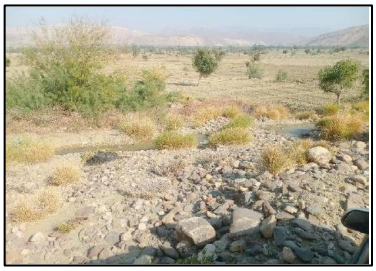
PAKISTAN
WATER AND POWER DEVELOPMENT AUTHORITY

Feasibility Study, Detailed Engineering Design, Preparation of Tender Documents and PC-I of Murunj Dam Project













ENVIRONMENTAL IMPACT ASSESSMENT (EIA) REPORT

OCTOBER, 2023

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ENVIRONMENT IMPACT ASSESSMENT (EIA) REPORT

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ABBREVIATIONS

ADP	Annual Development Program
AOI	Area of Influence
AWB	Area Water Boards
AD	Assistant Director
ADB	Asian Development Bank
AWS	Automatic Weather Station
BOD	Biochemical Oxygen demand
BCP	Building Code of Pakistan
BMP	Commandant Border Military Police
CAD	Computer Aided Design
CBOs	Community Based Organizations
CBD	Convention on Biological Diversity
CCA	Culturable Command Area
CDM	Clean Development Mechanisms
CMS	Conservation of Migratory Species
CITES	Convention on the International Trade of Endangered Species
DD	Deputy Director
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
EPRF	Emergency Preparedness and Response Framework
ECO	Economic Cooperation Organization
EMC	Environmental Monitoring Cell
EMMP	Environmental Management and Mitigation Plan
E&M	Electrical and Mechanical
E&R	Environment and Resettlement
E&RT	Environment & Resettlement Team
ERS	Electrical Resistivity Survey
FAO	Food and Agriculture Organization
FFA	Flood Frequency Analyses
FOs	Farmer Organizations
FPE	Farm Production Expenses
GOP	Government of Pakistan
GDP	Gross Domestic Product
GHG	Green House Gases
GIS	Geographic Information Systems
GPV	Gross Production Value
GCA	Gross Command Area
GRM	Grievance Redress Mechanism
HFL	Highest Flood Level
HSE	Health, Safety Environment
IEE	Initial Environmental Examination
IRSA	Indus River System Authority
IUCN	International Union for the Conservation of Nature
IDD	International Direct Dialing
LAA	Land Acquisition Act
LOE	Level of Effort
AMSL	Above Mean Sea Level
MDGs	Millennium Development Goals

MSDS	Material Safety Data Sheets
NCCW	National Council for Conservation of Wildlife
NESPAK	National Engineering Services Limited (Pvt.) Pakistan
NPO	No Project Option
NCS	National Conservation Strategy
NEP	National Environmental Policy
NEQS	Environmental Quality Standards
NPV	Net Production Value
NRSP	National Rural Support Program
NGOs	Non-Governmental Organization
O&M	Operation and Maintenance
OBE	Operating Basis Earthquake
OSHA's	Occupational Safety and Health Administration's
OIC	Organization of the Islamic Conference
PAPs	Project Affected Persons
PCAP	Pakistan Clean Air Program
PDMA	Provincial Disaster Management Authority
PID	Punjab Irrigation Department
PIDA	Punjab Irrigation and Drainage Authority
Punjab-EPA	Punjab Environmental Protection Agency
PC	Public Consultation
PEPA	Punjab Environmental Protection Act
PEQS	Punjab Environmental Quality Standards, 2016
PMU	Project Management Unit
PMD	Pakistan Meteorological Department
POPs	Persistent Organic Pollutants
PRSP	Poverty Reduction Strategy Paper
PSDP	Public Sector Development Program
PSHA	Pakistan Seismic Hazard Assessment
RAA	Rainfall Runoff Analyses
RNR	Renewable Natural Resources
TORs	Terms of References
T/Ls	Transmission Lines
SAARC	South Asian Association for Regional Cooperation
SC	Supervision Consultant
SOPs	Standard Operating Procedures
TOR	Terms of Reference
TMP	Traffic Management Plan
UBC	Uniform Building Code
UNO	United Nations Organization
UNESCO	United Nations Educational, Scientific and Cultural Organization
WAPDA	Water and power Development Authority
WAA	Water Apportionment Accord

EXECUTIVE SUMMARY

INTRODUCTION

The province of the Punjab is bounded from Balochistan province by the Sulaiman mountainous range in southern side. The Sulaiman mountainous range runs along the vicinity of 20-30 km along Dera Ghazi Khan (DG Khan) and Rajanpur Districts of Punjab. More than two hundred (200) hill torrents emerge from Sulaiman mountainous range during the rainy season which after passing the plain areas in DG Khan and Rajanpur falls into the mighty Indus.

These hill torrents are the source of irrigation water for the plain areas and also cause flood damages to the locals during floods. With the construction of Kachhi Canal, the dynamics of the area and the significance of the damages has changed drastically. Out of these hill torrents thirteen (13) are the major ones. Seven (07) hill torrents are in DG Khan District and remaining six (06) are in Rajanpur District. Map showing these hill torrents is attached as **Figure 1.1.**

These hill torrents flow to eastward and inundate/effect the vast area of these districts. Most of these torrents are non-perennial. These hill torrents are a permanent feature and has brought devastation to these districts off and on in different years. The worst years of flooding caused by these hill torrents were observed in recent past like 2001, 2008, 2010, 2012, 2013 and 2015.

The flows of the hill torrents are being used for the irrigation of traditional agriculture crops in the Pachad area since ancient times. The flood irrigation for growing crops is practiced as far as possible by the farmer's owned diversion arrangements named as Kamara irrigation system. This system is based on the sequential water rights and enforces the irrigation pattern from upper to lower riparian, without consideration of the duration and magnitude of the storm generated flows.

Kaha hill torrent is one of the major hill torrents of DG Khan Division. Kaha hill torrent mostly irrigates the plain areas locally known as Pachad areas (Plain areas) from the Sulaiman foot Hills. Kachhi Canal, DG Khan Canal and Dajal branch which originate from Taunsa Barrage located on the Indus River are also located in the way to this hill torrent. In the past, Irrigation Department has constructed many structures on this hill torrent for maximum dispersion of flood water in Pachad area for irrigation purpose. To an extent these structures also mitigate floods in these areas. However, these structures are not efficient in high flood situations. These dispersion structures failed to mitigate high flood situation.

During high floods, water reaches up to Dajal branch after causing huge disruption in Pachad area. This flood water creates severe problems such as loss of land due to erosion, damage to public and private infrastructure, breaches of canal system, loss of human lives, livestock and crops, suspension of irrigation supplies and threat to Kachhi Canal (front line canal).

Murunj Dam Project (MDP) is planned to store flows of Kaha nullah by the construction of a dam on this torrent. The stored water will be released mainly to meet the irrigation water requirements of the downstream cultivable area while power generation will be a by-product. The Murunj Dam will create a 0.44 million acre-feet storage area reservoir which would supply irrigation water to the Gross Command Area (GCA) of 114,015 acres. The project has been funded by the Government of Pakistan and Water & Power Development Authority (WAPDA) is the Executing Agency (EA) of the project.

WAPDA (Client) has initiated the work to carry out the feasibility study of Dam on Kaha hill torrents. As per Terms of References (TORs), environmental and land acquisition & resettlement studies are an important part of the feasibility study to evaluate the environmental feasibility and sustainability of the proposed Dam.

Punjab Environmental Protection Agency (Punjab-EPA) is the concerned regulatory authority and Punjab Environmental Protection Act (PEPA), 1997 (as amended 2017) has been considered for the Environmental Impact Assessment (EIA) study as it is the core legislation which deals with the protection of environment in the Province. As per Section 12 of PEPA, 1997 (as amended 2012); no proponent shall commence construction or operation unless he has obtained Environmental Approval from the concerned Environmental Protection Agency i.e. Punjab-EPA.

Under the exercise of power conferred by Section 33 of PEPA, 1997 (as amended 2012), Punjab-EPA with the approval of the Provincial Cabinet has promulgated Review of IEE/EIA Regulations, 2016. These regulations provide the basis for the screening of a Project as per project size and magnitude. The subject Project falls under the Schedule II of category E, which is related to Water Management, Dams, Irrigation and Flood Protection with criteria that dams and reservoir with storage volume of 50 million m^3 and above or surface area of 8 km^2 and above requires an EIA Study to initiate the process of Environmental Approval from the EPA. Murunj Dam has a gross storage volume of 575 million m^3 (0.44 MAF) and reservoir surface area of 17.60 km^2 (4,350 acres) therefore, an EIA Study has been carried out for this Project.

The proposed Murunj Dam site is located on Kaha hill torrent locally named as Kaha Sultan I.e. King of Hill Torrents, 116 km west of Rajanpur, the Punjab province. Nearest village is Maari which is about 15 km from dam site. A metalled road link exists between D.G. Khan to Rajanpur and further up to Maari village. Dam site co-ordinates are 29° 33' 36.86" N and 69° 48' 29.90" E.

The type of proposed dam is Zoned Earth Fill with a maximum height of about 310 ft and the dam crest length is 3,754ft. Dam has a catchment area of 5,500 km^2 with reservoir area of about 4,350 acres and GCA is about 0.44 MAF. The GCA is spread in Pachad area, District Rajanpur up to the proposed Kachhi Canal.

ENVIRONMENTAL REGULATORY REQUIREMENTS AND FRAMEWORK

The Pakistan National Conservation Strategy (NCS), which was approved by the federal cabinet in March 1992, is the principal policy document on environmental issues in the country (EUAD/IUCN, 1992).

Punjab Environmental Protection Agency (Punjab-EPA), is primarily responsible for administering the provisions of the PEPA, 1997 (as amended 2012). The Government of Pakistan promulgated "Pakistan Environmental Protection Act (PEPA)" in 1997 which was amended in 2017 by Govt. of Punjab. PEPA, 1997 is a fairly comprehensive legislation and provides protection, conservation, rehabilitation and improvement of the environment. It contains concrete action plans and programs for the prevention of pollution and promotes sustainable development.

Other laws, acts, ordinances and guidelines applicable are Land Acquisition Act, 1894, Punjab-EPA Regulations, 2016, Punjab Environmental Quality Standards (PEQS), 2016, Pakistan Penal Code, 1860, The Affected Persons Ordinance, 2001, The Forest Act, 1927, Punjab Wildlife (Protection, Preservation, Conservation and Management) Act, 1974, Punjab Plantation and Maintenance of Trees Act, 1974, Cutting of Trees (Prohibition) Act, 1975, Protection of Trees and Brushwood Act, 1949, Punjab Plantation and Maintenance of Trees Act, 1974, Cutting of Trees (Prohibition) Act, 1975, Protection of Trees and Brushwood Act, 1949, Provincial Local Government Ordinances, 2001, Antiquities Act, 1975, Explosives Act, 1884, Hazardous Substance Rules, 2003, Water Apportionment Accord, 1991, The Canal and Drainage Act, 1873, Punjab Mining Concession Rules, 2002, etc. Since Pakistan is a member of a number of international organizations, it has to follow the international protocols and obligations related to the environmental perspective.

PROJECT DESCRIPTION

The proposed Murunj Dam is a flood water storage dam and is being planned and designed to manage the flood waters of Kaha Hill Torrent. The main purpose of the dam is the flood attenuation and to regulate water for irrigation purpose. The other associated objectives of the proposed Dam are enlisted below:

- The Murunj Dam will create a 0.44 million acre-feet storage area reservoir which would supply irrigation water to the Gross Command Area (GCA) of 114,015 acres;
- The water storage will augment the short fall of the irrigation supplies to the Pachad area of downstream of the proposed Dam;
- The construction of the proposed Dam would reduce the damages caused by the flood water in the downstream areas and under construction Kachhi Canal through arresting the flood water in the proposed reservoir;
- This will bring socio-economic uplift and prosperity in GCA by the maximum utilization of the agricultural and livestock resources;
- The reservoir developed due to the proposed Dam will provide a recreational activity for the locals as well as the tourists;
- In addition to irrigation benefits, the generation of electricity by this hydropower will provide cheaper, renewable, environmental friendly and most needed power, keeping in view the present and future requirements of Pakistan especially rural and remote areas for the development of the country; and
- In addition, recharge of groundwater aquifer is also an indirect benefit associated with the proposed Dam.

The salient features are shown in below Table.

Table E-1: Salient Project Features

Concerned Authorities	
Sponsored By	Government of Pakistan
Execution	WAPDA
Operation and Maintenance	WAPDA
Concerned Federal Ministry	Ministry of Water and Power
A. Main Dam	
Type	Zoned Earth Fill Dam
Height	310 ft
Valley Section Width	≈ 3700 Ft
Max. Conservation Level	1098 Ft
River Bed Elevation	≈ 860 Ft
Free Board	5.5 Ft
B. Reservoir	
Reservoir Area	4,350 acres
Reservoir Length	6.8 km
Gross Storage Capacity	0.44 MAF
Live Storage Capacity	0.101 MAF
Dead Storage Capacity	0.20 MAF
Conservation Level	1,098 ft
C. Hydrology	
Catchment Area	5,500 km^2
Average Annual Inflow	178.44 million m^3 at 50% of time 90.96 million m^3 at 75% of time
Average Annual Total Sediment Influx	8.1 magnetic susceptibility (mst) considering 25% Bedload
D. Command Area Development	
Gross Command Area (GCA)	≈ 114,015 acres
E. Hydropower	
Total Installed Capacity	6.0 MW

Approximately 8,280 acres of land (3,991 acres of land in reservoir areal; 4,149 acres of land in irrigation and drainage network and 140 acres of land for proposed offices and colony buildings) is required for the proposed project interventions which will be acquired from government and private land owners. Total man power required for the proposed project will be estimated by the contractor at construction stage, whereas as per consultant's previous experience the workforce for proposed project has been estimated as 450 workers 150 skilled and 300 unskilled labour. The water consumption is estimated to be 18,000 liters /day[1] for 450 construction workers comprising skilled and unskilled labors for the proposed Project. The wastewater generation is estimated to be 14,400 liters/day for 450 construction workers comprising skilled and unskilled labour for the proposed Project. The solid waste generation is estimated to be 202.5 kg/day (as per 0.45 kg/capita/day waste generation)[2] for 450 construction workers comprising skilled and unskilled labors for the proposed Project.

1. Water requirements for 450 Work Force = (450) x (40) = 18,000 liters/day
   Wastewater Generation = (18,000) x (80% of wastewater) =14,400 liters/day
2. Source: The World Bank Report 2012 – What a Waste: A global review of solid waste management. Based on UNEP estimates for waste generation in the Asia Pacific. Average is 0.45 kg/capita/day

DESCRIPTION OF ENVIRONMENT

The purpose of the baseline study is to document the existing conditions of the resources likely to be affected including physical, ecological and socio-economic environment. For this purpose, a consultant's team comprised of experienced experts including: Environmental Scientist, Environmental Engineers, Ecologist and Sociologists was constituted to establish the baseline conditions of the Study Area/Area of Influence (AOI). Based on the impact zones for the various predicted impacts, Study Area/AOI was developed and demarcated. The said team carried out the field visit during December, 2021 to the proposed dam site, potential reservoir area, catchment area in the vicinity of the reservoir located in Kaha Hill Torrent, Rajanpur and downstream command area in order to collect the baseline data of physical, ecological and socio-economic conditions.

For the collection of baseline information checklists/proformas, Satellite Imagery (Google Earth), and General Topographic (GT) sheets were used. AOI was delineated based on expert judgment, field reconnaissance, Consultant's experience, study of available maps and data collected through secondary sources and results of the consultation with the relevant departments. Each expert prepared a checklist/proforma for the collection of baseline data of the important parameters of physical, ecological and socio-economic environment. Meetings and scoping sessions with all the concerned Project stakeholders were held for the collection of primary information, disclosure of Project interventions, provide information and to clear queries and misconceptions of the Project. Government offices were contacted and visited for the verification of baseline data collected during the field visit and to obtain relevant published documents

The relevant collected data was computerized and analyzed using software such as Microsoft Office, Statistical Package for Social Sciences (SPSS), and Computer Aided Design (CAD) etc.

Points for environmental monitoring and sampling were selected and an environmental monitoring and sampling plan is provided in the report. However, due to the budget constraints as per the instructions of the Project Manager this task will be completed during the Phase-II of the Project and the Report will be updated accordingly.

Following is the description of the baseline conditions of the Study Area/AOI.

Physical Environment

The proposed Project Area falls within the territory of District Rajanpur which is located about 116 km North West of Rajanpur city. The Project site can be accessed through Fazilpur and Jampur which are mainly connected to the upstream and downstream country through Indus Highway (N-55). Travelling from Jampur, approx. at about 23 km two lane Jampur-Dajal road can be utilized which continues up to Dajal. Afterward, about 28 km one lane road connects Dajal with Lundi Saidan. Similarly, Lundi Saidan locality is also connected with Hajipur – Fazilpur through a two lane road of approx. 40 km.

The area is characterized by a combination of landforms produced by tectonic and peneplanation phenomena. The landform is constituted by ridges, piedmonts, sub-piedmonts flood plains, sand dunes, active flood plains, meander belts and presently running water

storms. The average slope from the Indus river to the foot of the Sulaiman Mountain Range is about 02 percent.

The bed width of torrent at the proposed Murunj dam site is about 300 feet. Right abutment is high and has steep slope as compare to left abutment. The river is meandering in the u/s of the dam site containing perennial flows. The area is highly dissected, covered with piedmont and alluvial terrace deposits which are distributed in the u/s side.

At the top of left abutment sandstone bed is exposed with thin layers of conglomerate. Thickness of sandstone bed is 54m. At the top of right abutment shale is exposed having approximate thickness of 11 m. Shale is reddish brown, splintery, fine to very fine grained, sparsely jointed, low to very low strength. At The top of nullah bed about 6.0 to 10.0m overburden covers the bed rock. Overburden consists of river deposits, rounded to sub rounded gravel and cobbles of sedimentary origin dominantly of limestone and sandstone.

The proposed Dam site falls in Zindapir, Mari-Bugti anticlinal zone and Khalifat Sulaiman arc of Suleiman fold belt tectonic zone of Pakistan. Building Code of Pakistan, Seismic Provisions (2007) shows that the Study Area falls in Moderate to High Seismic Zone i.e. Zone-2A, Zone-2B and Zone-3 with peak horizontal ground acceleration of 0.08 to 0.32g.

Four textural groups have been recognized in the Project area. These are fine textured soils 28.0% (31977 acres) consisting of clays and silty clay, moderately fine texture soils 4.1% (4609 acres) comprising of silty clay loam / clay loams, medium textured 43.5 percent (49602 acres) soils consisting of silt loams, very fine sandy loams and loams and coarse textured 7.2% (8240 acres) soils including sands and loamy sand. The remaining 1.8% (2077 acres) is gravelly area, 2.1% (2377 acres) torrent bed / nullah and 2.1% (2339 acres) is settlements.

The climate of the area is semi-arid, hot subtropical with pleasant winter and spring, summer with dust and heat wave periods and dry autumn. Climate is characterized by the movement of monsoon in summer season and westerlies in winter season. Both these phenomenon causes rainfall in the Study Area/AOI. As there is no climatic station in the Murunj catchment, therefore, meteorological data of Barkhan Weather Station for the proposed Project has been used. The average data of hill torrents region for the various climatic parameters such as temperature, rainfall, relative humidity, wind speed and direction has been acquired for the year 1981 to 2010 (recent 30-year average normal meteorological data). Based on acquired data, it can be revealed that month of June is the hottest, when temperature rises up to about 42 °C and January is the coldest month of the year, when temperature falls up to about 4 °C. According to the daily rainfall data of Pakistan Meteorological Department, the annual average rainfall for the period (1981-2010) is 402 mm. The maximum (e.g. 69.1 mm) rainfall occurs during the monsoon season in the month of July while minimum rainfall is recorded during the month of November (e.g. 2.9 mm). Meteorological data also reveals that at 12 UTC, the wind speed is low in winter season, while in summer season, winds are blowing at a relatively higher speed than winter. However, at 00 UTC and 03 UTC very low velocity winds are blowing during July to September annually.

The major surface water sources in the Study Area are the nullahs/streams and rainfall. Kaha hill torrent is one among the thirteen major Hill Torrents in DG Khan Division. The torrent is a non-perennial stream having 5,500 km^2 catchment area at dam site. The ground water in the

Study Area is extracted through hand pumps and tube wells installed in nearby villages where few settlements exist.

In the AOI, no conventional solid waste collection and transportation system is in practice. There is presently no disposal facility available for solid waste and no arrangements of solid waste collection are seen in the AOI. People are used to throw their solid wastes into the streets or in open areas. Similarly, there is no proper sewerage system is available in the AOI. The common wastewater discharge practices in the AOI are the use of soakage pits and discharge of wastewater into the open agricultural fields. However, some open drains are constructed in the vicinity for the discharge of wastewater into the agricultural fields.

Ecological Environment

The study area is situated in semiarid subtropical continental monsoon region of Pakistan. Around sixty-five percent of catchment areas consist of barren mountains without vegetative cover (Hanson, 1995). The region is characterized by extremely dry climate both in summer and winter season. The water precipitation is in the form of occasional seasonal rains, during rainy season (July– September). The high intensity fleshy rains result in torrential flow (fast flowing water). Natural Flora of the Project Area is highly degraded of tropical thorn forest. Shrubs, Trees, Medicinal Plants, Forbs, Herbs, Weeds, and Grasses, typical of arid zone are found.

In general, the areas traversed by the Project are poorly vegetated and are ecologically very poor in terms of presence of flora and fauna, due to the very arid and rocky nature of the terrain. There are no indigenous species of conservation importance. The flora and fauna in the area have already adjusted/ accommodated to the presence of track and adjacent areas. Consequently, the project works and operations will have small impacts on the Flora & Fauna of the area, if any. Much of this region has been cleared for different purposes by locals, and remnants of the original forests are heavily degraded as a result of the growing need for fuel wood, fodder, and timber. The forest areas are under degradation due to hazards such as illicit cuttings, overgrazing, over exploitation, fires, flash floods and other biotic factors. Forest is being lost at a substantially greater rate than regeneration. The project area in general is under significant biotic pressure and under retrogression due to various factors such as unsustainable practices, Natural hazards causing the habitat loss, soil erosion and lack of proper functioning of ecosystems. In this way, a habitat may be thought of as analogous to a “keystone species “within a biotic community. For practical reasons, rarity is often the criterion by which a habitat’s value is determined.

The project area, on account of nature of vegetation and topography, once rich in vegetation and wildlife has now reduced its potential due to over hunting, loss of proper habitat, conversion of forest land. Fauna of the tract consists of mammals, rodents, reptiles, amphibians and birds. The Rajanpur district is important corridor for Houbara Bustard (Wild Life Department Rajanpur). Chlamydotis macqueenii, commonly known as the Asian Houbara Bustard (hereafter ‘houbara’), is listed as vulnerable in the International Union for the Conservation of Nature (IUCN) Red List of threatened species. Large numbers of Houbara Bustard are illegally hunted and trapped, in Pakistan, and shipped to Arabia for use in training falcons to hunt. Houbaras are also hunted and killed for their meat. Habitat loss and degradation compound to this problem.

Currently in the project area there is no significant availability of fish. It is worth mentioning here that after proposed project completion the scope of fisheries development will be of very importance and will provide good grounds for raising/development of fisheries at different levels. A variety of agricultural crops, fodders and vegetables are grown in the vicinities, however, land is still dominated by Wheat (Triticum L), Cotton (Gossypium) and Maize (Zea mays L). Most agricultural activities in reservoir and catchment area are confined where irrigation is possible. Large areas on sides are Barani/Rain fed where in good rainy periods dry farming is practiced.

Socio-Economic Environment

Social assessment of the people of the AOI was carried out through socio-economic baseline surveys; village profile survey, and public/stakeholder's consultations/focus group discussions in the AOI. During the socio-economic survey, 68 respondents were selected from the project area

The overall population of 84 households was calculated as 689. Average household size was concluded as about 8.2. The male population is high as compared to female population in the project area. On average the male population is 51% while the female population is 49%. About 42% of the population are below 15 years of age. Percentage of theoretically active population between 15 and 64 is 54%. Age group of 65 and above have a share of 4% of the total population.

The literacy level of the respondents, identified during the survey, depicts that the majority of the respondents in the AOI were illiterate and their weightage is 92 % followed by 3.6 % primary, 2.0% middle and 1.9% respondents having secondary level education. The total literate rate is 8.0%.

The majority of the households (85%) are engaged in farming and its related activities including livestock rearing, etc. The second major source of income identified in the project area was labour (07%). The remaining 08% were engaged in government, private service and shopkeeping.

The average monthly income comes out PKR 20,000. Among the surveyed respondents, (10%) were found has having monthly income below the Official Poverty Line (OPL).

Natural (Sui) gas and sewerage network were not exist in the area, however, most of the mobile phone networks are being used.

STAKEHOLDER CONSULTATIONS

Stakeholders' involvement especially the local population is an important feature of an environmental assessment study and can lead to a better and more acceptable decision-making regarding the project design and its implementation. It gives the feeling of an ownership to the local population. A series of consultations were held with various provincial and district level departments and NGOs to get their feedbacks regarding environmental issues. Generally, they appreciated the efforts of the proponent to develop such type of project to control flood damages and effective water management.

As mentioned above, locals were also consulted in this regard and they were of the view, that the development of water reservoirs will have a positive impact on the economy of the area in term of availability for the longest period. Moreover, they provided following suggestions:

- Proper mechanism for the use of stored water will be developed in order to avoid conflicts over the use of waters.
- Command area will be developed with provision of lined watercourses
- The people are facing drinking water problem; therefore; they have requested to the team to incorporate the water supply component in the project.
- Social structures (women water collection structures, structures for livestock drinking and abolition structures for the males) in the scope of work.
- The community will be involved in maintenance of development structures, as during each flood, damages to wahs took places. Water user organizations at each channel (wah) required to be developed, which may require legislation, which will be responsible for operation and maintenance of concerned channel

The respondents had some reservations about the project; which have been described below:

- Area of grazing land will reduce because of construction of Dam crop cultivation.
- Area of the proposed Dam would silt up after some years.

IMPACTS AND MITIGATION MEASURES

Impact assessment has been conducted for various phases of the proposed Project and the project envisages following potential positive impacts:

- Provision of Water Storage;
- Protection against Devastating Floods;
- Irrigation Benefits;
- Enhancement of green cover in the area;
- Habitat improvement for Wildlife;
- Agriculture Benefits;
- Saving of Flood Damages Due to Breaching of Kachhi Canal;
- Infrastructure Development;
- Employment Opportunities; and
- Socio-Economic Uplift.

Following adverse impacts have been anticipated during different especially construction phase of the proposed Project:

- Land Acquisition (permanent & lease);
- Aesthetics;
- Site Accessibility;
- Soil Contamination & Erosion;
- Liquid & Solid Waste;
- Surface Water Quality;
- Ambient Air & Noise Pollution
- Borrowing/quarry hazards;
- Impact on Flora & Fauna;

- Impacts on Sensitive Receptors;
- Social and Cultural Issues;
- Communicable Disease;
- Loss of Income;
- Gender Issues;
- Occupational Health and Safety; and
- Conflict with Locals.

Sedimentation, water rights in Pachad area (lower riparian), loss of nutrients, water logging ass salinity, water seepage, dam safety and emergencies, etc. may be anticipated as adverse environmental impacts during operation and maintenance phase of the proposed project. However, mitigation measures have also been provided to lower down significance of adverse environmental impacts.

ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN (EMMP)

The EMMP has been prepared for all phases (e.g. pre-construction, construction and operation and maintenance) of the proposed project as part of the EIA report with following objectives:

- To ensure that all necessary corrective actions are carried out in time to counter any adverse environmental impact;
- To ensure the regular monitoring of those factors which may affect the safety of the environment under a systematic monitoring approach;
- Define the responsibilities of the project Proponent, Contractors, Supervision Consultants (SC) and environmental monitors;
- Provide a procedure for timely action in the face of unanticipated environmental situation;
- Identify training requirements at various levels including project proponent, Contractor and SC;
- Provide a monitoring mechanism in the form of an environmental monitoring program, which includes monitoring parameters, monitoring frequency to ensure that all the mitigation measures are completely and effectively implemented;
- Provides estimation of environmental cost for the implementation of EMMP; and
- Identify the resources required for the implementation of EMMP.

The EMMP also provides information regarding institutional requirements for the implementation of EMMP at proponent, supervisory consultant and contractor level, environmental mitigation plan, environmental monitoring plan. Various management plans including HSE management, tree plantation, emergency preparedness and response framework, restoration and rehabilitation, waste management, traffic management and change management have also been prepared as part of EMMP. Furthermore, EMMP cost is also provided as part of EMMP which is PKR 287.65 Million excluding the land acquisition and resettlement cost.

CONCLUSION AND RECOMMENDATIONS

The report provides conclusions based on the impacts assessed and the mitigation measures suggested. The implementation of the proposed project will have many positive impacts for

the country, province and on the population residing within the Study Area. Apart from the positive impacts of the project, the proposed project will also have potential adverse environmental and social impacts during the construction and operational stages. Most of these adverse impacts during construction are of a temporary nature. These potential impacts can be avoided or mitigated by adopting suitable mitigation or remedial measures as mentioned in this report.

In order to minimize, avoid or reduce the potential adverse impact appropriate mitigation and remedial measures have been suggested against each identified impact. Efforts are made to propose economical and sustainable mitigation and remedial measures which can be easily implemented. In order to provide compensation for crops, land, structures and trees losses, a RAP study is in progress. In the end, EMMP has been developed to provide proper framework for the implementation of the suggested mitigation measures. This includes the identification of the major stakeholders, roles and responsibilities along with the resource requirements.

As a conclusion of the study, the proposed project will not cause potentially significant adverse environmental impacts that are sensitive, diverse or unprecedented after the implementation of mitigation measures. Considering the water availability situation and flood damages in the study area and the efforts being made by the GOP, the proposed project is a prerequisite. It is suggested that the proposed project will be implemented as soon as possible after all necessary approvals, design provisions and the implementation of EMMP.

1 INTRODUCTION

1.1 PROJECT BACKGROUND

The province of the Punjab is bounded from Balochistan province by the Sulaiman mountainous range in southern side. The Sulaiman mountainous range runs along the vicinity of 20-30 km along Dera Ghazi Khan (DG Khan) and Rajanpur Districts of Punjab. More than two hundred (200) hill torrents emerge from Sulaiman mountainous range during the rainy season which after passing the plain areas in DG Khan and Rajanpur falls into mighty Indus.

These hill torrents are the source of irrigation water for the plain areas and also cause flood damages to the locals during floods. With the construction of Kachhi Canal the dynamics of the area and the significance of the damages has changed drastically. Out of these hill torrents thirteen (13) are the major ones. Seven (07) hill torrents are in DG Khan District and remaining six (06) are in Rajanpur District. Map showing these hill torrents is attached as **Figure 1.1.**

These hill torrents flow to eastward and inundate/effect the vast area of these districts. Most of these torrents are non-perennial. These hill torrents are a permanent feature and has brought devastation to these districts off and on in different years. The worst years of flooding caused by these hill torrents were observed in recent past like 2001, 2008, 2010, 2012, 2013 and 2015.

The flows of the hill torrents are being used for the irrigation of traditional agriculture crops in the Pachad area since ancient times. The flood irrigation for growing crops is practiced as far as possible by the farmer's owned diversion arrangements named as Kamara irrigation system. This system is based on the sequential water rights and enforces the irrigation pattern from upper to lower riparian, without consideration of the duration and magnitude of the storm generated flows.

Kaha hill torrent is one of the major hill torrents of DG Khan Division. Kaha hill torrent mostly irrigates the plain areas locally known as Pachad areas (Plain areas) from the Sulaiman foot Hills. Kachhi Canal, DG Khan Canal and Dajal branch which originate from Taunsa Barrage located on the Indus River are also located in the way to this hill torrent. In the past, Irrigation Department has constructed many structures on this hill torrent for maximum dispersion of flood water in Pachad area for irrigation purpose. To an extent these structures also mitigate floods in these areas. However, these structures are not efficient in high flood situations. These dispersion structures failed to mitigate high flood situation.

During high floods, water reaches up to Dajal branch after causing huge disruption in Pachad area. This flood water creates severe problems such as loss of land due to erosion, damage to public and private infrastructure, breaches of canal system, loss of human lives, livestock and crops, suspension of irrigation supplies and threat to Kachhi Canal (front line canal).

Keeping in view of these flooding issues considering the newly constructed Kachhi Canal, a proper flood mitigation engineering measures such as dams on Kaha hill torrent was suggested as part of Kachhi Canal Project.

Murunj Dam Project (MDP) is planned to store flows of Kaha nullah by the construction of a dam on this torrent. The stored water will be released mainly to meet the irrigation water requirements of the downstream cultivable area while power generation will be a by-product.

The Murunj Dam will create a 0.44 million acre-feet storage area reservoir which would supply irrigation water to the Gross Command Area (GCA) of 114,015 acres. The project has been funded by the Government of Pakistan and Water & Power Development Authority (WAPDA) is the Executing Agency (EA) of the project.

WAPDA (Client) has initiated the work to carry out the feasibility study of Dam on Kaha hill torrents. As per Terms of References (TORs) – attached as **Annex-I**, environmental and land acquisition & resettlement studies are an important part of the feasibility study to evaluate the environmental feasibility and sustainability of the proposed Dam.

1.2 OBJECTIVES OF THE PROJECT

The proposed Murunj Dam is a floodwater storage dam and is being planned and designed to manage the floodwaters of Kaha Hill Torrent. The main purpose of the dam is the flood attenuation and to regulate water for irrigation purpose. The project will provide many benefits to the residents of the project area. Direct beneficiaries will be small farmers getting regular irrigation supplies and increased crop yield. The project will reduce land degradation in the command area. The other beneficiaries will include farm labour and women through enhanced farming actives.

The other associated objectives of the proposed Dam are enlisted below:

- The Murunj Dam will create a 0.44 million acre-feet storage area reservoir which would supply irrigation water to the Gross Command Area (GCA) of 114,015 acres;
- The water storage will augment the short fall of the irrigation supplies to the Pachad area of downstream of the proposed Dam;
- The construction of the proposed Dam would reduce the damages caused by the flood water in the downstream areas and under construction Kachhi Canal through arresting the flood water in the proposed reservoir;
- This will bring socio-economic uplift and prosperity in GCA by the maximum utilization of the agricultural and livestock resources;
- The reservoir developed due to the proposed Dam will provide a recreational activity for the locals as well as the tourists;
- In addition to irrigation benefits, the generation of electricity by this hydropower will provide cheaper, renewable, environmental friendly and most needed power, keeping in view the present and future requirements of Pakistan especially rural and remote areas for the development of the country; and
- In addition, recharge of groundwater aquifer is also an indirect benefit associated with the proposed Dam.

1.3 PROJECT LOCATION, SIZE AND MAGNITUDE

The proposed Murunj Dam site is located on Kaha hill torrent locally named as Kaha Sultan i.e. King of Hill Torrents, 116 km west of Rajanpur, the Punjab province. Nearest village is Maari which is about 15 km from dam site. A metalled road link exists from D.G. Khan to Rajanpur and further up to Maari village. Dam site co-ordinates are 29° 33' 36.86" N and 69° 48' 29.90" E. The location map of the proposed Murunj Dam is shown in **Figure 1.2**.

The type of proposed dam is Zoned Earth Fill with a maximum height of about 310 ft and the dam crest length is 3,754ft. Dam has a catchment area of 5,500 km^2 with reservoir area of about 4,350 acres and GCA is about 0.44 MAF. The GCA is spread in Pachad area, District Rajanpur up to the proposed Kachhi Canal.

1.4 NEED OF ENVIRONMENTAL STUDIES

Punjab Environmental Protection Agency (Punjab-EPA) is the concerned regulatory authority and Punjab Environmental Protection Act (PEPA), 1997 (as amended 2017) has been considered for the Environmental Impact Assessment (EIA) study as it is the core legislation which deals with the protection of environment in the Province. As per Section 12 of PEPA, 1997 (as amended 2017); no proponent shall commence construction or operation unless he has obtained Environmental Approval from the concerned Environmental Protection Agency i.e. Punjab-EPA.

Under the exercise of power conferred by Section 33 of PEPA, 1997 (as amended 2017), PEPA Review of IEE/EIA Regulations, 2000. These regulations provide the basis for the screening of a Project as per project size and magnitude. The subject Project falls under the Schedule II of category E, which is related to Water Management, Dams, Irrigation and Flood Protection with criteria that dams and reservoir with storage volume of 50 million m^3 and above or surface area of 8 km^2 and above requires an EIA Study to initiate the process of Environmental Approval from the EPA.

Murunj Dam has a gross storage volume of 575 million m^3 (0.44 MAF) and reservoir surface area of 17.60 km^2 (4,350 acres) therefore, an EIA Study has been carried out for this Project.

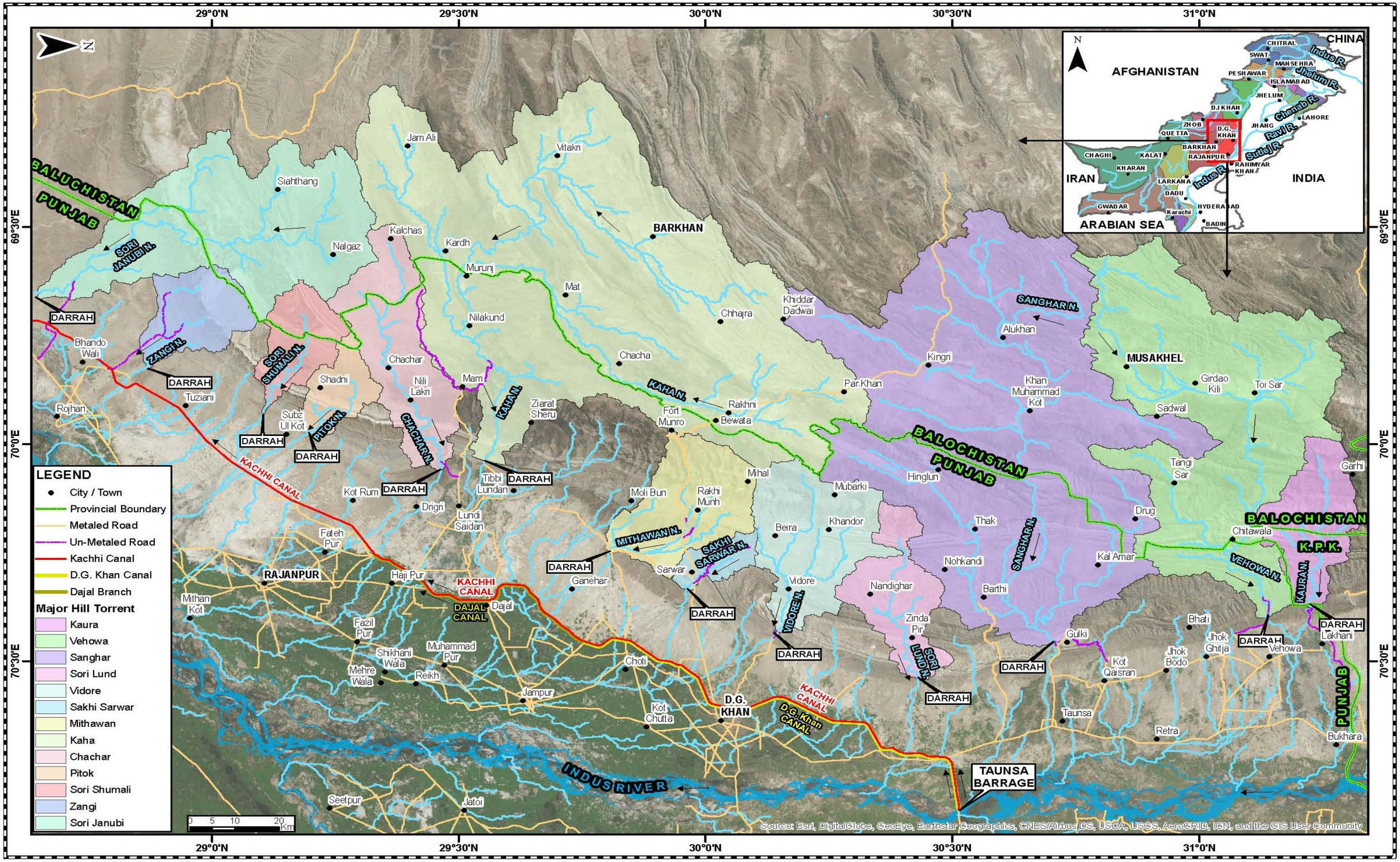


Figure 1.1: Location of the Hill Torrents in DG Khan and Rajanpur

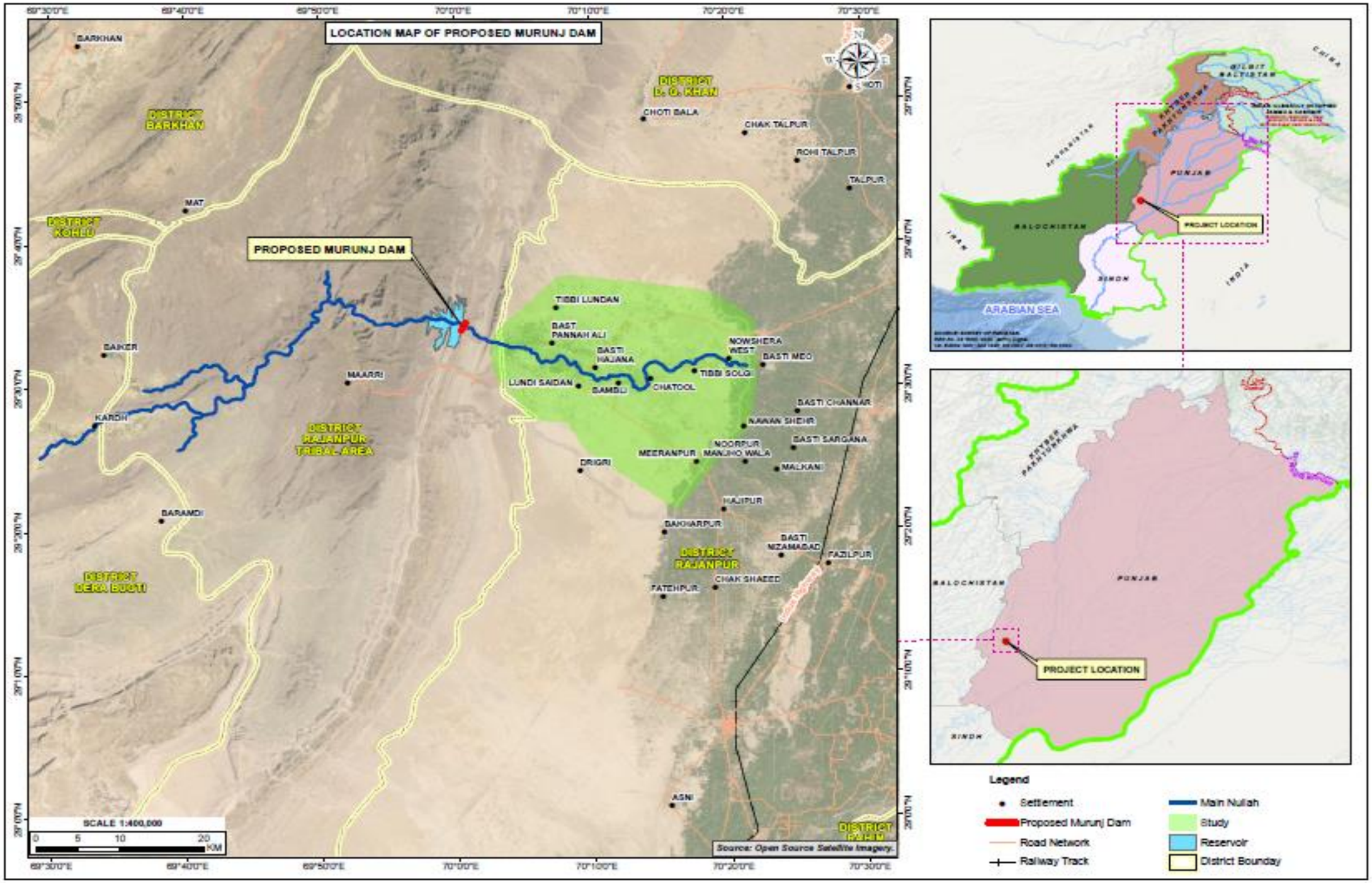


Figure 1.2: Location Map of the Proposed Murunj Dam

1.5 DELINEATION OF STUDY AREA/AOI

Identification of Study Area/Area of Influence (AOI) is an important activity for environmental studies at this stage. AOI if not delineated properly can impact the overall objectives and conclusions of an environment study. Moreover, it also impacts the allocated resources including the level of effort (LOE) and time. AOI is the area over which the proposed Project activities can potentially impact directly or indirectly on the environment. In this report the word study area and AOI is used interchangeable.

In order to finalize the Study Area/AOI during the reconnaissance survey, key members of the EIA team i.e. environmental scientist, environmental engineer, ecologist and sociologists visit the site and identify the potential impacts due to the implementation of the proposed Project on the physical, ecological and social environment. Based on these impacts, each expert delineated the impact zone and these zones were overlaid on the base map to develop the Study Area/AOI. Study Area mainly includes the dam site, reservoir area, proposed canal command, downstream/low riparian, area of temporary interventions such as construction camps, workshops etc. and the areas where significant adverse or positive impacts may be foreseen due to the implementation of the proposed Project. Arc Geographic Information Systems (GIS) has been used to demarcate the boundary of Study Area. Study Area/AOI is shown as **Figure 1.3**.

1.6 EIA TEAM

A team of multi-disciplinary experts was formed as per the requirement of the TOR to integrate the identified impacts and mitigation measures into the design. NESPAK EIA team comprised the following experienced experts:

- Mr. Nasir Khan Afridi, Project Manager
- Engr. Muhammad Shariq Ahmad, Team Leader/Section Head ERSD;
- Mr. Fahad Saleem, Senior Environmental Specialist;
- Mr. Ibadullah Khan, Ecologist/Biodiversity Expert;
- Ms Shehnila Hanif, Senior Environmental Scientist;
- Mr. Wasim Abbas; Senior Sociologist;
- Mr. Muhammad Asim, RS/GIS Analyst;
- Mr. Salman Randhawa, Hydrological Expert;
- Mr. Ayub Khawar, Dam Design Expert;
- Mr. M. Tayyab, Agronomist; and
- Mr. Asad Nazakat, Geotechnical Expert.



Figure 1.3: Study Area/AOI Map

2 ENVIRONMENTAL REGULATORY REQUIREMENTS AND FRAMEWORK

2.1 GENERAL

This chapter provides an overview of the official policy framework and legislation that applies for controlling the environmental consequences of the Project implementation and operation. The Project is expected to comply with all the policies, laws, guidelines, acts and legislations of the Pakistan and other related environmental aspects.

2.2 NATIONAL/PROVINCIAL POLICES, LAWS, REGULATIONS AND GUIDELINES

Following is the brief about the national and local laws, regulations and guidelines related to environment and resettlement,

2.3 NATIONAL CONSERVATION STRATEGY, 1992

Pakistan National Conservation Strategy (NCS), which was approved by the federal cabinet in March 1992, is the principal policy document on environmental issues in the Country (EUAD/IUCN, 1992).

The NCS outlines 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, restoration of rangelands, increasing energy efficiency, conserving biodiversity, supporting forestry and plantation and the preservation of the cultural heritage.

2.4 NATIONAL ENVIRONMENT POLICY, 2005

The national environmental policy 2005 aims to protect, conserve and restore Pakistan's environment in order to improve quality of life of the citizens through sustainable development.

The main objectives of the policy are:

- Conservation, restoration and efficient management of the environmental resources;
- Integration of the environmental considerations in policy making and planning process;
- Capacity building of government agencies and other stakeholders at all levels for the better environmental management;
- Meeting international obligations effectively in line with the national aspirations; and
- Creation of a demand for environment through mass awareness and community involvement.

2.5 NATIONAL CLIMATE CHANGE POLICY, 2012

The National Climate Change Policy provides a framework for addressing the issues that Pakistan faces or will face in future due to the changing climate. In view of Pakistan's high vulnerability to the adverse impacts of climate change, in particular extreme events, adaptation

effort is the focus of this policy document. The vulnerabilities of various sectors to climate change have been highlighted and appropriate adaptation measures spelled out.

The policy covers measure to address issues in various sectors such as water, agriculture, forestry, coastal areas, biodiversity and other vulnerable ecosystems.

Notwithstanding the fact that Pakistan's contribution to global greenhouse gas (GHG) emissions is very small, its role as a responsible member of the global community in combating climate change has been highlighted by giving due importance to mitigation efforts in sectors such as energy, forestry, agriculture and livestock.

Furthermore, appropriate measures relating to disaster preparedness, capacity building, institutional strengthening; technology transfer; introduction of the climate change issue in higher education curricula; ensuring environmental compliance through IEE and EIA in the development process; addressing the issue of deforestation and illegal trade in timber; promoting Clean Development Mechanisms (CDM); and raising Pakistan's stance regarding climate change at various international forums, have also been incorporated as important components of the policy.

The policy thus provides a comprehensive framework for the development of Action Plans for national efforts on adaptation and mitigation. This policy document is a 'living' document and will be reviewed and updated regularly to address emerging concepts and issues in the ever-evolving science of climate change.

2.6 NATIONAL DISASTER RISK REDUCTION POLICY, 2013

Disasters have an enormous and significant adverse impact on the development of key sectors of economy like agriculture, infrastructure, housing, health, and education and above all the environment, they result in a serious social and economic set-back to the sustainable development. Disasters also pose threat to increasing poverty and resultantly backslide the national development targets set to achieve the Millennium Development Goals (MDGs). Climate change induced disasters pose even greater threat to sustainable development in developing country like Pakistan which is ranked quite amongst the most vulnerable countries. Continuous floods of 2010, 2011 and 2012 are seen as an indication of more intense and frequent extreme events in the future.

Disaster risk reduction interventions were being carried out in the country till date by different departments / agencies in isolation at national, province and district levels. There was a strong need to give them directions and sound guidelines to align their activities in line with the true spirit of National Disaster Management Act, 2010 to counter the threats of disasters faced by the country. NDMA, being the lead focal agency for disaster preparedness and management, has therefore, embarked upon formulation of a comprehensive National Disaster Risk Reduction Policy through wider consultations with all stakeholders including all provinces, state of Azad Jammu and Kashmir (AJ&K) and regions. This policy covers disasters risk reduction in a more holistic way and introduces a proactive and anticipatory approach by laying special emphasis on risk assessment and prevention.

2.7 PAKISTAN LABOR POLICY, 2010

The main objective of the Labour Policy, 2010 is the social and economic well-being of the labour of Pakistan. The Labour Policy, 2010 has following four (04) parts:

i) Legal Framework;
ii) Advocacy: rights of workers and employers;
iii) Skill development and employment; and
iv) Manpower export.

2.8 POVERTY REDUCTION STRATEGY PAPER, 2003

The full Poverty Reduction Strategy Paper of Pakistan (PRSP), prepared after a long consultative process involving the ministries, provincial and district governments, civil society, various interested groups, donors and grass root communities across the provinces of Pakistan. It outlines the broad framework and strategy for poverty reduction based on four (04) pillars:

- Accelerating economic growth while maintaining the macro-economic stability;
- Improving the governance;
- Investing in human capital; and
- Targeting the poor and vulnerable.

The PRSP also highlights the programs and policies of the Government under each of these pillars and proposes indicators to monitor the outcome of these policies as well as intermediate indicators for social sectors.[3]

2.9 NATIONAL FOREST POLICY PAKISTAN, 2001

This policy covers the Renewable Natural Resources (RNR) of Pakistan i.e. forests, watersheds, rangelands, wildlife, biodiversity and their habitats. The policy seeks to launch a process for eliminating the fundamental causes of the depletion of RNR through the active participation of all the concerned agencies and stakeholders, to realize the sustainable development of the resources. It is an umbrella level policy providing guidelines to the Federal Government, Provincial Governments and territories for the management of their RNR. In consonance with it, the Provincial and District Governments may devise their own policies in accordance with their circumstances.

The goal of this policy is to foster the sustainable development of RNR of Pakistan, for the maintenance and rehabilitation of its environment and the enhancement of the sustainable livelihoods of its rural masses especially women, children and other vulnerable groups.

The elements of the policy are as follows:

- Reducing the impact of socio-economic causes;
- Population planning in critical ecosystems;
- Providing substitutes to firewood in the wooded mountains;
- Reducing poverty, poverty of opportunity and Powerlessness;
- Reducing political interference in the Forestry and Wildlife Departments;
- Renovating and invigorating the institutions of RNR;
- Supporting Local Governments in the sustainable development of their RNR;

[3] *www.finance.gov.pk*

- Policies for fragile ecosystems;
- Riverine forests;
- Irrigated plantations;
- Preservation of relict and unique forests;
- Wildlife;
- Rangelands and desert ecosystems; and
- Planting of trees and fodders on farmlands.

2.10 NATIONAL RESETTLEMENT POLICY AND ORDINANCE

As referred above, at present the only legislation relating to land acquisition and compensation is the Land Acquisition Act (LAA) of 1894. Experience with large-scale infrastructure development projects implemented by institutions such as WAPDA has demonstrated the need for a cohesive national policy for resettlement. Following a national consultative process, a national resettlement policy and a related ordinance were drafted known as Draft Resettlement Policy, 2002 which still has to be approved by the Government.

2.11 PUNJAB ENVIRONMENTAL PROTECTION ACT (PEPA), 1997 (AS AMENDED 2017)

Pakistan Environmental Protection Act, 1997 was the core legislation of Pakistan related to Environment. After the approval of 18th amendment powers of Pak-EPA have been delegated to provincial EPAs for the conservation and protection of environment. Punjab-EPA has prepared PEPA, 1997 (as Amended 2017) which was passed by the provincial assemblies of Punjab. These are fairly comprehensive legislation and provides legislative framework for protection, conservation, rehabilitation and improvement of the environment. It contains concrete action plans and programs for the prevention of pollution and promotes sustainable development.

The 'environment' has been defined in the Act as: (a) air, water and land; (b) all layers of the atmosphere; (c) all organic and inorganic matter and living organisms; (d) the ecosystem and ecological relationships; (e) buildings, structures, roads, facilities and works; (f) all social and economic conditions affecting community life; and (g) the interrelationships between any of the factors specified in sub-clauses 'a' to 'f'.

The salient features of the law are:

- No proponent of a Project shall commence construction or operation unless he has filed with the Provincial Agency designated by the Provincial EPAs an EIA, and has obtained an approval;
- Establishment and Formation of the Punjab Environmental Protection Council;
- Prohibition of certain discharges or emissions;
- PEQS, 2016 for wastewater, air emissions and noise; and
- Law also empowers Provincial Government to issue notices and to enforce them for the protection of the environment.

The provinces are required to enact their own legislation for environmental protection. Other minor amendments include the increase of penalty cost for violations.

Moreover, the provincial Agency deals in following functions:

- The Agency can advise the potential proponent(s) for taking up environment assessment studies according to Schedule I and II of the PEPA 1997 as amended 2017;
- Issuance of NOC for an IEE or EIA.
- The Agency can impose penalties on the violators of the applicable laws / environmental polluters; and
- The Provincial Agency can inquire or investigate any environmental issue at its own or upon complaint from any person or community within its jurisdiction.

2.12 REVIEW OF IEE/EIA REGULATIONS 2000

These regulations / schedules present the policy and procedures for the filing / review and approval of environmental assessment reports. The Projects falling under Schedule-I of these regulations require an IEE Report while Projects falling under Schedule-II require an EIA for the issuance of NOC by the concerned agency prior to the construction of the Project.

According to the Pak-EPA Regulations 2000 for Review of IEE and EIA, the proposed Murunj Dam Project falls under Schedule-II Projects, (water management, dams, irrigation and flood protection).

The IEE / EIA regulations 2000 stipulate that within ten (10) working days of the IEE or EIA having been submitted, the provincial agency will confirm that the document submitted is complete for the purpose of review. During this time, should the agency require the proponent to submit additional information, it will return the IEE or EIA to the proponent for revision, clearly listing those aspects that need further discussion. Subsequently, the Provincial EPA would make every effort to complete an IEE review within forty-five (45) days and an EIA review within ninety (90) days of filing.

2.13 GUIDELINES FOR ENVIRONMENTAL ASSESSMENT

PEPA has published a set of environmental guidelines for conducting environmental assessments and the environmental management of different types of development Projects. The guidelines that are relevant to the proposed Project are listed below.

- Guidelines for the Preparation and Review of Environmental Reports, Pakistan Environmental Protection Agency, 1997;
- Guidelines for Public Consultation, Pakistan Environmental Protection Agency, May, 1997; and
- Sectoral Guidelines: Pakistan Environmental Assessment Procedures, Pakistan Environmental Protection Agency, October 1997.

2.14 GUIDELINES FOR CRITICAL AND SENSITIVE AREAS

Protected areas are of crucial and growing importance. Properly managed protected areas are based on the establishment of a system, which aims to:

- Safeguard the earth’s precious biodiversity;
- Protect outstanding areas of natural beauty; and

- Conserve areas of cultural significance.

In Pakistan, there exists a system of protected areas for the protection of endangered species, habitats, ecosystems, archaeological sites, monuments, buildings and other cultural heritage. The threats to protected areas in Pakistan are commercial-industrial pressures including mining, logging, overgrazing, cutting wood for fuel, development Projects and mismanaged tourism. Protected areas in Pakistan can be broadly categorized into two groups; i.e.

- Ecosystems; and
- Archaeological and cultural sites.

There is no central or federal level legislation for Wildlife conservation in Pakistan. However, each province has its own laws covering protected areas. There are separate Wildlife departments in the provinces that administer protected areas.

It should be noted that the above legislation consists of complicated, lengthy and legal documentation. Logically, only the relevant conservation authorities are in a position to provide the Proponent or Consultant with the most appropriate technical, scientific, administrative and regulatory assistance relating to the different legislations.

The GOP in the past years has taken some concrete steps to preserve, conserve and manage our national heritage, fauna and vegetation through the establishment of protected areas. This is being done through legislation, scientific research and education. In all the four (04) provinces, there are statutes that provide for creation and management of national parks, wildlife sanctuaries and game reserves.

The official classification of notified protected ecosystems in Pakistan consists of wildlife sanctuaries, national parks and game reserves.

In addition, there are protected forests, reserved forests, village forests/guzara forests, state forests and range lands. The relevant conservation authorities supply information on these areas to the Proponent or Consultant. In planning and sitting a Project, the Proponent needs to focus on being sensitive to the particular values of the relevant ecosystem or archaeological and cultural sites.

2.15 GUIDELINES FOR PUBLIC CONSULTATION

The Pak-EPA published these guidelines to deal with possible approaches to public consultation and techniques for designing an effective program of consultation that reaches out to all major stakeholders and ensures the incorporation of their concerns in any impact assessment study. These guidelines cover:

- Consultation, involvement and participation of stakeholders;
- Effective public consultation (planning, stages of EIA where consultation is appropriate); and
- Facilitation involvement (including the poor, women and NGOs).

2.16 PUNJAB ENVIRONMENTAL QUALITY STANDARDS (PEQS), 2016

The PEQS, 2016, specify the following standards:

- Maximum allowable concentration of pollutants (32 parameters) in municipal and liquid industrial effluents discharged to inland waters, sewage treatment facilities and the sea (three separate sets of numbers);
- Maximum allowable concentration of pollutants (16 parameters) in gaseous emissions from industrial sources;
- Maximum allowable concentration of pollutants (two (02) parameters) in gaseous emissions from vehicle exhaust; and
- Maximum allowable noise levels from vehicles.

The PEQS for motor vehicle exhaust and noise was approved in 2016. These PEQS specify the exhaust and noise standards for in use vehicles and new vehicles (Petrol and Diesel vehicles).

The PEQSs for ambient air quality, drinking water quality and noise has been approved in 2016. These PEQS specify the following:

- Maximum allowable concentration of pollutants (nine (09) parameters) for ambient air;
- Maximum allowable concentration of pollutants (35 parameters) in drinking water; and
- Maximum allowable noise levels during day and night time for residential area, commercial area, industrial area and silence zones.

2.17 THE LAND ACQUISITION ACT, 1894

At this point, the only legislation relating to land acquisition and compensation is the LAA of 1894. The LAA is, however, 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 consider the rehabilitation and resettlement of disrupted populations and the restoration of their livelihoods.

2.18 THE TELEGRAPH ACT, 1885

This Act was promulgated for installation of telegraph poles and stringing. This Act makes a provision of installing poles/towers without acquiring any land. However, provision is there for temporary acquisition of land during the construction period. As such, compensation is made for the loss of crop for a specific period.

2.19 PAKISTAN PENAL CODE, 1860

The Pakistan Penal Code deals with offences where public or private property and/or human lives are affected due to the intentional or accidental misconduct of an individual or body of people. In the context of environment, the Penal Code empowers the local authorities to control noise, noxious emissions and disposal of effluents. The PEQS enforced by the EPAs supersede the application of this legislation on industries and municipalities.

2.20 AFFECTED PERSONS ORDINANCE, 2001

This Ordinance was promulgated in 2001 by the federal government to provide relief to persons or households affected by any Project due to loss of land or displacement. The Project under review is not affected by the provisions of this law as no displacement of population is expected to occur.

2.21 THE WEST PAKISTAN WATER AND POWER ACT, 1958

This Act authorizes WAPDA to construct and operate electrical T/Ls with Powers and obligations of a license under the Telegraph Act, 1910. This Act also establishes policy for land acquisition and compensation, as well as the degree of liability of WAPDA for damages sustained by landowners or others.

2.22 THE FOREST ACT, 1927

This Act provides rules and regulations for the protection of forests, control of timber and other forest-produce transit, village forest and social forestry. The Act is being revised as the law was framed for regulating forests all over undivided India before independence in 1947. It was adopted as it is, after the creation of Pakistan and it continues to remain in force till to date.

This act has been comprehensively formed and allocates power to the concerned agency to declare protected and reserved forests through government notification and specifies powers allocated to the forest officers. It also contains the description of power to acquire land and the powers to stop ways and water-courses in reserved forests, dealing of claims relating to shifting of cultivation, power to issue and publish notification to reserve trees, power to make rules for protected forests, power to declare forest no longer reserved, order on rights of pasture or transit forest-produce, record keeping by the forest officer(s), commutation of right to appeal, time limit for resolution of claims and appeals, notification of acts prohibited in such forests (unlawful cutting of trees), awarding penalties on violations etc.

2.23 PUNJAB WILDLIFE (PROTECTION, PRESERVATION, CONSERVATION AND MANAGEMENT) ACT, 1974

This Act was enacted in 1974 for the regulation of activities relating to protection, conservation and management of Wildlife in the province. Enabling rules were notified in the same year to enforce the Act.

According to Act, no person shall hunt any wild animal by means of Gun, drop spear, deadfall, explosives, bomb grenade, net or any other trap except under a permit and in accordance with the provisions of this act or the rules framed under this act.

According to provisions of the act, hunting of birds is permitted under permits to be issued by the Wild-Life Department of the Punjab province for specific number and seasons. Use of call birds or decoys is prevented except in case of ducks. Hunt is also prohibited after sunset or before sunset, except in case of all kind of ducks. Similarly use of Hawks of Dogs for coursing the game animals is prevented, except on payment of prescribed fee.

2.24 PUNJAB PLANTATION AND MAINTENANCE OF TREES ACT, 1974

The provincial government enacted this law in 1974 to regulate tree plantation and enforce measures for the protection of tree plantations in the province.

2.25 CUTTING OF TREES (PROHIBITION) ACT, 1975

The Act was enforced in 1975 to place restrictions on cutting of trees in order to restrain unchecked trend of tree felling without replacement plantations.

2.26 PROTECTION OF TREES AND BRUSHWOOD ACT, 1949

The Protection of Trees and Brushwood Act, 1949 prohibits cutting or chopping of trees and brushwood without prior permission of the relevant department in the provincial government.

2.27 PROVINCIAL LOCAL GOVERNMENT ORDINANCES, 2001

These ordinances, issued following the devolution process, establish regulations for landuse, 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.

2.28 ANTIQUITIES ACT, 1975

The Antiquities Act relates to the protection, preservation and conservation of archaeological/ historical sites and monuments.

2.29 EXPLOSIVES ACT, 1884

Under the Explosives Act, the Project contractors are bound by regulations on handling, transportation and using explosives during quarrying, blasting, and other purposes.

It is an Act to regulate the manufacture, possession, use, sale, transport, import or export of dangerous explosives. It also sets out the rules for grant or refusal of licenses, especially for the under-age group. It provides the right to appeal as well as making rules for inspection, search, detention, removal of any explosives being manufactured or possessed in violation of the Act, notification and inquiries into any serious accidents, punishment for certain offences and arresting the offenders.

2.30 WATER APPORTIONMENT ACCORD, 1991

In 1991, an agreement to share waters of the Indus River was reached between the four provinces of Pakistan in the form of the Water Apportionment Accord (WAA). This accord is based on both, the existing and future water needs of the four provinces.

The Water Apportionment Accord was agreed upon on March 16, 1991 at Karachi in a meeting of the Chief Ministers of the four provinces along with several provincial representatives. The accord allocates the share to provinces given in **Table 2.1.**

Table 2.1: Allocation of Share to Provinces Share

Province	Kharif (MAF)	Rabi (MAF)	Total (MAF)
Punjab	37.07	18.87	55.94
Sindh *	33.94	14.82	48.76
KPK (a)	3.48	2.3	5.78

Province	Kharif (MAF)	Rabi (MAF)	Total (MAF)
(b) Civil Canals **	1.80	1.2	3.00
Balochistan	2.85	1.02	3.87
Total	77.34	37.01	114.35
**	1.8	1.2	3
* Including already sanctioned Urban and Industrial uses for Metropolitan Karachi.			
** Ungauged Civil Canals above the rim stations			

The need for storages, wherever feasible on the Indus and other rivers was admitted and recognized by the participants for planned future agricultural development. For the implementation of this accord, the need to establish an Indus River System Authority (IRSA) was recognized and accepted.

2.31 THE CANAL AND DRAINAGE ACT, 1873

This is an Act to regulate irrigation, navigation and drainage. Throughout the territories to which this Act extends, the Provincial Governments are entitled to use and control for the public purposes, the water of all the rivers and streams flowing in natural channels, and of all the lakes and other natural collections of still water; and to amend the law relating to irrigation, navigation and drainage in the said territories.

2.32 LABOR, HEALTH AND SAFETY LEGISLATION

Punjab Occupational Health and Safety Act 2019 is the core legislation in Punjab for the health and safety of the workers, staff and visitors at construction site. Apart from this, the Constitution of Pakistan contains a range of provisions with regards to labor rights, in particular:

- Article 11 of the Constitution prohibits all forms of slavery, forced labor and child labor;
- Article 17 provides for a fundamental right to exercise the freedom of association and the right to form unions;
- Article 25 lays down the right to equality before the law and prohibition of discrimination on the grounds of sex alone; and
- Article 37(e) makes provision for securing just and humane conditions of work, ensuring that children and women are not employed in vocations unsuited to their age or sex and for maternity benefits for women in employment.

Labor law is enforced at both provincial and national levels. The employment agreement must comply with the applicable labor laws. There are various laws containing health and safety requirements including: Factories Act 1934; Provincial Factories Rules; Hazardous Occupations Rules 1963; Provincial Employees Social Security Ordinance 1965; Workmen's Compensation Act 1923 and Dock Laborers Act 1934.

2.33 HAZARDOUS SUBSTANCE RULES, 2003

Hazardous Substance Rules, 2003 deals with handling, storage, transportation and health & safety procedures to be followed in the workplace. These rules deal with the generation and handling of any kind of hazardous substance (solid, liquid & gas) as listed in Schedule I of the

rules. There are guidelines in the act for the provision of safety plans, waste management plans, hazardous material transportation procedures as well as reporting mechanisms in case accidents take place. Under these rules a license has to be taken from Federal/Provincial Agency for the handling and transportation of hazardous materials (Schedule II of Rules). This rule will be applicable in the case of handling lubricants, fuel and for gas cylinders. The contractor for handling hazardous waste has to be a licensed contractor. Contravention to any of these rules may cause cancellation of the license by the Federal/Provincial Agency as the case may be.

2.34 PUNJAB MINING CONCESSION RULES, 2002

According to Presidential Order 8 of Act 1961 and clause 61 of Land Revenue Act 1967 the rights of all minerals including sand and stone are invested to Government of the Punjab. The Province of Punjab exercised its powers and obligations under the Punjab Mining Concession Rules 2002 framed under the regulation of Mines and Oilfields and Minerals Development (Government Control) Act, 1948 to accommodate the locals for the exploitation of minerals resources on small scale and at the same time contemplate the grant of mining concessions to the foreign entrepreneurs for under taking mega mineral projects falling in the category of large scale mining in Punjab. Under the existing Rules, there is a lot of difference between large scale and small scale mining. The large-scale mining can be any mega project either undertaken by the foreign investors or by the local entrepreneurs, involving investment of PKR. 300 million or more in Pakistan currency. All the local chemical and cement manufacturing companies are in the category of large scale mining. The term small scale mining is confined to any mining project in which investment is for an amount less than PKR. 300 million in Pakistan currency. The short-term leases for Minor Minerals i.e. ordinary sand, sandstone, siltstone, slate stone, tuff, basalt & gravel, etc., are granted through open auction and are regulated under Punjab Mining Concession Rules, 2002.

2.35 ASIAN DEVELOPMENT BANK (ABD) SAFEGUARD POLICY, 2009

ADB's safeguard policy aims to help developing member countries (DMCs) address environmental and social risks in development projects and minimize and mitigate, if not avoid, adverse project impacts on people and the environment. Approved by ADB's Board of Directors in July 2009, the SPS builds upon the three previous safeguard policies on the environment, involuntary resettlement, and indigenous peoples, and brings them into a consolidated policy framework that enhances effectiveness and relevance. The SPS applies to all ADB-supported projects reviewed by ADB's management after 20 January 2010.

Besides identifying the general policy of the ADB about the EIA, this document lays down the procedures and guidelines for conducting EIA of the projects including the aspects to be considered in EIA, environmental planning and management, habitats, health and safety, public consultation and information disclosure procedures, Grievance mechanism etc.

2.36 INTERNATIONAL TREATIES AND CONVENTIONS

Pakistan is a member of several international organizations such as United Nations Organization (UNO), Organization of the Islamic Conference (OIC), South Asian Association for Regional Cooperation (SAARC), and the Economic Cooperation Organization (ECO). The

conventions, ratification dates and obligations related to the proposed Project are given in **Table 2.2**.

Table 2.2: International Agreements/Conventions Relevant to the Project

Sr. No.	Agreement/Convention	Ratification	Description
1	Convention on Biological Diversity, 1994 **Web Link:** https://www.cbd.int/	Signed in 1992 and ratified in 1994.	The Convention on Biological Diversity (CBD) has three main goals: conservation of biological diversity (or biodiversity); sustainable use of its components; and fair and equitable sharing of benefits arising from genetic resources. This is applicable to the Project for conservation of biological diversity and restoring habitats during the Project life.
2	The Rio Declaration, 1992 **Web Link:** http://www.unep.org/documents.multilingual/default.asp? documented =78 &articled = 1163	Signed on 13th June 1992, and ratified on 1st June 1994	The Rio Declaration comprises 27 principles which address important issues such as; sustainable development to integrate environmental protection into the development process; common but differentiated responsibilities to conserve, protect and restore the earth's ecosystems; public participation and information access at the national level, reduce and eliminate unsustainable patterns of production and consumption. The provision of the declaration is applicable for environmental protection during the Project life**.**
3	Kyoto Protocol, 1992 **Web Link:** http://unfccc.int/kyoto_protocol/items/2830.php	Ratified in 2005	The Kyoto Protocol is a protocol to reduce greenhouse gasses that cause climate change. It was agreed on 11th December, 1997 at the 3rd Conference of the countries to the treaty when they met in Kyoto, and entered into force on 16th February, 2005. As of November 2007, 175 countries have ratified the protocol. One hundred and thirty-seven (137) developing countries have ratified the protocol, including Brazil, China, India and Pakistan but have no obligation beyond monitoring and reporting emissions. The protocol is applicable to reduce the emissions from Project construction activities.
4	The Basel Convention, 1989 **Web Link**: http://www.basel.int/theconvention/overview/tabid/1271/default.aspx	Ratified 26th July 1994	Basel Convention on the control of trans-boundary movements of hazardous wastes and their disposal is an international treaty that was designed to reduce the movements of hazardous waste between nations, and specifically to prevent transfer of hazardous waste from developed to Less Developed Countries (LDCs). It does not, however, address the movement of radioactive waste. The Convention is also

Sr. No.	Agreement/Convention	Ratification	Description
			intended to minimize the amount and toxicity of wastes generated, for environmentally sound management as closely as possible to the source of generation, and to assist LDCs in environmentally sound management of the hazardous and other wastes they generate. The provisions of this convention imply to minimize the amount of waste generated and its management during construction and O&M phases.
5	Stockholm Convention on Persistent Organic Pollutants (POPs), 2004 **Web Link:** http://chm.pops.int/TheConvention/Overview/tabid/3351/	Pakistan signed the convention on December 6, 2001 and ratified it on 17 April 2008.	Convention seeks to protect human health and the environment from POPs as set out in Article 1, which are chemicals that remain intact in the environment for long periods, become widely distributed geographically and accumulate in the fatty tissue of humans and wildlife. This convention is applicable to the Project with reference to protect human and environment from POPS (if any) during the Project life.
6	Convention on the International Trade of Endangered Species (CITES), 1975 **Web Link:** https://www.cites.org/	Pakistan signed the Convention in 1973 and ratified it in April 1976.	The convention entered in to force on 1st July 1975. The principal obligations of contracting parties to the CITES are to safeguard the trade in rare or endangered species and it established a permit system to control imports and exports of wild fauna and flora. According to this convention species threatened with extinction whose movement between countries is prohibited except for conservation purposes such as captive breeding, species whose commercial trade is permitted but export permits are needed. The National Council for Conservation of Wildlife (NCCW) is the CITES Scientific and Management Authority in Pakistan. This convention is applicable during the construction and operation phase of the Project in terms of safeguarding the flora and endangered fauna such as migratory birds.
8	The United Nations Educational, Scientific and Cultural Organization (UNESCO) Convention on the Protection of the World's Cultural and Natural Heritage, 1972 **Web Link:** http://whc.unesco.org/en/convention text/	Pakistan ratified this convention on 23rd July 1976.	Convention concerning the Protection of the World Cultural and Natural Heritage - requires parties to adopt a general policy on the protection of the natural and cultural heritage, to set up services for such protection, to develop scientific and technical studies, to take appropriate legal, technical, scientific and administrative measures and to foster training and education for such protection.

Sr. No.	Agreement/Convention	Ratification	Description
			The convention is applicable for protection and conservation of cultural and heritage site (accidental discoveries) during the construction phase of the project.
9	The Rotterdam Convention on Chemicals, 1998 **Web Link:** http://www.pic.int/	Pakistan signed this convention on 9 September, 1999 and ratified on 14th July, 2005	The convention promotes shared responsibilities in relation to importation of hazardous chemicals. The convention promotes open exchange of information and calls on exporters of hazardous chemicals to use proper labeling, include directions on safe handling, and inform purchasers of any unknown restrictions or bans. Signatory nations can decide whether to allow or ban the importation of chemicals listed in the treaty, and exporting countries are obliged to make sure that procedures within their jurisdiction are complied. The convention is applicable with reference to proper labeling and safe handling of hazardous chemical if used during the Project implementation.

2.37 MANDATORY ENVIRONMENTAL PERMIT (ENVIRONMENTAL APPROVAL)

The following general stages have to be followed in the application and approval process for the obtaining an “Environmental Approval” for the proposed Murunj Dam Project.

a) Project Screening;
b) Preparation of EIA;
c) Submission of EIA;
d) Public Hearing; and
e) Issuance of Environmental Approval.

Detailed process for obtaining Environmental Approval according to PEPA-1997 as amended 2017 is as follows:

2.37.1 Project Screening

The initial step of any EIA is the Project screening. As per PEPA Review of IEE/EIA Regulations, 2000 provide the screening of the Project. The proposed Project requires an EIA in accordance with Schedule II.

2.37.2 Preparation of EIA

Keeping in view the applicable laws, regulations and guidelines this EIA has been prepared to initiate the process of Environmental Approval.

2.37.3 Submission of EIA

Under Section 13 of the PEPA Act 1997 as amended 2017, a Project falling under any category specified in Schedule-II, requires the proponent to file an EIA with the provincial

agency for obtaining the Environmental Approval. After preparation of EIA report, ten hard copies and two electronic copies need to be submitted to the concerned agencies.

2.37.4 Public Hearing

As per applicable laws after the submission of the EIA Report to the concerned EPA a Public Hearing will be arranged in which all the stakeholders and general public will be invited through open invitation to present and discuss the findings of the EIA study.

2.37.5 Issuance of Environmental Approval

Within ten working days of the filling of IEE or EIA; the concerned agencies will confirm that the document submitted is complete for the purpose of review. During this time, should the concerned agency require the proponent to submit any additional information, it will return the IEE/EIA to the proponent for revision, clearly listing those aspects that need further discussion. Subsequently, the concerned agency should make every effort to complete an IEE review within 45 days and an EIA review within 90 days of filing and finally issue conditional Environmental Approval having validity of three years. The Environmental Approval process for EIA is given in **Table 2.3**.

Table 2.3: EIA- Environmental Approval Process

Name of Authorization	Approval of EIA
Purpose (Regulated Activity)	Mandatory by PEPA-1997 as amended 2017.
Project Phase	Feasibility Stage
Approving Authority	Punjab-EPA,
Applicable Legislation	PEPA, 1997 as amended 2017.
Pertinent Regulations / Steps	Application form (Annexure II-Policy and procedures for the filing, review and approval of environmental assessments-EA). Notification of submission of EIA (Annexure III) by the receiving body. Form of register entries (Annexure IV) by receiving body. Public consultations. Form of environmental approval (conditional)-Annexure V.
Application File Contents	EIA. Application form (Annexure II-Policy and procedures for the filing, review and approval of environmental assessments). Submission of the prescribed fee to the provincial treasury account.
Application File Preparation	Consultants (on behalf of Client)
Applicant	Punjab Irrigation Department
Timeframe	Approx. 3-4 months.

3 DESCRIPTION OF THE PROJECT

3.1 GENERAL

This Chapter provides a brief description of the Murunj Dam Project design including the description and details of the dam, project components, construction aspects and operation and maintenance activities.

3.2 OBJECTIVES OF THE PROJECT

The proposed Murunj Dam is a flood water storage dam and is being planned and designed to manage the flood waters of Kaha Hill Torrent. The main purpose of the dam is the flood attenuation and to regulate water for irrigation purpose.

The other associated objectives of the proposed Dam are enlisted below:

- The Murunj Dam will create a 0.44 million acre-feet storage area reservoir which would supply irrigation water to the Gross Command Area (GCA) of 114,015 acres;
- The water storage will augment the short fall of the irrigation supplies to the Pachad area of downstream of the proposed Dam;
- The construction of the proposed Dam would reduce the damages caused by the flood water in the downstream areas and under construction Kachhi Canal through arresting the flood water in the proposed reservoir;
- This will bring socio-economic uplift and prosperity in GCA by the maximum utilization of the agricultural and livestock resources;
- The reservoir developed due to the proposed Dam will provide a recreational activity for the locals as well as the tourists;
- In addition to irrigation benefits, the generation of electricity by this hydropower will provide cheaper, renewable, environmental friendly and most needed power, keeping in view the present and future requirements of Pakistan especially rural and remote areas for the development of the country; and
- In addition, recharge of groundwater aquifer is also an indirect benefit associated with the proposed Dam.

3.3 PROJECT ADMINISTRATIVE JURISDICTION

The proposed project falls under administrative jurisdiction of the District Rajanpur, Punjab.

3.4 PROJECT LOCATION

The proposed dam site is located on Kaha hill torrent, 116 km west of Rajanpur district, Punjab Province, which is one of the major hill torrents of Dera Ghazi (DG) Khan Division. It rises from Suleiman Range in the province of Balochistan between Kohlu and Vitakri at an altitude of 6,730 ft (2,050 m) amsl. The project area can be accessed through metaled road from Fazilpur i.e. a town between DG Khan & Rajanpur. The location & accessibility map of project area is shown in **Figure 3.1**.

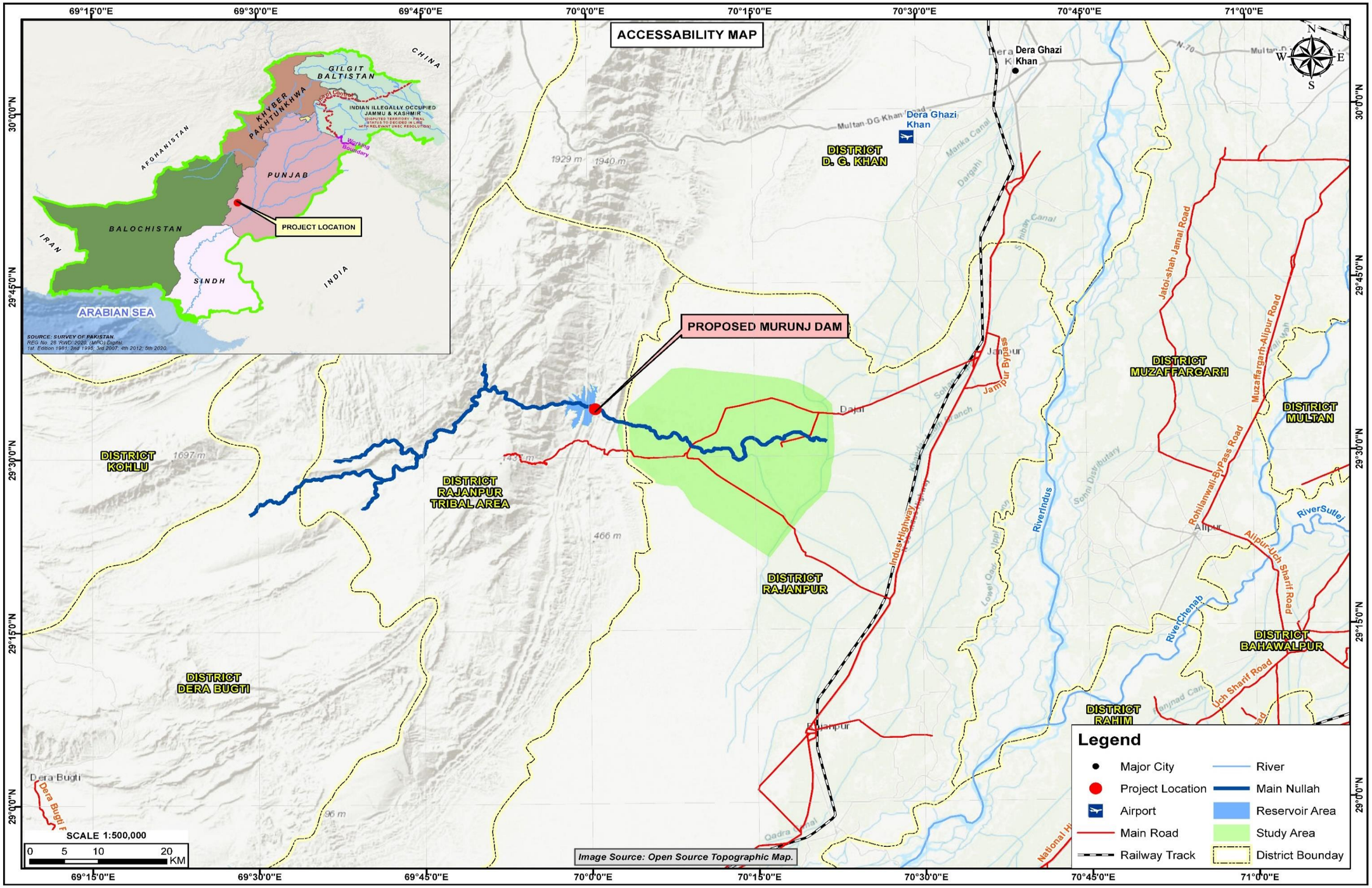


Figure 3.1: Project Area Accessibility Map

3.5 PROJECT LAYOUT

The proposed Murunj Dam is a floodwater storage dam and is being planned and designed to manage the floodwaters of Kaha Hill Torrent. The Project will comprise a 310 ft high Earth Core Rock Fill Dam that will create a reservoir with a gross storage volume of about 0.44 MAF. The main purpose of the dam is the flood attenuation and to regulate water for irrigation purpose. The catchment area at proposed dam site is about 5,500 km^2.

The layout plan of Murunj Dam Project is shown in **Figure 3.2** and salient features are shown in **Table 3.1**.

Table 3.1: Salient Project Features

Concerned Authorities	
Sponsored By	Government of Pakistan
Execution	WAPDA
Operation and Maintenance	WAPDA
Concerned Federal Ministry	Ministry of Water and Power
A. Main Dam	
Type	Zoned Earth Fill Dam
Height	310 ft
Valley Section Width	≈ 3700 Ft
Max. Conservation Level	1098 Ft
River Bed Elevation	≈ 860 Ft
Free Board	5.5 Ft
B. Reservoir	
Reservoir Area	4,350 acre
Reservoir Length	6.8 km
Gross Storage Capacity	0.44 MAF
Live Storage Capacity	0.101 MAF
Dead Storage Capacity	0.20 MAF
Conservation Level	1098 ft
C. Hydrology	
Catchment Area	5,500 km^2
Average Annual Inflow	178.44 million m^3 at 50% of time 90.96 million m^3 at 75% of time
Average Annual Total Sediment Influx	8.1 mst considering 25% Bedload
D. Command Area Development	
Gross Command Area (GCA)	≈ 114,015 acres
E. Hydropower	
Total Installed Capacity	6.0 MW

3.5.1 Main Dam

Main Dam has been proposed to be a Zoned Earth Fill Dam type with maximum height of 310 ft. Typical cross section of Main Dam is shown in **Figure 3.3**. Total Four (04) dykes of varying heights with a crest El. 1170 ft. has been proposed at the right side of the main dam to close the reservoir rim. The cross sections of dykes are shown in **Figure 3.4**.

a) Abutments of Main Dam and Dykes

The coordinates of left and right abutments of Main Dam and Dykes for defining the alignments are given in **Table 3.2**.

Table 3.2: Alignment / Abutment Coordinates of Main Dam and Dykes

Structure	Left Abutment		Right Abutment	
	Easting	Northing	Easting	Northing
Main Dam	1962085.87	10735173.32	1960337.82	10731925.79
Dyke 1	1959955.04	10730980.32	1960132.21	10730099.87
Dyke 2	1959558.89	10728503.20	1959540.02	10727768.05
Dyke 3	1959424.17	10727232.91	1959553.71	10726854.42
Dyke 4	1959424.17	10727232.91	1959553.71	10726854.42

b) Size of Main Dam

Main characteristics of Murunj Dam based are given in **Table 3.3**.

Table 3.3: Characteristics of Main Dam and Dykes

Feature	Main Dam (feet)	Dyke (Feet)
Crest Elevation	1170	1170
Crest Width	40	25
Crest length	3,754	Dyke-1=898, Dyke-2=735, Dyke-3=400, Dyke-4=567
River Bed Elevation	≈ 860	--
Maximum reservoir level	1,164.5	
Free Board	5.5	
Height of Main dam	310	Dyke-1=102, Dyke-2=81, Dyke-3=90, Dyke-4=18

c) Upstream and Downstream Shoulders

The slope for upstream shoulder is kept as 3.5H : 1V and a downstream slope of 2.5H : 1V with 25 ft berm at El. 1016 ft. was adopted for main dam. For Dykes upstream and downstream slope of 2.5H : 1V has been adopted.

3.5.2 Murunj Reservoir

Based on topographic and geological site features, zoned earth fill dam is selected as an appropriate type of dam for present project at Mud Kund site A. The Murunj Dam will create approximately 0.44-MAF storage area reservoir which would supply irrigation water to the Gross Command Area of 114,015 acres. The GCA is spread in Pachad area, District Rajanpur up to the Kachhi Canal.

At Kaha, proposed multipurpose reservoir (delay action & storage) has various storage components i.e., (i) to accumulate long-term sedimentation, (ii) to meet agriculture demands, (iii) to reduce flood peaks, (iv) flood surcharge zone.

