958.	Signed
The UN Convention on Law of the Sea on December 10, 1982	Signed
The Convention on Territorial Sea and the Contiguous Zone and the Agreement for the establishment of Network of Aquaculture Centers in Asia and the Pacific	Signed
The Convention on Wetlands of the International Importance on July 23, 1976	Ratified
The Convention on protection of the World Cultural and Natural Heritage on July 23, 1976	Ratified
The Convention on International Trade in Endangers Spice of Wild Fauna and Flora	Signed
The Convention on Conservation of Migratory Specie of Wild Animal on Dec 01, 1987	Signed

The Convention on Biological Diversity in 1994 and became party to the CBD. Convention duly recognizes the intrinsic value of biological diversity, genetic, social, economic, cultural, educational, recreational and esthetic values of biodiversity and its components

The International Plant Protection Convention. Signed

The Plant Protection Agreement for Area & Pacific region Signed

The Agreement for the establishment of a convention for Signed

controlling the desert locust in eastern region of its Distribution Area in South East Asia

The Treaty Banning Nuclear Weapon Test in the Atmosphere, in Outer Space and under Water on March 3, 1988 Signed

The International Convention on Oil Pollution Preparedness Response and Cooperation Signed

The Convention on prohibition of Military or any other Hostile Use of Environmental Modification Techniques and Accession of Feb 27, 1986

Pakistan became a party to Montreal Protocol by Ratifying the protocol and its London amendment on Dec 18, 1982, the subsequent amendments known as Copenhagen Amendment which accelerate the phase out for rectified in Jan 1995. Signed

Convention of International trade Endangerous Species (CITS) Signed

World heritage Convention Ramsar Convention Signed

United Nation Convention to Combat Ozone Depletion (CCD). Signed

The convention signed and ratified in 1996
Stockholm Convention for Phasing out Parenting Organic pollutants (POPs) in 2001. Signed

5.9 Requirements of Potential Investors, Lenders and Insurers

The client intends to get finances for the project under reference from International Finance Corporation - IFC/WB (World Bank), therefore, requirements of potential investors, lenders and insurers are to be followed as described hereunder:

INTERNATIONAL FINANCE CORPORATION'S (IFC) POLICY ON ENVIRONMENTAL AND SOCIAL SUSTAINABILITY, EFFECTIVE JANUARY 1, 2013

International Finance Corporation (IFC) is the private sector arm of the World Bank Group. Summarily, it aims at fighting poverty with passion and professionalism for lasting results and to help people help themselves and their environment by providing resources, sharing knowledge, building capacity, and forging partnerships in the public and private sectors.

International Finance Corporation's (IFC) Policy on Environmental and Social Sustainability, Effective January 1, 2013 supersedes the IFC Disclosure of Information Policy (April 2006) in its entirety. This Policy is not an express or implied waiver of IFC's privileges and immunities under its Articles of Agreement, international conventions, or any applicable law, nor does it provide any contractual or other rights to any party.

At IFC while transparency and accountability are fundamental to fulfilling its development mandate, IFC encourages its clients to be more transparent about their businesses and believes that when clients are committed to transparency and accountability they help promote the long-term profitability of their investments.

IFC strives for positive development outcomes in the activities (including (i) investments financed directly by IFC; (ii) investments implemented through financial intermediaries (FIs) or managed by IFC's Asset Management Company or any other IFC subsidiary, as well as investments funded in part or in whole by donors; and (iii) advisory services) it supports in developing countries.

IFC believes that an important component of achieving positive development outcomes is the environmental and social sustainability of these activities, which IFC pursues and expects to achieve through the application of this Policy on Environmental and Social Sustainability (the Sustainability Policy or the Policy), and a comprehensive set of environmental and social Performance Standards. Through this Policy, IFC puts into practice its commitments to environmental and social sustainability. Activities supported and financed by IFC include a wide range of investment and advisory products including technical, financial and/or regulatory advice, project structuring as well as training to companies, industries, and governments.

and legal status limits their capacity to defend their rights to, and interests in, lands and natural and cultural resources, and may restrict their ability to participate in and benefit from development. Indigenous Peoples are particularly vulnerable if their lands and resources are transformed, encroached upon, or significantly degraded. Their languages, cultures, religions, spiritual beliefs, and institutions may also come under threat. As a consequence, Indigenous Peoples may be more vulnerable to the adverse impacts associated with project development than non-indigenous communities. This vulnerability may include loss of identity, culture, and natural resource-based livelihoods, as well as exposure to impoverishment and diseases.