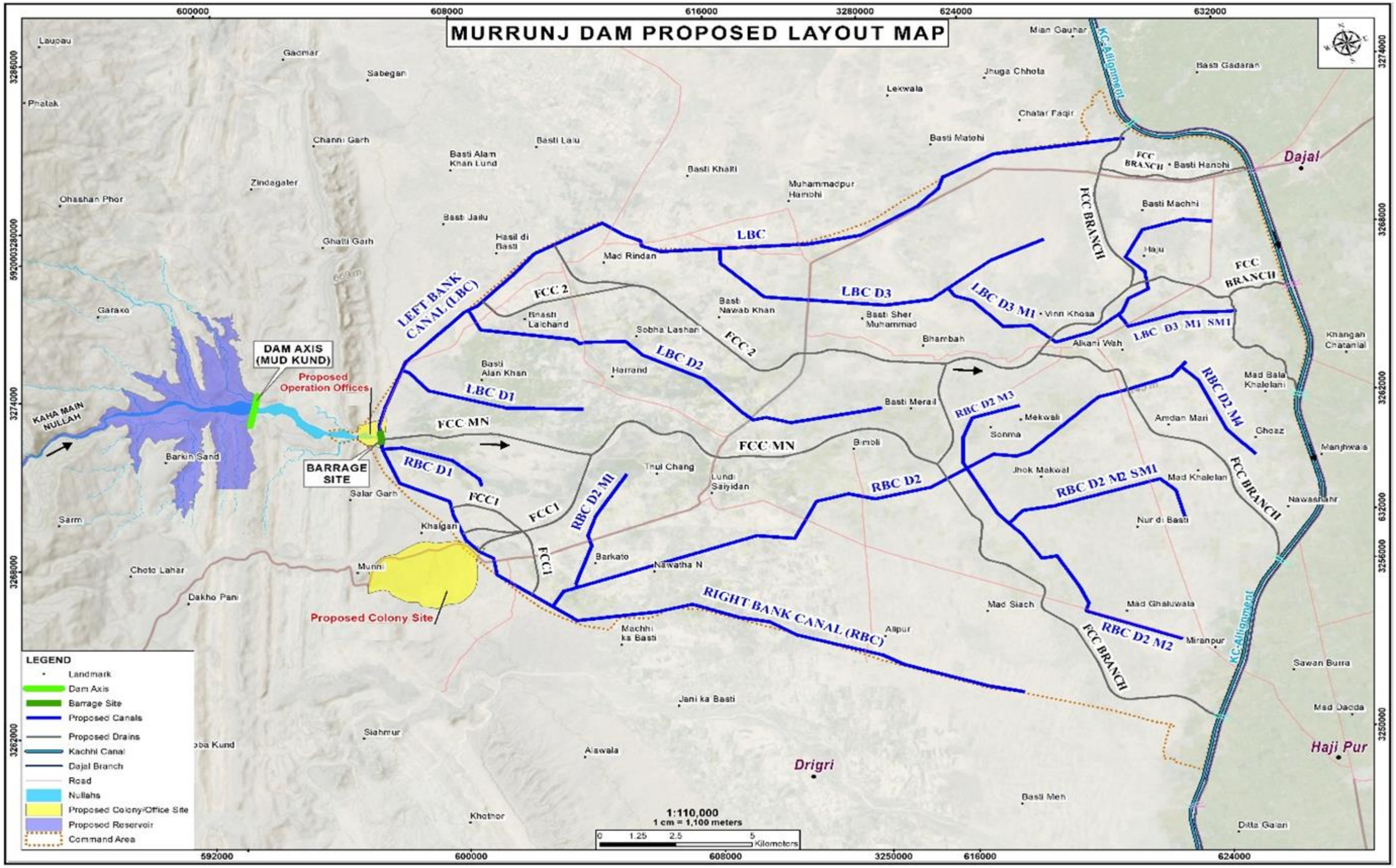


Figure 3.2: Layout Plan of Murunj Dam Project

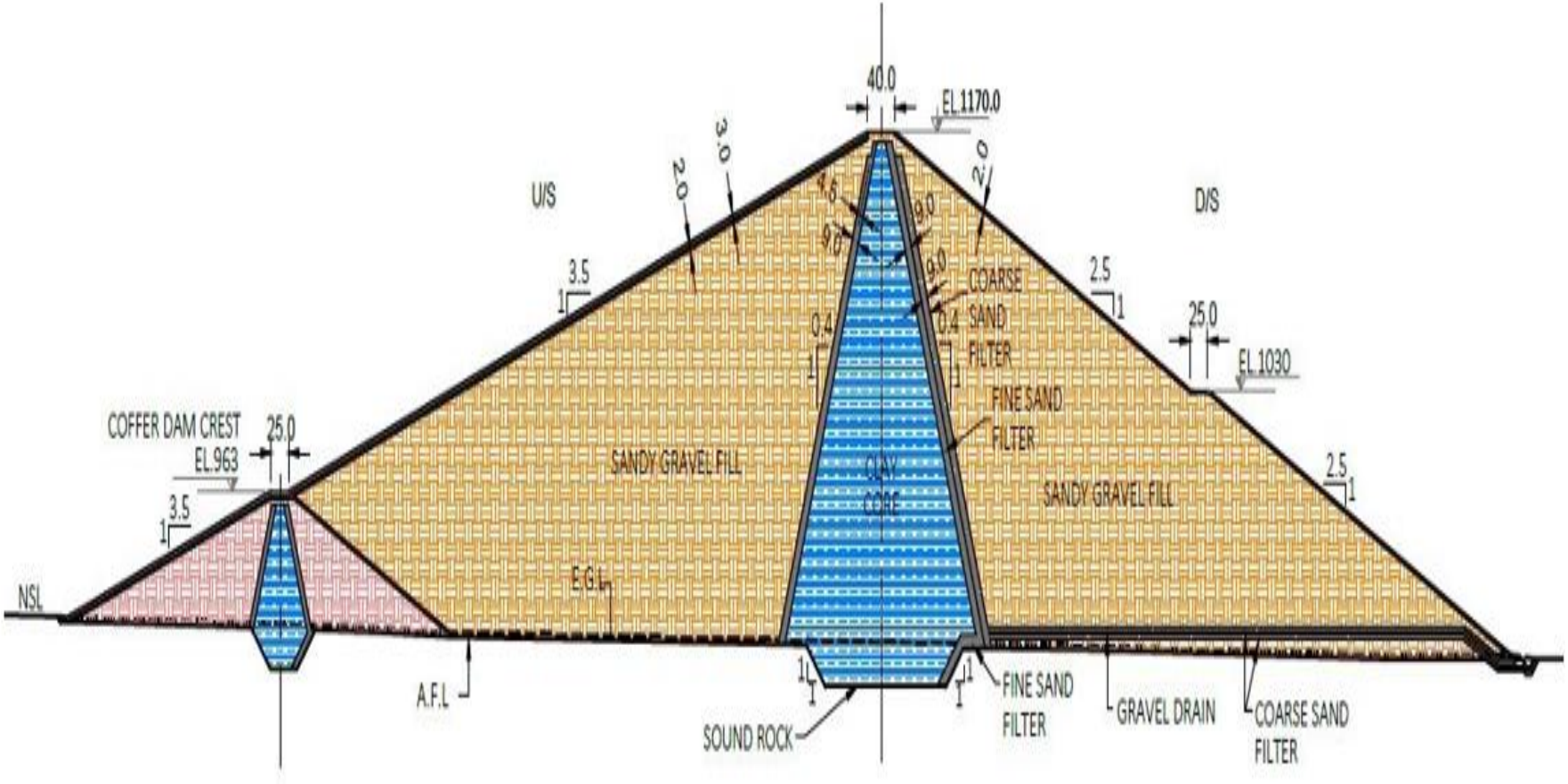


Figure 3.3: Typical Cross Section of Main Dam

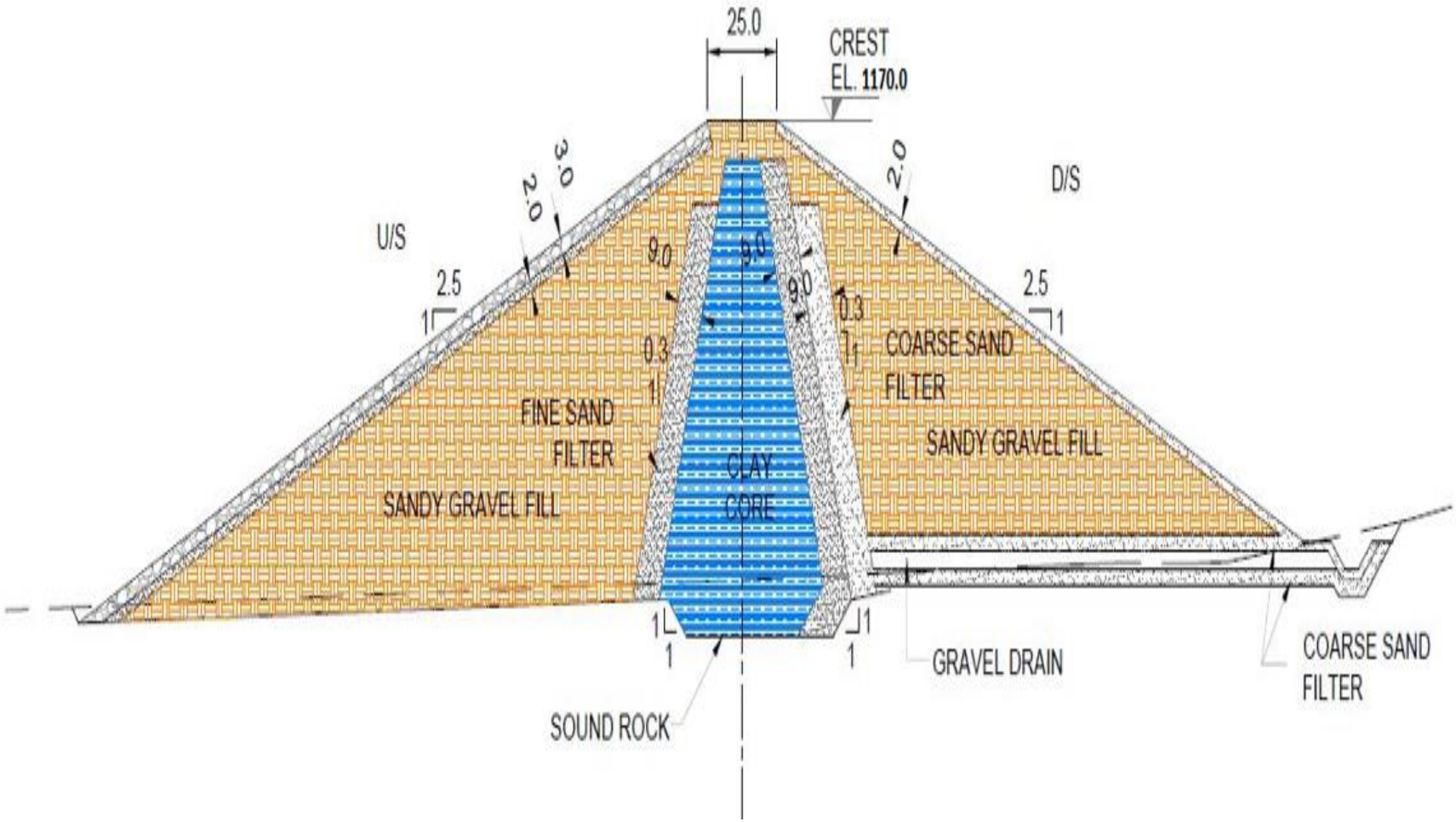


Figure 3.4: Typical Cross Section of Dykes

3.5.3 Murunj Dam Spillways

Keeping in view the hydrological parameters, spillway capacity has been calculated for two options i.e., gated and ungated. The most suitable layout of ungated spillway is adopted which generates maximum net benefits.

According to the International Commission on Large Dams (ICOLD) criteria, the Murunj dam falls in the category of large dams. As per ICOLD criteria, design flood of such dam is the %PMF or 10,000 - 100 return period whereas safety check flood is PMF or 5,000 – 10,000 return period. Spillway of Murunj Dam is sized to pass 10,000-year return period flood by satisfying minimum freeboard of 5.5 ft. The design concept of the finalized spillway option is based on maximum conservation level at 1147 ft. amsl, i.e. 23 ft. lower from Dam crest. It is an ungated spillway having ogee shape with 1250 ft. total waterway with no piers. Due to the high head involved, there will be high velocity along the chute and in the stilling basin.

- Discharge capacity 358,900 cusecs
- Maximum Water Level El. 1164.45 ft.
- Spillway Crest Elevation El. 1147 ft.
- Total Width section 1250 ft.
- Number of bays 01
- Type of Energy Dissipation Single Stilling Basin

The present spillway design concept is based on normal conservation level at 1147 ft. amsl, i.e. 23 ft. lower from Dam crest. It is an ungated spillway having ogee shape with 1147 ft. clear waterway. The spillway has been dimensioned to safely pass the design flood of 358,900 cusecs with full freeboard requirements and without over topping of the dam. Due to the high heads involved, there will be high velocities along the chute and in stilling basin.

A single Energy dissipation arrangement has been found necessary to prevent damage at the downstream of spillway. The spillway has been designed in a way that scour formation downstream of the stilling basin will not endanger the stability of dam itself and its appurtenant structures. Furthermore, the depth of scouring must not endanger the stability of bed slopes downstream of the dam. Plan and profile are shown in **Figure 3.5** & **Figure 3.6**.

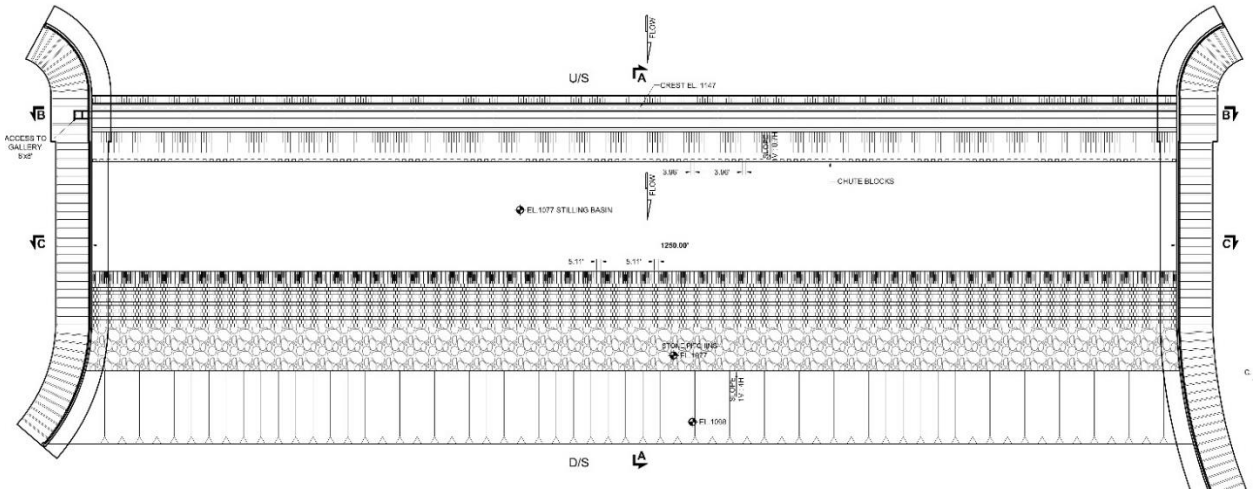


Figure 3.5: Plan of Ungated Spillway

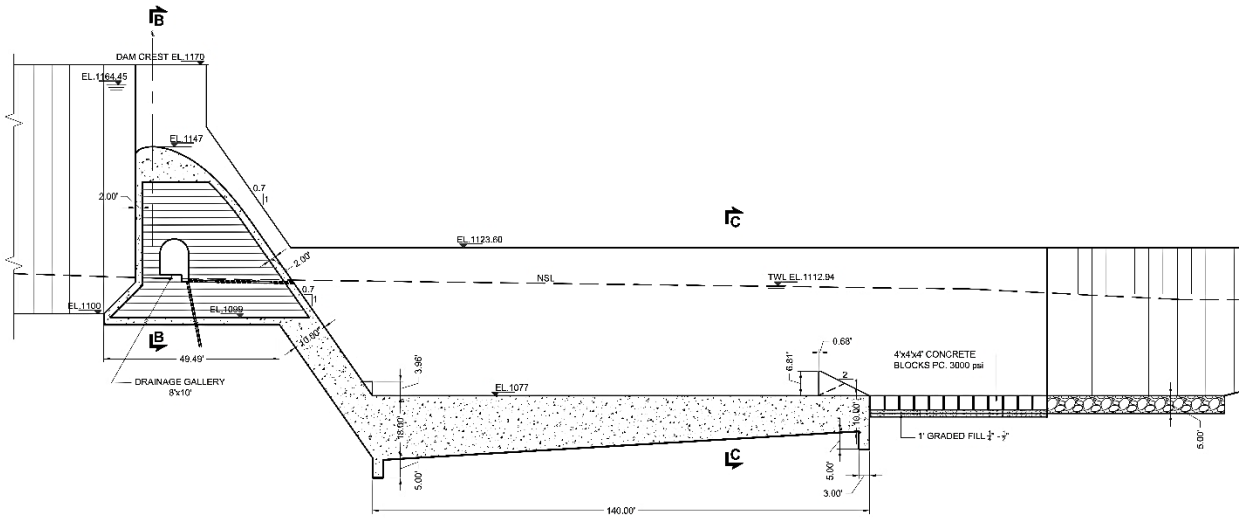


Figure 3.6: Profile of Ungated Spillway

3.5.4 Diversion Weir / Barrage

Flow released from Dam will be controlled / diverted to left and right bank canals through a diversion structure / barrage at Darrah site. Intake / head regulators will be provided to regulate the inflows into the off-taking canals. Escape channel is planned on left side of the structure to dispose of additional flood water without damaging the main structure.

3.5.4.1 Design of Diversion Structure

Water stored through construction of dam would be released in the Kaha Nullah for irrigation and flood relief purposes in accordance with the scheduled reservoir operation. This released water will be further managed through a diversion / control structure. In this regard, a multipurpose diversion structure has been planned to regulate the flows released downstream of the proposed dam through Low level outlets as well as spillway. For irrigation releases into the canals and to achieve required head to generate flows, heading of water is required. For this purpose, a diversion weir will be constructed. 25,700 cusecs will be released downstream in to the flood carrier channel while 13,000 cusecs will be safely diverted through fuse plug at upstream of the weir. Crest is fixed at 750 ft. amsl and HFL at 755.37 ft. amsl. This section is designed as an ogee shaped weir, having a 28 ft. high vertical upstream face.

3.5.5 Irrigation System

The flows of the hill torrents are being used for the irrigation of traditional agriculture crops in the Pachad Area since ancient times. Presently, the farmers in the proposed command area of Murunj Dam grow crops by utilizing flood water of Kaha Nullah through dispersion structures and also through rainwater. Due to the lack of proper irrigation system and regular irrigation supplies, farmers in the project area face low agricultural production and low farm income.

Under the proposed project, water will be released from the dam as per the approved water delivery schedule. Stored water of Kaha Nullah will be utilized for irrigating vast lands in the Pachad Area extending from Darrah to Kachhi Canal right bank. The stored water will be supplied to the command area through a network of newly proposed irrigation system.

3.5.5.1 Components of Irrigation System

Murunj dam irrigation system comprises of a diversion weir / barrage structure at Darrah site. Two (2) canals will off-take from the barrage named as Right Bank Canal and Left Bank Canal. Flow from the main canals will be further supplied to the agricultural lands through distributaries, minors, and outlets. Various hydraulic structures will be proposed to control & regulate the system flows. Schematic layout of irrigation system is shown in **Figure 3.7** and summary of irrigation system is presented in **Table 3.4**.

Table 3.4: Summary of Irrigation System

Sr. No.	Right Bank Channel	Length (ft)	Sr. No.	Left Bank Channel	Length (ft)
1	Right Bank Canal (RBC)	87,106	8	RBC/Disty-2 / M-4	8,150
2	RBC/Disty-1	12,594	9	Left Bank Canal (LBC)	100,991
3	RBC/Disty-2	77,500	10	LBC/Disty-1	12,594
4	RBC/Disty-2 / M-1	16,679	11	LBC/Disty-2	44,017
5	RBC/Disty-2 / M-2	31,964	12	LBC/Disty-3	40,933
6	RBC/Disty-2 / M-2 / SM-1	23,400	13	LBC/Disty-3/ M-1	42,301
7	RBC/Disty-2 / M-3	13,568			

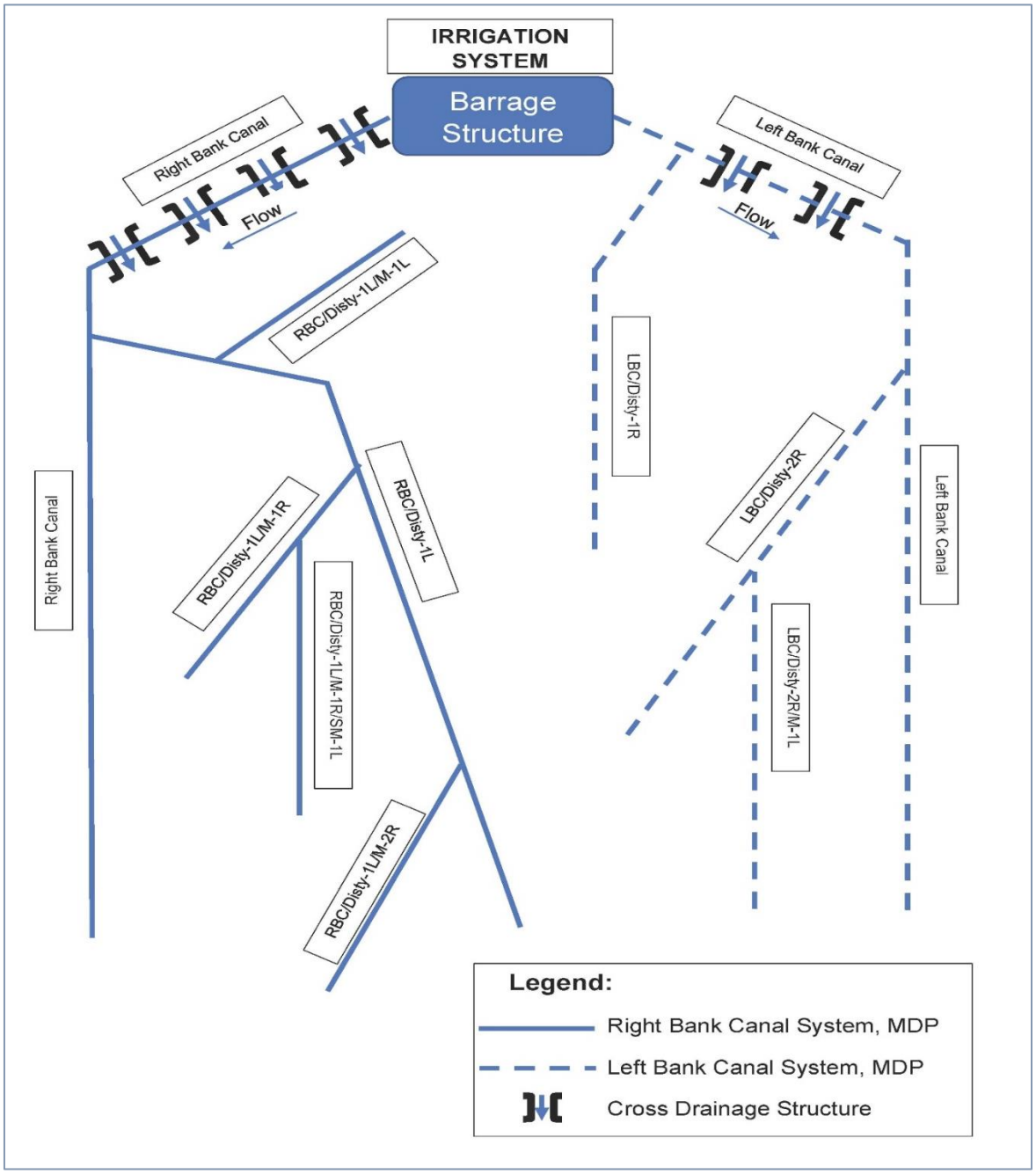


Figure 3.7: Schematic Layout of Proposed Irrigation System

3.5.5.2 Alignment of Irrigation Network

The Consultants have marked the alignment of the main canals, distributaries and minors and following considerations have been followed during finalization of alignments of the channels.

- The alignments have been so selected, so that these irrigate maximum of CCA with minimum length of channels;
- The main canals are aligned on left and right edges of the command area to serve as flood protection bunds and protect the proposed infrastructure from the sheets flows of adjoining minor hill torrents;
- Distributaries and minors are aligned to irrigate on both sides;
- Economize canal design with respect to cut and fill;

- Crossing of natural depressions is minimum;
- Excessive sinuosity has been avoided to minimize channel lengths; and
- Disturbance to existing or planned infrastructure and population settlements has been avoided as far as possible.

3.5.6 Flood Protection Works

The Right and Left Main Canals of the proposed system are aligned on extreme boundaries of the command area. The outer banks of these canals will be designed to act as flood protection bunds against the sheet flow generated from various small torrents in adjoining areas. This will ensure the safety of proposed infrastructure, villages and agricultural lands. Stone-pitching may be proposed along the outer banks to reduce the erosive action of expected sheet flows.

3.5.6.1 Flood Carrier Network & Drainage System

Flood carrier network / drainage system has a pivotal role in the development of command area of Murunj Dam Project. Development of flood carrier network is the key to harness the floods of Kaha hill torrent as well as hill torrents in the vicinity of Kaha for the development and protection of irrigation system. Flood Carrier Network (FCN) is a complex system to be managed under the proposed project.

Various small hill torrents originate from Suleiman range and spread over in command area of Kaha Hill Torrent. These streams outfall in Indus River stretched in a long reach. Flood flows in these torrents damage crops and other infrastructure. To counter and mitigate the hazardous effects of these torrents, channelization of hill-torrents has been proposed to dispose-off the flood water through existing drainage system of DG Khan Canal System. Under proposed network, Kaha Main Nullah (FCC-MN) will act as backbone of the system. This main nullah will collect and disperse the flood flows at designated disposal points.

3.5.6.2 Flood Carrier Channel

Two types of flood carrier channels (FCC) have been designed under this project.

- First type will collect the discharge originated from other catchments / hill torrents entering to Kaha command area and will dispose it into main Kaha.
- Other will comprise of Kaha main stream which will carry discharge of 1st type of FCC in addition to its own flood and will disperse flood waters to the respective cross drainage structures over Kachhi Canal for its safe disposal through DG Khan canal system.

Both types of FCC are being designed for 40 years return period discharge of respective hill torrent. Main stream of Kaha hill torrent will be designed for 25,700 cfs which is the cumulative discharge of cross drainage structures at Kachhi Canal at RD 425+630 (10,000 cfs), RD 441+195 (700 cfs), RD 455+390 (1000 cfs), RD 468+860 (5,000 cfs), RD 489+965 (7,000 cfs) and at RD 511+050 (2,000 cfs).

List of proposed FCCs along with summary of progress is presented in **Table 3.5**, Schematic layout of flood carrier network under Murunj Dam Project is briefed as line diagram in **Figure 3.8.**

Table 3.5: Summary of Flood Carrier Network

Sr. No.	Channel	Length (ft)	Discharge (cfs)
1.	FCC-MN	106,965	25,700
2.	FCC-1/1	8,778	1,400
3.	FCC-1/2	6,653	9,400
4.	FCC-1/3	5,482	2,000
5.	FCC-1/4	8,175	1,400
6.	FCC-1	12,850	12,950
7.	FCC-2/1	17,446	4,300
8.	FCC-2/2	11,017	11,300
9.	FCC-2	38,452	14,550
10.	FCC-MN/B1	48,742	2,000
11.	FCC-MN/B2	40,362	7,000
12.	FCC-MN/B3	27,269	5,000
13.	FCC-MN/B4	6,730	1,000
14.	FCC-MN/B5	32,247	700
15.	FCC-MN/B6	6,272	10,000

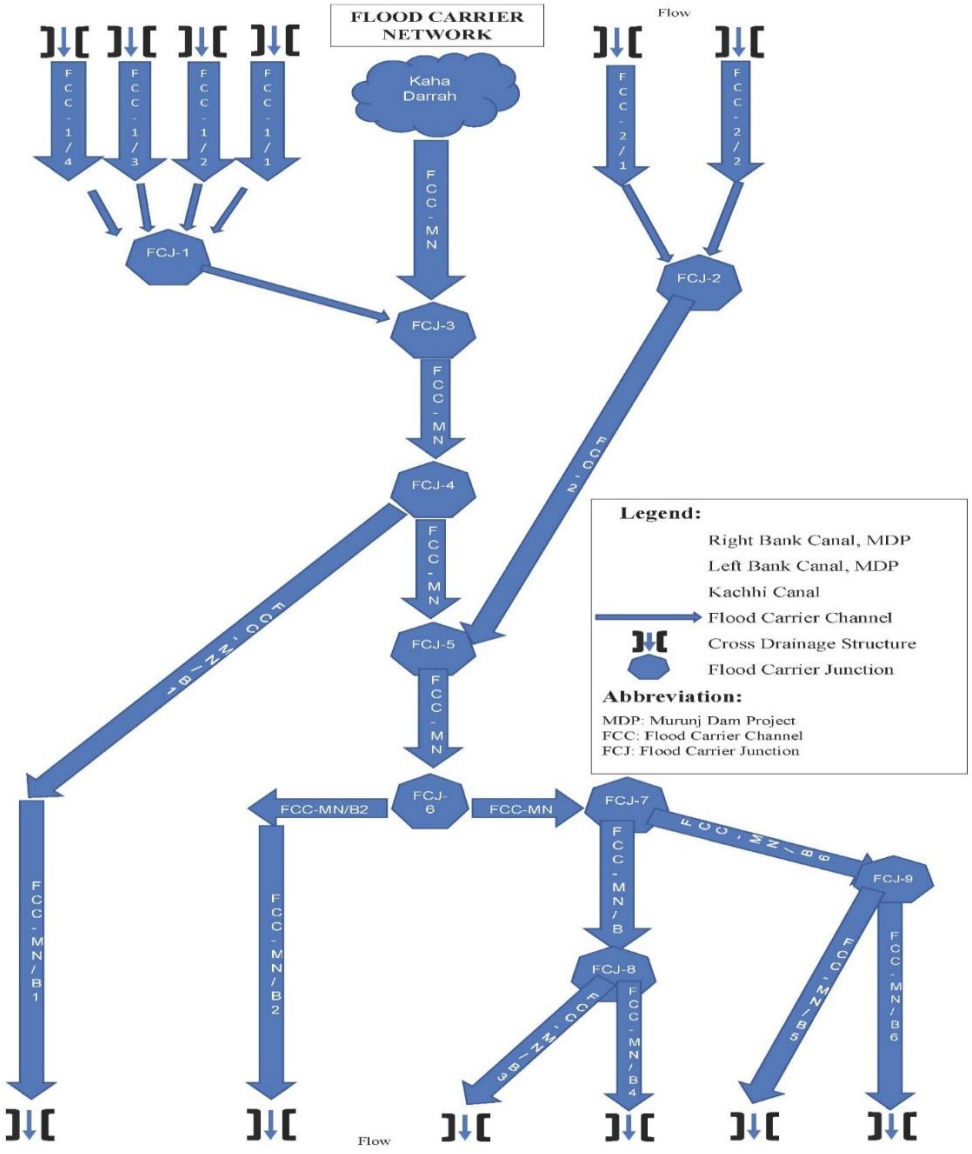


Figure 3.8: Schematic Layout of Flood Carrier Network under Murunj Dam Project

3.5.7 Hydraulic Structures

Various hydraulic structures will be provided for controlled flow distribution in any irrigation system. Following hydraulic structures are proposed to be designed for the Murunj Irrigation distribution system.

3.5.7.1 Head Regulators for Distributaries

Head regulators would be provided for all distributaries and minors to regulate the supplies. The head regulators will be located at the head of off-taking channel and provide control of flow entering the respective channel.

Left Side Head Regulator

To release 179.05 cusecs into left canal, crest of regulator is fixed at 738 ft. amsl. Width of crest is taken as 8 ft. HFL to generate required flow is calculated as 741.7 ft. amsl. A gate of size 8 ft. x 4 ft. is provided to regulate flow.

Right Side Head Regulator

To release 209.69 cusecs into right canal, crest of regulator is fixed at 738 ft. amsl. Width of crest is taken as 9.5 ft. Full supply level to deliver required flow is calculated as 741.7 ft. amsl. A gate size of 9.5 ft. x 4 ft. is provided to regulate flow.

3.5.7.2 Fall Structures

Fall structures are necessary on canals to provide flatter longitudinal bed slope to the canals, when the average natural slope of land is steeper than required longitudinal slope to design stable (non-silting and non-scouring) channels in regime condition. The falls also serve the purpose of economy in designing the channel with balance cutting and filling.

3.5.7.3 Energy Dissipation for Weir

To dissipate energy and contain the hydraulic jump of the flows coming over the diversion weir a stilling basin is required. A 60 ft. long and 590 ft. wide stilling basin is provided. The stilling basin is of USBR-Type-II.

The elevation of the cistern is 703.75 feet. amsl and the water level due to the discharge attains a level of 717.07 feet. amsl. Proposed protection works include cutoff walls, concrete blocks and stone apron. Chute blocks of size 0.77 ft are provided at toe of the glacis to dissipate the initial energy of the overflow. End sill height is 2.4 ft. To avoid uplift pressures at downstream of the weir, concrete blocks are provided, whereas, stone apron for protection against scouring.

3.5.8 Irrigation Outlets

As a general practice, for any new irrigation system, initially the pipe outlets are installed and maintained till the commands of outlets are well established. After the commands are confirmed and all command and land consolidation problems are resolved, pipe outlets are replaced with most suitable type of outlet. Therefore, Consultants also propose to design outlets as pipe outlets in MDP.

3.5.9 Road Bridges

Various types of bridges are being proposed as after the commissioning of the main canal and distributaries, there will be rapid development of the towns and villages. Since the canal, distributaries and minors will intercept the villages, therefore the bridges on the main canal and distributaries will have to be provided.

3.6 CONSTRUCTION ASPECTS

3.6.1 Land Acquisition

Approximately 3991 acres of land in reservoir area and 2733 acres of land in irrigation and drainage network is required for the proposed project interventions which will be acquired from government and private land owners.

3.6.2 Construction Materials

The materials used for construction purpose would include coarse aggregates (crush), fine aggregates (sand), steel, water, asphalt, reinforcement, cement etc. Availability of materials required for construction of the Earth-Core Rock fill (ECRD) type of embankment proposed for Murunj dam project is explored at and in the vicinity of project area. Construction of Murunj Dam involves an ample amount of construction materials comprising naturally available materials such as clay for central core, sandy gravel for upstream and downstream shoulder, fine and coarse sand for filters, rocks fragments for riprap and water. Moreover, materials like fine & coarse aggregates and cement will be used for spillway construction. The details of the construction material for the proposed project are given as under:

a) Material Quarries (Crushed Aggregate Source)

By crushing these aggregates, desired size can be produced without producing a significant amount of flat and elongated particles. However, aggregates produced by crushing slate contain a considerable amount of flat and elongated particles. The inclusion of slate may therefore be avoided during blasting and crushing. Crush stone were tested by the Design Consultant and suggested that this material is suitable for use in road construction, after crushing to the specified size and gradation. The quantities available are quite large and mining leases have already been obtained by various parties.

b) Fine Aggregate (Sand)

Good quality natural fine aggregate or sand of acceptable gradation will be obtained from licensed or approved entities dealing with fine aggregates.

c) Asphalt, Reinforcement and Cement

Asphalt, reinforcement and cement material will be transported from the factories of DG Khan and Rajanpur for MDP. Two cement factories i.e. DG Cement Factory and Maple Cement Factory are located at distances of about 150 km and 532 km respectively from the project area. Cement can be procured from any of these, preferably from DG Cement Factory to avoid extra haulage. Large quantities of steel will be required for the project construction. To fulfill the need, steel (grade 60) can be procured from Lahore and Karachi, preferably Lahore to reduce the haulage cost.

d) Quantity Estimation:

Required quantity of material for different structures of the project is given in the following **Table 3.6**.

Table 3.6: Estimated Material Quantities

Sr. No.	Description	Quantity (cu ft.)			
		Shell	Clay core	Riprap	Cobbles and Boulders
1	Main Dam	616841943.7	124107619.6	13107998.48	4160029.266
2	Dyke-1	15928563.33	1946602.878	1530323.12	375524.0999
3	Dyke-2	9445155.623	1139673.799	1293812.269	159763.6728
4	Dyke-3	4142892.252	739787.0131	248540.3761	142540.5996
5	Dyke-4	350680.0139	107463.2041	93049.45362	28885.56503
6	Coffer Dam	3635688.681	12957836.57	6492416.192	-
	Total	**650344923.6**	**140998983.1**	**22766139.89**	**4866743.204**
Total Quantity with 15% increase		**747896662.1**	**162148830.6**	**26181060.87**	**5596754.684**

3.6.3 Work Force

Man power demand estimation is an essential component to facilitate deployment of manpower. Total man power required for the proposed project will be estimated by the contractor at construction stage, whereas as per consultant's previous experience the workforce for proposed project has been estimated as 450 workers 150 skilled and 300 unskilled labour.

3.6.4 Construction Camps

Camp sites will be selected keeping in view the availability of adequate area for establishing camp sites, including parking areas for machinery, stores and workshops, access to communication and local markets, and an appropriate distance from sensitive areas in the vicinity. Keeping in view the following criteria guidelines, the Contractor has to identify the construction camp sites before start of the construction activities:

- There will be no resettlement issue for the location of the camps;
- Camp site will be away from the residential areas and sensitive receptors;
- Selection of sites for construction camps shall be near the project area having proper access to the nearby main/link road;
- The camps must be located in a place where the drainage from and through the camps will not threaten any domestic or public water supply;
- Camp site must be adequate in size to prevent overcrowding of necessary structures;
- The camp site will consider avoiding any damage of property, vegetation, irrigation, and drinking water supply systems;
- The camp site must not be subject to periodic flooding; and
- There will not be any ecological sensitive areas e.g. wildlife sanctuaries, game reserves, national parks, forest areas, etc. near to the construction camp site.

The tentative location of construction camps (02 in numbers) are shown in **Figure 3.9**.

3.6.5 Water Requirement

The source of water during the construction phase will be from water bowser tanks and groundwater (if available) from local sources will be used. The water consumption is estimated

to be 18,000 liters /day[4] for 450 construction workers comprising skilled and unskilled labors for the proposed Project.

3.6.6 Wastewater Generation

The wastewater generation is estimated to be 14,400 liters/day for 450 construction workers comprising skilled and unskilled labour for the proposed Project.

3.6.7 Solid Waste Estimation

Due to construction activities waste will be generated at construction site and contractors camp. The contractor will provide the estimated quantity of excavation material during the construction phase. These wastes will be generated due to the construction activities and the up to the extent possible the excavated materials will be reused, where applicable, for construction purposed. Solid waste generated during construction and camp sites shall be safely disposed in demarcated waste disposal sites.

The solid waste generation is estimated to be 202.5 kg/day (as per 0.45 kg/capita/day waste generation)[5] for 450 construction workers comprising skilled and unskilled labors for the proposed Project.

3.6.8 Power Requirement/ Power Source

The main source of electricity/electric power during construction phase will be diesel generators for construction camps and construction machinery and during the operational phase it would be taken from main electric power grid, supplying power to the main city. The Contractor(s) will provide the details about capacity, type and number of generators to be utilized during construction phase.

3.7 PROJECT IMPLEMENTATION SCHEDULE

The proposed Project is expected to be completed within seventy-two (72) Months.

3.8 COST OF THE PROJECT

The estimated cost of the construction works of proposed Project is PKR 120.23 Billion.

4. Water requirements for 450 Work Force = (450) x (40) = 18,000 liters/day
   Wastewater Generation = (18,000) x (80% of wastewater) =14,400 liters/day
5. Source: The World Bank Report 2012 – What a Waste: A global review of solid waste management. Based on UNEP estimates for waste generation in the Asia Pacific. Average is 0.45 kg/capita/day

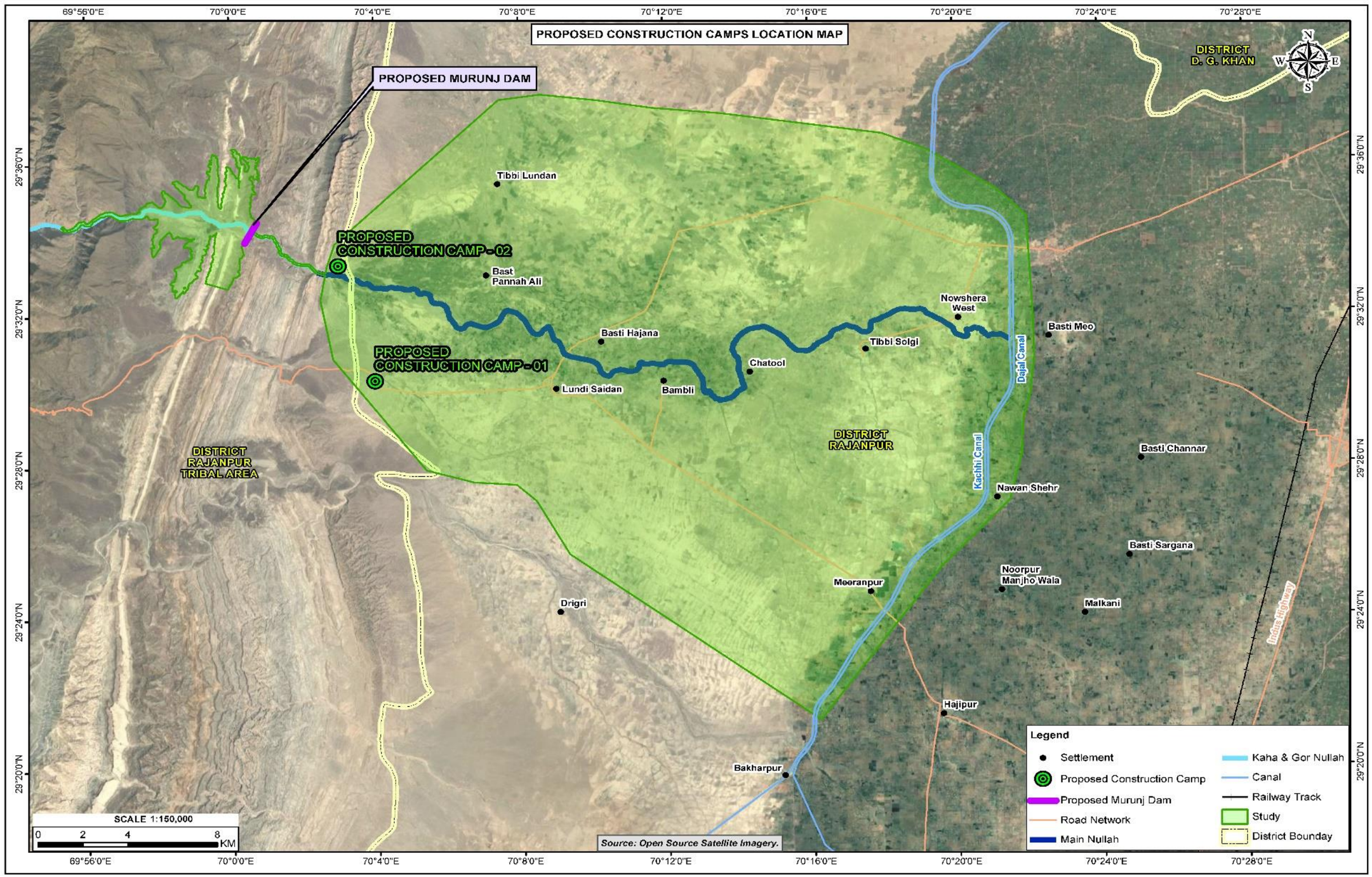


Figure 3.9: Tentative Construction Camp Locations for the MDP

4 ANALYSIS OF ALTERNATIVES

Analysis of alternatives is one of the core components of an Environmental Assessment. Analysis of alternatives ensures that all the available options and alternatives to the solution of a problem are being considered and compared. This comparison helps the proponent and the designers to adopt the most economical, technically viable and environmental and socially sound alternative for the implementation.

4.1 NO PROJECT OPTION

Pakistan is an agriculture country. Agriculture is critical to the development of Pakistan. Despite its declining share of Pakistan's Gross Domestic Product (GDP), agriculture remains central to the country's economy. It is the single most important source of employment and exports, accounting for two-thirds of employment and 80 percent of exports. Pakistan's agriculture sector is almost wholly dependent on irrigation: irrigated land supplies more than 90 percent of agricultural production and agriculture in most areas is not possible without irrigation because of Pakistan's uneven arid and semi-arid climate distribution with low, variable and unreliable rainfall patterns.

DG Khan and Rajanpur Districts of Punjab Province cover an area of 5.9 million acres (2.39 million ha) which consists of 17 percent canal command area, 35 percent Pachad area and 48 percent sub-mountainous and mountainous area. Thirteen major and 192 minor hill torrents emanating from Sulaiman Range devastate large areas during major floods.

Flooding from hill torrents in different parts of Pakistan constitutes one of the most serious environmental and economic hazards. Most of the settlements in these areas have developed around the banks of hill torrents as the rich alluvial soils transported by the hill torrents onto the plain areas have held much lure for the people. Since the time immemorial, people have been diverting flood flows to their fields by constructing small diversion bunds. These earthen bunds adequately divert low floods, but generally fail in case the flood flows exceed the manageable limits. In case of breaches in the diversion bunds, concentrated flows move downstream damaging standing crops, communication facilities and other infrastructure. It is generally beyond the capacity of the farmers to reconstruct these bunds during the flood season. A major flood, thus, deprives the farmers from the subsequent benefits of low floods. The complexity of hill torrents problems in DG Khan and Rajanpur districts has been posing a challenge to the ingenuity of engineers and planners. Hill torrents flooding have been the primary constraint in the development of these two districts.

Kaka hill torrent has been taken as one of the major hill torrent of the Rajanpur district. The area lies within the Arid Zone of the country and agricultural production is dependent on flood irrigation or soil moisture retention. Only a small part of the rainfall on the catchment area is utilized for agriculture, while the flood flow part cause serious damage to standing kharif crops, canals, roads, railway, and other infrastructure.

The flood flows largely exceeding the capacity of the hill torrent crossings breached canal system (Dajal Branch, DG Khan Canal and Kachhi Canal) at various places and caused serious damage to the canal system, crops and property in addition to loss of human life during the past floods. Since there is no trans-channel to the Indus River, the flood waters accumulate along the banks of channels and depressions in the canal command area thereby aggravating

the problem of water-logging and salinity. There is no proper dispersion structure at any of the distribution site and small diversion bunds constructed for this purpose are frequently damaged, resulting in unequal distribution. For effective flood management, proper distribution structures and training works are required.

In the Pachad area basin irrigation by hill torrents has been practiced since centuries. The fields are evenly terraced and bunded, so as to store about one-meter depth of water. A substantial amount of flood water was, thus, utilized in basin irrigation. Due to changes in the socio-economic conditions during the past three to four decades, the system has gradually deteriorated, and reduced the irrigation capacity. At present, even, the normal flood flows are not effectively controlled for irrigation and flow through to cause damage to canal irrigated areas, left of the Kachhi Canal, DG Khan Canal and Dajal Branch. Kachhi Canal, DG Khan Canal and Dajal Branch constructed almost parallel to the mountain range, and Kachhi Canal serves as the first line of defense against the flood flows from hill torrents. After the construction of CRBC and Dajal Branch extension, these canals will also face the brunt of flood flows from other hill torrents of Sulaiman Range.

In addition to inflicting heavy loss of life and property, the floods of Kaha hill torrent also create ecological imbalance in the area. Normal life remains disrupted for months. The health hazard has been increased due to contamination of drinking water. Programs of immunization to human beings and the livestock have to be launched. The value of property drops as a result of insecurity and uncertainty created by flood.

Based on the above-mentioned flood damages to infrastructure, canals, crops, livestock, livelihood and ecological imbalance; the construction of proposed dam at Kaha hill torrent is much important. Therefore, the no Project option means that no construction of flood protection dam, no reduction in flood damages and no improvement in irrigation and infrastructure system of area. This is not a feasible option as the attenuation high flow floods is the only option to assure the safety of infrastructure, canals (Kachhi, Dajal Branch originating from DG Khan Canal), present in the Study Area/AOI.

4.2 ALTERNATIVES FOR FLOOD MITIGATION

Various program level alternatives for the flood mitigation were used during the past few decades. The thirteen (13) major hill torrents of DG Khan and Rajanpur district for which flood management and mitigation will be required to save the Kachhi, Chashma Right Bank, DG Khan and Dajal Canals from flood damages. The utilization of flood flows for the agriculture development is also a secondary benefit. The two (02) out of thirteen (13) hill torrents namely Pitok and Sori Shumali have brackish water which is not fit for agriculture. On broader spectrum, following two types of flood mitigation plans were proposed in previous studies:

Development Plan 1: It is the short-term plan targeting the hill torrent management against 25 years return period flood. This plan has been proposed for management of flood water of all thirteen (13) major hill torrents including Kaha. It involves he improvements in the Rodkohi / Kamara irrigation system and design based on the 25-year return period flood.

Development Plan 2: It is the long-term plan targeting the hill torrents against 100 years return period flood. In this plan fifteen (15) dams have been proposed in upper catchment of these thirteen (13) major hill torrents. The proposed dam (Murunj Dam) is also one of the dams

proposed under this development plan. This development plan further divided into two sub plans:

(a) Flood mitigation through delay action dams in hilly terrain and existing Rodkohi irrigation channel for manageable flow; and

(b) Flood mitigation through retaining of flow in delay action cum storage dams in hilly terrain and controlled release should be allowed through low level outlets in accordance with the crop water requirements to obtain maximum agriculture benefits. The water flow will be supplied through irrigation channels as per Canal Act.

Based on the previous studies and evaluation, the development plan 1 will be effective for those hill torrents where some of the development works have already been constructed by the Government of Pakistan. The long-term flood mitigation measures under development plan 2 are more suitable for major hill torrents. Furthermore, the previous studies strongly recommended that the Development Plan 2(b) i.e. delay action cum storage dams will be technically suitable and feasible on economic ground for flood mitigation as a long-term measure which will be more effective for betterment and prosperity of the Pachad area of DG Khan and Rajanpur Districts of Punjab.

4.3 DAM TYPES ALTERNATIVES

The selection of dam types depends upon various factors including topography, geology and geotechnical conditions prevailing at the selected dam site. A detailed study was conducted after completion of the site investigations and site assessments. The site conditions were weighed up methodically for selecting best suiting dam types. Various aspects including abutment morphology, geologic conditions, availability of construction materials, etc., were examined in this process.

Entire range of dam types was considered and evaluated in the selection process. Selection of dam type impact type of construction material required which ultimately impact the local environment of quarry site, storage of material, etc. The types of dams studied for this Project included (a) earth core rock fill gravity dam, (b) concrete face rock fill dam (c) concrete gravity dam and (e) arch concrete dam. Finally keeping in view, the economy and the availability of the material *Zoned Earth Fill dam* type was selected for detailed analysis.

A comparative review of the suitability of major dam types considering the site-specific conditions is given in **Table 4.1** below:

Table 4.1: Comparative Review of the Suitability of Major Dam Types

Sr. No.	Relevant Aspect	Zoned Earth Fill Dam (Earth Core Rock Fill Dam)	Concrete Face Rock Fill Dam	Concrete Gravity Dam
1.	Abutment Morphology	Favorable	Marginally Favorable	Not Favorable
2.	Width of Valley Section	Favorable	Marginally Favorable	Not Favorable
3.	Engineering Characteristics of Abutment Rocks	Favorable	Favorable	Not Favorable
4.	Engineering Characteristics of Rocks at riverbed level	Favorable	Not Favorable	Not Favorable
5.	Depth to Bedrock in Valley Section	Favorable	Marginally Favorable	Favorable

Sr. No.	Relevant Aspect	Zoned Earth Fill Dam (Earth Core Rock Fill Dam)	Concrete Face Rock Fill Dam	Concrete Gravity Dam
6.	Orientation of Bedrock	Favorable	Favorable	Favorable
7.	Construction Material Availability	Available (Anticipated)	Available (Anticipated)	Available (Anticipated)
8.	Seismicity	Acceptable	Acceptable	Acceptable
9.	Construction Experience	Available	Very Little	Very Little
10.	Accessibility	Satisfactory	Satisfactory	Satisfactory
11.	Suitability	Most Suitable	Suitable	Not Suitable
12.	Technical Rating	**First**	**Second**	**Third**

Conclusions drawn from the above comparison are as follows:

- Zoned earth fill dam is considered most suitable to the site-specific conditions and thus is technically rated as the first choice;
- Concrete face rock fill dam type is considered also suitable to the site specific conditions and is technically rated as the second choice; and
- Concrete gravity dam is not considered suitable.

Finally keeping in view, the above stated suitability and technical rating, 'Zoned Earth Fill / Earth Core Rock Fill' type dam has been selected for the proposed Murunj Dam.

4.4 DAM SITE ALTERNATIVES

As per TORs of the project, the proposed dam site was located on Kaha Nullah near Murunj Valley. To finalize the Dam location, comparison of proposed and newly identified alternate dam sites based on various indicators i.e. accessibility to the site area, reservoir capacity, geological & topographical features and environment, etc. was required. In compliance with the contractual obligations and a better understanding of the ground realities, the Consultants conducted various site visits to the project area during the inception phase and thereafter. Experts/officials from WAPDA also accompanied the Consultants during these visits. Five (05) possible locations were visited and examined in details during these site visits. The alternate dam site location map is shown in **Figure 4.1**. These sites are categorized as follows:

- Alternate - 1 : Darrah
- Alternate - 2 : Mud Kund Site
  - Alternate - A : Mud Kund (about 6.5 km u/s of darrah)
  - Alternate - B : Mud Kund (about 6 km u/s of darrah)
  - Alternate - C : Mud Kund (about 5 km u/s of darrah)
- Alternate - 3 : Nila Kund (about 25 km u/s of darrah)

4.4.1 Darrah Site: Alternate-1

Darrah Dam site is located on Kaha nullah, about 110 Km NW of Rajanpur city. The access to the site is via Fazil Pur - HajiPur - Lundi Syedan - Harand Village and Darrah through a metaled road from Rajanpur to Lundi Sydan. From Lundi Sydan the dam site the access is through a jeepable semi metaled and kacha track. Travel time is 2.5 hours from Rajanpur city.

Coordinates of Darrah Dam site are: N: 29° 33.202', E: 70° 02.373 and bed Elevation is 220 m (msl) taken with the help of GPS. Bed width of the torrent nullah at the dam site is 200m to 230 m.

At dam site area Chaudhwan Formation is well exposed, consisting of conglomerate with alternate beds of sandstone, thin beds of siltstone/claystone present at places. Shales are also exposed at various locations. Generally, beds are orientated N20° to 30° E, dipping 40° to 50° SE. A thin layer of conglomerate consists of gravel and cobble with sand matrix present at the top of the Formation. Over all exposed rock is moderately weathered, fractured and broken. Open bedding joints, 20 to 30 mm wide, are observed.

Conglomerate is light brownish grey comprising boulders, cobbles, and pebbles of limestone, Quartzite and sandstone embedded in sandy and calcareous matrix.

At the right abutment, same rock units are exposed. The rock condition is slightly better than the left abutment.

4.4.2 Mud Kund Site: Alternate-2

Mud Kund Dam site is located on Kaha nullah about 5 Km upstream of Darrah Dam site and about 116 Km NW of Rajanpur city. The access to the site is via Fazil Pur - HajiPur - Lundi Syedan - Mud Kund; 3.5 hours journey from Rajanpur city.

The project area is easily approachable from Rajanpur city to Mud Kund through metaled road from Rajanpur to Lundi Sydan. From Lundi Sydan to dam site is accessible through a metaled, semi metaled, and kacha track, although at various places road is eroded by nullahs, local community has made a parallel access to cross the damaged road areas.

At Mud Kund two possible dam locations were visited in detail and are described below under Mud Kund site A, Mud Kund site B and Mud Kund site C. At location C of Mud Kund site rock conditions are formed favorable as compared to site A and B.

Mud Kund Site A

Coordinates of Mud Kund Dam Site A: N 29° 34.380 E 69° 59.839, Elevation 267m msl taken with the help of GPS.

The geology of the both abutments are mirror image of each other, dissected by Kaha River.

Alternate beds of greenish grey to greenish brown shale (highly weathered, weak and disintegrated) with thinly bedded limestone (whitish grey, fine grained, highly fractured, jointed broken). Generally, bed orientation is N15°to 25°E/ 35°SE

Geology is exposed at both abutments and easily erodible due to its weak nature. Hence they cannot be considered for abutment of Dam Foundation. Bed width of the torrent nullah at dam site A is 900m to 1030m.

Mud Kund Site B

Coordinate of Mud Kund Dam Site B: N 29° 34.265, E 70° 00.096, Elevation 262m msl taken from google earth. The geology of the both abutments is exposed. It consists of pale greenish grey or brownish shale, hard, flaky and calcareous with lime stone thinly to thickly bedded, chalky white and yellowish in color.

Shale is highly weathered, weak and disintegrated, partially destabilized, easily erodible. The basal part of both abutments consists of shale which cannot provide a suitable foundation.

Mud Kund Site C

Coordinates of Dam site are: N: 29° 34.081', E: 70° 00.669 and bed Elevation is 256 m (msl) taken with the help of GPS. Bed width of the torrent nullah at dam site is 800m to 850 m.

At right abutment Grey to light grey sandstone with reddish brown fine-grained siltstone/mudstone and intraformational conglomerate of Litra Formation (Neogene age). Generally, beds are orientated N20° E, dipping 42°SE. Exposed sandstone is massive fine to medium grained, strong to medium strong slightly to moderately weathered, fractured at places. Siltstone is highly weathered, while intraformational conglomerate are well cemented gravels cobbles of limestone, and sandstone origin.

The basal part of left abutment consists of massive sandstone beds, are well exposed, fine to medium grained hard slightly to moderately weathered. Sandstone beds are bisected by nullah flow at basal level. At U/S of left abutment alternate beds of weak sand stone and siltstone are exposed. Hence, Mud Kund site C is selected for detailed studies.

Detailed deliberations were held from time to time between officials of the Client and the Consultants representatives, wherein pros & cons of above sites were discussed. In view of the said discussions and apprehensions regarding Mud Kund Site, ***Mud Kund Site – Alternate C*** has been proposed as possible dam site for further studies. A barrage / diversion structure has been proposed at Darrah site for diverting flows to the left and right canals.

4.4.3 Nila Kund: Alternate-3

The Nila Kund site is located at about 130 Km NW of Rajanpur City. The access to the site is via Fazil Pur – Haji Pur - Lundi Syedan – Marri Top and Murunj. Access through the nullah beds and valleys is extremely difficult. Travel time is 4 hours from Marri top to Murunj.

Coordinates of Dam site are: N: 29° 33.082', E: 69° 47.824 with riverbed elevation of 590 m (msl) observed with the help of GPS. Bed width of the torrent nullah flow is about 100m to 120 m and is of meandering nature.

At the left abutment, massive limestone of Dungan Formation is well exposed. Exposed rock is slightly weathered and fractured at places. At the right abutment, basal part consists of greenish grey highly weathered/disintegrated shale mostly covered with scree material. Mudstone and limestone are also exposed at places. Limestone is moderately weathered, highly jointed and fractured. The shale is thinly bedded, brittle highly weathered and extremely weak and erode able. Folding structure can be seen in shale and limestone upstream of right bank. The left abutment is slightly higher as compared to the right abutment.

The cross-section of the river is narrow at this site. Both sides of the river have mild slopes of about 30o to 35o. Depending upon the availably of construction material an Earth fill, Earth Core Rockfill dam, Concrete Face Rockfill Dam or Concrete Gravity Dam may be a possible choice for this site. Location for the planning of spillway structure is not available near the proposed dam axis. Extensive excavation will be required to achieve the required level and width of the spillway. To close the reservoir rim boundary, no dykes are required at this alternative.

Selected Site

Detailed deliberations were held from time to time between officials of the Client and the Consultants representatives, wherein pros & cons of above sites were discussed. In view of the said discussions and apprehensions regarding ***Mud Kund Site C of Alternative 2*** has been proposed as possible dam site for further studies. A barrage / diversion structure has been proposed at Darrah site for diverting flows to the left and right canals.

4.5 SPILLWAY OPTIONS CONSIDERED

Initially for a dam crest level of 1200ft amsl, different alternatives of the spillway were considered not only from technical and economic point of view but also for the social and environmental impacts as well. The non-feasible alternatives in term of construction or excessive cost were omitted. Later on the spillway location was changed with a dam height of 1170ft amsl to make the project more economical and feasible. The most suitable location and layout of ungated spillway was adopted which delivers maximum net benefits.

Based on hydrological analysis and dam area topography, following spillway options were analyzed and shown in **Table 4.2**.

Table 4.2: Murunj Dam Project, Spillway Layout Options

Option No	Description
1	Gated (Chute spillway) on right bank (Q_d= 398,000 cusecs)
2	Gated (Chute spillway) on left bank (Q_d= 398,000 cusecs)
3	Gated and Ungated Spillway combined spillway at Saddle near right bank (Gated=238,000 cusecs and ungated=159,200 cusecs, combined=398,000 cusecs).
4	Totally ungated spillway at saddle on right side (capacity=398,000 cusecs)
5	A combination of Spillway and fuse plug/ flip bucket
6	Ungated spillway between saddle 2 & 3 (capacity = 358,900 cusecs)
7	Ungated spillway at saddle 9 (capacity = 358,900 cusecs)

All the alternates were checked for suitable design and those found unacceptable in terms of Social and environmental aspects were omitted. Finally, the Alternate 7 i.e. ungated spillway at saddle 9 is adopted as final design for Murunj dam Project.

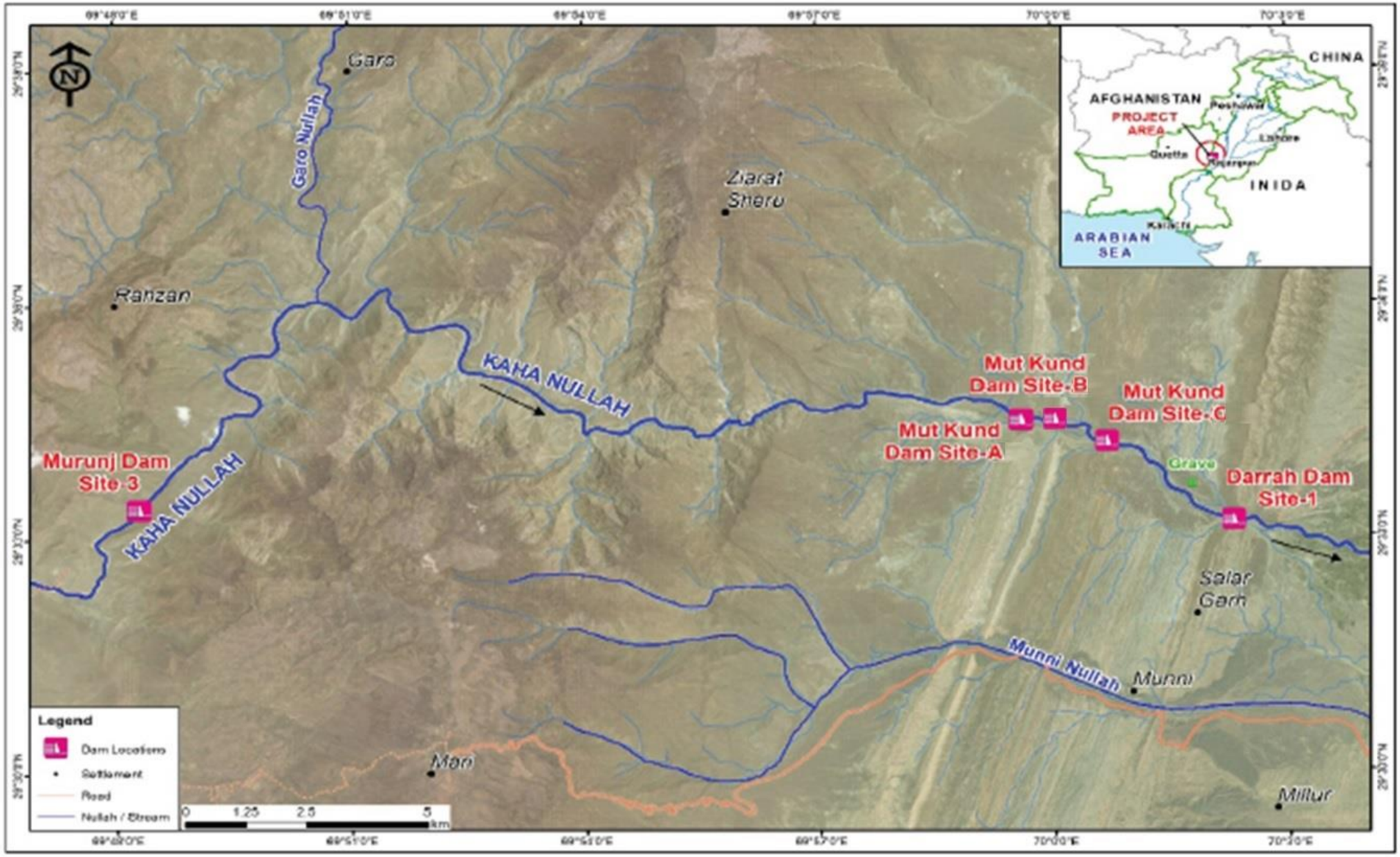


Figure 4.1: Dam Site Alternative Map

5 EXISTING BASELINE PROFILE

5.1 GENERAL

This section provides the existing conditions of the proposed AOI. These conditions will also act as a benchmark for the assessment of impacts as well as during the compliance and effect monitoring during and after construction of the Project. This baseline will also provide the datum for assessing the impacts and suggesting the mitigation measures, which will be implemented effectively at various phases of the Project activities and description of baseline conditions of the Project as well as the AOI.

5.2 APPROACH ADOPTED

The consultant's team comprised of experienced experts including: Environmental Scientist, Environmental Engineers, Ecologist and Sociologists was constituted to establish the baseline conditions of the AOI/Study Area (**Figure 1.3**).

For the collection of baseline information checklists/proformas, Satellite Imagery (Google Earth), and General Topographic (GT) sheets were used. AOI was delineated based on expert judgment, field reconnaissance, Consultant's experience, study of available maps and data collected through secondary sources and results of the consultation with the relevant departments.

Each expert prepared a checklist/proforma for the collection of baseline data of the important parameters of physical, ecological and socio-economic environment (Refer **Annex-II**). Meetings and scoping sessions with all the concerned Project stakeholders were held for the collection of primary information, disclosure of Project interventions, provide information and to clear queries and misconceptions of the Project. Government offices were contacted and visited for the verification of baseline data collected during the field visit and to obtain relevant published documents.

5.3 PROJECT ACCESSIBILITY

The proposed Project Area falls within the territory of District Rajanpur which is located about 116 km North West of Rajanpur city. Please refer to the location map as **Figure 1.2**. The Project site can be accessed through Fazilpur and Jampur which are mainly connected to the upstream and downstream country through Indus Highway (N-55). Travelling from Jampur, approx. at about 23 km two lane Jampur-Dajal road can be utilized which continues up to Dajal. Afterward, about 28 km one lane road connects Dajal with Lundi Saidan. Similarly, Lundi Saidan locality is also connected with Hajipur – Fazilpur through a two lane road of approx. 40 km.

Afterward, the Project site is connected with Lundi Saidan through 20 km long paved road toward Marri and then about 10km in north direction toward Mud Kund site though unpaved tracks. The specific location and accessibility to the Project Site is shown in Error! Reference s ource not found..

DG Khan and Rajanpur are also connected with other provinces of Pakistan by railway line apart from road network. The project Area Accessibility Map is shown in **Figure 5.1**.

5.4 FIELD VISIT

A team of experts carried out the field visit from 05th to 13th of December 2021 to the proposed dam site, potential reservoir area, canal command area in the vicinity of the reservoir located in Kaha Hill Torrent, Rajanpur and downstream command area in order to collect the baseline data of physical, ecological and socio-economic conditions.

Primary data was collected through direct field surveys while secondary data was collected from various authentic sources. The people living within the AOI were interviewed to have their views about the proposed project intervention and the perceived impacts on the natural environment within the AOI. This included information on land, surface water, groundwater, air, vegetation, animals and human. Stakeholder consultations were undertaken, details for stakeholder consultations are provided in **Section 6** of this report.

Following is the description of baseline conditions of the AOI.

5.5 PHYSICAL RESOURCES

The following section provides an overview of the information on physical environment of the proposed Project study area collected from primary as well as secondary sources. The major parameters covered include Physiographic and Topography, Geology, Soil, Seismicity, Climate and Meteorology, Ambient Air & Noise, Water Resources, Solid Waste, and Land Use.

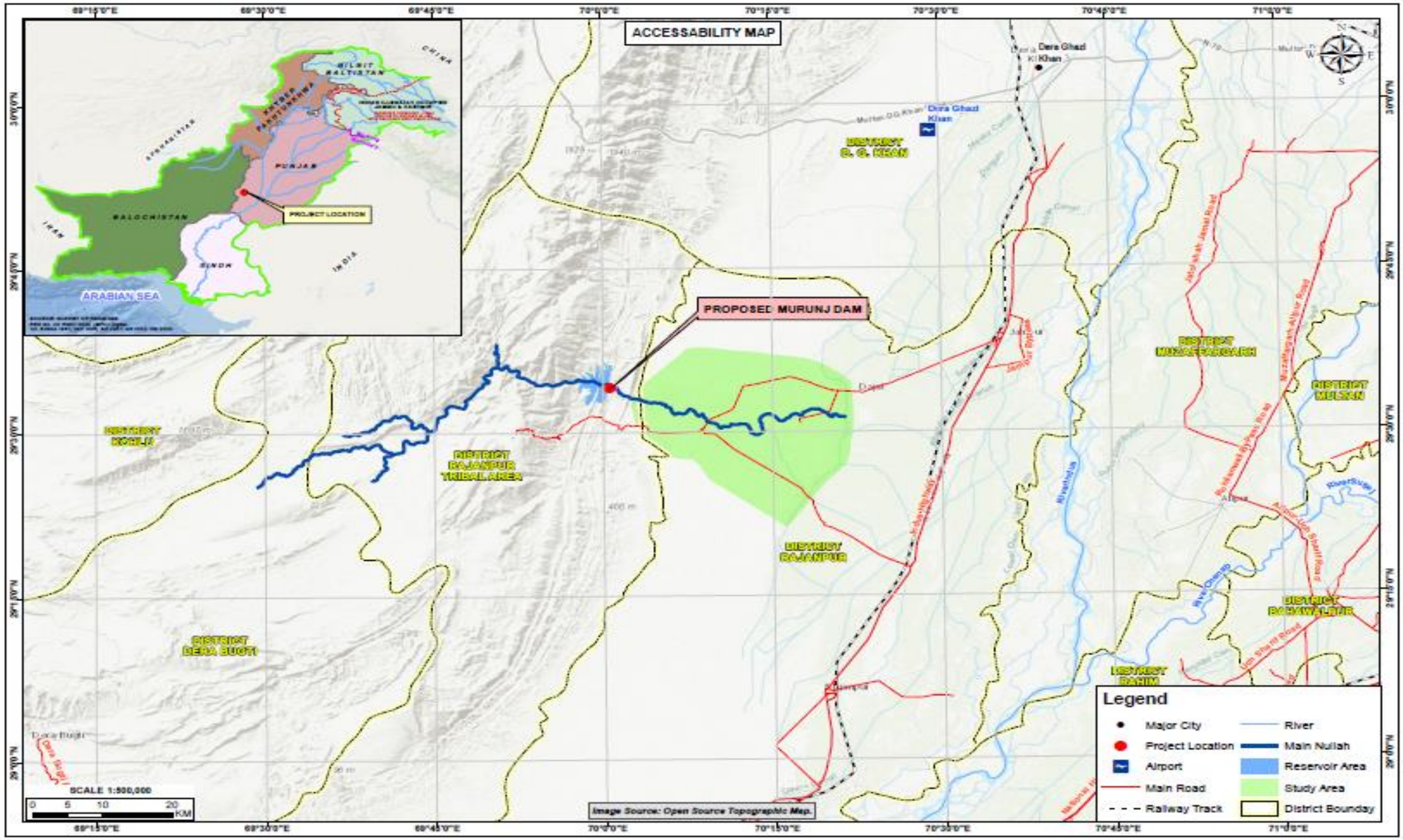


Figure 5.1: Project Area Accessibility Map

5.5.1 Topography

DG Khan and Rajanpur Districts are split into high mountains and plain areas. The mountains or hilly terrains are part of Sulaiman Mountain Range whereas the plain areas represent the Southern part of the tract that extends from Dera Ismail Khan to Rajanpur.

The Sulaiman Range has a general elevation that varies between 1,540 and 3,400 amsl. It contains a series of north-east trending, moderately steep, parallel ridges and broad to narrow valleys.

The younger rock formations occur in the eastern part while the older rocks are present on the western side of the Sulaiman Range. The rocks that form DG Khan area, range in height from 228 to 2,328 meters. The area is thus marked by rugged topography having mountain peaks and deep incised valleys. Badland topography and dissected terraces also constitute the physiographic features of hilly terrain.

The area is characterized by a combination of landforms produced by tectonic and peneplanation phenomena. The landform is constituted by ridges, piedmonts, sub-piedmonts flood plains, sand dunes, active flood plains, meander belts and presently running water storms. The average slope from the Indus river to the foot of the Sulaiman Mountain Range is about 02 percent.

The bed width of torrent at the proposed Murunj dam site is about 300 feet. Right abutment is high and has steep slope as compare to left abutment. The river is meandering in the u/s of the dam site containing perennial flows. The area is highly dissected, covered with piedmont and alluvial terrace deposits which are distributed in the u/s side. The elevation map is shown in **Figure 5.2**.

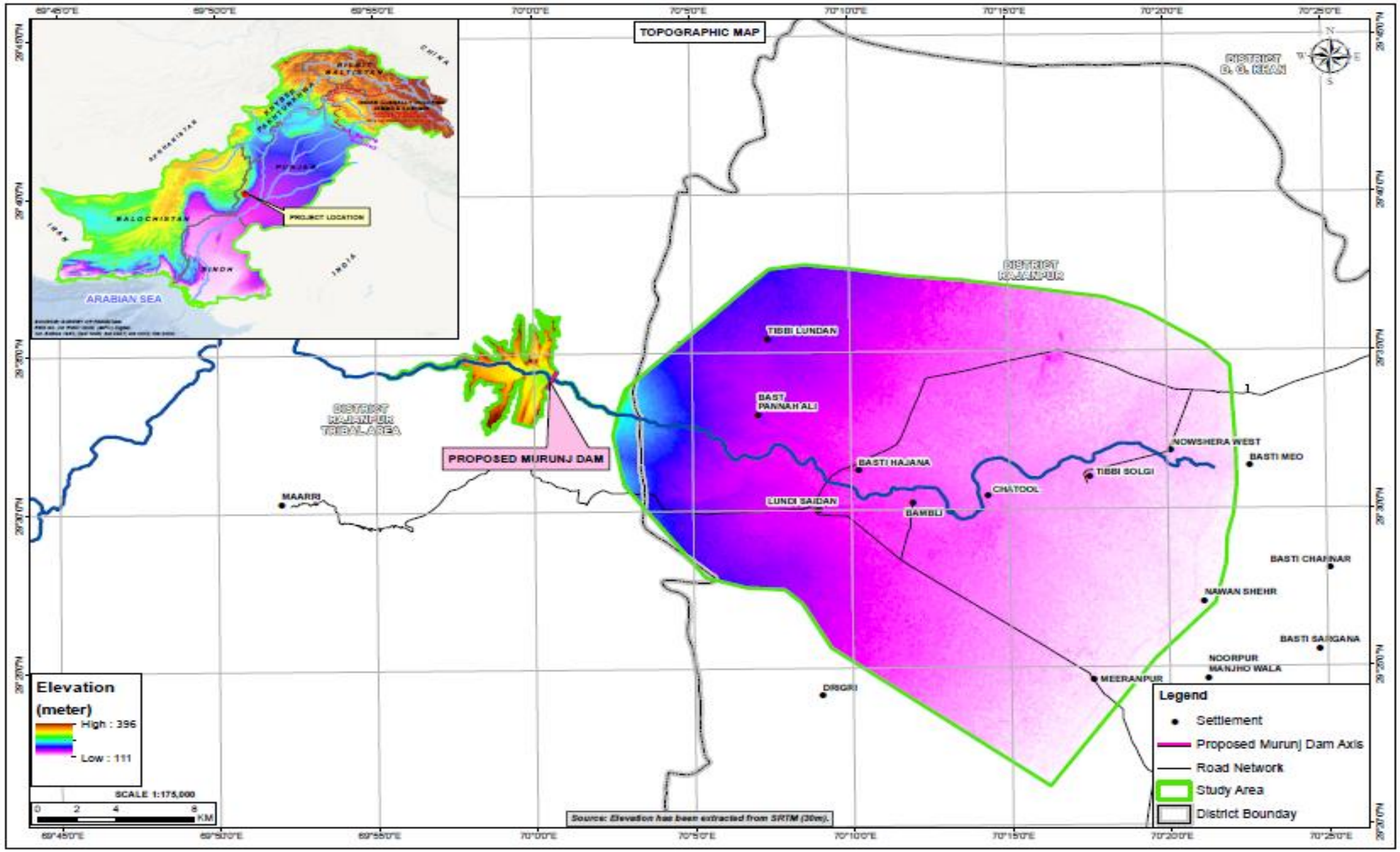


Figure 5.2: Project Area Elevation Map / Topography Map

5.5.2 Geology

5.5.2.1 General Geology

The sedimentary orogeny spread throughout the project area. The rock formations are exposed in the project area from Cretaceous to Neogene era. Rock mainly exposed of undifferentiated beds of Simber Formation (Phosphatic shale); Parh Formation (limestone) and Grey shale and sandstone belonging to Mughal Kot Formation (Cretaceous). Dungan Formation (Cretaceous) exposed in the area consists of limestone with subordinate shale. Undividable Ghazij and Kirther Formation (Eocene) mostly consists of marine shale and Limestone. Kirthar Formation (Eocene) Fossiliferous Limestone with interbedded shale, arenaceous lime stone can also be seen in the area. Ghazij Group Eocene (Shaheed ghat Formation: greenish brown shale with Limestone and minor Gypsum. Drug Formation: sand stone and conglomerate with coal seam. Baska Formation: Brownish shale and Gypsum). Vihowa Formation is missing in project area. Litra Formation (Neogene) Grey sandstone with reddish brown siltstone and intraformational conglomerate. Chaudhwan Formation (Neogene) consists of conglomeratic rocks mostly in gravel and cobble with sandy matrix.

5.5.2.2 Geotechnical/Geological Investigations (Mud Kund Dam Site C)

In order to evaluate the foundation conditions of subsurface at the site, Geotechnical investigations were executed to provide principal information i.e. geological assessment of the proposed dam site, properties of rocks and soils and tectonic assessment, required for design of the dam and appurtenant structures.

Left Abutment:

At the top of left abutment sandstone bed is exposed with thin layers of conglomerate. Thickness of sandstone bed is 54m. Sandstone is brownish grey, fine to medium grained, friable and low to very low strength. Conglomerate is matrix as well as supported of different rock types with reddish brown, medium to coarse grained sandy matrix. It is moderately jointed and low to medium strength. The underneath layer is shale strata which is about 26 m thick. Shale is reddish brown, splintery, very fine grained, calcareous, jointed, low to very low strength. Below shale strata, 25 m thick bed of mudstone. Mudstone is reddish brown, low to very low strength. Underneath the mudstone bed, 05 m thick siltstone bed has been observed. Siltstone is fine to very fine grained, calcareous, low to very low strength.

Right Abutment:

At the top of right abutment shale is exposed having approximate thickness of 11 m. Shale is reddish brown, splintery, fine to very fine grained, sparsely jointed, low to very low strength. Underneath the shale strata alternate beds of sandstone, siltstone and mudstone with variable thickness have been observed. Sandstone is light grey, fine to medium grained, medium strong, jointed, calcareous and friable. Siltstone is brown to brownish grey, fine to very fine grained, low strength. Mud stone is reddish brown, low to very low strength.

Nullah Bed:

At The top of nullah bed about 6.0 to 10.0m overburden covers the bed rock. Overburden consists of river deposits, rounded to sub rounded gravel and cobbles of sedimentary origin dominantly of limestone and sandstone. Below the overburden 10m thick bed of Shale exists.

Shale is brownish grey, splintery, low to very low strength. Underneath the shale strata 16m thick bed of sandstone exists. Sandstone is light grey, fine to medium grained, low strength, jointed, calcareous, and friable. Below the sandstone bed alternate beds of shale, siltstone and mudstone exist. Silt stone is light brown, fine grained, medium strong while the mudstone is reddish brown, weak to very weak. The Geological and tectonic map are shown in **Figure 5.3** and **5.4**.

5.5.3 Seismology

The proposed Dam site falls in Zindapir, Mari-Bugti anticlinal zone and Khalifat Sulaiman arc of Suleiman fold belt tectonic zone of Pakistan. Zindapir anticline is a major tectonic feature in the proximity of collision zone. The anticlinal has continental to shallow marine rocks of Paleocene to Eocene age.

The anticlinal axis runs almost in NS direction. Main geological and tectonic feature in the vicinity of Study Area/AOI are Ziarat, Khalifat, Harnai, Tatra, Tadri, Bark Khan, Kohlu, Mekhter, Murga Kibzai, Kingri and Chauhwan faults. No reliable authentic seismo-tectonic studies have been carried out in the region including DG Khan and Rajanpur districts so far.

Ministry of Housing and Works, Government of Pakistan has published “Building Code of Pakistan” (Seismic Provision 2007) in which maps of Seismic Zoning of Punjab are shown. **Figure 5.5** provides the Seismic Zones of Punjab. The boundaries of these zones are defined on the basis of peak horizontal ground acceleration (g) as shown in **Table 5.1.**

Table 5.1: Seismic Zones of Pakistan

Seismic Zone	Peak Horizontal Ground Acceleration (g)
1	0.05 to 0.08
2A	0.08 to 0.16
2B	0.16 to 0.24
3	0.24 to 0.32
4	> 0.32

* Where ‘g’ is the acceleration due to gravity.

The seismic zoning of Pakistan on the basis of determined ‘g’ generalized values may be applicable for buildings and other small infrastructure but not for mega structures like Dams, Barrages, Hydropower Stations, Large Bridges, etc.

Being located close to the collision boundary of the Indian and Eurasian plates, Pakistan lies in a seismically active zone. Probabilistic seismic hazard assessment carried out as part of the revision of the Building Code of Pakistan, Seismic Provisions (2007) shows that the Study Area falls in Moderate to High Seismic Zone i.e. Zone-2A, Zone-2B and Zone-3 with peak horizontal ground acceleration of 0.08 to 0.32g. The generalized “g” value and Seismic Zones may not be dependable and sufficiently reliable for the feasibility and selection of a dam site. Therefore, detailed seismo-tectonic studies will be required during detailed design studies.

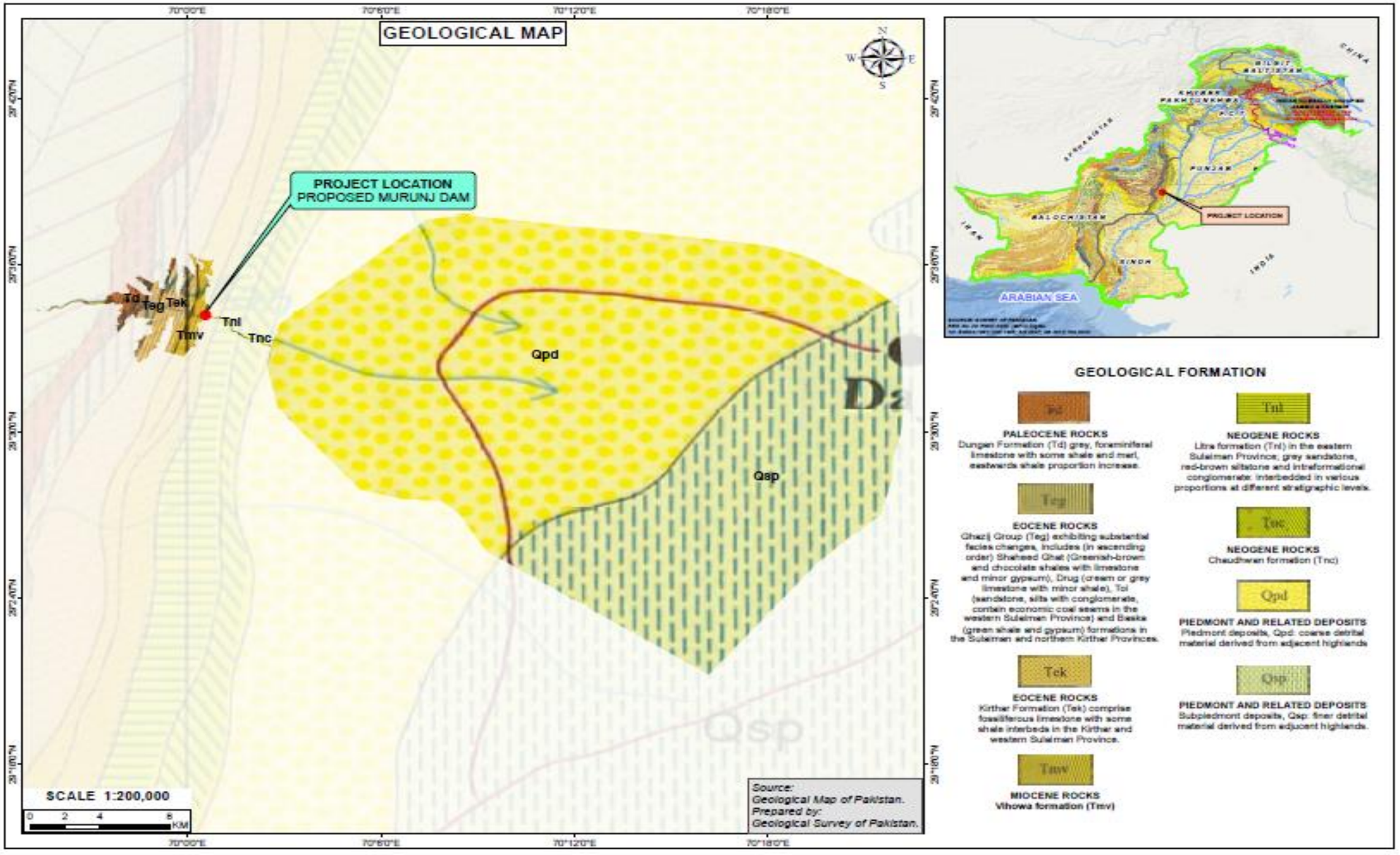


Figure 5.3: Project Area Geological Map

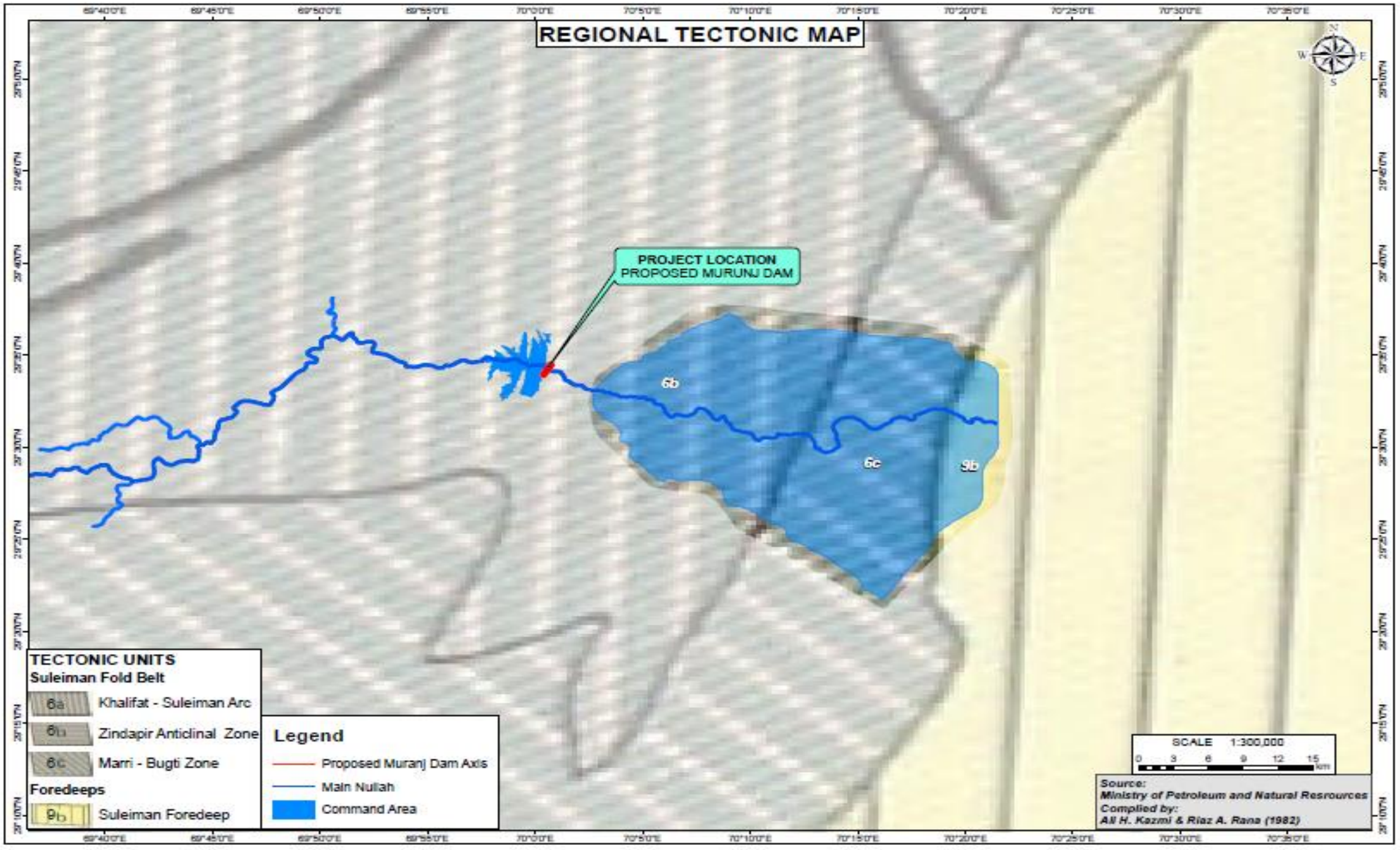


Figure 5.4: Tectonic Map of Project Area

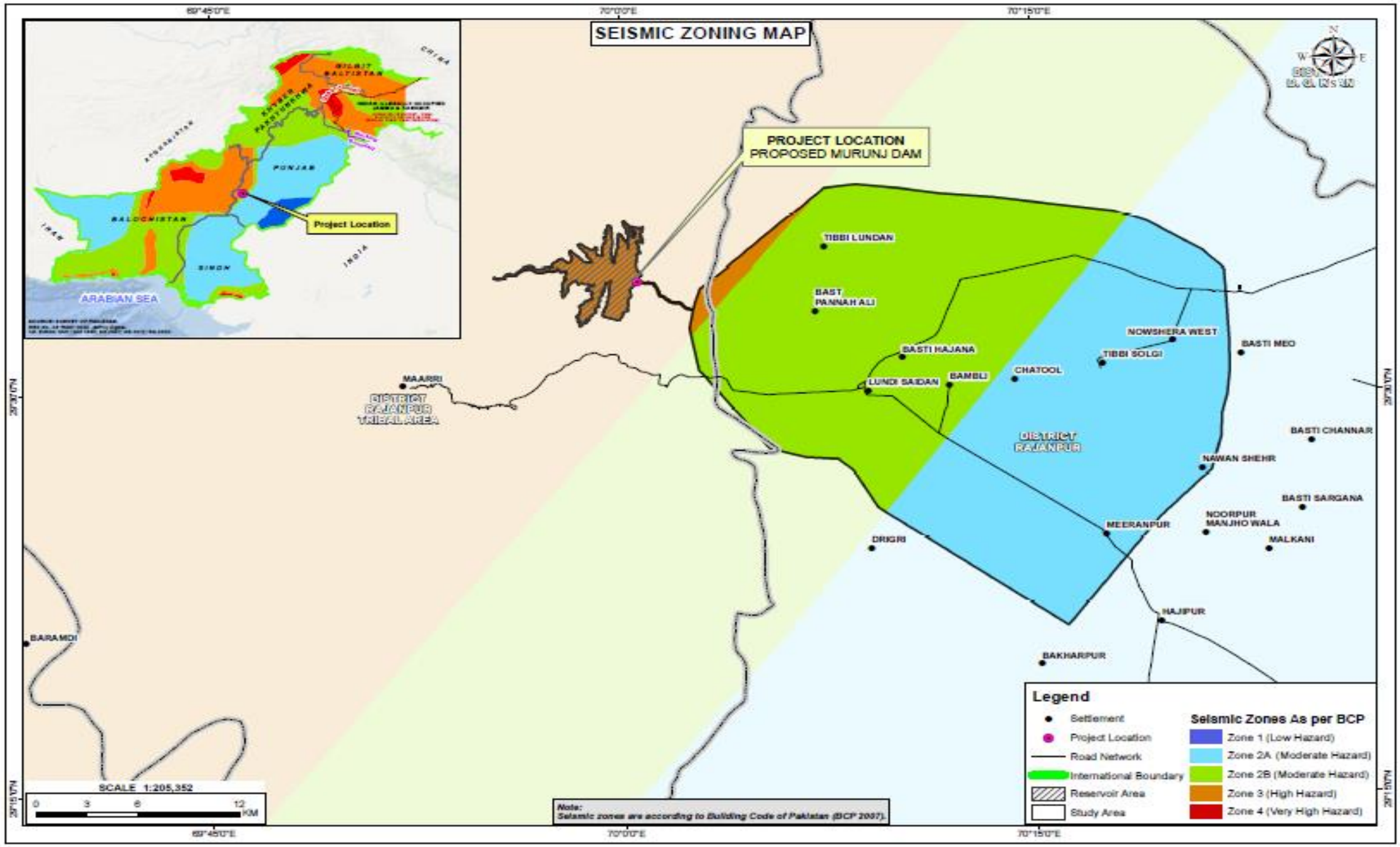


Figure 5.5: Seismic Zoning Map of Proposed Project Area

5.5.4 Soils

The soils of the Project area were formed in piedmont alluvium of mixed mineralogical composition derived from the Sulaiman ranges consisting of shale, limestone and sandstone. The soil texture varies from sand to clay. The soils are massive/stratified to weakly structured. They are generally dark yellowish brown to brown / dark brown to grayish brown in color.

Soil textural classification were carried out at semi-detailed level of Murunj Dam Project. The statistics of soil textural groups is presented in **Table 5.2** and their aerial distribution is shown in **Figure 5.6**.

Four textural groups have been recognized in the Project area. These are fine textured soils 28.0% (31977 acres) consisting of clays and silty clay, moderately fine texture soils 4.1% (4609 acres) comprising of silty clay loam / clay loams, medium textured 43.5 percent (49602 acres) soils consisting of silt loams, very fine sandy loams and loams and coarse textured 7.2% (8240 acres) soils including sands and loamy sand. The remaining 1.8% (2077 acres) is gravelly area, 2.1% (2377 acres) torrent bed / nullah and 2.1% (2339 acres) is settlements.

Table 5.2: Statistics of Soil Textural Groups

Soil Textural Groups	Acreage	Percentage
Fine textured soils	31,977	28.0
Fine textured soils with silt loam surface	3,908	3.4
Moderately fine textured soils	4,609	4.1
Moderately fine textured soils with silt loam surface	8,780	7.7
Medium textured soils	48,674	42.7
Medium textured soils with silty clay loam surface	928	0.8
Coarse textured soils	8,240	7.2
Coarse textured soils with loamy surface	134	0.1
Sub Total	107,250	94.0
Miscellaneous Land Types		
Gravelly area	2,077	1.8
Torrent Bed / Nullah	2,377	2.1
Settlements	2,339	2.1
Sub Total	**6,793**	**6.0**
Grand Total	**114,043**	**100.0**

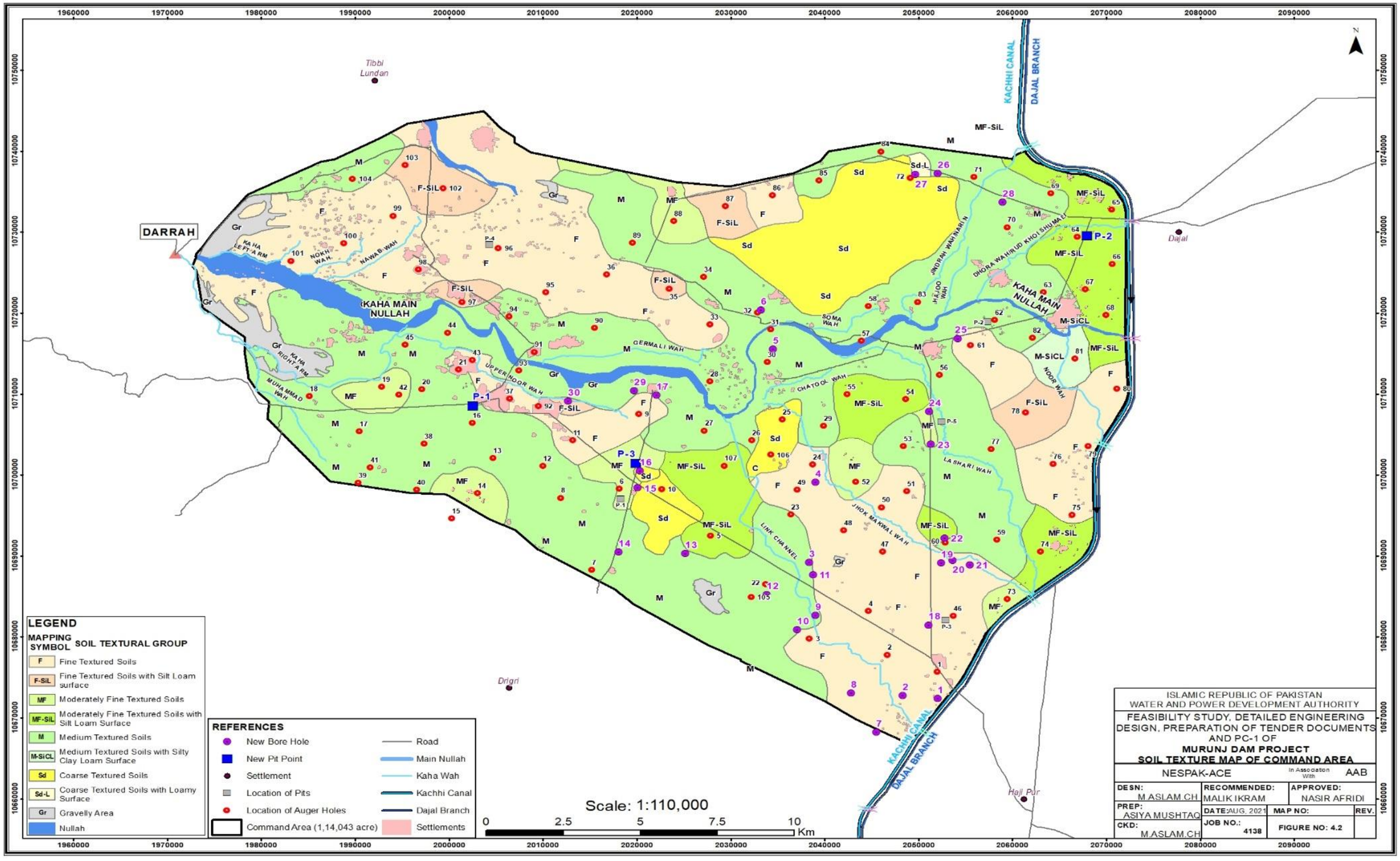


Figure 5.6: Classification of Soil in Pachad Area of Kaha Hill Torrent

5.5.5 Climate

The climate of the area is semi-arid, hot subtropical with pleasant winter and spring, summer with dust and heat wave periods and dry autumn. Climate is characterized by the movement of monsoon in summer season and westerlies in winter season. Both these phenomenon causes rainfall in the Study Area/AOI.

Temperature, precipitation, relative humidity, wind speed and wind gust of the study area (District Rajanpur) is discussed below.

5.5.5.1 Temperature

Figure 5.7 shows mean minimal and maximal temperatures observed for each month between 2010 and 2020 in the Study Area. The highest temperature measured between 2009 and 2019 was 48°C, and the lowest temperature was 10°C.

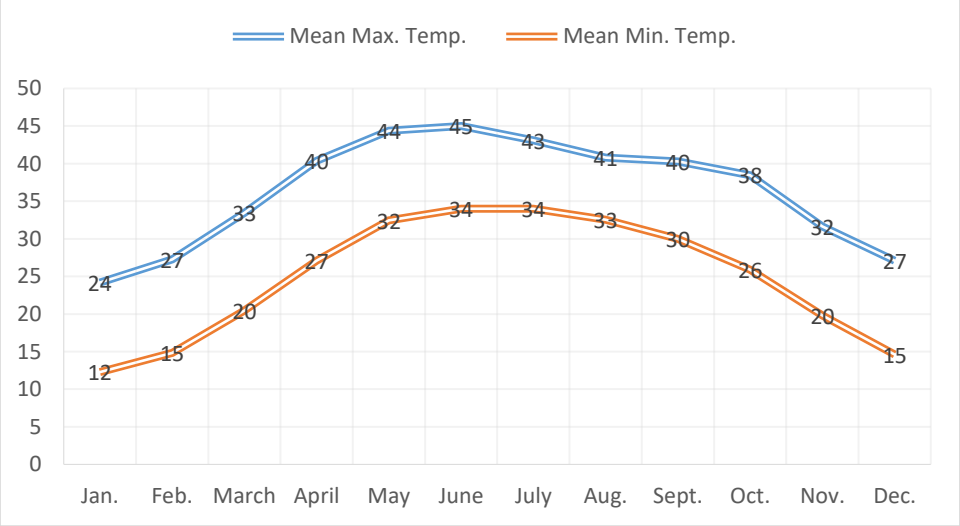


Figure 5.7: Mean Maximum and Minimum Temperature in the Study Area (2010-2020)

5.5.5.2 Precipitation (Rainfall)

Mean monthly precipitation observed in the Study Area from 2010 to 2020 with an annual average rainfall of 150.68 mm. The maximum (200 to 400 mm) rainfall occurs during the monsoon season in the month of July to September while minimum rainfall is recorded during the month of October to December (15 to 30 mm). **Figure 5.8** shows mean monthly precipitation observed in the Study Area

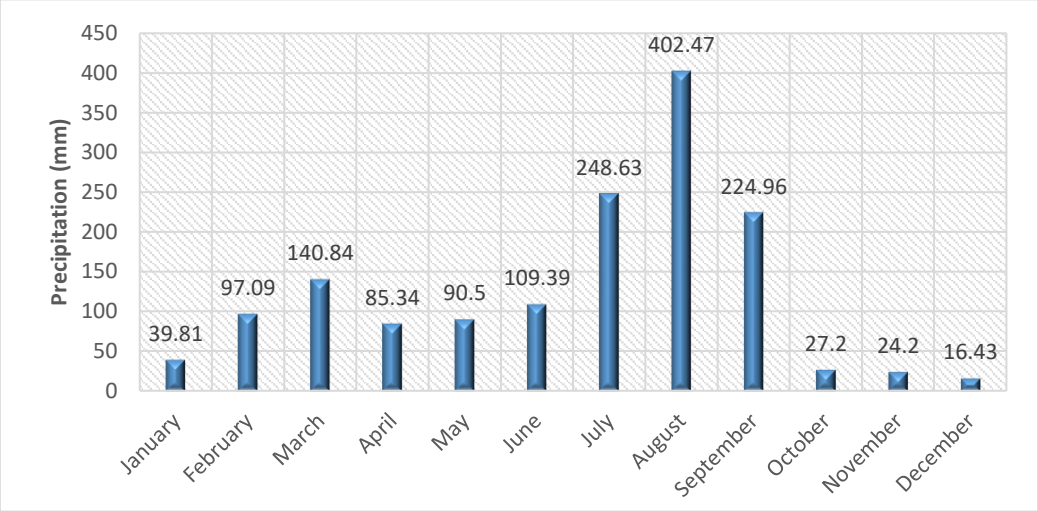


Figure 5.8: Average Precipitation in the Study Area (2010-2020)

5.5.5.3 Relative Humidity

Mean relative monthly humidity is ranging from 16% to 39% in the Study Area from 2010 to 2020. Minimum humidity observed (16%) during May whereas maximum observed during August (39%). **Figure 5.9** shows mean relative monthly humidity observed in the Study Area from 2010 to 2020.

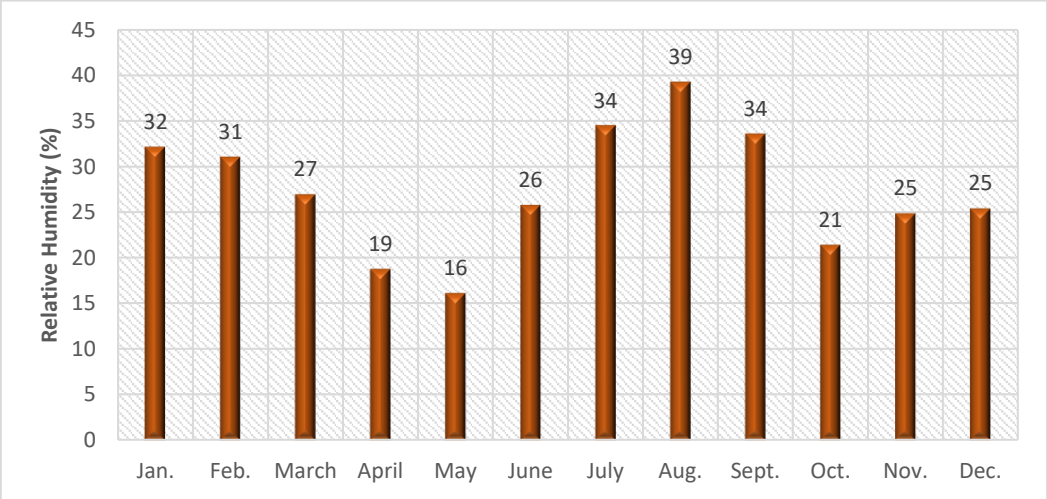


Figure 5.9: Relative Humidity in the Study Area (2010-2020)

5.5.5.4 Wind Speed and Wind Gust

The wind data is being recorded on daily basis for 00 UTC, 03 UTC and 12 UTC. The monthly mean for the wind speed is calculated in knots. It is observed that at 12 UTC, the wind speed is low in winter season, while in summer season, winds are blowing at a relatively higher speed than winter. However, at 00 UTC and 03 UTC very low velocity winds are blowing during July to September annually. The mean monthly wind speed and direction is provided in **Table 5.3**.

Table 5.3: Mean Monthly Wind Speed and Direction

Months	Mean Monthly Wind Speed and Direction					
	00 UTC	Wind Direction	03 UTC	Wind Direction	12 UTC	Wind Direction
January	2.7	N	2.6	N	2.9	S49W
February	2.2	N	2.3	N2E	3.5	S40W
March	2.4	N4W	2.1	N	3.9	S40W
April	2.5	N5W	1.9	N4W	4.2	S34W
May	2.6	N4W	1.9	N5W	4.4	S41W
June	1.3	N4E	1.2	N	4.6	S14W
July	0.6	N	0.8	N29E	4.1	S7W
August	0.6	N17E	0.4	N36E	3.8	S11W
September	0.9	N6E	0.8	N5E	3.7	S14W
October	2.3	N	1.9	N	2.8	S29W
November	2.8	N	2.6	N	2.7	S35W
December	2.7	N	2.4	N2E	2.2	S46W
Annual	**2.3**	**N**	**2.0**	**N**	**3.9**	**S29W**

Source: Pakistan Meteorological Department

Figure 5.10 depicts average wind speed on a monthly basis in district Rajanpur from year 2010 to 2020.

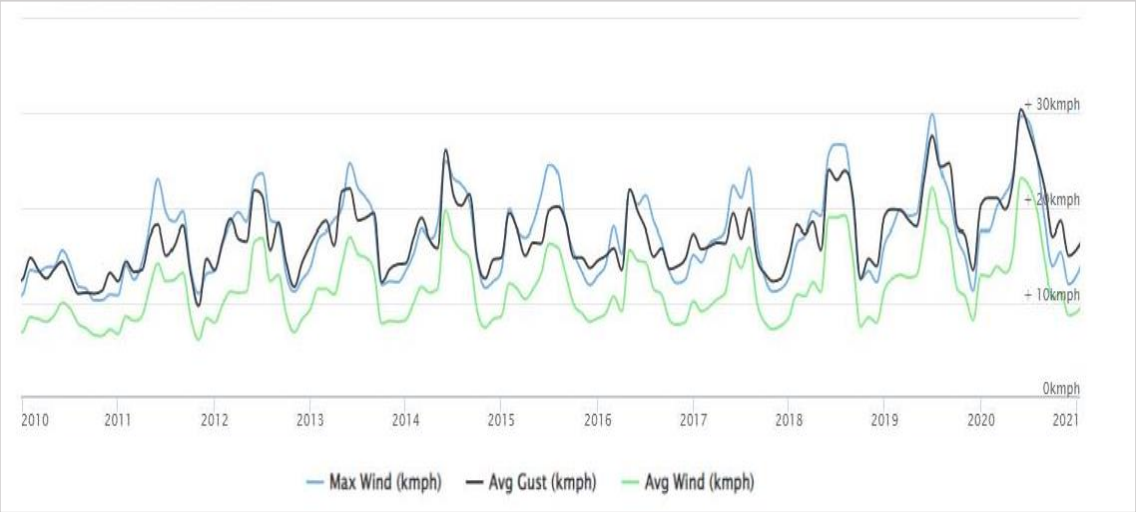


Figure 5.10: Wind Speed in the Study Area (2010-2020)

5.5.6 Water Resources

The major surface water sources in the Study Area are the nullahs/streams and rainfall. The ground water in the Study Area is extracted through hand pumps and tube wells installed in nearby villages where few settlements exist.

5.5.6.1 Surface Water

As mentioned earlier, Kaha hill torrent is one among the thirteen major Hill Torrents in DG Khan Division. The torrent is a non-perennial stream having 5,500 km^2 catchment area at dam site. Based on monthly flow series from 1970-2015, average annual flow of Kaha Hill Torrent is 191,400 AF.

Kachhi canal and Dajal branch are the other surface water sources in the area. Kachhi canal originating from Taunsa Barrage and Dajal Branch originating from the tail of DG Khan Canal, are the major water bodies of the area which are situated in eastern side of the proposed Project Area. Discharge of Kachhi canal is about 6,000 cusecs. The surface water sources are also shown in **Figure 5.11.**

5.5.6.2 Groundwater

The groundwater sources of the Project Area (Command Area) generally comprise the unconsolidated alluvial deposits lying between the Indus River and the Sulaiman Range i.e. in Pachad Area. The sub-surface aquifer is mainly recharged by precipitation, and surface runoff of hill torrents. The groundwater table depth is found up to 200-300 feet. About 32% of the available groundwater is fit for irrigation and another 9% is marginally fit. This starch of study area at the north of main Kaha nullah (proposed FCC main) is majorly fall in this category. Nearby 59% is unfit for drinking as well as irrigation purpose which is mostly located at Drigri side.

5.5.6.3 Sedimentation

The estimated annual suspended sediment load at Kaha hill torrent comes out to be 1.18 Million tons /year. Assuming bed load to be ten percent of the estimated annual sediment load, the estimated total annual sediment load at Kaha hill torrent is 1.29 Million tons/year[6].It is worth mentioning that the sediment load estimation is totally relying on water availability. In case water availability changes in future, annual sediment load will also be revised accordingly.

[6] Hydrological and Sedimentation Studies of Kaha Hill Torrent (NESPAK, 2017)

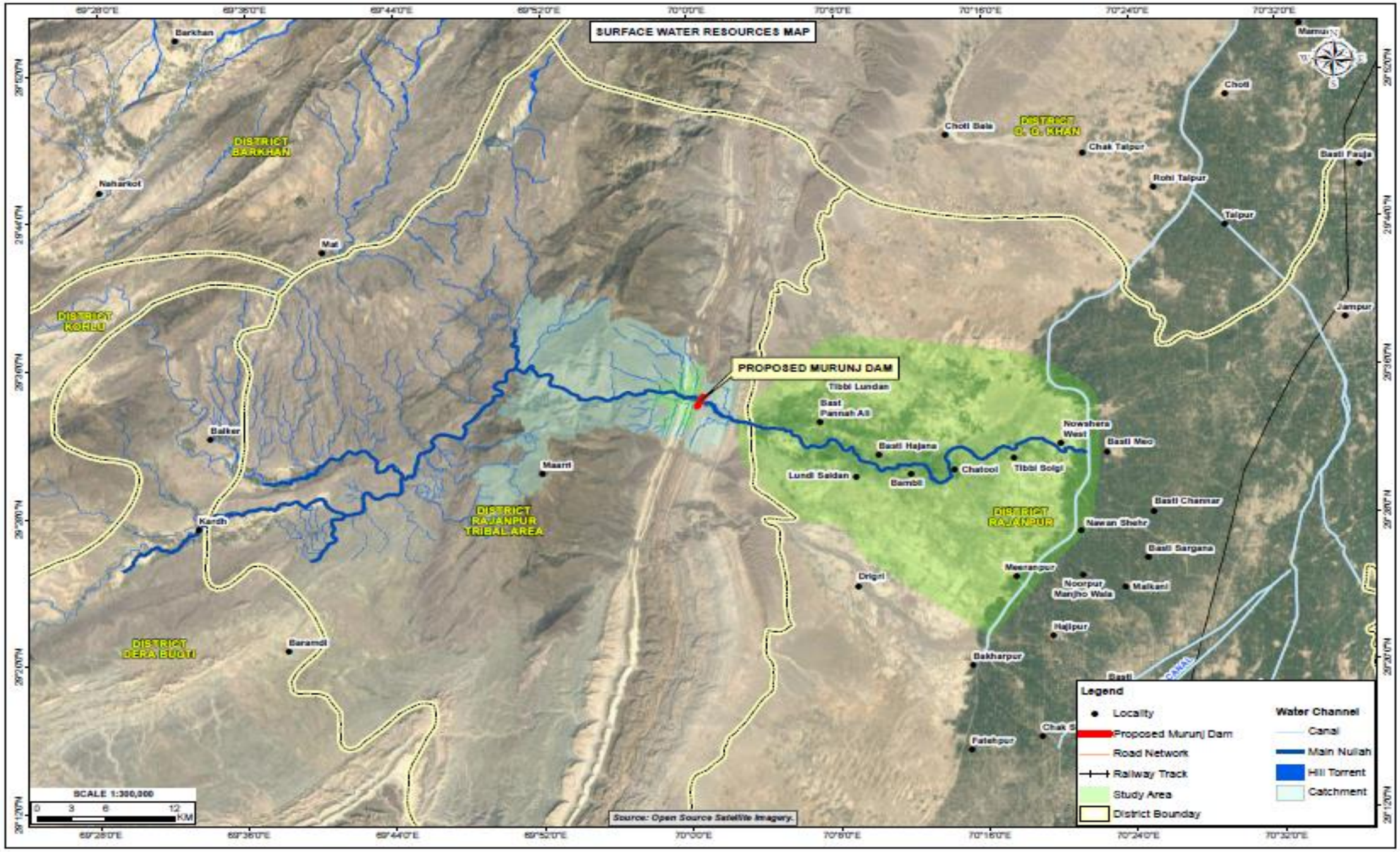


Figure 5.11: Surface Water Resource Map

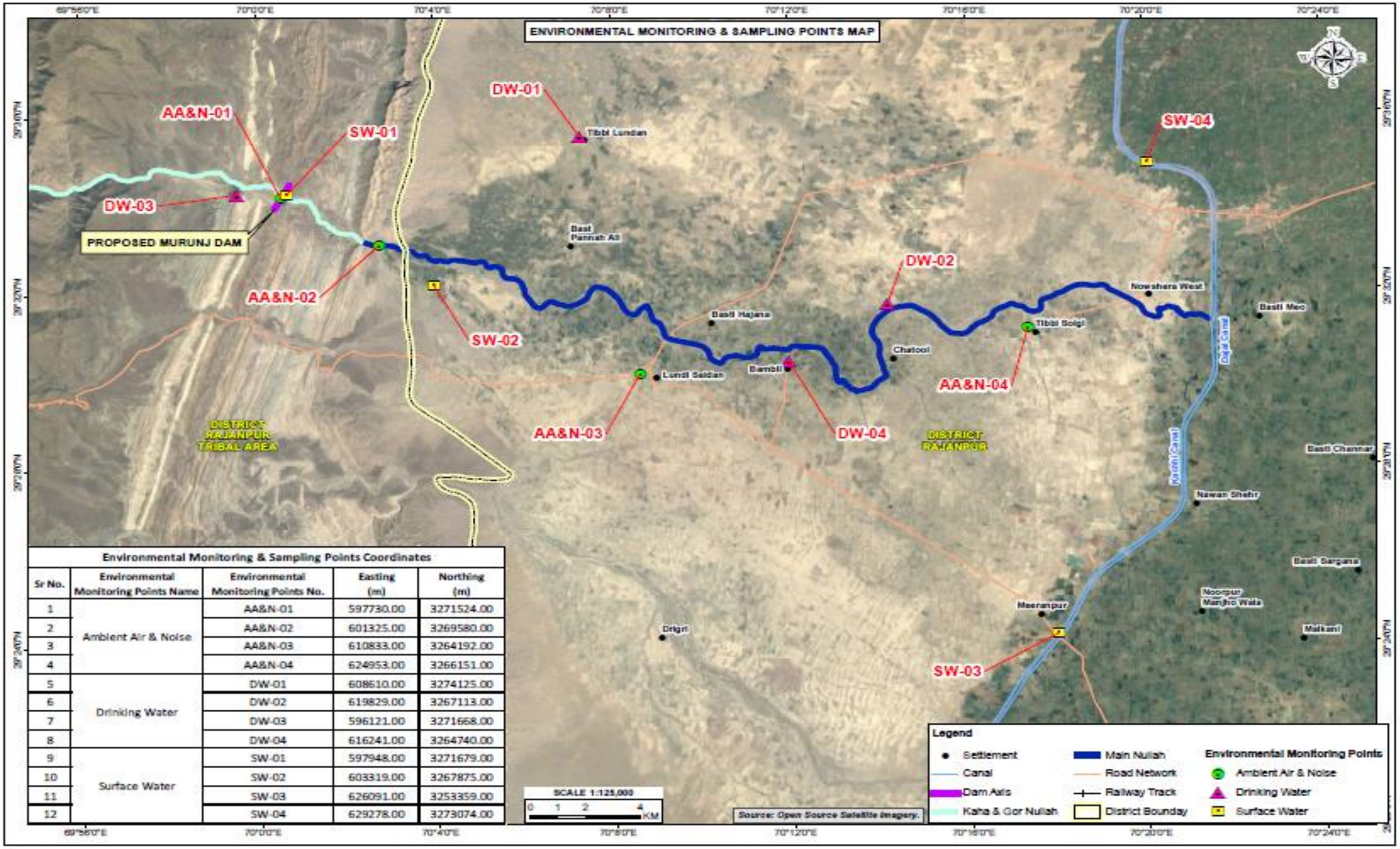
5.5.7 Solid Waste and Wastewater Drainage

In the AOI, no conventional solid waste collection and transportation system is in practice. There is presently no disposal facility available for solid waste and no arrangements of solid waste collection are seen in the AOI. People are used to throw their solid wastes into the streets or in open areas. Similarly, there is no proper sewerage system is available in the AOI. The common wastewater discharge practices in the AOI are the use of soakage pits and discharge of wastewater into the open agricultural fields. However, some open drains are constructed in the vicinity for the discharge of wastewater into the agricultural fields.

5.5.8 Environmental Monitoring, Sampling and Testing for Proposed Project

In order to determine the existing ambient air, noise, water and wastewater quality of the area following locations were selected in the CoI. The sampling locations for the environmental monitoring of ambient air, noise and water for proposed project are shown in **Figure 5.12** respectively. These monitoring locations has been finalized considering the sensitive receptors along the corridor.

Total four (04) surface water and four (04) drinking water samples have been collected. Similarly, four (04) samples were collected for ambient air & noise monitoring.



Environmental Monitoring & Sampling Points Coordinates

Sr No.	Environmental Monitoring Points Name	Environmental Monitoring Points No.	Easting (m)	Northing (m)
1	Ambient Air & Noise	AA&N-01	597730.00	3271524.00
2		AA&N-02	601325.00	3269580.00
3		AA&N-03	610833.00	3264192.00
4		AA&N-04	624953.00	3266151.00
5	Drinking Water	DW-01	608610.00	3274125.00
6		DW-02	619829.00	3267113.00
7		DW-03	596121.00	3271668.00
8		DW-04	616241.00	3264740.00
9	Surface Water	SW-01	597948.00	3271679.00
10		SW-02	603319.00	3267875.00
11		SW-03	626091.00	3253359.00
12		SW-04	629278.00	3273074.00

Figure 5.12: Environmental Monitoring Sampling and Testing Map

5.5.8.1 Air Quality

The ambient air quality monitoring for Nitrogen Dioxide (NO_2), Nitrogen Oxide (NO), Sulfur Dioxide (SO_2), Carbon Monoxide (CO), Ozone (O_3), Particulate Matter ($PM_{2.5}$), Particulate Matter (PM_{10}) and Suspended Particulate Matter (SPM) was carried out at Project Site. The sampling was conducted for 24 hours duration for NO_2, NO, SO_2, $PM_{2.5}$, PM_{10} and SPM, 1 hour for O_3 and 8 hours for CO.

The detailed results of ambient air quality monitoring have been attached in **Annex-III**, while the average concentrations of ambient air pollutants are given in **Table 5.4**. A pictorial view of ambient air monitoring is shown in **Plate 5.1**.

Table 5.4: Average Concentration of Ambient Air Pollutants

Parameter	Unit	Monitoring Duration	Average Concentration of Pollutants				Limits as Per PEQS, 2016
			AA-01	AA-02	AA-03	AA-04	
Nitrogen Dioxide (NO_2)	µg/m^3	24 Hours	20.99	21.61	18.46	20.61	80 µg/m^3 for 24 Hours
Nitrogen Oxide (NO)	µg/m^3	24 Hours	11.90	12.02	11.95	10.83	40 µg/m^3 for 24 Hours
Sulfur Dioxide (SO_2)	µg/m^3	24 Hours	13.23	12.62	12.54	12.14	120 µg/m^3 for 24 Hours
Carbon Monoxide (CO)	mg/m^3	08 Hours	0.70	0.99	0.68	0.82	5.0 µg/m^3 for 8 Hours
Ozone (O_3)	µg/m^3	01 Hours	11.56	11.09	10.78	12.01	130 µg/m^3 for 01 Hours
Particulate Matter (PM_{10})	µg/m^3	24 Hours	19.42	20.05	17.71	21.64	150 µg/m^3 for 24 Hours
Particulate Matter ($PM_{2.5}$)	µg/m^3	24 Hours	97.88	100.29	96.75	104.67	35 µg/m^3 for 24 Hours
Suspended Particulates Matter (SPM)	µg/m^3	24 Hours	152.30	154.34	148.46	160.31	500 µg/m^3 for 24 Hours
Lead (Pb)	µg/m^3	24 Hours	0.020	0.031	0.018	0.024	1.5 µg/m^3 for 24 Hours

µg/m^3: micrograms per cubic meter **PEQS:** Punjab Environmental Quality Standards

Table 5.4 indicate that all parameters are well within the permissible limits of Punjab Environmental Quality Standards (PEQS), 2016 except Particulate Matter ($PM_{2.5}$).



Plate 5.1: A view of Air & Noise Level Monitoring at Project Site

5.5.9 Noise Level

Noise level monitoring was carried out in the study area. The detailed results of noise monitoring have been attached in **Annex-III**, while the average concentrations of noise level are given in **Table 5.5**.

Table 5.5: Average Concentration of Noise Level

Averaging Time	PEQS, 2016	Unit	Average Value in dB (A)			
	Residential Area	dB (A)	N-01	N-02	N-03	N-04
Day-time	55		46.55	51.35	53.07	46.74
Night-time	45		34.48	39.46	36.33	40.98

The above results show that the average noise values at day and night time are within the permissible limits of PEQS in the Study Area.

5.5.10 Drinking / Ground Water Quality

Drinking water samples were also collected in the study area and were analyzed for physical, chemical and microbiological parameters. **Table 5.6** shows the results of ground water analysis. A pictorial view of groundwater monitoring is shown in **Plate 5.2**.

Table 5.6: Results of Ground Water Analysis

Sr. No.	Parameter	Unit	Test Results (Ground Water)				Punjab Standards for Drinking Water Quality, 2016
			DW-01	DW-02	DW-03	DW-04	
A.	**Physical and Chemical Analysis**						
1.	pH	-	7.78	7.46	7.24	7.43	6.5-8.5
2.	Odor	-	Odorless	Odorless	Odorless	Odorless	Non-Objectionable
3.	Taste	-	Salty	Salty	Salty	Sweet	Non-Objectionable
4.	Color	Pt-Co	<1.0	<1.0	<1.0	<1.0	≤ 15 TCU
5.	Turbidity	NTU	ND	ND	ND	ND	< 5 NTU
6.	Total Hardness	mg/l	474.32	245.0	205.8	215.6	< 500 mg/l
7.	Total Dissolved Solids	mg/l	1765.0	2355.0	1809.0	391.0	< 1000
8.	Chloride	mg/l	116.55	101.01	97.13	13.59	< 250
9.	Cyanide (Cn)	mg/l	<0.01	<0.01	<0.01	<0.01	≤ 0.05
10.	Fluoride (F)	mg/l	<0.01	<0.01	<0.01	<0.01	≤ 1.5
11.	Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01	≤ 3
12.	Nitrate	mg/l	0.6	0.5	0.7	<0.1	≤ 50
13.	Phenolic Compound	mg/l	<0.01	<0.01	<0.01	<0.01	-
14.	Residual Chlorine	mg/l	<0.1	<0.1	<0.1	<0.1	0.2-0.5
15.	Aluminum (Al)	mg/l	<0.028	<0.028	<0.028	<0.028	≤ 0.2
16.	Cadmium	mg/l	<0.0028	<0.0028	<0.0028	<0.0028	0.01
17.	Copper	mg/l	<0.0045	<0.0045	<0.0045	<0.0045	2
18.	Chromium	mg/l	<0.0054	<0.0054	<0.0054	<0.0054	≤ 0.05
19.	Mercury	mg/l	<0.0008	<0.0008	<0.0008	<0.0008	≤ 0.01
20.	Antimony (Sb)	mg/l	ND	ND	ND	ND	≤ 0.005
21.	Nickel	mg/l	<0.008	<0.008	<0.008	<0.008	≤ 0.02
22.	Zinc	mg/l	0.0052	0.022	0.0068	<0.0033	5.0
23.	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01	≤ 0.05

Sr. No.	Parameter	Unit	Test Results (Ground Water)				Punjab Standards for Drinking Water Quality, 2016
			DW-01	DW-02	DW-03	DW-04	
24.	Barium	mg/l	<0.031	<0.031	<0.031	<0.031	0.7
25.	Boron	mg/l	<0.1	<0.1	<0.1	<0.1	0.3
26.	Manganese	mg/l	<0.0016	0.0019	<0.0016	<0.0016	≤ 0.5
27.	Lead	mg/l	<0.013	<0.013	<0.013	<0.013	≤ 0.05
28.	Selenium	mg/l	ND	ND	ND	ND	0.01
B.	**Microbiological Analysis**						
1.	Total Coliforms	CFU45/ 100ml	02	03	02	02	Must not be detectable in any 100ml Sample
2.	Faecal Coliforms (E. Coli)	CFU/ 100ml	Absent	Absent	Absent	Absent	

mg/l: Milligram per Liter **ND:** Not Detectable

The above table illustrates that all physical and chemical parameters are well within permissible limits of Punjab Standards for Drinking Water Quality, 2016. However, Total Coliform parameters of Drinking Water Quality are exceeding the permissible limits of PEQS due to the mixing of sewerage water into groundwater at some source.





Plate 5.2: A view of Ground Water Quality Monitoring at Project Site

5.5.11 Surface Water Quality

The surface water quality was measured at four (04) different locations. The water samples were analyzed for the parameters specified in PEQS, 2016. The detailed wastewater results are given in **Table 5.7**.

Table 5.7: Surface Water Quality Monitoring

Sr. No.	Parameter	Test Results				PEQS, 2016
		SW-01	SW-02	SW-03	SW-04	
1.	pH	8.15	7.89	7.84	7.90	6-9
2.	Biochemical Oxygen Demand (BOD_5)	<1.0	2.6	<1.0	<1.0	80
3.	Chemical Oxygen Demand (COD)	15.0	18.0	7.0	9.0	150
4.	Total Suspended Solids (TSS)	27.0	37.0	48.0	29.0	200
5.	Total Dissolved Solids (TDS)	1424.0	1689.0	188.0	191.0	3500

Sr. No.	Parameter	Test Results				PEQS, 2016
		SW-01	SW-02	SW-03	SW-04	
6.	Phenolic Compounds (as Phenols)	<0.01	<0.01	<0.01	<0.01	0.1
7.	Grease and Oil	1.6	3.2	3.5	2.1	10
8.	Chloride (Cl^-)	120.44	116.55	11.65	11.65	1000
9.	Fluoride (F^-)	<0.01	<0.01	<0.01	<0.01	10
10.	Cyanide (CN^-)	<0.01	<0.01	<0.01	<0.01	1.0
11.	An-ionic Detergents (as MBAs)	ND	ND	ND	ND	20
12.	Sulfate (SO_4^{2-})	88.08	105.36	26.34	29.22	600
13.	Sulfide (S^{2-})	<0.4	<0.4	<0.4	<0.4	1.0
14.	Ammonia (NH_3)	<0.002	<0.002	<0.002	<0.002	40
15.	Cadmium (Cd)	<0.0028	<0.0028	<0.0028	<0.0028	0.1
16.	Chromium (Cr)	<0.0054	<0.0054	<0.0054	<0.0054	1.0
17.	Copper (Cu)	<0.0045	<0.0045	<0.0045	<0.0045	1.0
18.	Lead (Pb)	<0.013	<0.013	<0.013	<0.013	0.5
19.	Mercury (Hg)	<0.0008	<0.0008	<0.0008	<0.0008	0.01
20.	Selenium (Se)	ND	ND	ND	ND	0.5
21.	Nickel (Ni)	<0.008	<0.008	<0.008	<0.008	1.0
22.	Silver (Ag)	<0.0032	<0.0032	<0.0032	<0.0032	1.0
23.	Total Toxic Metals	<0.01	<0.01	<0.01	<0.01	2.0
24.	Zinc (Zn)	<0.0033	<0.0033	<0.0033	<0.0033	5.0
25.	Arsenic (As)	<0.01	<0.01	<0.01	<0.01	1.0
26.	Barium (Ba)	<0.031	<0.031	<0.031	<0.031	1.5
27.	Iron (Fe)	0.2	0.3	<0.1	<0.1	8.0
28.	Manganese (Mn)	<0.0016	<0.0016	<0.0016	<0.0016	1.5
29.	Boron (B)	<0.1	<0.1	<0.1	<0.1	6.0
30.	Residual Chlorine (Cl_2)	<0.1	<0.1	<0.1	<0.1	1.0

It is evident from the monitoring results that all the parameters are well within prescribed limits of the PEQS, 2016.



Plate 4.3: A view of Ground Water Quality Monitoring at Project Site

5.5.12 Land Use Pattern

The land use of the study area is a mix of Agricultural, barren land, flood plan, nullahs, roads, settlements, shrubs/grasses and trees. The land use map of the proposed Project reservoir and within ROW of canals/drainage structures is shown in **Figure 5.13 and 5.14. Table 5.8 and 5.9** depicts land use cover of the study area.

Table 5.8: Land Use Cover of the Study Area in Reservoir

Sr. No.	Land Use / Land Cover	Area Sq. Km	Area Acres
1	Barren Area	4.369	1079.584
2	Built up	0.014	3.481
3	Cultivated Area	1.823	450.552
4	Flood Plain	0.676	167.019
5	Hill	7.904	1953.233
6	Nullah	1.363	336.924
Grand Total		**16.150**	**3990.794**

5.5.13 Sensitive Receptor

For the proposed project, the sensitive receptors include, but are not limited to the educational, health, religious, cultural, archeological, and ecological resources. These are the areas where the occupants are more susceptible to the adverse effects of exposure to toxic chemicals and other pollutants through air and noise emissions due to construction and O&M activities within the defined study area. A comprehensive map showing environmental sensitive receptors of the project area such as, schools, mosques, graves, Shrine, BHU, etc. is given in **Figure 5.15**.

Table 5.9: Land Use Cover of the Study Area in ROW of Proposed Canal and Drainage

Sr. No	Canal / Drain Name	Agricultural Area (Acres)	Barren Land (Acres)	Flood Plan (Acres)	Nullah (Acres)	Road (Acres)	Settle-ment (Acres)	Shrubs/ Grasses (Acres)	Grand Total (Acres)
1	FCC 2	350.239	36.038	14.904	39.647	0.567	0.004		441.399
2	FCC BRANCH	714.609	6.948	54.517	103.191	1.061	2.469		882.794
3	FCC MN	386.769		523.850	210.530	0.583	0.785	3.256	1125.772
4	FCC1	51.150	119.775	23.898	29.024	0.096	0.725		224.668
5	LBC	288.279	36.344	2.145	3.461	3.540	0.522		334.293
6	LBC D1	37.709	9.646		0.169	0.055	0.058		47.639
7	LBC D2	112.392			0.159	0.170	1.017	0.135	113.873
8	LBC D3	77.440	15.026			0.060			92.525
9	LBC D3 M1	91.315	4.300	0.249	0.459	0.035	0.129		96.486
10	LBC D3 M1 SM1	30.726				0.073	0.017		30.817
11	RBC	174.084	107.585		0.940	0.233	0.029		282.871
12	RBC D1	27.410			0.793		0.001		28.205
13	RBC D2	163.068	13.932		1.233	0.234	0.199		178.667
14	RBC D2 M1	34.854			0.230	0.060	0.061		35.205
15	RBC D2 M2	65.497	12.028			0.119	0.253		77.898
16	RBC D2 M2 SM1	54.185			0.189	0.110	0.019		54.502
17	RBC D2 M3	20.543	6.180		0.144	0.049	0.007		26.924
18	RBC D2 M4	30.934					0.099		31.033
19	SLP	21.447	8.235	5.856	7.744	0.120	0.164		43.566
Grand Total		**2732.651**	**376.037**	**625.418**	**397.914**	**7.165**	**6.559**	**3.391**	**4149.136**

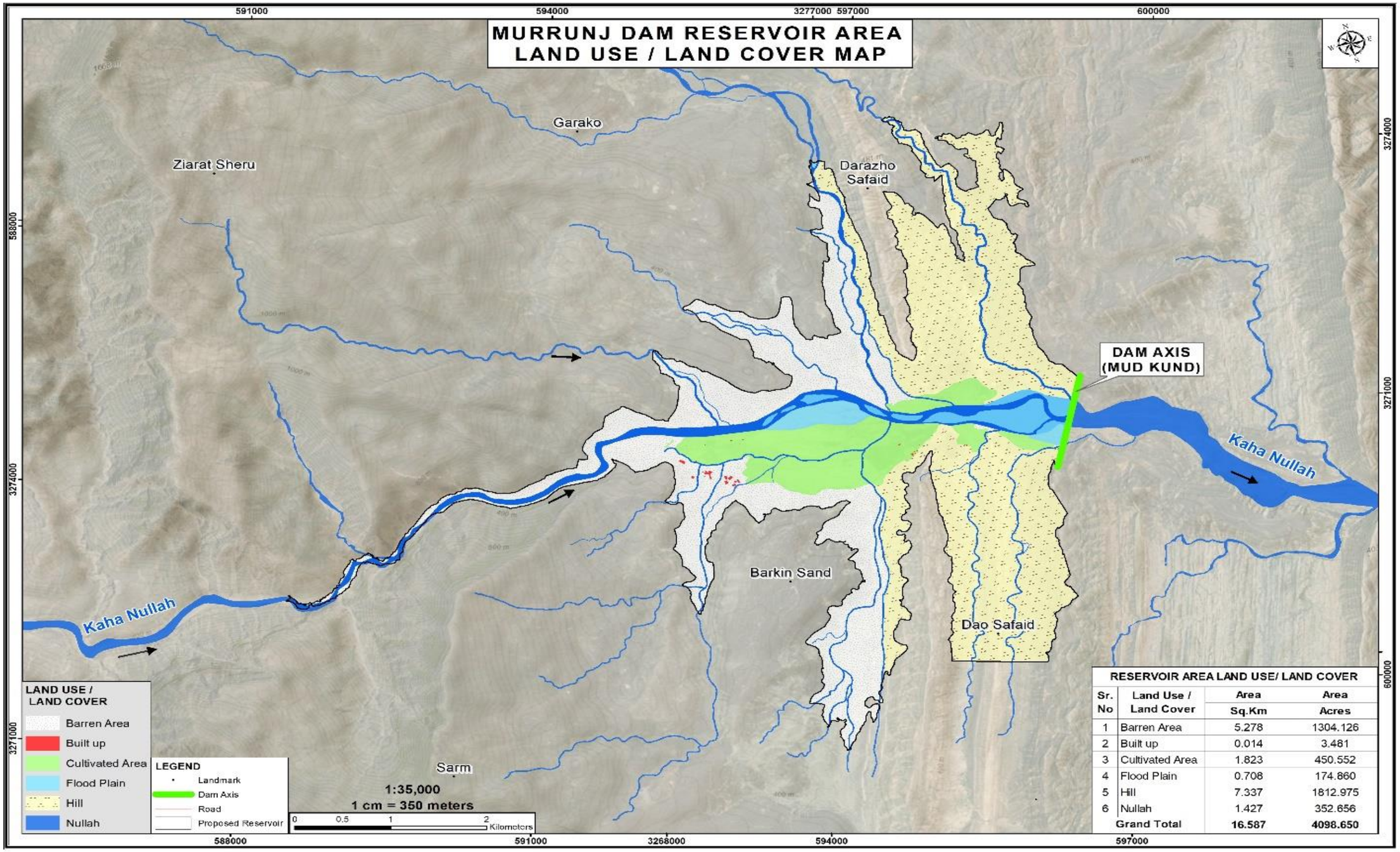
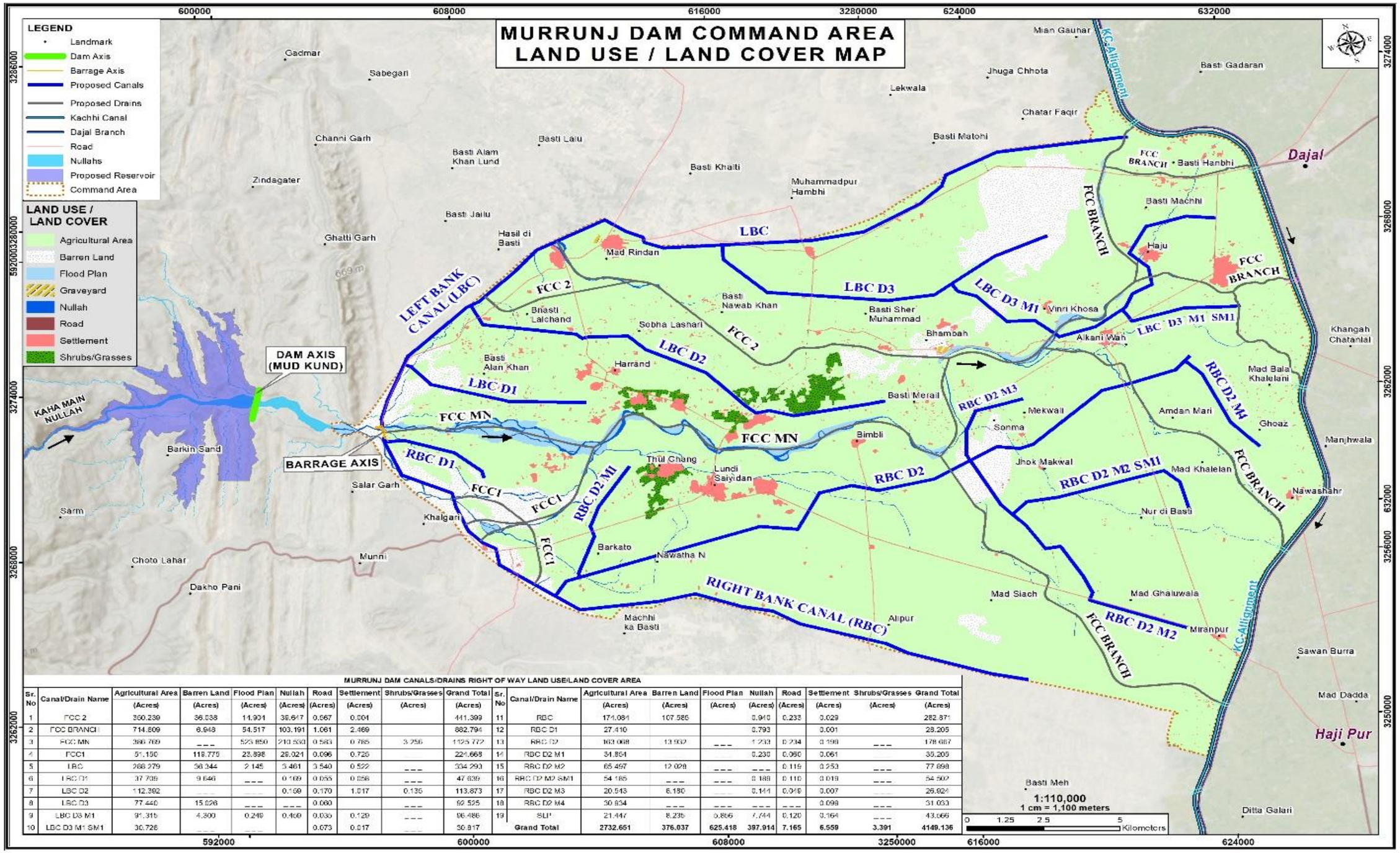


Figure 5.13: Landuse Map of Proposed Reservoir Area



MURRUNJ DAM CANALS/DRAINS RIGHT OF WAY LAND USE/LAND COVER AREA

Sr. No	Canal/Drain Name	Agricultural Area (Acres)	Barren Land (Acres)	Flood Plan (Acres)	Nullah (Acres)	Road (Acres)	Settlement (Acres)	Shrubs/Grasses (Acres)	Grand Total (Acres)
1	FCC 2	350.239	36.038	11.901	35.647	0.567	0.001		441.399
2	FCC BRANCH	714.809	6.948	54.517	103.191	1.061	2.469		882.794
3	FCC MN	386.769	---	523.850	210.530	0.583	0.785	3.256	1125.772
4	FCC1	51.150	118.775	23.898	28.021	0.096	0.725		224.668
5	LBC	288.279	36.344	2.145	3.461	3.540	0.522	---	334.293
6	LBC D1	37.709	9.646	---	0.169	0.055	0.056	---	47.639
7	LBC D2	112.392	---	---	0.169	0.170	1.017	0.135	113.873
8	LBC D3	77.440	15.026	---	---	0.060		---	92.525
9	LBC D3 M1	91.315	4.300	0.248	0.409	0.030	0.129	---	96.486
10	LBC D3 M1 SM1	30.726	---	---		0.073	0.017	---	30.817

Sr. No	Canal/Drain Name	Agricultural Area (Acres)	Barren Land (Acres)	Flood Plan (Acres)	Nullah (Acres)	Road (Acres)	Settlement (Acres)	Shrubs/Grasses (Acres)	Grand Total (Acres)
11	RBC	174.084	107.585		0.940	0.233	0.029		282.871
12	RBC D1	27.410			0.793		0.001		28.205
13	RBC D2	163.068	13.992	---	1.203	0.234	0.198	---	178.687
14	RBC D2 M1	34.864			0.230	0.060	0.061		35.205
15	RBC D2 M2	65.497	12.028	---	---	0.119	0.253	---	77.898
16	RBC D2 M2 SM1	54.185	---	---	0.188	0.110	0.019	---	54.502
17	RBC D2 M3	20.543	6.180	---	0.141	0.048	0.007	---	26.924
18	RBC D2 M4	30.934	---	---	---	---	0.099	---	31.033
19	SLI*	21.447	8.235	0.866	1.744	0.120	0.164	---	43.066
	Grand Total	2732.651	376.037	625.418	397.914	7.165	6.559	3.391	4149.136

Figure 5.14: Landuse Map of Proposed Reservoir Area

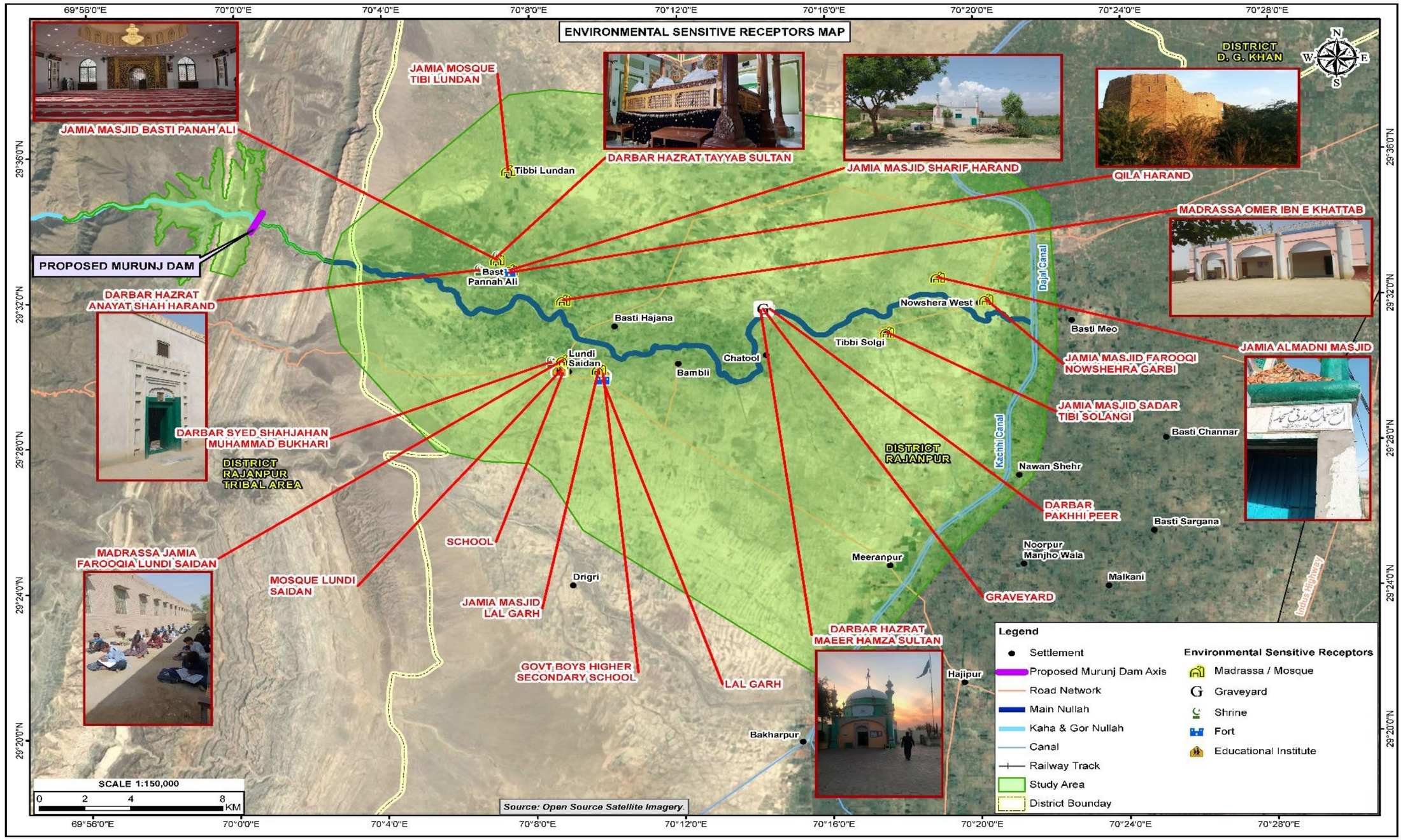


Figure 5.15: Sensitive Receptor Map of Project Area

5.6 ECOLOGICAL ENVIRONMENT

This section describes the biodiversity and natural resources as they exist in the Study Area, its baseline conditions, ecosystem and discusses existing ecological conditions. This section also lists the trees, shrubs, grasses and wildlife species and identifies those that are to be protected (if any due to current status). Ecological Environment of the Area is highly complex, fragile and sensitive with a fairly large diversity of Flora and Fauna species.

In general, the areas traversed by the Project are poorly vegetated and are ecologically very poor in terms of presence of flora and fauna, due to the very arid and rocky nature of the terrain. There are no indigenous species of conservation importance. The flora and fauna in the area have already adjusted/ accommodated to the presence of track and adjacent areas.

Consequently, the project works, and operations will have small impacts on the Flora and Fauna of the area, if any. Much of this region has been cleared for different purposes by locals, and remnants of the original forests are heavily degraded as a result of the growing need for fuel wood, fodder, and timber.

5.6.1 Methodology

All the available literature was thoroughly reviewed to have a better understanding of the project area and its surrounding habitats including flora and fauna. Ecological study of the area has been conducted using standard ecological assessment techniques based on primary and secondary information and inclusion of additional information collected during site visits, discussion with Government departments and meetings with groups of communities/public living in and around Project Area coupled with expert visual observations.

5.6.2 Biodiversity and Habitat Evaluation

Every organism of living world is unique and this uniqueness of the individual is the basis of biodiversity. Different places such as hills, forests, and land or sea side, in different parts of the world have their own typical type of the fauna and flora. Loss of the biodiversity is a global concern and is being looked upon as one of the world's most pressing crisis. Biologically rich and unique habitats are being degraded, fragmented and destroyed due to problems caused by exponential growth of human population, over consumption of resources and effects of population.

According to local evidences hunting has been common from long ago also degradation of forest cover and vegetation in green areas by cutting of trees and clearing vegetation for agricultural and other uses. Indigenous population played a critical role in destruction of biodiversity.

The levels of disturbance in the Study Area have been high and the areas have been accessible to humans for a long time. As a result, wildlife abundance and diversity in this area is very low.

The original Species of area in the past such as are hog deer, Indian hare and wild boar are no more found in the area due to human activities. A fairly not diverse range of bird species is found living in some of suitable areas of the proposed reservoir, including common species such as the dove, common myna, bulbul, tree pie, crow, and sparrow. Rarely seen birds of prey include the common pariah kite and the black-shouldered kite are rare. As a level of

threats/disturbance along the project area are high but the occurrence or observation of occurrence of birds in the dame site or project AOI is low.

In the Project Area, the original or natural habitat has been modified and converted into barren land. In the Project Area, trees are very less in number populated by Mesquite, Van, khana and Jhand bushes due to limited resources.

In general, entire forest areas are under degradation due to hazards such as illegal cutting of trees, overgrazing, over exploitation, flash floods and other biotic factors. Forest is being lost at a substantially greater rate than regeneration. The Study Area in general is under significant biotic pressure and under retrogression due to various factors such as unsustainable practices, Natural hazards causing the habitat loss, soil erosion and lack of proper functioning of ecosystems. For practical reasons, rarity is often the criterion by which a habitat's value is determined.

However, in assessing the value of a habitat, rarity, ecological functioning, regional diversity, and other important attributes must be in consideration.

5.6.3 Flora

The project area being part of the lower Indus basin the climate of the tract is semiarid, sub-tropical, the original flora of the area consists of tropical thorn forest type vegetation, in which thorny usually hard wooded species predominate, acacia species being particularly characteristic. The trees have usually short boles and low branching crowns, which rarely meet except on exceptionally favorable spots. The usual-height of tree is 6-10 m. Flora of the project area falls in the scrub Dry Tropical Thorn Forest Zone.

This is the natural vegetation of the Indus Basin. It has the capacity to survive and grow in areas with extremely high temperatures and low precipitation. The flora consists of spiny and hard wooded species. Acacia species are the dominant one. The trees usually have short boles and low branching areas. Their usual height is 6-9 meters. The leaves are small, except in a few genera like Salvadoran and Caltrops. Main trees in the Project Area are Acacia nilotica (Kikar), Eucalyptus camaldulensis (Safaida), Phoenix dactylifera (Date Palm), Dalbergia sissoo (Shisham). Azadirachta indica (Neem), Salvadora oleoides (Peelu) and Ficus religiosa (Peeple). Among the grasses; Arislida depressa (Lumb), Eleusinecom pressa (Chemmer), lasiuruss indicus (Gorkha) and Saccharum bengalensis (Kana) are found in the project area.

The Study Area is situated in semi-arid subtropical continental monsoon region of Pakistan and consists of 13 catchments. Around sixty-five percent of catchment areas consist of barren mountains without vegetative cover (Hanson, 1995). The region is characterized by extremely dry climate both in summer and winter season. The water precipitation is in the form of occasional seasonal rains, during rainy season (July– September). The high intensity fleshy rains result in torrential flow (fast flowing water).

Natural Flora of the Project Area is highly degraded of tropical thorn forest. Shrubs, Trees, Medicinal Plants, Forbs, Herbs, Weeds, and Grasses, typical of arid zone are found. List of floral species are shown in **Table 5.10**.

Table 5.10: List of Flora Found in Study Area

Sr. No	Common/English Name	*Botanical Name*
1	Jhand	Prosopis cineraria
2	Mesquite	Prosopis juliflora
3	Ber	Zizyphus mauritiana
4	Van	Salvadora oleoides
5	Kikar	Acacia nilotica
6	Khana	Saccharum munja
7	Willow	Salix species
8	Ecycalptus	Eucalyptus camaldulensis
9	Frash	Tamarix aphylla
10	Khabbal	Cynodon dactylon
11	Aak	Calatropis procera
12	Karrira	Capparis decidua
13	Kandar	Comus macrophylla
14	Seva	Pyrus malus

5.6.4 Fauna

The project area, on account of nature of vegetation and topography, once rich in vegetation and wildlife has now reduced potential due to over hunting, loss of proper habitat, conversion of forest land. Fauna of the tract consists of mammals, rodents, reptiles, amphibians and birds

The details are given in **Table 5.11**.

Table 5.11: List of Fauna Found in Study Area

Sr. No.	Common Name	Scientific Name
1	Jackal	*Canis aureus*
2	Porcupine	*Hystrix indica*
3	Squirrel	*Funambulus pennant*
4	Mouse	*Funambulus pennant*
5	Mongoose	*Herpestes auropunctatus*
6	Hare	*Lepus nigricollis*
7	Fox	*Vulpus*
8	Wild Boar	*Sus scrofa*
9	wolf	*Canis spps*

5.6.5 Reptiles

Reptiles reported in the Study Area are Cobra, Indian Krait, Spiny tailed Lizard, and Fringed toed Lizard. Reptiles of study area are shown in **Table 5.12**.

Table 5.12: Names of Reptiles in the Study Area

Sr. No.	Common Name	Scientific Name
1.	Cobra	*Naja*
2.	Indian Krait	*Bungarus caeruleus*
3.	Spiny tailed Lizard	*Uromastyx hardwickii*
4.	Fringed toed Lizard	*Acanthodactylus cantoris*

5.6.6 Amphibians

Amphibians found in the Study Area are given in **Table 5.13.**

Table 5.13: Names of Amphibians in the Study Area

Sr. No.	Common Name	Scientific Name
1.	Common Frog	*Rana tigrine*
2.	Common Toad	*Bufo bufo*

5.6.7 Avifauna

Avifauna of the area is not plentiful and birds were not seen frequently in the immediate project site. Birds of the tract consist of small and medium sized in insignificant number due to non-availability of suitable habitat includes Food & shelter. Bater, Koel, Ring Dove, Myna, Common Snipe, Tree Pie, and Crow are the major avifauna of study area. The avifauna species are shown in **Table 5.14**.

Table 5.14: Names of Avifauna in the Study Area

Sr. No.	Common Name	Zoological Name
1	Bater	*Grey Francolin*
2	Koel	*Eudynamys scolopaceus*
3	Ring Dove	*Columba livia*
4	Myna	*Acridotheres tritis*
5	Common Snipe	*Gallinago*
6	Tree Pie	*Dendrocitta vagabunda*
7	Crow	*Corvus corax*

5.6.8 Migratory Birds

The Migratory Houbara Bustard (*Chlamydotis undula/macqueenii*)

Class: Aves
Phylum: Chordata
Higher classification: Chlamydotis
Order: Bustard
Rank: Species

The Rajanpur district is important corridor for Houbara Bustard (Wildlife Department Rajanpur). As per consultation with Wildlife department the specific project area is not a permanent habitat to any migratory and endangered species. Chlamydotis macqueenii, commonly known as the Asian Houbara Bustard (hereafter 'houbara'), is listed as vulnerable in the International Union for the Conservation of Nature (IUCN) Red List of threatened species. Large numbers of houbara bustard are illegally hunted and trapped, in Pakistan, and shipped to Arabia for use in training falcons to hunt. Houbaras are also hunted and killed for their meat. Habitat loss and degradation compound to this problem.

It is also listed in of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and of the Convention on the Conservation of Migratory Species of Wild Animals (CMS), pertaining to species that are vulnerable to hunting and poaching. CITES

lists those wildlife species that are threatened with extinction and prohibits their international trade in any form. CITES allows limited non-commercial trade of listed species under exceptional circumstances such as for scientific research. In these exceptional cases, trade may take place provided it is authorized by the granting of both import and export permits. The CMS lists those migratory species that have an unfavorable conservation status and that require international agreements to ensure their conservation and management. Pakistan is a signatory/party to both aforementioned international conventions.

Pakistan lies at a crossroads for bird migration, as a result of its deliberate geographical location. The Indus basin is one of the world's great migratory flyways and is the principal route followed by many bird species that breed extra limitary and winter in Pakistan or in other regions of the Indian subcontinent. The journey of these migratory birds starts from Siberia (Russia) in December through Afghanistan and land in Pakistani lakes and ponds of seepage.

The migratory birds from Siberia and European countries returns back to their native abode after spending winter in many parts of Pakistan. That migratory birds fly from Siberia to Afghanistan, Karakorum range, across river Indus in Pakistan and finally towards India every year. During their journey, the birds make stopovers at lakes and water basins at Nowshera, Tanda Dam in Kohat, Swat, Chitral, Punjab and at Haleji, Keenjhar and Lungsee lakes in Sindh.

The distance covered by migratory birds during migration is calculated to be around 4,500 kilometers. Every year take flight from their homelands and travel along several routes to reach warm wintering grounds. These migratory birds mainly consist of houbara bustard, water fowl, falcons, cranes, teals, pintail, mallard, geeze, spoon bills, waders, palicons and gadwall. From February end, the return journey starts and completes by the end of April.

5.6.8.1 Houbara Bustard Global Population and Trend

The global population of houbara has been estimated to be between 78,960 and 97,000 individuals in 2014. It must be emphasized, however, that accurately establishing the global population is extremely challenging, and this figure should be treated as a tentative 'best estimate'. The population is therefore expected to fall within the population band for 50,000 - 99,999 individuals, which is assumed to equate to ca. 33,000 - 67,000 mature individuals. The population is estimated and projected to be declining by 30-49% over a three-generation (20-year) window, stretching from the past into the future. Overexploitation remains the foremost threat to the species, primarily as a result of unsustainable levels of hunting and poaching.

5.6.9 Fisheries

Currently the project area is non-supportive to fisheries or non-supportive to aquatic biodiversity. The dedicated write-up may be needs to be revised after detailed studies by fisheries department. This assessment is based on the observations on the low flow season and some available data. Previously the fisheries department has not conducted any fisheries study in the project area so no data for the study area was provided by the stakeholder department. It is worth mentioning here that after proposed project completion the scope of fisheries development will be of very importance and will provide good grounds for raising/development of fisheries at different levels.

5.6.10 Agriculture

A variety of agricultural crops, fodders and vegetables are grown in the Study Area, however, land is still dominated by Wheat (Triticum L), Cotton (Gossypium) and Maize, (Zea mays L). Most agricultural activities in the reservoir and catchment area are confined where irrigation is possible. Large areas on sides are Barani/Rain fed where in good rainy periods dry farming is practiced. In the Reservoir and Catchment area main agricultural crops are Wheat, Maize, Cotton, Shaftal, Barseen. The list of crops and their yield are shown in **Table 5.15**.

Table 5.15: **Agricultural Crops and Yield in Study Area**

Sr. No	Crop	Production/Acer
1	**Wheat**	600 kg
2	**Cotton**	400 kg
3	**Millet**	250 kg
4	**Fodder**	2400 kg

The crops like cotton, millets, maize, mungbean and sesame are included in Kharif whereas wheat, Berseem and Canola are Rabi crops. The calendar of crops are shown in **Figure 5.16**.

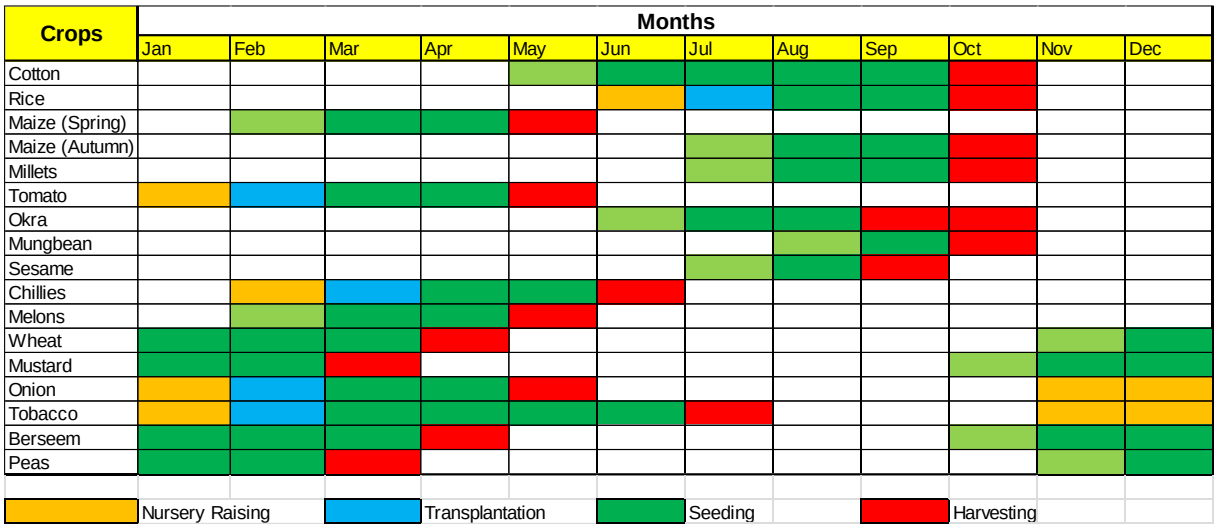


Figure 5.16: Cropping Calendar of proposed crops

5.6.11 Livestock

According to the reports found from the livestock keepers their socioeconomic status has been grown up as the Livestock sector is an important source of protein rich products which plays a pivotal role in the economy of developing countries of the world. It is an important generator of employment. It provides cushion for food shortages, means of storing wealth, as a source of fuel and fertilizer, a source of transportation and traction in agriculture production.

Livestock grazing is common in the Study Area and is an important source of income for the rural population. Goats, Camels and sheep are seen, freely grazing in open shamlat areas or in fallow agricultural fields. Almost all the households, who have their link with agriculture, are keeping cattle. Field data shows that, household keeps livestock in large herds, depending upon the household landholding size and capacity to store the crop residues, fodder and had to feed animals during the winter. The trend of livestock keeping is decreasing due to reduction in grazing areas.

5.7 SOCIO-ECONOMIC ENVIRONMENT

5.7.1 Approach and Methodology

The methodology was developed after thorough review of the Terms of References (TORs), the quantum of work/expected outputs and the prescribed period of study. The study is coupled with the safeguard input in the light of international safeguard policies and country safeguard system which is the key for successful completion of the project. The procedure is based on the modern and state-of-art techniques and approaches based on the best international safeguard practices. The methodology is reflected in the **Figure 5.17**.

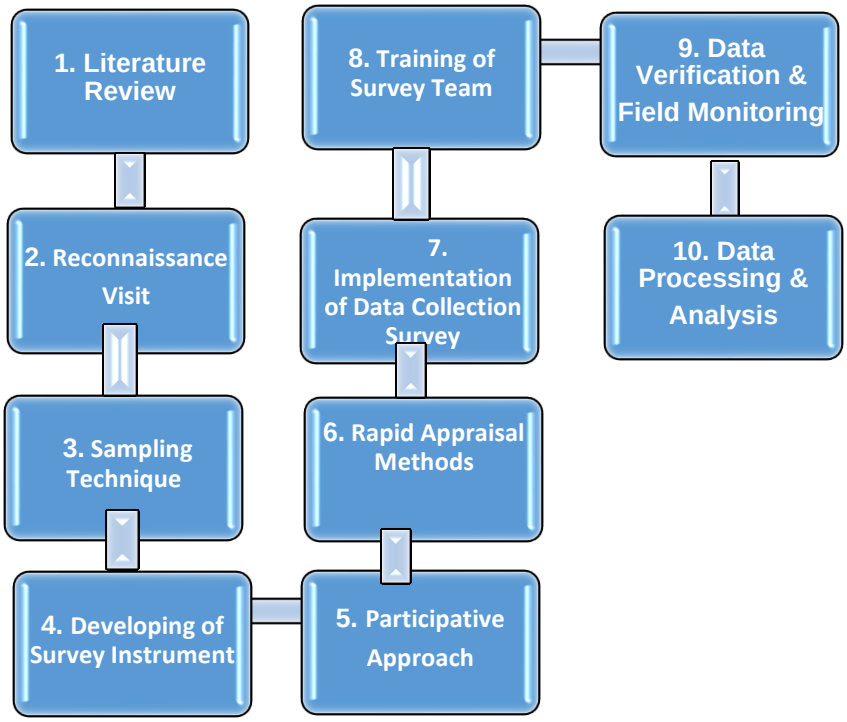


Figure 5.17: Study Methodology

5.7.1.1 Literature Review

Immediately after the mobilization, the consultant reviewed all the available information/data, reports; studies related to project, the detail is as followed;

- Foot Prints of the project;
- District census report for the Rajanpur district;
- Project area location map;
- LAA 1894; and
- International Safeguard Policies.

5.7.1.2 Field Reconnaissance Visit

The reconnaissance site visit was conducted to develop an understanding of the Project. The visit helped to prepare key milestones detailing socio-economic, poverty & gender and LAR (Land Acquisition and Resettlement) activities to be undertaken.

5.7.1.3 Sampling Technique

In order to achieve the target of the study, a stratified random sampling technique was adopted to select adequate and representative sample from reservoir and project command area to make the survey findings more compatible with the highest level of statistical confidence and thus get meaningful sociological facts/findings. Accordingly, 84 respondents were selected from the project reservoir and command area, and detail is provided in **Table 5.16 & Table 5.17.** The settlement map is shown in **Figure 5.18**.

Table 5.16: Sampled Respondents of Reservoir Area

Sr. No.	Villages / Settlements in the Reservoir Area	Total Households	Number of Respondents	Percentage
1	Basti Haji Bakhtiar	5	3	60
2	Basti Mureed Bakhsh	4	3	75
3	Basti Abdullah	4	2	50
4	Basti Sabzal Khan	4	2	50
5	Basti Shikar Khan	4	2	50
6	Basti Ghulam Ali	4	2	50
7	Basti Ali Murad	7	5	71
8	Basti Haji Wazeer Khan	5	2	40
9	Basti Rasool Bakhsh	6	3	50
10	Basti Haji Jalal Khan	3	2	67
11	Basti Jahan Khan	5	3	60
12	Basti Naseer Khan	3	1	33
13	Basti Haji Mehmand Khan	5	3	60
Total		**59**	**33**	**56**

Table 5.17: Sampled Respondents of Reservoir Area

Sr. No.	Villages/Settlements in the Command Area	Number of Respondents
1	Tibbi Lundan	9
2	Basti Hajana	6
3	Harrand	7
4	Lundi Saidan	11
5	Lal Garh	8
6	Tibi Solgi	6
7	Noushehra Gharbi	4
Total		**51**

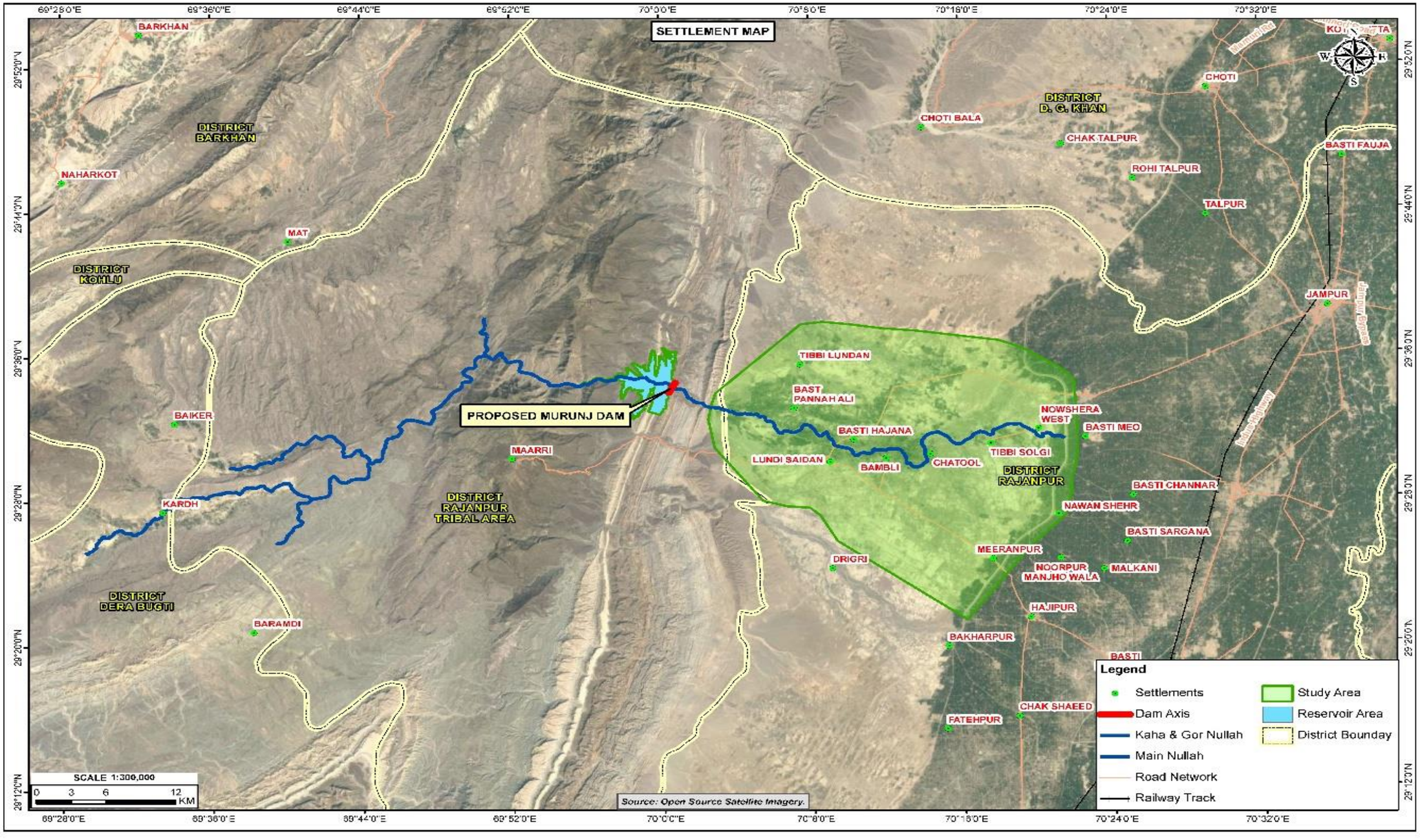


Figure 5.18: Location of Major Settlements of Project Area

5.7.1.4 Developing Survey Instruments

The TORs of the Consultant highlight the importance of collecting primary data; hence the consultants designed the questionnaires covering the various types (social, poverty, gender and resettlement). The questionnaire was pre-tested in project area to measure the relevancy and understanding of the questions.

5.7.1.5 Training of Survey Team

The consultant hired the services of the enumerator from local area to overcome the language barrier and collect data in an effective way. Team was properly trained prior to mobilizing for the formal survey. The training was comprised on the in house lecture and field visit.

5.7.1.6 Implementation of Data Collection Survey

The field methodology was prepared for data collection, used by the field teams during the execution of the study. A map of the project area was obtained prior to the survey to facilitate the identification of sample respondents in the Project area. Nonetheless, following techniques were applied in data collection.

5.7.1.7 Rapid Appraisal Methods

Rapid appraisal method was used which is quick way to gather the views and feedback of beneficiaries and other stakeholders. Rapid appraisal methods include (i) Key informant interview, (ii) Community group interview and consultations, and (iii) Direct observation.

5.7.1.8 Participative Approach

- A two-ways approach was adopted and respondents were given the opportunity to express their concerns and views freely about the project;
- Community groups including marginalized sections (vulnerable groups etc.) were the target of the study;
- The participatory tool like group meeting was applied to identify and listing of the beneficiaries; and
- Participatory process with the political and community for prioritization of strategy and development options.

5.7.1.9 Data Processing and Analysis

The following steps were undertaken to ensure proper data processing and analysis.

- The collected data/information from the field was computerized;
- A tabulation plan was prepared;
- Data was processed according to separate category of the indicators for analysis; and,
- All analyzed data was tabulated for interpretation and deriving conclusions and recommendations.

5.7.2 Findings of Socio-Economic Survey

A socio-economic survey was conducted to obtain a detailed understanding of the project area and to provide baseline data of the project area. The main objective of the socio economic was to analyze socioeconomic and cultural characteristics of the intended project beneficiaries

in order to understand their interrelationships, dynamics, and inequalities and to identify opportunities and constraints in accessing the project benefits by all beneficiaries or a segment of them (based on gender, ethnicity, level of income, geographical remoteness etc.).

5.7.2.1 District Rajanpur at a Glance

The Rajanpur city is situated on the right bank of River Indus while the district itself is situated on both sides of the River. The district is bounded on the North by DG Khan, East by Muzafar Garh, south by Rahim Yar Khan and Jaccobabad and Dera Bughti & Barkhan is situated on the west of Rajanpur. The district comprised on three tehsils namely, i) Rajanpur, ii) Jampur and iii) Rojhan and 47 Union Councils and the area comprised on 12,318 square kilometers.

According to census 2017, total population of District Rajanpur is 1,995,958 and among them males are 1,028,015 and female are 967,878.

5.7.2.2 Language

Inhabitants of Rajanpur District speak a great variety of Punjabi dialects, although few of these dialects are called as separate language like Saraiki and Balochi, but because of good and loving nature of people there is no distinction or hate among different dialects and have a mix culture of great (North and South) Punjab.

5.7.2.3 Cultural and Sensitive Places

Concept of culture can provide ways of explaining and understanding human behavior, belief systems, values and ideologies, as well as particular culturally specific personality types. Culture is the full range of learned human behavior patterns. Culture is a powerful human tool for survival, but it is a fragile phenomenon. It is constantly changing and easily lost because it exists only in our minds. [7]

The project area is a rich in culture, it has many historical places that represent its culture, like;

Shrine of Hazrat Sahal Bin Adi (R.A): Hazrat Sahal bin Adi (R.A), companion of Prophet Muhammad S.A.W is buried near Matt Kund. He started his journey to spread Islam from Arab to here and conquered many states and preached Islam.

Mithankot: The shrine of the great Sufi Saraiki poet Hazrat Khawaja Ghulam Farid is the historical place in Kot Mithan. Thousands of his disciples come to Rajanpur every year on the anniversary of Hazrat Khawaja Ghulam Farid.

Hajipur: The shrine of the great Sufi Hazrat Khawaja Noor Muhammad Narowala is the historical place in Hajipur. Thousands of his disciples come to Rajanpur every year on the anniversary of Hazrat Khawaja Noor Muhammad Narowala.

Fazilpur: The shrine of the great Peer/Sufi Hazrat Chan Charagh Shah Sain a.k.a. Ghorrey Shah Sain is the historical place in Fazilpur. Fazilpur is situated in the center of district Rajanpur. Its importance in district Rajanpur is like heart in every field specially politics.

Harrand fort built in British era is situated in the tribal area of Rajanpur.

[7] Edward B. Tyler 1832-1917

Lalgarh is situated in the foot-hills of Suleman Range Mountains. It is HQ of Gorchani tribe. It is a small village having a population of about 3000 inhabitants. Government offices include a Police Station, a Higher Secondary School, a Girls Middle School, a Civil Dispensary, and a Veterinary Dispensary.

Chatool is a small village. Chatool is the shrine of the great Sufi Hazrat Ameer Hamza Sultan is the historical place in Chatool, Lalgarh, Tehsil Jampur. Thousands of his disciples come to Rajanpur every year on the anniversary of Hazrat Ameer Hamza Sultan.

Marri is the resort Hill Station in Rajanpur similar to Forte Monroe. Its altitude is 4800 ft and very cold weather in the summer season.

Ada Chiragh Shah is situated on Indus highway. There is a shrine of Baba Chiragh Shah, a Sufi peer.

5.7.2.4 Tribes

Feudal are dominant in the Rajanpur. Gopang, Gurchani, Dreshik and Mazari are the main tribes of the Rajanpur.

5.7.2.5 Industry

Hundreds of large, medium and small industrial units of Cotton Ginning, flour mills, Rice Mills are existed in the district, Addition to this, one Sugar Mill is also present.

5.7.3 Demography of Surveyed Households

5.7.3.1 Gender Composition

Socioeconomic survey was carried out to understand the demographic and socio-economic characteristics of the population in the project area. According to survey of sampled households (84 households), the male population was high as compared to female population in the project area. On average the male population was 51% with compare to 49% female population among the surveyed families. As per survey, the household size was 8.2 persons per household. The family size clearly indicates that the existence of extended family system is still dominant in the Project Area. Detail of the population of sampled households is given in **Table 5.18**.

Table 5.18: Gender Compositions

Sex	Number	Percentage
Male	351	51
Female	338	49
Total	**689**	**100**

Source: Field Survey

5.7.3.2 Age Group of Population

Age is another important demographic characteristic which has a bearing on employment and mobility. A study of distribution of members of households by age will throw some light on the type of strategies which may be helpful in raising their income and employment. The data regarding the distribution of household members by age categories are presented in **Table 5.19**.

About 42% of the population was below 15 years of age which considered economically inactive. Together with the population that was at the age group of 65 and above have a share of 4% of the total population. Percentage of theoretically active population between 15 and 64 was 54%. Age group and population are shown in **Table 5.19**.

Table 5.19: Age Group and Population of Sample Households

Age group	Age group and Population	
	Number	Percentage
Less than 15	289	42
15-64	372	54
65 and above	28	04
Total:	**689**	**100**

5.7.3.3 Education Level

A person if he could read a newspaper or a journal of the same standard and could write the simple letter in any language defined as a literate in the Census of 1998. Education is one of the key factors in assessing the socio-economic condition of any area and is a more contributing factor than income for uplifting the living standards in society.

As per census 1998, the literacy ratio (10 years of age and above) of the District was 20.7 on an overall basis. The literacy ratio for males calculated 29 percent against 11.3 percent for females. The literacy rate is barrier with limited educational infrastructures.

Based on sample survey (**Table .20**), 92 percent of the respondent population was illiterate and only 08 percent was literate. **Table 5.21** show that in term of education distribution, out of the literate population, 3.6% of the respondents got the education till primary level (five years of schooling), 2.0% of the respondents have the education up to middle level (8 years of schoolings),1.3% & 0.6% of the respondents were matriculates and intermediate respectively. However, 0.4% respondents had their education till postgraduate levels.

Table 5.20: Literacy Level of Male and Female of Sample Households

Literacy Level	Male	%	Female	%	Overall	%
Illiterate	303	48	331	52	634	100
Literate	48	87	07	13	55	100
Total	**351**		**338**		**689**	

Source: Field Survey

Table 5.21: Educational Attainment level of Male and Female of Sample Households

Sr. No.	Education Level	Male	%age	Female	% age	Number	%age
1	Primary	21	3	4	1	25	3.6
2	Middle	13	2	1	0	14	2.0
3	Matriculate	7	1	2	0	9	1.3
4	Intermediate	4	1	0	0	4	0.6
5	Graduate	0	0	0	0	0	0.0
6	Post Graduate	3	0	0	0	3	0.4
7	Total Literate	48	7	7	1	55	8
8	Illiterate	303	44	331	48	634	92
Total		**351**	**51**	**338**	**49**	**689**	**100**

Source: Field Survey

5.7.3.4 Source of Income

Household income could be the best indicator to assess the actual socio economic situation of the target communities. The economy of the respondents living in reservoir area is entirely based on agriculture and livestock. However, besides the agriculture and livestock rearing, respondents from project command area (settled villages) were engaged in different jobs and labor works to earn their livelihood.

Agriculture & livestock rearing was major economic activity of the people living in the proposed project area. Due to scarcity of water and low rainfalls the lands were not under complete utilization. However, people living in reservoir area were utilizing the water of Kaha for irrigation purpose through lift irrigation. However, agriculture of the command area people was associated with the intensity of rains. Therefore, few of the farmers had installed solar irrigation pumping system to irrigate their cultivable land. These farmers were nominal in numbers. Due to shortage of water and disappointment from yearly low crop yields, many of them have adopted occupations other than farming for their livelihood. The occupations have been categorized based on primary source of income. The sample survey revealed that the majority of the HHs (85%) were engaged in farming and its related activities including livestock rearing, etc. followed by the labour work with 07% and remaining 08% were engaged in government and private services as well as in shop keeping. **Table 5.22** below shows the occupation of the surveyed HHs.

Table 5.22: Distribution of Households by Economic Activities

Sr. No.	Occupation	Number of Sampled HH	Percentage
1	Agriculture/livestock	71	85
2	Labor	6	7
3	Government Servant	1	1
4	Shopkeeper	4	5
5	Private Servant	2	2
Total		**84**	**100**

5.7.3.5 Monthly Income of Households

During the socioeconomic survey of the sampled HHs, it was observed that 10% HHs were earning less than official minimum wage rate of PKR 20,000 per month. Whereas, 56% HHs were earning between the range of 20,001 to 30,000 per month. 18% HHs were earning between the ranges of 30,001 to 40,000. However, 11% and 6% HHs were earning between 40,001 to 50,000 and above 50,000 per month respectively. **Table 5.23** below shows the average monthly household income of the surveyed HHs.

Table 5.23: Range of Income of Households

Sr. No.	Monthly Income (PKR)	Households (No.)	Percentage
1	Upto 20,000	8	10
2	20,001 to 30,000	47	56
3	30,001 to 40,000	15	18
4	40,001 to 50,000	9	11
5	Above 50,000	5	6
	Total	**84**	**100**

(Source: field survey)

5.7.3.6 Monthly Expenditures of Households

Household expenditure depends on the earning of the households. 08% respondents reported their monthly expenditure less than 20,000 due to their low income. However, 64% HHs reported their expenses within the range of 20,001 to 30,000 per month. Whereas, 14% and 10% households reported their monthly expenditures between the ranges of 30,001 to 40,000 and 40,001 to 50,000 respectively. Moreover, only 04% HHs were expensing above 50,000 per month to fulfill their family needs. The information relating to the household expenditure in respect of sample population is shown in **Table 5.24**.

Table 5.24: Expenditures of Households

Sr. No.	Average Monthly Expenditure (PKR)	Households (No.)	Percentage
1	Upto 20,000	7	8
2	20,001 to 30,000	54	64
3	30,001 to 40,000	12	14
4	40,001 to 50,000	8	10
5	Above 50,000	3	4
Total		**84**	**100**

(Source: field survey)

5.7.3.7 Ownership Status of the Houses

Housing is a major element of people's material living standards. It is essential to meet basic needs, such as shelter from harsh weather conditions, and to offer a sense of personal security, privacy and personal space. Good housing conditions are also essential for people's health and affect childhood development. Further, housing costs make up a large share of the household budget and constitute the main component of household wealth.

Regarding the ownership of the houses, findings of the study indicated that 100% of the sampled respondents owned their houses. Detail of the ownership of the houses is given in the **Table 5.25**.

Table 5.25: House Ownership Status

Sr. No.	Ownership Status	Number	Percentage
1	Yes	84	100
2	No	00	00
Total		**84**	**100**

5.7.3.8 Type of the Houses

The Housing conditions of the respondents have been analyzed according to the type of houses in which they were residing. These are categorized as pacca houses, semi-pacca houses and katcha houses. Pacca, the house or building constructed with concrete and / or bricks fall in pacca category. House or building constructed with burnt bricks and mud comes under semi-pacca category, whereas house constructed with un-burnt bricks and mud, or temporary wooden poles are categorized as katcha category. Detail of housing condition is given in the **Table 5.26**.

Table 5.26: Types of Houses

Sr. No.	Housing Condition	No of Households	Percentage
1	Katcha	39	46
2	Semi Pacca	18	21
3	Pacca	27	32
Total		**84**	**100**

5.7.3.9 Borrowing Status

There were two types of credit sources available to the people, formal and informal. The survey revealed that none of the respondent availed the facility of loan. **Table 5.27** shows the barrowing status of the respondents.

Table 5.27: Borrowing Status of the Respondents

Sr. No.	Borrowing Status	Number	Percentage
1	Yes.	0	0
2	No.	84	100
Total		**84**	**100**

5.7.3.10 Land Holding Status of Respondents

About 11% of the sampled Households were landless depending on livestock and general labour. 69% of the HHs were holding up to 5 acres of land. 13% of the respondents were holding land between 6 to 10 acres. However, 5% owned between 11 to 15 acres. The **Table 5.28** below shows the land tenure status of the surveyed households.