Private sector projects can create opportunities for Indigenous Peoples to participate in, and benefit from project-related activities that may help them fulfill their aspiration for economic and social development. Furthermore, Indigenous Peoples may play a role in sustainable development by promoting and managing activities and enterprises as partners in development. Government often plays a central role in the management of Indigenous Peoples' issues, and clients should collaborate with the responsible authorities in managing the risks and impacts of their activities.

Performance Standard 8

Cultural Heritage Introduction

Performance Standard 8 recognizes the importance of cultural heritage for current and future generations. Consistent with the Convention Concerning the Protection of the World Cultural and Natural Heritage, this Performance Standard aims to ensure that clients protect cultural heritage in the course of their project activities. In addition, the requirements of this Performance Standard on a project's use of cultural heritage are based in part on standards set by the Convention on Biological Diversity.

B. THE WORLD BANK ENVIRONMENTAL ASSESSMENT PROCESS

The principal international guidance utilized in assessing the significance of impacts from the proposed development, and for determining content and form of reporting from the World Bank was also utilized.

World Bank Operational Policies OP4.01 Environmental Assessment (January 1999):

ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIA)

This sets out the World Bank's policy on projects requiring an EIA and defines what the assessment is designed to achieve and what issues must be considered. It also sets out guidance for screening projects and identifies other World Bank guidance and policies that may be relevant.

World Bank – Pollution Prevention and Abatement Handbook (1998):

This handbook sets out the basic principles that are considered appropriate to evaluating and controlling pollution from any defined project. The handbook provides guidance on pollution management and sets out generic environmental standards for air, water and soil pollution. This handbook also provides sector guidance. Of most significance to this project is the guidance for Thermal Power: Guidelines for new plant (July 1998).

The environmental assessment undertaken in this report also utilizes, as a precautionary measure only, The World Bank guidelines presented in the "Pollution Prevention and Abatement Handbook" effective July 1998.

CHAPTER 6: POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

6.1 Location of the project

and extraction with Dredger Machine from River Chenab District Muzaffargarh

6.2 Methodologies for Impact Identification

Simple methodologies and tools are applied to identify the impact. These simple methods are of proven value for undertaking a systematic approach to identify impacts. The most common formal methods used for impact identification are:

- Checklists
- Matrices
- Networks
- Overlays and geographic information systems (GIS)

As per project need, ease, time frame, simplicity, credibility the methodology involved in assessing and defining environmental impacts for the project was checklists. Checklists are standard lists of the types of impacts associated with a particular type of project. Checklists methods are primarily for organizing information or ensuring that no potential impact is overlooked. Specific areas of impact are listed and instructions are supplied for impact identification and evaluation. Checklists include list of impacts that are either ranked in order of magnitude or severity or in which numerous environmental parameters are weighted (using open judgment). A basic example is the "to do list."

HEC-RAS model was used for computation of cross-section hydraulic parameters and river discharge capacity. Sediment transport computation and deposition study of project area performed at river cross-section# 1085 by using Acker-White and Engelund-Hansen equations.

6.3 Identification and Analysis of Potential Impacts

This section generally describes the potential environment impacts associated with the construction and operation of the project and accordingly their mitigation measures to minimize the impacts. The initial evaluation of the project was carried out considering location, scope, importance, sensitivity and expected environmental impacts.

potential environmental impacts are identified by comparing the existing environmental conditions with the predicted environmental conditions during the project construction and operation phases. Summary of impact identification are shown with the help of matrix methodology. The potential impacts will be identified depending on their significance (i.e., major, minor, negligible), duration (i.e., short term and long term), type (i.e., direct and indirect) and speciation (i.e., local or widespread). In this study, each element of the proposed development, which specifically relates to its construction and operations is studied/ examined to determine the environmental effects.