Table 5.28: Land Holding Status of Surveyed HHs

Sr. No.	Land Ownership (Acres)	Households (No.)	Percentage
1	Landless	9	11
2	Up to 05	58	69
3	06 to 10	11	13
4	11 to 15	4	5
5	16 to 20	1	1
6	21 and above	1	1
Total		**84**	**100**

5.7.3.11 Livestock

Livestock is the second largest income source in rural Punjab after agriculture. Livestock is considered a source of wealth that can relatively easily be converted to cash and also as an asset be quickly recovered. Livestock is used for exchange of gifts in communal ceremonies like weddings, tribal celebrations, childbirth or funerals and animals are slaughtered for feasts. The main source of livestock fodder is grazing in the reservoir as well as in command area. The rainfall is scarce and not enough due to its unusual distribution for cultivation of crops and fodder. According to field survey, cows, goats, sheep, camels and donkey appear to be the common livestock species in the areas.

5.7.3.12 Source of Drinking Water

Drinking water, also known as potable water, improved drinking water is water safe enough for drinking and food preparation. Access to safe drinking water supply is not only a basic need and a precondition for healthy life, but is also a basic human right. The quality of water is directly linked to the quality of health. Drinking water is not available in adequate quantity for human and livestock population as the ground water in the area is brackish. The project area is a rain fed where humans, livestock and vegetation all is dependent on rain water. People live on or near the water sources. In reservoir area, water of Kaha was being used for drinking purpose. However, in project command area, multiple sources of drinking water were being used including tubewell, water supplies and fetching from canal.

The project development objectives are to store Hill torrents (Rodh Kohi) water in the main reservoir and provide canal water for the local inhabitants, their livestock and for agriculture purpose through water channels. It will assist in flood control, improving health, poverty alleviation and help to reduce further desertification and minimize the migration trend of people towards the settled areas.

The findings of the survey indicated that 27% of the households had facility of the drinking water inside their home in shape of hand pumps and electric water pumps, while majority 73% fetch drinking water outside of their homes from different sources. Detail of facility of drinking water is given in **Table 5.29** and source of water is depicted in **Table 5.30**.

Table 5.29: Availability of Drinking Water

Sr. No.	Availability	Household (No.)	Percentage
1	Inside	23	27
2	Outside	61	73
Total		**84**	**100**

Almost 39% of the HHs were fetching water from Kaha Nallah for drinking purpose. 27% of the respondents reported that they were using hand pumps and electric water pumps as their source of drinking water. However, 19% and 14% of the respondents were fetching water from tube wells and water supplies (fetching through canes from nearby village) respectively for their drinking and domestic use.

Table 5.30: Source of Drinking Water of Households

Sr. No.	Source of Drinking Water	Households (No.)	Percentage
1	Kaha Nallah	33	39.3
2	Handpump/Electric Pumps	23	27.4
3	Tube well	16	19.0
4	Water Supply (Fetching Through Water Canes)	12	14.3
Overall		**84**	**100**

5.7.3.13 Source of Fuel

Wood (fire wood) is most commonly used as a source of fuel, followed by animal dung cake and kerosene oil pointed by the HHs.

5.7.3.14 Available Social Amenities in the Project Area

Social infrastructure and amenities are crucial to creating sustainable communities. This assessment sets spaciousness of a household's dwelling, household amenities like availability of electricity and modern appliances, nature of access to water, fuel for cooking (ease of fetching in what are primarily women's tasks), and type of sanitation facilities available as primary indicators for assessing standard of living.

The result of the survey revealed that 58% of the households had electricity facility while the facility of basic health unit was available to 46% HHs. Facility of schooling and mettle road was mentioned by 61% & 64% respectively. However, facilities of Water Supply, Sewerage and Sui Gas were not available for any HHs in the proposed project area. The information in respect of access to social amenities and their quality of services is given in **Table 5.31**.

Table 5.31: Access to Social Amenities in the Project Area

Sr. No.	Social Amenities	Available (%)	Satisfactory (%)
1	Electricity	58	52
2	Water Supply	0	0
3	BHU	46	63
4	School	61	87
5	Mettle Road	64	10
6	Mobile Service	97	100
7	Sewerage	0	0
8	Sui Gas	0	0

Source: field survey

5.7.3.15 Mode of Transport

Transport is another issue faced by the local community as available public transport system is very poor and even does not exist among many villages. Road infrastructure is very poor from settlements to main towns in the periphery, which is the main hindrance for them to have easy access to markets, health and educational facilities. People mostly travel by motorcycles or use motorcycle rickshaws. However, bus service is also available from Lundi Saidan to Fazilpur which is main town and market for the local people. Very few buses moves between Lundi Saidan and Fazilpur in day times and no public transport is available in evening and night time. The survey data indicated that 76% of sampled household used motorcycle as a mode of transport and remaining 24% of the respondents use different modes to travel, i.e. motorcycle rickshaws and buses as public transport. Detail of available transport facilities is given in the Table below **5.32**.

Table 5.32: Mode of Transport of Households

Sr. No.	Mode of Transport	Household (No.)	Percentage
1	Motorcycle	64	76
2	Public Transport	20	24
	Overall	**84**	**100**

5.7.3.16 Mechanism of Conflict Resolution

In the past, it was an age of perfect harmony among different users of scarce natural resources. Access to land and water was formerly regulated through local codes of tradition and diplomacy. Today, however, access to resources varies with position in the social hierarchy of the area, also affect the decision making and acceptance level.

During the field survey, discussions were held with the local communities. It was observed that most of activities are carried out under the instruction of the head of a caste/tribe. The decisions about conflicts, right to vote, marriage settlement and other matters are usually resolved by the heads of the castes/tribes. Most of the conflicts in the project area are insignificant, i.e. theft of animals or quarrels among youngsters which are mutually resolved within the tribes at local level. Sometimes, the conflicts not resolved by the parties are referred to the police or court.

5.7.3.17 Common Diseases in the Project Area

The climate of the project area is typically arid and characterized by low rainfall very hot summer and cold winter. Here is less vegetation cover and no fresh ground water. The climate and environment are hard for the human body and health. The ground water is brackish and contaminated which is not fit for drinking purpose in the project area. During the survey, diarhea, pain in joints, Hepatitis, & Sugar were commonly pointed out diseases by the respondents.

5.7.3.18 Non- Government Organizations & the Project Area

The floods hit the fertile lands and displaced thousands of people from their homes. The local and international NGOs respond effectively in the natural disaster and rehabilitation efforts were commendable.

During the field survey, it was observed that CESVI NGO provided support to flood affected communities by providing muddy room shelter and restoration of livelihoods of 400 most vulnerable flood-affected families' in the project area with the financial assistance of USAID & CONCERN worldwide NGOs. Moreover, HELP FOUNDATION with the help Oxfam Novib installed submersible water pumps at different locations of the Rajanpur District as well in the command area of the proposed project to provide facility of improved drinking water for the habitants as well as for livestock.

National Rural Support Program (NRSP) also exist in the proposed command area which constructed small water ponds to collect and store rain water for drinking purpose in the past. These ponds provide water long time to the community for drinking and domestic use.

Other NOGs (AAGAHI, AKHUWAT, etc.) were also working at the district level with the aim to improve socio-economic condition of the poorer and to reduce the poverty, but their services in the command area were not available.

5.7.4 Gender Situation

Rural-women are major contributors in four sub-sectors of the rural economy, crop production, livestock rearing, cottage industry, household and family maintenance activities, such as transporting water, fuel and fodder to and from the home, food preparation and preservation

and caring for children. The women have no recognized role in the authority structure of the villages despite representing about 49% of the population of the project area, the literacy rate of the female population of sampled HHs was only 1% due to lack of educational facilities and traditional attitude of not sending the girls to schools.

Most of the women stay home and only travel outside the village in case of visit to relatives and to hospitals in nearby towns in case of health emergencies.

5.7.4.1 Women Participation

Women have a vital role in maintaining domestic functions. During the field survey the question was asked from the respondents about female participation in different activities of daily life.

The information on gender was collected through individual interviews & group discussions with male respondents as females were not interviewed directly and their male members were contacted to collect the following information.

The findings of the survey revealed that participation of women in various household activities in the project area. The women participation in the child caring and household activities was (100%), it was drift that women were usually responsible for the child caring & household activities. Women of the area help their male family members in income generation activities and their participation in the livestock and farming was also remarkable. It was normal practices in the rural set up that women were actively participating in these activities. The women participation was very low in the sale and purchase of the items and livestock, usually, sales and purchase was done by the male members of the family. In addition, the women participation was zero in local representation which is disappointing. **Table 5.33** depicts the women participation in various activities.

Table 5.33: Women Participation in the Various Activities

Sr. No.	Activities	Physical Participation Level
1	Household	100%
2	Child caring	100%
3	Livestock Rearing	70%
4	Farming	75%
5	Employment	0%
6	Sale & Purchase of properties	20%
7	Social obligations (marriage, birthday& other functions)	90%
8	Local representation (councilor/political gathering)	0%

Source: Field Survey

5.7.4.2 Women Issues

During the survey following issues related to the women highlighted by the respondents which are prioritized as under;

- Scarcity of public transport service, especially for females;
- Scarcity of portable water; women are forced to fetch water from outside of their households;
- Access to medical treatment facilities, especially unavailability of female medical staff in local BHUs;

- Access to educational institutions. Educational facilities for women are not sufficient in the local educational institutions;
- Skill development centers are not available in the proposed project area; and
- Scarcity of sanitation and hygiene facilities for the females.

5.7.5 Awareness Regarding the Proposed Project

A large number of respondents (89%) were those, who had prior knowledge of the Project. Only 11% were unaware about the Project as shown below in **Table 5.34.** All respondents were briefed about the features of the proposed Project.

Table 5.34: Awareness about the Project

Sr. No.	Awareness of the Project	Number of Respondent	Percentage
1	Yes	75	89
2	No	09	11
Total		**84**	**100**

5.7.6 Acceptability of the Proposed Project

During the survey, majority (94%) of respondents favored the construction of the proposed Project keeping in view its importance and need. The reason for accepting the proposed Project is pressing need of water in command area and attenuation of flood. Contrary to this, only 6% responses were against the proposed Project due to loss of their property and agricultural land. (**Table 5.35**).

Table 5.35: Acceptability of the Proposed Project

Sr. No.	Frequency of Project Acceptability	Number of Respondent	Percentage
1	Yes	79	94
2	No	05	06
Total		**84**	**100**

5.7.7 Pressing Needs of the Area

Water scarcity is a natural and human-made phenomenon, while inexorable rise in demand for water to grow agriculture, food, supply industries and sustain urban and rural populations has led to a growing scarcity of freshwater in many parts of the world; consequently, water scarcity emerged as a global issue. Pakistan and especially South Punjab faces one of the worst situations of water quality due to poor water governance. The majority of the residents in the Project Area are facing problems of clean drinking water, sewerage, shortage of medical facilities and schools. Facility of sui gas is also not available for the majority. Mostly people in the Project Area get water for drinking and domestic use through combined open source.

The use of poor water quality causes several environmental health related problems and number of diseases related to renal complexities, skin allergies, reproductive, blood disorders and carcinogenic problems. During the survey most pressing need voiced by the respondents both males and females was the provision of clean drinking water in the area. The local people also demanded supply of clean drinking water, sui gas and medical facilities in the area. Employment in different sectors was also expressed by the people of the Project Area.

6 STAKEHOLDER IDENTIFICATION AND CONSULTATIONS PROGRAM

6.1 GENERAL

Stakeholders' involvement especially the local population is an important feature of an environmental assessment study and can lead to a better and more acceptable decision-making regarding the project design and its implementation. It gives the feeling of an ownership to the local population.

6.2 BACKGROUND

Pakistan EPA's Guidelines[8] for public consultation require that public participation should be ensured during the preparation of an EIA require that the proponents of a Project to consult the affected community and Non-Government Organizations (NGO's) as a part of the environmental assessment of the development Projects. The primary purpose of this provision is to protect and safeguard the interests of the affected communities, especially the poor and vulnerable groups.

Public involvement, undertaken in a positive manner and supported by a real desire to use the information gained to improve the Project design and lay the basis for on-going positive relationships between the stakeholders. Public involvement is also necessary for smooth implementation of the Project. The local community support is a key for the overall success of the Project.

Under the proposed Project, public consultation was carried out in the Study Area/AOI with the locals, PAPs, Government Departments, NGO's and general public. These consultations were carried out from 06th December to 13th December, 2021. The major categories of people who participated in public consultation were the local population, community groups, landowners, businessmen, tenants, vulnerable groups and potential Project Affected Persons (PAPs).

The feedbacks and issues raised during the consultation were recorded and documented for developing the strategy. Consultations with Government departments were mostly related to the proposed Murunj Dam Project's legal requirements, associated impacts, availability of requisite baseline information, specific legal requirements, information regarding any future development plans and coordination between the various concerned departments.

6.3 OBJECTIVES

The objectives of stakeholder consultations were to contribute openness, transparency and dialogue. The concerned stakeholder groups were identified to include in the assessment process.

The objectives of stakeholders' engagement include:

- Informing the stakeholders about the proposed Project;

[8] *Pakistan Environmental Assessment Procedures – PAK EPA Publication*

- Providing an opportunity to those who remained unable to present their views and values, therefore allowing more sensitive consideration of mitigation measures and trade-offs;
- Providing those involved with planning the proposal with an opportunity to ensure that the benefits of the proposal are maximized and that no major impacts have been overlooked;
- Providing an opportunity for the public to influence the project design in a positive manner;
- Increasing public confidence in front of proponent, reviewers and decision makers;
- Providing better transparency and accountability in decision making;
- Reducing conflict through the early identification of contentious issues, and working through these to find acceptable solutions;
- Creating a sense of ownership of the proposal in the minds of the stakeholders; and
- Developing proposals which are truly sustainable.

More intangible benefits flow from the public involvement as the participants realize that their ideas can help to improve the Project. People gain confidence and self-esteem through taking part in the decision-making process and perceptions are expanded by meeting and exchanging views with people who have different values and ideas.

6.4 STAKEHOLDER IDENTIFICATION

The first step for the stakeholder consultation is the identification of the stakeholders. WAPDA is the Project Proponent for the proposed Project. As per definition, stakeholder is an entity which is concerned with the proposed Project in any way. Direct stakeholders are those entities which are directly concerned with the Project. The Project has both primary as well as secondary stakeholders.

The primary stakeholders include all the PAP's according to their loss of assets and living conditions, Provincial and District Level Government Departments of Punjab such as Environmental Protection Department (EPD), Irrigation Department, Agriculture Department, Wildlife Department, etc. However, the secondary stakeholders include the public and private agencies involved in the implementation of the Project.

Following is a list of major stakeholders consulted for the proposed Project:

6.4.1 Department Level Stakeholders

1 Political Assistant/Commandant Border Military Police (BMP);
2 Environment Protection Department, Rajanpur;
3 Irrigation Department, Rajanpur;
4 Water Management Department, Rajanpur;
5 Agriculture Department, Rajanpur;
6 Forest Department, Rajanpur;

7 Wildlife Department, Rajanpur;
8 Fisheries Department, Rajanpur;
9 Social Welfare Department, Rajanpur; and
10 Revenue Department, Rajanpur.

6.4.2 Village Level Consultations

1 Project Affected Persons (PAPs)-Individual Interviews;
2 Community Consultations; and
3 NGOs.

Details regarding roles and responsibilities of the concerned agencies and departments are given below **Table 6.1.**

Table 6.1: Roles of Concerned Agencies/Departments

Sr. No.	Name	Roles
1.	Environmental Protection Agency	• EPA is the regulatory authorities and mainly responsible for the development and implementation of the environmental policies and strategies in order to integrate the environmental issues and sustainable development approaches into the legal and regulatory frameworks as per Punjab Environmental Protection Act; • EPAs are responsible for the issuance of Environmental Approval of the proposed Project; and • EPA-Punjab is responsible for the compliance of EMMP and Environmental Approval provision during the construction and operation phases of the Project.
2.	WAPDA	• WAPDA is an autonomous and statutory body under the administrative control of the Federal Government and divided into three sectors Water, Power and Finance. • Water Wing of WAPDA is responsible for planning, designing and execution of Water Resources Development Projects in the sector of irrigation, drainage and hydropower. Inter-provincial major surface water Projects including large dams are also operated and maintained by Water Wing, WAPDA. • Roles of Power wing were redefined as Hydel Power Generation and O&M of power houses. • The Charter of Duties of WAPDA is to investigate, plan and execute schemes for the following fields: ○ Generation, Transmission and Distribution of Power; ○ Irrigation, Water Supply and Drainage; ○ Prevention of Water logging and Reclamation of Waterlogged and Saline Lands; ○ Flood Management; and ○ Inland Navigation.
3.	Irrigation Department	• The Irrigation Department is committed to provide ensured and adequate water for irrigated agriculture for which it resorts to both development of new irrigation (flow/lift) schemes and conservation of flood water through small dams to meet province's requirements for food & fiber; and • Its ultimate aim is to provide year-round irrigation water/facilities and increase the irrigable area of the province through implementation of new schemes and improvement in the existing infrastructure for optimal utilization of available water resources.

Sr. No.	Name	Roles
4.	Water Management Department	• Renovation, rehabilitation, and improvement of watercourses; • Strengthening of precision land leveling services in the private sector; • Promotion of high efficiency pressurized (drip and sprinkler) irrigation systems; • Provision of solar system with High Efficiency Irrigation Systems; • Development of small scale irrigation schemes in non-canal commanded areas; • Construction of water storage ponds / tanks; • Provision of on-farm surface drainage facilities; • Identification, acquisition, pilot testing/ evaluation, indigenization, and promotion/up-scaling of the latest irrigation water management interventions/ technologies through adaptive research; • Capacity building of stakeholders in improved water management interventions; and • Coordination with international, regional, national and provincial organizations as well as Research, Extension and Field wings of Punjab Agriculture Department for irrigation water management technology transfer.
5.	Agriculture Department	• Ensuring food security; • Enhancing productivity through better varieties and improved management practices; • Promoting high value crops, fruits and vegetables; • Promoting export of high value agricultural products; • Promoting efficient use of water and other inputs; • Improving soil health; • Development of cultivable waste lands; and • Ensuring fair returns for the growers in marketing of their produce.
6.	Forest Department	• Protection, improvement and maintenance of existing forests; • Increase forests by planting new trees; and • Extension and advisory services to the general public about tree plantation.
7.	Wildlife Department	• To save and protect wildlife.
8.	Fisheries Department	• Responsible for the Conservation, Management and Development of Natural Fisheries resources through the enforcement of Punjab Fisheries Ordinance and Rules; • Promote aquaculture practices in private sector to bridge gap of protein deficiency in the diet of common man; and • Provide white meat to improve the health of people, utilize the untapped Fisheries resources to obtain maximum production, increase our share in the national economy.
9.	Revenue Department	• Revenue Department is responsible for the land assessment, collection of land revenue and preparation of land records; and • The work relating to land acquisition, land lease, alienation of land etc. is also looked after by the Revenue & Estate Department.

Prior letters were written to the concerned department for stakeholder consultation (refer **Annex-IV**) and consultations with the departments were carried out through meetings while consultations with locals, village people, directly affected people, local NGOs etc. were undertaken during the baseline survey of the study area. The consultation is an on-going process which should be continued during the project life cycle i.e. even after submission of EIA.

6.5 DEPARTMENTAL CONSULTATIONS

Details of officials contacted are given in below:

Table 6.2: List of Government Officials Consulted

Sr. No.	Name of Person	Designation	Name of Department/ Office
1.	Mr. Zahoor Hussain Bhutta	Addl. Deputy Commissioner	Revenue Department -Rajanpur
2.	Mr. Asif Iqbal	Assistant Commissioner	Revenue Department -Rajanpur
3.	Mr. Imran	Political Assistant / Commandant	Border Military Police
4.	Syed Ishfaq Hussain	District Officer	Environment Department
5.	Mr. Arif Hussain	Inspector	Environment Department
6.	Mr. Ashfaq Ahmed	Deputy Director	On Farm Water Management Department
7.	Mr. Zafarullah Arif	Agriculture Officer	Agriculture Department
8.	Mr. Muhammad Asif	Deputy Director	Agriculture Extension
9.	Mr. Salahuddin	Crop Reporting (Statistical) Officer	Agriculture Department (Crop Reporting)
10.	Mr. Allaudin	Sub Divisional Forest Officer	Forest Department
11.	Mr. Akram	Assistant Director Wildlife	Wildlife Department
12.	Ms. Humaira Bukhari	Deputy Director	Fisheries Department
13.	Mr. Wasim Akram	Branch Manager	Akhuwat NGO
14.	Mr. Imdad Hussain	Branch Manager	Kashf Foundation

6.6 CONSULTATIONS WITH DEPARTMENTS

Meetings and consultations were held with officials of different above mentioned district governments departments and NGO etc. The following points were discussed to provide information about the project:

- Location of the Project area;
- Objectives and purpose of the project;
- Status of land ownership under the impact of the proposed water reservoir;
- Status of land ownership under the Canal, distribution system and FCCs;
- Role of Departments and NGOs; and
- Services being provided in the area by NGO and Departments.

During the meeting the officials extended their full cooperation for the proposed project and their views were in the favor the project.

6.6.1 Views & Suggestions of the Officials of Departments

The responses of the participants about the construction of the Dam were recorded during the discussions. Generally, the officials were of the view, that the construction of the proposed project will have a positive impact on the economy of the area in term of availability of water for the irrigation purpose. Moreover, they provided following suggestions:

- Proper mechanism for the use of water should be developed in order to avoid conflicts over the use of waters.
- Command area should be developed with provision of lined watercourses

- The people are facing drinking water problem; therefore; they have requested to the team to incorporate the provision of water supply component in the project.
- Provision of washing points for women and cattle Ghats for livestock should keep in the scope of work of distributaries and minors.
- The community should be involved in maintenance and development of structures, as during each flood, damages to infrastructures took places. Water user organizations at each water channel are required to be developed, which will be responsible for operation and maintenance of concerned water channel.

The respondents had few reservations about the project; which have been described below:

- Due to construction of proposed dam, the area of grazing land will be reduced for livestock.
- Area of the proposed dam would silt up after few years.

6.7 COMMUNITY CONSULTATIONS

For ascertaining the perceptions of different stakeholders about the project (during/ after construction) meetings were held with local communities and anticipated project PAPs within the project area of influence. These meetings were held in an open atmosphere, in which participants expressed their views freely. Informal group discussions were also held as an additional tool for the assessment of the perceptions of the stakeholders about the project and potential impacts both positive and adverse likely to occur due to its implementation. The views of the local residents and general public were formally recorded and effort was made to make those beneficial for the Project.

6.7.1 Methods of Community/Public Consultations

The following methods were used for public consultations with project stakeholders in order to ascertain their stakes regarding project implementation. The views of the beneficiaries were formally recorded. The specific project PAPs were consulted along with general public (randomly selected) who were residing or working in the COI of the proposed reservoir and command area.

- Community/Public Consultations; and
- Individual meetings with PAPs.

The public consultation and information disclosure sessions were conducted to inform the PAPs about land acquisition and resettlement requirements, impact assessment, valuation and compensation mechanism, eligibility and entitlement criteria etc. and record their concerns and views. Following main aspects were discussed & disclosed to the PAPs during the consultation meetings;

- Introduction of the project, various components including distribution system and FCCs, its activities and possible positive and negative impacts on local community;
- Description of land acquisition process and approval of land prices;
- Description of entitlement matrix which will be developed for the PAPs;
- Description of provisions which will be made for the PAPs in the RAP document;
- Description of criteria for evaluation of land and trees;
- Basis for determining the rates of land, trees and other infrastructure;

- Possible compensation framework for the PAPs;
- Compensation criteria which may be followed for the payment to the PAPs;
- Establishment of grievances redress mechanism and procedures;
- Discuss overall land acquisition and resettlement related impacts of the project; and
- Needs, priorities and reactions of the PAPs regarding the proposed project.

6.7.2 Locations of the Public Consultations and Participation

The detail of the locations with number of participation is provided in the **Table 6.3**.

Table 6.3: Consultation with Location and Number of Participants

Sr. No.	Village	Number of Participants
1	Mud Kund	08
2	Basti Shikar Khan	09
3	Lundi Saidan	18
4	Laal Garh	15
5	Basti Naushehra Gharbi	11
6	Tibbi Solgi	10
7	Basti Zafar Khan	16
Total Participants:		**87**

6.7.3 Findings of Community Consultations

Extensive consultations were conducted with the local communities and anticipated PAPs in the reservoir and proposed project command area to record their views and incorporating in the project planning. Seven (07) consultative meetings were held with locals in the proposed project area. The major categories participated in these meetings were local population, community groups, landowners, and particular project affected Persons. All participants were briefed about the importance of the project and its impacts.

During the consultations, it was assessed that mostly people were aware about the project, its benefits and adverse impacts. During discussions, participants have shown keen interest in discussion, gave valuable suggestions and also raised various questions. The local people expressed their willingness and cooperation with the project staff during survey and implementation of the project.

The question raised and response given are provided in **Table 6.4** whereas, list of participants has been provided in the **Annex-V**. Moreover, pictorial view of the community consultations, data collection and other filed activities is depicted as Photolog.

Table 6.4: Consultation Meetings

Sr. No.	Questions/Concerns Raised by Participants	Responses of Team Consultant
1	What will be the exact location of the reservoir and where the Dam will be constructed?	The participants were briefed about the tentative location of the proposed reservoir area and location of dam axis through projects maps and awareness drawings. However, the final location of dam and its allied structures will be finalized after detailed Geotechnical and seismic studies.

Sr. No.	Questions/Concerns Raised by Participants	Responses of Team Consultant
2	Is there any provision of construction of small water reservoirs in the command area?	Only one main Dam will be constructed from the upstream of the *darrah* already available natural space. There is no need of small water reservoirs because the proposed Dam will have enough capacity to store water.
3	Has a new canal System being proposed from the Dam?	Yes. Proper canal and distribution system will be developed to irrigate its proposed command area. Due to establishment of the proper canal and distributary system, there will be no need to construct small dams in the command area.
4	How flood channels will be managed? Is there any provision of construction of Flood Carrier Channels (FCCs) in the project design?	Yes, proper flood carrier channels will be constructed to channelize the water of hill torrents which can disturb the irrigation system in command area. Alignment of the proposed FCCs was shown and discussed with the participants of the consultative meetings.
5	How the proper and equitable distribution of the water will be ensured to the farmers?	It was briefed to the participants that command area will be developed with the help of the On-farm Water Management Department (OFWM), government of the Punjab. Proper water channels will be constructed and mechanism will be developed for unbiased and equitable distribution of the irrigation water.
6	Various surveys were conducted for the propose Dam but, there is no visible progress on ground.	Feasibility and detailed engineering designing of the mega projects involves various studies which takes time. After completion of the respective studies, it is assessed that either the respective project is feasible or not. After approval of feasibility and detailed engineering design, projects are commenced and civil work is initiated on the ground. Respective project will also commenced very soon in future once the necessary studies and field investigations are carried out/completed.
7	What will be the impact of proposed Dam on ground water?	Due to construction of water reservoir and provision of water in the command area, the ground water will recharge. Hence, water table will increase and the quality of the groundwater will improve in future.
8	How water availability will be ensured at the tail portion of the canals?	With the construction of canals and distributaries, proper mechanism of the water distribution will be prepared through Irrigation channels and water courses. Availability of the water will be made sure till the tail portion of each canal and distributary.
9	Is there any provision of bridges to cross the canals and FCCs?	The crossing points will be ensured in the design as per requirement of the local population. Already established links between settlements will be restored and access to social amenities will be ensured without any interruption.

Sr. No.	Questions/Concerns Raised by Participants	Responses of Team Consultant
10	The flow of water from the hill torrents turned into flash floods during heavy rains. It may become cause of damages to the constructed infrastructure of dam and canals.	The water of the hill torrents will be managed in reservoir area as well as through proper construction of FCCs. Moreover, speed of the water coming from hill torrents will be controlled with water speed braking system.
11	How the land under the impact of the proposed reservoir and command area will be identified & evaluated?	Political Assistant office for tribal area and district Revenue department will be responsible to mark and identify the land under impact with the help of design drawings. Moreover, respective departments will provide land ownership record and assess the price of land according to different categories of land.
12	Residential structures falls in the ROW of the reservoir and proposed command area. All affected persons should be compensated and resettled properly.	The compensation for all affected structures and assets will be provided as per market rates. In addition, various allowances will be given to the PAPs according to severity of impacts faced by them.
13	Is there any provision for other civic facilities associated with the proposed project as respective project area lacking many civic amenities?	Is was told to the participants that, respective project is comprised of construction of Murunj Dam and its allied distribution system. There is no provision in the design package to provide other social amenities in the local area.
14	Provision of drinking water supply schemes for the community should be kept under scope of work of the proposed project.	Provision of water supply is not under scope of work of the Project at this stage but it is a need of the community in the project area. We will forward this request to decision making authority to include the community demand in the project.
15	When construction of the proposed project will get start?	After completion of the feasibility study and final approval of the detailed design, the construction work will be started.
16	Will pacca watercourses be constructed after completion of the Dam and canal system?	After construction of the Dam, canal and distribution system, concerned OFWM department will work to improve the agriculture production and command area development as an important component in coordination with the Irrigation and Agriculture Departments.
17	During the construction period, mobility of the local community will be disturbed.	Alternate route will be provided before the commencement of the civil work on the proposed project.
18	Participants were of the view that due to construction of the proposed project, several social amenities will be disturbed. These social amenities should be restored before commencement of the civil work to avoid any inconvenience for the local community.	The respective social amenities which will be disturbed due to construction of the proposed project, will be restored at its prior position before commencement of the civil work.
19	Due to construction activities as well as influx of labor, movement of the citizens	In order to tackle this situation, construction will be carried out in scheduled hours. So that after construction hours, local community, particularly

Sr. No.	Questions/Concerns Raised by Participants	Responses of Team Consultant
	particularly of females, residing in the local area will be restricted.	females can easily move in the area. People would be aware about complete construction activity plans so that they can move in the area freely and safely.
20	Dust and noise will disturb the nearby residential and commercial structures during construction of canal & FCCs.	All protective measures will be taken to keep safe the local community from noise and dust. Contractor will be bound to take all protective and precautionary measures to keep safe the health and properties of the local people. Internationally approved practices will be adopted in this regard.
21	Skilled and unskilled work force should be hired from local community. It will enhance the acceptability of the proposed project among local people.	Contractor will be bound to hire the skilled and unskilled work force from the local community at priority. It will enhance the acceptability of the project among the masses as well as provide proper livelihood to the deprived and marginalized community.

6.7.4 Community Priority Needs

During public consultations and socio-economic survey in the proposed project area, the needs of the local communities were assessed and prioritized as following;

- The consultations revealed that protection from flash floods of the hill torrents was the priority demand of the local people. Respective issue will be resolved after construction of dam and proper channelization of the FCCs.
- Scarcity of water for drinking and irrigation purpose was the second major problem for the local community. Participants requested to install water supply schemes and water filtration plants in the area to provide safe drinking water to the local communities which is basic human need.
- Local community also demanded for provision of basic social/civic amenities because entire area lacking in basic social amenities like electricity, gas and road infrastructures. These social amenities should be provided at earliest.
- Participants of the consultations also demanded for quality education facilities in the local area for both male and female students.
- They were of the view that health facilities are very poor in the area. New hospitals should be constructed at village level and capacity of the existing hospitals should be improved through appointment of staff, proper equipment and uninterrupted supply of the medicines. Moreover, qualified female staff should be appointed in the hospitals for the convenience of the female patients.
- Livelihood opportunities should be provided to the local community.

6.7.5 General Opinion of Consulted Communities

The people of the project area were in the favour of the proposed project. The availability of water for irrigation purpose and livestock would boost-up the socio-economic characteristics

of the local community and modify the ecology of the area. Due to availability of water, agricultural practices in the area would result in increasing the cropped area, crop yields and cropping intensities, etc. that will be in conjunction with better quality produce into higher farm incomes in the Project area. Moreover, the area will be protected from the floods of Hill Torrents.

The people of the project area are pleased to learn about the project. They considered this project a very favorable for protection the valuable infrastructure and inhabitants. They were of the view that with the implementation of the proposed project, the livelihood and small business will be improved with faith and trust. Ultimately the project will have a positive impact in the livelihoods of the local communities.

6.8 STAKEHOLDER CONSULTATIONS FRAMEWORK FOR PRE-CONSTRUCTION, CONSTRUCTION AND OPERATION PHASE

Key stakeholders of the Project include provincial and district level government departments such as EPD, Agriculture Department, Forest Department, Wildlife Department, Irrigation Department, Project directly affected people, land owners and local people. The community members will be compensated by project proponent and they will be encouraged to participate in project activities during pre-construction, construction and operation phases. The consultations are recommended be made in future to facilitate the community at the local level.

The consultations should be carried out during the construction and operation phases of Project. Efforts is recommended to be made to maximize the consultations during the project implementation. The consultations will be carried out with the objectives to develop and maintain communication linkages between the project promoters and stakeholders, provide key project information to the stakeholders, and to solicit their views on the project and its potential or perceived impacts, and ensure that views and concerns of the stakeholders are incorporated during the implementation with the objectives of reducing or offsetting negative impacts and enhancing benefits of the proposed Project. The framework for the future consultations is elaborated in **Table 6.5**.

Table 6.5: Future Consultations Framework

Sr. No.	Stakeholders	Project Phase	Frequency of Consultation
1	Department Level Government Officials	• Pre-Construction, • Construction • Operation and Maintenance	• One round of consultations before start of implementation of project. • Monthly during construction stage; and • Bi-annually during operation phase of the project.
2	PAPs	• Pre-Construction, • Construction • Operation and Maintenance	• One rounds of consultations before start of implementation. • Fortnightly during construction stage; and • Bi-annually during operation phase of the project.
3	Surrounding Villages	• Pre-Construction, • Construction • Operation and Maintenance	• One round of consultation before start of implementation. • Quarterly during construction stage; and • Bi-annually during operation phase of the project.
4	Local Elders	• Pre-Construction, • Construction • Operation and Maintenance	• One round of consultations before start of implementation of project. • Monthly during construction stage; and • Bi-annually during operation phase of the project.

Sr. No.	Stakeholders	Project Phase	Frequency of Consultation
5	Women	• Pre-Construction, • Construction • Operation and Maintenance	• One rounds of consultations before start of implementation. • Fortnightly during construction stage; and • Bi-annually during operation phase of the project.

7 ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENT AND MITIGATION MEASURE

7.1 GENERAL

This chapter identifies the potentially significant beneficial as well as adverse environmental and social impacts of the pre-construction, construction and operational phases of the proposed Project on the physical, ecological and socio-economic domains of the environment. Moreover, appropriate, technically viable and economically feasible mitigation measures were suggested for each potentially adverse impact.

7.2 METHODOLOGY FOR IMPACT IDENTIFICATION

Selection of an appropriate and customized methodology for the impact assessment is critical for the whole outcome of an EIA study. The identification, categorization and evaluation of impacts were carried out by using various tools such as impact screening checklist, impact assessment matrices and overlay. Based on the notion of significance criteria each impact was classified. Based on the vast experience of the experts in the field of impact assessment, identification of the potentially significant and non-significant environmental and social impacts different tools has been utilized as detailed below:

7.2.1 Screening Checklist

Based on the findings of desk studies, processed satellite imageries, previous studies, screening checklist was prepared to screen out the potentially significant adverse environmental and social impacts during the construction and operation phases of the proposed Project. The objective of the impact screening is to assess the significance of the issues related to the atmosphere, climate, water resources, land resources, ecological environment, socio-economic environment, transport, infrastructure and communication, natural risks, hazards and external constraints of the Project for the proposed development. After the compilation of baseline information, processing of acquired satellite imagery, the screening checklist was filled to screen out the positive and adverse impacts of the proposed Project during the construction and operational phases.

7.2.2 Impact Matrices

Various EIA methodologies are available for identification of impacts including the checklist and project impact matrix. Among these methods, project impact matrix was used as impact identification methodology for the identification of temporal based impacts.

The Impact Evaluation Matrix was developed by placing project activities along one axis (i.e. Y-axis), and on the other axis (i.e. X-axis) the different environmental parameters likely to be affected by the proposed project actions grouped into categories i.e. physical, ecological and socio-economic environment. For the impact assessment, project impact evaluation matrix is used by dividing the project action into different phases (design/pre-construction, construction and operational phases).

7.2.3 Notion of Significance

The “notion of significance” was based on the following criteria:

- **Extent:** The scale of impact, i.e., limited to the immediate areas of development activity (the site); limited to within a distance reach of the development; affecting the region as a whole; or occurring at a national or international scale;
- **Duration and Frequency**: A prediction/forecasting of the lifetime of the impact: i.e., short-term; medium term; long term with the impact ceasing after the operational life of the development; or considered permanent and how many times the event will occur during that period;
- **Intensity:** A description of the intensity (magnitude/size) of the impact: i.e., high, medium, low, or negligible (no impact). The specialist studies must attempt to quantify the magnitude of impacts and outline the rationale used. Where appropriate, national standards are to be used as a measure of the level of impact;
- **Reversible/Irreversible:** Changes considered irreversible, for example, the loss of biodiversity within a river due to a change in water quality;
- **Probability:** The likelihood that the event will actually occur; and
- **Legal Restriction:** If the action is likely to affect, or be affected by a legal restriction.

Taking into account these criteria, potential significance was classified as either:

- **Low:** an impact for which no mitigation is necessary;
- **Medium:** an impact that requires effective mitigation; and
- **High:** an impact, which, if not mitigated, could stop the Project from proceeding.

The potentially significant impacts were then further investigated in detail to carry out a comprehensive assessment of the significant impacts.

Categorization of environmental impacts based on significance of notion is shown in **Table 7.1.**

Table 7.1: Categorization of Environmental Impacts

Sr. No.	Impact	Extent	Duration and Frequency	Intensity	Reversibility Category	Probability	Potential Significance
A	**Pre-construction Phase**						
	Physical Environment						
1.	Permanent Land Acquisition	Site-specific	Permanent	High	Irreversible	Possible	High Significant
2.	Temporary Land Acquisition	Site-specific	Temporary	High	Reversible	Possible	High Significant
3.	Affected Population	Site-specific	Permanent	High	Irreversible	Possible	High Significant
4.	Impact on Infrastructure	Site-specific	Permanent	High	Reversible	Possible	High Significant
5.	Field Investigations	Site-specific	Temporary	Medium	Reversible	Likely	Medium Significant
	Ecological Environment						
1.	Flora and Fauna	Site-specific	Temporary	Low	Reversible	Likely	Low Significant
	Socio-economic Environment						
1.	Depriving the host community of any development activity	Site-specific	Temporary	High	Reversible	Possible	High Significant
2.	Uncertainty and security of future activities	Site-specific	Permanent	Medium	Irreversible	Likely	Medium Significant
3.	Fear of displacement and resettlement	Site-specific	Permanent	High	Irreversible	Possible	High Significant
4.	Imminent loss of physical assets	Site-specific	Permanent	High	Irreversible	Possible	High Significant
5.	State of disturbance and stress prevalent among communities	Site-specific	Temporary	Medium	Irreversible	Likely	Medium Significant
6.	Fair compensation and delaying factor in making payment if any involved;	Site-specific	Temporary	High	Reversible	Possible	Medium Significant
B	**Construction Phase**						
	Physical Environment						
1.	Aesthetics	Local	Long Term	High	Irreversible	Likely	Medium Significant
2.	Access Roads and Transportation	Local	Medium Term	High	Reversible	Likely	Highly Significant
3.	Natural Drainage	Site-specific	Medium Term	High	Reversible	Likely	Medium Significant
4.	Loss of Land in Disposal Area	Local	Medium Term	Medium	Reversible	Likely	Medium Significant
5.	Soil Contamination and Erosion	Local	Medium Term	High	Irreversible	Likely	Highly Significant
6.	Liquid and Solid Waste	Site-specific	Medium Term	Medium	Reversible	Possible	Medium Significant

Sr. No.	Impact	Extent	Duration and Frequency	Intensity	Reversibility Category	Probability	Potential Significance
	Generation						
7.	Surface Water Quality	Local	Medium Term	Medium	Irreversible	Likely	Medium Significant
8.	Quarrying/Borrow Pits Hazards	Site-specific	Medium Term	Medium	Reversible	Possible	Medium Significant
9.	Hydrology	Local	Medium Term	Medium	Irreversible	Likely	Medium Significant
10.	Ambient Air Quality	Local	Medium Term	Medium	Reversible	Likely	Medium Significant
11.	Noise and Vibration	Local	Medium Term	Medium	Reversible	Likely	Medium Significant
	Ecological Environment						
1.	Flora and Fauna	Local	Permanent	High	Irreversible	Likely	High Significant
	Socio-economic Environment						
1.	Skilled and unskilled labor opportunities	Local	Medium Term	Medium	Reversible	Likely	Medium Significant
2.	Employment of locals and immigrants	Local	Medium Term	Medium	Reversible	Likely	Medium Significant
3.	Local economic development	Local/National	Long Term	High	Irreversible	Likely	Medium Significant
4.	Loss of privacy and security	Site-specific	Temporary	Medium	Reversible	Likely	Medium Significant
5.	Differences of cultural values	Local	Temporary	Medium	Reversible	Likely	Low Significant
6.	Disruption of utilities and load on physical infrastructure	Local	Temporary	Medium	Reversible	Likely	Low Significant
7.	Development of solid waste on dam site	Site-specific	Medium Term	Medium	Reversible	Possible	Low Significant
8.	Gentrification	Local	Temporary	Medium	Reversible	Likely	Low Significant
C	**Operation and Maintenance Phase**						
	Physical Environment						
1.	Sedimentation	Local	Long Term	High	Irreversible	Likely	High Significant
2.	Loss of Nutrients	Local	Short term	Medium	Reversible	Likely	Medium Significant
3.	Landslides Hazard	Local	Long Term	Medium	Irreversible	Likely	Medium Significant
4.	Change in Land Use	Site-specific	Long Term	Medium	Irreversible	Likely	Medium Significant
5.	Water Logging and Salinity	Site-specific	Long Term	Low	Irreversible	Likely	Low Significant
6.	Water Seepage	Local	Long Term	Significant	Irreversible	Unlikely	Low Significant
7.	Water Quality	Local	Medium Term	Medium	Irreversible	Likely	Medium Significant
8.	Climate	Regional	Medium Term	Medium	Irreversible	Likely	Medium Significant
9.	Water Rights in Pachad Area	Local	Long Term	High	Irreversible	Likely	High Significant
10.	Dam Safety and Emergencies	Local	Long Term	High	Irreversible	Likely	High Significant
11.	Attenuation of Floods	Local	Long Term	High	Reversible	Likely	High Significant

Sr. No.	Impact	Extent	Duration and Frequency	Intensity	Reversibility Category	Probability	Potential Significance
12.	Air and Noise	Local	Short Term	Low	Reversible	Likely	Low Significant
	Ecological Environment						
1.	Flora and Fauna	Local	Long Term	Medium	Reversible	Likely	Medium Significant
	Socio-economic Environment						
1.	Development of economic activities that boost the living standards of locals	Local/National	Long Term	High	Irreversible	Likely	Medium Significant
2.	Affected farming patterns due to change in downstream flow	Local	Medium Term	Medium	Reversible	Likely	Low Significant
3.	Increased agricultural productivity and price of land	Local/District	Long Term	High	Irreversible	Likely	Medium Significant
4.	Secured water rights	Local	Long Term	High	Irreversible	Likely	Medium Significant
5.	Regular water supply for irrigation	Local	Long Term	High	Irreversible	Likely	Medium Significant
6.	Promotion of recreational activity and fish farming	Local	Long Term	High	Irreversible	Likely	Medium Significant
7.	Water borne diseases as a result of large-scale water project	Local	Medium Term	Medium	Reversible	Likely	Low Significant

7.3 POSITIVE IMPACTS DURING CONSTRUCTION AND OPERATIONAL PHASES

The proposed Project have direct benefits called as Project main objective however, there are also associated benefits known as indirect benefits. Following are the associated positive benefits of the proposed Project:

7.3.1 Direct Benefits

7.3.1.1 Provision of Water Storage[9]

According to the International Commission on Large Dams, total dams and reservoirs in Pakistan over the height of 15 m (49 ft.) are known as large Dams. Tarbela Dam is the largest earth filled dam in the world and is second largest by the structural volume[10]. Mirani Dam is the largest dam in the world in terms of volume for flood protection with a flood stock of 588,690 cubic hectometer while Sabakzai Dam is 7th largest with a flood stock of 23,638 cubic hectometer. Pakistan's water storage capacity is just for 30 days against the minimum requirement of 120 days while most of the developed countries have 1-2 years' water storage capability. The agriculture productivity in Pakistan in the wake of just 30 days' water storage capacity has alarmingly tumbled because of the water scarcity and its contribution towards gross domestic product has lowered by 21.8 per cent of GDP.

As the population of Pakistan is going to increase up to about 250 million by year 2030, the water availability which was around 5000 m^3/capita/annum in 1951 (presently stands around 900 m^3/capita/annum) is going to further reduce to around 700 m^3/capita/annum by 2030, thus creating a water scarcity problem of acute nature unless adequate measures are taken to mitigate the above challenge.

The dwindling per capita availability of water in the country is shown in **Table 7.2.**

Table 7.2: Per Capita Water Availability in Pakistan

Year	Population (Million)	Per Capita Water Availability (m^3)
1951	34	5260
1961	46	3888
1972	65	2751
1981	84	2129
1991	115	1565
2002	139.5	1282
2010	173.51	1030
2015	191.71	932
2020	210.13	850
2025	227.35	786
2030	242.05	738

[9]Falkenmark Water Stress Indicator
Pakistan Strategic Country Environmental Assessment
https://www.thenews.com.pk/archive/print/240583-population-explosion-a-threat-to-pak-progress#
http://www.pbs.gov.pk/sites/default/files/other/pocket_book2006/2.pdf
http://www.pakistaneconomist.com/pagesearch/Search-Engine2010/S.E634.php
[10] Asianics Agro-Dev. International (Pvt) Ltd. (2000)

The construction of proposed dam will aid to store the flood water of hill torrent and overall increase the water storage of the Pakistan. The proposed Project will form an active storage reservoir of about 575 Mm^3 capacities with the aim of providing assured and sustained supply of irrigation water for the downstream of the proposed dam and power supply need as a by-product. This would not only help to irrigate the new command areas downstream but would also augment the irrigation as well as power shortfall.

7.3.1.2 Energy Production

Proposed Murunj Dam will generate an estimated annual energy production of about 80 GWh with the installed capacity of 06 MW. This will be produced as a by-product and help the National Power Policy achieve the goals of meeting Pakistan's energy needs in a sustainable manner and ensuring the generation of affordable electricity, while helping to close the existing energy supply gap.

Pakistan is facing acute shortage of Power due to increase in population and industrial development, which has created a huge gap between the demand and supply of electric Power. Its continued economic development is under threat unless the present shortages can be eliminated, increasing dependence on oil-fired electricity reversed and the country provided with affordable electricity at times of the day and the seasons when it is required. Currently being utilized Power generating sources are not sufficient to meet the electricity demand of today and obviously insufficient to meet the future ever increasing demand.

The current power load-shedding in the urban and rural areas, had become a routine matter, having a devastating impact on the national economy, industry and agriculture, putting millions of workers jobless. The rise in unemployment is having a direct adverse impact on the already deteriorated law & order situation in the country. Therefore, addition of this associated 06 MW of energy in the national grid will be a direct positive impact of the Murunj Dam Project.

7.3.1.3 Protection against Devastating Floods

Due to lack of sufficient cross drainage facilities under Kachhi and Dajal Branch originating from DG Khan Canals, the high flood flow after breaching the canals enters in canal command areas and cause heavy damages to crops, property, communication system, and infrastructure and even to human lives. These damages will be minimized by proper management of flood water through regular irrigation in Pachad area by construction of storage cum delay action dam on Kaha Hill Torrent and channelizing excessive water to Indus River through flood channels/drains. The major flood damages "without" project option can be envisaged in terms of crops, houses, irrigation system and infrastructure.

With construction of storage cum delay action dam against design flood on Kaha Hill Torrent, all flows will be utilized for irrigation in Pachad area. The storage cum delay action dam is designed to curtail flashy flows of peak floods up-to 100 years return period. The flow will be diverted proportional to the size of agricultural lands in command area of Kaha while excess water will safely pass through cross regulators on canals and will drain into Indus River on its natural routes without causing noticeable damages.

The construction of Murunj Dam will alleviate the risk of such hill torrent flood damages in future to a great extent. The reservoir would store flash flood flows and minimize the intensity of floods downstream. Therefore, the reservoir would be source of flood protection.

Based on the flood studies, the observed recorded 100 year return period flood inflow at proposed dam site of Murunj Dam is about 146,000 ft^3/s. After the construction of the proposed Dam, the flood attenuation due the proposed Dam will be about 26%[11] i.e. outflow is about 38,700 ft^3/s.

7.3.1.4 Irrigation Benefits

Construction of Murunj Dam will increase irrigation benefits by attenuating flood flows behind the dam and securing the existing Kachhi Canal from breaches. Due to Kachhi Canal breaches during peak floods and silt deposit in the canal bed under "without" construction of proposed works, canal supply will be disrupted/suspended for long periods. The restoration of canal irrigation supplies to the command area depends on the repair time of canal which relates to type, magnitude and place of damage. Repair of canal may also require canal closure to stop water hindrance at working area. The disruption of canal flow will disturb irrigation supply in Kachhi Canal command area which will affect the growth of agricultural production of standing crops. The disruption of irrigation supply for few weeks/months will proportionally reduce yield. While, irrigation supply cutoff for longer period will result in complete crop failure. The response of crops to soil moisture deficiency differs and it also relates to the irrigation supply cutoff duration, weather conditions and soil structure.

Additionally, regulated supply of Murunj Dam water to all wahs and sub-wahs (19 in numbers) as well as the proposed canal irrigation network will ensure water availability for longer period of time resulting definite improvement of agricultural production and reduction in social conflicts.

7.3.1.5 Agriculture Benefits

Agricultural benefits, being the part of the total Project benefits, have been measured in terms of with and without project option and Gross Production Value (GPV), Farm Production Expenses (FPE) and Net Production Value (NPV) for with and without Project have been provided in **Table 7.3.**The main agricultural benefits will primarily accrue from the incremental crop production as a result of an increase in cropping intensities and crop yields due to the increase and assured releases from dam.

Table 7.3: Agriculture Benefits of Regular Irrigation in Pachad Area of Kaha

	GPV	FPE	NPV
Existing Benefits	205.28	63.05	142.22
Benefits with Project	3090.26	928.65	2161.61
Incremental Benefits	2884.98	865.6	2019.39

Source: Hill Torrent Management Study, 2016

[11] Flood Studies of Murunj Dam Project, 2022

7.3.1.6 Saving of Flood Damages Due to Breaching of Kachhi Canal

The construction of multipurpose earth core rock fill dam on Kaha Hill Torrent will control flood flows of hill torrent, thereby, protecting the Kachhi Canal from flood damages. Ensured protection of Kachhi Canal from flood damages are essential due to its special features; long length, high flow, large command area and inter-provincial location. The canal is 500 km long, mostly lined with 6000 cusecs discharge estimated to irrigate 713,000 acres of command area in Balochistan. Under without construction of proposed works/ structures scenario, if Kachhi canal breaches during peak floods, the canal repair will be required long time because lining repair needs special machinery along with lot of technical inputs. Also long period will be needed for canal closure and restoration of supply because the canal does not possess escape channels.

7.3.1.7 Infrastructure Development

Access and approach roads will be improved for the transportation of machinery of the Project, especially during construction activities of the dam for various components of the Project. Locals will be benefited by these roads and infrastructure during the construction and after the construction of the proposed Dam.

7.3.1.8 Employment Opportunities

Employment opportunities will be created for the unskilled and skilled local labor especially during construction and O&M phases of the proposed Project. The requirement of engineers, workers, labor, technicians, para-professionals etc. will help to generate employment opportunities from local communities preferably. Apart of this, opportunities of small businesses (for example, shop keepers etc.) will also be increased to have more income for local inhabitants. Locals will also have the opportunity to diversify their incomes by being employed during the construction period of the proposed Project. This will bring prosperity among locals and help in increasing the confidence of locals towards development Project. Transportation of the material, equipment, labor and other accessories the business of transport and cargo will also flourish in the area. This will also be a positive impact for the locals.

7.3.1.9 Socio-Economic Uplift

Development of small and local business, water for irrigation and job opportunities during the construction and O&M phases will cause socio-economic uplift of the area. The proposed Project will create new job opportunities for local residents preferably during the construction and O&M phases of the Project. This will uplift the socio-economic situation of the area. Non-quantifiable benefits include a significant improvement in general hygiene and living conditions of the rural area population with improved water quantity/quality as well as environment. It is also expected to increase in the land value and owners will have an opportunity to sell their land at increased prices and start new businesses.

7.3.2 Indirect Benefits

Other indirect benefits due to the construction of the Murunj Dam could be listed as follows:

- Enhancement and improvement of the local economy due to enhanced irrigation facilities, and consequent benefits, which will create additional employment opportunities at the local level (for instance mechanics for modern machinery & equipment for irrigation);
- Easy access to educational and/or health care facilities, which will come up as a consequence of the Project activities;
- New roads / infrastructure in the form of access roads to the Dam area;
- New recreational facilities due to proposed reservoir; and
- The increased crop production will stimulate business and employment opportunities for the labor in form of handling, transportation, marketing, processing, etc. of agriculture produce.

7.4 EVALUATION OF ADVERSE IMPACTS DURING DESIGN/PRE-CONSTRUCTION PHASE

7.4.1 Physical Environment

7.4.1.1 Permanent Land Acquisition

a) Impact

The major impact due to the implementation of the proposed Project will be the impounding of about 4098.65 acres of area. This will form a reservoir area which may result in the loss of land and the land based resources and assets in the reservoir area. These resources mostly include land such as barren and hilly land along with other land cover type such built-up, cultivated, flood plains nullah and trees.

Due to the impounding, the area will be lost on permanent basis. Permanent land acquisition will be required for the reservoir up to the Peak conservation level of (1,170 ft). The total land to be acquired is about 3990.79 acres for the reservoir area as per the land use map of reservoir area provided in **Figure 5.13**.

Details of land to be acquired for the proposed reservoir are given in **Table 7.4** below:

Table 7.4: Land Falling in Reservoir Area

Sr. No.	Description	Total Area (Acres)	Percentage of Total Area (%)
1	Barren Area	1079.584	27.05
2	Built up	3.481	0.09
3	Cultivated Area	450.552	11.29
4	Flood Plain	167.019	4.19
5	Hill	1953.233	48.94
6	Nullah	336.924	8.44
Total		**3990.794**	100

Similarly, the total land required for the establishment of canal and drainage structures in command area is about 4149.13 acres. **Figure 5.14** shows the land use map of command area. Details of land to be acquired for the proposed canal and drainage structures are given in **Table 7.5** below:

Table 7.5: Land Falling in Canal and Drainage Structures

Sr. No.	Description	Total Area (Acres)	Percentage of Total Area (%)
1	Agricultural Area	2732.651	65.86
2	Barren Land	376.037	9.06
3	Flood Plain	625.418	15.07
4	Nullah	397.914	9.59
5	Road	7.165	0.17
6	Settlement	6.559	0.16
7	Shrubs/Grasses	3.391	0.08
Total		**4149.13**	100

Apart from above, land to be acquired for various other project components is detailed in below **Table 7.6** and shown in **Figure 7.1.**

Table 7.6: Land Acquisition details of Other Project Area Facilities

Sr. No.	Description	Area (Acre)
1	Proposed Operational Offices	23
2	Proposed Colony	117
Total Area for Project Components		**140**

This impact will also trigger associated impacts like submergence of flora and habitat of fauna which are discussed in the later paragraphs. This piece of land with respect to classification is totally barren and mostly related to state owned land. Hence, this impact is Site-specific, Permanent, Irreversible, Possible, High Significant.

b) Mitigation

The land required for the proposed Project falls in Rajanpur District of Punjab. The LAA, 1894 is the core legislation for the acquisition of private land for development Project. Local needs for land acquisition are addressed through the system of land rights and distribution.

Almost all civil works will be carried out within the state land. Hence, no private land is required in the execution of this sub-project. The land will be transferred from department to department as per rules.

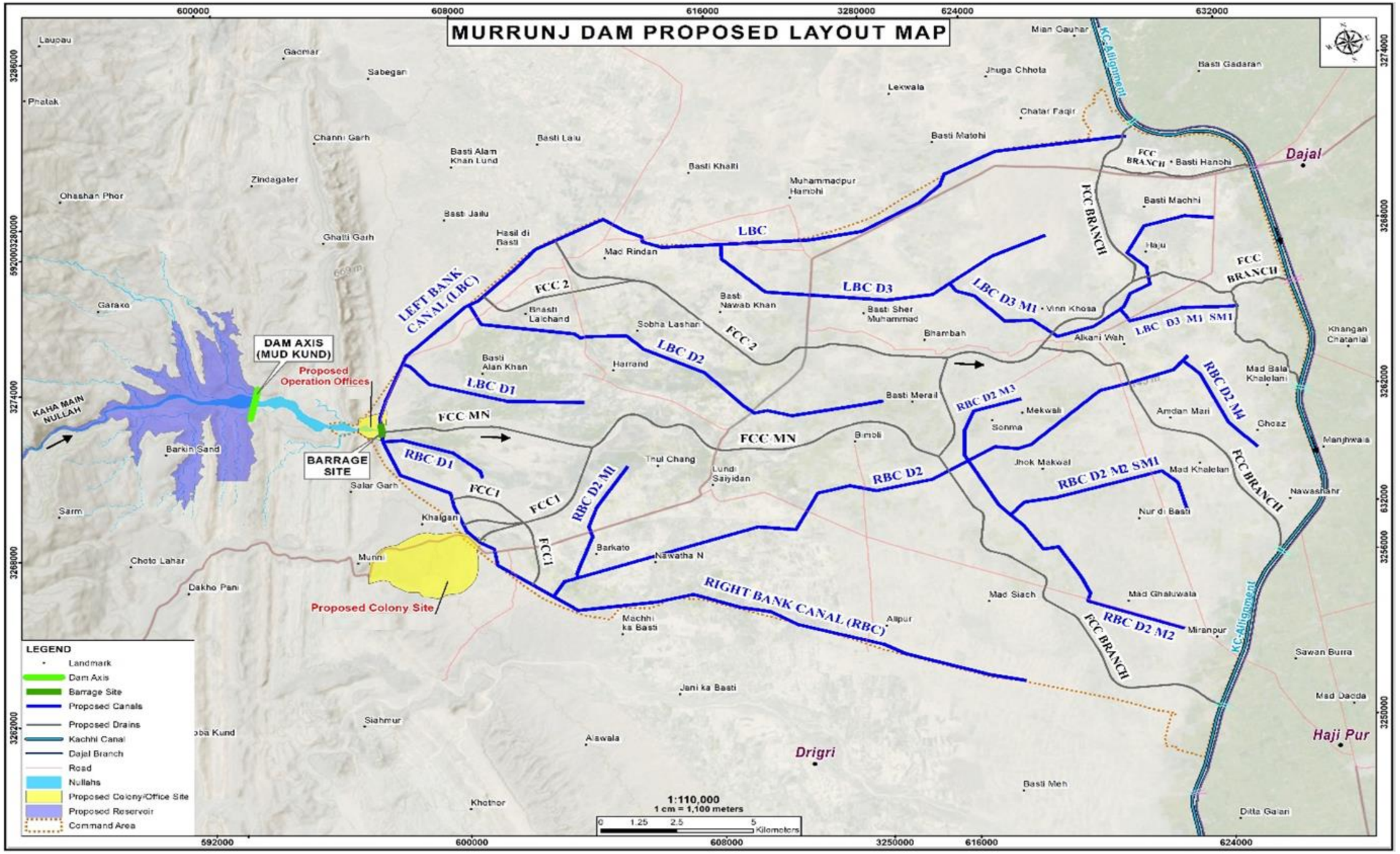


Figure 7.1: Location of Proposed Colony and Offices

7.4.1.2 Temporary Acquisition (Land on Lease)

a) Impact

During the construction activities, contractor will establish contractor camps, storage areas for materials and equipment including vehicles, workshops, stockpile yard, etc. The tentative location of these construction camp areas is shown in **Figure 7.2** which need to be finalized yet. Contractor need to lease the land for these areas in the vicinity of the construction sites. These areas will be acquired on temporary basis by direct negotiation and agreement with the owners or negotiated with or decided by the district administration office. Temporary acquisition will principally be the responsibility of the contractor. The total estimated land which will be occupied by the construction camps and associated facilities is about 18-20 acres (08-10 acres for staff and labour camps and 10 acres for material and equipment storage area). This impact is Site-specific, Medium Term, Reversible, Possible, High Significant.

b) Mitigation

Land for above mentioned facilities will be directly rented from the private landowners by the contractor. The provisions of the Land Acquisition Act (LAA), 1894 will not be involved as the acquisition of the land will be temporary and will be covered by short-term lease agreements between the landowners and contractor. Temporary acquisition will principally be the responsibility of the contractor. Rental terms will be negotiated to the satisfaction of the concerned landowners and the agreement will be made in local language to make the process clear.

As mentioned the location of these areas are not finalized yet, therefore a criterion has been suggested which will be followed to avoid the adverse impact on the environment. The land for above mentioned facilities will be selected and leased prior to the start of construction phase.

Lease agreement will also govern the process of site restoration of the leased or rented land after the construction phase and will ensure through the terms of the construction contracts that landowners are compensated according to the terms of the lease agreements and the site restoration plans agreed upon by the contractors are duly carried out.

The following general site selection criteria have been suggested to be complied by the contractor:

- Minimize the resettlement, relocation of the existing infrastructure like roads, cultural and religious sites etc. and avoid the cutting of trees;
- It will be elevated to avoid floods and for other security reasons;
- Proximity to the major disaster and emergency management authorities;
- Avoid potentially security vulnerable areas;
- Minimize disturbance to the natural habitats of flora and fauna;
- Avoid densely populated areas/towns;
- Avoid indigenous or tribal settlements;
- Avoid wildlife sanctuaries, national parks and game reserves;
- Appropriate distance from the sensitive receptors (for instance, minimum 500m); and
- Avoid cultural, religious and historical buildings.

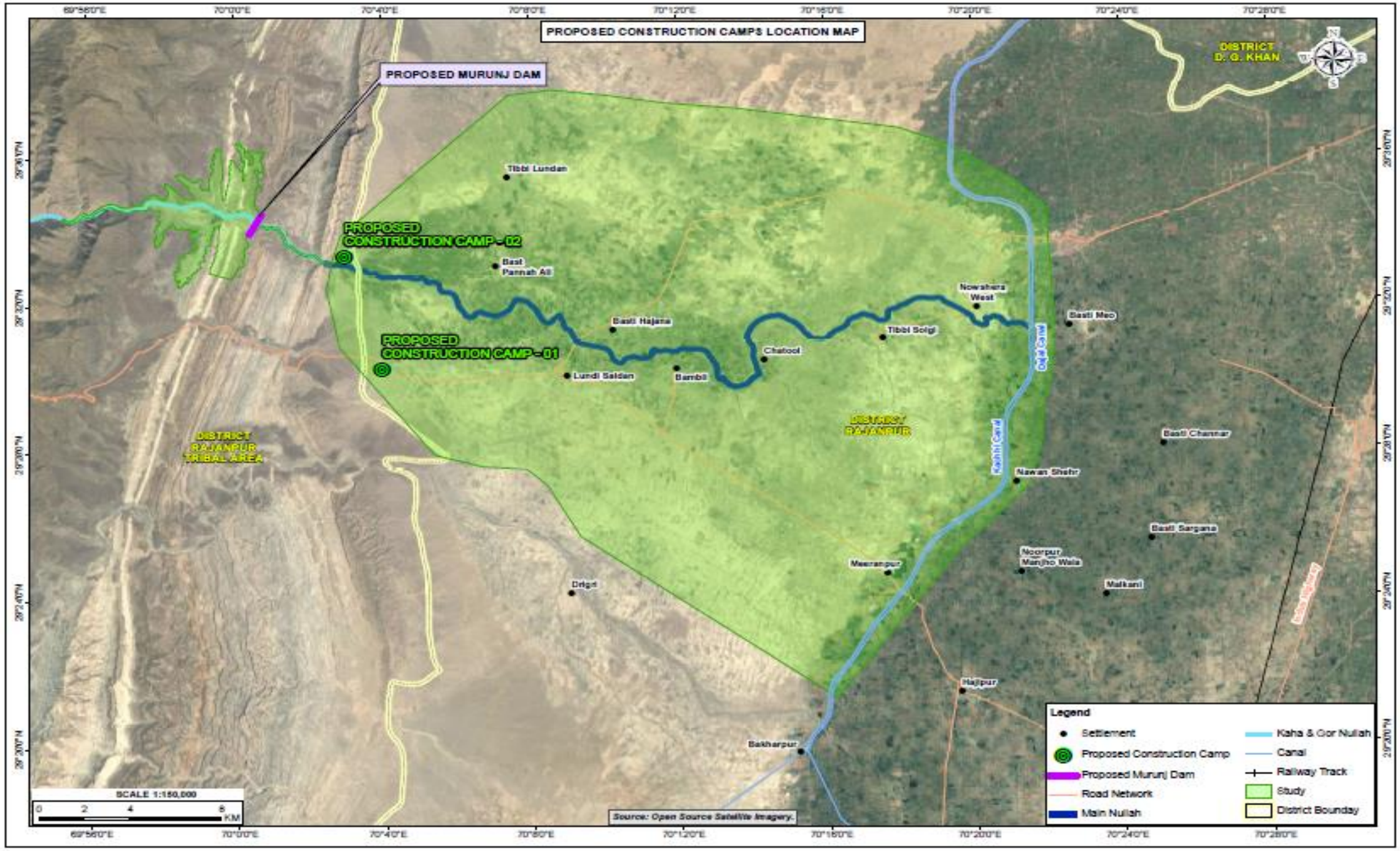


Figure 7.2: Location of Proposed Construction Camp Sites

7.4.1.3 Impact of Structure Loss

a) Impact

The project will impact about 59 numbers of structures in reservoir area (Refer **Table 7.7**) and approx. 75 numbers of structures in canal and drainage scheme (Refer **Table 7.8**). Formal assessment and detailed measurement of the affected structures will be finalized after implementation of Section-4 of LAA and will be updated in the final RAP. This impact is Site-specific, Medium Term, Reversible, Possible, High Significant.

Table 7.7: Structures/Settlements in Reservoir Area

Sr. No.	Villages/Settlements in the Reservoir Area	Total Households
1	Basti Haji Bakhtiar	5
2	Basti Mureed Bakhsh	4
3	Basti Abdullah	4
4	Basti Sabzal Khan	4
5	Basti Shikar Khan	4
6	Basti Ghulam Ali	4
7	Basti Ali Murad	7
8	Basti Haji Wazeer Khan	5
9	Basti Rasool Bakhsh	6
10	Basti Haji Jalal Khan	3
11	Basti Jahan Khan	5
12	Basti Naseer Khan	3
13	Basti Haji Mehmand Khan	5
Total		**59**

Table 7.8: Structures/Settlements in ROW of Canal and Drainage Scheme

Sr. No.	Canal/Drain Name	Settlement Nos.
1	FCC 2	2
2	FCC BRANCH	12
3	FCC MN	6
4	FCC1	10
5	LBC	3
6	LBC D1	2
7	LBC D2	18
8	LBC D3	0
9	LBC D3 M1	2
10	LBC D3 M1 SM1	3
11	RBC	1
12	RBC D1	1
13	RBC D2	3
14	RBC D2 M1	1
15	RBC D2 M2	3
16	RBC D2 M2 SM1	2
17	RBC D2 M3	1
18	RBC D2 M4	3
19	SLP	2
Grand Total		**75**

b) Mitigation

Effort has been made to minimize the diverse impact of religious and cultural structures. Resettlement Plan will include provision for payment of compensation to PAPs against loss of any structure.

All government structures to be affected will be evaluated by the relevant Department and will be restored and rebuild according to the specification of the existing building. The detail of compensation will be provided in the RP of the Proposed Project.

Impact on the structures will be assessed in the detail and compensation against damages of structures with all allowance will be provided in the RP document of the Project.

7.4.1.4 Impacts due to Field Investigations

a) Impact

Low level adverse impacts on the air quality, impact on surface water quality, soil contamination, soil erosion due to the pre-construction activities like geotechnical investigations including drilling, topographical surveys and seismic investigation will affect the existing settings. Activities like drilling, blasting, movement of machines and setup of contractor and consultant camps will also impact the soil, wildlife, noise levels etc. However, this impact is Site-specific, Temporary, Medium Term, Reversible, Likely, Low Significant.

b) Mitigation

Good engineering practices and Standard Operating Procedures (SOPs) are required to be adopted by the contractors. This will mitigate or avoid this insignificant impact.

Measures such as sprinkling of water on the roads and dirt tracks, use of water to reduce air pollution during the stone crushing operation and tuning of vehicles and equipment will reduce the air pollution. The excavated material will be managed by ensuring proper storage areas located far away from the water bodies. The choice and design of these measures such as reduction of slope gradient and height, reduction in slope angle, removal of unstable material, use of reinforcement material etc. will be the responsibility of the contractor. The contractor will be required to train his workforce in the storage and handling of materials, like oil, diesel, petrol and chemicals, etc., which can potentially cause soil contamination. Special measures will be adopted to minimize the impacts on the nearby settlements such as avoiding noise generating activities during night time, etc.

7.4.1.5 Physical, Religious and Cultural Resources

a) Impact

According to the field survey, various local village mosques are coming in the reservoir area. Furthermore, ancient shrines such as Grave of Sahabi e Rasool SAWW “Hazrat Sahal Bin Adi RA”, Darbar Hazrat Anayat Shah Harand, Darbar Hazrat Tayyab Sultan, Darbar Hazrat Maeer Hamza Sultan, Darbar Syed Shahjahan Muhammad Bukhari are located near to the project components. These sensitive places are not directly affected due to proposed project however special considerations are required to eliminate the probability of impact.

b) Mitigation

Due consideration shall be given to minimize the adverse impacts on the religious and community structures and places.

7.4.1.6 Resource Conservation

a) Potential Impact

Resources involved in the construction of proposed Project would include water, fuel and construction materials.

Excessive water consumption by the construction staff may stress water resources in the Project Area and in certain cases may disturb the existing water supplies in the Project Area. Construction material to be used for construction includes coarse aggregates, fine aggregates, asphalt, cement, lining material, earthworks, reinforced and structural steel etc. Almost all the materials to be used in the construction of proposed Project are non-renewable and therefore their efficient use is necessary for the future use.

Fuel will be used to operate construction machinery. Efficient use of energy resources is important to reduce air emissions. For conservation of energy, efficiency of the engines and burning processes is important. The impact is minor negative. The impact significance is medium adverse.

b) Mitigation Measures

Following practices shall be adopted to conserve these natural resources:

- Use potable water bowsers for construction works and mineral water bottles/ ground water for drinking purpose;
- Plan for the provision/purchase of adequate insulation to reduce heat loss through batching plants;
- Reduction of wastage of water through training of workers involved in water use;
- Reuse of construction waste materials may be adopted wherever possible;
- Diesel and fuels with low sulphur content will be used to operate construction machinery and equipment;
- The efficient and well maintained equipment and machinery will be used;
- The equipment and machinery will be turned off when not in use;
- Ensure adequate insulation to reduce heat loss through batching plants;
- Regularly monitor CO and CO^2 content of the flue gases to verify that combustion systems are using practical excess air volumes; and
- A good camp design and an efficient worksite management plan can help the contractor to reduce the water demand, wastewater and solid waste volumes to the lowest levels.

7.4.2 Ecological Environment

7.4.2.1 Flora

a) Impact

During the pre-construction phase, activities such as installation of construction camps, construction of temporary roads & mobility of construction staff may damage the local vegetation/trees. As the heavy machinery and camps will be moved and installed, which require significant space due to which available vegetation is expected to be removed. This impact is Site-specific, Permanent, Irreversible, Possible, Medium Significant and needs to be encountered prior to the start of construction stage. Possible impact is anticipated on designated forest ''Ragistan Pachadi and Ragistan Shumali Protected Forest'' in command area. If not avoided, then the impact may consider as significant.

b) Mitigation

- The camps, mobility of machinery and construction of temporary road will be proper planned and well designed to avoid any loss to local green cover;
- It is recommended to establish the construction camps where no or minimum vegetation exists.
- Similarly, the alternate routes for roads and points for camps are recommended where no loss of vegetation is expected; and
- The location of construction camp will be selected so, as to have limited environmental impact during construction phase and to reduce the cost and land requirement.
- Compensation to the forest department for all type of plants (saplings, sub-mature, mature trees and other green assets) will be paid by the proponent as mutual understanding with the Punjab, FD and as per law of land.
- Potential green areas and designated forest in project area will be avoided and re-routing re consideration of design is strongly recommend.

7.4.2.2 Fauna

a) Impact

As movement and installations of machinery and vehicles will take place so, noise and habitat loss is expected. The routes of the available wildlife and other habitats may be affected due to camps set-up and machinery movements and installations. Temporary road may also affect the habitat of locally available fauna. This impact is Site-specific, Temporary, Irreversible, Possible and Low Significant.

b) Mitigation

- The standard measures must be adopted to minimize noise due to machinery movements and installations;
- Wildlife movements and routes must be considered during activities and will be avoided to their maximum level;
- The alternate routes and points are recommended to avoid any damage to locally available fauna;

- The camps shall be properly fenced and gated to check the entry of animals in search of eatable goods; and
- Similarly, wastes of the camps shall be properly disposed of to prevent it being eaten by animals, as it may be hazardous to them.
- Fruit trees along with other broad leaved and coniferous trees must be considered for plantation to balance the local ecosystem.
- Proper waste management plan will be considered and mandatory to safeguard the local environment.

7.4.3 Socio-economic Environment

a) Impacts

During the planning and design phase of the project, it is anticipated that there will not be any potentially significant adverse impact on the socio-economic environment. Locals may be temporarily disturbed due to the field investigations and drilling activities. This impact can be categorized as indirect, low, site-specific, short term, temporary, low probable and reversible.

b) Mitigation

No mitigations measures are required except good engineering practices to avoid and reduce these low adverse impacts.

7.5 ADVERSE IMPACTS DURING CONSTRUCTION PHASE

Following impacts are anticipated during the construction activities on reservoir area, dam site, distribution weir site, gross command area and access roads:

7.5.1 Physical Environment

7.5.1.1 Aesthetics

a) Impact

Construction activities at dam axis, distribution weir and saddle axis will result in some visual impacts. The construction activities will involve the cutting of trees/bushes, excavation, soil filling and cutting operation. This disturbs the natural scenic value of the environment. In addition to that the sitting of construction equipment and the lacks of resurfacing/replanting of exposed areas are also the leading factor to aesthetic reduction. This impact is Local, Long Term, Irreversible, Likely, Medium Significant.

b) Mitigation

The adverse environmental impacts related to the aesthetic could be effectively minimized at the construction phase. These will be mitigated by the control of clearing vegetation to the area in the construction limits and by plantation and quick re-vegetation during the construction phase. Good house-keeping, cleaning, efficient solid waste management system will be implemented to improve the aesthetics of the working environment.

7.5.1.2 Site Accessibility

a) Impact

The proposed Project Area falls within the territory of District Rajanpur which is located about 116 km North West of Rajanpur city. Please refer to the location map as Figure 1-2. The Project site can be accessed through Fazilpur and Jampur which are mainly connected to the upstream and downstream country through Indus Highway (N-55). The specific location and accessibility to the Project Site is shown in Error! Reference source not found. and detailed r oute length is shown in **Table 7.9**

Table 7.9: Roads Description from Indus Highway (N55) to Project Site

Sr. No.	Description	Length of Road (km)	
		Via Fazilpur	Via Jampur
1.	Jampur - Dajal	--	25
2.	Dajal – Lundi Saidan	--	30
3.	Fazilpur-Hajipur-Lundi Saidan	40	--
4.	Paved Road from Lundi Saidan to Dam Site	20	20
5.	Unpaved Road/Track from Lundi Saidan to Dam Site	10	10
	Total	**70**	**85**

Heavy vehicles will be utilized to transfer construction plants, equipment, construction materials, cement and fuel. These activities may have adverse impacts on the access roads. Apart from that it will increase the air and noise pollution. This impact is Local, Medium Term, Reversible, Likely, Highly Significant.

b) Mitigation

The access roads to the dam site has to be pre-determined in consultation with the highway/traffic management officials. Access roads would have to be widened and/or improved to carry the anticipated load of traffic.

During the course of construction of proposed Murunj Dam Project, contractor(s) will provide the signage and/or traffic control to the extent deemed necessary by the traffic utilizing or accessing the site roads. These signs will inform, control, warn, shift, or stop traffic on all site roads affected by the Project's heavy traffic. The following measures will be taken by the contractor(s) during the construction phase for the effective implementation of the traffic plan:

- Pakistan national and local traffic rules and regulations, instructions manual for motor vehicle and mobile machinery operation will be followed;
- No one will be allowed to drive motor vehicle or operate mobile machinery without a driving license;
- It will be prohibited to drive or operate vehicle in case of over fatigued or mental disease;
- Traffic speeds on unpaved roads will be limited to no more than allowable traffic speed;
- Traffic speed signs will be displayed prominently at all site entrances;

- A daily routine check-up of vehicles will be conducted no less than 5 minutes before its service;
- Use of appropriate signs, equipment, and traffic control measures that conform to the provisions in the traffic manual of city traffic police;
- Traffic inspection and security during transportation;
- Limit vehicular traffic designated access roads, construction laydown area, parking areas and the Project site;
- All damaged, destroyed or modified pavement legend, traffic control devices, signing and striping associated with the proposed development will be replaced as required prior to issuance of a certificate of occupancy; and
- Construction signs, lighting and barricading will be provided during construction as required.

The contractor(s) will also be responsible to prepare a comprehensive Traffic Management Plan and follow the conditions of contract for construction.

7.5.1.3 Natural Drainage

a) Impact

Construction activities such as excavation, filling and construction of the dam structure, distribution weir and saddle axis will affect the existing soil pattern in the Project Area, its surroundings and along the command area. In addition, this will lead to changes in the existing drainage pattern. The conditions will be more hazardous during the flood periods and can affect the construction activities. This impact is Site-specific, Medium Term, Reversible, Likely, Medium Significant.

b) Mitigation

During the construction phase, excavated material will be properly disposed of ensuring that it will not block the natural drainage paths. Open drains for drainage of rain/flood water will be constructed, if considered necessary during construction period.

7.5.1.4 Potential Loss of Land in Disposal Areas

a) Impact

During the construction phase, huge quantities of rock will have to be excavated. Part of the excavated rock can be used as concrete aggregate provided the fragmented rock meets the quality standards needed for the work. In order to reduce the amount of rock to be disposed, excavated rock can be used in the Project for different types of infrastructural works. The remaining spoil will be disposed in designated and safe disposal areas. Based on the notion of significance, this impact is Local, Medium Term, Reversible, Likely, Medium Significant.

b) Mitigation

The following mitigation measures will be implemented to reduce the impact significance:

- Minimize the generation of spoils by recycling the excavated rock to the maximum extent possible by using them as aggregate material in the concrete works;
- A restoration and re-use plan for the disposal areas will be prepared in advance;
- A spoil disposal plan will be prepared and implemented;
- Barren lands or natural depressions will be used for dumping the excavated spoil material ensuring that the local drainage will not be disturbed;
- The disposal area will be re-contoured to minimize changes in topography;
- Dispose excess rock material in the designated disposal site in an orderly manner (different spots to different size rocks); soil erosion control measures through bio-engineering techniques; and
- Potential risks of acid drainage will be assessed during construction by the contractor and necessary treatment measures will be adapted.

7.5.1.5 Soil Contamination & Erosion

a) Impact

During the construction phase of the Murunj Dam Project, large quantities of waste materials, chemicals, fuel and lubricants will be used apart from the generation of solid waste and liquid waste from the construction camps. Fuels and chemicals will be stored at the site for their immediate use, which will contaminate the soil if not handled properly.

Similarly, removal of vegetation and shrubs for the purpose of construction activities will lead to loosing of the soil, soil disturbances, and exposure of bare soil surface. This causes problems of soil erosion and siltation during rain. This impact is Local, Medium Term, Irreversible, Likely, Highly Significant.

b) Mitigation

Good engineering practices will help in controlling soil erosion at construction sites. Following measures will be adopted according to site condition:

- Soil erosion impact on the area during the construction phase will be of a temporary nature. However, the contractor will be required to train his workforce regarding storage and handling of materials, like oil, diesel, petrol and chemicals, etc., which can potentially cause soil contamination;
- Retain as much existing vegetation possible;
- Use natural and artificial cover on disturbed areas;
- Divert runoff away from disturbed areas;
- Minimize runoff velocity and discharge;
- Proper solid waste management and housekeeping at construction camps will be practiced;
- The contractor will be required to prepare training manual and modules for all the construction related activities along with the schedule of training program and submit to the supervising consultants for approval;
- Soil contamination due to concrete transportation will be minimized by placing all containers in casings;

- The oil, fuel and chemical storage areas will be designed as per applicable standards i.e. Statutory Notifications (S.R.O), Government of Pakistan, Oil and Gas Regulatory Authority, Notification, Islamabad, 2nd July, 2009, etc.;
- Material Safety Data Sheets (MSDS) will be strictly followed during handling and storage of chemicals;
- Solid waste generated at the camp sites will be properly treated and safely disposed only in the demarcated waste disposal sites/areas; and
- Site restoration plan for the Project will be strictly followed.

7.5.1.6 Liquid and Solid Waste from Construction Camps

a) Impact

Development of construction camps in the Project Area will generate a significant quantity of liquid and solid waste. Residential accommodation is required for about large number of staff and workers of the contractor, the consultant and the employer on the Project. It is proposed to locate the necessary temporary and permanent colonies at or near the proposed Project site. Approximate proposed strength of the total staff for camps is about 450 at this phase of the Project. As a general rule the water consumption will be about 40 liters/capita/day and will subsequently generate about 70 to 80% of this water as sewage.

Disposal of wastewater without treatment will pollute the soil and surface water. Hence, water demand, on average, will be 18,000 liters/day for camps during the construction phase and estimated generated wastewater will range from 14,400 liters/day.

Camps will generate about 0.45 kg/person/day domestic solid waste comprising kitchen waste, garbage, putrescible waste, rubbish, and small portion of ashes and residues. Estimated quantity of solid waste will be about 202.5 kg/day. Improper waste management activities can increase disease transmission, contaminate ground and surface water and ultimate damage to the ecosystem. This impact is Site-specific, Medium Term, Reversible, Possible, and Medium Significant.

b) Mitigation

To dispose the liquid and solid waste generated from the construction activities, the following steps will be taken by the contractor:

- Domestic and chemical effluents from the construction camp will be disposed by the development of on-site sanitation systems i.e. septic tank along with soakage pits, prior to discharge. Septic tank will be located adjacent to the construction camp. Proper monitoring to check the compliance of PEQS will be carried out;
- The domestic sewage will be treated with biological treatment technology and will be discharged as per PEQS. Proper monitoring to check the compliance of PEQS will be carried out;
- As per standard engineering practices after digestion of sludge for an extended period, the sludge will be dried and be used for the landfilling at proper location for final disposal;

- All the solid waste from the camps will be properly collected at source by placing containers and disposed of through proper solid waste management system. The contractor will coordinate with local representatives and concerned authorities, if any, for the disposal of solid waste;
- Toxic waste will be handled, stored, transported and disposed separately;
- The waste will be properly sealed in containers with proper labels indicating the nature of the waste;
- Solid waste will be segregated at source so that it can be re-used or recycled; and
- A waste management plan will be developed by the contractor and will be implemented with true spirit.

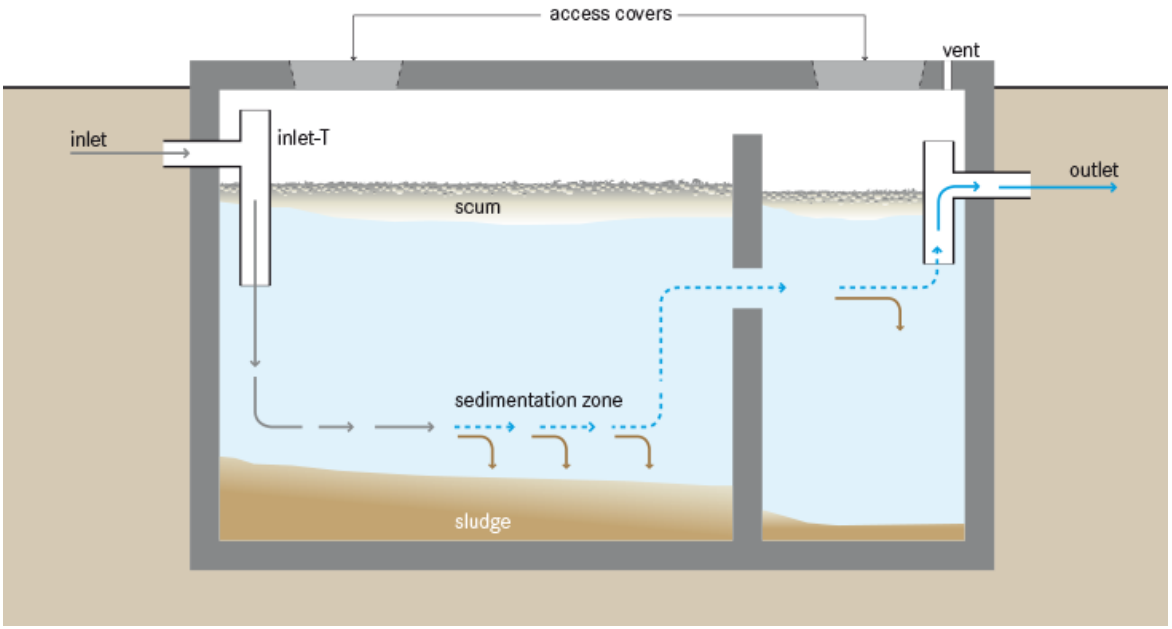


Figure 7.3: Schematic of Septic Tank

7.5.1.7 Surface Water Quality

a) Impact

Surface water quality of the Kaha Hill Torrent may get deteriorated due to the construction activities. During the construction phase of the proposed Project, materials like sand, gravel and stones will be required in large quantities. Extraction of the materials will also affect the surface water quality by increasing the sediment load. This water will be used during different construction activities. The movements of heavy vehicles on the unpaved tracks, excavation activities, cut and fill processes in the Project Area, fuel and chemical spills may deteriorate the quality of the surface water. These activities will also increase the sediments and turbidity of the water.

Waste streams can bleed toxic materials from items such as batteries, used computer equipment, leftover paints and pesticides and pathogenic organisms include specific strains of bacteria like E. coli into the leachate of dumps. Leachate from waste piles caused by exposure to precipitation and from residual liquids in the waste itself may contain organic matter, nutrients, metals, salts, pathogens, and hazardous chemicals. If allowed to migrate,

leachate can contaminate surface water. The impact of waste transportation and disposal on surface water quality is considered to be Local, Medium Term, Irreversible, Likely, Medium Significant.

b) Mitigation

The excavated material will be managed by ensuring proper storage areas located far away from the water bodies. It will not cause the siltation of the Kaha Nullah/Hill Torrent. All the solid waste from the camps will be properly collected at source by placing containers and disposed of through proper solid waste management system**.** To reduce the impact of sediment, load the contractor will make arrangements such as fine screens and drains to limit the siltation into the water bodies. A simplified sedimentation tank shall be built on the construction site for the primary treatment of the construction equipment wastewater, detergents and mud. Wastewater effluent from the contractors' workshops and equipment washing-yards will be passed through gravel/sand beds to remove oil/grease contaminants before discharging into the natural streams. This is the general guideline principle for the contractor.

According to the PEQS, the BOD concentration in sewage must be brought down to less or equal to 80 mg/l before being discharged into a natural stream having capacity to dilute the effluent. For wastewater, apart from BOD, COD of 150 mg/l will also be checked; and similarly, if the sewage after treatment is to be discharged on to the land it will meet the requirements of the PEQS for disposal of wastewater.

7.5.1.8 Quarrying/Borrow Area Hazards

a) Impact

Four (04) number of potential quarry/borrow sites were identified near the proposed Murunj Dam Study Area. The Location of these sites along with the material type is mentioned in **Table 7.10** These quarry/borrow sites are located at few kilometers away from the dam site (**Figure 7.4**). Transportation of material from the quarry sites to the dam site will be a major task involving movement of heavy vehicles.

Table 7.10: Borrow Area Location and Coordinates

Sr. No.	Material Type	Location	Easting (m)	Northing (m)
1	Clayey Silt / Silty Clay and Silty Sand	Near Darra Police Station	604822.00	3272051.00
2	Silt and Sand	Near Lundi Saidan	609223.00	3264029.00
3	Gravel, Sandy Gravel, Boulder and Cobble	Near Muni Nullah	594921.00	3266803.00
		Near Khumbi Check Post	600824.00	3264894.00

Development, excavation, loading and transportation of material from each site will create various adverse impacts on the existing environment. This would also affect the quality of surface water being utilized in the downstream area of dam axis due to high turbidity. Temporary storage of huge quantities of material in the shape of heaps may also affect the drainage pattern of the area. Hence based on the notion of significance, this impact is Site-specific, Medium Term, Reversible, Possible and Medium Significant.

b) Mitigation

Proper Quarry Development and Management Plan for each identified quarry area will be made prior to the execution of work. The Plan will include all the infrastructural requirements of each site and implementation plan for the development of each quarry site in an environmental friendly manner. This plan will be submitted to the supervisory authority for approval. Guideline quarry management plan is attached as **Annex-VI.**

7.5.1.9 Hydrology

a) Impact

Due to the construction activities of the proposed Project, the existing hydrology of the Kaha Nullah/River may get disrupted, which mainly includes disturbance in the flow of the existing hill torrent and surface drainage of the site. This impact is Local, Medium Term, Irreversible, Likely, Medium Significant, which will remain till construction phase only.

b) Mitigations

Prior to the commencement of the construction activities, the contractor will make some arrangements in view the maximum possible discharge of the hill torrent and surface water bodies may not disturb during the entire construction period.

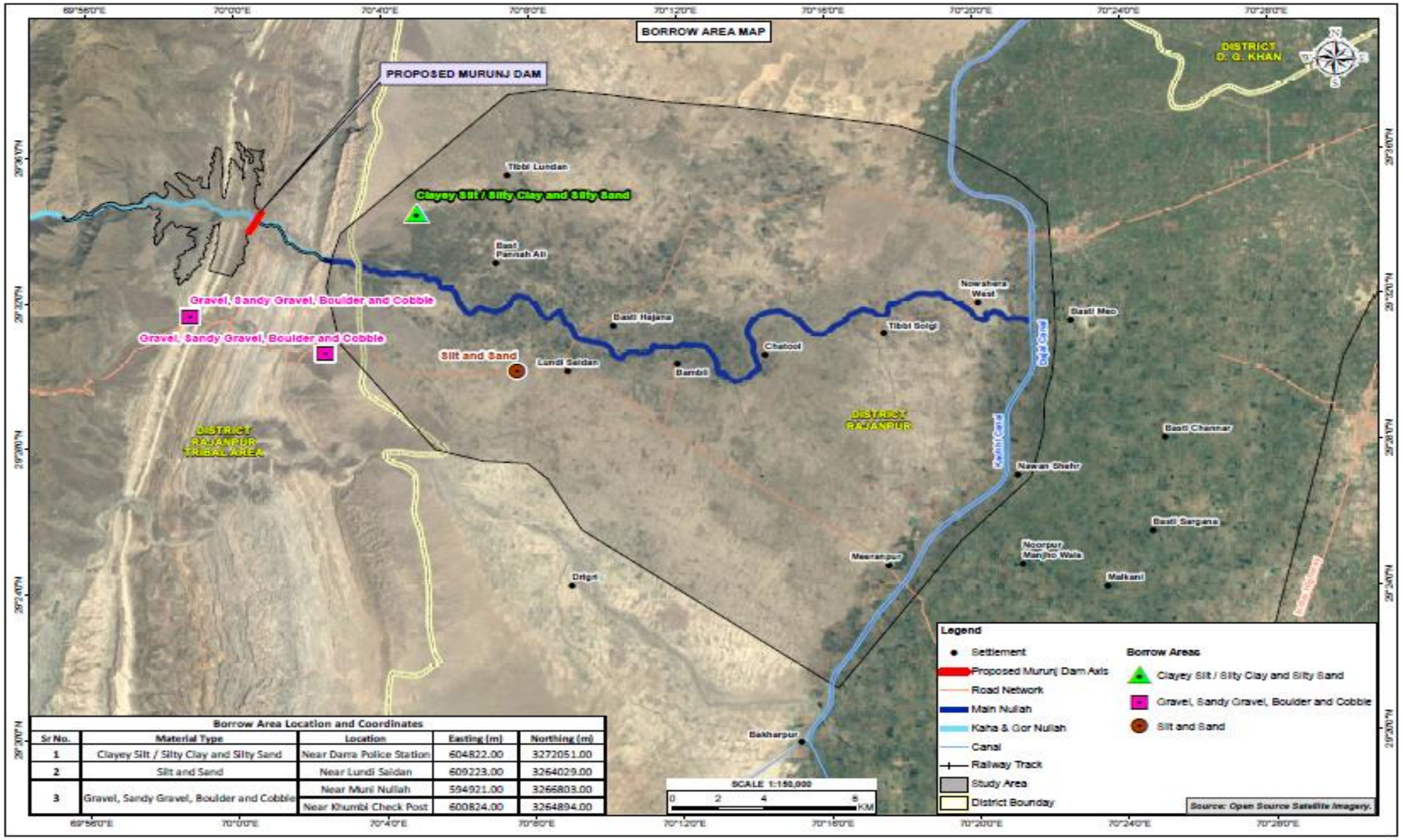
7.5.1.10 Ambient Air Quality

a) Impact

A large number of machinery and equipment will be deployed at site for the implementation of the Project. Different varieties of machinery/equipment will be required during the construction phase of the Project. The start of construction activities, working of equipment and vehicles will cause deterioration of the ambient air quality. Apart from the emissions of exhaust gases from the vehicles, generators, batching plants and machinery, fugitive dust emission will be the major air quality deterioration component. During the summer season, high winds will moderate the effect due to the dispersion, however, during the winter season, inversion will make the conditions worse. However, this impact will be of a temporary nature. The critical sources of air pollution during the construction phase are:

- Particulate matter from the excavation, movement of traffic and working equipment (stone crushing plants);
- Sulphur dioxide (SO2) and lead in exhaust emissions of vehicles and machinery on site; and
- Carbon monoxide (CO), carbon dioxide (CO2) and NOx in the exhaust gases of vehicles.

This impact is Local, Long Term, Reversible, Likely, Highly Significant.



Borrow Area Location and Coordinates

Sr No.	Material Type	Location	Easting (m)	Northing (m)
1	Clayey Silt / Silty Clay and Silty Sand	Near Dama Police Station	604822.00	3272051.00
2	Silt and Sand	Near Lundi Saidan	609223.00	3264029.00
3	Gravel, Sandy Gravel, Boulder and Cobble	Near Muni Nullah	594921.00	3266803.00
		Near Khumbi Check Post	600824.00	3264894.00

Figure 7.4: Potential Quarry Area Location Map

b) Mitigation

These adverse impacts are likely to occur during the construction phase only. These will be effectively mitigated by adopting the following preventive measures:

- Constant sprinkling of water on the unpaved/dirt tracks to avoid the deterioration of air quality in reservoir area;
- Use of water to reduce air pollution during the stone crushing operation. This will also reduce the dust pollution during the hauling of the material due to the remaining moisture;
- Old plant, equipment and transport vehicles will not be used on the construction Project. Vehicles and plants older than 5 years will not be allowed;
- Haul-trucks carrying sand aggregate and other materials will be kept covered with tarpaulin to reduce the dust pollution;
- Planting rapidly growing trees, shrubs and grasses would help in reduction in air quality deterioration;
- Vehicle will be properly tuned; and
- PEQS provisions for ambient air quality, stack emission, noise levels and vehicular exhaust will be used for reference during the construction works.

7.5.1.11 Noise Pollution

a) Impact

The project activities which generate air pollution also generate noise. Hence during the construction phase, activities like movement of vehicles, operation of machinery, excavation, blasting, etc. will cause noise as well as vibrations. Existing environment of the area is free from noise pollution and the use of machines such as vehicles in the daily activities of the locals is almost negligible. Hence any noise generated during the night time will have a pronounced effect on the nearby receptors. Similarly, use of explosives during the excavation and construction will have a significant adverse impact on the safety of the workers.

The significant impact may be of high magnitude for the labor working in a place that is close to the area where explosives are in operation. This impact is Local, Long Term, Reversible, Likely, Highly Significant.

b) Mitigation

To mitigate the above-mentioned impacts, following measures are recommended:

- Heavy duty machinery will be provided with mufflers in order to reduce the noise to within acceptable limits;
- Construction timing will be consulted with the residents of the nearby villages. This will minimize the disturbance to the local population;
- Provision of mufflers on machinery producing noise;
- Vehicle will be properly tuned;
- During the blasting activities for material quarries and borrow pits, labour will be provided with ear muffs to avoid hearing loss; and

- Construction timing will be coordinated with locals. Normally heavy noise generating activities are allowed from 9 AM to 5 PM during day time to avoid disturbance to humans as well as fauna.

7.5.2 Ecological Environment

7.5.2.1 Flora

a) Impact

Loss of natural vegetation and trees in the area reserved for project facilities including reservoir, canal command area is the major impact. Approximately a total number of 6,183 trees (41% sub-mature trees and 59% mature trees) has been identified. The majority of the trees present in area where the main project facilities will be constructed have been surveyed. The provided number of trees is approximate and tentative (GIS based) which needs proper detailed field surveys, assessment and authentication with help of Forest department. The most dominant species are indicated generally all species present are very common and widely distributed throughout the project area including downstream of dam axis.

Sr. No.	Project Component	Mature Trees	Sub-Mature Trees	Dense Shrubs
1	**Reservoir Area**	**586**	**326**	**391**
2	**Canal and Drainage**	**3075**	**2197**	**3514**
i)	FCC_1	76	54	87
ii)	FCC_1_1	0	0	0
iii)	FCC_1_2	0	0	0
iv)	FCC_1_3	136	97	156
v)	FCC_1_4	8	6	9
vi)	FCC_2	321	229	367
vii)	FCC_2_1	84	60	96
viii)	FCC_2_2	40	29	46
ix)	FCC_MN	827	591	945
x)	FCC_MN_B1	205	146	234
xi)	FCC_MN_B2	149	106	170
xii)	FCC_MN_B3	112	80	128
xiii)	FCC_MN_B4	60	43	69
xiv)	FCC_MN_B5	237	169	271
xv)	FCC_MN_B6	36	26	41
xvi)	LBC	100	72	115
xvii)	LBC_D1	40	29	46
xviii)	LBC_D2	205	146	234
xix)	LBC_D3	40	29	46
xx)	LBC_D3_M1	16	11	18
xxi)	LBC_D3_M1_SM1	0	0	0
xxii)	RBC	177	126	202
xxiii)	RBC_D1	20	14	23
xxiv)	RBC_D2	76	54	87
xxv)	RBC_D2_M1	64	46	73
xxvi)	RBC_D2_M2	32	23	37
xxvii)	RBC_D2_M2_SM1	12	9	14

Sr. No.	Project Component	Mature Trees	Sub-Mature Trees	Dense Shrubs
xxviii)	RBC_D2_M3	0	0	0
xxix)	RBC_D2_M4	0	0	0

Moreover, trees of small and medium sizes will be removed due to the layout of the project for which compensation will be made to concerned parties (if any local community, forest and other relevant departments). During the construction phase, due to clearing and grubbing activities and installation of batching plants, natural vegetation, which includes herbs, shrubs and trees, will be damaged, resulting in potentially adverse environmental impact. During construction activities, the Contractor's workers may damage the vegetation and trees (for use as fire-wood to fulfill the camps requirements).

This impact is Site-specific, Temporary, Irreversible, Possible and High Significant.

b) Mitigations

- Cutting and / or disturbance of trees shall be avoided, as far as possible and select the alternate site for the proposed project as the impact on local ecosystem (specially trees) is expected as high. So, that negative effects on the process of natural regeneration of species are minimized and possible alternate area must be considered for proposed project, in which minimum ecological and environmental losses are expected;
- A tree plantation program shall be implemented with the recommendations and technical support of Punjab, Forest Department;
- NOC for working in Protected Forest and tree cutting from Punjab, Forest Department is mandatory;
- As a principal, ten trees (1:10) shall be planted in place/lieu of felling of one tree in consideration of mortality. Total 62,000 trees shall be planted in compensation/lieu of 6,183 trees;
- It is pertinent to mention that trees will be relocated/transplanted/replanted (where possible) instead of cutting and may be replanted within the 500 meters' radius of its original location;
- The compensatory plantation shall be carried out in the project area (in the available space) or in the vicinity of project area like associated roads and nearby parks / green areas, etc. to reduce the negative impacts of the tree cutting in the immediate project area and overall;
- Final and actual plantation and trees compensation cost will be finalized after assessment by Punjab, FD. All the activates will be executed as per agreement/MOU between proponent and Punjab, Forest department while strictly considering law of land.
- The proponent shall implement the program with the help of Forest Department and with the consultation of concerned consultant ecologist;
- Open fires will be banned in the area to avoid hazards of fire in the area;
- Clearing of vegetation cannot be avoided at the areas specified for project structures, but damage to the natural vegetation may be minimized by establishing camp sites, workshops and batching plants on waste/barren land rather than on forested or green land.

- However, if such type of land is not available, it shall be ensured that minimum clearing of the vegetation is carried out and minimum damage is caused to trees and undergrowth;
- Construction vehicles, machinery and equipment will remain confined within their designated areas of movement;
- The Contractor's staff and labor shall be strictly directed not to damage any vegetation such as trees or bushes; and
- Contractor shall provide gas cylinders at the camps for cooking purposes and cutting of trees/bushes for fuel shall be strictly prohibited.

7.5.2.2 Fauna

a) Impact

During construction phase the existing population of birds, mammals and reptiles of the construction areas will be affected due to disturbance arising from construction activities involving excavation, movement of machinery and vehicular traffic, movement of labor, camping, etc. The existing fauna will leave the directly affected areas due to construction activities and human intervention. Some animals particularly reptiles may get killed during the earthworks operations. Moreover, the movements of the mammals and reptiles will be restricted during the construction phase.

Birds as well, will tend to move away from the construction areas and find shelter and food elsewhere due to the activities mentioned above for fear of being hunted / trapped.

Noise generated from machinery particularly during the night hours will even scare the wildlife residing in habitats located at some distance from the construction areas. Food and refuse at the Contractor's camps may attract animals that might in turn be hunted by the workers. This impact is Indirect, Site-specific, Temporary, Reversible, Possible and Medium Significant.

b) Mitigations

- Care shall be taken during construction activities for avoiding purposely or chance killing of animals;
- If any wild species and habitat is found during construction, it must be dealt carefully and local wildlife department officials will be informed;
- Hunting, poaching and harassing of wild animals shall be strictly prohibited, and Contractor shall be required to instruct and supervise its labor force accordingly and clear orders will be given in this regard;
- The Contractor must be held responsible for instructing his work force accordingly and for enforcing this restriction. In addition, this shall have to be controlled by the Wildlife Department.
- Special measures shall be adopted to minimize impacts on the wild birds, such as avoiding noise generating activities during the critical periods of breeding;
- Noise generating activities shall not be carried out during the night by the work force;
- Wastes of the camps shall be properly disposed of to prevent it being eaten by animals, as it may be hazardous to them; and
- Noise produced due to construction activities may be kept to acceptable level.

7.5.3 Socio Economic Environment

7.5.3.1 Social Issues/Community Disturbance, Health and Safety

a) Impact

The construction activities can potentially impact the residents of area, particularly the movement and safety of locals. In addition, due to increased use of trucks and other vehicles on the narrow roads in the Project Area and the access roads pedestrians, particularly elderly people and children will be more exposed to dangerous situations, which may lead to traffic accidents. Construction activities also pose safety hazards for the site staff.

The rough terrain and difficult work conditions in some parts of the area will need extra attention from contactors and Project management for the increased risk of accidents, unsafe working conditions and health risks. This is especially true for underground work in tunnels and caverns, but also during excavation and construction work. This impact is Site Specific, Long Term, Irreversible, Likely, High Significant.

b) Mitigation

The following mitigation measures will be implemented:

- Occupational health and safety procedures will be enforced at site. Each contractor(s) will be required to prepare, obtain approval of, and implement an occupational health and safety (OHS) plan;
- Contractor shall have a system to ensure that Risk, Emergency Preparedness, Environmental and Working Environment, analysis are carried out as integrated part of the design and engineering process;
- Contractor shall have implemented an Environmental Management System corresponding to the ISO 14001or EMAS standards;
- A Traffic Management Plan will be implemented that will aim at ensuring access to residential areas, and preventing of unsafe situations, especially near schools, housing areas, construction areas, camps and offices;
- Construction activities such as blasting and excavation particularly at the borrow areas may pose safety risks to the nearby population;
- Appropriate procedures will be maintained for such activities, including cordoning off the area, prior information to nearby population and liaison with the community;
- There will be appropriate medical services and a facility with the capacity to treat emergency cases and trauma patients;
- Special attention will be focused on safety training for workers to prevent and restrict accidents and on the knowledge how to deal with emergencies;
- Road signage will be fixed at appropriate locations to reduce safety hazard associated with Project-related vehicular traffic;
- Liaison with traffic police will be maintained;
- Project drivers will be trained on defensive driving; and
- Vehicle speeds near / within the communities will be kept low, to avoid safety hazards

7.5.3.2 Conflict between Labours and Communities

a) Impact

The Project construction will bring significant changes in the lives and livelihoods, including new opportunities for employment and income for the local people. The development also attracts thousands of new in-migrants to the Project Area. Through the influx of workers and business people the population of area will increase within a few years. Unless properly managed this sudden influx of people could create adverse aspects such as an increased crime rate, tensions and social conflicts between the various groups. This impact is Local, Medium Term, Reversible, Likely, Medium Significant.

b) Mitigation

The following mitigation measures will be implemented:

- Project has developed a pro-active approach by working out for a number of key issues which have been proposed including issues regarding housing and accommodation, food security, local infrastructure, community health, labor contracts, employment and business opportunities, security, integration and cultural understanding and community and area development. In accordance with this Plan procedures and rules will be worked out by the PMU in close cooperation with the contractors and local authorities; and
- Responsibilities for the implementation of these suggestions will rest with the local authorities, the line departments, WAPDA and the contractors.

7.5.3.3 Communicable Diseases

a) Impact

The labour in the Contractor Camp, truck drivers and like personnel who interact with each other have the potential for the spread of COVID-19 and HIV/AIDS if the incidence exists. Majority of the people living in the surrounding of the Project, and potential Labor are not aware of the source, mode of communication or consequences of HIV/AIDS. Although their religious and cultural value system, to a large extent excludes the outbreak or rapid communication of COVID-19 and HIV/AIDS, yet its occurrence in such a situation cannot be precluded. It is necessary that awareness and preventive campaigns are run from time to time in the Labor campus and the field offices of the Project to prevent the communicable diseases like Cholera, Typhoid and Tuberculosis.

There is a chance of spreading of an epidemic of Coronavirus disease **(*COVID*-19)** due to close interaction of the labor force during construction not only among the workers but also in the area. This impact can be categorized as direct, medium, site-specific, short term, temporary, high probability and reversible.

b) Mitigation

The Contractor shall:

- Arrange to run an active campaign, in the labour camp, to make people aware of the cause, mode of transmission and consequences of HIV/AIDS;

- SOPs related to the construction industry advised by National Action Plan for COVID-19 Pakistan to control spreading of COVID-19, shall be implemented by the contractor and will be strictly monitored;
- Strengthen the existing local health & medical services for the benefit of labour as well as the surrounding villages;
- Ensure cleanliness and hygienic conditions at the labour camp by ensuring proper drainage
  and suitable disposal of solid waste. Inoculation against Cholera will be arranged at intervals recommended by the Health Department;
- Locating a labour camp at least away from the villages (local settlement), and
- Keep all the camps, offices, material depots, machinery yards and work sites open for the inspection of health and safety measures and related documents.

7.5.3.4 Indigenous People

a) Impact

During the social field survey of the Project, no indigenous group of people was identified, which comes under the definition of the "Indigenous People". So, no impact on the indigenous people is envisaged due to the implementation of the Project. Thus no impact is foreseen on indigenous people.

b) Mitigation

No mitigation required.

7.5.3.5 Conflicts due to Cultural

a) Impact

Workers coming from different parts of Pakistan may have norms and values in social behavior and religion that differ from those of the resident population. This can potentially cause tension and conflicts between outside workers and local community. This impact is Local, Medium Term, Reversible, Likely, Medium Significant.

b) Mitigation

The following mitigation measures will be implemented:

- Maximum local Labour will be preferred for skilled and unskilled activates;
- This situation will be addressed by an awareness campaign;
- The contractors would be aware of the possibility and risks of miscommunications between local residents and workers, a situation which easily could lead to social unrest. This would be prevented by raising awareness and implementation of a Code of Conduct for the workers;
- Complaints from the local community will be addressed by the grievance redress mechanism; and
- The Contractor will be required to maintain close liaison with the local elders and religious scholars of nearby local community to ensure that any potential conflicts related to common resource utilization for the Project are resolved easily.

7.5.3.6 Impacts on Local Communities

a) Impact

The community belonging to the reservoir and Project Areas will be affected during the construction phase as follows:

- During the construction phase, the general mobility of the local residents and their livestock in and around the Study Area is likely to be hindered;
- Unmonitored construction activities, e.g. blasting may create an accidental risk for the local residents particularly the women and children;
- Usage of community common resources like potable water, fuel wood etc. by Contractor workforce may create conflicts between the community and the Contractor;
- Community will have to face the noise and dust problems during the construction activities;
- Induction of outside workers in the Contractor labor may cause cultural issues with the local community; and
- Theft problems to the community by the Contractor's workers and vice versa.

This impact is Site Specific, Medium Term, Irreversible, Likely, Medium Significant.

b) Mitigation

- During the construction phase, mobility of the workers in the nearby areas will be strictly restricted by the Contractor to avoid any inconvenience to the local communities;
- Proper arrangements in the form of alternative routes will be made to ensure that the mobility of locals will not be disturbed;
- Before starting the construction activities, Contractor will inform residents of the Project Area about the scheme of work, likely disturbances, and their duration as to whom they will addressed their complaints.
- The Contractor will select specific timings for stringing so as to cause least disturbance to the local population considering their peak movement hours;
- The Contractors will be required to maintain close liaison with the local communities to ensure that any potential conflicts relating to the common resource utilization are resolved quickly;
- Contractor will take care of the concerns of the local community and the sensitivity towards the local customs. Contractor also needs a proper security to avoid any theft issue by the community;
- Use of good engineering practices such as water sprinkling, encasement and provision of silencer and mini stacks of generators etc. will be adopted to avoid inconvenience to the locals due to noise, smoke and fugitive dust; and
- The Contractor will warn the workers not to indulge in any theft activities and if anyone gets involved in such activities, he will have to pay heavy penalty and would be handed over to the police. Similarly, at the time of employing, the Contractor has to take care that the workers will be of good repute. The Contractor camp will be fenced properly and main gate.

7.5.3.7 Communication Loss Especially due to Canal and Drainage Structures

a) Impact

The excavation for the main canals, the general mobility of the local residents and their livestock in and around the Project Area is likely to be hindered and may need to be travel long distances. Hence with the development of the irrigation network in the command area, movement of locals as well as livestock will be significantly affected.

Likewise access to the natural resource may be affected. This particularly implies to the women folk and children, especially in the context of Tribal areas of Punjab where women observe proper veil and do not interact with non-locals. This impact is Site Specific, Medium Term, Reversible, Likely, Medium Significant and needs to be encountered prior to the start of construction stage.

b) Mitigation

The contractor will ensure that the mobility of the local communities and their livestock is not hindered by the construction activities. The contractor will provide temporary crossing points at appropriate places to facilitate the people for going across the main canals for their daily works and having free access to the natural resources

7.5.3.8 Loss of Income

a) Impact

During the construction activities, people will suffer loss in their annual income due to the loss of crops, trees etc. This impact can be categorized as indirect, moderate, local, medium term, permanent, medium to highly probable and irreversible.

b) Mitigation

- Fair, prompt and negotiated compensation for the crops and trees on private land will be provided to the affectees along with the land value; and
- Affectees will be involved in the valuation process of the Project.

7.5.3.9 Gender Issues

a) Impact

Findings of the socioeconomic survey reveal that the privacy of women is a major cause of concern for the communities of the Project Area. Due to the Project activities, local women many not be able to perform their daily outdoor chores. Women in the Project are participating in other outdoor activities such as livestock rearing, bringing of potable water, collection of fire wood etc. that may also be affected by the Project activities.

The induction of outside labor may create social and gender issues due to the labor force being unaware of local customs and norms. It may also cause hindrance to the mobility of

local women for working in the field, herding livestock, picking fuel wood, etc. This impact is Local, Medium Term, Reversible, Likely, Low Significant.

b) Mitigation

The Contractor will select the specific timings for the activities particularly near the settlements, so as to cause least disturbance to the local population particularly women.

The Contractor will carry out the field investigation activities in such a way that the open defecation timings by the local community particularly women, will not be affected. The normal defecation timings are early in the morning and at late in the evening. So, the Contractor will have to take care of these timings.

Contractor will take due care of the local community and observe sanctity of local customs and traditions by his staff. Contractor will warn the staff strictly not to involve in any unethical activities and to obey the local norms and cultural restrictions particularly with reference to women, if privacy of the nearby households is affected, the Contractor will inform the house owner to make some arrangements. Similarly, Contractor will take care as much as possible that the construction activities will not affect the privacy particularly with reference to women.

7.5.3.10 Health & Safety

a) Impact

Workers and the local community will be prone to accidents/incidents during the construction stage. Un-monitored activities such as movement of heavy vehicles on roads and the outer periphery road may create an accidental risk especially to the children. Safety of the locals and their animals during the construction activities needs special attention. Exchange of communicable diseases such as COVID-19 and HIV between the work force and local communities is a high risk during this phase.

Community will have to face the noise and dust problems during the construction activities and this would affect the health of the people. This impact is Site Specific, Long Term, Irreversible, Likely, High Significant.

b) Mitigation

The training of workers in occupational health and safety, equipping all the construction workers with PPEs i.e. safety boots, helmets, gloves, ear muffs and protective masks, and monitoring their proper and sustained usage, will be done to mitigate impacts related to health and safety.

Vehicles will be driven not more than 20 to 40km/hr speed on road, in village and on the peripheral road (Project Area) in order to avoid any serious accidents.

7.6 ADVERSE IMPACTS DURING THE OPERATION AND MAINTENANCE PHASE

7.6.1 Physical Environment

7.6.1.1 Sedimentation

a) Impact

Kaha hill torrent lies in Sulaiman Range and carries mainly alluvium soils derived from sedimentary rocks. The watershed has sparse vegetation due to arid climate. Because of very low vegetation cover and the soil type which is highly prone to erosion, the said hill torrent carries high concentrations of sediment (suspended and bed load sediment) with flash flows. The estimated annual suspended sediment load at Kaha hill torrent comes out to be 1.18 Million tons /year. Assuming bed load to be ten percent of the estimated annual sediment load, the estimated total annual sediment load at Kaha hill torrent is 1.29 Million tons/year[12].

Construction of dam at Kaha hill torrent will disturb the sediment flow and sediments will start depositing in reservoir of dam resulting decrease in water storage capacity. Furthermore, reduction in storage will eventually alters the capacity for flow regulation, water supply and flood control benefits. The impact can be categorized as Local, Long Term, Irreversible, Likely, Highly Significant.

b) Mitigation

Watershed management can reduce erosion processes and sediment flows into the dam reservoir consequently increasing its life span. Watershed management activities may include engineering e.g. check dams, etc. and non-engineering measures e.g. tree plantation, etc.

7.6.1.2 Loss of Nutrients via Sediment Deposits

a) Impact

As discussed earlier, about total annual sediment load at Kaha hill torrent is 1.29 Million tons/year. After construction of Kaha Dam, the major part of the sediment load of Kaha hill torrent would be trapped by the dam and only fine suspended sediment (clay and fine silt) may be released with outflows. Therefore, loss of sediments will deplete the nutrient content of the water to be distributed through distribution weir which may impact agricultural production in Pachad area. This impact is Local, Short Term, Reversible, Likely, Medium Significant.

b) Mitigation

This is residual impact. However, shortage of nutrients in irrigation water (due to the development of reservoir) in downstream area can be overcome by use of fertilizers and manures. Urea (Nitrogenous Fertilizers) and Phosphates fertilizers are very popular with Agriculturists in catchment and downstream area.

[12] Hydrological and Sedimentation Studies of Kaha Hill Torrent (NESPAK, 2017)

a) Impact

Landslide is the movement of ground, whichever it is active or stable (active in the past)[13]. In terms of safety of a dam, hazard of landslide means the maximum wave height at the landslide area or just below the landslide area in a reservoir, the when landslide is active and moved down to the reservoir.

Although landslides hazard is not common phenomena in the Study Area. However, it may trigger along reservoir boundary due to lubrication or saturation of rock support structure by rainfall or by water seepage from reservoir area. The main problems associated with landslides into the reservoir include: direct damage to civil structures of dam, landslide dam-break flooding and reduction of reservoir capacity.

The impact can be anticipated as medium significance; however, the assessment needs further detailed investigation based on field observation. This impact is Local, Long Term, Irreversible, Likely, Medium Significant.

b) Mitigation

The following mitigation measures will be implemented:

- Pro-active measures will be implemented to stabilize and protect slopes. Early warning systems will be introduced that will indicate when cracks appear and allow any widening to be monitored;
- The risk of landslide will be judged with stability of landslide, together with the estimated wave height. If the landslides are judged stable, no wave is generated, which means that there is no risk of landslide;
- Stone riprap will be provided as slope protection against wave action on the u/s face of the embankment. The selected stone obtained from spillway excavation and from nearby quarry will be used for this purpose. Slope protection will also be provided on the d/s face of the embankment to prevent rain erosion;
- The seismic zoning of Pakistan on the basis of determined ‘g’ generalized values may be applicable for buildings and other small infrastructure but not for mega structures like Dams, Barrages, Hydropower Stations, Large Bridges, etc. Being located close to the collision boundary of the Indian and Eurasian plates, Pakistan lies in a seismically active zone. Probabilistic seismic hazard assessment carried out as part of the revision of the Building Code of Pakistan, Seismic Provisions (2007) shows that the Study Area falls in Zone-2A, Zone-2B and Zone-C with peak horizontal ground acceleration of 0.08g to 0.34g. The generalized “g” value and Seismic Zones may not be dependable and sufficiently reliable for the feasibility and

[13] *Varnes, D.J. (1978) Slope movement types and processes, in Schuster, R.L., and Krizek, R.J., eds., Landslides – Analysis and control: National Research Council, Washington, D.C.., Transportation Research Board, Special Report 176, p11-33*

selection of a dam site. Therefore, detailed seismo-tectonic studies will be required during detailed design studies;

- It is therefore strongly recommended that detailed Regional scale Seismo-Tectonic Studies including determination of Project Site Specific Seismicity parameters may be carried out during detailed design phase and the findings and conclusion may be considered accordingly; and
- Most part of the reservoir rim consists of sandstone/conglomeratic sandstone which might create issue of seepage and consequently land sliding after impounding and submergence. This issue needs to be investigated properly with the help of additional geotechnical investigations at the detailed design phase.

7.6.1.4 Change in Land Use

a) Impact

During the operational phase the land use pattern of the area will be changed to some extent due to the formation of 19.6 km^2 lake. The commercial and recreational activities will also be increased due to lake formation which may affect ecosystem of the area and bring economic boom in the area. It can also be assessed that development of lake will not losing any agricultural land. This impact is Site-specific, Long Term, Irreversible, Likely, Medium Significant.

b) Mitigation

The tree plantation will be carried out in and nearby the Study Area and will have positive impact on the eco system of the area.

7.6.1.5 Water Logging and Salinity

a) Impact

It is anticipated that due to the impounding of reservoir, some areas in the immediate vicinity of the reservoir may be prone to water logging and salinity. However, the extent of this impact will not be much as agriculture is not being practiced within immediate vicinity of the area except downstream of Darrah. This impact is Site-specific, Long Term, Irreversible, Likely, Low Significant.

b) Mitigation

Areas in the close vicinity of the reservoir will be prone to water logging and salinity but this impact is of negligible value i.e. insignificant. Since it is a residual impact, therefore, this impact cannot be mitigated completely.

The impact of water logging and salinity is an insignificant impact in the gross command area. However, after the fully development and passage of time in the proposed command areas,

the potential impact of water logging and salinity needs to be reassessed through sub-surface hydrological studies.

7.6.1.6 Water Seepage

a) Impact

Seepage analysis of the highest dam and dyke sections was carried out using SEEP/W software. Seepage analysis of the highest sections was carried out using SEEP/W software. The results indicated that the design provision for filters and drains are sufficient to cater for seepage water. The maximum quantity of seepage through the dam body was estimated to be 4.3 x 10^{-4} cusecs. The analysis also revealed that the seepage gradient across the core and at downstream end was 0.08 and 0.05 respectively, well within the specified limits of 0.3. Dyke-1 has been analyzed for slope and seepage analysis as this dyke is critical as compared to other dykes. The maximum quantity of seepage through the dyke was estimated to be 1.54 x 10^{-5} cusecs/ft and the exit gradients across the core and downstream end for dykes were determined to be 0.018 and 0.19 respectively which are within the permissible limits of 0.3.

Similarly, the exit gradients across the core for dykes were determined to be from 0.147 to 0.17 which are within the permissible limits of 0.3. Exit gradient at the downstream end of Dyke were determined to be from 0.16 to 0.032 which are within the permissible limits of 0.30.

Seepage Through Dam Body	Per. Foot Length	4.33 x 10^{-4}cusecs/ft.
	For Total Dam Length (3754 ft.)	1.63 cusecs
Seepage Through Dam Foundation	Per. Foot Length	3.7 x 10^{-6} cusecs/ft.
	For Total Dam Length (3754 ft.)	0.014 cusecs
Seepage Through Dyke-1 Body	Per. Foot Length	1.54 x 10^{-5}cusecs/ft.
	For Total Dyke Length (938 ft.)	0.014 cusecs
Seepage Through Dyke-1 Foundation	Per. Foot Length	2.33 x 10^{-7} cusecs/ft.
	For Total Dyke Length (938 ft.)	0.0002 cusecs
Seepage Through Dyke-2 Body	Per. Foot Length	2.76 x 10^{-5}cusecs/ft.
	For Total Dyke Length (735 ft.)	0.02 cusecs
Seepage Through Dyke-2 Foundation	Per. Foot Length	9.06 x 10^{-7} cusecs/ft.
	For Total Dyke Length (735 ft.)	0.00067 cusecs
Seepage Through Dyke-3 Body	Per. Foot Length	2.64 x 10^{-5}cusecs/ft.
	For Total Dyke Length (400 ft.)	0.01 cusecs
Seepage Through Dyke-3 Foundation	Per. Foot Length	5.32 x 10^{-7} cusecs/ft.
	For Total Dyke Length (400 ft.)	0.0002 cusecs

Typical results of seepage analysis are provided in **Figures 7.5** and **7.8**:

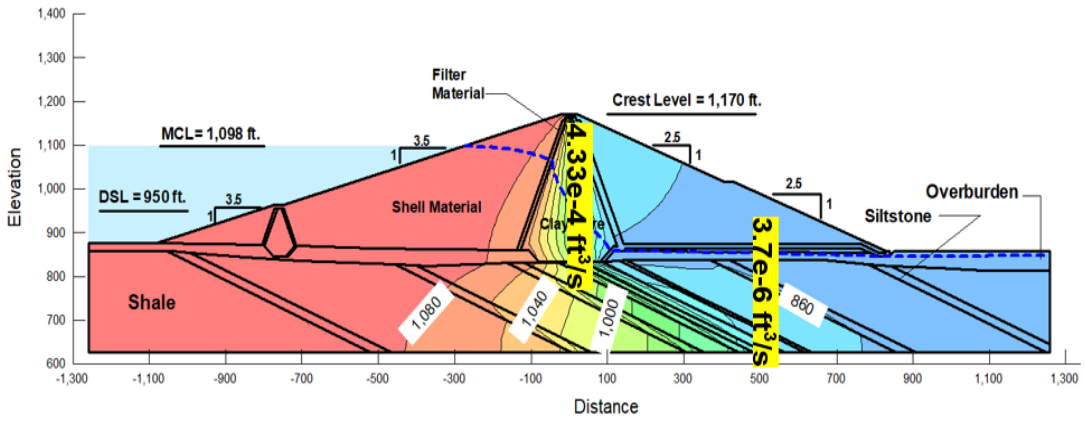


Figure 7.5: Seepage Through Main Dam Body & Foundation at Deepest

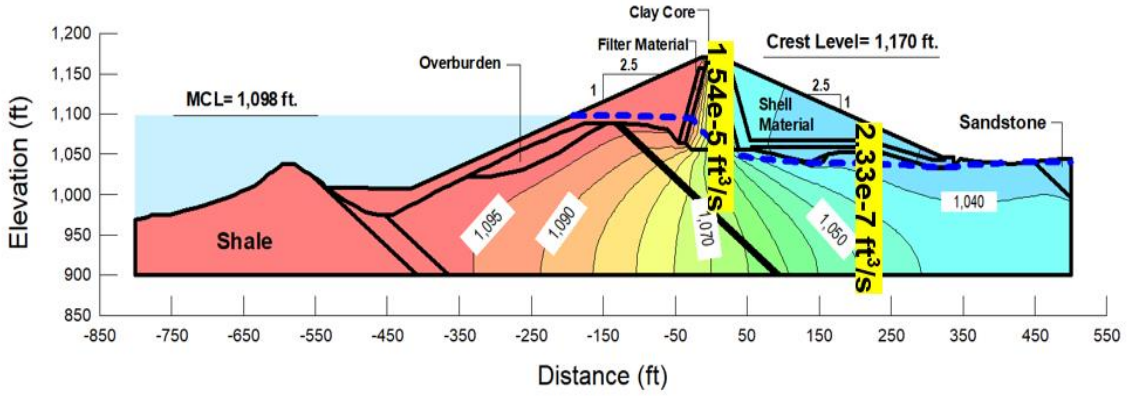


Figure 7.6: Seepage Through Dyke-1 Body & Foundation at Deepest Section

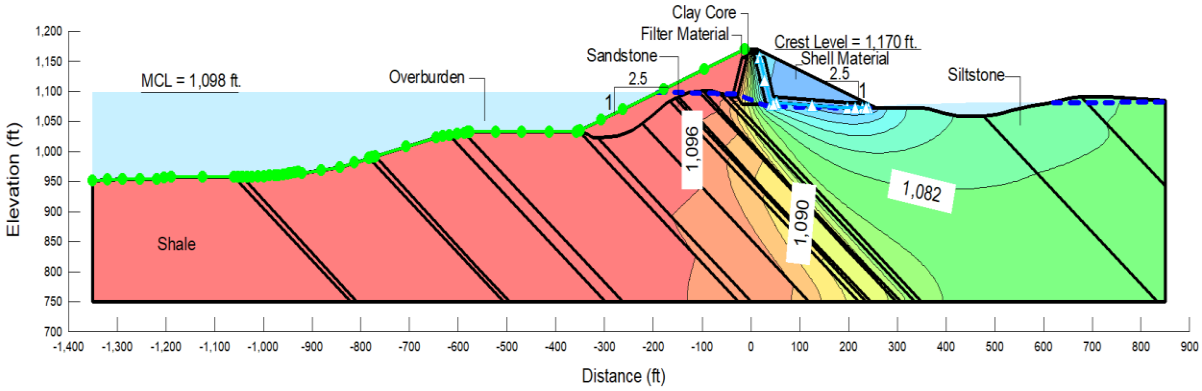


Figure 7.7: Seepage Through Dyke-2 Body & Foundation at Deepest Section

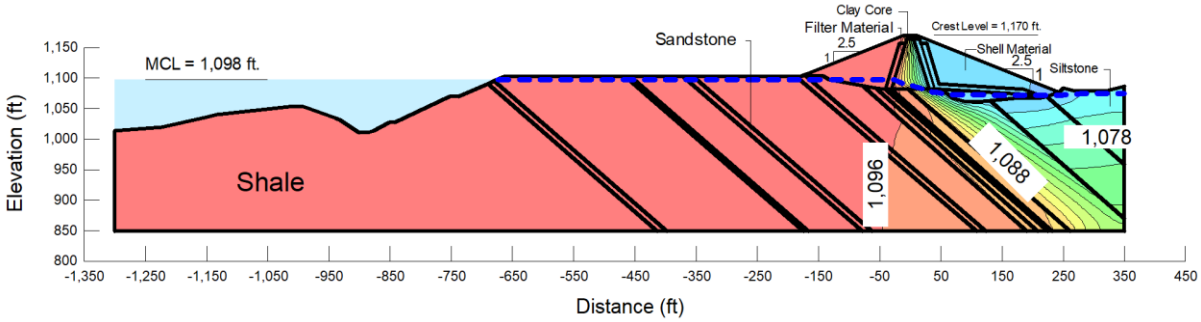


Figure 7.8: Seepage Through Dyke-3 Body & Foundation at Deepest Section

The impact can be anticipated as low significant as the results of seepage analysis show that seepage will be insignificant due to joint openings. This impact is Local, Long Term, Irreversible, Unlikely, Low Significant.

b) Mitigation

Following mitigation measures have been suggested in design report to control seepage during O&M phase:

- A grout curtain has been provided under the dam foundation to minimize seepage;
- A central core comprising of clay has been incorporated with side slopes of 0.4H: 1V and 0.3H: 1V on both sides for main dam and dykes respectively. In order to ascertain the stability of the core, the core will be placed at the depth of 30 ft from N.S.L in the

valley section for main dam and 10 ft from NSL in valley section for dykes. The core trench will have side slopes of 1H:1V. The core trench will be placed on bedrock to minimize seepage. The depth of core trench has been fixed on the bases of stability against sliding; and

- Clayey core is provided to minimize the seepage trough the dam body. The core of main dam and dykes will have top width of 12.6 ft. and 12.0 ft. respectively. The top of the core has been kept at El. 1164.5 ft.

7.6.1.7 Water Quality

a) Impact

Water stored in a dam or reservoir is subject to undergo certain physical, chemical and biological transformations. These phenomena are induced by natural forces mainly at the bottom anaerobic digestion of the biomass, climatic conditions (heat exchanges, aeration, etc.), chemical exchanges from geological formations, aquatic chemical reactions and material degradations among others as well as biological reactions associated with the organic materials decaying (biomass and humic matter decomposition from the flora and fauna i.e. submerged after first filling of reservoir). Variations in weather conditions and exposure to atmospheric conditions are among other conditions with potential effect to water quality.

Among the anticipated water quality aspects of interest for the dam would include:

- Turbidity and suspended matter from the entering flows, surface runoff discharges and organic reactions among other sources might lead to limited light penetration that has got direct linkage to biological quality of the water;
- Biomass accumulation in the dam area could render high humic (organic concentration) levels in the dam water. It also has a potential to increase the nutrients and other minerals associated with plant decaying matter;
- Limited water mixing, aeration and light penetration reduces available oxygen resulting into anoxic conditions at the lower layers of the water. Anaerobic conditions in the lower layers of the water generate carbon dioxide, methane, hydrogen sulphide and create low pH scenarios. Due to the lowered pH, the geologically held iron and manganese and other heavy metals are likely to be released into the water effectively changing the water quality; and
- Implications on water quality would be felt by the water consumers in the immediate location of the dam as well as social and ecological dependents of Kaha hill torrent.

This impact is Local, Medium Term, Irreversible, Likely, Medium Significant.

b) Mitigation

These can be mitigated by the following:

- Institute a broad water quality monitoring system such as to focus on the catchment sources, incoming flows, entire dam water, treated water and water downstream of the dam location;

- Clearing and removal of all vegetation materials (live and dead) at the dam site before the area is excavated and inundated, maintain appropriate records on water quality as required by the law;
- Proliferation of aquatic macro-fauna could be encouraged along the periphery of the dam to ensure natural aeration of the water; and
- Effective reservoir maintenance manual would have to be developed to deal with the deteriorating water quality.

7.6.1.8 Climate Change

a) Impact

Reservoir impounding (after few years of operation) will have a small impact on the local climate. It is expected that the humidity in nearby areas will increase and temperatures in nearby settlements are likely to decrease in the summer time as compared to without Project situation.

Release of Green House Gases (GHG) may also bring some changes in the climate. World Commission on Dams declared that dam reservoirs are observed to be the emitters of GHG such as CO, methane (CH_4), and Carbon Dioxide (CO_2) with large variations with situations. A range of factors directly influence the GHG emissions from reservoirs such as: storage depth, size, climate, age of reservoir, etc.

Research has not yet produced an exact amount of GHG emissions from the reservoirs all over the world but it is proved that large reservoirs are one of the sources of gases effect. Release of these gases may have low potential adverse impact on climate in the Study Area. This impact is Regional, Medium Term, Irreversible, Likely, Medium Significant.

b) Mitigation

GHG at international level can be considered as an “Unresolved Issue” and research is still in progress for controlling this process. However, tree plantation around the reservoir area may minimize the potential adverse impacts of GHG and a separate study regarding GHG emissions will be conducted during O&M phase of the Project.

7.6.1.9 Water Rights in Pachad Area (Lower Riparian)

a) Impact

The flow of Kaha Hill Torrent has been used for irrigation of traditional agriculture crops in Pachad area since ancient times. The flood irrigation for raising agriculture crops is practiced as far as possible by the farmer’s own diversion arrangements named as Radkohi/Kamara irrigation system. This system enforces the sequential water rights and dictates the irrigation pattern from upper to lower riparian, without consideration of the duration and magnitude of the storm generated flow. Currently, water being distributed through 15 wahs and 05 sub-wahs and a schematic diagram of the existing Kamara system is shown in **Figure 7.9**.

The water rights of the area will be given due importance otherwise many social issues might be generated. Therefore, this impact is Local, Long Term, Irreversible, Likely, High Significant.

b) Mitigation

In order to conserve the water rights of the lower riparian following approaches will be considered:

- A provision of regulated flow as per Radkohi/Kamara irrigation system will ensure during the dam operation. Therefore, lower riparian will not be devoid of their ancient water rights.
- A provision of new irrigation system as per the Punjab Irrigation Department (PID) practices. In this new alignment of the channel along with their capacities will be established based on water allowance. This approach will affect the existing water rights.

The Conflict Resolution Mechanism will be prepared and finalized by the Client. However, the consultant will suggest the following mechanism to resolve the conflict of water rights.

The Client (WAPDA) will consult with the PID, Agriculture and Revenue Department and prepare the plans of both above strategies. Consultant will help to establish preliminary design outcome brochures of both strategies. After finalization from the Government stakeholder's (WAPDA, PID and Agriculture and revenue), these strategies will be disclosed and consulted with local authoritative personal in the presence of the Political Assistant / Commandant BMP. The final strategy will be vetted by all the authorities and agreement will be made on the agreed system.

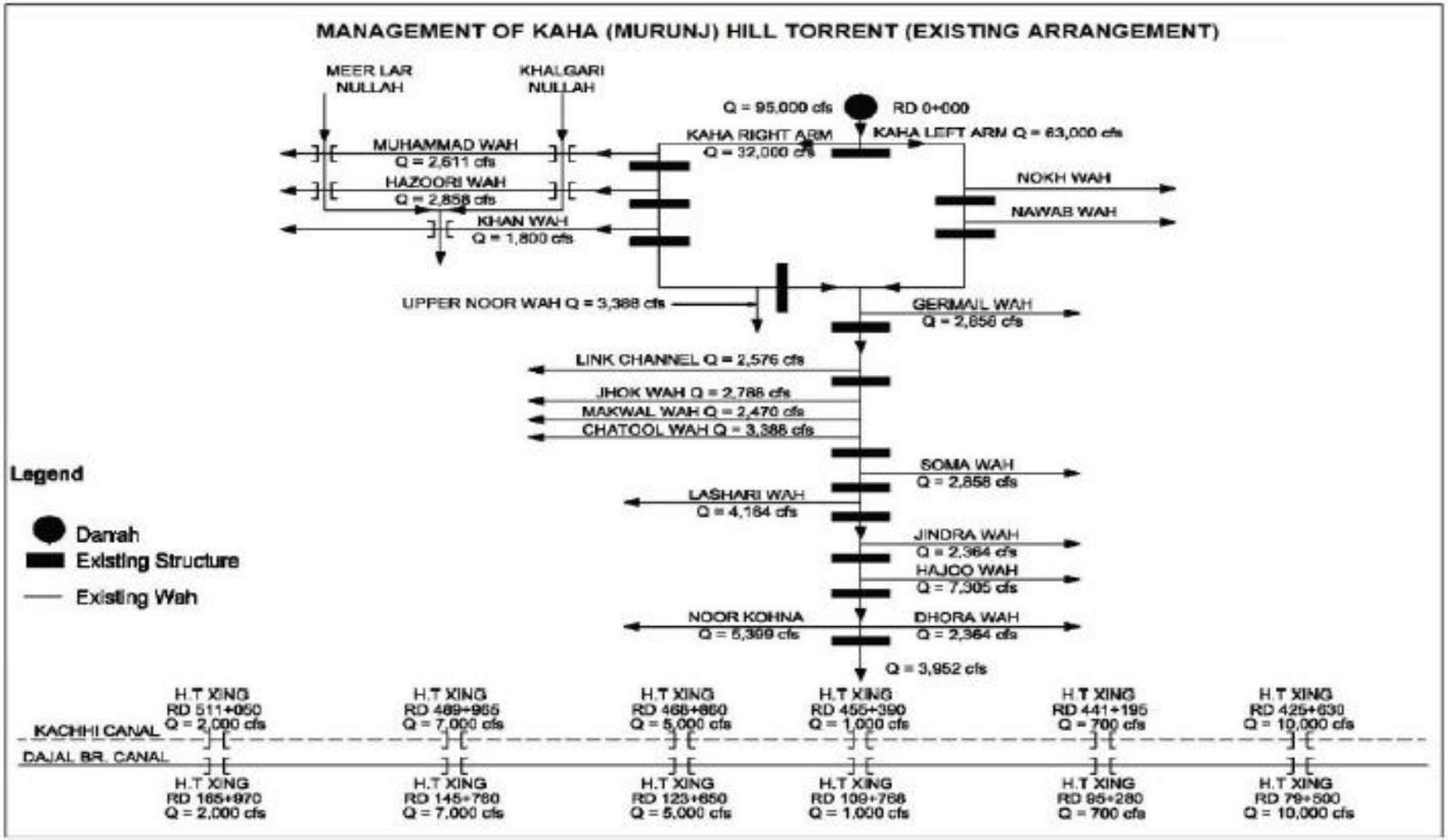


Figure 7.9: Line Diagram of Kaha (Murunj) Hill Torrent

7.6.1.10 Settlement of Dam Crest

a) Impact

Settlements will occur due to elastic compression of the embankment and foundation as the embankment is raised and due to subsequent consolidation of core and creep. Settlement of main dam and dykes has been estimated by the finite element method using the computer program SIGMA/W. Equivalent moduli of the fill and foundation have been assumed in reasonable range and used to calculate the expected settlements of the embankments. Design parameters adopted for the settlement analysis of main dam and dykes and summary of analysis results are shown in **Table 7.14** and **Figure 7.10 to 7.13**.

Table 7.11: Maximum Settlements at Main Dam and Dykes

Embankment	Settlement
Main Dam	2.8 ft.
Dyke-1	0.4 ft.
Dyke-2	0.3 ft.
Dyke-3	0.28 ft.

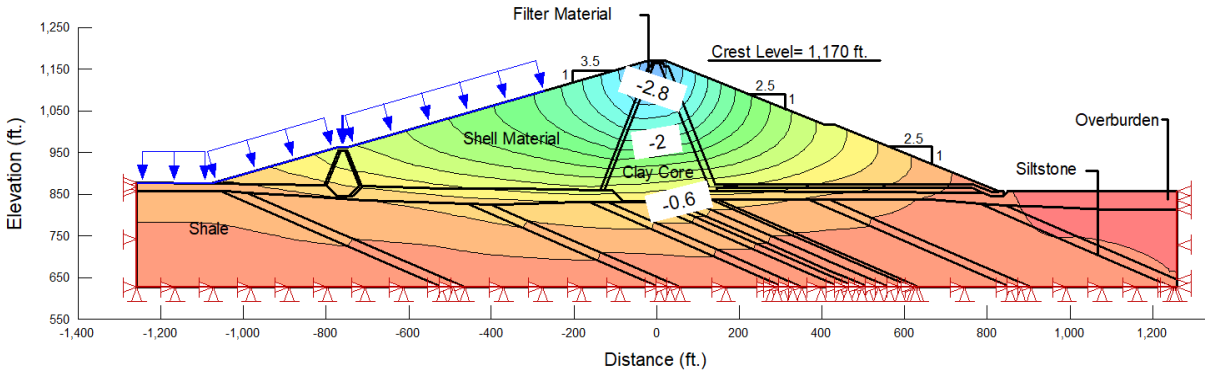


Figure 7.10: Settlement Analysis of Main Dam Deepest Section

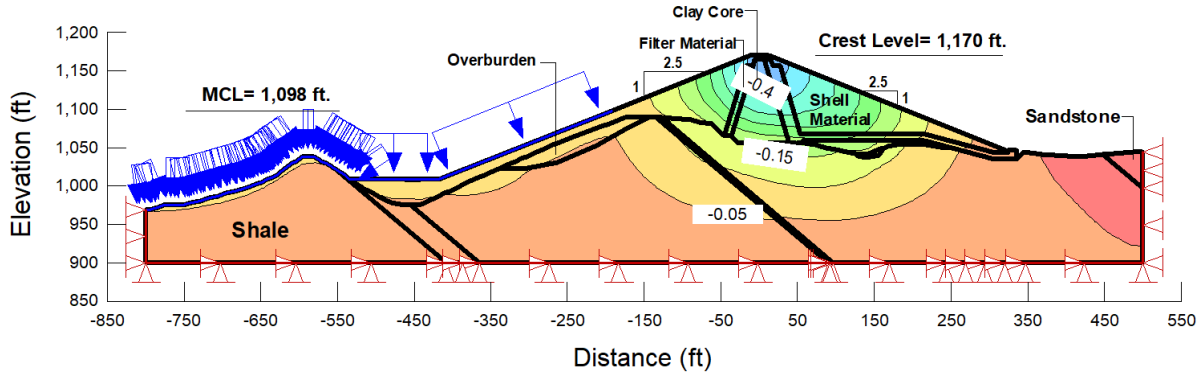


Figure 7.11: Settlement Analysis of Dyke-1 Deepest Section

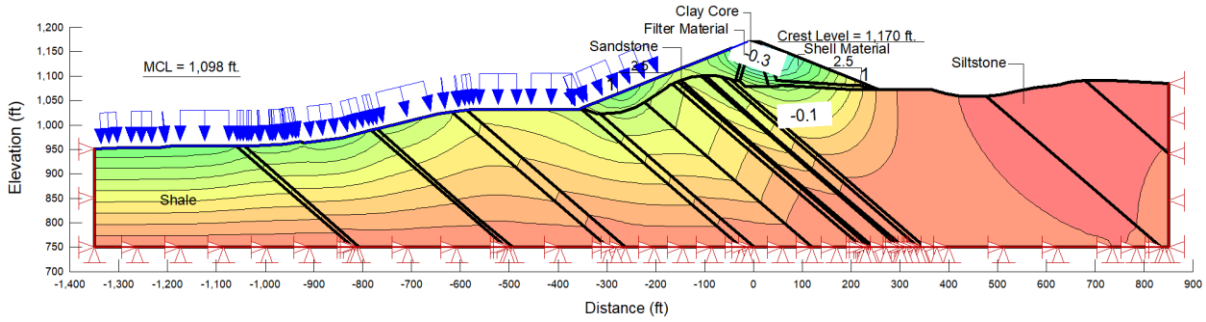


Figure 7.12: Settlement Analysis of Dyke-2 Deepest Section

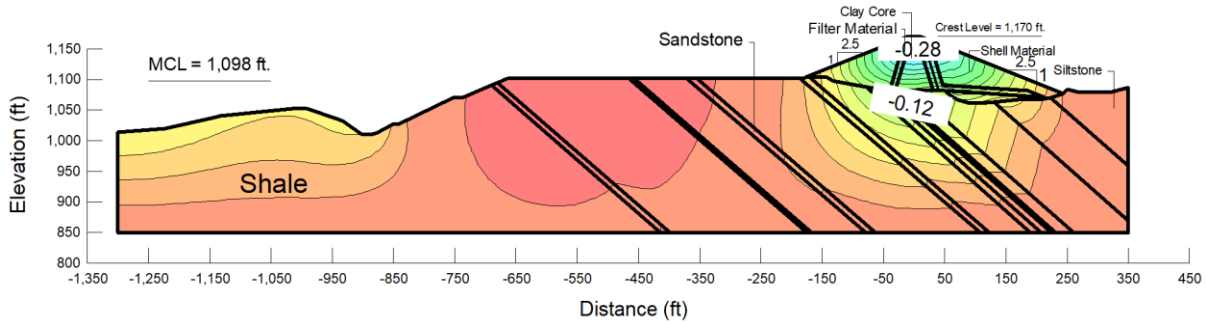


Figure 7.13: Settlement Analysis of Dyke-3 Deepest Section

b) Mitigation Measures

The finished height of the embankment will be sufficient to ensure that the crest level remains at or above El. 1170 after long term settlement.

7.6.1.11 Dam Safety and Emergencies

a) Impact

In the event of a dam safety incident or failure which results in uncontrolled release of volume of the water stored behind Murunj Dam, this release is capable of causing loss of life and significant property damages. The dam may fail for one or a combination of the following reasons:

- Overtopping caused by unusual precipitation event or flood;
- Differential deformation leading to cracking and displacement;
- Excessive settlement of the top of dam/crest;
- Foundation or abutment erosion;
- Abutment slope failure;
- A major slide in the reservoir close to the dam;
- Operational errors; and
- Deliberate man-made actions.

Failure of the dam resulting in uncontrolled release of the reservoir as well as high floods would result in inundation of downstream areas, consequences of which could be loss of life (reduction of loss of life is the top priority of emergency planning), property damage in flood plain, damage to infrastructure and irrigation water supply from the dam. The damages inflicted by hill torrents flooding in the Project Area can generally be categorized as follows:

- Loss of land due to erosion;
- Loss of standing crops due to inundation;
- Damages to public and private properties due to submergence;
- Damages to infrastructure;
- Breaches of canal systems and suspension of irrigation supplies, major threat to Kachhi Canal being the front-line canal; and
- Loss of human lives and livestock.

This impact is Local, Long Term, Irreversible, Likely, High Significant.

b) Mitigation

Impacts resulting from dam failure can be mitigated by ensuring strict adherence to standards in design and construction as well as regular dam inspection coupled with the preparation of emergency planned access control. It will be a highly potential significant adverse impact on the environment. Rim stability and dam safety studies are also recommended to be conducted during detail design phase of the Project.

7.6.1.12 Attenuation of Floods

a) Impact

Devastating flashy floods is the main feature of Rajanpur Hill Torrents. The study area consists of hilly area (hill torrent area up to Darrah) and flat area (hill torrent area from Darrah to the Kachhi Canal, also called Pachad area). The cultivation in Pachad is carried out through spate irrigation, as the only source of irrigation in the area is diversion of floods of hill torrents. The lower frequency floods are diverted in Wahs (irrigation channels) as per respective water rights, but the higher frequency floods are causing loss of lives and damages to the crops and infrastructure (as stated earlier).

Flood studies were carried out for the planning and design of spillway and other outlet structures as well as checking the safety of the proposed Murunj Dam. These studies are the basis to evaluate the impact of the dam on the attenuation of floods in the downstream areas. Following methods were used for the estimation of the peak floods:

1. Rainfall Runoff Analyses (RAA);
2. Flood Frequency Analyses (FFA);
3. Diversion Design Flood;
4. Design Criteria; and
5. Flood Routing.

Keeping in view the overall picture of the results obtained from above methods, it is recommended to adopt the estimates of FFA for designing of Murunj Dam. Design floods against various return periods recoded at Murunj dam site are provided in below **Table 7.15**.

Table 7.12: Design Floods for Kaha Hill Torrent by FFA

Sr. No.	Return Period	Discharge (ft^3/s)
1	100	146,000
2	10,000	365,500

As stated earlier, the Murunj Dam will supply irrigation water through existing Kamara irrigation system (15 wahs and 05 sub-wahs) after its completion. Based on the flood studies, the observed recorded 100 year return period flood at proposed dam site of Murunj Dam is about 38,700 ft^3/s. After the construction of the proposed Dam, the flood attenuation due the proposed Dam will be about 26%[14]. This impact is Local, Long Term, Irreversible, Likely, High Significant.

b) Mitigation

This is residual impact. However, a detailed flood study needs to be carried out for this purpose.

7.6.1.13 Air Quality and Noise

a) Impact

Commissioning and operation of the dam may affect the air quality in the area due to the increase in traffic volume and frequency due to recreation activities after formation of lake behind the dam. The traffic movement will induce some dust and noise problems in the area. There would be a marked difference of values between 'with' and 'without' Project situation. However, as the Project components are mostly civil works, these surely will not pollute the air to a serious extent. As compared to construction stage, air quality and noise pollution will improve.

Noise levels are expected to rise during the operation phase of the proposed Project due to the increased traffic volumes and population flow into the Project Area as compared to baseline conditions. However, noise levels will be lesser than the construction phase of the Project. The main contributor to noise level will be the engine sounds and horns. These noise levels will be much less as compared to the level during the construction phase but are expected to have Local, Short Term, Reversible, Likely, Low Significant.

b) Mitigation

To enhance the air quality of the Study Area, a tree plantation program will be initiated by Irrigation Department in consultation with Forest Department on priority basis. As noise levels, will not be a significant problem, no specific measures for noise levels are suggested.

7.6.1.14 Breaching of Canal, Distribution Structures

a) Impact

Breach of canal will threat system sustainability. This impact would be of high significance with low probability. Following factors may trigger the process:

- Improper operation of water control facilities;
- Deterioration of free board due to cattle trespass and other factors;
- Tampering of outlets;

[14] Flood Studies of Murunj Dam Project, 2022

- Canal siltation;
- Action of borrowing animals such as rats and porcupines;
- Inadequate supervision;
- Lack of timely and adequate repairs; and
- Lack of coverage of hydraulic gradient.

b) Mitigation

Following measures will step down the significance of impact from high to low.

- Irrigation Department, Punjab to monitor the system regularly on district level;
- Important facilities that need attention and annual maintenance are canal embankments, falls and control structures and bed levels which are affected by siltation or scour. Canal section has been designed to ensure safety by following the standard design principals to design the banks against piping. For major nullahs, canal syphons have been provided so that nullah flows unhindered and therefore does not cause damage to the Canal;
- Include capacity building of the communities in the O&M activities;
- Liaise with the communities to identify potential weaknesses in the system that could cause breaches;
- Ensure that the canal lining is regularly monitored to avoid any cracking impact from weathering; and
- Flood protection spurs will be regularly checked to undertake any prone damage;
- Repairs on urgent basis.

7.6.2 Ecological Environment

7.6.2.1 Flora

a) Impact

During operational stage of the Project, there will be minimal effect on flora or release of any significant pressure detrimental to flora. Low level impact is expected at operational phase on Flora due to the operation and maintenance activities. This impact is Site-specific, Temporary, Short-term, Irreversible, Unlikely and Low Significant.

b) Mitigations

- The implementation of plantation plan recommends compensation for cutting of trees and work will be started during operational phase to ensure the ecological balance and to avoid any impact on local environment;
- Large scale planting with suitable indigenous trees, shrubs and ornamental plants in the form of tree groves, and linear plantation will be carried out in accordance with the Tree Plantation Plan to improve aesthetic value and offset the effect of removal of vegetation;
- Proper check and balance for above activities is highly recommended. Plantations so raised must be maintained according to the Silvicultural practices which includes

proper irrigation, cleaning, pruning, thinning at prescribed intensity, silt clearance and trench-opening, etc.;

- Maintenance and security of the plantation will be done for at-least four to five years (in consultation with the Forest department). Measures such as fencing, watch guards and fire protection will be considered; and
- All activities must be done under the technical supervision of Punjab, Forest and Wildlife departments.

7.6.2.2 Fauna

a) Impact

There is no protected area, game reserve, game sanctuary or national park in the project area so, no major impact on wildlife in the area is expected through noise, vibration and any type of normal activity in the project area. This impact is Insignificant.

b) Mitigations

- Strict control must be exercised for stoppage of killing/poaching of available wildlife species (if any) by enhancing protection practices; and
- The precautionary measures described (mentioned above) for future shall also be applicable during operation phase as relevant for the conservation of wildlife species in the Study Area.
- The water storage in reservoir will attract different type of birds and animals as water is core part of ecosystem.
- The fisheries department will also be involved to start the activities regarding fisheries development in the reservoir waters.
- After all the environmental friendly planning, implementation and maintenance the project will have overall positive impact on local biodiversity and commons as well.

7.6.3 Socio-Economic Environment

7.6.3.1 Communication Loss

a) Impact

The general mobility of the local residents and their livestock in and around the Project Area is likely to be hindered and may need to be travel long distances. Hence with the development of the irrigation network in the command area, movement of locals as well as livestock will be significantly affected.

Likewise access to the natural resource may be affected. This particularly implies to the women folk and children, especially in the context of rural and tribal area of Rajanpur where women observe proper veil and do not interact with non-locals. This impact is Site Specific, Medium Term, Reversible, Likely, Medium Significant.

b) Mitigation

The contractor will ensure that the mobility of the local communities and their livestock is not hindered by the construction activities. The contractor will provide permanent crossing points at appropriate places to facilitate the people for going across the main canals for their daily works and having free access to the natural resources.

The contractor will always consider the local sensitivities while performing the Project activities. All the personnel engaged would also be properly briefed about the local norms and ethics prior to commencement of work.

7.6.3.2 Occupational Health and Safety

a) Impact

The flow of electric current in the conductors will have an impact on the safety of the workers and locals (staff colony). The burning of the transformer or other electrical equipment due to short circuiting can create a fire which can spread. This will become a safety hazard for the workers. This impact is Site Specific, Long Term, Irreversible, Likely, High Significant.

b) Mitigation

During the operational phase of the Project, a security plan will be employed to ensure the safety of the employees working at the Powerhouse, Switchyard and other electrical equipment. An effective communication system must be established so that the proper authorities are notified in case there is a fire in the Powerhouse, Switchyard and other electrical equipment.

Separated fire alarm systems shall be provided for station general area (comprising control building, administration building, machine Hall, workshop etc.), the generators and the transformers. The fire alarm system will be based on optical smoke detectors, manual call points, alarm sounders and auxiliary devices.

Fire water tank capacity has been worked out considering NFPA 851 requirements of two hours' worst fire scenario and fire hose stream requirements. Portable and trolley fire extinguishers will be provided at all entrances to the power stations. Clean Agent Gas System will be provided for Control room, Computer room and other electrical equipment rooms.

The protection equipment will be complete with all relay panels, instruments, meters, interposing and auxiliary relays, control switches, interposing current and voltage transformers, transducers and all auxiliary equipment. All protections, as far as possible, will be connected to separate current transformers and will have separately protected voltage circuit. Backup protection will be 100 % redundant of the main protection.

The main earthling system for the Powerhouse will be a separate distributed grid of conductors, properly designed to carry electrical fault currents without overheating. The earthling system will be designed according to IEEE-80 "Guide for Safety in AC Substation Grounding" and IEEE 665-1995 "Guide for Generating Station Grounding".

The overall control and monitoring of the entire powerhouse will be carried out from a central control room. Unit Control Level will deal with the control of individual units, which include the

generating units, electrical distribution and other auxiliary systems. Local Control Level will comprise hardwired instrumentation and control through the local control panels e.g. local panels of circuit breakers, generators etc. Monitoring at all levels will be done simultaneously

7.6.3.3 Culture and Heritage

a) Impact

Due to the development of weir and lake(reservoir), influx of people from the adjacent areas will be more pronounced. This change might adversely affect the cultural norms of the area. This impact is Site Specific, Medium Term, Reversible, Likely, Medium Significant.

b) Mitigation

Care will be taken in the workers' interaction with the locals. Persons from other regions will take utmost care for the culture and norms of the locals during the work at the proposed Weir site and canals to avoid any cultural clashes.

8 GRIEVANCE REDRESS MECHANISM

Grievance redress mechanism (GRM) is important for developmental projects where ongoing risks or adverse impacts are anticipated. This mechanism serves as a way to meet requirements, prevent and address community concerns, reduce risks, and assist larger processes that create positive social change. The major objective of GRM is to implement and maintain a procedure for handling environmental and social concerns of the project stakeholders. This procedure will include a redress mechanism scaled to the project's identified risks and adverse impacts, focusing on stakeholders.

WAPDA will establish a Grievance Redress Committee (GRC) to facilitate resolution of complaints by Project Affected People (PAPs) and grievances about the project's environmental performance. The GRC will be coordinated by the Chief Resident Engineer and Environment Head. The GRC will address affected people concerns and complaints promptly, using an understandable and transparent process.

8.1 COMPOSITION OF GRC

The GRC will work directly under the supervision of Chief Resident Engineer. The following members are recommended to form a GRC to look into the environmental matters.

- WAPDA Environment Cell
- Environment and Social Head of E&ST
- Representative from PAPs
- Environmental Engineer of Supervision Consultant
- Environmental Engineer of Construction Contractor

Environment and Social Head of E&ST will nominate one member of GRC and shall act as Project Environmental Grievance Officer (PEGO).

He will review the case on merit and address the problem in accordance with prevailing rules/ procedures applicable to such grievances as per EMMP. The PEGO will then refer the case to GRC for final decision, whether to update and make necessary amendments in EMMP. The GRC will deliver its decision within thirty (30) days of registration of the case. If the affected person does not receive a response from GRC within thirty (30) days of the registry of the complaint, he/she can appeal to Environment and Social Head of E&ST, who will act on the compliant/ grievance within two weeks of day of its filing. If the affected person is not satisfied with the decision of Environment and Social Head of E&ST, then it can be referred to higher authorities / relevant govt. departments for its resolution. As a last resort, he/she may submit the complaint to Punjab EPA.

8.2 RESPONSIBILITIES OF GRC

The responsibilities of GRC will include the following;

- The GRC shall review, consider and resolve grievances related to environmental issues during implementation received by the PD office – Murunj Dam WAPDA.
- Environmental Specialist of SC is responsible for conducting investigations on these grievances.

Any grievances presented to the GRC will ideally be resolved on the first day of hearing or within a period of one week, in case of complicated issues requiring additional investigations.

GRC is empowered to take decision which is binding on WAPDA and considered final.

GRC meeting will be held in the Murunj Dam WAPDA, PD office or other locations agreed by the committee. If needed GRC members will conduct field visits to verify and review the issues at dispute.

8.3 PROCEDURES FOR FILING THE COMPLAINTS

Any affected person can register his complaint through application at PD office. The PD will direct the Environment and Social Head of E&ST to address the complainant at the same day. The Environment and Social Head of E&ST will have maximum one week to resolve the complaint. If complaint is not addressed within a week time, then the complainant can raise a grievance with the GRC.

There are several ways one can report a grievance:

- Contact the PEGO of GRC over the phone. The contact details will be provided in the PD office.
- Send an email to the address provided in the PD- office.

The grievance will be reviewed and will be decided by the GRC. In case the grievance is not connected to the project related activity or in case the project authority finds that they are working within the applicable Punjab EPA standards, the grievance will not be further processed. In these cases, this will be explained in writing to the grievant.

In all the other cases the GRC will investigate whether they have failed to work to the intended standard and if they have identified measures which might be taken to protect against the incident occurring again.

The grievance mechanism will be made public through the public consultations and information leaflets during implementation.

8.4 TYPE OF GRIEVANCE

The following are some of the environmental issues could be subject for grievance from the affected people, concerned public and NGOs.

- Dust, noise and air pollution from construction activities
- Nuisance
- Intensive schedule of construction activities
- Inappropriate timing of construction vehicle flow
- Traffic Movement
- Water Pollution
- Waste disposal
- Disturbances to flora and fauna
- Health and safety
- Criminal activities
- Failure to comply with standards or legal obligations
- Non Compliance of EMMP
- Social and Cultural Issues.

9 ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

9.1 GENERAL

Environmental Management and Monitoring Plan (EMMP) is a tool for the implementation of the all the suggested measures to make the project environmentally sustainable. It provides an overall approach for managing and monitoring the environmental, ecological and socio-economic issues of the proposed Project, and describes the institutional framework and reporting mechanism to implement EMMP for the Project.

9.2 EMMP COMPONENTS

The EMMP comprises following main components:

1) EMMP Objectives;
2) Scope of the EMMP;
3) Environmental Policy, Legislation and Framework;
4) Institutional Requirements;
5) Environmental Audits;
6) Training and Capacity Building;
7) Communication & Documentation;
8) Environmental Mitigation Plan;
9) Environmental Monitoring Plan;
10) Management Plans;
11) Grievance Redressal Mechanism; and
12) Environmental Management and Monitoring Cost.

9.3 OBJECTIVES OF EMMP

The basic objective of the EMMP is to manage potentially significant adverse environmental and social impacts of the Project. The specific objectives of the EMMP are to:

- Provide the details of the Project impacts along with the proposed mitigation measures, and the corresponding implementation activities;
- To ensure that all necessary corrective actions are carried out and monitored in time to counter any adverse environmental impact under a systematic monitoring approach;
- Provide a procedure for timely action in the face of unanticipated environmental situation;
- Define the role and responsibilities of the Project Proponent (WAPDA), Contractor(s), Supervisory Consultant(s) and other key players in order to effectively communicate environmental and social issues among them;
- Define a monitoring mechanism, reporting frequency and identify monitoring parameters to ensure that all the mitigation measures are completely and effectively implemented;
- Design the training and capacity building plan for enhancing the capacities of the Project Proponent (WAPDA), Contractor(s), Supervisory Consultant(s) on environmental and social management;

- Identify the resources required to implement the EMMP and outline the corresponding financing arrangements; and
- Define the requirements necessary for documenting compliance with EMMP and communicating it to all the concerned regulatory agencies.

9.4 SCOPE OF THE EMMP

The scope of the EMMP includes the following phases of the proposed Murunj Dam:

- Pre-construction Phase;
- Construction Phase; and
- Operation and Maintenance Phase.

All the activities performed during these phases will be controlled and monitored according to this EMMP.

9.5 ENVIRONMENTAL POLICY, LEGISLATION AND FRAMEWORK

The PEPA, 1997 (amended 2017) is a fairly comprehensive legislation which provides legislative framework for protection, conservation, rehabilitation and improvement of the environment. It contains provisions for the prevention of pollution and promotes sustainable development. The 'environment' has been defined in the Act as: (a) air, water and land; (b) all layers of the atmosphere; (c) all organic and inorganic matter and living organisms; (d) the ecosystem and ecological relationships; (e) buildings, structures, roads, facilities and works; (f) all social and economic conditions affecting community life; and (g) the interrelationships between any of the factors specified in sub-clauses 'a' to 'f'.

The salient features of the law are:

- No proponent of a project shall commence construction or operation unless they have filed an EIA with the Provincial Agency (Punjab-EPA), and has obtained an approval;
- Establishment and formation of the Punjab Environmental Protection Council;
- Prohibition of certain discharges or emissions;
- PEQS for wastewater, air emissions and noise; and
- Law also empowers Provincial Government to issue notices and to enforce them for the protection of the environment.

The PEPA, 1997 was amended in 2017 under the 18th amendment which gives legislatives power related to environment and ecology to the Provincial government from the Federal government. The provinces are required to enact their own legislation for environmental protection. Other minor amendments including increasing the penalty cost for violations.

The capability of regulatory institutions for environmental management largely ensures the success of environmental assessment for ensuring that the development projects are environmentally sound and sustainable.

Other project related national environmental laws, regulations, policies and guidelines are as follows:

- National Conservation Strategy (NCS), 1992;
- National Environment Policy, 2005;
- Pakistan Labor Policy, 2010;

- PEPA, 1997 (Amended 2017);
- Pak-EPA (Review of IEE and EIA Regulations, 2000);
- Pakistan EIA Procedures;
- Punjab Environmental Quality Standards (PEQS), 2016;
- Land Acquisition Act (LAA), 1894;
- Punjab Katchi Abadis Act, 1992;
- Cutting of Trees (Prohibition) Act, 1975;
- Punjab Wildlife (Protection, Preservation, Conservation and Management) Act, 1974;
- Punjab Plantation and Maintenance of Trees Act, 1974;
- Antiquities Act, 1975;
- Pakistan Penal Code, 1860;
- Canal and Drainage Act, 1873;
- Punjab Irrigation and Drainage Authority (PIDA) Act, 1997;
- Punjab Occupational Health and Safety Act, 2019;
- Pakistan Clean Air Program (PCAP); and
- Guidelines for Public Consultation.

9.6 INSTITUTIONAL SETUP FOR IMPLEMENTATION AND MANAGEMENT OF EMMP

9.6.1 Project Proponent - WAPDA

To implement and monitor the mitigation measures, the following institutions will be involved:

- WAPDA is the Proponent of the proposed Project and all the responsibility related to the protection of the environment lies with him;
- Project Contractor, as the executors of the EMMP during the construction phase of the project;
- EPA-Punjab, as observer and top monitoring agency during the construction and operation phases; and
- WAPDA Environmental Cell (WEC) and PIU/PMU of Murunj Dam Project.

WAPDA was established through an Act of Parliament in 1958. It is an autonomous and statutory body under the administrative control of the Federal Government. The Authority consists of a Chairman and three Members (Water, Power and Finance). WAPDA was unbundled in the year 2007 whereby the functions of its Power wing were redefined as Hydel Power Generation and O&M of power houses. Following unbundling of its power wing, WAPDA's mandate is now development of water and hydropower resources in an efficient manner.

The current setup of WAPDA comprises a Chairman and three (3) Members working through a Secretary. The two main departments of WAPDA are Power Wing and Water Wing. Finance Department deals with financial matters of WAPDA. All wings are headed by their respective Members as mentioned above.

WAPDA Power Wing

WAPDA Power Wing currently headed by Member (Power). Power wing of WAPDA comprising Generation, Transmission and Distribution has been restructured into fourteen (14) public limited companies, in which four (4) Thermal Generation Companies (GENCOs), one

(1) National Transmission and Power Dispatch Company (NTDC) and nine (9) Distribution companies (DISCOs).

WAPDA Water Wing

WAPDA Water Wing functions under Member (Water). For effective control, the entire country is divided into north, south, central and west zones generally covering all Provinces, for execution of surface water development Projects. Chief Engineers and Project Directors implement Projects falling under regions within the various zones. The Water Wing as a Chief Engineer (Coordination and Monitoring) for construction and operation of dams and all other Projects under Water Wing technical services and two separate General Managers for Ghazi Barotha Hydropower and National Drainage Project. The Planning Division of Water Wing headed by a General Manager, looks after all the planning activities on the water side. The activities of water resources and hydropower development and Vision-2025 are handled by three General Managers i.e. Technical, South, North, General Manager (Planning and Development) and General Manager Hydro Planning Development (directly involved for the proposed Project).

WAPDA Environmental Cell (WEC)

WAPDA Environmental Cell (WEC) works under General Manager (Technical Services) WAPDA and is headed by Director General (WEC). Current staff strength of WEC is about 15. Technical staff consists of environmental engineers, geologists, ecologists and civil engineers. EMMP execution and monitoring is be carried out by the Project based Environment and Social Unit (ESMU) headed by the Project director along with Supervisory Consultant and representatives of Contractor. WEC based at Lahore will carry out periodic monitoring, top supervision and internal auditing during Project construction phase.

The organizational structure of WAPDA is shown in **Figure 9.1.**

The general responsibilities of the Project proponent are;

- To facilitate the execution of Development Works which ultimately provide relief to Public;
- Execution of following Public Sector Development Program (PSDP) funded by Federal Government;
- Execution of Schemes under Provincial Annual Development Programm (ADP); and
- Operation and Maintenance of Dams and flood protection schemes.

9.6.2 Proposed Organizational Structure – Construction and O&M Phases

Considering the project nature, it is strongly recommended that proponent will establish its own environment and social setup. The proposed organizational setup for construction phase of the Project is shown in **Figure 9.2**. The immediate requirement considering the existing institutional setup of proponent is the establishment of Environmental Management Cell (EMC). The cell will have a competent Environment & Resettlement Team (E&RT) that will render its duties in close coordination with the Contractor. It is a pre-requisite that all the land acquisition issues and compensation (if any) to Project Affected People (PAP) need to be handled and covered before mobilization of Contractor.

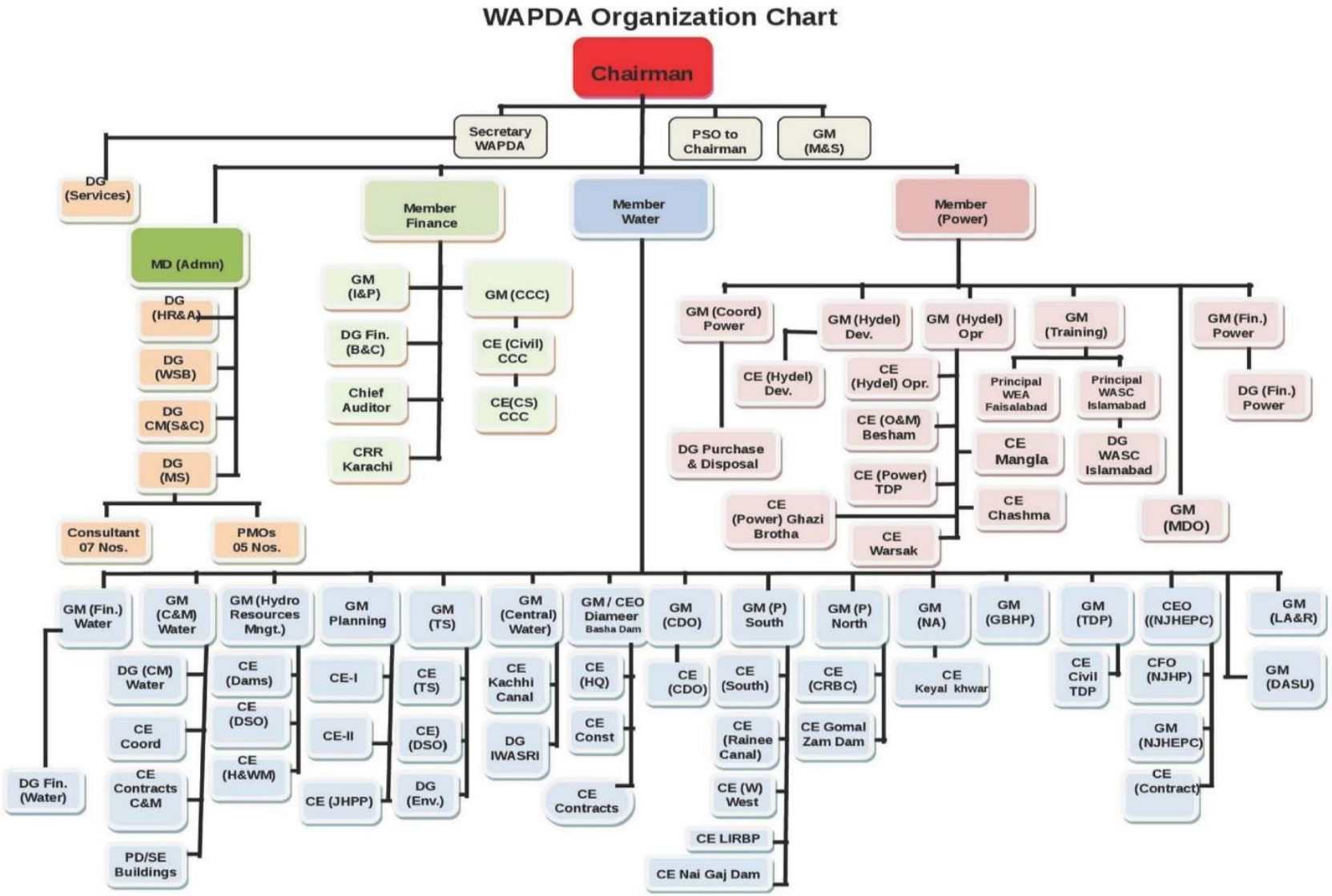


Figure 9.1: WAPDA Organization Chart

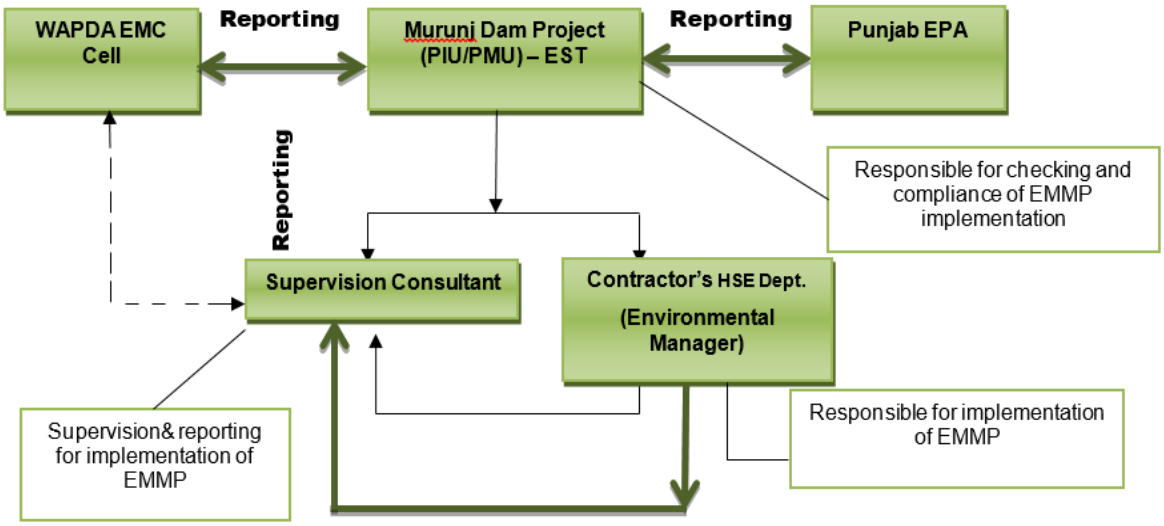


Figure 9.2: Organizational Structure during the Construction Phase

The E&RT will focus its activities as a monitor specifically during the construction phase of the Dam and other allied structures/interventions. This E&RT will remain on-board throughout the construction time and will finally be merged into the proposed HSE Section. The HSE Section is highly recommended to be on-board within the existing setup of proponent. The department will primarily be responsible for tackling all the Health Safety and Environment (HSE) issues throughout the project cycle. The proposed staff is listed below:

a) E&RT:

- Senior Environmental Engineer/Scientist (Masters in Environmental Engineering/ Sciences or related Field)–with 5 years' experience in Dam and Irrigation Projects; and
- Senior Sociologist (Master in Social Work/Sociology or related Field) with 5 years' experience in resettlement sector.

b) HSE Section:

- Senior Safety Engineer (Masters in Environmental Engineering and Safety Certification) will 5 years' experience in Dams and Irrigation Projects; and
- HSE Engineer Masters in Environment Engineering and NEBOSH Certified with 5 years' experience in Dams and Irrigation Projects.

Contractor must have an HSE Section having qualified professional staff. Proponent must consider this matter while selecting the Contractor.

EPA-Punjab is the regulatory authority for issuance of NOC for this proposed project. As part of its mandate, protection of environment (water, air and noise) is their responsibility. Therefore, the agency will undertake an audit (as and when required) of the activities of the project (both phases) with respect to the protocols as defined in EMMP.

9.6.3 Roles and Responsibilities

The foremost responsibilities of proponent, EMC (E&RT/HSE Section) and Contractor are given in **Table 9.1** below.

Contractor is the main force behind meeting the project goals. Contractor is essentially deemed as the commercial leader of the project, in close coordination with the proponent, he has to manage and ensure some of the most important elements of the project including safety of the project workers, equipment handling, HSE compliance, budget control, time allocation and remaining costs of the project.

Table 9.1: Roles and Responsibilities

Organization	Designation	Responsibilities
Proponent	Site Manager	▪ Overall in-charge and supervision of EMC's activities. ▪ To ensure the project's compliance with the PEPA 1997 (Amended, 2017) and other national environmental regulations and stakeholder participations in the project construction and operation phases. ▪ Liaison with Contractor.
EMC (E&RT)- *Construction Phase*	E&RT	▪ Monitor the and check the proper implementation of all mitigation measures for physical, ecological and social sectors. ▪ Liaison with HSE department of Contractor. ▪ Ensure compliance and implementation of national and provincial rules and regulations enforced by Punjab - EPA especially regarding social and environmental aspects. ▪ To assist Contractor for obtaining necessary approvals from the concerned departments. ▪ To document the social complaints and prepare the social complaint register. ▪ Monitoring and evaluation of environmental & social related matters of the project. ▪ Carry out consultation with the locals with regards to any social issue that needs to be settled down. ▪ Supervise the Contractor activities and make sure that all the contractual obligations related to the environmental and social compliance are met. ▪ Prepare periodic Environmental Reports and distribute according to the requirement of EMMP.
Proponent (HSE Section) *Operational Phase*	HSE	▪ Oversee all the HSE activities being carried out. ▪ Implement the HSE activities as provided in HSE plan. ▪ Conduct site visits to ensure compliance with HSE protocols. HSE department will also ensure the compliance of all safety and health protocols during the operation phase.
Contractor	HSE Team	▪ Compliance of all the monitoring programs as given in EMMP (MMP, emergency plan, plantation plan, waste management plan etc.). ▪ Ensure health & safety of site workers. ▪ Liaison with EMC Section Proponent. ▪ Training of workers. ▪ Strict compliance of social mitigation measures. ▪ Effective liaison with locals and heads of the villages.
EPA-Punjab	Monitoring Team	▪ Audit of the activities being undertaken by Contractor and all other organizations as given in the proposed institutional plan. ▪ Liaison with the Proponent and HSE Section to check compliance of measures as given in the EMMP during operation phase.

9.6.4 Supervisory Consultant

A Supervisory Consultant for the Project will be appointed by WAPDA, who will be designated as the “SC”. He will be responsible for the supervision of environmental mitigation measures as well as for the environmental monitoring of the Project activities. The role of SC will only be during the construction stage of the Project. The Consultant will be responsible for:

- Supervising the Project's Contractor(s) activities and ensuring that all the contractual obligations related to the design and construction, as well as environmental and social compliance are met.
- Ensuring that day-to-day construction activities are carried out in an environmentally sound and sustainable manner.
- Monitoring of the environmental aspects of the Project during construction to ensure that the environmental requirements of the contract and the mitigation measures proposed in the EMMP are implemented.
- Developing guidelines and a code of good practice describing the low-cost environmental measures that can be implemented during the construction and maintenance programs.
- Developing and conducting environmental training activities for Contractors and the Supervisory Consultant staff.
- Ensuring that the construction camps and other facilities are properly sited and installed in accordance with the contract.
- The identification of the exact locations and timing of baseline and periodic air, noise and water quality monitoring in accordance with the contract provisions.
- Undertaking critically important routine visual monitoring of the construction activities, waste disposal and overall environmental management practices by the Contractor(s). Effective environmental management during the construction will require frequent site visits and observation skills.
- Devising solutions to the environmental issues as they arise.
- Assisting the WEC in coordination with the EPA, Punjab and provincial departments (where applicable), district administration, NGOs and other public/private sector organizations.
- SC will also impart training to Environmental Management/ Monitoring Cell (EMMC) appointed by the Project Proponent i.e. WAPDA.

9.7 PARTICIPATORY CONSULTATION FRAMEWORK

This aspect has been discussed in detail in the Chapter 6.

9.8 PLANNING FOR EMMP IMPLEMENTATION

For the effective implementation of EMMP during construction and O&M phase, the NOCs as well as necessary approvals from concerned departments and stakeholder coordination is a mandatory requirement at planning stage or before mobilization. Based on the outcomes of

this EIA report, following but not limited to, the requisite NOCs/approvals and communication/ coordination with relevant stakeholders are required.

9.8.1 NOC and Other Approvals

9.8.1.1 EPA Approval Process

The EIA report duly reconciled with WAPDA is to be submitted to respective Punjab EPA obtaining NOC. A demand draft of required EIA review fee has to be deposited along with the report by the Proponent to respective Punjab EPA for initiating the review and EIA approval process. The approval from Punjab EPA is the mandatory requirement before commencement of the proposed Project activities.

9.8.1.2 Provincial Departments of Wildlife, Forest and Archaeology

At the feasibility stage of the Project as per the requirement of EPA guidelines for the Sensitive and Critical Areas, concerned provincial departments are informed through letters for the proposed project.

During the construction stage, if the implementation of the proposed Project involves the clearing of vegetation and trees which belongs to the forest or wildlife department, the Project Contractor will be responsible for acquiring a No Objection Certificate (NOC) from the provincial forest department. The application for an NOC will need to be endorsed by WAPDA. Similarly, if any Archaeological monument or site is crossed by or near to the proposed Project concerned provincial department needs to be contacted for NOC.

Where construction is to be carried out in the close proximity of the any archaeology sites (if identified during construction stage), the WAPDA is required to coordinate with the concerned departments to ensure that the impacts are minimized. The Contractor is also required to contact with concerned department before the start of the construction work.

9.8.1.3 Provincial Revenue Departments

Under the national law, matters relating to the land-use and ownership are the provincial subjects and the revenue department of the concerned province is empowered to carry out the acquisition of private land or built-up property for public purposes, including on behalf of other provinces. For this purpose, the concerned department must lodge an application with the concerned provincial government to depute a Land Acquisition Collector (LAC) and other revenue staff, who will be responsible for handling the matters related to the acquisition and disbursement of compensation.

9.8.2 Stakeholder Coordination

Notwithstanding the efforts so far put in for public participation, this activity will have to be pursued through the forthcoming implementation phases of the Project. In particular, the focus will be on the improvement and modification of the proposed intervention designs.

Participation mechanisms facilitate the consultative process and include information sharing and dissemination, disclosure, and participation of affected people and other stakeholders in the proposed Project related activities. In the peculiar social set-up of the Project Area, it is also important to involve the religious leaders as representatives of the public as well as part

of effective communication process. They can provide a very effective medium to bring information to the affected male population through Friday prayers. Local business community, especially the affected one, will also be brought into the process of awareness and participation.

The related institutional arrangements will also be in place for continuous consultation throughout the process of planning and implementation. During construction, WAPDA will have to implement EMMP.