Different possible impacts due to the construction and operation of proposed project will be identified. The possible physical impacts could be related to air pollution, noise pollution, stability hindrance surface and ground water. The impacts on flora and fauna will also be identified. Detailed study will be carried out to identify any possible impacts on endangered species, migratory birds etc. Socio-economic impacts related to any local plan or policy relevant to the project will be identified and analyzed. Impacts on agriculture, recreation, livestock, and conservation areas (if any) will also be considered due to the development.

Impacts during the operation phases will be considered in this step. Different impact identification techniques are available in literature e.g., checklists, matrices, networks, and overlays. Any one or combination of these techniques will be adopted based for impact identification. EIA methods like water balance, surface and ground water assessment methods, and air quality models could be used for the analysis of most critical and adverse impacts depending on the availability of technical resources and data requirements.

6.4 Environmental impacts and their mitigation measures

This section outlines potential impacts during the from a process that included a review of available documentation, verified during the site visit, i.e. how, where and when the proposed development can interact and affect the environment significantly, and details what mitigation measures may be taken to counteract these impacts.

Impacts with possible mitigation measures have been presented in table below.

6.5 Mitigation measures during design Phase

Deposition will be identified first. The Lease holder/ Environmental NOC holder may be allowed to extract the sand deposit in these locations.

ment gets the area for sand extraction on lease. The lease documents are attached in the annex.

Mitigation measures during construction Phase

Construction is involved. Dredge flow is specifically designed and manufactured for easy installation. The installation of dredge requires three easy steps which can be carried out in working hours.

- Positioning of the hull and clamping through vertical pins
- Positioning of the power unit
- Pump fixing

ment will hire trained staff for the assembly of the dredge flow.

Operational Phase

section outlines potential impacts during the operation phase gathered from a process included a review of available documentation, verified during the site visit, i.e. how, when and where the proposed development can interact and affect the environment significantly, and details what mitigation measures may be taken to counteract these impacts.

Impacts with possible mitigation measures have been presented in table below

Table 6-1 Environmental Impacts and their mitigation Measures during operation

Aspects	Mitigation Measure
Ground and surface water Pollution	Ensure that the machinery is properly maintained. Equipment must be regularly serviced and inspected to make sure there are no leaks of oil, diesel, fuel, detergents or hydraulic fluids. Servicing and maintenance of vehicles as far as possible must occur outside of the boundaries of permit area. If maintenance does occur on site due to breakdown, all steps must be undertaken to avoid hydrocarbon spills/leakages. Minimize petrol, diesel, and oil leaks by allocating a loading zone, which is protected against such leaks. Drip trays must be secured and emptied regularly. Secondary containment will be provided. Spilled hydrocarbon must be treated as a hazardous waste and needs to be disposed of as it occurs in appropriate hazardous waste containers and removed off site as soon as possible. No washing of equipment or machinery may occur on the permit site or in the watercourse Spill kit will be used in case of any spill
Maintain the hydrology of the landscape level	The extraction of sand must not exceed the replenishment rate of sand during the rainy season. Reduce the turbulence produced from sucking up material from the river bed

Minimize soil erosion	Restrict river access to only one corridor through the Riparian buffer. Ensure water course is not altered to the extent that the integrity of the river banks are compromised and eroded. Excavated filled slopes and stockpiles must be kept at a stable angle and capable of accommodating normal expected water flows Topsoil stripped from the operation footprint must not be spoiled but stockpiled and preserved for use in rehabilitation. Top-soil and sub-soil stockpiles and spoil sites to be placed on opposite sides of the access roads as this is where they will cause the least impact
Limit the disturbance and destruction of vegetation, fauna and habitat	All operation activity will be contained within the designated permit area. The Environment Officer and Project Manager must establish working and no-go areas, which need to be strictly adhered to. The "no go" areas where possible must be clearly demarcated. There shall be no un-authorized entry, litter, stockpiling, dumping or storage of equipment or materials within the demarcated "no go" areas. If this does occur the developer shall be reliable for rehabilitation. Keep surrounding vegetation, especially larger trees and shrubs, to create a screen that reduces flood impacts Protected trees must be marked, their location recorded and must be avoided as best as possible. If any protected species cannot be avoided a permit must be applied for. All effort must be made to minimize the disturbance of wild animals on and within the close vicinity of the permit site No trapping, snaring, hunting, fishing or killing of any animal may occur on the permit site. Disturbed areas will be rehabilitated and vegetation planted to resemble the area prior to operation, both in terms of vegetation cover and habitat

Vehicle access	The access road to the permit area must be established before operation commences and existing roads shall be used as far as possible Vehicle access must be strictly contained onsite. Vehicles may only use designated roads and access points as determined by the Environment officer and project Manager before operations commence When transporting sand on public roads, these will be kept clear of spills, leaks, mud and sand. Access road and loading area will be properly maintained, and this includes appropriate storm water management and dust control.
Waste Management	There is not any worth mentioning solid waste will generate on site. If any solid waste will generate on site it will be disposed of in clearly marked bins and solid waste will be handover to the contractor Domestic/general waste and hazardous waste must be separated and bins clearly marked. No waste may be buried or burned Empty fuel storage drums will be handover to the authorized contractor.
Minimize atmospheric emissions and dust Generation	Inspection of vehicles and warning systems will be implemented for vehicles emitting excessive emissions Rehabilitation will ensure good vegetative cover which will reduce dust creation.
Control noise	Hearing protection will be provided for employees operating heavy or noisy machinery. Noise level monitoring will be implemented if necessary.
Reduce the visual impact	Site must be kept neat and tidy at all times

CHAPTER 7: ENVIRONMENTAL MANAGEMENT PLAN

Institutional Arrangement

The project will be implemented and monitored by the Proponent which will assign Engineer and over-all management support shall be handled by Contractor.

The Contractor

This individual / agency:

- complies with all applicable legislation, is conversant with the requirements of the EMP, and briefs staff about the requirements of same
- Ensures any sub-contractors/ suppliers, who are utilized within the context of the contract, comply with the environmental requirements of the EMP. The Contractor will be held responsible for non-compliance on their behalf
- Supplies method statements for all activities requiring special attention as specified and/or requested by the Engineer or Environmental Expert during the duration of the Contract
- provides environmental awareness training, to the staff
- bears the costs of any damages/ compensation resulting from non-adherence to the EMP or written site instructions
- conducts all activities in a manner that minimizes disturbance to directly affected residents and the public in general, and foreseeable impacts on the environment
- ensures that the Engineer is inform timely manner of any foreseeable activities that will require input from the Environmental Expert
- appoints one fulltime Environmental Safeguard Officer for implementation of EMP, community liaison and reporting on day to day basis

Project Manager

This agency:

- is conversant with the requirements of the EMP and all applicable legislation
- Monitor the implementation of EMP on site and recommends requisite measures in case of non-compliances to proponent.

Engineer

This agency:

- Complies with all applicable legislation and is conversant with the requirements of the

EMP

- arranges information meetings for and consults with interested and affected parties about the impending project activities
- enforces and monitors compliance with the requirements of EMP on site
- assesses the Contractor's environmental performance in consultation with the Environmental Expert
- documents in conjunction with the Contractor, the state of the site prior to commencing project activities

Environmental Officer

This individual:

- briefs the Contractor on the requirements of the environmental specification and/or EMP
- advises the Engineer on the interpretation, implementation and enforcement of the environmental specifications and other related environmental matters
- monitors and reports on the performance of the contractor/ project in terms of environmental compliance with the EMP to the Engineer/ proponent
- provides technical advice relating to environmental issues to the Engineer

1.2 Training Schedules

Training and orientation programmes will be organized by the Environmental Experts, Engineers and proponent for the contractors, laborers, and technical/ office staff of the contractors, site engineers and the relevant staff or building their capacity with regards to principles and procedures of environmental management, pollution abatement measures, health and safety measures and implementation of EMP. Employees will be trained to use fire extinguishers in case of fire break out.