The construction schedule will be established/updated before the commencement of construction work considering the activities specifically suggested in EMMP for its implementation.

9.9 ENVIRONMENTAL AUDITS

The environmental audit of the proposed project will be carried out both internally by WEC and externally by the external auditor e.g. Punjab-EPA. Punjab-EPA will check the various parameters with reference to the guidelines provided by PEPA, 1997 (amended 2017) and the standards specified by PEQS. The primary aim of the auditing is to assess the compliance and effectiveness of the EMMP as well as to assess the effectiveness of the previous corrective actions. Audit will also suggest remedial measures to overcome the environmental and social problems. External audit will be conducted on annual basis and at the time of completion of the Project.

Following are the main objectives of the audit.

- To evaluate whether the monitoring done is in compliance with the targets as set in EIA/EMMP;
- To determine the conformity of the environmental and social management plans with the specified requirements and identify non-conformity in environmental and social parameters as per EIA/EMMP; and
- Meet regulatory requirements and commitments.

9.10 TRAINING AND CAPACITY BUILDING

To enhance the capacity of the Proponent as well as the Contractor, training will be imparted related to the environmental and social issues of the proposed Project, implementation of mitigation measures and the monitoring protocols and reporting mechanism will also be carried out.

In-house training for the project staff including contractor, consultant and the supervisory staff of the Proponent will be ensured through the provision of one-day basic training and one-day advanced training, covering environmental and social aspects of the development projects in general, and implementation requirements with emphasis on the roles and responsibilities of the proponent and the contractor staff while executing the environmental management and monitoring plan in particular. The training protocols will include the following aspects:

- Procedures for monitoring the air quality parameters and measures to be adopted for avoiding or minimizing air pollution, particularly from the concrete batching plant, haul-trucks, etc.;

- Procedures for monitoring water quality parameters and measures to be adopted for avoiding or minimizing water pollution, particularly from the wastewater effluent generated from the workshops, machinery washing yards, and other obnoxious chemicals;
- Safe waste management and disposal practices;
- Safe noise levels from the construction machinery etc.;
- General housekeeping and cleanliness;
- Communicable diseases;
- Safety measures against hazards for workforce and the local communities arising from the construction activities; and
- Use of safety gadgets by the workforce.

A comprehensive training manual will be developed and implemented by the Contractor with prior consent of SC environmental staff.

9.10.1 Training Program

The detailed training program is given in **Table 9.2**. A training log will be maintained by the Consultant. The training log will include:

- Topic;
- Date, time and location;
- Trainer; and
- Participants.

Table 9.2: Training Program

Sr. No.	Staff	Trainers	Contents	Timing/Frequency
1.	Project Director, Construction, Chief Resident Engineer Resident Engineers, staff of the Environmental Management/ Monitoring Cell.	Supervisory Consultants (SC)	Introduction to Punjab Environmental Protection Act, 1997 as amended 2017. Introduction to the applicable national environmental laws and regulations. Roles and responsibilities of various stakeholders especially the Construction Contractors/ staff and Consultants. Introduction to EMMP and its contents and provisions/ limitations. Introduction to the Environmental Monitoring Plan. Documentation mechanism * Use of laboratory equipment for testing and monitoring water and air quality parameters ect.	To be initiated soon after the start-up of the Project construction phase.

Sr. No.	Staff	Trainers	Contents	Timing/Frequency
2.	Construction Manager of the Contractor/ Contractor's staff.	SC	Mitigation measures included in the EMMP Good construction practices Wildlife and vegetation issues in the Study Area EMMP communication, documentation and monitoring requirements Workers/labour Health and Safety measures Community participation and consultations	To be initiated at the start of the construction phase of the Project.
3.	Operational / Managerial Staff of WAPDA	SC	Introduction to EMMP Related mitigation measures given in EMMP Safe handling, use and disposal of pesticides (fungicides, insecticides) fertilizers and hazardous wastes etc. Introduction to the Environmental Monitoring Plan and its relevant clauses.	Prior to the start of operation and at least one training session during the first year of operation
4.	Camp Staff/ Support Staff (Drivers, in-charge of workers/ labour, workshop force, kitchen staff etc.)	SC/ Contractor EMMP Staff	Road safety and restrictions Proper Vehicle maintenance Defensive driving Waste disposal Emergency handling Fire fighting Sanitation Camp(s) operation Housekeeping	Prior to the start of any construction activity and one training session during the operation stage.
5.	Contractor's Restoration and Clean-up team for borrow materials and camp areas	SC	Site Restoration & Restoration requirements	Prior to the start of restoration activity (one training session)
6.	Community	SC/ Contractor EMMP Staff	Introduction to the Project features and operations Interaction mechanism with the Project owner and Project's key staff Introduction of any negative impacts on wildlife, vegetation, water etc. due to Project interventions & mitigation measures adopted. Benefits to the community by the Project/Positive outcomes	To be initiated before the start-up of the Construction Activities under the Project.

Sr. No.	Staff	Trainers	Contents	Timing/Frequency
			Mechanism of community participation in the Project activities Complaints/ Grievance handling procedures	
7.	Contractor's Staff/ Support Staff (Drivers, in-charge of workers/ labour, workshop force, kitchen staff etc.)	SC	An "alleviation programme" with respect to HIV/AIDS, COVID -19 and other infectious diseases. Compulsory HIV/AIDS awareness and other infectious diseases prevention training. Educational campaigns to be conducted in the Project Area.	To be started immediately after the start of the construction activities.

9.11 COMMUNICATION AND DOCUMENTATION

Communication and documentation is an essential feature of the EMMP. The key features of such mechanism are provided below:

- Meetings and Reporting;
- Photographic Record and Data Base; and
- Non-compliances(s) of EMMP.

9.11.1 Meetings and Reporting

Monthly meetings will be held at site during the construction phase. The purpose of these meetings will be to discuss the routine activities, non-compliances and their remedial measures. Various reports will also be produced at periodic time intervals, as provided in **Table 9.3** along with information regarding persons responsible for report preparation and review process. Additionally, minutes of meeting will also be submitted as part of routine environmental reports.

Table 9.3: Periodic Reporting Mechanism

Report Category	Prepared by	Reviewed by
Monthly	Contractors' environmental staff	Proponent and SC
Quarterly	Contractors' environmental staff	Proponent and SC
Annual Report	Contractors' environmental staff	Proponent and SC
Completion Report	Contractors' environmental staff	Proponent and SC

9.11.2 Photographic Record and Data Base

The Contractor will maintain photographic records of all activities during the implementation of the project. As a minimum, the photographic record will include the photographs of the sites, quarry sites, access tracks/roads, construction camps, and monitoring of different categories, etc. Data base of persons involved in monitoring, compliance and effects, HSE database,

trainings, meetings, site restoration, tree plantation, compliance and non-compliance record according to HSE Plan will also be maintained.

Photographic record will also include shot number, photograph name, date, time, etc. to identify key locations by using digital camera. The activity will be performed before start and after end of activities.

9.11.3 Non-Compliance(s) of EMMP

The implementation of the proposed EMMP involves inputs from various functionaries. The Contractor will be primarily responsible for ensuring implementation and reporting of the mitigation measures proposed in the EMMP, which will be part of the contract documents. The provision of the EMMP cost will be made in the total cost of Project, for which Contractor will be paid on the basis of monthly compliance reports. However, if the Contractor fails to comply with the implementation of EMMP and submission of the monthly compliance reports, deductions will be made from the payments to the Contractor claimed under the heads of environmental components. Additionally, all non-compliances will be communicated to Contractor via non-compliance memos, emails, letters, etc. and will also be recorded in all environmental reports.

9.12 ENVIRONMENTAL MITIGATION PLAN

Environmental mitigation plan is considered as one of the main elements of EMMP. It will be used as the management tool for the implementation of mitigation measures. The plan includes following:

- The envisaged impacts as identified in EIA and their recommended mitigation measures; and
- The person/organization directly responsible for adhering to or executing the required mitigation measures.

It is highlighted that although the responsibilities for executing and monitoring the mitigation measures have been delegated to different organizations, PIU/PMU will hold the primary responsibility for ensuring the full implementation of EMMP. **Table 9.4** provides information about all impacts to be raised due to project activities during different phases of the Project i.e. pre-construction, construction and operation.

Table 9.4: Mitigation Management Matrix

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
Pre-Construction / Design Phase				
1.	**Permanent Land Acquisition** The major impact due to the implementation of the proposed Project will be the impounding of about 3991.79 acres of area. This will form a reservoir area which may result in the loss of land and the land based resources and assets in the reservoir area. These resources mostly include land such as barren and hilly land along with other land cover type such built-up, cultivated, flood plains nullah and trees. Due to the impounding, the area will be lost on permanent basis. Permanent land acquisition will be required for the reservoir up to the Peak conservation level of (1,170 ft). The total land to be acquired is about 3991 acres for the reservoir area. Similarly, the total land required for the establishment of canal and drainage structures in command area is about 4149.14 acres. Moreover, 140 acres for building, colony and offices will also be acquired.	• The land required for the proposed Project falls in Rajanpur District of Punjab. The LAA, 1894 is the core legislation for the acquisition of private land for development Project. Local needs for land acquisition are addressed through the system of land rights and distribution. • Almost all civil works will be carried out within the state land. Hence, no private land is required in the execution of this sub-project. The land will be transferred from department to department as per rules.	District Government Proponent	
2.	**Temporary /Leasing Land** During the construction activities, contractor will establish contractor camps, storage areas for materials and equipment including vehicles, workshops, stockpile yard, etc. The tentative location of these construction camp areas which need to be finalized yet.	• Land for above mentioned facilities will be directly rented from the private landowners by the contractor. The provisions of the Land Acquisition Act (LAA), 1894 will not be involved as the acquisition of the land will be temporary and will be covered by short-term lease agreements between the landowners and contractor. Temporary acquisition will principally be the responsibility	District Government Proponent	

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
	Contractor need to lease the land for these areas in the vicinity of the construction sites. These areas will be acquired on temporary basis by direct negotiation and agreement with the owners or negotiated with or decided by the district administration office. Temporary acquisition will principally be the responsibility of the contractor. The total estimated land which will be occupied by the construction camps and associated facilities is about 18-20 acres (08-10 acres for staff and labour camps and 10 acres for material and equipment storage area).	of the contractor. Rental terms will be negotiated to the satisfaction of the concerned landowners and the agreement will be made in local language to make the process clear. • As mentioned the location of these areas are not finalized yet, therefore a criterion has been suggested which will be followed to avoid the adverse impact on the environment. The land for above mentioned facilities will be selected and leased prior to the start of construction phase. • Lease agreement will also govern the process of site restoration of the leased or rented land after the construction phase and will ensure through the terms of the construction contracts that landowners are compensated according to the terms of the lease agreements and the site restoration plans agreed upon by the contractors are duly carried out. • Criteria for land acquired for temporary based is mentioned in Section 7.1.4.2.		
3.	**Structure Loss** The project will impact about 59 numbers of structures in reservoir area and approx. 75 numbers of structures in canal and drainage scheme. Formal assessment and detailed measurement of the affected structures will be finalized after implementation of Section-4 of LAA and will be updated in the final RAP.	• Effort has been made to minimize the diverse impact of religious and cultural structures. Resettlement Plan will include provision for payment of compensation to PAPs against loss of any structure. • All government structures to be affected will be evaluated by the relevant Department and will be restored and rebuild according to the specification of the existing building. The detail of compensation will be provided in the RP of the Proposed Project. • Impact on the structures will be assessed in the detail and compensation against damages of structures with all	District Government, Proponent	

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
		allowance will be provided in the RP document of the Project.		
4.	**Impacts due to Field Investigations** Low level adverse impacts on the air quality, impact on surface water quality, soil contamination, soil erosion due to the pre-construction activities like geotechnical investigations including drilling, topographical surveys and seismic investigation will affect the existing settings. Activities like drilling, blasting, movement of machines and setup of contractor and consultant camps will also impact the soil, wildlife, noise levels etc.	• Good engineering practices and Standard Operating Procedures (SOPs) are required to be adopted by the contractors. This will mitigate or avoid this insignificant impact. • Measures such as sprinkling of water on the roads and dirt tracks, use of water to reduce air pollution during the stone crushing operation and tuning of vehicles and equipment will reduce the air pollution. The excavated material will be managed by ensuring proper storage areas located far away from the water bodies. The choice and design of these measures such as reduction of slope gradient and height, reduction in slope angle, removal of unstable material, use of reinforcement material etc. will be the responsibility of the contractor. The contractor will be required to train his workforce in the storage and handling of materials, like oil, diesel, petrol and chemicals, etc., which can potentially cause soil contamination. Special measures will be adopted to minimize the impacts on the nearby settlements such as avoiding noise generating activities during night time, etc.	CC, Design Consultant	Proponent
5.	**Physical, Religious and Cultural Resources** According to the field survey, various local village mosques are coming in the reservoir area. Furthermore, ancient shrines such as Grave of Sahabi e Rasool SAWW “Hazrat Sahal Bin Adi RA”, Darbar Hazrat Anayat Shah Harand, Darbar Hazrat Tayyab Sultan, Darbar Hazrat Maeer Hamza Sultan, Darbar	• Due consideration shall be given to minimize the adverse impacts on the religious and community structures and places	CC, Design Consultant	Proponent

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
	Syed Shahjahan Muhammad Bukhari are located near to the project components. These sensitive places are not directly affected due to proposed project however special considerations are required to eliminate the probability of impact.			
6.	**Resource Conservation** Resources involved in the construction of proposed Project would include water, fuel and construction materials. Excessive water consumption by the construction staff may stress water resources in the Project Area and in certain cases may disturb the existing water supplies in the Project Area. Construction material to be used for construction includes coarse aggregates, fine aggregates, asphalt, cement, lining material, earthworks, reinforced and structural steel etc. Almost all the materials to be used in the construction of proposed Project are non-renewable and therefore their efficient use is necessary for the future use. Fuel will be used to operate construction machinery. Efficient use of energy resources is important to reduce air emissions. For conservation of energy, efficiency of the engines and burning processes is important.	• Use potable water bowsers for construction works and mineral water bottles/ ground water for drinking purpose; • Plan for the provision/purchase of adequate insulation to reduce heat loss through batching plants; • Reduction of wastage of water through training of workers involved in water use; • Reuse of construction waste materials may be adopted wherever possible; • Diesel and fuels with low sulphur content will be used to operate construction machinery and equipment; • The efficient and well maintained equipment and machinery will be used; • The equipment and machinery will be turned off when not in use; • Ensure adequate insulation to reduce heat loss through batching plants; • Regularly monitor CO and CO2 content of the flue gases to verify that combustion systems are using practical excess air volumes; and • A good camp design and an efficient worksite management plan can help the contractor to reduce the water demand, wastewater and solid waste volumes to the lowest levels.	CC, Design Consultant	Proponent

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
7.	**Flora** During the pre-construction phase, activities such as installation of construction camps, construction of temporary roads & mobility of construction staff may damage the local vegetation/trees. As the heavy machinery and camps will be moved and installed, which require significant space due to which available vegetation is expected to be removed. This impact is Site-specific, Permanent, Irreversible, Possible, Medium Significant and needs to be encountered prior to the start of construction stage. Possible impact is anticipated on designated forest ''Ragistan Pachadi and Ragistan Shumali Protected Forest'' in command area. If not avoided, then the impact may consider as significant.	• The camps, mobility of machinery and construction of temporary road will be proper planned and well designed to avoid any loss to local green cover; • It is recommended to establish the construction camps where no or minimum vegetation exists. • Similarly, the alternate routes for roads and points for camps are recommended where no loss of vegetation is expected; and • The location of construction camp will be selected so, as to have limited environmental impact during construction phase and to reduce the cost and land requirement. • Compensation to the forest department for all type of plants (saplings, sub-mature, mature trees and other green assets) will be paid by the proponent as mutual understanding with the Punjab, FD and as per law of land. • Potential green areas and designated forest in project area will be avoided and re-routing re consideration of design is strongly recommend.	CC, Design Consultant	Proponent
8.	**Fauna** As movement and installations of machinery and vehicles will take place so, noise and habitat loss is expected. The routes of the available wildlife and other habitats may be affected due to camps set-up and machinery movements and installations. Temporary road may also affect the habitat of locally available fauna.	• The standard measures must be adopted to minimize noise due to machinery movements and installations; • Wildlife movements and routes must be considered during activities and will be avoided to their maximum level; • The alternate routes and points are recommended to avoid any damage to locally available fauna; • The camps shall be properly fenced and gated to check the entry of animals in search of eatable goods; and • Similarly, wastes of the camps shall be properly disposed of to prevent it being eaten by animals, as it may be hazardous to them.	CC, Design Consultant	Proponent

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
		• Fruit trees along with other broad leaved and coniferous trees must be considered for plantation to balance the local ecosystem. • Proper waste management plan will be considered and mandatory to safeguard the local environment.		
9.	**Socio-economic Environment** During the planning and design phase of the project, it is anticipated that there will not be any potentially significant adverse impact on the socio-economic environment. Locals may be temporarily disturbed due to the field investigations and drilling activities.	• No mitigations measures are required except good engineering practices to avoid and reduce these low adverse impacts.	CC, Design Consultant	Proponent
Construction Phase				
1.	**Aesthetics** Construction activities at dam axis, distribution weir and saddle axis will result in some visual impacts. The construction activities will involve the cutting of trees/bushes, excavation, soil filling and cutting operation. This disturbs the natural scenic value of the environment. In addition to that the sitting of construction equipment and the lacks of resurfacing/replanting of exposed areas are also the leading factor to aesthetic reduction.	• The adverse environmental impacts related to the aesthetic could be effectively minimized at the construction phase. These will be mitigated by the control of clearing vegetation to the area in the construction limits and by plantation and quick re-vegetation during the construction phase. Good house-keeping, cleaning, efficient solid waste management system will be implemented to improve the aesthetics of the working environment.	CC	Proponent
2.	**Site Accessibility** The proposed Project Area falls within the territory of District Rajanpur which is located about 116 km North West of Rajanpur city. Please refer to the location map as Figure 1-2. The Project site can be accessed through	• The access roads to the dam site has to be pre-determined in consultation with the highway/traffic management officials. Access roads would have to be widened and/or improved to carry the anticipated load of traffic.	CC	Proponent

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
	Fazilpur and Jampur which are mainly connected to the upstream and downstream country through Indus Highway (N-55). Heavy vehicles will be utilized to transfer construction plants, equipment, construction materials, cement and fuel. These activities may have adverse impacts on the access roads. Apart from that it will increase the air and noise pollution.	• During the course of construction of proposed Murunj Dam Project, contractor(s) will provide the signage and/or traffic control to the extent deemed nece ssary by the traffic utilizing or accessing the site roads. These signs will inform, control, warn, shift, or stop traffic on all site roads affected by the Project's heavy traffic. The following measures will be taken by the contractor(s) during the construction phase for the effective implementation of the traffic plan: ○ Pakistan national and local traffic rules and regulations, instructions manual for motor vehicle and mobile machinery operation will be followed; ○ No one will be allowed to drive motor vehicle or operate mobile machinery without a driving license; ○ It will be prohibited to drive or operate vehicle in case of over fatigued or mental disease; ○ Traffic speeds on unpaved roads will be limited to no more than allowable traffic speed; ○ Traffic speed signs will be displayed prominently a t all site entrances; ○ A daily routine check-up of vehicles will be conducted no less than 5 minutes before its service; ○ Use of appropriate signs, equipment, and traffic control measures that conform to the provisions in the traffic manual of city traffic police; ○ Traffic inspection and security during transportation; ○ Limit vehicular traffic designated access roads, construction laydown area, parking areas and the Project site;		

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
		○ All damaged, destroyed or modified pavement legend, traffic control devices, signing and striping associated with the proposed development will be replaced as required prior to issuance of a certificate of occupancy; and ○ Construction signs, lighting and barricading will be provided during construction as required. • The contractor(s) will also be responsible to prepare a comprehensive Traffic Management Plan and follow the conditions of contract for construction.		
3.	**Natural Drainage** Construction activities such as excavation, filling and construction of the dam structure, distribution weir and saddle axis will affect the existing soil pattern in the Project Area, its surroundings and along the command area. In addition, this will lead to changes in the existing drainage pattern. The conditions will be more hazardous during the flood periods and can affect the construction activities.	• During the construction phase, excavated material will be properly disposed of ensuring that it will not block the natural drainage paths. Open drains for drainage of rain/flood water will be constructed, if considered necessary during construction period.	CC	Proponent
4.	**Potential Loss of Land in Disposal Areas** During the construction phase, huge quantities of rock will have to be excavated. Part of the excavated rock can be used as concrete aggregate provided the fragmented rock meets the quality standards needed for the work. In order to reduce the amount of rock to be disposed, excavated rock can be used in the Project for different types of infrastructural works. The remaining spoil will	• Good engineering practices will help in controlling soil erosion at construction sites. Following measures will be adopted according to site condition:	CC	Proponent

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
	be disposed in designated and safe disposal areas.			
5.	**Soil Contamination & Erosion** During the construction phase of the Murunj Dam Project, large quantities of waste materials, chemicals, fuel and lubricants will be used apart from the generation of solid waste and liquid waste from the construction camps. Fuels and chemicals will be stored at the site for their immediate use, which will contaminate the soil if not handled properly. Similarly, removal of vegetation and shrubs for the purpose of construction activities will lead to loosing of the soil, soil disturbances, and exposure of bare soil surface. This causes problems of soil erosion and siltation during rain.	• Good engineering practices will help in controlling soil erosion at construction sites. • Soil erosion impact on the area during the construction phase will be of a temporary nature. However, the contractor will be required to train his workforce regarding storage and handling of materials, like oil, diesel, petrol and chemicals, etc., which can potentially cause soil contamination; • Retain as much existing vegetation possible; • Use natural and artificial cover on disturbed areas; • Divert runoff away from disturbed areas; • Minimize runoff velocity and discharge; • Proper solid waste management and housekeeping at construction camps will be practiced; • The contractor will be required to prepare training manual and modules for all the construction related activities along with the schedule of training program and submit to the supervising consultants for approval; • Soil contamination due to concrete transportation will be minimized by placing all containers in casings; • The oil, fuel and chemical storage areas will be designed as per applicable standards i.e. Statutory Notifications (S.R.O), Government of Pakistan, Oil and Gas Regulatory Authority, Notification, Islamabad, 2nd July, 2009, etc.; • Material Safety Data Sheets (MSDS) will be strictly followed during handling and storage of chemicals; • Solid waste generated at the camp sites will be properly treated and safely disposed only in the demarcated waste disposal sites/areas; and	CC	Proponent

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
		• Site restoration plan for the Project will be strictly followed.		
6.	**Liquid and Solid Waste from Construction Camps** Development of construction camps in the Project Area will generate a significant quantity of liquid and solid waste. Residential accommodation is required for about large number of staff and workers of the contractor, the consultant and the employer on the Project. It is proposed to locate the necessary temporary and permanent colonies at or near the proposed Project site. Approximate proposed strength of the total staff for camps is about 450 at this phase of the Project. As a general rule the water consumption will be about 40 liters/capita/day and will subsequently generate about 70 to 80% of this water as sewage. Disposal of wastewater without treatment will pollute the soil and surface water. Hence, water demand, on average, will be 18,000 liters/day for camps during the construction phase and estimated generated wastewater will range from 14,400 liters/day. Camps will generate about 0.45 kg/person/day domestic solid waste comprising kitchen waste, garbage, putrescible waste, rubbish, and small portion of ashes and residues. Estimated quantity of	• Domestic and chemical effluents from the construction camp will be disposed by the development of on-site sanitation systems i.e. septic tank along with soakage pits, prior to discharge. Septic tank will be located adjacent to the construction camp. Proper monitoring to check the compliance of PEQS will be carried out; • The domestic sewage will be treated with biological treatment technology and will be discharged as per PEQS. Proper monitoring to check the compliance of PEQS will be carried out; • As per standard engineering practices after digestion of sludge for an extended period, the sludge will be dried and be used for the landfilling at proper location for final disposal; • All the solid waste from the camps will be properly collected at source by placing containers and disposed of through proper solid waste management system. The contractor will coordinate with local representatives and concerned authorities, if any, for the disposal of solid waste; • Toxic waste will be handled, stored, transported and disposed separately; • The waste will be properly sealed in containers with proper labels indicating the nature of the waste; • Solid waste will be segregated at source so that it can be re-used or recycled; and • A waste management plan will be developed by the contractor and will be implemented with true spirit.	CC	Proponent

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
	solid waste will be about 202.5 kg/day. Improper waste management activities can increase disease transmission, contaminate ground and surface water and ultimate damage to the ecosystem.			
7.	**Surface Water Quality** Surface water quality of the Kaha Hill Torrent may get deteriorated due to the construction activities. During the construction phase of the proposed Project, materials like sand, gravel and stones will be required in large quantities. Extraction of the materials will also affect the surface water quality by increasing the sediment load. This water will be used during different construction activities. The movements of heavy vehicles on the unpaved tracks, excavation activities, cut and fill processes in the Project Area, fuel and chemical spills may deteriorate the quality of the surface water. These activities will also increase the sediments and turbidity of the water. Waste streams can bleed toxic materials from items such as batteries, used computer equipment, leftover paints and pesticides and pathogenic organisms include specific strains of bacteria like E. coli into the leachate of dumps. Leachate from waste piles caused by exposure to precipitation and from residual liquids in the waste itself may contain organic matter, nutrients, metals, salts, pathogens,	• The excavated material will be managed by ensuring proper storage areas located far away from the water bodies. It will not cause the siltation of the Kaha Nullah/Hill Torrent. All the solid waste from the camps will be properly collected at source by placing containers and disposed of through proper solid waste management system. To reduce the impact of sediment, load the contractor will make arrangements such as fine screens and drains to limit the siltation into the water bodies. A simplified sedimentation tank shall be built on the construction site for the primary treatment of the construction equipment wastewater, detergents and mud. Wastewater effluent from the contractors' workshops and equipment washing-yards will be passed through gravel/sand beds to remove oil/grease contaminants before discharging into the natural streams. This is the general guideline principle for the contractor. • According to the PEQS, the BOD concentration in sewage must be brought down to less or equal to 80 mg/l before being discharged into a natural stream having capacity to dilute the effluent. For wastewater, apart from BOD, COD of 150 mg/l will also be checked; and similarly, if the sewage after treatment is to be discharged on to the land it will meet the requirements of the PEQS for disposal of wastewater.	CC	Proponent

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
	and hazardous chemicals. If allowed to migrate, leachate can contaminate surface water.			
8.	**Quarrying/Borrow Area Hazards** Four (04) number of potential quarry/borrow sites were identified near the proposed Murunj Dam Study Area. The Location of these sites along with the material type is mentioned in Section 7.1.5.8 These quarry/borrow sites are located at few kilometers away from the dam site. Transportation of material from the quarry sites to the dam site will be a major task involving movement of heavy vehicles. Development, excavation, loading and transportation of material from each site will create various adverse impacts on the existing environment. This would also affect the quality of surface water being utilized in the downstream area of dam axis due to high turbidity. Temporary storage of huge quantities of material in the shape of heaps may also affect the drainage pattern of the area.	• Proper Quarry Development and Management Plan for each identified quarry area will be made prior to the execution of work. The Plan will include all the infrastructural requirements of each site and implementation plan for the development of each quarry site in an environmental friendly manner. This plan will be submitted to the supervisory authority for approval.	CC	Proponent
9.	**Hydrology** Due to the construction activities of the proposed Project, the existing hydrology of the Kaha Nullah/River may get disrupted, which mainly includes disturbance in the flow of the existing hill torrent and surface drainage of the site.	• Prior to the commencement of the construction activities, the contractor will make some arrangements in view the maximum possible discharge of the hill torrent and surface water bodies may not disturb during the entire construction period.	CC	Proponent

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
10.	**Ambient Air Quality** A large number of machinery and equipment will be deployed at site for the implementation of the Project. Different varieties of machinery/equipment will be required during the construction phase of the Project. The start of construction activities, working of equipment and vehicles will cause deterioration of the ambient air quality. Apart from the emissions of exhaust gases from the vehicles, generators, batching plants and machinery, fugitive dust emission will be the major air quality deterioration component. During the summer season, high winds will moderate the effect due to the dispersion, however, during the winter season, inversion will make the conditions worse.	• Constant sprinkling of water on the unpaved/dirt tracks to avoid the deterioration of air quality in reservoir area; • Use of water to reduce air pollution during the stone crushing operation. This will also reduce the dust pollution during the hauling of the material due to the remaining moisture; • Old plant, equipment and transport vehicles will not be used on the construction Project. Vehicles and plants older than 5 years will not be allowed; • Haul-trucks carrying sand aggregate and other materials will be kept covered with tarpaulin to reduce the dust pollution; • Planting rapidly growing trees, shrubs and grasses would help in reduction in air quality deterioration; • Vehicle will be properly tuned and • PEQS provisions for ambient air quality, stack emission, noise levels and vehicular exhaust will be used for reference during the construction works.	CC	Proponent
11.	**Noise Pollution** The project activities which generate air pollution also generate noise. Hence during the construction phase, activities like movement of vehicles, operation of machinery, excavation, blasting, etc. will cause noise as well as vibrations. Existing environment of the area is free from noise pollution and the use of machines such as vehicles in the daily activities of the locals is almost negligible. Hence any noise generated during the night time will have a pronounced effect on the nearby receptors. Similarly, use	• Heavy duty machinery will be provided with mufflers in order to reduce the noise to within acceptable limits; • Construction timing will be consulted with the residents of the nearby villages. This will minimize the disturbance to the local population; • Provision of mufflers on machinery producing noise; • Vehicle will be properly tuned; • During the blasting activities for material quarries and borrow pits, labour will be provided with ear muffs to avoid hearing loss; and • Construction timing will be coordinated with locals. Normally heavy noise generating activities are allowed	CC	Proponent

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
	of explosives during the excavation and construction will have a significant adverse impact on the safety of the workers. The significant impact may be of high magnitude for the labor working in a place that is close to the area where explosives are in operation.	from 9 AM to 5 PM during day time to avoid disturbance to humans as well as fauna.		
12.	**Flora** Loss of natural vegetation and trees in the area reserved for project facilities including reservoir, canal command area is the major impact. Approximately a total number of 6,183 trees (41% sub-mature trees and 59% mature trees) has been identified. the majority of the trees present in area where the main project facilities will be constructed have been surveyed. The provided number of trees is approximate and tentative (GIS based) which needs proper detailed field surveys, assessment and authentication with help of Forest department. The most dominant species are indicated generally all species present are very common and widely distributed throughout the project area including downstream of dam axis. Moreover, trees of small and medium sizes will be removed due to the layout of the project for which compensation will be made to concerned parties (if any local community, forest and other relevant departments). During the construction phase, due to clearing	• Cutting and / or disturbance of trees shall be avoided, as far as possible and select the alternate site for the proposed project as the impact on local ecosystem (specially trees) is expected as high. So, that negative effects on the process of natural regeneration of species are minimized and possible alternate area must be considered for proposed project, in which minimum ecological and environmental losses are expected; • A tree plantation program shall be implemented with the recommendations and technical support of Punjab, Forest Department; • NOC for working in Protected Forest and tree cutting from Punjab, Forest Department is mandatory; • As a principal, ten trees (1:10) shall be planted in place/lieu of felling of one tree in consideration of mortality. Total 62,000 trees shall be planted in compensation/lieu of 6,183 trees; • It is pertinent to mention that trees will be relocated/transplanted/replanted (where possible) instead of cutting and may be replanted within the 500 meters' radius of its original location; • The compensatory plantation shall be carried out in the project area (in the available space) or in the vicinity of project area like associated roads and nearby parks /	CC	Proponent

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
	and grubbing activities and installation of batching plants, natural vegetation, which includes herbs, shrubs and trees, will be damaged, resulting in potentially adverse environmental impact. During construction activities, the Contractor's workers may damage the vegetation and trees (for use as fire-wood to fulfill the camps requirements).	green areas, etc. to reduce the negative impacts of the tree cutting in the immediate project area and overall; • Final and actual plantation and trees compensation cost will be finalized after assessment by Punjab, FD. All the activates will be executed as per agreement/MOU between proponent and Punjab, Forest department while strictly considering law of land. • The proponent shall implement the program with the help of Forest Department and with the consultation of concerned consultant ecologist; • Open fires will be banned in the area to avoid hazards of fire in the area; • Clearing of vegetation cannot be avoided at the areas specified for project structures, but damage to the natural vegetation may be minimized by establishing camp sites, workshops and batching plants on waste/barren land rather than on forested or green land. • However, if such type of land is not available, it shall be ensured that minimum clearing of the vegetation is carried out and minimum damage is caused to trees and undergrowth; • Construction vehicles, machinery and equipment will remain confined within their designated areas of movement; • The Contractor's staff and labor shall be strictly directed not to damage any vegetation such as trees or bushes; and • Contractor shall provide gas cylinders at the camps for cooking purposes and cutting of trees/bushes for fuel shall be strictly prohibited.		

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13.	**Fauna** During construction phase the existing population of birds, mammals and reptiles of the construction areas will be affected due to disturbance arising from construction activities involving excavation, movement of machinery and vehicular traffic, movement of labor, camping, etc. The existing fauna will leave the directly affected areas due to construction activities and human intervention. Some animals particularly reptiles may get killed during the earthworks operations. Moreover, the movements of the mammals and reptiles will be restricted during the construction phase. Birds as well, will tend to move away from the construction areas and find shelter and food elsewhere due to the activities mentioned above for fear of being hunted / trapped. Noise generated from machinery particularly during the night hours will even scare the wildlife residing in habitats located at some distance from the construction areas. Food and refuse at the Contractor's camps may attract animals that might in turn be hunted by the workers.	• Care shall be taken during construction activities for avoiding purposely or chance killing of animals; • If any wild species and habitat is found during construction, it must be dealt carefully and local wildlife department officials will be informed; • Hunting, poaching and harassing of wild animals shall be strictly prohibited, and Contractor shall be required to instruct and supervise its labor force accordingly and clear orders will be given in this regard; • The Contractor must be held responsible for instructing his work force accordingly and for enforcing this restriction. In addition, this shall have to be controlled by the Wildlife Department. • Special measures shall be adopted to minimize impacts on the wild birds, such as avoiding noise generating activities during the critical periods of breeding; • Noise generating activities shall not be carried out during the night by the work force; • Wastes of the camps shall be properly disposed of to prevent it being eaten by animals, as it may be hazardous to them; and • Noise produced due to construction activities may be kept to acceptable level.	CC	Proponent
14.	**Social Issues/Community Disturbance, Health and Safety** The construction activities can potentially impact the residents of area, particularly the movement and safety of locals. In addition,	• Occupational health and safety procedures will be enforced at site. Each contractor(s) will be required to prepare, obtain approval of, and implement an occupational health and safety (OHS) plan;	CC	Proponent

Sr. No.	Impacts	Mitigation Measure	Responsibility	
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	due to increased use of trucks and other vehicles on the narrow roads in the Project Area and the access roads pedestrians, particularly elderly people and children will be more exposed to dangerous situations, which may lead to traffic accidents. Construction activities also pose safety hazards for the site staff. The rough terrain and difficult work conditions in some parts of the area will need extra attention from contactors and Project management for the increased risk of accidents, unsafe working conditions and health risks. This is especially true for underground work in tunnels and caverns, but also during excavation and construction work.	• Contractor shall have a system to ensure that Risk, Emergency Preparedness, Environmental and Working Environment, analysis are carried out as integrated part of the design and engineering process; • Contractor shall have implemented an Environmental Management System corresponding to the ISO 14001or EMAS standards; • A Traffic Management Plan will be implemented that will aim at ensuring access to residential areas, and preventing of unsafe situations, especially near schools, housing areas, construction areas, camps and offices; • Construction activities such as blasting and excavation particularly at the borrow areas may pose safety risks to the nearby population; • Appropriate procedures will be maintained for such activities, including cordoning off the area, prior information to nearby population and liaison with the community; • There will be appropriate medical services and a facility with the capacity to treat emergency cases and trauma patients; • Special attention will be focused on safety training for workers to prevent and restrict accidents and on the knowledge how to deal with emergencies; • Road signage will be fixed at appropriate locations to reduce safety hazard associated with Project-related vehicular traffic; • Liaison with traffic police will be maintained; • Project drivers will be trained on defensive driving; and • Vehicle speeds near / within the communities will be kept low, to avoid safety hazards		

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15.	**Conflict between Labour and Communities** The Project construction will bring significant changes in the lives and livelihoods, including new opportunities for employment and income for the local people. The development also attracts thousands of new in-migrants to the Project Area. Through the influx of workers and business people the population of area will increase within a few years. Unless properly managed this sudden influx of people could create adverse aspects such as an increased crime rate, tensions and social conflicts between the various groups.	• Project has developed a pro-active approach by working out for a number of key issues which have been proposed including issues regarding housing and accommodation, food security, local infrastructure, community health, labor contracts, employment and business opportunities, security, integration and cultural understanding and community and area development. In accordance with this Plan procedures and rules will be worked out by the PMU in close cooperation with the contractors and local authorities; and • Responsibilities for the implementation of these suggestions will rest with the local authorities, the line departments, WAPDA and the contractors.	CC	LAC-Proponent
16.	**Communicable Diseases** The labor in the Contractor Camp, truck drivers and like personnel who interact with each other have the potential for the spread of COVID-19 and HIV/AIDS if the incidence exists. Majority of the people living in the surrounding of the Project, and potential Labor are not aware of the source, mode of communication or consequences of HIV/AIDS. Although their religious and cultural value system, to a large extent excludes the outbreak or rapid communication of COVID-19 and HIV/AIDS, yet its occurrence in such a situation cannot be precluded. It is necessary that awareness and preventive campaigns are run from time to time in the Labor campus and the field	• Arrange to run an active campaign, in the labour camp, to make people aware of the cause, mode of transmission and consequences of HIV/AIDS; • SOPs related to the construction industry advised by National Action Plan for COVID-19 Pakistan to control spreading of COVID-19, shall be implemented by the contractor and will be strictly monitored; • Strengthen the existing local health & medical services for the benefit of labour as well as the surrounding villages; • Ensure cleanliness and hygienic conditions at the labour camp by ensuring proper drainage and suitable disposal of solid waste. Inoculation against Cholera will be arranged at intervals recommended by the Health Department; • Locating a labour camp at least away from the villages (local settlement), and	CC	Proponent

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	offices of the Project to prevent the communicable diseases like Cholera, Typhoid and Tuberculosis. There is a chance of spreading of an epidemic of Coronavirus disease **(COVID-19)** due to close interaction of the labor force during construction not only among the workers but also in the area.	• Keep all the camps, offices, material depots, machinery yards and work sites open for the inspection of health and safety measures and related documents.		
17.	**Cultural Conflicts** Workers coming from different parts of Pakistan may have norms and values in social behavior and religion that differ from those of the resident population. This can potentially cause tension and conflicts between outside workers and local community.	• Maximum local Labour will be preferred for skilled and unskilled activates; • This situation will be addressed by an awareness campaign; • The contractors would be aware of the possibility and risks of miscommunications between local residents and workers, a situation which easily could lead to social unrest. This would be prevented by raising awareness and implementation of a Code of Conduct for the workers; • Complaints from the local community will be addressed by the grievance redress mechanism; and • The Contractor will be required to maintain close liaison with the local elders and religious scholars of nearby local community to ensure that any potential conflicts related to common resource utilization for the Project are resolved easily.	CC	Proponent
18.	**Impacts on Local Communities** The community belonging to the reservoir and Project Areas will be affected during the construction phase as follows: ○ During the construction phase, the general mobility of the local residents	• During the construction phase, mobility of the workers in the nearby areas will be strictly restricted by the Contractor to avoid any inconvenience to the local communities; • Proper arrangements in the form of alternative routes will be made to ensure that the mobility of locals will not be disturbed;	CC	Proponent

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	and their livestock in and around the Study Area is likely to be hindered; ○ Unmonitored construction activities, e.g. blasting may create an accidental risk for the local residents particularly the women and children; ○ Usage of community common resources like potable water, fuel wood etc. by Contractor workforce may create conflicts between the community and the Contractor; ○ Community will have to face the noise and dust problems during the construction activities; ○ Induction of outside workers in the Contractor labor may cause cultural issues with the local community; and Theft problems to the community by the Contractor's workers and vice versa.	• Before starting the construction activities, Contractor will inform residents of the Project Area about the scheme of work, likely disturbances, and their duration as to whom they will addressed their complaints. • The Contractor will select specific timings for stringing so as to cause least disturbance to the local population considering their peak movement hours; • The Contractors will be required to maintain close liaison with the local communities to ensure that any potential conflicts relating to the common resource utilization are resolved quickly; • Contractor will take care of the concerns of the local community and the sensitivity towards the local customs. Contractor also needs a proper security to avoid any theft issue by the community; • Use of good engineering practices such as water sprinkling, encasement and provision of silencer and mini stacks of generators etc. will be adopted to avoid inconvenience to the locals due to noise, smoke and fugitive dust; and • The Contractor will warn the workers not to indulge in any theft activities and if anyone gets involved in such activities, he will have to pay heavy penalty and would be handed over to the police. Similarly, at the time of employing, the Contractor has to take care that the workers will be of good repute. The Contractor camp will be fenced properly and main gate.		
19.	**Communication Loss Especially due to Canal and Drainage Structures** The excavation for the main canals, the general mobility of the local residents and	• The contractor will ensure that the mobility of the local communities and their livestock is not hindered by the construction activities. The contractor will provide temporary crossing points at appropriate places to facilitate the people for going across the main canals for	CC	Proponent

Sr. No.	Impacts	Mitigation Measure	Responsibility	
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	their livestock in and around the Project Area is likely to be hindered and may need to be travel long distances. Hence with the development of the irrigation network in the command area, movement of locals as well as livestock will be significantly affected. Likewise access to the natural resource may be affected. This particularly implies to the women folk and children, especially in the context of Tribal areas of Punjab where women observe proper veil and do not interact with non-locals.	their daily works and having free access to the natural resources		
20.	**Loss of Income** During the construction activities, people will suffer loss in their annual income due to the loss of crops, trees etc. This impact can be categorized as indirect, moderate, local, medium term, permanent, medium to highly probable and irreversible.	• Fair, prompt and negotiated compensation for the crops and trees on private land will be provided to the affectees along with the land value; • Affectees will be involved in the valuation process of the Project.	CC	Proponent
21.	**Gender Issues** Findings of the socioeconomic survey reveal that the privacy of women is a major cause of concern for the communities of the Project Area. Due to the Project activities, local women many not be able to perform their daily outdoor chores. Women in the Project are participating in other outdoor activities such as livestock rearing, bringing of potable water, collection of fire wood etc. that may also be affected by the Project activities.	• The Contractor will select the specific timings for the activities particularly near the settlements, so as to cause least disturbance to the local population particularly women. • The Contractor will carry out the field investigation activities in such a way that the open defecation timings by the local community particularly women, will not be affected. The normal defecation timings are early in the morning and at late in the evening. So, the Contractor will have to take care of these timings. • Contractor will take due care of the local community and observe sanctity of local customs and traditions by his	CC	Proponent

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	The induction of outside labor may create social and gender issues due to the labor force being unaware of local customs and norms. It may also cause hindrance to the mobility of local women for working in the field, herding livestock, picking fuel wood, etc.	staff. Contractor will warn the staff strictly not to involve in any unethical activities and to obey the local norms and cultural restrictions particularly with reference to women, if privacy of the nearby households is affected, the Contractor will inform the house owner to make some arrangements. Similarly, Contractor will take care as much as possible that the construction activities will not affect the privacy particularly with reference to women.		
22.	**Health & Safety** Workers and the local community will be prone to accidents/incidents during the construction stage. Un-monitored activities such as movement of heavy vehicles on roads and the outer periphery road may create an accidental risk especially to the children. Safety of the locals and their animals during the construction activities needs special attention. Exchange of communicable diseases such as COVID-19 and HIV between the work force and local communities is a high risk during this phase. Community will have to face the noise and dust problems during the construction activities and this would affect the health of the people.	• The training of workers in occupational health and safety, equipping all the construction workers with PPEs i.e. safety boots, helmets, gloves, ear muffs and protective masks, and monitoring their proper and sustained usage, will be done to mitigate impacts related to health and safety. • Vehicles will be driven not more than 20 to 40km/hr speed on road, in village and on the peripheral road (Project Area) in order to avoid any serious accidents.	CC	Proponent
		Operation and Maintenance Phase		
1.	**Sedimentation** Kaha hill torrent lies in Sulaiman Range and carries mainly alluvium soils derived from sedimentary rocks. The watershed has sparse vegetation due to arid climate.	• Watershed management can reduce erosion processes and sediment flows into the dam reservoir consequently increasing its life span. Watershed management activities may include engineering e.g. check dams, etc. and non-engineering measures e.g. tree plantation, etc.	Proponent	

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	Because of very low vegetation cover and the soil type which is highly prone to erosion, the said hill torrent carries high concentrations of sediment (suspended and bed load sediment) with flash flows. The estimated annual suspended sediment load at Kaha hill torrent comes out to be 1.18 Million tons /year. Assuming bed load to be ten percent of the estimated annual sediment load, the estimated total annual sediment load at Kaha hill torrent is 1.29 Million tons/year[15]. Construction of dam at Kaha hill torrent will disturb the sediment flow and sediments will start depositing in reservoir of dam resulting decrease in water storage capacity. Furthermore, reduction in storage will eventually alters the capacity for flow regulation, water supply and flood control benefits.			
2.	**Loss of Nutrients via Sediment Deposits** As discussed earlier, about total annual sediment load at Kaha hill torrent is 1.29 Million tons/year. After construction of Kaha Dam, the major part of the sediment load of Kaha hill torrent would be trapped by the dam and only fine suspended sediment (clay and fine silt) may be released with outflows. Therefore, loss of sediments will deplete the nutrient content of the water to be distributed	• This is residual impact. However, shortage of nutrients in irrigation water (due to the development of reservoir) in downstream area can be overcome by use of fertilizers and manures. Urea (Nitrogenous Fertilizers) and Phosphates fertilizers are very popular with Agriculturists in catchment and downstream area.	Proponent	

[15] Hydrological and Sedimentation Studies of Kaha Hill Torrent (NESPAK, 2017)

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	through distribution weir which may impact agricultural production in Pachad area.			
3.	Landslide Hazard Landslide is the movement of ground, whichever it is active or stable (active in the past)[16]. In terms of safety of a dam, hazard of landslide means the maximum wave height at the landslide area or just below the landslide area in a reservoir, the when landslide is active and moved down to the reservoir. Although landslides hazard is not common phenomena in the Study Area. However, it may trigger along reservoir boundary due to lubrication or saturation of rock support structure by rainfall or by water seepage from reservoir area. The main problems associated with landslides into the reservoir include: direct damage to civil structures of dam, landslide dam-break flooding and reduction of reservoir capacity.	• Pro-active measures will be implemented to stabilize and protect slopes. Early warning systems will be introduced that will indicate when cracks appear and allow any widening to be monitored; • The risk of landslide will be judged with stability of landslide, together with the estimated wave height. If the landslides are judged stable, no wave is generated, which means that there is no risk of landslide; • Stone riprap will be provided as slope protection against wave action on the u/s face of the embankment. The selected stone obtained from spillway excavation and from nearby quarry will be used for this purpose. Slope protection will also be provided on the d/s face of the embankment to prevent rain erosion; • The seismic zoning of Pakistan on the basis of determined 'g' generalized values may be applicable for buildings and other small infrastructure but not for mega structures like Dams, Barrages, Hydropower Stations, Large Bridges, etc. Being located close to the collision boundary of the Indian and Eurasian plates, Pakistan lies in a seismically active zone. Probabilistic seismic hazard assessment carried out as part of the revision of the Building Code of Pakistan, Seismic Provisions (2007) shows that the Study Area falls in Zone-2A, Zone-2B and Zone-C with peak horizontal ground acceleration of 0.08g	Proponent	

[16] *Varnes, D.J. (1978) Slope movement types and processes, in Schuster, R.L., and Krizek, R.J., eds., Landslides – Analysis and control: National Research Council, Washington, D.C.., Transportation Research Board, Special Report 176, p11-33*

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		to 0.34g. The generalized "g" value and Seismic Zones may not be dependable and sufficiently reliable for the feasibility and selection of a dam site. Therefore, detailed seismo-tectonic studies will be required during detailed design studies; • It is therefore strongly recommended that detailed Regional scale Seismo-Tectonic Studies including determination of Project Site Specific Seismicity parameters may be carried out during detailed design phase and the findings and conclusion may be considered accordingly; and • Most part of the reservoir rim consists of sandstone/conglomeratic sandstone which might create issue of seepage and consequently land sliding after impounding and submergence. This issue needs to be investigated properly with the help of additional geotechnical investigations at the detailed design phase.		
4.	**Change in Land Use** During the operational phase the land use pattern of the area will be changed to some extent due to the formation of 17.6 km^2 lake. The commercial and recreational activities will also be increased due to lake formation which may affect ecosystem of the area and bring economic boom in the area. It can also be assessed that development of lake will not losing any agricultural land.	• The tree plantation will be carried out in and nearby the Study Area and will have positive impact on the eco system of the area..	Proponent	
5.	**Water Logging and Salinity** It is anticipated that due to the impounding of reservoir, some areas in the immediate vicinity of the reservoir may be prone to water	• Areas in the close vicinity of the reservoir will be prone to water logging and salinity but this impact is of negligible value i.e. insignificant. Since it is a residual impact, therefore, this impact cannot be mitigated completely.	Proponent	

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	logging and salinity. However, the extent of this impact will not be much as agriculture is not being practiced within immediate vicinity of the area except downstream of Darrah.	• The impact of water logging and salinity is an insignificant impact in the gross command area. However, after the fully development and passage of time in the proposed command areas, the potential impact of water logging and salinity needs to be reassessed through sub-surface hydrological studies.		
6.	**Water Seepage** Seepage analysis of the highest dam and dyke sections was carried out using SEEP/W software. Seepage analysis of the highest sections was carried out using SEEP/W software. The results indicated that the design provision for filters and drains are sufficient to cater for seepage water. The maximum quantity of seepage through the dam body was estimated to be 3.3 x 10-4 cusecs. The analysis also revealed that the seepage gradient across the core and at downstream end was 0.08 and 0.004 respectively, well within the specified limits of 0.3. Similarly, the exit gradients across the core for Dyke-1 and Dyke-3 were determined to be 0.147 and 0.17 respectively which are within the permissible limits of 0.3. Exit gradient at the downstream end of Dyke-1 and Dyke-3 were determined to be 0.16 and 0.032 respectively which are within the permissible limits of 0.30.	• A grout curtain has been provided under the dam foundation to minimize seepage; • A central core comprising of clay has been incorporated with side slopes of 0.4H: 1V and 0.3H: 1V on both sides for main dam and dykes respectively. In order to ascertain the stability of the core, the core will be placed at the depth of 30 ft from N.S.L in the valley section for main dam and 10 ft from NSL in valley section for dykes. • The core trench will have side slopes of 1H:1V. The core trench will be placed on bedrock to minimize • seepage. The depth of core trench has been fixed on the bases of stability against sliding. • Clayey core is provided to minimize the seepage trough the dam body. The core of main dam and dykes will have top width of 12.6 ft. and 12.0 ft. respectively. The top of the core has been kept at El. 1193 ft.	Proponent	
7.	**Water Quality** Water stored in a dam or reservoir is subject to undergo certain physical, chemical and biological transformations. These	• Institute a broad water quality monitoring system such as to focus on the catchment sources, incoming flows, entire dam water, treated water and water downstream of the dam location;	Proponent	

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
	phenomena are induced by natural forces mainly at the bottom anaerobic digestion of the biomass, climatic conditions (heat exchanges, aeration, etc.), chemical exchanges from geological formations, aquatic chemical reactions and material degradations among others as well as biological reactions associated with the organic materials decaying (biomass and humic matter decomposition from the flora and fauna i.e. submerged after first filling of reservoir). Variations in weather conditions and exposure to atmospheric conditions are among other conditions with potential effect to water quality. Among the anticipated water quality aspects of interest for the dam would include: ○ Turbidity and suspended matter from the entering flows, surface runoff discharges and organic reactions among other sources might lead to limited light penetration that has got direct linkage to biological quality of the water; ○ Biomass accumulation in the dam area could render high humic (organic concentration) levels in the dam water. It also has a potential to increase the nutrients and other minerals associated with plant decaying matter;	• Clearing and removal of all vegetation materials (live and dead) at the dam site before the area is excavated and inundated, maintain appropriate records on water quality as required by the law; • Proliferation of aquatic macro-fauna could be encouraged along the periphery of the dam to ensure natural aeration of the water; and • Effective reservoir maintenance manual would have to be developed to deal with the deteriorating water quality.		

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
	○ Limited water mixing, aeration and light penetration reduces available oxygen resulting into anoxic conditions at the lower layers of the water. Anaerobic conditions in the lower layers of the water generate carbon dioxide, methane, hydrogen sulphide and create low pH scenarios. Due to the lowered pH, the geologically held iron and manganese and other heavy metals are likely to be released into the water effectively changing the water quality; and Implications on water quality would be felt by the water consumers in the immediate location of the dam as well as social and ecological dependents of Kaha hill torrent.			
8.	**Climate Change** Reservoir impounding (after few years of operation) will have a small impact on the local climate. It is expected that the humidity in nearby areas will increase and temperatures in nearby settlements are likely to decrease in the summer time as compared to without Project situation. Release of Green House Gases (GHG) may also bring some changes in the climate. World Commission on Dams declared that dam reservoirs are observed to be the emitters of GHG such as CO, methane (CH_4), and	• GHG at international level can be considered as an "Unresolved Issue" and research is still in progress for controlling this process. However, tree plantation around the reservoir area may minimize the potential adverse impacts of GHG and a separate study regarding GHG emissions will be conducted during O&M phase of the Project.	Proponent	

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
	Carbon Dioxide (CO_2) with large variations with situations. A range of factors directly influence the GHG emissions from reservoirs such as: storage depth, size, climate, age of reservoir, etc. Research has not yet produced an exact amount of GHG emissions from the reservoirs all over the world but it is proved that large reservoirs are one of the sources of gases effect. Release of these gases may have low potential adverse impact on climate in the Study Area.			
9.	**Water Rights in Pachad Area (Lower Riparian)** The flow of Kaha Hill Torrent has been used for irrigation of traditional agriculture crops in Pachad area since ancient times. The flood irrigation for raising agriculture crops is practiced as far as possible by the farmer's own diversion arrangements named as Radkohi/Kamara irrigation system. This system enforces the sequential water rights and dictates the irrigation pattern from upper to lower riparian, without consideration of the duration and magnitude of the storm generated flow. Currently, water being distributed through 15 wahs and 05 sub-wahs The water rights of the area will be given due importance otherwise many social issues might be generated.	• In order to conserve the water rights of the lower riparian following approaches will be considered: ○ A provision of regulated flow as per Radkohi/Kamara irrigation system will ensure during the dam operation. Therefore, lower riparian will not be devoid of their ancient water rights. ○ A provision of new irrigation system as per the Punjab Irrigation Department (PID) practices. In this new alignment of the channel along with their capacities will be established based on water allowance. This approach will affect the existing water rights. • The Conflict Resolution Mechanism will be prepared and finalized by the Client. However, the consultant will suggest the following mechanism to resolve the conflict of water rights. • The Client (WAPDA) will consult with the PID, Agriculture and Revenue Department and prepare the plans of both above strategies. Consultant will help to establish	Proponent	

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
		preliminary design outcome brochures of both strategies. After finalization from the Government stakeholder's (WAPDA, PID and Agriculture and revenue), these strategies will be disclosed and consulted with local authoritative personal in the presence of the Political Assistant / Commandant BMP. The final strategy will be vetted by all the authorities and agreement will be made on the agreed system.		
10.	**Settlement of Dam Crest** Settlements will occur due to elastic compression of the embankment and foundation as the embankment is raised and due to subsequent consolidation of core and creep. Settlement of main dam and dykes has been estimated by the finite element method using the computer program SIGMA/W. Equivalent moduli of the fill and foundation have been assumed in reasonable range and used to calculate the expected settlements of the embankments. It is estimated that 2.8ft settlement in main dam and 0.28 to 0.40 ft of settlement in dykes was observed through analysis.	• The finished height of the embankment will be sufficient to ensure that the crest level remains at or above El. 1170 after long term settlement	Proponent	
11.	**Dam Safety and Emergencies** In the event of a dam safety incident or failure which results in uncontrolled release of volume of the water stored behind Murunj Dam, this release is capable of causing loss of life and significant property damages. The dam may fail for one or a combination of the following reasons:	• Impacts resulting from dam failure can be mitigated by ensuring strict adherence to standards in design and construction as well as regular dam inspection coupled with the preparation of emergency planned access control. It will be a highly potential significant adverse impact on the environment. Rim stability and dam safety studies are also recommended to be conducted during detail design phase of the Project.	Proponent	

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
	○ Overtopping caused by unusual precipitation event or flood; ○ Differential deformation leading to cracking and displacement; ○ Excessive settlement of the top of dam/crest; ○ Foundation or abutment erosion; ○ Abutment slope failure; ○ A major slide in the reservoir close to the dam; ○ Operational errors; and ○ Deliberate man-made actions. Failure of the dam resulting in uncontrolled release of the reservoir as well as high floods would result in inundation of downstream areas, consequences of which could be loss of life (reduction of loss of life is the top priority of emergency planning), property damage in flood plain, damage to infrastructure and irrigation water supply from the dam. The damages inflicted by hill torrents flooding in the Project Area can generally be categorized as follows: ○ Loss of land due to erosion; ○ Loss of standing crops due to inundation; ○ Damages to public and private properties due to submergence; ○ Damages to infrastructure; ○ Breaches of canal systems and suspension of irrigation supplies,			

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
	major threat to Kachhi Canal being the front-line canal; and ○ Loss of human lives and livestock.			
12.	**Attenuation of Floods** Devastating flashy floods is the main feature of Rajanpur Hill Torrents. The study area consists of hilly area (hill torrent area up to Darrah) and flat area (hill torrent area from Darrah to the Kachhi Canal, also called Pachad area). The cultivation in Pachad is carried out through spate irrigation, as the only source of irrigation in the area is diversion of floods of hill torrents. The lower frequency floods are diverted in Wahs (irrigation channels) as per respective water rights, but the higher frequency floods are causing loss of lives and damages to the crops and infrastructure (as stated earlier). Flood studies were carried out for the planning and design of spillway and other outlet structures as well as checking the safety of the proposed Murunj Dam. These studies are the basis to evaluate the impact of the dam on the attenuation of floods in the downstream areas. As stated earlier, the Murunj Dam will supply irrigation water through existing Kamara irrigation system (15 wahs and 05 sub-wahs) after its completion. Based on the flood studies, the observed recorded 100 year return period flood at proposed dam site of Murunj Dam is about	• Two types of flood carrier channels (FCC) has been designed. One type will collect the discharge originated from other catchments / hill torrents entering to Kaha command area and will dispose it into main Kaha. Other flood carrier channel comprises of Kaha main stream which will carry discharge of 1st type of FCC in addition to its own flood and will disperse flood waters to the respective cross drainage structures over Kachhi Canal for its safe disposal through DG Khan canal system. Both types of FCC have been designed for 40 years return period discharge of respective hill torrent. Main stream of Kaha hill torrent has been designed for 25,700 cfs which is the cumulative discharge of cross drainage structures at Kachhi Canal at RD 425+630 (10,000 cfs), RD 441+195 (700 cfs), RD 455+390 (1000 cfs), RD 468+860 (5,000 cfs), RD 489+965 (7,000 cfs) and at RD 511+050 (2,000 cfs). • Localized flood protection measures for training of the hill torrents towards the proposed cross drainage structure viz; guide bunds / walls with armoured noses, sloping spurs, studs and side pitching for checking the wave wash and parallel flows are provided as per requirement. • Furthermore, as flood protection measures 15ft wide embankment having side slope of 1V:2H has been provided along left bank canal and right bank canal to protect the command area from flood flows of adjoining catchments.	Proponent	

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
	38,700 ft3/s. After the construction of the proposed Dam, the flood attenuation due the proposed Dam will be about 29%. There will be a significant flood impact on the irrigation and draining structure of the proposed project due to the flood from adjoining hill torrents.			
13.	**Air Quality and Noise** Commissioning and operation of the dam may affect the air quality in the area due to the increase in traffic volume and frequency due to recreation activities after formation of lake behind the dam. The traffic movement will induce some dust and noise problems in the area. There would be a marked difference of values between 'with' and 'without' Project situation. However, as the Project components are mostly civil works, these surely will not pollute the air to a serious extent. As compared to construction stage, air quality and noise pollution will improve. Noise levels are expected to rise during the operation phase of the proposed Project due to the increased traffic volumes and population flow into the Project Area as compared to baseline conditions. However, noise levels will be lesser than the construction phase of the Project. The main contributor to noise level will be the engine sounds and horns.	• To enhance the air quality of the Study Area, a tree plantation program will be initiated by Irrigation Department in consultation with Forest Department on priority basis. As noise levels, will not be a significant problem, no specific measures for noise levels are suggested.	Proponent	

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
14.	**Flora** During operational stage of the Project, there will be minimal effect on flora or release of any significant pressure detrimental to flora. Low level impact is expected at operational phase on Flora due to the operation and maintenance activities.	• The implementation of plantation plan recommends compensation for cutting of trees and work will be started during operational phase to ensure the ecological balance and to avoid any impact on local environment; • Large scale planting with suitable indigenous trees, shrubs and ornamental plants in the form of tree groves, and linear plantation will be carried out in accordance with the Tree Plantation Plan to improve aesthetic value and offset the effect of removal of vegetation; • Proper check and balance for above activities is highly recommended. Plantations so raised must be maintained according to the Silvicultural practices which includes proper irrigation, cleaning, pruning, thinning at prescribed intensity, silt clearance and trench-opening, etc.; • Maintenance and security of the plantation will be done for at-least four to five years (in consultation with the Forest department). Measures such as fencing, watch guards and fire protection will be considered; and • All activities must be done under the technical supervision of Punjab, Forest and Wildlife departments.	Proponent	
15.	**Fauna** There is no protected area, game reserve, game sanctuary or national park in the project area so, no major impact on wildlife in the area is expected through noise, vibration and any type of normal activity in the project area. This impact is Insignificant.	• Strict control must be exercised for stoppage of killing/poaching of available wildlife species (if any) by enhancing protection practices; and • The precautionary measures described (mentioned above) for future shall also be applicable during operation phase as relevant for the conservation of wildlife species in the Study Area. • The water storage in reservoir will attract different type of birds and animals as water is core part of ecosystem.	Proponent	

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
		• The fisheries department will also be involved to start the activities regarding fisheries development in the reservoir waters. • After all the environmental friendly planning, implementation and maintenance the project will have overall positive impact on local biodiversity and commons as well.		
16.	**Communication Loss** The general mobility of the local residents and their livestock in and around the Project Area is likely to be hindered and may need to be travel long distances. Hence with the development of the irrigation network in the command area, movement of locals as well as livestock will be significantly affected. Likewise access to the natural resource may be affected. This particularly implies to the women folk and children, especially in the context of rural and tribal area of Rajanpur where women observe proper veil and do not interact with non-locals.	• The contractor will ensure that the mobility of the local communities and their livestock is not hindered by the construction activities. The contractor will provide permanent crossing points at appropriate places to facilitate the people for going across the main canals for their daily works and having free access to the natural resources. • The contractor will always consider the local sensitivities while performing the Project activities. All the personnel engaged would also be properly briefed about the local norms and ethics prior to commencement of work.	Proponent	
17.	**Occupational Health and Safety** The flow of electric current in the conductors will have an impact on the safety of the workers and locals (staff colony). The burning of the transformer or other electrical equipment due to short circuiting can create a fire which can spread. This will become a safety hazard for the workers.	• During the operational phase of the Project, a security plan will be employed to ensure the safety of the employees working at the Powerhouse, Switchyard and other electrical equipment. An effective communication system must be established so that the proper authorities are notified in case there is a fire in the Powerhouse, Switchyard and other electrical equipment. • Separated fire alarm systems shall be provided for station general area (comprising control building, administration building, machine Hall, workshop etc.), the generators and the transformers. The fire alarm system will be based	Proponent	

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
		on optical smoke detectors, manual call points, alarm sounders and auxiliary devices. • Fire water tank capacity has been worked out considering NFPA 851 requirements of two hours' worst fire scenario and fire hose stream requirements. Portable and trolley fire extinguishers will be provided at all entrances to the power stations. Clean Agent Gas System will be provided for Control room, Computer room and other electrical equipment rooms. • The protection equipment will be complete with all relay panels, instruments, meters, interposing and auxiliary relays, control switches, interposing current and voltage transformers, transducers and all auxiliary equipment. All protections, as far as possible, will be connected to separate current transformers and will have separately protected voltage circuit. Backup protection will be 100 % redundant of the main protection. • All Powerhouse buildings and equipment shall be provided with a fire detection and alarm sys-tem designed to protect life and property in accordance with NFPA 72. The main earthling system for the Powerhouse will be a separate distributed grid of conductors, properly designed to carry electrical fault currents without overheating. The earthling system will be designed according to IEEE-80 "Guide for Safety in AC Substation Grounding" and IEEE 665-1995 "Guide for Generating Station Grounding". • A distributed system shall be provided with independent local fire alarm panels, reporting to a central operator station in the central control room (CCR). Fire alarm indications shall be reflected on the main fire alarm panel located in the CCR. • Two separated alarm systems will be provided. All separate systems will have connection to the main fire alarm panel in the CCR by cables and fiber optical cables.		

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
		• The transformer cells and the generators will have separate fire alarm and extinguishing sys-tems linked to the plant control system and the main alarm fire panel. • The fire alarm system will be based on addressable optical smoke detectors, manual call points, alarm sounders and auxiliary devices. • The overall control and monitoring of the entire powerhouse will be carried out from a central control room. Unit Control Level will deal with the control of individual units, which include the generating units, electrical distribution and other auxiliary systems. Local Control Level will comprise hardwired instrumentation and control through the local control panels e.g. local panels of circuit breakers, generators etc. Monitoring at all levels will be done simultaneously		
18.	**Culture and Heritage** Due to the development of weir and lake(reservoir), influx of people from the adjacent areas will be more pronounced. This change might adversely affect the cultural norms of the area.	• Care will be taken in the workers' interaction with the locals. Persons from other regions will take utmost care for the culture and norms of the locals during the work at the proposed Weir site and canals to avoid any cultural clashes.	Proponent	
19.	**Breaching of Canal, Distribution Structures** Breach of canal will threat system sustainability. This impact would be of high significance with low probability. Following factors may trigger the process: ○ Improper operation of water control facilities; ○ Deterioration of free board due to cattle trespass and other factors; ○ Tampering of outlets; ○ Canal siltation;	• Irrigation Department, Punjab to monitor the system regularly on district level; • Important facilities that need attention and annual maintenance are canal embankments, falls and control structures and bed levels which are affected by siltation or scour. Canal section has been designed to ensure safety by following the standard design principals to design the banks against piping. For major nullahs, canal syphons have been provided so that nullah flows unhindered and therefore does not cause damage to the Canal;	Proponent	

Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
	○ Action of borrowing animals such as rats and porcupines; ○ Inadequate supervision; ○ Lack of timely and adequate repairs; and ○ Lack of coverage of hydraulic gradient.	• Include capacity building of the communities in the O&M activities; • Liaise with the communities to identify potential weaknesses in the system that could cause breaches; • Ensure that the canal lining is regularly monitored to avoid any cracking impact from weathering; • Flood protection spurs will be regularly checked to undertake any prone damage; • Repairs on urgent basis.		

9.13 ENVIRONMENTAL MONITORING

Environmental Monitoring provides timely and useful information to the project management and implementation agencies. Conceptually, “monitoring” means to check and balance, on a regular basis, the status of the project activities and realization of various developmental targets during construction, operation and maintenance. It helps in timely identification/ analysis and removal of the bottlenecks and expedites actions. Certain environmental parameters (physical, chemical and ecological) are selected and quantitative analysis is carried out. The results of analysis are compared with the guidelines; standards and pre-project condition to investigate whether the EMMP and its implementation are effective for the mitigation of impacts or not.

The main objectives of the construction phase monitoring plan will be to:

- Monitor the actual impact of the works on the project site physical, biological and socio-economic receptors;
- Recommend mitigation measures for any unexpected impact or where the impact level exceeds the anticipated impact;
- Ensure compliance with legal obligations including safety on construction site; and
- Monitor the rehabilitation of borrow areas and the restoration of construction campsites as described in the EMMP; and
- Ensure the safe disposal of excess construction materials.

The Construction Contractor (CC) will be responsible for environmental monitoring and reporting throughout the construction phase under the supervision of Environmental Engineer of Supervision Consultant (SC); in coordination with Project Director, WAPDA. During construction phase, environmental testing reports will be prepared on quarterly basis and one comprehensive report will be prepared at the end of the construction phase and will be submitted to each of the following authorities and institutions: (i) WAPDA and (ii) EPA- Punjab.

During project operation phase, WAPDA will be responsible to conduct environmental testing and monitoring along with its cost through a third party contractor and EPA-Punjab certified lab. The reports will be prepared biannually and one comprehensive report will be prepared annually and submitted to the EPA-Punjab. Contents of the final report will include results of environmental monitoring in comparison to the standards for the various parameters, location and sampling time along with recommendations for the future environmental testing and monitoring.

9.13.1 Monitoring Parameters and Frequency

The major negative impacts of the Project activities are related to ambient air & noise, and water resources, which will directly or indirectly effect the environment and will cause health problems to the receptors residing in the surrounding. In order to counteract these problems an environmental monitoring protocol has been proposed (**Table 9.5**)**.** The proposed protocol contains the following monitoring parameters:

a) Physical Environment

For physical environment, following parameters will be monitored:

- Ambient air quality;

- Smoke, dust;
- Noise levels;
- Water (Ground and surface); and
- Wastewater.

b) Ecological Environment

During construction activities, it will be required to check whether plantation of trees was carried out or not and Contractor staff is advised not to cut the existing trees in the Study Area. During operation phase, monitoring team will be required to observe the growth of new plantation to be carried out by the HSE staff.

c) Socio-economic Environment

Effects on the socio-economic environment during construction phase will be monitored by EMC, considering parameters like hiring of local employment, community health and safety, mobility of local women, cultural compliance due to presence of foreign Contractor. Similarly, the above parameters will be monitored by HSE Section of proponent during operation phase. EMC at construction phase and HSE Manager at operation phase will maintain a Social Complaint Register.

Table 9.5: Monitoring Plan for all Phases of the Project

Sr. #	Parameter	Location	Monitoring Mechanism / Parameters	Frequency
A.	**DESIGN/PRE-CONSTRUCTION PHASE**			
1.	Land acquisition	Project Area	Confirm that all acquisition has been completed and compensation paid to affectees as per RAP	Monthly
2.	Tree cutting	Project Area	Comply with the Project Area tree plantation plan as and when required	Monthly
3.	Drinking Water	Water being used for drinking purposes by workers and nearby communities	Discrete grab sampling and laboratory testing of groundwater according to PEQS	Once (Two samples of drinking water from the workers' camp and other from nearby villages)
4.	Wastewater	Workers' camp	Effluent discharges from workers' camp to be tested for all 32 parameters mentioned in PEQS	Once
5.	Noise Levels	Active construction sites and workers' camp(s)	Noise level monitoring (Day and Night) according to PEQS	Once (Once prior to the start of construction)
6.	Ambient Air	Near project site, access roads and settlements	Visual checks and monitoring of SO_2, NO, NO_2, CO, Suspended Particulate Matter, PM_{10}, $PM_{2.5}$ according to PEQS	Once

Sr. #	Parameter	Location	Monitoring Mechanism / Parameters	Frequency
B.	**CONSTRUCTION PHASE**			
1.	Drinking Water	Water being used for drinking purposes by workers and nearby communities	Discrete grab sampling and laboratory testing of groundwater according to PEQS	Quarterly (Two samples of drinking water from the workers' camp and other from nearby villages)
2.	Wastewater	Workers' camp	Effluent discharges from workers' camp to be tested for all 32 parameters mentioned in PEQS	Quarterly
3.	Noise Levels	Active construction sites and workers' camp(s)	Noise level monitoring (Day and Night) according to PEQS	Weekly (Once prior to the start of construction and then weekly throughout the construction period)
4.	Ambient Air	Near project site, access roads and settlements	Visual checks and monitoring of SO_2, NO, NO_2, CO, Suspended Particulate Matter, PM_{10}, $PM_{2.5}$ according to PEQS	Quarterly
5.	Solid Waste	Workers' camps and active construction sites	Visual Checks for assessment of condition of waste generation, segregation, storage, collection and disposal.	Fortnightly
6.	Health and Safety	Workers' camps, batching plant, and active construction sites	All HSE related activities to be monitored including Tool Box Talks, safety signage, PPEs, first aid boxes, dispensary, medical check-ups, etc.	Daily
7.	Communicable Diseases	Labor camp / project colony	Medical check-ups and routine safety check-ups of the communicable diseases and accidents	Quarterly
8.	Ecological aspects	At and around project site or in the whole Study Area	Illegal hunting of fauna / avifauna	Weekly
9.	Environmental Audit	Whole Project Area	Auditor's checklists & performs	Annually
C.	**OPERATION AND MAINTENANCE PHASE**			
1.	Reservoir Water Quality	Comprehensive water sampling plan has to be devised to assess reservoir water quality w.r.t. irrigation, fisheries (as it is	Reservoir water sampling as specified by PEQS	Bi-annually

Sr. #	Parameter	Location	Monitoring Mechanism / Parameters	Frequency
		recommended to breed some compatible fish species during O&M phase)		
2.	Noise Levels	Near project site, colony, offices and settlements	Noise level monitoring (Day and Night) according to PEQS	Quarterly
3.	Ambient Air	Near project site, colony, offices and settlements	Visual checks and monitoring of SO_2, NO, NO_2, CO, Suspended Particulate Matter, PM_{10}, $PM_{2.5}$ according to PEQS	Bi-annually
4.	Environmental Audit	Whole Project Area	Auditor's checklists & performs	Annually

9.14 MANAGEMENT PLANS

Various site-specific management plans will be prepared by Contractor as a part of EMMP for the better management and implementation of EMMP during all phases of the proposed Project. However, approval of these site-specific plans from WAPDA will be sought before start of construction activities. These site-specific plans are listed below but not limited to these:

- Tree Plantation / Reforestation Plan;
- Health, Safety and Environment (HSE) Management Plan;
- Emergency Preparedness and Response Plan;
- Site Restoration and Rehabilitation Plan;
- Waste Management Plan;
- Disaster Management Plan;
- Drinking Water Supply and Sanitation Plan
- Traffic Management Plan;
- Change Management Plan
- Quarry Management Plan; and
- Resource Conservation Plan.

9.14.1 Tree Plantation / Reforestation Plan

The basic purpose of reforestation/afforestation/plantation of suitable species in the project area is to reduce the risk been made due to cutting of trees for the proposed project and to enhance green cover and improve the overall environment of the area. Reforestation will not only reduce the risk been made but will also increase the carrying capacity of the area regarding many positive aspects.

Afforestation will be done in those areas in which there is low forest cover or in areas which have been clearly felled and leave barren. Afforestation is highly important to maintain the biodiversity and ecological balances. It is also important to prevent global warming, soil erosion and pollution. Afforestation purifies the environment and helps in reducing the carbon

dioxide level. Along with the importance of proposed Project to the local communities, the afforestation activity will further help in enhancing the socio-economic condition of the local communities. The spacing of the plantings will be wide enough to prevent competition for soil moisture, or when part of management, to accommodate machinery used for irrigation.

Based on the estimation, total cost of approximately 62,000 numbers of trees/plants will be 119.8 million PKR. The details are attached as **Annex-VII**.

9.14.2 HSE Management Plan

Health risks and work safety problems may result at the workplace if the working conditions provide unsafe and/or unfavorable working environment due to storage, handling and transport of hazardous construction material. Workers will be provided with safe and healthy working environment taking into account risks inherent to the particular sector and specific classes of hazards in Project Area. During construction phase, Contractor will be responsible for all HSE related issues and to comply with national laws and international standards for occupational health and safety. Guideline for contractor's Occupational Health and Safety Plan is attached as **Annex-VIII**. The ultimate goal of the plan is to eliminate any injury to human and damage to facilities, materials and the environment.

The following measures are identified for health, safety, and environment protection during all activities of the proposed Project to minimize risk of accidents, which could endanger the life of personnel, cause damage to properties and environment:

- All contractor staff shall be well informed and trained on the HSE policies and guidelines;
- Contractor shall provide adequate health services as well as site first aid services for its workforce;
- The main priority of the contractor shall be to prevent accidents during mobilization, construction phase of the proposed Project. Prevention of workplace accidents during the construction activities will be achieved using approved work plan/instructions by the supervisors;
- Work safety measures and good workmanship practices shall be followed by the contractor to ensure no health risks for workers;
- Provision of adequate sanitation, washing, cooking and dormitory facilities;
- Proper maintenance of facilities for workers shall be monitored;
- Provision of protective clothing for labour handling hazardous materials, e.g. helmet, adequate footwear for bituminous pavement works, protective goggles, etc. and contractor will ensure strict use of wearing these protective clothing during work activities;
- Elaboration of a contingency planning by the contractor at work site in case of major accidents shall be carried out. A comprehensive emergency preparedness and response plan will be developed and implemented at site;
- A site-specific fire-fighting plan also needs to be developed and implemented by Contractor during construction phase;

- Accidents shall be reported to and investigated by the Contractor. All personnel shall be encouraged to report all accidents/incidents and to cooperate in the investigation of such occurrence. A comprehensive accident/incident report will be produced for its review and necessary action;
- Adequate signage, lightning devices, barriers, and persons with flags during construction to manage traffic at haulage and access roads shall be conducted;
- The communicable disease of most concern during construction phase, like sexually-transmitted diseases such as HIV/AIDS, will be prevented by successful initiative typically involving health awareness, education initiatives, training heath workers in disease treatment, immunization program and providing health service;
- Trainings, awareness and campaigns will be conducted for workers and surrounding communities on awareness and prevention of COVID-19. Guidelines to combat with COVID-19 are attached as **Annex-IX**;
- Reducing the impacts of vector borne diseases on long-term health effect of workers will be accomplished through implementation of diverse interventions aimed at eliminating the factors that lead to disease;
- All construction activities shall be properly managed through careful planning and the applicable and relevant HSE policies; and
- Prior approval from proponent's environment team (E&ST) will be sought before starting any construction related activity.

9.14.3 Emergency Preparedness and Response Plan

Emergency Preparedness and Response Plan provides an overview of the procedures to mitigate and control the impacts on community, on occupational health and safety, on the environment and on the Project in the event of emergency situations and to respond in life threatening situations usually occurring suddenly and unexpectedly during the construction and operational phases of the proposed project. The contractor will be responsible for the preparation of plan and implemented at site after prior review and approval from the supervisory consultant and proponent. Guideline for contractor's EPRP is attached as **Annex-X.**

9.14.4 Restoration and Rehabilitation Plan

The implementation of the proposed Project would involve construction workers' camp for staff and labor, establishment of fences around construction site, over usage of access roads for movement of heavy machinery/motor vehicles linking to various components of project, offices, borrow/quarry areas, etc. During construction, these activities could also result in accumulation of large amount of unused or spoil material at various sites such as at access roads, muck dumping sites, quarry sites, colonies, offices, etc. which will change the existing land cover in the project area. After completion of the construction work, it is required to restore the disturbed area to its original conditions wherever it is possible that is the sole responsibility of the Contractor. Various engineering and biological measures have been suggested for the restoration of these areas:

- Top soil will be stored at designated areas before performing excavation activities at quarry sites (if these are agriculture land) and after the completion of all the

construction activities, quarry sites (if applicable) and construction sites will be covered with the top soil to support the growth of plant species;

- The area will be planted with indigenous vegetation that would require the initial establishment of fast growing grasses along with annuals and perennials, nitrogen fixing herbaceous legumes and non-legume shrubs to increase the soil conditioning and to stabilize the project site;
- Material stockpiles shall be removed as soon as the construction work will be completed;
- All the construction, toxic and hazardous chemicals/materials shall be completely removed from the site;
- All fencing and gates shall be removed and pits shall be backfilled;
- The reconstruction of interrupted drainage channels and pipes shall be carried out;
- Rehabilitation of affected roads will be carried out to avoid any inconvenience to the road commuters; and
- A clearance certificate from the proponent has to be taken by the Contractor in this regard.

Guideline Resource Conservation Plan is attached as **Annex-XI**.

9.14.5 Waste Management Plan

Management of solid and hazardous waste is one of the most important issues during construction phase of the Project. It is estimated that around 60 workers will be accommodated at construction camps (total of about 02 camp sites) during construction phase. As a general rule the water consumption will be about 40 liter/capita/day and will subsequently generate about 80% of this water as sewerage. Based on this water consumption, around 18,000 liter/day of water will be utilized for washing, cooking and bathing purposes at each camp site which will generate approximately 14,400 liter/day sewage at each the construction camp sites. In addition to that each construction camp site will generate about 202.5 kg/day of solid waste at site @ 0.45 kg/capita/day.

The major components of the workers' camp waste are garbage, putrescible waste, rubbish and small portion of ashes and residues, wastewater from camps toilets and washing yards, etc. The construction waste will include wastewater, oil spillage from machinery and solid waste (damaged or spoiled materials, temporary and expendable construction materials, etc.). Insecure and unhygienic disposal of the wastes may cause degradation of soil, land and water resources. However, a criterion has been developed for the solid and hazardous waste management at site. The criterion for plan is as follows:

- All the anticipated solid wastes will be collected through a properly designed solid waste management system. Enough number of containers will be placed inside the camps and within the construction area for the collection of various types of waste;
- These containers will help the component separation of various types of waste at source. Classification will be based on organic waste, recyclable waste, reusable waste (for resource and recovery) and waste for disposal site. Based on the

conditions of the region, organic waste will be frequently collected to avoid odor problems;

- Recyclable, reusable and waste for disposal site will be collected twice a week and on alternate days and will be transferred to a properly designed disposal site;
- The special strategy for safe handling, storage and use of hazardous substances/material will be developed and ensured at site;
- The sewage system for camps shall be properly designed (pit latrines or, as required, septic tanks) to receive all sanitary wastewaters;
- Lined wash areas shall be constructed within the camp site or at site, for the receipt of wash waters from construction machinery;
- Medical waste and construction waste will be handled with care;
- The pesticide use shall not be allowed at site for clearance;
- Construction waste i.e. waste concrete, bricks, cement, etc. will be disposed of at the designated areas; and
- Construction workers and supervisory staff will be encouraged and educated to practice waste minimization, reuse and recycling to reduce quantity of the waste for disposal.

Based on the above guidelines, Contractor(s) will be responsible for the preparation of Waste Management Plan before the commencement of construction activities and its implementation at site after the prior review and approval from SC and proponent. Guideline Waste Management Plan is attached as **Annex-XII**.

9.14.6 Disaster Management Plan

A disaster is a sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses that exceed the community ‘s or society ‘s ability to cope using its own resources. Disasters are of two types i.e., Natural and Manmade.

The flooding, earthquake, wind storms are the major disastrous phenomena in the region. The mountainous terrain makes the community as well as worker more vulnerable to disasters. The development of poor infrastructural measures, poses greater vulnerability risk in relation to the onset of potential disasters. In such cases, even a moderate disaster could bring devastating effects on communities.

The Provincial Disaster Management Authority (PDMA) of Government of Punjab are mandated for planning, implementing and coordinating all activities in case of the onset of a disaster. Therefore, there is a specific requirement for developing a plan that effectively responds to any Monsoon induced emergency. PDMA specialize in mitigation, preparedness and an organized response to a disaster. The most important role of PDMA lie in providing a platform to come together and strategize management and response to disasters and calamities.

9.14.7 Drinking Water Supply and Sanitation Plan

Separate water supply and sanitation provisions will be needed for the temporary facilities including offices, labour camps and workshops in order not to cause shortages and/or contamination. A Plan will be prepared by the Contractor on basis of the mitigation plans. The Plan will be submitted to the CSC for their review and approval before contractor mobilization. Guideline Sanitation Plan is attached as **Annex-XIII**.

9.14.8 Traffic Management Plan

A comprehensive Traffic Management Plan (TMP) will be developed by Contractor mentioning routes to be followed for transportation of construction machinery and materials e.g. cement, steel, gravels, sand, etc. A guideline accessibility map is shown in Chapter 3 of this EIA report. Traffic Management Plan will comprise following contents necessarily:

- Goals and objectives of plan;
- Purpose & Scope;
- Project specific traffic;
- Roles & responsibilities of contractors' environmental personnel;
- Routes to be followed along with necessary maps;
- Transportation timing; and
- Mechanism to address road accidents (if occurs).

Guideline for contractor's TMP is attached as **Annex-XIV.**

9.14.9 Change Management Plan

The present EIA has been carried out on the basis of the Project information available at this stage. It is however possible that the changes are made in some components of the Project during the design and construction phases. In order to address the environmental and social implications of these changes, a simple framework has been devised, which is described in this section. The change management framework recognizes the three broad categories (A, B & C) of the changes in the Project as detailed below:

Category 'A' Change: The 'Category A' change is one that will lead to a significant departure from the Project described in the EIA and consequently requires a reassessment of the environmental and socioeconomic impacts associated with the change. In such an instance, proponent will be required to conduct a fresh EIA of the changed aspect of the Project design and send the updated report to the relevant agencies for approval.

Category 'B' Change: The Category 'B' change is one that will entail Project activities not significantly different from those described in the EIA, which may result in the Project effects with overall magnitude to be similar to the assessment made in this report. In case of such changes, the EIA will be required to reassess the environmental and socio-economic impacts of the activity, specify additional mitigation measures, if necessary and report the changes to the relevant agencies (Contractors, PEPA).

Category 'C' Change: A Category 'C' change is one that is of little consequence to the EIA findings. This type of change does not result in effects beyond those already assessed in the EIA; rather it may be made onsite to minimize the impact of an activity, such as re-aligning a particular section to avoid cutting a tree, or relocating construction campsites to minimize

clearing vegetation. The only actions required for such changes are informing all the key personnel and document the change.

9.14.10 Reservoir Fisheries Management Plan

Presently, due to unfavorable environmental conditions, fishery activities in the project are nominal. However, after creation of a very large water body through construction of Murunj Dam, a tremendous boost could be provided to the fishery activities. To harness this potential, it will be necessary to develop a 'Reservoir Fisheries Management Plan'. Its two basic areas of focus will be: fish stocks management; and reservoir fishery management.

Major impact on fish stocks will occur after reservoir impounding with significantly changed hydrological conditions of Kaha. Particularly, the spawning areas in upstream and downstream of the dam will be changed with adverse impacts on fish stocks.

With the experience at Mangla, Chashma, Hub and Tarbela, WAPDA could develop Murunj Dam reservoir as a sizeable fishery resource. Fishery would also become a very relevant factor of employment, which presently is not the case. In addition, the fish would significantly improve food basis of this distant area of Pakistan, where the nutritional level for most of the population is very poor.

9.14.11 Chance Find Procedure

The purpose of these guidelines is to address the possibility of archaeological deposits, finds and features becoming exposed during earth removing and ground altering activities associated with the construction and to provide procedures to follow in the event of a chance archaeological find. The chance find procedure of archaeological deposits is attached as **Annex-XV**.

9.15 CODES OF PRACTICE

The Contractor will seek to develop codes of practice for its staff and employees in order to ensure that the intrusion of workers in the Project Area does not result in any social and environmental and social issues between the workers and locals which can harm the Project by causing unnecessary delays.

These codes will be based on the principles of environmental protection, occupational health and safety, good engineering practices, respect, integrity and sound ethical values. Each code will include, at minimum, the purpose and objectives, a policy statement from the in-charge explaining the importance of this code for the success of the Project, and examples of such conduct. Guidelines for the code of practices are discussed below.

9.15.1 General

General code of conduct will be developed for the Project and will include, at minimum, the following practices;

- Rules and guidelines will be given to the workers regarding the use of common resources such as wood, plants, water sources etc. to ensure their sustainable use.

- The code will also include provisions of the solid waste management plan to address solid waste collection and disposal in order to prevent unhygienic conditions and contamination of soil and water.
- The Contractor will be made arrangements to avoid accidental risks such as traffic signs board and speed control measures for the safety of locals.
- In construction camps, amenities of life including clean food, water and sanitation facilities must be provided to these camps, and the workers will be provided with guidelines on how to dispose of their waste and maintain a sense of hygiene.
- The training of workers in the construction safety procedures, equipping all construction workers with Personnel Protective Equipment (PPEs) i.e. safety boots, helmets, gloves, ear plugs, and protective masks also and monitoring their proper and sustained usage.
- Prior to blasting thorough inspection will be conducted and standard SOP will be developed and followed.
- Safety lookouts will be built to prevent people and vehicles from passing at the time of blasting.
- The Contractor will ensure that the construction labor is trained in safety procedures for all relevant aspects of construction.
- Formal emergency procedures will be developed for construction site in case of an accident. First Aid Kits and other necessary equipment will be kept available at site along with the list of emergency phone numbers at the construction site to be contacted in case of any accident.
- The safety of the public at all stages of the construction and operation will be ensured by appropriate public education and safety measures such as use of sign boards, barriers and flags and use of proper illumination at night.

9.15.2 Good Engineering Practices

Good engineering practices will be developed for the Project and will include, at minimum, the following practices;

- Standard Operating Procedures (SOP) for handling, storage and transportation of oil leakages, chemicals and other toxic materials will be strictly followed.
- Workers must be familiar with the Material Safety Data Sheets (MSDS) of each chemical used at site. MSDS are provided with each chemical drum. Chemicals will be stored as per their MSDS. Utmost care will be taken during the handling of these chemicals.
- Precautions will be taken to prevent spills and all workers will be trained in proper handling, storage and disposal of hazardous or toxic materials.
- Proper disposal plans of excavated material.

9.15.3 Cultural Norms

Cultural Code of Practice (CCP) will be developed for the Project and will include, at minimum, the following practices;

- Self-respect and sensitivity to insult is an important trait of the locals. The poorest among them has his own sense of dignity and honor and he vehemently refuses to submit to any insult. In fact, every local resident considers himself equal if not better than his fellow tribesmen and an insult is, therefore, taken as scurrilous reflection on his character. So the contractor will be careful to avoid any unceremonious interaction with the locals and inform their staff to be humble and polite.
- The Contractor will also take care of the norms of local community and their sensitivity towards local customs and traditions;
- The Contractor will brief the staff about local culture and norms;
- As per local culture wearing of pant shirt, half shirts, and short trouser are considered inappropriate attire, therefore the contractor inform the staff to avoid wearing short trousers and short shirt;
- Contractor will strictly warn the staff not to involve in any unethical activities and to obey the local norms and cultural restrictions particularly with reference to women;
- The Contractor will be required to maintain close liaison with the local elders and religious scholars of nearby local community to ensure that any potential conflicts related to common resource utilization for the Project are resolved easily;
- Privacy of women is a major cause of concern for the communities of the Project Area. Due to the Project activities local women may not be able to perform their daily outdoor chores. Women in the Project are participate in other outdoor activities such as livestock rearing, bringing of potable water, collection of fire wood etc. that may be affected by the Project activities;
- The Contractor will have to select the specific timings for the construction activities so as to cause least disturbance to the local population particularly women considering their peak movement hours; and
- The Contractor will warn the staff strictly not to indulge in any un-ethical activities and to obey the local norms and cultural restrictions particularly with reference to women.
- If privacy of the nearby households is to be affected, the Contractor will inform the house owner in advance to make some alternative arrangements. Similarly, the Contractor will have to take great care that the construction activities will not affect the privacy particularly with reference to women.