The potential impacts, mitigation measures, monitoring mechanism and responsibility of concerned institution are presented in Table 6.1

1.3 Equipment maintenance details

The maintenance of equipment is necessary for

- Achieving the best performance for the equipments and facilities.
- Reduction of the risks resulting from operation conditions to minimum levels.

For the current proposed project, it is therefore recommended to

- Prepare and keep the record of equipment maintenance log.(template of maintenance log is attached in annexure of the report)
- Prepare proper maintenance sheets for vehicles.
- Use fully tuned vehicles and machinery.

Environmental budget

Environmental budget for the project is 0.2 million. The proponent will plant ornamental and generic species.

Environmental Monitoring Plan

Environmental monitoring is normally undertaken during the operational stage to ensure the effectiveness of the proposed mitigation measures. In order to respond to unexpected environmental concerns at an early stage and to determine the accuracy of impact, predictions also required.

Proponent will manage all the environment related activities including its monitoring and maintenance. The Proponent will be responsible for all Environment related issues and the proponent complete monitoring plan for project which will be strictly adhered.

Scope of Environmental Management Plan

Environmental Management Plan (EMP) provides the framework for the implementation of mitigation measures and environmental management and monitoring for the project. This document contains all commitments made in the EIA Report to ensure that all environmental protection measures are implemented.

Environmental measures have been identified in this EIA Report to prevent or mitigate the adverse environmental impacts generated by the project to ensure that these measures are incorporated in the operation phase of the project, it is necessary to develop a comprehensive Environmental Management Plan (EMP). This section outlines the EMP. The plan addresses the mechanism through which the measures will be implemented; defines the responsibilities of the workers and the management.

Roles and Responsibilities of EMP Team

Environmental Management Plan Team will have responsibility to implement the environmental mitigation measures and monitor environmental compliance of different activities during operation phase.

ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIA)

Responsibilities of EMP Team are as follows:

- To ensure implementation of all the proposed mitigation measures while the project is working.
- To implement the Environmental Management Plan.
- To ensure that the project is implemented in an environment friendly manner, causing least harm to the existing environment including flora and fauna, site of religious and cultural significance and minimal land acquiring etc.

CHAPTER 8: PROPONENT, RESPONSIBLE AUTHORITY, OTHER DEPARTMENTS, STAKEHOLDERS/ PUBLIC CONSULTATIONS

During the detailed field survey, consultations were made with local community/ general public. The basic purpose of these consultative meetings/ focus group discussions were to

- i) share information with stakeholders about the expected impacts of proposed development works on the physical, biological and socioeconomic environment;
- ii) understand stakeholders' concerns regarding various aspects of the project, including the existing conditions and the potential impacts either positive or negative of the proposed project.

The following methodologies were used for carrying out public consultation:

- Local communities, individuals affected and owners and employees of affected commercial establishments who are directly or indirectly affected were given priority while conducting public consultation.
- Walk-through informal group consultations in the proposed project area
- The local communities had been informed through public consultation with briefing on project interventions including its benefits.

The environmental concerns and suggestions made by the participants were listed out, discussed and suggestions were accordingly incorporated in the EMP.

ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIA)

Table K.1 List of Participants during the Public Consultation & Concerns

Sl. No.	Location/Venue	No. of participants	Names of main Participants	Feedback/Concerns (Positive)	Feedback/Concerns (Negative)
1	River Chenab District Muzaffargarh	1	Mr. Murtaza	Provide labor opportunities to locals.	None
2	River Chenab District Muzaffargarh	1	Mr. Zahid Ali	In favor because sand quality is good and it is really good for construction purpose.	None
3	River Chenab District Muzaffargarh	1	Mr. Naeem	in favor of this project. This project will create business for local people	None
4	River Chenab District Muzaffargarh	1	Mr. Raffay	In favor of this project	None

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8	River Chenab District Muzaffargarh	1	Mr. Zaheer	No issues regarding this project. Because this project improve the economical condition of the area.	None
9	River Chenab District Muzaffargarh	1	Mr. Mehmood	The project will provide labor opportunities to unskilled people of nearby villages And increase the economic condition.	None

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8	River Chenab District Muzaffargarh	1	Mr. Saeed	The project will increase the labor opportunities. Sand is the Basic raw material for construction...	None
9	River Chenab District Muzaffargarh	1	Mr. Zohaib	People are satisfied with the project. On overall basis, this is a good project because it will provide raw material for construction Sand is used in all kind of construction which include, road, building etc.	None
9	River Chenab District Muzaffargarh	1	Mr. Nadeem Ali	No issues regarding this project	None

4.1.1 Feedbacks/Concerns Highlighted

The people of the area are satisfied with the project because the project will provide the labor opportunities to the locals and improve the economic condition of the area.

The project will also provide the good quality of sand which is the basic raw material of construction

CHAPTER 9: RECOMMENDATIONS AND CONCLUSIONS

Recommendations

Environmental Impact Assessment (EIA) Report and survey results are finally evaluated and recommend the following:

The present Environmental Impact Assessment (EIA) Report for Sand extraction with Dredger meets the administrative and legal framework of the EPA Punjab.

Provide all required PPEs to the workers.

Diesel will be stored on site secondary containment will be provided. Spilled hydrocarbon must be treated as a hazardous waste and needs to be disposed off in appropriate hazardous waste containers and removed off site as soon as possible.

No washing of equipment or machinery may occur on the permit site or in the watercourse. Spill kit will be used in case of any spill.

The hydrology of the landscape will be maintained by ensuring that extraction takes place away from the riparian zone and the stockpile area drainage is monitored.

The extraction of sand must not exceed the replenishment rate of sand during the rainy season.

The area within the river must be contained and the stockpile area is limited to 0.5 hectares.

All operation activity will be contained within the designated permit area. The Environment Officer and Project Manager must establish working and no-go areas, which need to be strictly adhered to. Keep surrounding vegetation, especially larger trees and shrubs, to create a screen that reduces flood impacts. Protected trees must be marked, their location recorded and must be avoided as best as possible. If any protected species cannot be avoided a permit must be applied for. No trapping, snaring, hunting, fishing or killing of any animal may occur on the permit site.

- The Proponent assign task of proper housekeeping near in and around the project site.
- The Proponent plant indigenous plants and trees to increase the aesthetics of the inner and the surrounding area.



- Consider Fire safety precautions to prevent or reduce the likelihood of a fire to break out.
- Follow the maintenance and cleaning plan to keep the machines running smoothly and to avoid any spillage, leakage or shutdown.
- Placing and maintaining fire extinguishers in easily accessible places.
- Display of Safety and Information Sign Boards at required places.
- Adequate training of workers on use of firefighting system to deal with the situation as well as environmental and waste management trainings.
- Proper training of workers to operate the machine.
- Use advance technology for sand removing in the river bed and minimized the environment impacts on river banks.
- Sand mining in river bed will be one meter depth layer by layer up to 5 meters
- Maintained the river flow carrying capacity in active channel without any serious activities.
- Avoid pollution of river water leading to water quality deterioration.

9.2 Conclusion

The EIA Report for "Sand extraction with Dredger Machine from River Chenab District Muzaffargarh, is made to fulfill the legal requirement of Pakistan Environmental Protection Act 1997 (amended 2012). In order to address the potentially adverse impacts of the project, particularly during the operational phase, an EMP has been developed, which will further improve the environmental performance of the project. The EMP assigns roles and responsibilities, provide environmental guidelines and discuss the scope of Environmental Management Plan.

The EIA Report has thoroughly assessed all the potential environmental impacts associated with the project. The environmental impacts identified by the study are manageable. Site specific and practically suitable mitigation measures are recommended to mitigate the impacts. The EIA concludes that constructional and operational phase of proposed project will not pose any major adverse environmental impacts on environment if the anticipated impacts are properly mitigated and the Environmental management Plan is properly implemented.