9.16 PUBLIC DISCLOSURE

WAPDA will disclose this EIA to all the stakeholders prior to the start of the construction. This report will be made available to the stakeholders at places as designated by the Punjab EPA. In addition, executive summary of the Report will be translated into Urdu language and made available to the affected communities and locals. The copies will also be kept at construction site for ease in accessibility of the locals. This will ensure the locals to be aware of the Project

impacts, its mitigation, responsible staff and mode of implementation. In addition, the executive summary will also be published on WAPDA website.

9.17 CONTRACTUAL OBLIGATIONS

In order to make contractors fully aware and responsible of the implementation of the EMMP and to ensure compliance, it is recommended that environmental and social management measures are included in the tender documentation. The various contractors must be made accountable to implement the plans and mitigation measures which pertain to them through contract documents and/or other agreements of the obligations and importance of the environmental and social components of the Project.

Payments to contractors would be linked to environmental performance, measured by completion of the prescribed environmental and social mitigation measures. Contractors would be trained how to join forces with the executing agency, Project management unit, supervising consultants and local population for the mitigation of adverse impacts of the Project. For effective implementation of the proposed mitigation and monitoring measures they would attract trained and experienced environmental management staff.

9.18 EMMP COST

The contractor will be responsible for implementation of mitigation measures and environmental Monitoring during construction phase, whereas WAPDA will be responsible for implementation of mitigation measures and environmental Monitoring during operation phase. For an effective implementation of environmental mitigation measures during construction and operational phase, it is very important to provide sufficient funds for the implementation of environmental and social mitigation measures, monitoring and training. The tentative cost of environmental and social mitigation measures, monitoring and training is about **287.65 Million PKR** excluding land acquisition and resettlement cost as given in the **Table 9.6**.

Table 9.6: Tentative Annual Environmental Monitoring and Management Cost

Sr. No.	Parameter	Mechanism	Frequency	Unit Rate (PKR)	Quantity	Cost (PKRs)	Remarks
A	**PRE- CONSTRUCTION PHASE**						
A-1	**Environmental Monitoring Cost**						
1	Water Resources/ Water Quality	Discrete grab sampling and laboratory testing of water samples by Punjab EPA approved Laboratory for monitoring.	Once	20,000	05	100,000	One-time monitoring shall be carried out before the mobilization of Contractor.
2	Drinking Water Quality	Discrete grab sampling and laboratory testing of water samples by EPA approved Laboratory for monitoring.	Once	20,000	05	100,000	
3	Noise Levels	dBA Leq. as per SEQS 2014	Once	2,000	05	10,000	
4	Ambient Air Monitoring	Monitoring of CO, CO_2, SOx, NO_x, HC and $PM_{2.5}$ PM_{10} by EPA approved Laboratory	Once	30,000	04	120,000	
	Sub-Total (A-1)					**330,000**	
A-2	**Compensation and Resettlement Cost**						
1	Land Acquisition and structure	Land cost to the owner, standing	Once based on market value	Lump sum tentative cost based on SIA and RAP		4,356,647,160	Acquisition and compensation cost shall be paid based on

Sr. No.	Parameter	Mechanism	Frequency	Unit Rate (PKR)	Quantity	Cost (PKRs)	Remarks
	compensation cost	crop, structure and tree compensation to affectee and tenant,					the actual loss measured as per final RAP prior construction stage by the Contractor and verified by PMU/PIU.
	Sub-Total (A-2)					**4,356,647,160**	
A-3	**Tree Plantation Cost**						
1	Tree Plantation Cost	The cost and maintenance of one hectare of afforestation and estimated including cost of layout, digging, planting, carriage and watch and ward and its maintenance for five years	Lump Sum Refer Section 9.14.1			119,784,000	The plantation cost is for the restoration of ecosystem and ensure the implementation of national legislations.
Sub-Total (A-3)						**119,784,000**	
Sub-Total A ((A-1)+(A-3))						**120,114,000**	**Excluding resettlement and compensation cost which is also incorporated in RAP**
B	**CONSTRUCTION PHASE**						
B-1	**Environmental Monitoring Cost**						
1	Water Resources/ Water Quality	Discrete grab sampling and laboratory testing of water samples by EPA approved	Quarterly	20,000	05x04	400,000	Quarterly monitoring cost for the one-year construction period and will be updated each year based on latest rates during construction

Sr. No.	Parameter	Mechanism	Frequency	Unit Rate (PKR)	Quantity	Cost (PKRs)	Remarks
		Laboratory for monitoring.					timeline of the proposed Project.
2	Drinking Water Quality	Discrete grab sampling and laboratory testing of water samples by EPA approved Laboratory for monitoring.	Once	20,000	05x04	400,000	
3	Noise Levels	dBA Leq. as per SEQS 2014	Quarterly	2,000	05x04	40,000	
4	Ambient Air Monitoring	Monitoring of CO, CO_2, SOx, NO_x, HC and $PM_{2.5}$ PM_{10} by EPA approved Laboratory	Quarterly	30,000	04x04	480,000	
Sub-Total (B-1)						**1,320,000**	
B-2	**Environmental and Social Management Cost**						
1	HSE	Environment Personnel will monitor / conduct all HSE related activities e.g. TBTs, PPEs, housekeeping, safety signage, emergency preparedness, etc.	Monthly	300,000		3,600,000	This is the tentative monthly cost for one-year period for one senior and two junior HSE experts along with their monthly logistics.
			Lump sum			2,000,000	Cost for PPEs, extinguishers, emergency lights, housekeeping equipment, safety signage and barricade, emergency preparedness kit, first aid kit, etc.

Sr. No.	Parameter	Mechanism	Frequency	Unit Rate (PKR)	Quantity	Cost (PKRs)	Remarks
2	Ecological and Biodiversity Monitoring & Management	Monitoring of disturbance of habitats through encroachment, noise and other construction activities.	Monthly	150,000		1,800,000	This is the tentative monthly cost for one-year period for one senior expert along with their monthly logistics.
3	Solid Waste Management	Collection, segregation, transportation, disposal and management of domestic, commercial, construction wastes	Monthly	150,000		1,800,000	This is the tentative monthly cost for one-year period for one senior expert along with their monthly logistics.
			Lump sum			1,000,000	Cost for Collection, segregation, transportation, disposal and management of domestic, commercial, construction wastes
4	Social Welfare and Development Cost	Based on the regular consultations with stakeholders including affectees and nearby community, through basic need assessment by the contractor and verified by PMU/PIU coordinating the district social welfare department.	Lump sum			3,000,000	Different social welfare and development Projects i.e. easy loans for affectees, rehabilitation of schools, roads, tracks, irrigation channels etc.

Sr. No.	Parameter	Mechanism	Frequency	Unit Rate (PKR)	Quantity	Cost (PKRs)	Remarks
5	Training Cost	Literature preparation, printed material such as posters & pamphlets trainer(s), and venue, etc.	Monthly	100,000		1,200,000	This is the tentative monthly cost for one-year period for one trainer along with logistics at site.
6	Audit	Auditor's checklists & proformas	Bi-annual	400,000		800,000	This is the tentative biannual cost for one-year period for at least two auditors along with logistics, travels and accommodation charges.
7	Communicable Diseases	Tests will be performed by approved laboratory	Biannually	600,000		1,200,000	This is the tentative cost for one-year period for medical tests of kitchen staff at each camp site.
Sub-Total (B-2)						**16,400,000**	
Sub-Total B ((B-1)+(B-2))						**17,720,000**	**Tentative for One (01) year construction period.**
Sub-Total B ((B-1)+(B-2))						**137,330,000**	**Tentative for 93 months (7.75 Years) year construction period. The cost shall be updated based on the current market prices during next years of construction phase.**

Sr. No.	Parameter	Mechanism	Frequency	Unit Rate (PKR)	Quantity	Cost (PKRs)	Remarks
C	**OPERATION & MAINTENANCE PHASE (One Year Cost)**						
C-1	**Environmental Monitoring Cost**						
1	Water Resources/ Water Quality	Discrete grab sampling and laboratory testing of water samples by EPA approved Laboratory for monitoring.	Biannually	20,000	04x02	160,000	Biannually monitoring cost for the one year O&M Phase and will be reproduced for next years of O&M based on updated rates.
2	Drinking Water Quality	Discrete grab sampling and laboratory testing of water samples by EPA approved Laboratory for monitoring.	Biannually	20,000	04x02	160,000	
3	Noise Levels	dBA Leq. as per SEQS 2014	Biannually	2,000	05x02	20,000	
4	Ambient Air Monitoring	Monitoring of CO, CO_2, SOx, NO_x, HC and $PM_{2.5}$ PM_{10} by EPA approved Laboratory	Biannually	30,000	02x02	120,000	
Sub-Total (C-1)						**460,000**	
C-2	**Environmental and Social Management Cost**						
1	HSE Activiti6es	WAPDA	Monthly	300,000		3,600,000	This is the tentative monthly cost for one-year period for one senior HSE staff along with his site visit cost and logistics arrangements.

Sr. No.	Parameter	Mechanism	Frequency	Unit Rate (PKR)	Quantity	Cost (PKRs)	Remarks
	Sub-Total (C-2)					**3,600,000**	
	Sub-Total C ((C-1)+(C-2))					**4,060,000**	**Tentative for one (01) year project O&M phase. The cost shall be reproduced for next years of O&M Phase and updated based on the current market prices during O&M phase.**
	Grand Total (A+B+C)					**261,504,000**	
	Contingency Charges		10% of Grand Total			**26,150,400**	
	Grand Total with Contingencies					**287,654,400**	**Excluding resettlement and compensation cost which is also incorporated in RAP**

10 CONCLUSION AND RECOMMENDATIONS

This chapter summarizes the conclusion drawn and provides recommendations based on these conclusions.

10.1 CONCLUSIONS

The Study Area affected by every flood due to the Kaha hill torrent and is one of the largest and most neglected and poverty stricken area of the district. The people of the gross command area of the Kaha hill torrent face the hardships of the floods and live a very hard life as many basic amenities of life are almost non-existent in the area. Construction of dam and provision water in the Study Area as per need would be a great relief for the people who are living under miserable conditions. The proposed Project will help to provide protection to the valuable infrastructures, agricultural lands and other properties from the ferocious hill torrent. Moreover, it will save Rajanpur, Fazilpur and Jampur cities and many adjoining settlements from floods. Moreover, the local labour will be hired during implementation of the proposed Project. This will go a long way to ensure security and prosperity in the area. Furthermore, no private land acquisition is involved in the sub-project. Displacement of informal and formal settlers, structures of residential, religious, community and loss of income sources will not be impacted, as there are no settlements in the area proposed water reservoir and near the Dam site.

In general, the areas traversed by the Project are poorly vegetated and are ecologically very poor in terms of presence of flora and fauna, due to the very arid and rocky nature of the terrain. There are no indigenous species of conservation importance. The flora and fauna in the area have already adjusted/ accommodated to the presence of track and adjacent areas. Consequently, the project works and operations will have small impacts on the Flora & Fauna of the area, if any.

In view of the socio-economic aspects of the proposed project area, the sub-project area is one of the most neglected and poverty stricken area of the District. The people of the command area of the Kaha Hill Torrent face the hardships of the floods and live a very hard life as many basic amenities of life are almost non-existent in the area. Construction of Dam and provision water in the project area as per need would be a great relief for the people who are living under miserable conditions. The sub-project will help to provide protection to the valuable infrastructures, agricultural lands and other properties from the ferocious Hill Torrent. It will save Rajanpur, Fazilpur and Jampur cities and many adjoining settlements from floods. Moreover, the local labour will be hired during implementation of the sub-project. This will go a long way to ensure security and prosperity in the area.

No private land acquisition is involved in the sub-project. Displacement of informal and formal settlers, structures of residential, religious, community and loss of income sources will not be impacted, as there are no settlements in the area proposed water reservoir and near the Dam site.

As a conclusion of the study, the proposed Murunj Dam will not cause potentially significant environmental and social adverse impacts on the local environment after the implementation of mitigation measures. Considering flood damages in the Pachad area and need of water management in the country it is suggested that the proposed Project will be implemented with its true spirit.

10.2 RECOMMENDATIONS

Following recommendations will be implemented during respective phases of the proposed Project:

- The proposed project will have both positive and negative impacts during the construction and operational phases, for which proper mitigation measures are necessary and proposed in the report. Proposed project may contaminate surface or drinking water to make them unfit for irrigation or drinking; or pollute the ambient air in dust and fugitive emissions;
- Construction activities may also contaminate soil due to the discarded construction materials and obstruction in natural drainage due to un-attended excavated material. Generation of solid waste will be an important soil contaminating source and may yield temporary adverse impact but its mitigation will be possible through implementation of waste management plan recommended in EMMP. Furthermore, oil spills and other lubrication materials may also contaminate soil which requires to be mitigated as per recommendations provided in report;
- Similarly, impact on water and air resources will also be of temporary nature during construction period. The water requirements for the project can be divided into two main uses i.e. water required for labor camp utilization and for construction purposes. If the generated sewage is not properly treated or disposed of this may contaminate the surface water and may affect the groundwater resources apart from soil contamination. It is recommended that wastewater effluent from contractors' camp will be treated at least primary level;
- Machinery in operation and other equipment's may yield temporary adverse impacts on the air resources. Most of these use diesel engines that generate noise and exhaust emissions. Generally, they will generate $PM_{2.5}$, PM_{10}, smoke, dust, CO and NO_x in the ambient air, which will deteriorate the air quality and resulting in temporary adverse impacts on the human health, fauna and flora. Similarly, fugitive dust due to the construction activities may also affect the local air quality. Good engineering, however, along with complying with EMMP and HSE plan will help to solve number of problems as mentioned here;
- A total of 62,000 trees will be raised in surrounding areas in lieu of 6,183 trees, which are liable to be removed during the construction of the propose Project. Thus, the number of plants to be raised is 10 times of plants to be removed. These all activates must be assigned, planned and implemented by Forest Department for successful plantation results and implementations on time. During the operation phase, there will be positive impact on the flora due to the extensive plantation;
- Impact on the fauna will be of minor and of temporary nature, and the project is not expected to have any significant adverse impact on them. With the improved flora of the track, due to extensive plantation, general fauna and especially the avifauna will be attracted to the area;
- As sedimentation is envisaged as an adverse impact during operation and maintenance phase of the proposed Project which emphasis on better watershed management & proper treatment of the catchment area/watershed is important;

- During operation and maintenance phase, some water rights issues may arise in Pachad area (lower riparian) which needs to be addressed amicably as per mitigations provided in the report;
- The proposed Project is an environmentally green project and will promote and strengthen the environmental profile of the area instead of any serious damage subject to EMMP implementation therefore, EMMP needs to be implemented with letter and spirit along with mentioned roles and responsibilities and mitigation measures;
- Need to consult with the locals and religious scholars to protect the graves situated near dam axis;
- Conducting the meaningful consultation with all the stakeholders including the local population on regular basis;
- A grievance redress mechanism (GRM) for the Project shall be established by PIU/PMU as part of the overall project management system in order to address community concerns and complaints. Through this mechanism, queries, problems, and complaints about the social and environmental will be answered, resolved effectively, and addressed expeditiously;
- Job will be provided to local people on priority basis and clause must be added, so that the contractor will be legally bound to provide the job to local people;
- With the construction of the Dam proper canal system will be developed;
- For the utilization of stored water efficient mechanism will be developed that all the farmers will be benefitted;
- Lined watercourse will be constructed and water saving practices will be introduced;
- Like other parts of the Punjab institutional reform (Farmers Organizations) will be introduced;
- Small water reservoirs in the command area will be constructed in addition to the Dam.
- Drinking water facilities will be added in the scope of work of the proposed project;
- There will not be any population dislocation issue connected with the proposed Project due to absence of settlements in the proposed reservoir, hence no resettlement, no damage to physical infrastructure and no compensation thereof; and
- There may be some temporary adverse impacts of the presence of labor camp or project colony near the settlements in terms of the chances of fatal accidents and undesirable social mixing. Both of these impacts can be mitigated through safe traffic management plan and strict application of rules and regulations by the contractor.

ANNEXES

Feasibility Study, Detailed Design, Tender Documents and PC-1 for Murunj Dam, District Rajanpur

ENVIRONMENTAL IMPACT ASSESSMENT (EIA) REPORT (Volume 02 of 02)

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ANNEX-I

ToRs of the Proposed Project

PAKISTAN
WATER AND POWER DEVELOPMENT AUTHORITY

MURUNJ DAM PROJECT

REQUEST FOR PROPOSALS

FOR

PROCUREMENT OF CONSULTANCY SERVICES FOR
FEASIBILITY STUDY, DETAILED ENGINEERING DESIGN,
PREPARATION OF TENDER DOCUMENTS AND PC-I

GENERAL MANAGER (HYDRO PLANNING)
WAPDA, SUNNY VIEW ESTATE, LAHORE.

July 2018

Section 7. Terms of Reference

1 Introduction

1.1 The proposed dam site is located 116 km west of Rajanpur, Punjab. Nearest village is Maari which is about 15 km from dam site. A metalled road link exists between D.G. Khan to Rajanpur and further up to Maari village. Dam site co-ordinates are 29° 33' 36.86" N and 69° 48' 29.90" E. Location Map attached as **FIGURE – 1**.

1.2 Murunj Dam Project is planned to store flows of Kaha nullah by the construction of 107 m high dam. The stored water will be released to meet the irrigation water requirements of the downstream cultivable area and the power generation will be a by-product. The Project Layout Plan is shown in **FIGURE – 2**.

1.3 The catchment area at proposed dam site is 5,060 km^2, out of which 850 km^2 lies in Punjab and 4,210 km^2 in Baluchistan. The catchment area is shown in **FIGURE – 3.** Average annual rainfall in project site and within watershed varies from 125 - 375 mm. Average annual inflow estimated at dam site is about 226 Mm^3.

2 Mode of Implementation / Organization of Study

2.1 To conduct the overall study and other related multi-disciplinary activities, WAPDA will engage consultants.

2.2 Consultants will review the previous studies data/ investigations including Detailed Engineering Design prepared with limited field investigations and propose additionally required data for survey and investigations. Based on the overall data, available studies, surveys and investigations, the Consultants will complete their assigned task as detailed in scope of work of proposed study.

2.3 General Manager (Hydro Planning), WAPDA will be the overall In-charge of the study envisaged over a period of twenty-four (24) months. Implementation Schedule of the Project is shown in **FIGURE – 4**.

2.4 In conducting the studies, Chief Engineer-II (Hydro Planning), WAPDA will provide to the Consultants, the available documentation / data / studies / reports / surveys, assistance in collecting additional data / reports for field investigations and studies. Cost of Survey and Investigation will be borne by WAPDA.

2.5 WAPDA will periodically review and advise on specific issues / activities of the Consultants. WAPDA will review the drafts of various reports / memoranda of consultants before finalization.

a. Consultants will carry out additional data collection and studies. However, additional surface / sub-surface geological investigations and topographic surveys, required to complete the assignment will be advised by the Consultants and carried out Hydro Planning Organization, WAPDA under the consultant's technical supervision. The Consultants shall provide appropriate schedule for timely completion of investigations. In house capabilities of WAPDA formations will be utilized to the maximum for such surveys and investigations.

b. The Consultants shall make their own arrangements for office and residential accommodation in connection with the assignment including furnishing as per consultancy cost estimates as reimbursable items.

c. The Consultants shall make their own arrangement for transport on rental / purchase basis and provision will be made available under reimbursable cost items in consultancy services agreement.

d. For conducting digitized topographic survey, the Consultants shall suggest necessary arrangements and will provide all assistance for digitization of topographic maps. The cost of digitization shall be borne by the Client.

e. In case of any deficiency, the Consultants will advise to WAPDA for necessary additional arrangements.

f. Monthly progress review meetings will be held in which consultant's sectional head will present progress, constraints and bottlenecks in the way of the working.

g. Periodic presentation will be made by the Consultants as and when desired by WAPDA for briefing, decision making and reviewing progress etc. as instructed by WAPDA.

3 Background Information

3.1 Brief note on Hill Torrents of Dera Ghazi Khan (1978)

In 1978 WAPDA prepared a report titled "Brief note on Hill Torrents of Dera Ghazi Khan". The objectives of the study were:

- Intensive hydrological monitoring of the hill torrents;
- Identification of projects, on the basis of available data;
- Prioritization of identified projects for implementation;
- Determination of feasibility of high priority projects; and
- Establishment of socio-economic worth and the subsequent selection of projects for detailed engineering design and construction.

3.2 Flood management of D.G. Khan hill torrents (1984)

Federal Flood Commission, MoW&P conducted a Flood Management of D.G. Khan Hill Torrents studies with the objective to reduce situations threatening the life and health of people, economic losses, loss of public revenues and overall alleviation of problem by fostering a unified programme of structural and non-structural measures. The strategy adopted in flood management proposals was to utilize maximum quantum of flow right in the area where it is generated for benefit of people, whose development is constrained by water.

3.3 Master feasibility studies for flood management of hill torrents of Pakistan (1998)

Federal Flood Commission, MoW&P carried out Feasibility Study with the objective to provide a basic framework for integrated development of land and water resources of hill torrents of Pakistan including D.G. Khan Hill Torrents.

3.4 Salient Features of Proposed Murunj Dam Project

Salient features of Murunj Dam Project are listed in the following table. These features will be firmed up / modified / optimized during the proposed study:

Sr. No.	PARAMETER	S.I	F.P.S
A	**Main Dam**		
1.	Type	Earth Core Rockfill Dam	
2.	Height	107 m	351 ft
3.	Valley Section Width	61 m	200 ft
4.	River Bed Level	El. 564 m AMSL	El. 1,850 ft AMSL
5.	Normal Conservation Level	El. 670.7 m AMSL	El. 2,200 ft AMSL
6.	Free Board	3.05 m	10 ft
B	**Hydrology**		
1.	Catchment Area • Balochistan • Punjab	5,060 sq. km 4,210 sq. km 850 sq. km	1,953.20 sq. miles 1,625.10 sq. miles 328.10 sq. miles
2.	Average Annual Rainfall	125 - 375 mm	4.92 – 14.75 inches
3.	Average Annual Inflow	226 Mm^3	0.183 MAF
4.	Sediment Inflow	3 - 19 % of discharge	
5.	Reservoir Area	4,500 hectares	11,120 acres
6.	Reservoir Length	25 km	15.53 miles
7.	Gross Storage Capacity	989 Mm^3	0.80 MAF
8.	Live Storage Capacity	741 Mm^3	0.60 MAF
9.	Dead Storage Capacity	248 Mm^3	0.20 MAF
10.	Historical Max. Flood (1978)	3,318 cumecs	118,500 cusecs
C	**Command Area Development**		
1.	Gross Command Area (GCA)	48,600 hectares	120,000 acres
D	**Hydropower**		
1.	Installed Capacity	12 MW	
2.	Annual Energy	80 GWh	
3.	Plant Factor	0.76	

4 Objectives and Standards of the Consultancy Services

4.1 The objective of the consultancy services is to review the previous studies, prepare feasibility report, project planning report, detailed engineering design, tender drawings / documents and PC-I Proforma etc. of the Project.

4.2 The consultancy services will be of such a quality as to allow WAPDA and Government of Pakistan for implementation of the Project.

4.3 Overall level of study and the degree of details on each aspect shall be sufficient to meet acceptability criteria of international donors that can be approached for funding of the Project for construction.

5 Scope of Work of Proposed Studies

The assignment will be accomplished in four tasks as given below;

TASK-I	Inception Report	(03 Months)
TASK-II	Mid-Term Report	(12 Months)
TASK-III	Feasibility Study Report	(18 Months)
TASK-IV	Project Planning Report, Detailed Engineering Design Report, Tender Drawings / Documents and PC-I	(24 Months)

5.1 Task-I: Inception Report (03 months):

Task-I will cover review of all existing surveys / field investigations, reports / available from WAPDA. Based on the findings of the review, the **Inception Report** will be prepared discussing alternative project layouts, storage capacity, area to be irrigated / benefited, water availability / requirement, power potential, seismotectonic study including infrastructure for implementation and operation of Murunj Dam Project. The report will also include: identification of data gaps and suggestion of additional requirements of data collection and field investigations, Consultant's approach and methodology, general design policy of the consultant, detailed work plan, required hydraulic and hydro-mechanical structures, hydrological/sedimentation studies, soil studies and aspects, identification of construction materials and their source, transport and access to the project and financial & economical analysis, social and environmental impact assessment, staffing status, detailed work program for the study and any other findings / recommendations for review and concurrence by the Client, giving particular attention to water and power benefits in terms of irrigation, agriculture, hydropower potential and fisheries development.

5.2 Task-II: Mid-Term Report (12 months):

Task-II will cover the progress made up to twelve (12) months study with conclusions and recommendations for further studies.

5.3 Task-III: Feasibility Study Report (18 months):

The following services to be performed under Task-I and Task-II shall be covered under the Feasibility Report.

a. In order to support the conclusions under Task-I, field surveys / investigations will be conducted under the supervision of the consultants. Optimization study of each alternative considered will be carried out.

b. Project layout, for the different locations of embankments / structures, intake & outfall structures and link channel shall be developed to the degree of detail necessary to provide a fair comparison between the alternatives considered.

c. Review of available data and produce comprehensive studies, which may comprise but not limited to the following:
   - Geology and Geotechnical Studies
   - Surveying & Mapping
   - Hydrology & Sedimentation along with Flood Studies
   - Project Layout Plan and optimization of Project components / features
   - Design of Dam and Appurtenant Structures
   - Dam instrumentation

- Soil and Agriculture Studies
- Development of Irrigation System and Associated Structures considering high efficiency irrigation system such as drip irrigation & lining of irrigation channels.
- Borrow Areas/Quarries
- Hydropower Development Studies including Power Evacuation Plan
- Socio-Economic Studies
- Environmental and Resettlement Studies
- Construction Materials
- Construction Planning and Contract Packaging
- Financial and Economic Analysis

d. Seismic risk evaluation to determine seismic design parameters for various project components. Disaster Risk during the Project implementation will be evaluated and mitigation measures be proposed.

e. The population resettlement and the environmental aspects of the project shall be reassessed at this stage of the study and quantified. The costs and benefits of resettlement and environmental aspects shall be taken into consideration in assessing the economic and financial viability of the project. For the economic feasibility study, all costs and benefits shall be valued in economic terms, while for the financial feasibility study, shall be expressed in financial terms.

f. The Consultants shall present their conclusions and recommendations to the above affects, in the shape of **Feasibility Report**, for review and concurrence by the Client.

Guidelines

a. The Consultants shall proceed with the work, to determine and firm up the technical, economic and financial feasibility of the selected layout of the Project.

b. Activities to follow this will include:

i. Preparation of project layout covering all the components of the Project including the layout of infrastructure facilities required for implementation and operation stage of the project.

ii. Preparation of feasibility level designs of all structures for the selected alternative, and the components of the project; layout of each major structure; and sufficient cross-sections to establish the magnitude and characteristics of the work and their construction costs, excluding infrastructure facilities

iii. For purpose of estimating project cost, all unit prices for major quantities of work shall be established by the latest methods. These methods will simulate each construction activity in such a way as to fit it into the available time span in the proposed construction schedule. Construction equipment, crews, materials and other resources would be adjusted to accomplish the work within the required time-span. The

computations of unit prices shall be supported by detailed sets of financial prices with source.

iv. Indirect cost of construction for all major items into which the construction work is subdivided for cost estimating purposes, should be established separately. Total cost of each construction item shall then be obtained by multiplying the direct cost of construction, by a bid factor representing the influence of indirect costs.

v. Preparation of cost estimates of the project broken down into local and foreign components. These shall include:
   - Reasonable breakdown by major items like of: electro-mechanical mechanical and civil works of the dam and spillway, tunnels and link canal, intake & outfall structures, and irrigation network. Price for major civil works and permanent equipment shall be estimated on the basis of ICB.
   - Environmental Impact Assessment and Resettlement Action Plan with cost estimation.
   - Project engineering and management expenses, the owner's overhead expenses, and an adequate allowance for physical contingencies.
   - Import duties, taxes and interest during construction (to be assessed separately and not be included in the base cost estimates).

vi. Price escalation provisions shall be computed on the basis of the construction schedule for local and foreign currency components on the criteria followed by the Planning Commission, Government of Pakistan. These price escalation provisions shall not be included in the economic cost estimates and shall be used only for financial forecast and financial requirement purposes.

vii. Preparation of a construction schedule using CPM analysis and schedules for annual construction expenditures, both for local and foreign currency components, throughout the construction period, as well as a schedule of annual expenditures for the Environmental Impact Assessment/ Resettlement Action Plan and other items which generally extend beyond the project commissioning.

viii. For the purpose of economic analysis, agricultural benefits of the project shall be based on realistic assumptions as to their value and on alternative scenarios for use of storage water in the existing or new irrigated areas.

ix. The financial analysis will cover the envisaged irrigation benefits available from the Project including fisheries development and others if any.

b. The Consultants will submit a Draft Feasibility Reports to be discussed in WAPDA for their views / comments. After clearance, the final Feasibility Report will be issued.

5.4 Task-IV: Project Planning Report, Detailed Engineering Design, Tender Documents & PC-I Proforma (24 months)

a. Preparation of engineering designs of all structures of the finally selected alternative including the components of the Project as at Part-III above. Environmental Impact Assessment and Resettlement Action Plan will also be prepared under Task – IV.

b. Project Planning Report may comprise but not limited to the following engineering studies:
   - Project Planning Concept
   - Project Constraints & their Mitigation
   - Project Area Geology & Hydrogeology
   - Existing Infrastructure of the Project Area
   - Pre-Construction Activities
   - Sources of Material, Labor & Equipment
   - Sedimentation & its Treatment
   - Activities regarding construction planning phase incorporating important aspects such as project logistics and supply chain management.

c. Preparation of tender drawings with sufficient details in respect of the above for international competitive bidding.

d. Preparation of tender documents in line with FIDIC, WAPDA guidelines and standard practice for donor funded projects. The tender documents shall cover the civil / electro-mechanical works of the project and its components.

e. Based on the Project Planning Report, Detailed Engineering Design, Tender Documents a PC-I Proforma will be framed as per the guidelines of Planning Commission of Pakistan.

f. The consultants will submit a Draft Project Planning Report, Detailed Engineering Design, EIA & RAP Reports, Tender Documents and PC-I Proforma to be discussed in WAPDA for their views / comments. After clearance, the final Reports will be issued.

5.4.1 Design Standards

The following design codes and standards will be followed:

• For Materials testing	ASTM
• For Structures	AASHTO, ACI & AISC, Conferences on RCC Dam
• For Seismic design	AASHTO code/ Pakistan Building Code, with latest seismic zoning map for Pakistan, ICOLD guidelines.

5.4.2 Additional Investigations

Additional geotechnical investigations may be required at the proposed site for detailed design. These investigations may include drilling, geophysical surveys, seismo-tectonic studies, field and laboratory tests.

Drilling: Additional drilling may be required at the dam site and structure area. It is envisaged that in this drilling program special attention will be paid to the dam foundations and abutments, spillway, powerhouse, tunnels and other

structure locations. Additional geotechnical investigations may also be required for main canal, distributaries and minors, cross-drainage structures, roads and utility crossings to be provided on the irrigation water distribution system. The type, depth and location of drilling will be provided by the Consultants.

Field Tests: Field tests may be carried out to determine the in-situ properties of rocks and soils. These may include pump out tests, direct shear tests in adits (if required). Suitable techniques will also be employed to determine the in-situ state of stress in the rock mass.

5.4.2.1 Water and Power Benefits

Because of the importance of irrigated agriculture for the Project area, the Consultants shall consider that storage reservoir to operate by optimizing the supply of water for irrigation and by-product power generation. The Consultants shall review the previous studies. This review will take into consideration any new aspect developed during the design stage of the studies.

Rating of generating units shall be examined to confirm the size selected in desk studies stage. In particular, system operational aspects should be analysed as well as constructional considerations. WAPDA shall decide on the final arrangement of project structures to be designed on proposal of consultants.

5.4.2.2 Optimization of Project Layout

The Project layout in the previous reports includes the following important structures:

- Earth Core Rockfill Dam
- River Diversion and Outlets
- Spillway and Stilling Basin
- Water Ways and Power House
- Transmission System
- Irrigation network for Irrigated Agriculture Development

The Consultants will review and optimize the Project layout given in previous reports. The review shall take into consideration how the overall quantum of work and cost of the Project can be reduced. To confirm the hydraulic aspects of project layout, the consultant shall propose appropriate hydraulic model studies to be carried at Irrigation Research Institute (IRI), Nandipur.

5.4.2.3 Detailed Design of the Main Components

On the basis of available information and additional field investigations, the Project arrangement and the optimized irrigation and energy parameters, and the hydraulic, geotechnical, structural, mechanical and electrical design criteria normally used for this type of work, the Consultants shall design various project components i.e. dam/ weir, reservoir rim, spillway alongwith energy dissipating structures & stilling basin, power house, power intake, forebay, trashracks, gates penstock, draft tube, relieve valves, irrigation system etc. The

design produced shall be adequate for preparation of drawings and specifications for bid documents including BOQ.

a) Main Dam

The Consultants shall design the dam and shall define its principal elements, including zoning mechanism of dam body, foundation treatment, grout curtain, drainage, instrumentation, construction method, construction planning etc. Structural integrity of the proposed dam shall be confirmed for the worst combination of loads.

b) Spillway and Stilling Basin

The Consultants shall design the spillway and its related energy dissipation system for design flood.

The Consultants shall carry out the detailed hydraulic and structural design of the spillway and energy dissipation system.

The Consultants shall carry out the detailed design study about the size of gates to be used for spillway and their operational problems. They shall design the gates and their operation system.

c) Reservoir Rim

Project reservoir will stretch the river valley. It is imperative that its stability be checked for the condition of full reservoir & rapid draw down & for any seepage potential. This will include checking the stability of both the rock slopes & the slopes in unconsolidated deposits in the upper reaches of the reservoir and proposing the protection/ remedial works for slope stability. The seepage potential & any other hazards posed by the rim slopes, if any, should be delineated & their effect included in the design. Areas with insufficient cover and inadequate seepage path length need to be carefully checked and remedial measures shall be designed as required.

d) Irrigation System

The Consultants shall review the proposed water conveyance, propose any modification and carry out detailed design of proposed water conveyance system i.e. main canals, distributaries, minors, ancillary structures, canal lining and their types as per site conditions etc. compatible with conventional and high efficiency irrigation system including detailed hydraulic and structural design of its intake and water conveyance system. However, the command area will be developed by the provincial irrigation and agriculture departments, technical assistance for which will be provided by the Pakistan Agriculture Research Council (PARC). The command area development, therefore, is not included in the scope of work.

e) Power House

The Consultants shall prepare design of the powerhouse, electrical & mechanical equipment set-up. The final design shall be prepared by consultation with leading suppliers to ascertain the current practices & trends in the design of hydropower generating units.

f) Coffer Dams and River Diversion

i. Coffer Dams

The Consultants shall design the coffer dams, if required. Special attention shall be paid to the foundation treatment i.e. cutoff design. The safety of the coffer dams will be checked for the various combinations of load, as per international design practices. The construction method & construction planning of these will also be deliberated upon.

ii. River / Nullah Diversion

The Consultants shall perform the hydraulic and structural designs of the river / nullah diversion structures and other outlets, as well as the closure elements needed to control the reservoir level. The Consultants shall analyze the risks involved for each configuration and river flood frequency.

g) Quality Control, Quality Assurance Organization and Manual

h) Temporary Access Roads

i) Contractor Camp, Workshop Facilities, Material Storage, Batching Pant, Power Facilities etc.

j) Project Accommodation

The Consultants shall design the temporary project accommodation to house the personnel that will be employed in the construction of the Project. The design shall cover all necessary facilities & amenities required during the implementation phase of the Project, including water supply, sewerage disposal, power supply, garbage disposal, street lighting, hospital, office buildings & other support facilities. In addition, the Consultants shall design the permanent project colony for the operating personnel with due attention to the climate conditions at the Project site.

5.4.2.4 Environmental Impact Assessment Study

The Consultants shall carry out Environmental Impact Assessment, Environmental & Social Management Plan, Resettlement Action Plan, Land Acquisition Plan, but not limited to only these studies, at design stage and obtain its clearance from concerned Environmental Protection Agency. The physical conditions of the Project area will be firmed up during the detailed engineering design stage. The aspects of EIA activities but not limited to the following will be considered:

- Aquatic life study
- Fauna and Flora
- Water quality study and effects on downstream river channel
- Cadastral survey of the Project affected area
- Institutional framework development for Resettlement Action Plan including development of compensation package based on cadastral survey and community consultation
- Women emancipation
- Minimum river flows required to maintain ecology of the area

- Evaluation of risks at construction phase measures for disaster risk reduction. Dam Break Analysis and impact of landslides in the reservoir will be assessed.
- Total cost estimate covering mitigation action, compensation and resettlement cost

The Consultants will advise WAPDA and WAPDA will implement Resettlement Action Plan (RAP).

5.4.2.5 Costs Estimate, Disbursements Schedule, & Construction Planning

a) The Consultants shall prepare a detailed project costs estimate. Pay items shall be grouped by contracts & shall be broken down into local & foreign cost components. Resources costs shall be thoroughly reviewed & checked against costs for similar type of works or supplies.

b) Construction & installation program for each contract shall be developed on the basis of a detailed simulation study of all activities involved & of the construction techniques planned. These programs shall take into consideration interference from other construction or erection activities, access availability, materials, balances, normal construction efficiencies, meteorology & river regime.

c) Construction & installation program developed for each contract shall then be integrated into a general CPM grid, which shall incorporate all contracting activities, supplies, civil works & equipment erection in such a way as to maintain an appropriate order of precedence. The program should count for the regional seismicity and security situation of the area.

d) The Consultants shall work out the most appropriate construction facilities arrangement, including material flow analysis & shall design the necessary access roads.

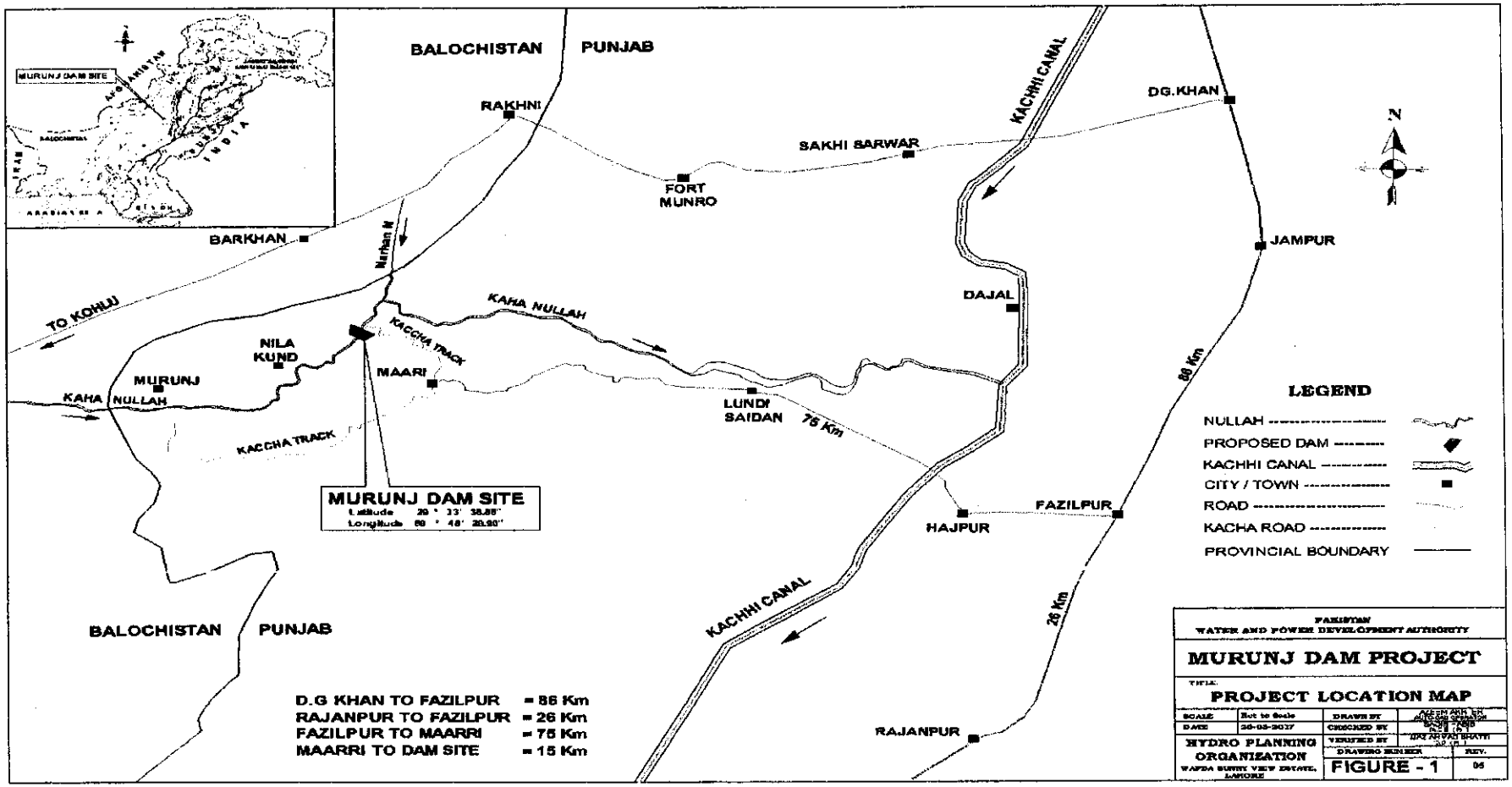
e) The Consultants shall prepare PC-I Proforma for implementation of the Project.

5.4.2.6 Tender Documents

Specifications of the components of the Project will be prepared including civil works, electrical and mechanical equipment. After the detailed engineering design & preparation of specification of works, the tender documents shall be undertaken by the Consultants at the level of International Competitive Bidding (ICB) based on engineer's estimate. The contract packages for bidding purposes shall be agreed beforehand between WAPDA and the Consultants. The works can be grouped in suitable number of packages. For all these packages the following will be prepared:

- General Conditions of Contract
- Particular Conditions of Contract
- Technical Specification
- Special Provisions
- Bill of Quantities

9.2 All submissions including software's purchased with funds provided by the client along with Compact Discs (CDs)/ DVDs for future reproduction on the same format on which reports/ maps etc. are prepared (05 sets) including in editable formats without password protection like MS Word, MS Excel (editable formulae) etc. The data of field investigation (raw and formatted data) acquired during the assignment should also be submitted in the format instructed by the Client.


MURUNJ DAM SITE
BALOCHISTAN
PUNJAB
RAKHNI
FORT MUNRO
SAKHI SARWAR
KACHHI CANAL
D.G.KHAN
JAMPUR
DAJAL
BARKHAN
Nafhan N
TO KOHUJ
KAHA NULLAH
KACCHA TRACK
NILA KUND
MURUNJ
KAHA NULLAH
MAARI
LUNDI SAIDAN
75 Km
KACCHA TRACK
MURUNJ DAM SITE
Latitude 29 ° 13' 38.88"
Longitude 69 ° 48' 20.30"
HAJPUR
FAZILPUR
88 Km
26 Km
KACHHI CANAL
RAJANPUR
BALOCHISTAN
PUNJAB
D.G KHAN TO FAZILPUR = 88 Km
RAJANPUR TO FAZILPUR = 26 Km
FAZILPUR TO MAARRI = 75 Km
MAARRI TO DAM SITE = 15 Km
N
LEGEND
NULLAH
PROPOSED DAM
KACHHI CANAL
CITY / TOWN
ROAD
KACHA ROAD
PROVINCIAL BOUNDARY
PAKISTAN
WATER AND POWER DEVELOPMENT AUTHORITY
MURUNJ DAM PROJECT
PROJECT LOCATION MAP
SCALE: Not to Scale
DATE: 30-05-2017
DRAWN BY
CHECKED BY
VERIFIED BY
DRAWING NUMBER
HYDRO PLANNING ORGANIZATION
WAPDA SURVEY VIEW ESTATE, LAHORE
FIGURE - 1
REV. 04

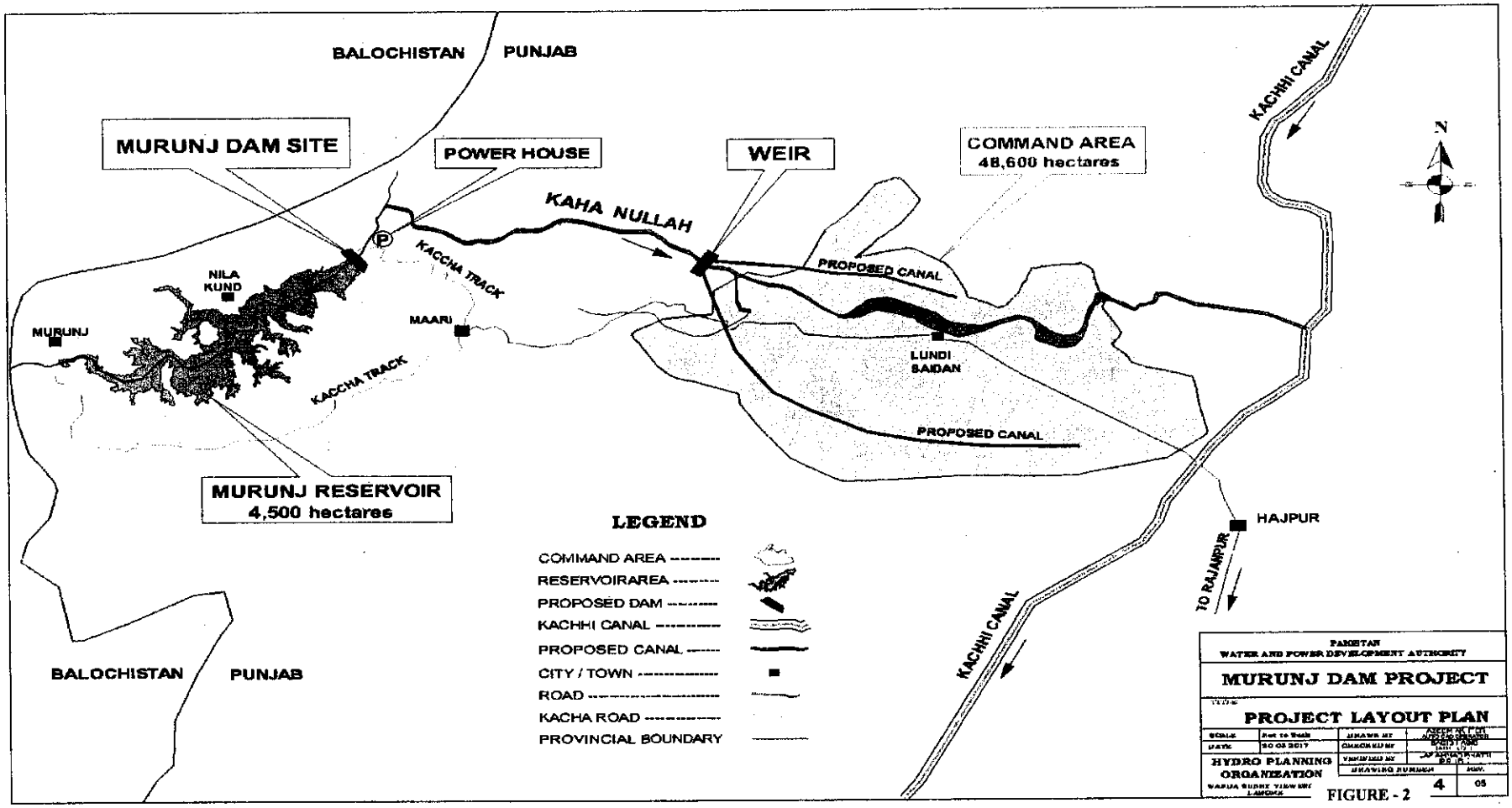
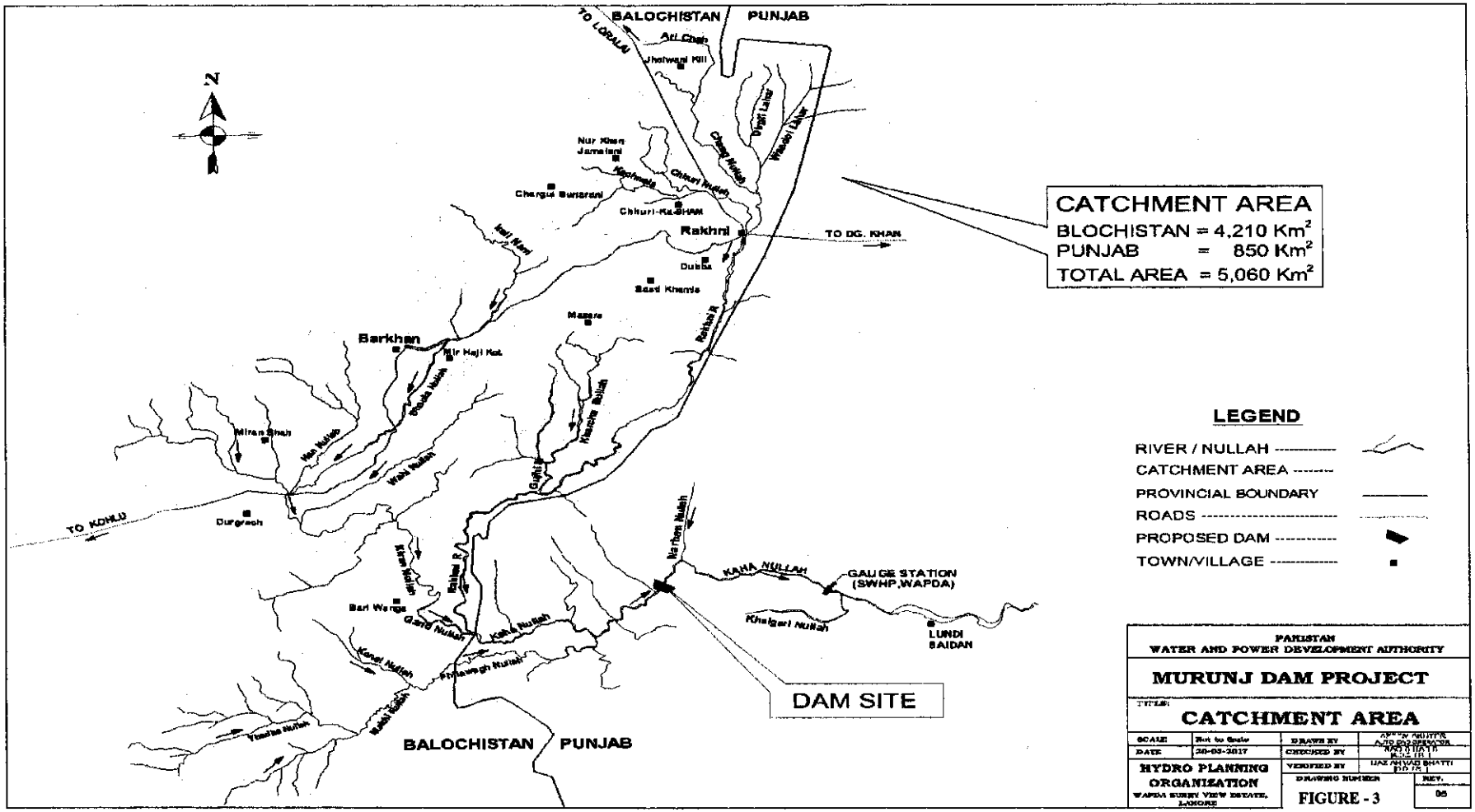

BALOCHISTAN
PUNJAB
MURUNJ DAM SITE
POWER HOUSE
WEIR
COMMAND AREA
48,600 hectares
KAHA NULLAH
KACCHA TRACK
NILA KUND
MURUNJ
MAARI
PROPOSED CANAL
LUNDI SAIDAN
KACCHA TRACK
PROPOSED CANAL
MURUNJ RESERVOIR
4,500 hectares
KACHHI CANAL
N
HAJPUR
TO RAJANPUR
KACHHI CANAL
BALOCHISTAN
PUNJAB
LEGEND
COMMAND AREA
RESERVOIRAREA
PROPOSED DAM
KACHHI CANAL
PROPOSED CANAL
CITY / TOWN
ROAD
KACHA ROAD
PROVINCIAL BOUNDARY
PAKISTAN
WATER AND POWER DEVELOPMENT AUTHORITY
MURUNJ DAM PROJECT
PROJECT LAYOUT PLAN
HYDRO PLANNING ORGANIZATION
4
05

FIGURE - 2


BALOCHISTAN
PUNJAB
TO LORALAI
Ari Chah
Jhalwagi Hill
Nur Khan Jamaldini
Chargul Bamarani
Chhuri-Ka-Dhan
Rakhni
TO DG. KHAN
Dubba
Saad Khamis
Masare
Barkhan
Mir Haji Kot
Mirza Shah
TO KOHLU
Durgaroh
Bari Warga
Kahla Nullah
KAHA NULLAH
GAUGE STATION (SWHP,WAPDA)
Khalgari Nullah
LUNDI BAIDAN
DAM SITE
BALOCHISTAN
PUNJAB
CATCHMENT AREA
BLOCHISTAN = 4,210 Km²
PUNJAB = 850 Km²
TOTAL AREA = 5,060 Km²
LEGEND
RIVER / NULLAH
CATCHMENT AREA
PROVINCIAL BOUNDARY
ROADS
PROPOSED DAM
TOWN/VILLAGE
PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY
MURUNJ DAM PROJECT
CATCHMENT AREA
SCALE
Not to Scale
DATE
26-03-2017
DRAWN BY
CHECKED BY
VERIFIED BY
IJAZ AHMAD BHATTI
HYDRO PLANNING ORGANIZATION
WAPDA SURVEY VIEW ESTATE, LAHORE
DRAWING NUMBER
FIGURE - 3
REV.
05

ANNEX-II

Checklist and Proforma

CHECKLIST FOR PHYSICAL BASELINE CONDITIONS

PHYSICAL ENVIRONMENT

a. Type of area

- Mountainous
- Arid
- Semi-arid
- Forest
- Dense forest
- Populated
- Densely populated

Any other _____specify)

b. Landuse of area

- Agriculture
- Barren
- Built-up
- Desert
- Access road
- Wetland

Any other _____(specify)

c. Geological conditions

- is the geology of the area rocky _____
- is the origin of rocks sedimentary/igneous/metamorphic
- any other _____ (specify)

d. Seismology

- is there any record of earthquakes in the past 50 years
- presence of faults/fractures
- any other details _____ (specify)

e. Topography & soils

- are the soils mixtures of sand /silt/clay/gravel/rock/clayey silt_____
- any other _____ (specify)

Proposed site	Soil description

Other features

- Drains
- Hills
- Plain Areas
- Any other _____ (specify)

f. Climate historical data from nearest weather station ( )

Temperature	Wind	Relative humidity	precipitation	Evapotranspiration

g. Surface and Ground water

Source of surface water

- Rivers
- Hill Torrents
- Surface Ponds
- Any other_____ (Specify)
- Surface water quality visual? _____

Sources of ground water

- Wells
- Hand Pumps
- Tube wells
- Any other_____ (Specify)
- Quality and Approx. depth _____

g. Air Quality

- Is the area visually pollution free _____
- Identification of point sources (Industries Refineries, power plants) or any other _____ (specify)
- Identification of non- point sources (cars, trucks, tractors) or any other _____ (specify)

h. Liquid effluents

- liquid effluents sources (industries/household/commercial)
- if any other _____ (specify)
- Identification of any disposal source for waste water from plant _____ _____

Describe Details

i. Solid Waste

- Types of waste (Municipal, commercial, institutional, agriculture industrial, biomedical) any other _____ (Specify)
- Waste Disposal facility (Landfill, dumping stations)
- Approx. waste generated (tons/day)_____
- Responsible solid waste management authority? _____
- Waste management (Good or Poor)_____if poor, specify the reasons (lack of awareness among people, authority is not responsible enough)

j. Noise

- Sources of noise (traffic/industry or other _____(Specify)
- Areas under high noise pollution? _____

k. Natural Hazards

- Does the project area has any previous records of flooding _____
- Are there any records of drought _____
- Any other_____(Specify)

l. Nearby Infrastructures in Study Area

Sr. No.	Infrastructure	Details
1.	Transmission Line Crossing	
2.	Surface Water Body	
3.	Water Supply Line	
4.	Roads	
5.	Quarry Area	
6.	Developmental Project	
7.	Sensitive Receptor	
8.	Other (Specify)	

Sr. No.	Significant Impacts	Details

ECOLOGICAL CHECKLIST FOR EIA

	Data Sheet No.		**Date**	/ /	**Expert Name**			
	Location/Village			**District**		**RD/KMs.**		
	BIODIVERSITY FEATURES							
(i)	**Vegetation Description**							
	Forests (Trees, Herbs, Shrubs)	Yes/No	**Ecological Zone/Forest Type**		**Legal Status**			
	Species Composition	ROW			**No of Trees (Possibly Affected)**			
	Diameter Class	0-15 cm	16-30 cm	31-45 cm	46-50 cm	51-65 cm	66-80 cm	81-95cm	Above 95 cm
	Rangeland	Yes/No	**Agricultural Land**	Yes/No		**Crop Type**		
(ii)	**Wildlife/ Fauna Description**							
	Wildlife Protected Areas (Notified or Sensitive)							
	Mammals	Yes/No						
	Reptiles	Yes/No						
	Amphibians	Yes/No						
	Aquatic Habitat	Yes/No						
	Avifauna/Birds	Yes/No						
	Natural Wetland	Yes/No						
	Endangered Species	Yes/No						
	Other Biodiversity Features							
	Remarks/Comments:							

QUESTIONNAIRE FOR SOCIOECONOMIC BASELINE SURVEY

Date. ---------- Photo No. ---------- ID No. ----------

1. IDENTIFICATION

1.1 Name of Respondent_____

1.2 Father's Name_____ **1.3 Cell. No:** _____

1.3 Permanent Address of the Respondent:

Village: _____Town _____ Tehsil _____ District: _____

1.5 Located _____**Caste**_____

1.6 Demographic Profile of Respondent (Children up to 10 yrs (#): M_____, F _____ T_____)

Sr. No.	(a) Relationship with Respondent (See codes)	(b) Sex (See Codes)	Age (Yrs.)	(c) Education (See Codes)	(d) Name of Business/ Occupation (See Codes)		Income from Business/ Occupation (Rs. / Annum)		(e) Health Condition
					Main	Secondary	Main	Secondary	
1	Self								
2									
3									
4									
5									
6									
7									
8									
9									
10									

Demographic Codes:

a) Relationship: 1=Self, 2=Wife, 3=Son, 4=Daughter, 5=Father, 6=Mother, 7=Brother, 8=Sister, 9=Grand Father, 10=Grand Mother, 11=Sister in Law, 12=Nephew, 13=Father-in-Law, 14=Mother-in-Law, 15=Niece, 16=Uncle,17=Aunty, 18= Son-in-law, 19= Daughter, 20= S. in Law,21=D. in Law, 22= Other_____

b). Sex: 1=Male, 2=Female, 3= Transgender

c). Education: 1= Primary 2= Middle 3= Metric, 4= Intermediate, 5= Graduate, 6= Post Graduate, 7=Law, 8=Engineer, 9=MBBS, 10=Technical Diploma, 11=Dars-e-Nizami, 12=Can Read Quran, 13= Can Insert Signatures, 14= Illiterate

d). Occupations:1=Agriculturist, 2=Shopkeeper, 3=Hotel, 4=Mechanic, 5=Barber, 6=Butcher, 7=Cobbler, 8= Business, 9= Govt. Servant,10=Private Servant, 11=Labor, 12=Student, 13=House-Maid, 14=Housewife, 15=Advocate, 16=Livestock/Dairy, 17=Fishing, 18=Driver, 19=Health Related, 20=Teaching, 21=Entertainer, 22=Gone Abroad, 23=Retired/Old, 24=Other_____

e). Health: 1= Good, 2= Average, 3= Poor

1.8) Language Spoken _____**Religion**_____

1.9) Type of family system: 1.Joint: _____ 2.Nuclear_____

2. AVERAGE MONTHLY EXPENDITURE ON FOOD AND NON- FOOD ITEMS (Rs.)

Items	Expenses
Food	
Non-food	
Utilities	
Health	
Education Care	
Other	

3. HOUSING CONDITIONS

3.1 Personal_____ Rented_____ Other_____

3.2 Type of Structure

(i) Katcha_____ (ii) Semi Pacca_____ (iii) Pacca_____

4. ACCESS TO SOCIAL AMENITIES *(TICK)*

Social Amenities	Available (Yes-No)	Satisfactory (Yes-No)	Reasons for Not Satisfaction
Electricity			
Gas			
Water Supply			
Water Filtration plant			
Telephone			
Sewerage/Drainage			
Hospital			
School (Boys-Girls)			
College (Boys-Girls)			
University (Boys-Girls)			
Religious Institution			
Road			
Source of Cooking if Sui Gas is not available			

5. CREDIT UTILIZATION

5.1 Have you obtained credit during last year? Yes___ No_____ if yes, source of credit:

a) Formal b) Informal

5.2 Please write the name of relevant source

Formal source (s) _____

Informal source (s) _____

Purpose of Loan _____

6. WOMEN'S PARTICIPATION AND ROLE IN DIFFERENT HOUSEHOLD ACTIVITIES

6.1 Participation and Decision Making (Tick)

Activities	Participation Extent (%)	Decision Making Extent (%)
Household activities		
Child caring		
Farm/Crop activities		
Livestock rearing		
Sale & Purchase of properties		
Social obligations (marriage, birthday & other functions)		
Local representation (councilor/political gathering)		

7. SOURCE OF DRINKING WATER:

1. Public Water Supply 2.Hand Pumps 3. Borehole 4. Any other __

7.1 Quality of water**:** Good_____ Poor: _____

If Poor (Reason) _____

8. DOES ANY NGO EXIST IN YOUR AREA?

Yes_____ No_____

If yes, Name of NGO -: _____

8.1 Are you member of NGO? yes---------- No---------- if yes,

Role in NGO-:_____

9. PERCEPTION OF RESPONDENTS FOR ACTION ASSOCIATED WITH THE PROJECT:

Possible impacts/effects of the Project	Increase	Decrease
Employment opportunities		
Industrial Development Opportunities		
Living standard		
Unemployment		
Income generating activities		
Improvement in transport		
Mobility (Access to Resources)		
Physical Displacement		
Other specify		

10. ANY OTHER HISTORICAL /ARCHEOLOGICAL MONUMENT IN OR NEARBY THE PROPOSED PROJECT AREA?

1. Yes_____ 2. No_____ If yes, please specify

Name _____ Type_____ Distance from the proposed project ____

11. MAJOR DISEASES COMMON IN THE PROPOSED PROJECT AREA

_____
_____
_____

12. IN YOUR OPINION, WHAT ARE SOME PRESSING NEEDS OF THIS AREA?

_____
_____
_____
_____

13. GENERAL REMARKS OF THE RESPONDENT

_____
_____
_____
_____

14. GENERAL OBSERVATIONS OF INTERVIEWER

_____
_____
_____
_____

Name of Interviewer: _____ Date: _____

ANNEX-III

Environmental Monitoring, Sampling and Testing Reports

GCEC

PNAC Pakistan National Accreditation Council LAB 121 17025

Punjab-EPA Certified

Federal-EPA Certified

Serial # 20B / 23175

ENVIRONMENTAL MONITORING REPORT

OF

MURUNJ DAM

Prepared By: Green Crescent Environmental Consultants Pvt. Ltd.

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Annex-1: Monitoring & Analysis Results.....i

LIST OF ABBREVIATIONS

AA	Ambient Air
SW	Surface Water
SPL	Sound Pressure Level
dB	Decibels
mg/m^3	Milligram per Cubic meter
mg/l	Milligram per Liter
$\mu g/m^3$	Micrograms per Cubic Meter
CO	Carbon Monoxide
SO_2	Sulfur Dioxide
NOx	Oxides of nitrogen
O_2	Oxygen
SPM	Suspended Particulate Matter
LDL	Lowest Detection Limit
PEQS	Punjab Environmental Quality Standards
LOR	Limit of Reporting
PM	Particulate Matter
SOPs	Standard Operating Procedures
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association

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SECTION 1: OBJECTIVES & SCOPE

1.1 STUDY OBJECTIVES

Followings were the main objectives of the study:

- To assess the current conditions of the environment in the surroundings of project area.
- To help the consultant and contractor to develop the strategies for the protection and betterment of environment.

1.2 SCOPE OF SERVICES

Scope of services covered following main components:

- Ambient Air Quality Monitoring
- Meteorological Monitoring
- Noise Level Monitoring
- Surface Water Sampling & Analysis
- Waste Water Sampling & Analysis

1.3 MONITORING TEAM

Monitoring team of Green Crescent Environmental Consultants involved in the monitoring and sampling is given in below table:

Table 1-1: Monitoring Team

Sr. No.	Name of The Employee	Designation
1.	Mr. Muhammad Zeeshan	Executive Field Officer

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SECTION 2: MONITORING SCHEDULE

Detailed Environmental monitoring was conducted at the mutually agreed sites of project area. The monitoring and sampling was conducted from 1st Jan. 2022 to 5th Jan. 2022.

Table 2-1: Monitoring Schedule

Sr. #	Intervention Date	Activity	Monitoring Location
1.	01-01-2021 to 05-01-2022	• Ambient Air Quality Monitoring • Noise Level Monitoring • Meteorological Monitoring	• Darrah Murunj Dam • Lundi Saidan • Dam Axis (Matt Khund) • Tibbi Solgi
2.	05-01-2022	• Surface Water	• Bakhtiar Kundh (Near Dam Axis) • Bumbli Village • Tibbi Lundi • Darbar Ameer Hamza Sultan
3.	05-01-2022	• Drinking Water	• Kaha River Near Darra • Dam Axis • Kachi Canal (Meeranpur) • Kachi Canal

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SECTION 3: MONITORING LOCATION

Monitoring and Sampling Locations are as per shown in the following figure.



Figure 3-1: Map Showing Ambient Air Monitoring Locations (1st Jan. to 5th Jan. 2022)

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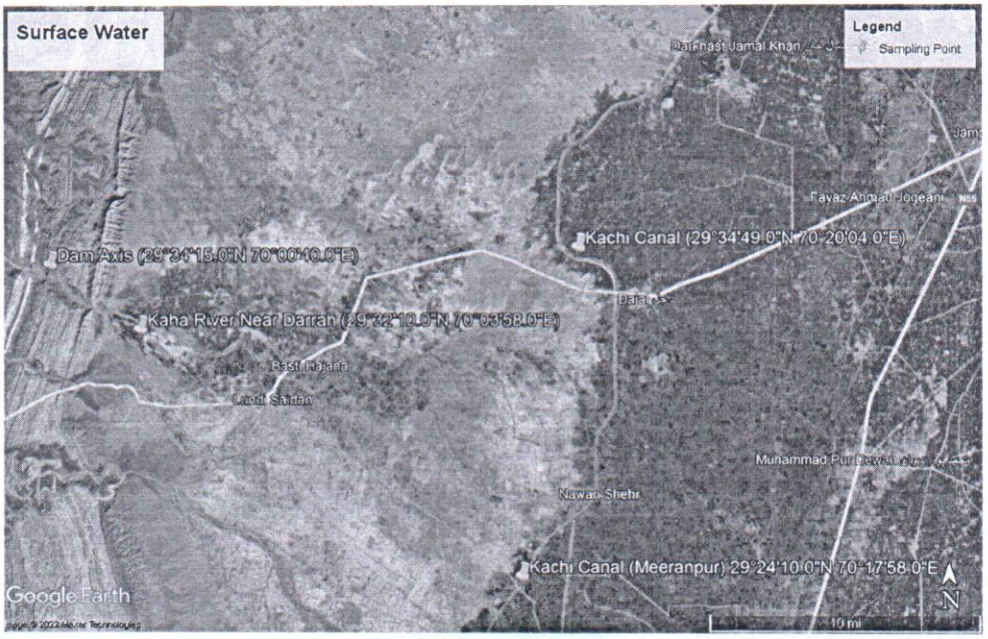


Figure 3-2: Map Showing Surface Water Sampling Locations (5th Jan. 2022)

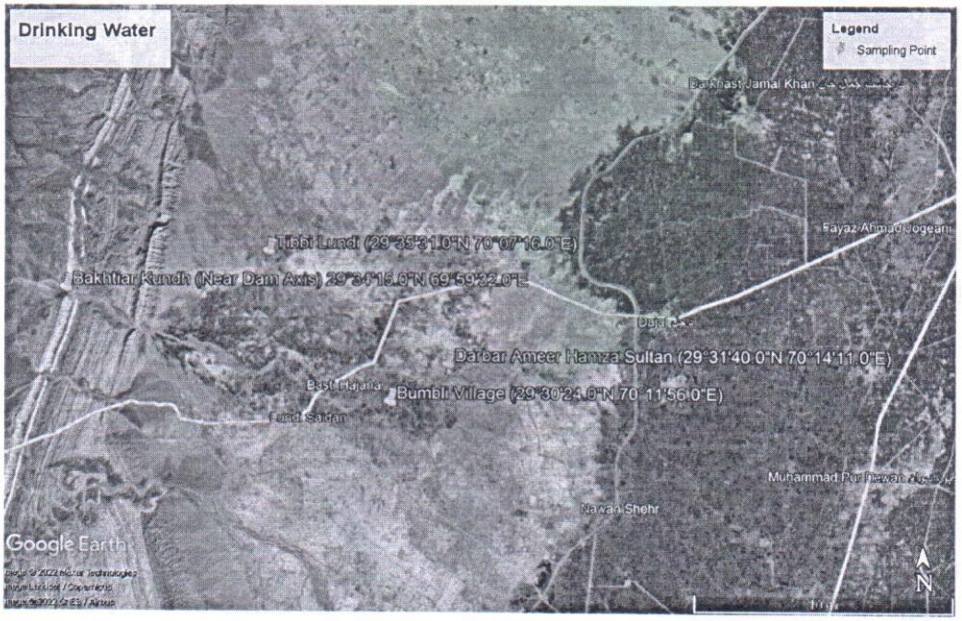


Figure 3-3 Map Showing Drinking Water Sampling Locations (5th Jan. 2022)

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SECTION 4: MONITORING & METHODOLOGY

Following is a brief description of the methodology adopted for this Environmental Monitoring, including Ambient Air, Metrological Data, Noise and Water Analysis:

4.1 Onsite Monitoring

Among the environmental parameters selected by the client;

- Ambient Air
- Temperature and pH of water samples

were monitored onsite. Ambient air monitoring including metrological monitoring and noise level monitoring was conducted using portable digital instruments while temperature and pH of the water samples were monitored manually using thermometer and pH strips. A brief description of each digital instrument used for onsite monitoring is given below;

4.1.1 Vantage Pro2, Davis

The Davis 6152 Wireless Vantage Pro2 Weather Station which was made in 2018 in America which consists of a console unit and an innovative integrated sensor suite that includes a rain collector with self-emptying bucket, temperature and humidity sensors and an anemometer. The sensor suite is housed inside a radiation shield, protecting the sensors against solar radiation and additional sources of reflected and/or radiated heat. It provides accurate weather data in a sophisticated yet easy-to-read format. With Wireless Vantage Pro2 Weather Station we can continuously measure metrological parameters including;

- Temperature
- Wind Direction
- Wind Velocity
- Humidity

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- Atmospheric Pressure

Davis wireless weather station Vantage Pro2 was used for the assessment of these parameters according to standard operating procedures and obtained results are presented in **Annex-1** of this report.



Figure 4-1: View of Davis Vintage Pro at Site

4.1.2 Dust Trak II Aerosol Monitor 8530, TSI

The Dust Trak II Aerosol Monitor 8530 is a desktop battery-operated, data-logging, light-scattering laser photometer which was manufactured in 2014, that gives you real-time aerosol mass readings.

It uses a sheath air system that isolates the aerosol in the optics chamber to keep the optics clean for improved reliability and low maintenance. Using this instrument, lead and particulate matters were monitored including;

- Lead
- PM_{10}
- $PM_{2.5}$
- SPM

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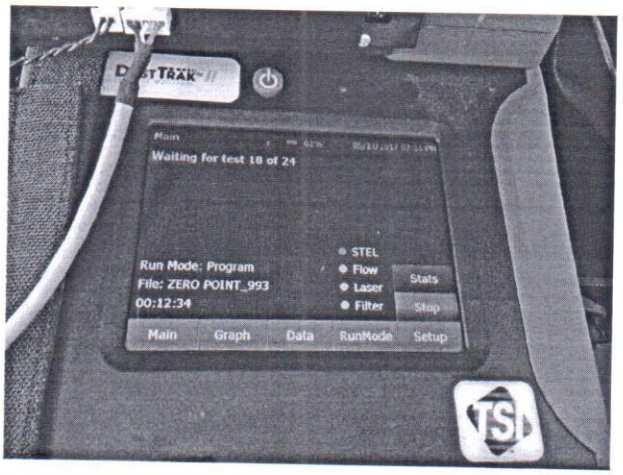


Figure 4-2: DustTrak II aerosol monitor 8530

4.1.3 Model 407730 Digital Sound Level Meter, Extech

It is a noise measuring instrument used to assess sound levels by measuring sound pressure. Often referred to as a sound pressure level (SPL) meter, decibel (dB) meter, noise meter or noise dosimeter, a sound level meter uses a microphone to capture sound. The sound is then evaluated within the device and acoustic measurement values are displayed. The most common unit of acoustic measurement for sound is the decibel (dBA). Hourly noise level monitoring was done for 24 hours at each point of selected location. Digital Sound meter was manufactured in 2014.

Noise level using portable digital sound meter was monitored at client's mutually agreed sampling points. Noise level measurement was performed according to standard operating procedures and obtained results are presented in **Annex-1** of this report.

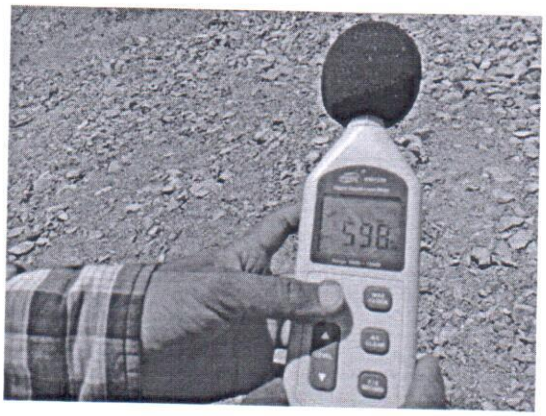


Figure 4-3: View of Digital Sound Level Meter

4.1.4 Environment S.A envea™

Environment S.A 710SMC-9021, was manufactured in 2018 which consists of ambient air analyzers and sampling systems for the measurement of regulatory pollutants and air quality control. It offers complete tailored or individual air quality monitoring solutions, in order to meet the requirements and regulatory needs of environmental monitoring.



Figure 4-4: Ambient Air Quality Monitoring Station (ESA)

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4.1.4.1 AC32M. NITROGEN OXIDES ANALYZER (NO, NOX, NO2)

Chemiluminiscence technology based, TÜV & US EPA approved. It is single chambered chemiluminescence technology with ultra-compact and lightweight – rackable 19"/3U. On board web server compatible with any internet browser and user interface with on-line help for the display, configuration, maintenance, diagnostics or software updating of the analyzer, remotely. It is capable to detect low levels of nitrogen oxides (NO-NO_2-NO_X) from 0.4 ppb to 20 ppm.

4.1.4.2 AF22E. NEW E-SERIES SO2 ANALYZER

UV Fluorescent sulfur dioxide analyzer AF22e, TUV certified and US-EPA approved for compliance with ISO 10498, 2008/50/EC, en 14212, EN 15267, 40 CFR part 53 SUB B and SUB C.

It is a light weight eco-friendly & eco-innovative conception unit which detects early signs of trouble, allows predictive maintenance, identifies the service needed and guides the service operations step by step.

It provides real-time calibration graph, animated synoptic, auto-diagnostic, control and maintenance data screens can be displayed while the instrument is operating. It provides superior metrological presentations for SO_2 measurements in the range of 0-20 ppm

4.1.4.3 CO12E. NEW E-SERIES CO ANALYZER

Non dispersive Infra-Red carbon monoxide analyzer CO12e, TUV certified and US-EPA approved for compliance with ISO 4224, EN 14626, EN 15267, 40 CFR part 53 SUB B and SUB C.

It is a light weight eco-friendly & eco-innovative conception unit with breakthrough mechanical design for weight and power saving as well as thermal insulation & reliability. It has automatic or programmable response time adjustment, ensuring efficient monitoring of low concentration levels of carbon monoxide. It provides superior metrological presentations for CO measurements in the range 0-300 ppm.

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4.2 Water Sample Collection and Preservation

Water samples were collected from mutually agreed sampling points according to the SOPs based on American Public Health Association (APHA) for water sampling and analysis. Decontaminated glass bottles were used to collect the samples. To prevent air bubbles from being trapped in the bottles, they were filled to the brim. The lids of the sampling bottles were then replaced tightly. The bottles were then labeled and chain of custody forms were filled out and signed to keep track of the collected samples. Collected samples were then preserved in appropriate containers as per APHA Preservation Guidelines. A shipping container containing ice packs with maintained temperature was used for transporting the samples from sampling location to GCEC Lahore Branch for testing.

4.2.1 Surface Water Testing & Analysis

Surface water samples were collected from the points mentioned in **Table 2-1**. Sample collected through grab sampling method were immediately stored at 4 °C in an icebox and transported to the GCEC Environmental laboratory, where sample is subjected to analysis within 24 hours of collection.

Surface water samples were tested and analyzed against selected physical and chemical parameters using American Public Health Association's (APHA) Standard Method. Analysis Results are presented in **Annex-1** of this report.

4.2.2 Drinking Water Sampling & Analysis

Sampling for drinking water was carried out at mutually agreed sampling point. Physical and chemical parameters were analyzed afterwards in GCEC labs for drinking water sample. Analytical methods used during the laboratory testing were in line with the American Public Health Association's Standard Methods for the Examination of Water. Analysis Results are presented in **Annex 1** of this report.

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4.3 Sample Tagging and Chain of Custody

In GCEC Lahore Branch, samples and chain of custody form were handed over by Field Monitoring to the Coordination Staff for in-house tagging and logging according to the company's policy and handed over to the Laboratory Staff for further physical, chemical and microbiological testing. A brief description of each sampling type and further proceedings are also discussed in following section.

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SECTION 5: RESULTS & DISCUSSIONS

This section of the report presents the Environmental testing results of noise-level monitoring, ambient air quality, surface water & drinking water analysis.

5.1 Background Noise Level Monitoring

The Noise monitoring activity was carried at the project site and at the surrounding areas of project site. Monitoring schedule is presented in Table 2-1. While a brief description of monitoring session is as below.

Hourly noise monitoring was conducted at 04 selected locations. The results of monitoring location was compared with residential noise standards for Punjab Environmental Quality Standards i.e., 55.0 dB (A) for Day Time and 45.0 dB (A) for Night Time.

Discussion on Noise Results

Noise level Monitoring was conducted at all monitoring locations on 24 hour basis. The monitoring results of all sites are complying well with the residential noise standards of PEQS. Day and Night Time averages for monitoring points are presented in figures below.

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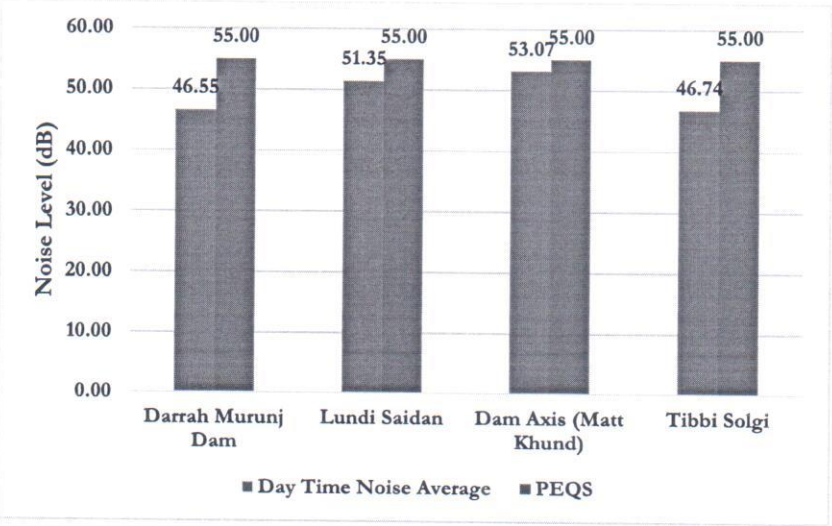


Figure 5-1: Day Time Average Noise Level Value Compared with Respective PEQS (1st Jan. to 5th Jan. 2022)

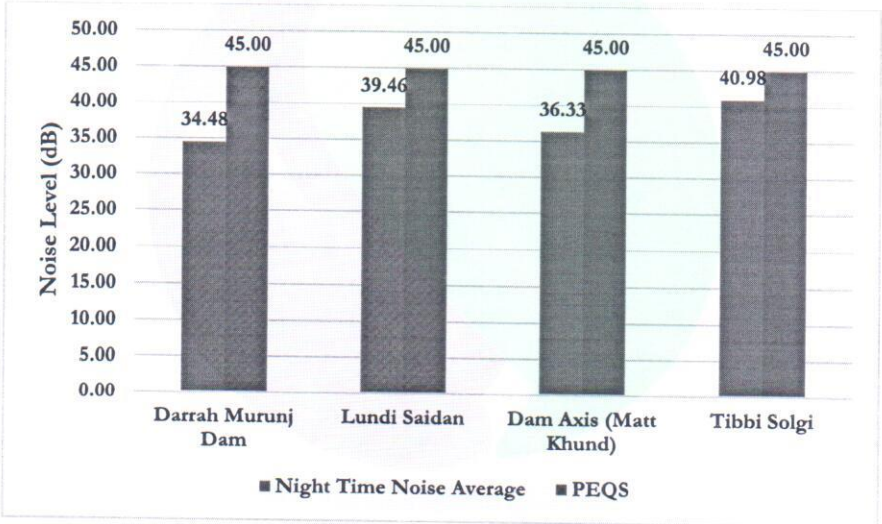


Figure 5-2: Night Time Average Noise Level Value Compared with Respective PEQS (1st Jan. to 5th Jan. 2022)

5.2 Ambient Air Quality Monitoring

The activity for monitoring the ambient air conditions was carried out at the project site and its vicinity for 24 hours, starting from **1st Jan. to 5th Jan. 2022**. To assess the current quality of ambient air, Carbon Monoxide, Oxides of Nitrogen, Sulphur Dioxide, Ozone, and Particulate

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Matter were monitored. Summary of monitoring results is presented in Table 5-1. Detailed result reports are also attached as **Annex 1.**

Discussion of NOx Measurements

The readings of NO, NO_2 and NOx for the project site and its surroundings comply with the Punjab Environmental Quality Standards i.e., 40 µg/m³, 80 µg/m³ and 120 µg/m³ respectively. Sum of NO and NO_2 is termed as NOx. NOx results found at all monitoring locations were within the PEQS limits. Monitoring results, compared with PEQS, are graphically presented in figure below and in Summary Table 5-1.

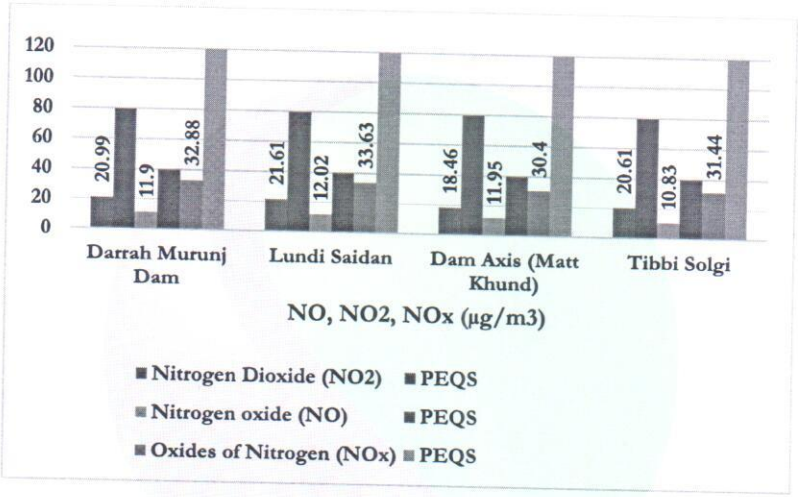


Figure 5-3: Daily Average NOx Measurements Compared with Respective PEQS (1st Jan. to 5th Jan. 2022)

Discussion of SO_2 Measurements

The SO_2 readings for all the monitoring locations are presented in the summary table which depicts that the monitoring results are within the prescribed limits of PEQS i.e. 120 µg/m³. SO_2 results found at all monitoring locations were within the PEQS limits. Monitoring results, compared with PEQS, are also graphically presented in figure below and in Summary Table 5-1.

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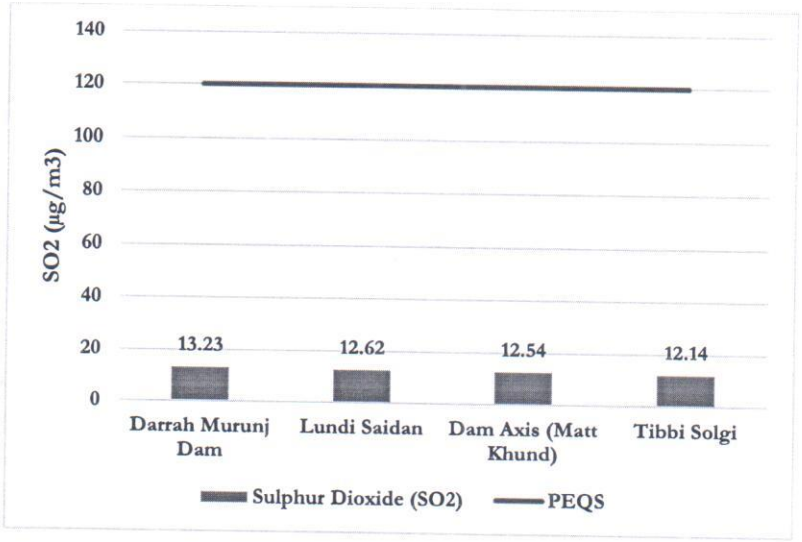


Figure 5-4: Daily Average SO_2 Measurement Compared with Respective PEQS (1st Jan. to 5th Jan. 2022)

Discussion of CO Measurements

Carbon Monoxide (CO) was monitored for 24 hours at all monitoring locations and the value detected at each location is within the permissible limit of PEQS i.e., 5.0 mg/m^3. Monitoring results, compared with PEQS, are graphically presented in figure below and in Summary Table 5-1.

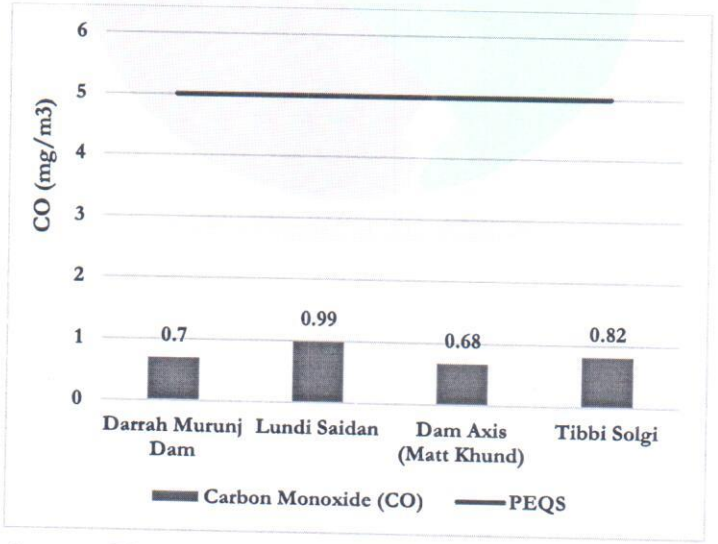


Figure 5-5: Daily Average CO Measurement Compared with Respective PEQS (1st Jan. to 5th Jan. 2022)

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Discussion of Ozone Measurements

Ozone (O_3) was monitored for 24 hours at all monitoring locations and the value detected at each location is within the permissible limit of PEQS i.e., 130.0 µg/m³. Monitoring results, compared with PEQS, are graphically presented in figure below and in Summary Table 5-1.

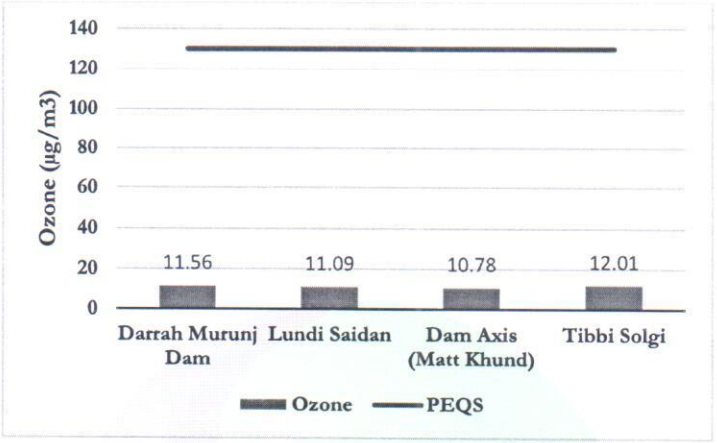


Figure 5-6: Daily Average Ozone Measurement Compared with Respective PEQS (1st Jan. to 5th Jan. 2022)

Discussion of Lead Measurements

Lead was monitored for 24 hours at all monitoring locations and the value detected at each location is within the permissible limit of PEQS i.e., 1.50 µg/m³. Monitoring results, compared with PEQS, are graphically presented in figure below and in Summary Table 5-1.

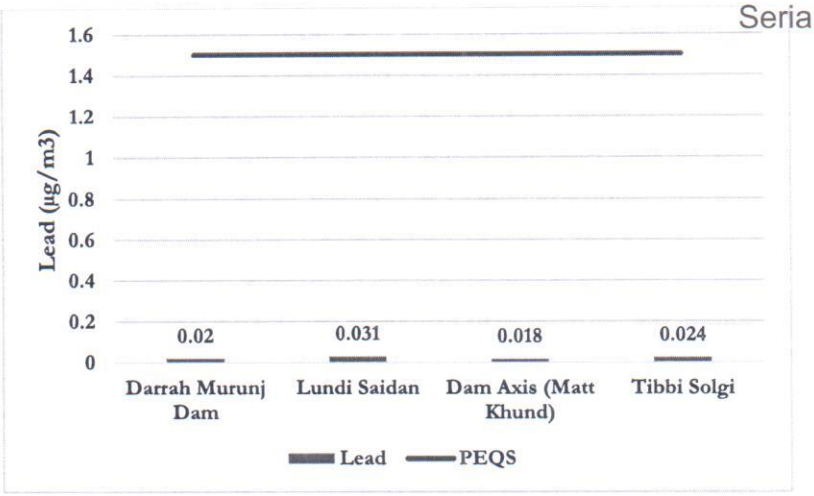


Figure 5-7: Daily Average Lead Measurement Compared with Respective PEQS (1st Jan. to 5th Jan. 2022)

Discussion on Suspended Particulate Matter (SPM)

The readings of PM_{10}, $PM_{2.5}$ and SPM for the project site and its surroundings are compared with the Punjab Environmental Quality Standard i.e., 150 µg/m³, 35 µg/m³ and 500 µg/m³ respectively. Suspended Particulate Matter (SPM) is the sum of PM_{10} and $PM_{2.5}$. All of the measured PM were found falling within the prescribed limits of PEQS. Monitoring results, compared with PEQS, are graphically presented in figure below and in Summary Table 5-1.

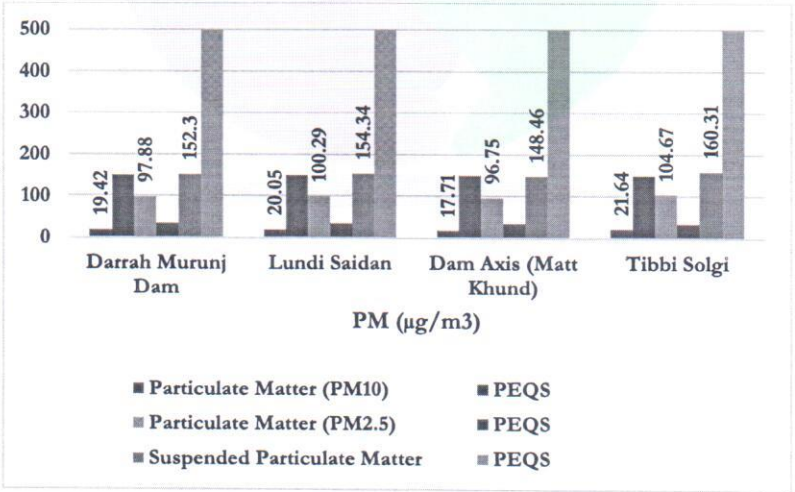


Figure 5-8: Daily Average SPM Measurements Compared with Respective PEQS (1st Jan. to 5th Jan. 2022)

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Table 5-1: Summary of Ambient Air Quality Monitoring Results

Location Identification				
Monitoring Site:	**01**	**02**	**03**	**04**
Monitoring Location:	Darrah Murunj Dam	Lundi Saidan	Dam Axis (Matt Khund)	Tibbi Solgi
Date:	01-01-2022 to 02-01-2022	02-01-2022 to 03-01-2022	03-01-2022 to 04-01-2022	04-01-2022 to 05-01-2022
Coordinates:	29°33'13.5"N 70°02'38.0"E	29°30'09.9"N 70°08'35.3"E	29°34'10.2"N 70°00'33.3"E	29°31'00.2"N 70°17'23.6"E

Parameter	Unit	Duration	Average obtained Concentration				PEQS
			01	02	03	04	
Nitrogen Dioxide (NO_2)	$\mu g/m^3$	24 hours	20.99	21.61	18.46	20.61	80.0
Nitrogen oxide (NO)	$\mu g/m^3$	24 hours	11.90	12.02	11.95	10.83	40.0
NO_X	$\mu g/m^3$	24 hours	32.88	33.63	30.40	31.44	120.0
Sulphur Dioxide (SO_2)	$\mu g/m^3$	24 hours	13.23	12.62	12.54	12.14	120.0
Carbon Monoxide (CO)	mg/m^3	08 hours	0.70	0.99	0.68	0.82	05.0*
Ozone (O_3)	$\mu g/m^3$	01 hour	11.56	11.09	10.78	12.01	130.0**
Particulate Matter (PM_{10})	$\mu g/m^3$	24 hours	19.42	20.05	17.71	21.64	150.0
Particular Matter ($PM_{2.5}$)	$\mu g/m^3$	24 hours	97.88	100.29	96.75	104.67	35.0
Suspended Particulate Matter (SPM)	$\mu g/m^3$	24 hours	152.30	154.34	148.46	160.31	500.0
Lead Airborne Particles	$\mu g/m^3$	24 hours	0.020	0.031	0.018	0.024	1.5

Abbreviations:

PEQS= Punjab Environmental Quality Standards
(*08 hour standard for CO)
(**01 hour standard for O_3)
$\mu g/m^3$= Micrograms per Cubic Meter
mg/m^3= Milligrams per Cubic Meter

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5.3 Drinking Water Analysis

Drinking water samples were collected from 04 locations on 05-01-2022 which ware preserved and submitted in GCEC-Laboratory according to the standard methods. Summary of Analysis Results are given below in **Table 5-2.**

Discussion on Results

The laboratory test results of drinking water are summarized in the table below. It is obvious from the analysis results that the drinking water of the project site meets the permissible limits of Punjab Environmental Quality Standards for all tested parameters except TDS and Total Coliforms.

In the light of the above discussion of test results, it is concluded that all drinking water samples are in compliance with the permissible limits of Punjab Environmental Quality Standards except TDS and Total Coliforms.

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Table 5 2: Summary of Drinking Water Analysis Results

Sample Marking & Identification			
01	Bakhtiar Kundh (Near Dam Axis)	Sampling Coordinates	29°34'15.0"N 69°59'32.0"E
02	Bumbli Village	Sampling Coordinates	29°30'24.0"N 70°11'56.0"E
03	Tibbi Lundi	Sampling Coordinates	29°35'31.0"N 70°07'16.0"E
04	Darbar Ameer Hamza Sultan	Sampling Coordinates	29°31'40.0"N 70°14'11.0"E

Parameters	Analysis Method	Unit	LOR	Result				PEQS
				01	02	03	04	
PHYSICAL & CHEMICAL ANALYSIS								
pH	APHA-4500H+ B	-	0.01	7.78	7.46	7.24	7.43	6.5-8.5
Odor	In-house	-	-	Odorless	Odorless	Odorless	Odorless	Non-Objectionable
Taste	In-house	-	-	Salty	Salty	Salty	Sweet	Non-Objectionable
Color	APHA-2120 B/C	Pt/Co	1.0	<1.0	<1.0	<1.0	<1.0	≤15 TCU
Turbidity	APHA-2130 B	NTU	-	ND	ND	ND	ND	<5 NTU
Total Hardness	APHA-2340 C	mg/l	0.1	474.32	245.0	205.8	215.6	< 500 mg/l
Total Dissolved Solid (TDS)	APHA-2540 C	mg/l	1.0	1765.0	2355.0	1809.0	391.0	< 1000
Chloride	APHA-4500Cl- B	mg/l	0.24	116.55	101.01	97.13	13.59	< 250
Cyanide (CN)	APHA-4500CN E	mg/l	0.01	<0.01	<0.01	<0.01	<0.01	≤ 0.05
Fluoride (F)	APHA-4500F- C	mg/l	0.01	<0.01	<0.01	<0.01	<0.01	≤ 1.5
Nitrite	APHA-4500NO2 B	mg/l	0.01	<0.01	<0.01	<0.01	<0.01	≤ 3 (P)
Nitrate	APHA-4500NO3 B	mg/l	0.1	0.6	0.5	0.7	<0.1	≤ 50
Phenolic Compound	APHA-5530 D	mg/l	0.01	<0.01	<0.01	<0.01	<0.01	-
Residual Chlorine	APHA-4500Cl G	mg/l	0.1	<0.1	<0.1	<0.1	<0.1	0.2-0.5
Aluminum (Al)	APHA-3111Al B	mg/l	0.028	<0.028	<0.028	<0.028	<0.028	≤ 0.2
Cadmium	APHA-3111Cd B	mg/l	0.0028	<0.0028	<0.0028	<0.0028	<0.0028	0.01
Copper	APHA-3111Cu B	mg/l	0.0045	<0.0045	<0.0045	<0.0045	<0.0045	2
Chromium	APHA-3111Cr B	mg/l	0.0054	<0.0054	<0.0054	<0.0054	<0.0054	≤ 0.05 (P)
Mercury	APHA-3112 Hg B	mg/l	0.0008	<0.0008	<0.0008	<0.0008	<0.0008	≤ 0.001
Antimony (Sb)	APHA-3111Sb B	mg/l	-	ND	ND	ND	ND	≤ 0.005 (P)
Nickel	APHA-3111 Ni B	mg/l	0.008	<0.008	<0.008	<0.008	<0.008	≤ 0.02
Zinc	APHA-3111 Zn B	mg/l	0.0033	0.0052	0.022	0.0068	<0.0033	5.0
Arsenic	APHA-3111 As B	mg/l	0.01	<0.01	<0.01	<0.01	<0.01	≤ 0.05 (P)
Barium	APHA-3111 Ba B	mg/l	0.031	<0.031	<0.031	<0.031	<0.031	0.7
Manganese	APHA-3111 Mn B	mg/l	0.0016	<0.0016	0.0019	<0.0016	<0.0016	≤ 0.5
Boron	APHA-4500B C	mg/l	0.1	<0.1	<0.1	<0.1	<0.1	0.3
Lead	APHA-3111 Pb B	mg/l	0.013	<0.013	<0.013	<0.013	<0.013	≤ 0.05
Selenium	APHA-3111 Se C	mg/l	-	ND	ND	ND	ND	0.01 (P)
MICROBIOLOGICAL ANALYSIS								
Total Coliforms	APHA:9222 B	CFU/100ml		02	03	02	02	0/100ml
Faecal Coliforms (Ecoli)	APHA:9222 D	CFU/100ml		Absent	Absent	Absent	Absent	0/100ml

Abbreviations:
ND: Not Detected **LOR:** Limit of Reporting **PEQS:** Punjab Environmental Quality Standards

Note:
**Uncertainty of all the parameters and laboratory conditions at the time of analysis will be provided as per client's requirement. The lab environmental conditions are maintained at 25±5C° and humidity at 50±20%.*

Disclaimer: *The results are solely of the samples provided.*

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5.4 Surface Water Analysis

Surface water samples were collected from 04 selected locations on 05-01-2022 which were preserved and submitted in GCEC-Laboratory according to the standard methods. Summary of Analysis Results are given in **Table 5-3 & Table 5-4**.

Discussion on Results

The laboratory test results of surface water are summarized in the table below. It is evident from the experimental results that physical and chemical parameters of surface water are satisfactory.

Table 5-3 Summary of Surface Water Analysis Results

Sample Marking & Identification			
01	Kaha River Near Darrah	Sampling Coordinates	29°32'10.0"N 70°03'58.0"E
02	Dam Axis	Sampling Coordinates	29°34'15.0"N 70°00'40.0"E
03	Kachi Canal (Meeranpur)	Sampling Coordinates	29°24'10.0"N 70°17'58.0"E
04	Kachi Canal	Sampling Coordinates	29°34'49.0"N 70°20'04.0"E

Parameters	Analysis Method	Unit	LOR	Result				FAO**
				01	02	03	04	
PHYSICAL & CHEMICAL ANALYSIS								
Temperature	-	°C	-	21.7	21.7	21.7	21.7	-
pH	APHA-4500H+ B	pH unit	0.01	8.15	7.89	7.84	7.90	6.5-8.4
Biological Oxygen Demand	APHA-5210 B	mg/l	1.0	<1.0	2.6	<1.0	<1.0	-
Chemical Oxygen Demand	APHA-5220-D	mg/l	1.0	15.0	18.0	7.0	9.0	-
Total Suspended Solid	APHA-2540-D	mg/l	1.0	27.0	37.0	48.0	29.0	-
Chloride (Cl)	APHA-4500Cl- B	mg/l	0.24	120.44	116.55	11.65	11.65	4-10
Total Dissolved Solid (TDS)	APHA-2540 C	mg/l	1.0	1424.0	1689.0	188.0	191.0	450-2000
Sulphate	APHA-4500-SO_4C	mg/l	0.41	88.08	105.36	26.34	29.22	-
Oil and Grease	USEPA-1664	mg/l	0.1	1.6	3.2	3.5	2.1	-
Phenolic Compound	APHA-5530 D	mg/l	0.01	<0.01	<0.01	<0.01	<0.01	-
Fluoride (F)	APHA-4500F- C	mg/l	0.01	<0.01	<0.01	<0.01	<0.01	1.0
Cyanide (CN)	APHA-4500CN E	mg/l	0.01	<0.01	<0.01	<0.01	<0.01	-
Detergent	APHA-5540 B	mg/l	-	ND	ND	ND	ND	-
Sulphide	APHA-4500-S_2-E	mg/l	0.4	<0.4	<0.4	<0.4	<0.4	-
Ammonia	APHA-4500-NH_3-B	mg/l	0.002	<0.002	<0.002	<0.002	<0.002	-
Cadmium	APHA-3500Cd B	mg/l	0.0028	<0.0028	<0.0028	<0.0028	<0.0028	0.10
Chromium	APHA-3500Cr B	mg/l	0.0054	<0.0054	<0.0054	<0.0054	<0.0054	0.10
Copper	APHA-3500Cu B	mg/l	0.0045	<0.0045	<0.0045	<0.0045	<0.0045	0.20
Lead	APHA-3500-Pb B	mg/l	0.013	<0.013	<0.013	<0.013	<0.013	5.0
Nickel	APHA-3111 Ni B	mg/l	0.008	<0.008	<0.008	<0.008	<0.008	0.20
Iron	APHA-3111Fe B	mg/l	0.1	0.2	0.3	<0.1	<0.1	-
Manganese	APHA-3111Mn B	mg/l	0.0016	<0.0016	<0.0016	<0.0016	<0.0016	0.20
Mercury	APHA-3500-Hg B	mg/l	0.0008	<0.0008	<0.0008	<0.0008	<0.0008	-
Zinc	APHA-3500-Zn B	mg/l	0.0033	<0.0033	<0.0033	<0.0033	<0.0033	2.0
Arsenic	APHA-3500As B	mg/l	0.01	<0.01	<0.01	<0.01	<0.01	0.10
Silver	APHA-3111Ag-B	mg/l	0.0032	<0.0032	<0.0032	<0.0032	<0.0032	-
Barium	APHA-3500Ba B	mg/l	0.031	<0.031	<0.031	<0.031	<0.031	-
Boron	APHA-4500B-C	mg/l	0.1	<0.1	<0.1	<0.1	<0.1	0.7-3.0
Total Chlorine	APHA-4500Cl-B	mg/l	0.1	<0.1	<0.1	<0.1	<0.1	-
Selenium	APHA-3500Se C	mg/l	-	ND	ND	ND	ND	-
Total Toxic Metals	By Calculation	mg/l	-	<0.01	<0.01	<0.01	<0.01	-

Abbreviations:

ND: Not Detected **LOR:** Limit of Reporting **FAO:** Food and Agriculture Organization

Note:

**Uncertainty of all the parameters and laboratory conditions at the time of analysis will be provided as per client's requirement. The lab environmental conditions are maintained at 25±5C° and humidity at 50±20%.*

Disclaimer: *The results are solely of the samples provided.*

***FAO Standards applied especially if the water is being used for irrigation purpose.*

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SECTION 6: CONCLUSION

Environmental monitoring was performed at Murunj Dam to assess the environmental conditions of its surroundings.

The results of ambient air monitoring depict that all the tested parameters for air quality were within the permissible limits prescribed by environmental protection agency.

Noise monitoring result of all sites were within the prescribed limits for residential noise of Punjab Environmental Quality Standards.

Results of drinking water samples showed compliance with permissible limits of Punjab Environmental Quality Standards except for TDS and Total Coliforms.

There are no PEQS values assigned for surface water. However, from the chemical analysis it can be concluded that the chemical condition of surface water samples is also satisfactory.

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ANNEXURE 1:

Monitoring

&

Analysis Reports

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GCEC

PNAC Pakistan National Accreditation Council LAB 121 17025

Punjab-EPA Certified

Federal-EPA Certified

Serial # 20B / 23204

Monitoring & Test Report

- Drinking Water
- Surface Water
- Ambient Air
- Metrological Data
- Noise Monitoring

WAPDA

13th Jan. 2022

Job Reference No.: GCEC-PK-475/2021

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Serial # 20B / 23206

Sample Details			
Job Ref. No:	GCEC-PK-475/2021	Client Name:	WAPDA
No. of Samples:	One	Sample Matrix:	Drinking Water Sample
Sample Date:	05-01-2022	Sampling Method:	APHA 1060-B & C
Sample Receipt Date:	06-01-2022	Sampled By:	GCEC

Sample Identification			
01	Bakhtiar Kundh (Near Dam Axis)	Sampling Coordinates	29°34'15.0"N 69°59'32.0"E



Parameters	Analysis Method	Unit	LOR	Result 01	PEQS
PHYSICAL & CHEMICAL ANALYSIS					
pH	APHA-4500H+ B	-	0.01	7.78	6.5-8.5
Odor	In-house	-	-	Odorless	Non-Objectionable
Taste	In-house	-	-	Salty	Non-Objectionable
Color	APHA-2120 B/C	Pt/Co	1.0	<1.0	≤15 TCU
Turbidity	APHA-2130 B	NTU	-	ND	<5 NTU
Total Hardness	APHA-2340 C	mg/l	0.1	474.32	< 500 mg/l
Total Dissolved Solid (TDS)	APHA-2540 C	mg/l	1.0	1765.0	< 1000
Chloride	APHA-4500Cl- B	mg/l	0.24	116.55	< 250
Cyanide (CN)	APHA-4500CN E	mg/l	0.01	<0.01	≤ 0.05
Fluoride (F)	APHA-4500F- C	mg/l	0.01	<0.01	≤ 1.5
Nitrite	APHA-4500NO2 B	mg/l	0.01	<0.01	≤ 3 (P)
Nitrate	APHA-4500NO3 B	mg/l	0.1	0.6	≤ 50
Phenolic Compound	APHA-5530 D	mg/l	0.01	<0.01	-
Residual Chlorine	APHA-4500Cl G	mg/l	0.1	<0.1	0.2-0.5
Aluminum (Al)	APHA-3111Al B	mg/l	0.028	<0.028	≤ 0.2
Cadmium	APHA-3111Cd B	mg/l	0.0028	<0.0028	0.01
Copper	APHA-3111Cu B	mg/l	0.0045	<0.0045	2
Chromium	APHA-3111Cr B	mg/l	0.0054	<0.0054	≤ 0.05 (P)
Mercury	APHA-3112 Hg B	mg/l	0.0008	<0.0008	≤ 0.001
Antimony (Sb)	APHA-3111Sb B	mg/l	-	ND	≤ 0.005 (P)
Nickel	APHA-3111 Ni B	mg/l	0.008	<0.008	≤ 0.02
Zinc	APHA-3111 Zn B	mg/l	0.0033	0.0052	5.0
Arsenic	APHA-3111 As B	mg/l	0.01	<0.01	≤ 0.05 (P)
Barium	APHA-3111 Ba B	mg/l	0.031	<0.031	0.7
Manganese	APHA-3111 Mn B	mg/l	0.0016	<0.0016	≤ 0.5
Boron	APHA-4500B C	mg/l	0.1	<0.1	0.3
Lead	APHA-3111 Pb B	mg/l	0.013	<0.013	≤ 0.05
Selenium	APHA-3111 Se C	mg/l	-	ND	0.01 (P)
MICROBIOLOGICAL ANALYSIS					
Total Coliforms	APHA:9222 B	CFU/100ml		02	0/100ml
Faecal Coliforms (Ecoli)	APHA:9222 D	CFU/100ml		Absent	0/100ml

Abbreviations:
ND: Not Detected **LOR:** Limit of Reporting **PEQS:** Punjab Environmental Quality Standards

Note:
Uncertainty of all the parameters and laboratory conditions at the time of analysis will be provided as per client's requirement. The lab environmental conditions are maintained at 25±5C° and humidity at 50±20%.* ***Disclaimer:* *The results are solely of the samples provided.*

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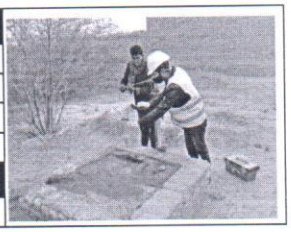
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Serial # 20B / 23207

Sample Details			
Job Ref. No:	GCEC-PK-475/2021	Client Name:	WAPDA
No. of Samples:	One	Sample Matrix:	Drinking Water Sample
Sample Date:	05-01-2022	Sampling Method:	APHA 1060-B & C
Sample Receipt Date:	06-01-2022	Sampled By:	GCEC

Sample Identification			
02	Bumbli Village	Sampling Coordinates	29°30'24.0"N 70°11'56.0"E



Parameters	Analysis Method	Unit	LOR	Result 02	PEQS
PHYSICAL & CHEMICAL ANALYSIS					
pH	APHA-4500H+ B	-	0.01	7.46	6.5-8.5
Odor	In-house	-	-	Odorless	Non-Objectionable
Taste	In-house	-	-	Salty	Non-Objectionable
Color	APHA-2120 B/C	Pt/Co	1.0	<1.0	≤15 TCU
Turbidity	APHA-2130 B	NTU	-	ND	<5 NTU
Total Hardness	APHA-2340 C	mg/l	0.1	245.0	< 500 mg/l
Total Dissolved Solid (TDS)	APHA-2540 C	mg/l	1.0	2355.0	< 1000
Chloride	APHA-4500Cl- B	mg/l	0.24	101.01	< 250
Cyanide (CN)	APHA-4500CN E	mg/l	0.01	<0.01	≤ 0.05
Fluoride (F)	APHA-4500F- C	mg/l	0.01	<0.01	≤ 1.5
Nitrite	APHA-4500NO2 B	mg/l	0.01	<0.01	≤ 3 (P)
Nitrate	APHA-4500NO3 B	mg/l	0.1	0.5	≤ 50
Phenolic Compound	APHA-5530 D	mg/l	0.01	<0.01	-
Residual Chlorine	APHA-4500Cl G	mg/l	0.1	<0.1	0.2-0.5
Aluminum (Al)	APHA-3111Al B	mg/l	0.028	<0.028	≤ 0.2
Cadmium	APHA-3111Cd B	mg/l	0.0028	<0.0028	0.01
Copper	APHA-3111Cu B	mg/l	0.0045	<0.0045	2
Chromium	APHA-3111Cr B	mg/l	0.0054	<0.0054	≤ 0.05 (P)
Mercury	APHA-3112 Hg B	mg/l	0.0008	<0.0008	≤ 0.001
Antimony (Sb)	APHA-3111Sb B	mg/l	-	ND	≤ 0.005 (P)
Nickel	APHA-3111 Ni B	mg/l	0.008	<0.008	≤ 0.02
Zinc	APHA-3111 Zn B	mg/l	0.0033	0.022	5.0
Arsenic	APHA-3111 As B	mg/l	0.01	<0.01	≤ 0.05 (P)
Barium	APHA-3111 Ba B	mg/l	0.031	<0.031	0.7
Manganese	APHA-3111 Mn B	mg/l	0.0016	0.0019	≤ 0.5
Boron	APHA-4500B C	mg/l	0.1	<0.1	0.3
Lead	APHA-3111 Pb B	mg/l	0.013	<0.013	≤ 0.05
Selenium	APHA-3111 Se C	mg/l	-	ND	0.01 (P)
MICROBIOLOGICAL ANALYSIS					
Total Coliforms	APHA:9222 B	CFU/100ml		03	0/100ml
Faecal Coliforms (Ecoli)	APHA:9222 D	CFU/100ml		Absent	0/100ml

Abbreviations:
ND: Not Detected **LOR:** Limit of Reporting **PEQS:** Punjab Environmental Quality Standards

Note:
Uncertainty of all the parameters and laboratory conditions at the time of analysis will be provided as per client's requirement. The lab environmental conditions are maintained at 25±5C° and humidity at 50±20%.* ***Disclaimer:* *The results are solely of the samples provided.*

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Serial # 20B / 23208

Sample Details			
Job Ref. No:	GCEC-PK-475/2021	Client Name:	WAPDA
No. of Samples:	One	Sample Matrix:	Drinking Water Sample
Sample Date:	05-01-2022	Sampling Method:	APHA 1060-B & C
Sample Receipt Date:	06-01-2022	Sampled By:	GCEC

Sample Identification			
03	Tibbi Lundi	Sampling Coordinates	29°35'31.0"N 70°07'16.0"E



Parameters	Analysis Method	Unit	LOR	Result 03	PEQS
PHYSICAL & CHEMICAL ANALYSIS					
pH	APHA-4500H+ B	-	0.01	7.24	6.5-8.5
Odor	In-house	-	-	Odorless	Non-Objectionable
Taste	In-house	-	-	Salty	Non-Objectionable
Color	APHA-2120 B/C	Pt/Co	1.0	<1.0	≤15 TCU
Turbidity	APHA-2130 B	NTU	-	ND	<5 NTU
Total Hardness	APHA-2340 C	mg/l	0.1	205.8	< 500 mg/l
Total Dissolved Solid (TDS)	APHA-2540 C	mg/l	1.0	1809.0	< 1000
Chloride	APHA-4500Cl- B	mg/l	0.24	97.13	< 250
Cyanide (CN)	APHA-4500CN E	mg/l	0.01	<0.01	≤ 0.05
Fluoride (F)	APHA-4500F- C	mg/l	0.01	<0.01	≤ 1.5
Nitrite	APHA-4500NO2 B	mg/l	0.01	<0.01	≤ 3 (P)
Nitrate	APHA-4500NO3 B	mg/l	0.1	0.7	≤ 50
Phenolic Compound	APHA-5530 D	mg/l	0.01	<0.01	-
Residual Chlorine	APHA-4500Cl G	mg/l	0.1	<0.1	0.2-0.5
Aluminum (Al)	APHA-3111Al B	mg/l	0.028	<0.028	≤ 0.2
Cadmium	APHA-3111Cd B	mg/l	0.0028	<0.0028	0.01
Copper	APHA-3111Cu B	mg/l	0.0045	<0.0045	2
Chromium	APHA-3111Cr B	mg/l	0.0054	<0.0054	≤ 0.05 (P)
Mercury	APHA-3112 Hg B	mg/l	0.0008	<0.0008	≤ 0.001
Antimony (Sb)	APHA-3111Sb B	mg/l	-	ND	≤ 0.005 (P)
Nickel	APHA-3111 Ni B	mg/l	0.008	<0.008	≤ 0.02
Zinc	APHA-3111 Zn B	mg/l	0.0033	0.0068	5.0
Arsenic	APHA-3111 As B	mg/l	0.01	<0.01	≤ 0.05 (P)
Barium	APHA-3111 Ba B	mg/l	0.031	<0.031	0.7
Manganese	APHA-3111 Mn B	mg/l	0.0016	<0.0016	≤ 0.5
Boron	APHA-4500B C	mg/l	0.1	<0.1	0.3
Lead	APHA-3111 Pb B	mg/l	0.013	<0.013	≤ 0.05
Selenium	APHA-3111 Se C	mg/l	-	ND	0.01 (P)
MICROBIOLOGICAL ANALYSIS					
Total Coliforms	APHA:9222 B	CFU/100ml		02	0/100ml
Faecal Coliforms (Ecoli)	APHA:9222 D	CFU/100ml		Absent	0/100ml

Abbreviations:
ND: Not Detected **LOR:** Limit of Reporting **PEQS:** Punjab Environmental Quality Standards

Note:
Uncertainty of all the parameters and laboratory conditions at the time of analysis will be provided as per client's requirement. The lab environmental conditions are maintained at 25±5C° and humidity at 50±20%.* ***Disclaimer:* *The results are solely of the samples provided.*

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Serial # 20B / 23209

Sample Details			
Job Ref. No:	GCEC-PK-475/2021	Client Name:	WAPDA
No. of Samples:	One	Sample Matrix:	Drinking Water Sample
Sample Date:	05-01-2022	Sampling Method:	APHA 1060-B & C
Sample Receipt Date:	06-01-2022	Sampled By:	GCEC

Sample Identification			
04	Darbar Ameer Hamza Sultan	Sampling Coordinates	29°31'40.0"N 70°14'11.0"E



Parameters	Analysis Method	Unit	LOR	Result 04	PEQS
PHYSICAL & CHEMICAL ANALYSIS					
pH	APHA-4500H+ B	-	0.01	7.43	6.5-8.5
Odor	In-house	-	-	Odorless	Non-Objectionable
Taste	In-house	-	-	Sweet	Non-Objectionable
Color	APHA-2120 B/C	Pt/Co	1.0	<1.0	≤15 TCU
Turbidity	APHA-2130 B	NTU	-	ND	<5 NTU
Total Hardness	APHA-2340 C	mg/l	0.1	215.6	< 500 mg/l
Total Dissolved Solid (TDS)	APHA-2540 C	mg/l	1.0	391.0	< 1000
Chloride	APHA-4500Cl- B	mg/l	0.24	13.59	< 250
Cyanide (CN)	APHA-4500CN E	mg/l	0.01	<0.01	≤ 0.05
Fluoride (F)	APHA-4500F- C	mg/l	0.01	<0.01	≤ 1.5
Nitrite	APHA-4500NO2 B	mg/l	0.01	<0.01	≤ 3 (P)
Nitrate	APHA-4500NO3 B	mg/l	0.1	<0.1	≤ 50
Phenolic Compound	APHA-5530 D	mg/l	0.01	<0.01	-
Residual Chlorine	APHA-4500Cl G	mg/l	0.1	<0.1	0.2-0.5
Aluminum (Al)	APHA-3111Al B	mg/l	0.028	<0.028	≤ 0.2
Cadmium	APHA-3111Cd B	mg/l	0.0028	<0.0028	0.01
Copper	APHA-3111Cu B	mg/l	0.0045	<0.0045	2
Chromium	APHA-3111Cr B	mg/l	0.0054	<0.0054	≤ 0.05 (P)
Mercury	APHA-3112 Hg B	mg/l	0.0008	<0.0008	≤ 0.001
Antimony (Sb)	APHA-3111Sb B	mg/l	-	ND	≤ 0.005 (P)
Nickel	APHA-3111 Ni B	mg/l	0.008	<0.008	≤ 0.02
Zinc	APHA-3111 Zn B	mg/l	0.0033	<0.0033	5.0
Arsenic	APHA-3111 As B	mg/l	0.01	<0.01	≤ 0.05 (P)
Barium	APHA-3111 Ba B	mg/l	0.031	<0.031	0.7
Manganese	APHA-3111 Mn B	mg/l	0.0016	<0.0016	≤ 0.5
Boron	APHA-4500B C	mg/l	0.1	<0.1	0.3
Lead	APHA-3111 Pb B	mg/l	0.013	<0.013	≤ 0.05
Selenium	APHA-3111 Se C	mg/l	-	ND	0.01 (P)
MICROBIOLOGICAL ANALYSIS					
Total Coliforms	APHA:9222 B	CFU/100ml		02	0/100ml
Faecal Coliforms (Ecoli)	APHA:9222 D	CFU/100ml		Absent	0/100ml

Abbreviations:
ND: Not Detected **LOR:** Limit of Reporting **PEQS:** Punjab Environmental Quality Standards

Note:
Uncertainty of all the parameters and laboratory conditions at the time of analysis will be provided as per client's requirement. The lab environmental conditions are maintained at 25±5C° and humidity at 50±20%.* ***Disclaimer:* *The results are solely of the samples provided.*

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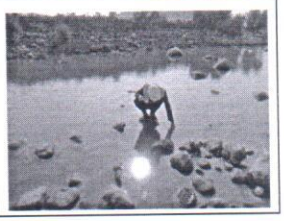
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Serial # 20B / 23210

Sample Details			
Job Ref. No:	GCEC-PK-475/2021	Client Name:	WAPDA
No. of Samples:	One	Sample Matrix:	Surface Water Sample
Sample Date:	05-01-2022	Sampling Method:	APHA 1060-B & C
Sample Receipt Date:	06-01-2022	Sampled By:	GCEC

Sample Identification			
01	Kaha River Near Darrah	Sampling Coordinates	29°32'10.0"N 70°03'58.0"E



Parameters	Analysis Method	Unit	LOR	Result 01	FAO**
PHYSICAL & CHEMICAL ANALYSIS					
Temperature	-	°C	-	21.7	-
pH	APHA-4500H+ B	pH unit	0.01	8.15	6.5-8.4
Biological Oxygen Demand	APHA-5210 B	mg/l	1.0	<1.0	-
Chemical Oxygen Demand	APHA-5220-D	mg/l	1.0	15.0	-
Total Suspended Solid	APHA-2540-D	mg/l	1.0	27.0	-
Chloride (Cl)	APHA-4500Cl- B	mg/l	0.24	120.44	4-10
Total Dissolved Solid (TDS)	APHA-2540 C	mg/l	1.0	1424.0	450-2000
Sulphate	APHA-4500-SO_4C	mg/l	0.41	88.08	-
Oil and Grease	USEPA-1664	mg/l	0.1	1.6	-
Phenolic Compound	APHA-5530 D	mg/l	0.01	<0.01	-
Fluoride (F)	APHA-4500F- C	mg/l	0.01	<0.01	1.0
Cyanide (CN)	APHA-4500CN E	mg/l	0.01	<0.01	-
Detergent	APHA-5540 B	mg/l	-	ND	-
Sulphide	APHA-4500-S_2-E	mg/l	0.4	<0.4	-
Ammonia	APHA-4500-NH_3-B	mg/l	0.002	<0.002	-
Cadmium	APHA-3500Cd B	mg/l	0.0028	<0.0028	0.10
Chromium	APHA-3500Cr B	mg/l	0.0054	<0.0054	0.10
Copper	APHA-3500Cu B	mg/l	0.0045	<0.0045	0.20
Lead	APHA-3500-Pb B	mg/l	0.013	<0.013	5.0
Nickel	APHA-3111 Ni B	mg/l	0.008	<0.008	0.20
Iron	APHA-3111Fe B	mg/l	0.1	0.2	-
Manganese	APHA-3111Mn B	mg/l	0.0016	<0.0016	0.20
Mercury	APHA-3500-Hg B	mg/l	0.0008	<0.0008	-
Zinc	APHA-3500-Zn B	mg/l	0.0033	<0.0033	2.0
Arsenic	APHA-3500As B	mg/l	0.01	<0.01	0.10
Silver	APHA-3111Ag-B	mg/l	0.0032	<0.0032	-
Barium	APHA-3500Ba B	mg/l	0.031	<0.031	-
Boron	APHA-4500B-C	mg/l	0.1	<0.1	0.7-3.0
Total Chlorine	APHA-4500Cl-B	mg/l	0.1	<0.1	-
Selenium	APHA-3500Se C	mg/l	-	ND	-
Total Toxic Metals	By Calculation	mg/l	-	<0.01	-

Abbreviations:

ND: Not Detected **LOR:** Limit of Reporting **FAO:** Food and Agriculture Organization

Note:

Uncertainty of all the parameters and laboratory conditions at the time of analysis will be provided as per client's requirement. The lab environmental conditions are maintained at 25±5C° and humidity at 50±20%.* ***Disclaimer:* *The results are solely of the samples provided.*

***FAO Standards applied especially if the water is being used for irrigation purpose.*

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Serial # 20B / 23211

Sample Details			
Job Ref. No:	GCEC-PK-475/2021	Client Name:	WAPDA
No. of Samples:	One	Sample Matrix:	Surface Water Sample
Sample Date:	05-01-2022	Sampling Method:	APHA 1060-B & C
Sample Receipt Date:	06-01-2022	Sampled By:	GCEC



Sample Identification			
02	Dam Axis	Sampling Coordinates	29°34'15.0"N 70°00'40.0"E

Parameters	Analysis Method	Unit	LOR	Result 02	FAO**
PHYSICAL & CHEMICAL ANALYSIS					
Temperature	-	°C	-	21.7	-
pH	APHA-4500H+ B	pH unit	0.01	7.89	6.5-8.4
Biological Oxygen Demand	APHA-5210 B	mg/l	1.0	2.6	-
Chemical Oxygen Demand	APHA-5220-D	mg/l	1.0	18.0	-
Total Suspended Solid	APHA-2540-D	mg/l	1.0	37.0	-
Chloride (Cl)	APHA-4500Cl- B	mg/l	0.24	116.55	4-10
Total Dissolved Solid (TDS)	APHA-2540 C	mg/l	1.0	1689.0	450-2000
Sulphate	APHA-4500-SO_4C	mg/l	0.41	105.36	-
Oil and Grease	USEPA-1664	mg/l	0.1	3.2	-
Phenolic Compound	APHA-5530 D	mg/l	0.01	<0.01	-
Fluoride (F)	APHA-4500F- C	mg/l	0.01	<0.01	1.0
Cyanide (CN)	APHA-4500CN E	mg/l	0.01	<0.01	-
Detergent	APHA-5540 B	mg/l	-	ND	-
Sulphide	APHA-4500-S_2-E	mg/l	0.4	<0.4	-
Ammonia	APHA-4500-NH_3-B	mg/l	0.002	<0.002	-
Cadmium	APHA-3500Cd B	mg/l	0.0028	<0.0028	0.10
Chromium	APHA-3500Cr B	mg/l	0.0054	<0.0054	0.10
Copper	APHA-3500Cu B	mg/l	0.0045	<0.0045	0.20
Lead	APHA-3500-Pb B	mg/l	0.013	<0.013	5.0
Nickel	APHA-3111 Ni B	mg/l	0.008	<0.008	0.20
Iron	APHA-3111Fe B	mg/l	0.1	0.3	-
Manganese	APHA-3111Mn B	mg/l	0.0016	<0.0016	0.20
Mercury	APHA-3500-Hg B	mg/l	0.0008	<0.0008	-
Zinc	APHA-3500-Zn B	mg/l	0.0033	<0.0033	2.0
Arsenic	APHA-3500As B	mg/l	0.01	<0.01	0.10
Silver	APHA-3111Ag-B	mg/l	0.0032	<0.0032	-
Barium	APHA-3500Ba B	mg/l	0.031	<0.031	-
Boron	APHA-4500B-C	mg/l	0.1	<0.1	0.7-3.0
Total Chlorine	APHA-4500Cl-B	mg/l	0.1	<0.1	-
Selenium	APHA-3500Se C	mg/l	-	ND	-
Total Toxic Metals	By Calculation	mg/l	-	<0.01	-

Abbreviations:

ND: Not Detected **LOR:** Limit of Reporting **FAO:** Food and Agriculture Organization

Note:

Uncertainty of all the parameters and laboratory conditions at the time of analysis will be provided as per client's requirement. The lab environmental conditions are maintained at 25±5C° and humidity at 50±20%.* ***Disclaimer:* *The results are solely of the samples provided.*

***FAO Standards applied especially if the water is being used for irrigation purpose.*

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Serial # 20B / 23212

Sample Details			
Job Ref. No:	GCEC-PK-475/2021	Client Name:	WAPDA
No. of Samples:	One	Sample Matrix:	Surface Water Sample
Sample Date:	05-01-2022	Sampling Method:	APHA 1060-B & C
Sample Receipt Date:	06-01-2022	Sampled By:	GCEC
Sample Identification			
03	Kachi Canal (Meeranpur)	Sampling Coordinates	29°24'10.0"N 70°17'58.0"E



Parameters	Analysis Method	Unit	LOR	Result 03	FAO**
PHYSICAL & CHEMICAL ANALYSIS					
Temperature	-	°C	-	21.7	-
pH	APHA-4500H+ B	pH unit	0.01	7.84	6.5-8.4
Biological Oxygen Demand	APHA-5210 B	mg/l	1.0	<1.0	-
Chemical Oxygen Demand	APHA-5220-D	mg/l	1.0	7.0	-
Total Suspended Solid	APHA-2540-D	mg/l	1.0	48.0	-
Chloride (Cl)	APHA-4500Cl- B	mg/l	0.24	11.65	4-10
Total Dissolved Solid (TDS)	APHA-2540 C	mg/l	1.0	188.0	450-2000
Sulphate	APHA-4500-SO_4C	mg/l	0.41	26.34	-
Oil and Grease	USEPA-1664	mg/l	0.1	3.5	-
Phenolic Compound	APHA-5530 D	mg/l	0.01	<0.01	-
Fluoride (F)	APHA-4500F- C	mg/l	0.01	<0.01	1.0
Cyanide (CN)	APHA-4500CN E	mg/l	0.01	<0.01	-
Detergent	APHA-5540 B	mg/l	-	ND	-
Sulphide	APHA-4500-S_2-E	mg/l	0.4	<0.4	-
Ammonia	APHA-4500-NH_3-B	mg/l	0.002	<0.002	-
Cadmium	APHA-3500Cd B	mg/l	0.0028	<0.0028	0.10
Chromium	APHA-3500Cr B	mg/l	0.0054	<0.0054	0.10
Copper	APHA-3500Cu B	mg/l	0.0045	<0.0045	0.20
Lead	APHA-3500-Pb B	mg/l	0.013	<0.013	5.0
Nickel	APHA-3111 Ni B	mg/l	0.008	<0.008	0.20
Iron	APHA-3111Fe B	mg/l	0.1	<0.1	-
Manganese	APHA-3111Mn B	mg/l	0.0016	<0.0016	0.20
Mercury	APHA-3500-Hg B	mg/l	0.0008	<0.0008	-
Zinc	APHA-3500-Zn B	mg/l	0.0033	<0.0033	2.0
Arsenic	APHA-3500As B	mg/l	0.01	<0.01	0.10
Silver	APHA-3111Ag-B	mg/l	0.0032	<0.0032	-
Barium	APHA-3500Ba B	mg/l	0.031	<0.031	-
Boron	APHA-4500B-C	mg/l	0.1	<0.1	0.7-3.0
Total Chlorine	APHA-4500Cl-B	mg/l	0.1	<0.1	-
Selenium	APHA-3500Se C	mg/l	-	ND	-
Total Toxic Metals	By Calculation	mg/l	-	<0.01	-

Abbreviations:

ND: Not Detected **LOR:** Limit of Reporting **FAO:** Food and Agriculture Organization

Note:

Uncertainty of all the parameters and laboratory conditions at the time of analysis will be provided as per client's requirement. The lab environmental conditions are maintained at 25±5C° and humidity at 50±20%.* ***Disclaimer:* *The results are solely of the samples provided.*

***FAO Standards applied especially if the water is being used for irrigation purpose.*

Lab Manager
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GCEC

PNAC Pakistan National Accreditation Council LAB 121 17025

Punjab-EPA Certified

Federal-EPA Certified

Serial # 20B / 23213

Sample Details			
Job Ref. No:	GCEC-PK-475/2021	Client Name:	WAPDA
No. of Samples:	One	Sample Matrix:	Surface Water Sample
Sample Date:	05-01-2022	Sampling Method:	APHA 1060-B & C
Sample Receipt Date:	06-01-2022	Sampled By:	GCEC

Sample Identification			
04	Kachi Canal	Sampling Coordinates	29°34'49.0"N 70°20'04.0"E



Parameters	Analysis Method	Unit	LOR	Result 04	FAO**
PHYSICAL & CHEMICAL ANALYSIS					
Temperature	-	°C	-	21.7	-
pH	APHA-4500H+ B	pH unit	0.01	7.90	6.5-8.4
Biological Oxygen Demand	APHA-5210 B	mg/l	1.0	<1.0	-
Chemical Oxygen Demand	APHA-5220-D	mg/l	1.0	9.0	-
Total Suspended Solid	APHA-2540-D	mg/l	1.0	29.0	-
Chloride (Cl)	APHA-4500Cl- B	mg/l	0.24	11.65	4-10
Total Dissolved Solid (TDS)	APHA-2540 C	mg/l	1.0	191.0	450-2000
Sulphate	APHA-4500-SO_4C	mg/l	0.41	29.22	-
Oil and Grease	USEPA-1664	mg/l	0.1	2.1	-
Phenolic Compound	APHA-5530 D	mg/l	0.01	<0.01	-
Fluoride (F)	APHA-4500F- C	mg/l	0.01	<0.01	1.0
Cyanide (CN)	APHA-4500CN E	mg/l	0.01	<0.01	-
Detergent	APHA-5540 B	mg/l	-	ND	-
Sulphide	APHA-4500-S_2-E	mg/l	0.4	<0.4	-
Ammonia	APHA-4500-NH_3-B	mg/l	0.002	<0.002	-
Cadmium	APHA-3500Cd B	mg/l	0.0028	<0.0028	0.10
Chromium	APHA-3500Cr B	mg/l	0.0054	<0.0054	0.10
Copper	APHA-3500Cu B	mg/l	0.0045	<0.0045	0.20
Lead	APHA-3500-Pb B	mg/l	0.013	<0.013	5.0
Nickel	APHA-3111 Ni B	mg/l	0.008	<0.008	0.20
Iron	APHA-3111Fe B	mg/l	0.1	<0.1	-
Manganese	APHA-3111Mn B	mg/l	0.0016	<0.0016	0.20
Mercury	APHA-3500-Hg B	mg/l	0.0008	<0.0008	-
Zinc	APHA-3500-Zn B	mg/l	0.0033	<0.0033	2.0
Arsenic	APHA-3500As B	mg/l	0.01	<0.01	0.10
Silver	APHA-3111Ag-B	mg/l	0.0032	<0.0032	-
Barium	APHA-3500Ba B	mg/l	0.031	<0.031	-
Boron	APHA-4500B-C	mg/l	0.1	<0.1	0.7-3.0
Total Chlorine	APHA-4500Cl-B	mg/l	0.1	<0.1	-
Selenium	APHA-3500Se C	mg/l	-	ND	-
Total Toxic Metals	By Calculation	mg/l	-	<0.01	-

Abbreviations:

ND: Not Detected **LOR:** Limit of Reporting **FAO:** Food and Agriculture Organization

Note:

Uncertainty of all the parameters and laboratory conditions at the time of analysis will be provided as per client's requirement. The lab environmental conditions are maintained at 25±5C° and humidity at 50±20%.* ***Disclaimer:* *The results are solely of the samples provided.*

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GCEC

PNAC Pakistan National Accreditation Council LAB 121 17025

Punjab-EPA Certified

Federal-EPA Certified

Serial # 20B / 23214

Ambient Air & Noise Monitoring Location-1

DARRAH MURUNJ DAM

(Rajanpur District)



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Ambient Air Quality Monitoring

Job Reference Number	GCEC-PK-475/2021
Monitoring Point	Darrah Murunj Dam
Date of Intervention	01-01-2022 to 02-01-2022
Monitoring Coordinates	29°33'13.5"N 70°02'38.0"E

Sr. #	Time	CO (mg/m³)	NO (µg/m³)	NO_2 (µg/m³)	NO_x (µg/m³)	SO_2 (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	SPM (µg/m³)	Lead (µg/m³)
1.	15:00	0.87	10.79	19.63	30.42	13.75	10	60	137	0.027
2.	16:00	0.84	11.43	18.15	29.57	14.66	12	62	137	0.027
3.	17:00	0.91	13.27	19.27	32.53	14.53	13	65	138	0.027
4.	18:00	0.73	12.44	21.87	34.31	15.68	15	68	139	0.025
5.	19:00	0.65	14.47	22.18	36.65	16.75	13	77	140	0.025
6.	20:00	0.87	14.34	21.91	36.25	15.79	17	83	141	0.025
7.	21:00	0.74	12.65	20.40	33.05	13.67	19	90	143	0.023
8.	22:00	0.73	12.02	19.52	31.54	17.32	20	98	145	0.023
9.	23:00	0.79	8.62	16.86	25.47	12.31	22	106	147	0.023
10.	00:00	0.61	10.45	20.45	30.91	10.83	23	112	151	0.019
11.	01:00	0.55	11.95	23.58	35.53	12.98	24	120	154	0.016
12.	02:00	0.30	8.66	16.86	25.52	8.34	25	121	157	0.015
13.	03:00	0.46	6.47	17.97	24.43	7.35	26	124	161	0.014
14.	04:00	0.70	7.95	19.24	27.19	6.74	26	125	164	0.018
15.	05:00	0.56	9.29	20.46	29.75	8.61	23	119	166	0.017
16.	06:00	0.50	8.57	21.53	30.10	7.87	24	118	169	0.017
17.	07:00	0.60	11.54	21.71	33.25	10.07	25	118	170	0.017
18.	08:00	0.67	16.05	25.09	41.14	12.42	20	116	165	0.019
19.	09:00	0.81	14.90	22.21	37.11	16.56	19	112	161	0.019
20.	10:00	0.76	13.77	23.47	37.23	18.93	19	109	161	0.018
21.	11:00	0.79	12.66	22.80	35.46	15.59	19	106	156	0.018
22.	12:00	0.81	14.52	21.83	36.35	17.51	19	88	153	0.019
23.	13:00	0.78	14.90	23.45	38.35	13.53	17	79	152	0.02
24.	14:00	0.85	13.78	23.22	37.00	15.77	16	73	149	0.02
Average Concentration		**0.70**	**11.90**	**20.99**	**32.88**	**13.23**	**19.42**	**97.88**	**152.30**	**0.020**

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Ambient Air Quality Monitoring

Job Reference Number	GCEC-PK-475/2021
Monitoring Point	Darrah Murunj Dam
Date of Intervention	01-01-2022 to 02-01-2022
Monitoring Coordinates	29°33'13.5"N 70°02'38.0"E

Parameter	Unit	Monitoring Duration	LDL	Average Obtained Concentration	PEQS
Nitrogen Dioxide (NO_2)	µg/m³	24 Hours	1.00	20.99	80.0
Nitrogen Oxide (NO)	µg/m³	24 Hours	1.00	11.90	40.0
NO_X	µg/m³	24 Hours	1.00	32.88	120.0
Sulphur Dioxide (SO_2)	µg/m³	24 Hours	1.00	13.23	120.0
Carbon Monoxide (CO)	mg/m³	08 Hours	0.01	0.70	05.0*
Ozone (O_3)	µg/m³	01 Hour	-	11.56	130.0**
Particulate Matter ($PM_{2.5}$)	µg/m³	24 Hours	1.00	19.42	35.0
Particulate Matter (PM_{10})	µg/m³	24 Hours	1.00	97.88	150.0
Suspended Particulate Matter (SPM)	µg/m³	24 Hours	1.00	152.30	500.0
Lead Airborne Particles	µg/m³	24 Hours	-	0.020	1.5

Abbreviations:
µg/m³= Micrograms per Cubic Meter
mg/m³= Milligrams per Cubic Meter
LDL= Lowest Detection Limit
PEQS= Punjab Environmental Quality Standards
*08 hour standard for CO
**01 hour standard for O_3

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Meteorological Data

Job Reference Number	GCEC-PK-475/2021
Monitoring Point	Darrah Murunj Dam
Date of Intervention	01-01-2022 to 02-01-2022
Monitoring Coordinates	29°33'13.5"N 70°02'38.0"E

Time	Ambient Temperature ^{0}C	Wind Direction	Wind Velocity m/s	Humidity %	Pressure (mm of Hg)
15:00	18	NE	1.4	45	766.8
16:00	18	NW	1.8	46	767.1
17:00	18	NE	1.9	47	767.9
18:00	17	N	2.0	49	767.8
19:00	15	N	1.9	48	767.6
20:00	13	S	2.0	44	766.6
21:00	11	NS	1.9	45	766.8
22:00	11	NS	2.0	46	767.1
23:00	10	NS	1.6	47	767.5
00:00	10	S	1.3	49	767.8
01:00	9	NS	1.8	48	767.6
02:00	8	S	1.1	44	766.6
03:00	7	N	0.8	45	766.8
04:00	7	NW	1.3	45	767.1
05:00	6	NS	1.2	46	767.5
06:00	7	S	1.0	47	767.3
07:00	8	NS	0.9	49	767.4
08:00	11	S	1.2	48	766.6
09:00	13	N	1.3	48	766.8
10:00	15	N	1.2	46	767.1
11:00	17	NW	1.5	44	767.5
12:00	19	NE	1.7	43	767.3
13:00	20	NE	1.8	42	767.4
14:00	21	NW	2.2	38	767.5

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Noise Level Monitoring Report

Job Reference Number	GCEC-PK-475/2021
Monitoring Point	Darrah Murunj Dam
Date of Intervention	01-01-2022 to 02-01-2022
Monitoring Coordinates	29°33'13.5"N 70°02'38.0"E

Sr. #	Time	Method/Technique	Unit	Results LAavg	PEQS (Residential)
Night Time					
1.	23:00	Noise Meter	dB	39.2	
2.	00:00	Noise Meter	dB	40.4	
3.	01:00	Noise Meter	dB	35.5	
4.	02:00	Noise Meter	dB	31.1	
5.	03:00	Noise Meter	dB	33.0	45.0
6.	04:00	Noise Meter	dB	30.8	
7.	05:00	Noise Meter	dB	31.5	
8.	06:00	Noise Meter	dB	34.2	
Night Time Average			**dB**	**34.48**	**45.0**
Day Time					
9.	07:00	Noise Meter	dB	44.4	
10.	08:00	Noise Meter	dB	41.5	
11.	09:00	Noise Meter	dB	41.7	
12.	10:00	Noise Meter	dB	42.9	
13.	11:00	Noise Meter	dB	45.7	
14.	12:00	Noise Meter	dB	49.7	
15.	13:00	Noise Meter	dB	50.9	
16.	14:00	Noise Meter	dB	51.7	
17.	15:00	Noise Meter	dB	48.4	55.0
18.	16:00	Noise Meter	dB	52.8	
19.	17:00	Noise Meter	dB	49.3	
20.	18:00	Noise Meter	dB	50.1	
21.	19:00	Noise Meter	dB	47.3	
22.	20:00	Noise Meter	dB	45.5	
23.	21:00	Noise Meter	dB	42.3	
24.	22:00	Noise Meter	dB	40.7	
Day Time Average			**dB**	**46.55**	**55.0**

Lab Manager
Green Crescent Environmental Consultants (Pvt) Ltd.

Ambient Air & Noise Monitoring Location-1

LUNDI SAIDAN

(Rajanpur District - Murunj Dam)



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Ambient Air Quality Monitoring

Job Reference Number	GCEC-PK-475/2021
Monitoring Point	Lundi Saidan
Date of Intervention	02-01-2022 to 03-01-2022
Monitoring Coordinates	29°30'09.9"N 70°08'35.3"E

Sr. #	Time	CO (mg/m³)	NO (µg/m³)	NO_2 (µg/m³)	NO_x (µg/m³)	SO_2 (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	SPM (µg/m³)	Lead (µg/m³)
1.	15:30	1.14	11.03	20.41	31.44	13.08	11	62	139	0.037
2.	16:30	1.11	11.6	19.08	30.68	13.89	13	64	139	0.037
3.	17:30	1.17	13.24	20.08	33.32	13.78	14	67	140	0.037
4.	18:30	1.01	12.5	22.41	34.91	14.80	16	70	141	0.035
5.	19:30	0.94	14.32	22.68	37.00	15.75	14	79	142	0.035
6.	20:30	1.14	14.2	22.44	36.64	14.90	18	85	143	0.035
7.	21:30	1.02	12.69	21.09	33.78	13.01	20	92	145	0.033
8.	22:30	1.01	12.13	20.31	32.44	16.27	21	100	147	0.033
9.	23:30	1.07	9.09	17.93	27.02	11.79	22	108	149	0.033
10.	00:30	0.91	10.73	21.14	31.87	10.47	23	114	153	0.029
11.	01:30	0.85	12.07	23.93	36.00	12.39	24	122	156	0.026
12.	02:30	0.63	9.13	17.93	27.06	8.25	25	123	159	0.025
13.	03:30	0.77	7.17	18.92	26.09	7.37	26	126	163	0.024
14.	04:30	0.99	8.49	20.06	28.55	6.82	25	127	166	0.028
15.	05:30	0.86	9.69	21.15	30.84	8.49	24	121	168	0.027
16.	06:30	0.81	9.05	22.10	31.15	7.83	25	120	171	0.027
17.	07:30	0.9	11.7	22.26	33.96	9.79	24	120	172	0.027
18.	08:30	0.96	15.73	25.28	41.01	11.89	21	118	167	0.029
19.	09:30	1.08	14.7	22.71	37.41	15.59	20	114	163	0.029
20.	10:30	1.04	13.69	23.83	37.52	17.70	20	111	163	0.031
21.	11:30	1.07	12.7	23.24	35.94	14.72	20	108	158	0.03
22.	12:30	1.08	14.36	22.37	36.73	16.43	20	90	155	0.03
23.	13:30	1.06	14.7	23.82	38.52	12.88	18	81	154	0.033
24.	15:30	1.12	13.7	23.61	37.31	14.88	17	75	151	0.035
Average Concentration		**0.99**	**12.02**	**21.61**	**33.63**	**12.62**	**20.05**	**100.29**	**154.34**	**0.031**

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Ambient Air Quality Monitoring

Job Reference Number	GCEC-PK-475/2021
Monitoring Point	Lundi Saidan
Date of Intervention	02-01-2022 to 03-01-2022
Monitoring Coordinates	29°30'09.9"N 70°08'35.3"E

Parameter	Unit	Monitoring Duration	LDL	Average Obtained Concentration	PEQS
Nitrogen Dioxide (NO_2)	µg/m³	24 Hours	1.00	21.61	80.0
Nitrogen Oxide (NO)	µg/m³	24 Hours	1.00	12.02	40.0
NO_X	µg/m³	24 Hours	1.00	33.63	120.0
Sulphur Dioxide (SO_2)	µg/m³	24 Hours	1.00	12.62	120.0
Carbon Monoxide (CO)	mg/m³	08 Hours	0.01	0.99	05.0*
Ozone (O_3)	µg/m³	01 Hour	-	11.09	130.0**
Particulate Matter ($PM_{2.5}$)	µg/m³	24 Hours	1.00	20.05	35.0
Particulate Matter (PM_{10})	µg/m³	24 Hours	1.00	100.29	150.0
Suspended Particulate Matter (SPM)	µg/m³	24 Hours	1.00	154.34	500.0
Lead Airborne Particles	µg/m³	24 Hours	-	0.031	1.5

Abbreviations:
µg/m³= Micrograms per Cubic Meter
mg/m³= Milligrams per Cubic Meter
LDL= Lowest Detection Limit
PEQS= Punjab Environmental Quality Standards
*08 hour standard for CO
**01 hour standard for O_3

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Meteorological Data

Job Reference Number	GCEC-PK-475/2021
Monitoring Point	Lundi Saidan
Date of Intervention	02-01-2022 to 03-01-2022
Monitoring Coordinates	29°30'09.9"N 70°08'35.3"E

Time	Ambient Temperature °C	Wind Direction	Wind Velocity m/s	Humidity %	Pressure (mm of Hg)
15:30	21	NE	2.0	34	768.4
16:30	20	NE	2.4	36	768.2
17:30	20	NW	2.5	36	767.2
18:30	20	NS	2.6	37	767.4
19:30	19	NS	2.5	37	767.7
20:30	19	NS	2.6	38	768.1
21:30	18	S	2.5	39	768.5
22:30	16	NW	2.6	32	768.4
23:30	15	NS	2.2	34	768.2
00:30	14	NS	1.9	34	768.2
01:30	11	NS	2.4	36	767.2
02:30	10	S	2.5	36	767.4
03:30	9	NS	2.6	37	767.7
04:30	10	S	2.5	37	768.1
05:30	11	NS	2.6	38	768.5
06:30	12	S	2.2	39	768.4
07:30	13	NS	1.9	41	768.2
08:30	13	S	2.4	40	767.2
09:30	15	N	2.7	40	767.4
10:30	18	N	1.8	38	767.7
11:30	18	NW	2.1	36	768.1
12:30	19	NE	2.3	35	767.9
13:30	19	NE	2.4	34	768.0
14:30	19	NW	2.8	30	768.1

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Noise Level Monitoring Report

Job Reference Number	GCEC-PK-475/2021
Monitoring Point	Lundi Saidan
Date of Intervention	02-01-2022 to 03-01-2022
Monitoring Coordinates	29°30'09.9"N 70°08'35.3"E

Sr. #	Time	Method/Technique	Unit	Results LAavg	PEQS (Residential)
Night Time					
1.	23:00	Noise Meter	dB	48.7	
2.	00:00	Noise Meter	dB	49.9	
3.	01:00	Noise Meter	dB	35.4	
4.	02:00	Noise Meter	dB	35.3	
5.	03:00	Noise Meter	dB	37.2	45.0
6.	04:00	Noise Meter	dB	35.0	
7.	05:00	Noise Meter	dB	35.7	
8.	06:00	Noise Meter	dB	38.4	
Night Time Average			**dB**	**39.46**	**45.0**
Day Time					
9.	07:00	Noise Meter	dB	43.6	
10.	08:00	Noise Meter	dB	40.7	
11.	09:00	Noise Meter	dB	48.7	
12.	10:00	Noise Meter	dB	51.7	
13.	11:00	Noise Meter	dB	51.8	
14.	12:00	Noise Meter	dB	51.9	
15.	13:00	Noise Meter	dB	52.3	
16.	14:00	Noise Meter	dB	52.5	
17.	15:00	Noise Meter	dB	54.9	55.0
18.	16:00	Noise Meter	dB	59.3	
19.	17:00	Noise Meter	dB	55.8	
20.	18:00	Noise Meter	dB	56.6	
21.	19:00	Noise Meter	dB	53.8	
22.	20:00	Noise Meter	dB	52.0	
23.	21:00	Noise Meter	dB	48.8	
24.	22:00	Noise Meter	dB	47.2	
Day Time Average			**dB**	**51.35**	**55.0**

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Ambient Air & Noise Monitoring
Location-1
DAM AXIS (MATT KHUND)
(Rajanpur District - Murunj Dam)



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Ambient Air Quality Monitoring

Job Reference Number	GCEC-PK-475/2021
Monitoring Point	Dam Axis (Matt Khund)
Date of Intervention	03-01-2022 to 04-01-2022
Monitoring Coordinates	29°34'10.2"N 70°00'33.3"E

Sr. #	Time	CO (mg/m³)	NO (µg/m³)	NO_2 (µg/m³)	NO_x (µg/m³)	SO_2 (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	SPM (µg/m³)	Lead (µg/m³)
1.	15:30	0.76	9.74	18.60	28.34	10.93	9	59	133	0.024
2.	16:30	0.74	10.28	17.34	27.62	11.75	11	61	133	0.024
3.	17:30	0.79	11.84	18.29	30.13	11.63	12	64	134	0.024
4.	18:30	0.64	11.14	17.55	28.69	12.67	14	67	135	0.022
5.	19:30	0.57	12.87	17.52	30.39	13.63	12	76	136	0.022
6.	20:30	0.76	12.75	17.29	30.04	12.77	16	82	137	0.022
7.	21:30	0.65	11.32	16.39	27.71	12.76	18	89	139	0.02
8.	22:30	0.64	10.79	15.65	26.43	14.15	19	97	141	0.02
9.	23:30	0.70	11.35	16.39	27.74	9.63	20	105	143	0.02
10.	00:30	0.69	12.91	16.59	29.49	8.30	21	111	147	0.016
11.	01:30	0.54	14.18	15.44	29.62	10.24	22	119	150	0.013
12.	02:30	0.42	11.39	16.39	27.77	13.62	23	120	153	0.012
13.	03:30	0.56	9.52	17.33	26.85	12.26	24	123	157	0.011
14.	04:30	0.76	10.78	18.41	29.19	11.71	23	124	160	0.015
15.	05:30	0.64	11.92	19.45	31.37	13.39	22	118	162	0.014
16.	06:30	0.69	11.31	20.35	31.66	11.72	23	117	165	0.014
17.	07:30	0.75	13.23	20.35	33.58	12.69	22	117	166	0.014
18.	08:30	0.69	14.21	21.35	35.55	13.80	19	115	161	0.016
19.	09:30	0.77	13.23	21.76	34.98	14.93	18	111	157	0.016
20.	10:30	0.67	12.27	19.97	32.24	15.05	18	108	157	0.018
21.	11:30	0.70	11.33	20.36	31.69	14.09	18	105	152	0.017
22.	12:30	0.71	12.91	20.48	33.39	13.80	18	87	149	0.017
23.	13:30	0.69	13.23	19.96	33.19	13.26	16	78	148	0.02
24.	14:30	0.75	12.28	19.76	32.04	12.28	15	72	145	0.022
Average Concentration		**0.68**	**11.95**	**18.46**	**30.40**	**12.54**	**17.71**	**96.75**	**148.46**	**0.018**

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Ambient Air Quality Monitoring

Job Reference Number	GCEC-PK-475/2021
Monitoring Point	Dam Axis (Matt Khund)
Date of Intervention	03-01-2022 to 04-01-2022
Monitoring Coordinates	29°34'10.2"N 70°00'33.3"E

Parameter	Unit	Monitoring Duration	LDL	Average Obtained Concentration	PEQS
Nitrogen Dioxide (NO_2)	µg/m³	24 Hours	1.00	18.46	80.0
Nitrogen Oxide (NO)	µg/m³	24 Hours	1.00	11.95	40.0
NO_X	µg/m³	24 Hours	1.00	30.40	120.0
Sulphur Dioxide (SO_2)	µg/m³	24 Hours	1.00	12.54	120.0
Carbon Monoxide (CO)	mg/m³	08 Hours	0.01	0.68	05.0*
Ozone (O_3)	µg/m³	01 Hour	-	10.78	130.0**
Particulate Matter ($PM_{2.5}$)	µg/m³	24 Hours	1.00	17.71	35.0
Particulate Matter (PM_{10})	µg/m³	24 Hours	1.00	96.75	150.0
Suspended Particulate Matter (SPM)	µg/m³	24 Hours	1.00	148.46	500.0
Lead Airborne Particles	µg/m³	24 Hours	-	0.018	1.5

Abbreviations:
µg/m³= Micrograms per Cubic Meter
mg/m³= Milligrams per Cubic Meter
LDL= Lowest Detection Limit
PEQS= Punjab Environmental Quality Standards
*08 hour standard for CO
**01 hour standard for O_3

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Meteorological Data

Job Reference Number	GCEC-PK-475/2021
Monitoring Point	Dam Axis (Matt Khund)
Date of Intervention	03-01-2022 to 04-01-2022
Monitoring Coordinates	29°34'10.2"N 70°00'33.3"E

Time	Ambient Temperature °C	Wind Direction	Wind Velocity m/s	Humidity %	Pressure (mm of Hg)
15:30	18	NW	1.4	49	763.3
16:30	17	NE	1.8	48	763.2
17:30	17	NW	1.9	40	763.5
18:30	16	NE	2.0	42	763.3
19:30	16	N	1.9	42	763.5
20:30	16	N	2.0	44	763.4
21:30	15	NW	1.9	44	763.3
22:30	15	NW	2.0	45	763.2
23:30	14	NE	1.6	45	763.4
00:30	13	NW	1.3	46	763.3
01:30	10	NE	1.8	47	763.2
02:30	9	N	1.3	44	763.5
03:30	8	N	1.2	45	763.3
04:30	9	NW	1.2	45	763.5
05:30	10	NE	1.2	46	763.4
06:30	11	NE	1.2	47	763.3
07:30	12	NW	1.2	49	763.2
08:30	12	NE	1.2	48	762.2
09:30	14	N	1.2	48	762.4
10:30	17	N	1.4	46	762.7
11:30	17	NW	1.5	44	763.1
12:30	18	NE	1.7	43	762.9
13:30	18	NE	1.8	42	763.0
14:30	18	NW	2.2	38	763.1

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Noise Level Monitoring Report

Job Reference Number	GCEC-PK-475/2021
Monitoring Point	Dam Axis (Matt Khund)
Date of Intervention	03-01-2022 to 04-01-2022
Monitoring Coordinates	29°34'10.2"N 70°00'33.3"E

Sr. #	Time	Method/Technique	Unit	Results LAavg	PEQS (Residential)
Night Time					
1.	23:00	Noise Meter	dB	44.5	
2.	00:00	Noise Meter	dB	45.7	
3.	01:00	Noise Meter	dB	31.2	
4.	02:00	Noise Meter	dB	32.8	
5.	03:00	Noise Meter	dB	34.7	45.0
6.	04:00	Noise Meter	dB	32.5	
7.	05:00	Noise Meter	dB	33.2	
8.	06:00	Noise Meter	dB	35.9	
Night Time Average			**dB**	**36.33**	**45.0**
Day Time					
9.	07:00	Noise Meter	dB	50.1	
10.	08:00	Noise Meter	dB	47.2	
11.	09:00	Noise Meter	dB	54.8	
12.	10:00	Noise Meter	dB	55.1	
13.	11:00	Noise Meter	dB	55.5	
14.	12:00	Noise Meter	dB	55.8	
15.	13:00	Noise Meter	dB	55.9	
16.	14:00	Noise Meter	dB	55.9	
17.	15:00	Noise Meter	dB	53.7	55.0
18.	16:00	Noise Meter	dB	58.1	
19.	17:00	Noise Meter	dB	54.6	
20.	18:00	Noise Meter	dB	55.4	
21.	19:00	Noise Meter	dB	52.6	
22.	20:00	Noise Meter	dB	50.8	
23.	21:00	Noise Meter	dB	47.6	
24.	22:00	Noise Meter	dB	46.0	
Day Time Average			**dB**	**53.07**	**55.0**

Lab Manager
Green Crescent Environmental Consultants (Pvt) Ltd.

GCEC

PNAC Pakistan National Accreditation Council LAB 121 17025

Punjab-EPA Certified

Federal-EPA Certified

Serial # 20B / 23229

Ambient Air & Noise Monitoring
Location-1

TIBBI SOLGI

(Rajanpur District - Murunj Dam)



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Ambient Air Quality Monitoring

Job Reference Number	GCEC-PK-475/2021
Monitoring Point	Tibbi Solgi
Date of Intervention	04-01-2022 to 05-01-2022
Monitoring Coordinates	29°31'00.2"N 70°17'23.6"E

Sr. #	Time	CO (mg/m³)	NO (µg/m³)	NO_2 (µg/m³)	NO_x (µg/m³)	SO_2 (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	SPM (µg/m³)	Lead (µg/m³)
1.	16:30	1.08	9.59	18.98	28.57	11.03	13	67	145	0.03
2.	17:30	0.88	9.78	19.85	29.63	11.27	15	69	145	0.03
3.	18:30	1.01	11.42	20.85	32.27	11.15	16	72	146	0.03
4.	19:30	0.92	10.68	20.07	30.75	12.24	18	75	147	0.028
5.	20:30	0.83	12.5	20.04	32.54	13.25	16	84	148	0.028
6.	21:30	0.88	12.38	19.80	32.18	14.40	20	90	149	0.028
7.	22:30	0.76	11.49	18.85	30.34	10.33	22	97	151	0.026
8.	23:30	0.75	10.31	19.11	29.42	13.80	23	105	153	0.026
9.	00:30	0.81	8.9	18.85	27.75	9.04	24	113	155	0.026
10.	01:30	0.8	10.54	20.24	30.78	7.64	25	119	159	0.022
11.	02:30	0.64	8.98	18.87	27.85	9.68	26	127	162	0.019
12.	03:30	0.52	7.94	18.85	26.79	13.24	27	128	165	0.018
13.	04:30	0.66	8.98	19.84	28.82	11.81	28	131	169	0.017
14.	05:30	0.88	10.3	20.98	31.28	11.23	27	132	172	0.021
15.	06:30	0.75	11.5	22.07	33.57	13.00	26	126	174	0.02
16.	07:30	0.8	8.86	20.02	28.88	11.24	27	125	177	0.02
17.	08:30	0.86	10.88	21.02	31.9	12.26	26	125	178	0.02
18.	09:30	0.8	13.91	24.07	37.98	13.43	23	123	173	0.022
19.	10:30	0.89	12.88	21.50	34.38	14.62	22	119	169	0.022
20.	11:30	0.78	11.87	22.62	34.49	14.74	22	116	169	0.024
21.	12:30	0.81	10.88	22.03	32.91	13.73	22	113	164	0.023
22.	13:30	0.82	10.54	21.16	31.7	13.43	22	95	161	0.023
23.	14:30	0.8	12.88	22.61	35.49	12.86	20	86	160	0.026
24.	15:30	0.86	11.88	22.40	34.28	11.83	19	80	157	0.028
Average Concentration		**0.82**	**10.83**	**20.61**	**31.44**	**12.14**	**21.64**	**104.67**	**160.31**	**0.024**

Lab Manager
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Ambient Air Quality Monitoring

Job Reference Number	GCEC-PK-475/2021
Monitoring Point	Tibbi Solgi
Date of Intervention	04-01-2022 to 05-01-2022
Monitoring Coordinates	29°31'00.2"N 70°17'23.6"E

Parameter	Unit	Monitoring Duration	LDL	Average Obtained Concentration	PEQS
Nitrogen Dioxide (NO_2)	µg/m³	24 Hours	1.00	20.61	80.0
Nitrogen Oxide (NO)	µg/m³	24 Hours	1.00	10.83	40.0
NO_X	µg/m³	24 Hours	1.00	31.44	120.0
Sulphur Dioxide (SO_2)	µg/m³	24 Hours	1.00	12.14	120.0
Carbon Monoxide (CO)	mg/m³	08 Hours	0.01	0.82	05.0*
Ozone (O_3)	µg/m³	01 Hour	-	12.01	130.0**
Particulate Matter ($PM_{2.5}$)	µg/m³	24 Hours	1.00	21.64	35.0
Particulate Matter (PM_{10})	µg/m³	24 Hours	1.00	104.67	150.0
Suspended Particulate Matter (SPM)	µg/m³	24 Hours	1.00	160.31	500.0
Lead Airborne Particles	µg/m³	24 Hours	-	0.024	1.5

Abbreviations:
µg/m³= Micrograms per Cubic Meter
mg/m³= Milligrams per Cubic Meter
LDL= Lowest Detection Limit
PEQS= Punjab Environmental Quality Standards
*08 hour standard for CO
**01 hour standard for O_3

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Meteorological Data

Job Reference Number	GCEC-PK-475/2021
Monitoring Point	Tibbi Solgi
Date of Intervention	04-01-2022 to 05-01-2022
Monitoring Coordinates	29°31'00.2"N 70°17'23.6"E

Time	Ambient Temperature ^{0}C	Wind Direction	Wind Velocity m/s	Humidity %	Pressure (mm of Hg)
16:30	20	NW	1.7	40	755.3
17:30	21	NE	2.0	41	752.0
18:30	20	N	2.1	38	750.0
19:30	19	N	1.8	41	750.5
20:30	18	NW	1.9	44	751.0
21:30	17	NE	2.0	42	750.2
22:30	16	NE	2.2	45	754.1
23:30	14	NW	2.0	44	755.0
00:30	13	NE	2.4	48	758.4
01:30	11	NW	1.7	50	747.3
02:30	10	NE	2.2	52	753.5
03:30	11	N	2.0	54	752.3
04:30	11	N	1.9	57	748.5
05:30	11	NW	2.0	56	747.4
06:30	12	NE	2.0	53	755.0
07:30	14	NE	1.7	52	758.4
08:30	15	NW	2.2	55	747.3
09:30	17	NE	1.9	54	753.5
10:30	18	N	1.8	52	752.3
11:30	19	N	2.0	51	748.5
12:30	19	NW	1.9	52	747.4
13:30	20	NE	2.3	48	746.6
14:30	20	NE	1.6	49	757.4
15:30	21	NW	2.1	44	744.4

Manager
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Noise Level Monitoring Report

Job Reference Number	GCEC-PK-475/2021
Monitoring Point	Tibbi Solgi
Date of Intervention	04-01-2022 to 05-01-2022
Monitoring Coordinates	29°31'00.2"N 70°17'23.6"E

Sr. #	Time	Method/Technique	Unit	Results LAavg	PEQS (Residential)
Night Time					
1.	23:00	Noise Meter	dB	42.7	
2.	00:00	Noise Meter	dB	43.6	
3.	01:00	Noise Meter	dB	40.5	
4.	02:00	Noise Meter	dB	43.6	
5.	03:00	Noise Meter	dB	39.1	45.0
6.	04:00	Noise Meter	dB	41.0	
7.	05:00	Noise Meter	dB	38.8	
8.	06:00	Noise Meter	dB	38.6	
Night Time Average			**dB**	**40.98**	**45.0**
Day Time					
9.	07:00	Noise Meter	dB	36.8	
10.	08:00	Noise Meter	dB	42.8	
11.	09:00	Noise Meter	dB	47.0	
12.	10:00	Noise Meter	dB	47.6	
13.	11:00	Noise Meter	dB	49.5	
14.	12:00	Noise Meter	dB	43.5	
15.	13:00	Noise Meter	dB	44.2	
16.	14:00	Noise Meter	dB	47.1	
17.	15:00	Noise Meter	dB	50.6	55.0
18.	16:00	Noise Meter	dB	49.0	
19.	17:00	Noise Meter	dB	47.3	
20.	18:00	Noise Meter	dB	50.1	
21.	19:00	Noise Meter	dB	51.0	
22.	20:00	Noise Meter	dB	48.3	
23.	21:00	Noise Meter	dB	48.0	
24.	22:00	Noise Meter	dB	45.0	
Day Time Average			**dB**	**46.74**	**55.0**

Lab Manager
Green Crescent Environmental Consultants (Pvt) Ltd.

PICTORAL EVIDENCE

For

MURUNJ DAM

(1st to 5th January, 2022)

GREEN CRESCENT ENVIRONMENTAL CONSULTANTS (PVT) LTD.

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DRINKING WATER

GREEN CRESCENT ENVIRONMENTAL CONSULTANTS (PVT) LTD.

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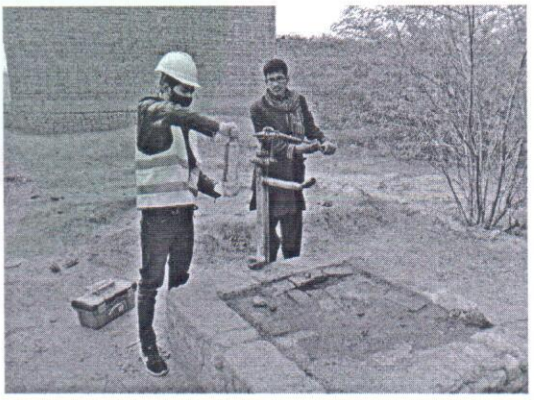
Bakhtiar Kundh (Near Dam Axis)





Bumbli Village





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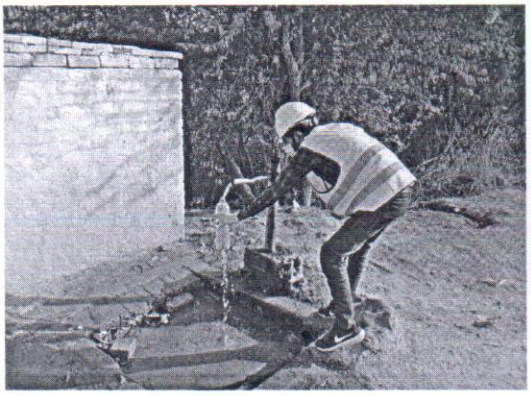
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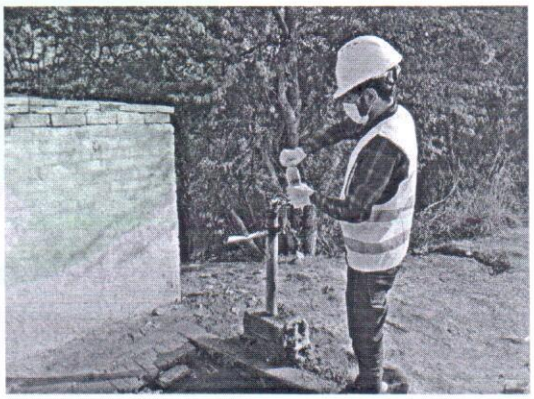
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Darbar Ameer Hamza Sultan





GREEN CRESCENT ENVIRONMENTAL CONSULTANTS (PVT) LTD.

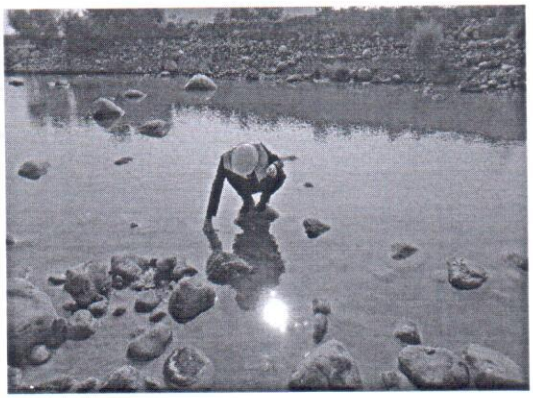
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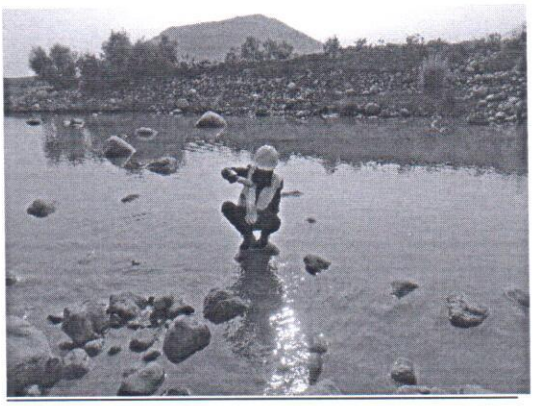
SURFACE WATER

GREEN CRESCENT ENVIRONMENTAL CONSULTANTS (PVT) LTD.

Pakistan Office: House No. 368-B Block B, Canal View, Lahore, Pakistan. Tel: +92 42 3561300 Mobile: 0321-4350777 Email: country.manager@gcee.pk Web: www.gceec.com

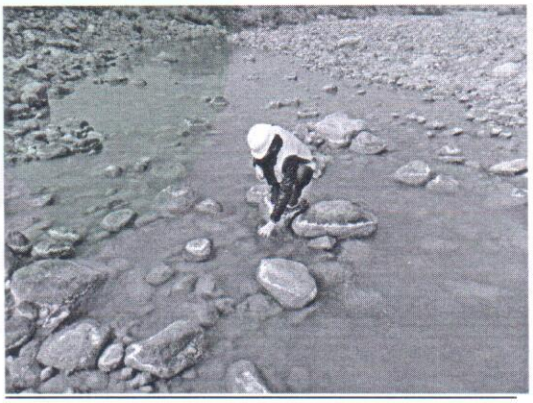
Kaha River Near Darrah





Dam Axis

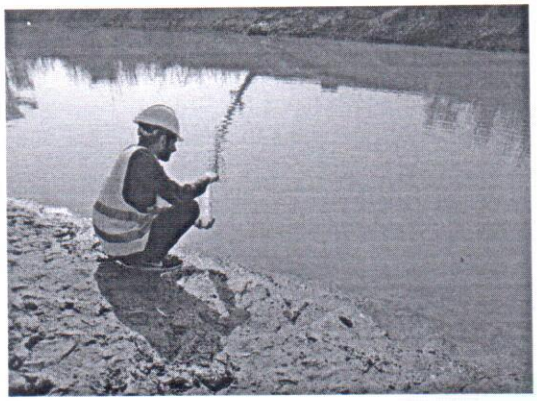


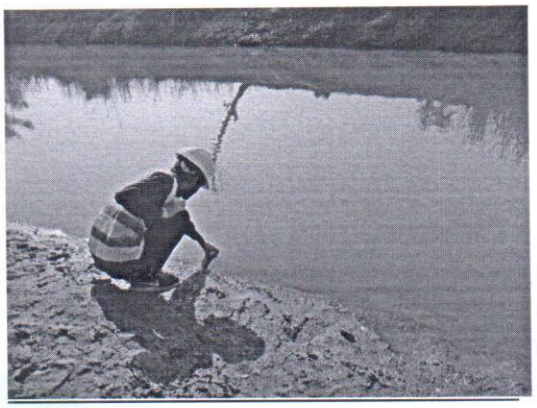


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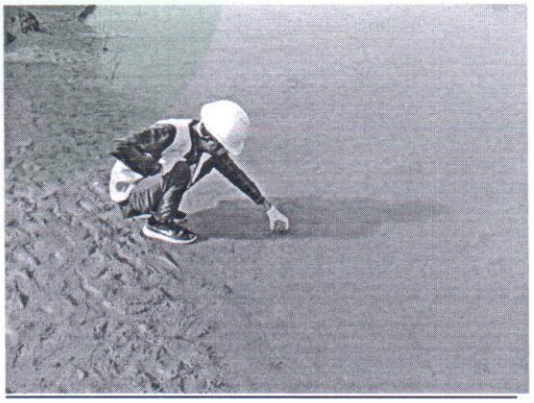
Kachi Canal (Meeranpur)





Kachi Canal





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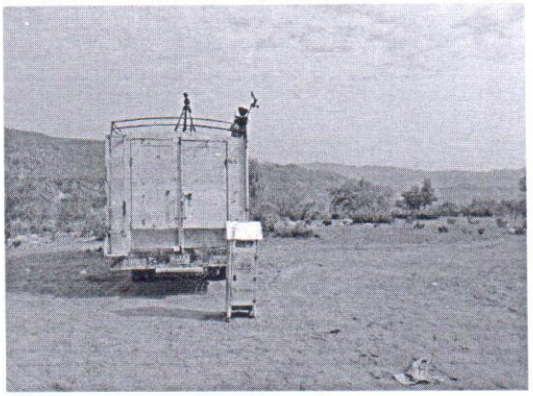
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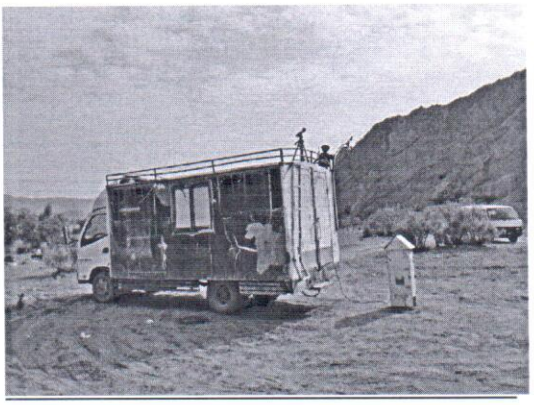
AMBIENT AIR MONITORING

GREEN CRESCENT ENVIRONMENTAL CONSULTANTS (PVT) LTD.

Pakistan Office: House No. 368-B Block B, Canal View, Lahore, Pakistan. Tel: +92 42 3561300 Mobile: 0321-4350777 Email: country.manager@gcee.pk Web: www.gceec.com

Darrah Murunj Dam





Lundi Saidan

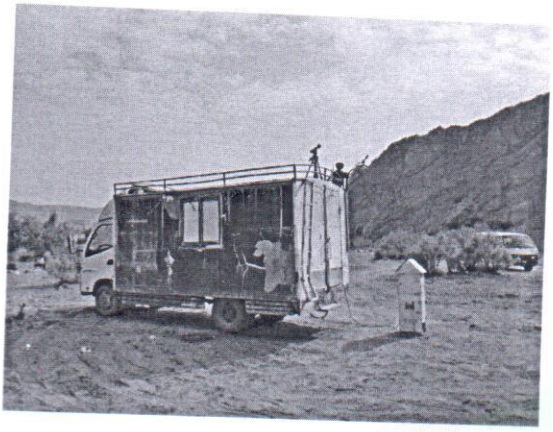


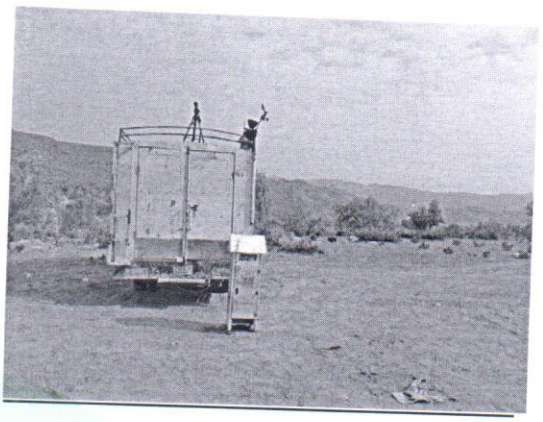


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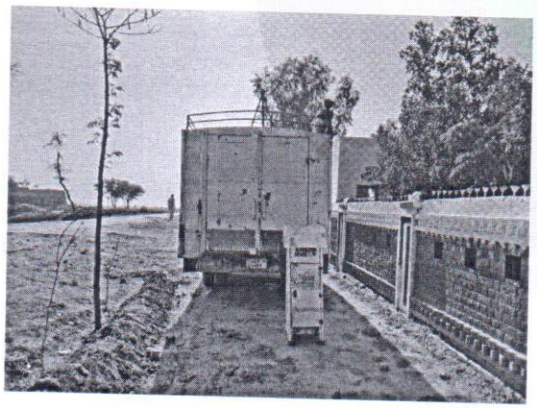
Pakistan Office: House No. 368-B Block B, Canal View, Lahore, Pakistan. Tel: +92 42 3561300 Mobile: 0321-4350777 Email: country.manager@gcee.pk Web: www.gceec.com

Dam Axis (Matt Khund)





Tibbi Solgi





End of Report

GREEN CRESCENT ENVIRONMENTAL CONSULTANTS (PVT) LTD.

Pakistan Office: House No. 368-B Block B, Canal View, Lahore, Pakistan. Tel: +92 42 3561300 Mobile: 0321-4350777 Email: country.manager@gcee.pk Web: www.gceec.com

ANNEX-IV

Letter to Departments for Consultation

Pakistan
Water and Power Development Authority

Tele: 042-99202691
Fax: 042-99202700
Email: cehydroplanning@gmail.com

Chief Engineer-II (Hydro) Planning
WAPDA, Sunny View Estate,
Kashmir Road, Lahore

No. CE-II(H)P/Works/1068/785

Date-: 01-12-2021

Divisional Forest Officer
Forest Department,
Rajanpur

Subject: STAKEHOLDER CONSULTATION - FEASIBILITY STUDY, DETAILED ENGINEERING DESIGN, PREPARATION OF TENDER DOCUMENTS & PC- I OF MURUNJ DAM PROJECT (MDP)

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As a standard practice, Environmental & Social Team visits the stakeholder and conduct consultation meetings/interview/gathering. It is requested to please depute relevant persons representing your department/organization for consultations on subject matter.

Best regards,

(Engr. Barkat Ali)
Chief Engineer-II (Hydro) Planning

Copy to:

1. Project Manager (MDC) NESPAK House,1-C, Block N Model Town Extension Lahore.
2. Engr. M. Shariq Ahmed, CE/Head ERSD/GT & GE Division, NESPAK House.
3. APS to General Manager (Hydro) Planning, WAPDA, Sunny View, Lahore.

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Pakistan
Water and Power Development Authority

Tele: 042-99202691
Fax: 042-99202700
Email: cehydroplanning@gmail.com

Chief Engineer-II (Hydro) Planning
WAPDA, Sunny View Estate,
Kashmir Road, Lahore

No. CE-II(H)P/Works/1068/786

Date-: 01-12-2021

Assistant Director Wildlife
District Office Wildlife,
Rajanpur

Subject: STAKEHOLDER CONSULTATION - FEASIBILITY STUDY, DETAILED ENGINEERING DESIGN, PREPARATION OF TENDER DOCUMENTS & PC- I OF MURUNJ DAM PROJECT (MDP)

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Pakistan
Water and Power Development Authority

Tele: 042-99202691
Fax: 042-99202700
Email: cehydroplanning@gmail.com

Chief Engineer-II (Hydro) Planning
WAPDA, Sunny View Estate,
Kashmir Road, Lahore

No. CE-II(H)P/Works/1068/787 **Date-:** 01-12-2021

Assistant Director Fisheries
District Office Fisheries,
Rajanpur

Subject: **STAKEHOLDER CONSULTATION - FEASIBILITY STUDY, DETAILED ENGINEERING DESIGN, PREPARATION OF TENDER DOCUMENTS & PC- I OF MURUNJ DAM PROJECT (MDP)**

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Water and Power Development Authority

Tele: 042-99202691
Fax: 042-99202700
Email: cehydroplanning@gmail.com

Chief Engineer-II (Hydro) Planning
WAPDA, Sunny View Estate,
Kashmir Road, Lahore

No. CE-II(H)P/Works/1068/788

Date-: 01-12-2021

Assistant Agricultural Extension Officer
District Office Agriculture Extension,
Rajanpur

Subject: STAKEHOLDER CONSULTATION - FEASIBILITY STUDY, DETAILED ENGINEERING DESIGN, PREPARATION OF TENDER DOCUMENTS & PC- I OF MURUNJ DAM PROJECT (MDP)

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Pakistan
Water and Power Development Authority

Tele: 042-99202691
Fax: 042-99202700
Email: cehydroplanning@gmail.com

Chief Engineer-II (Hydro) Planning
WAPDA, Sunny View Estate,
Kashmir Road, Lahore

No. CE-II(H)P/Works/1068/789

Date-: 01-12-2021

Assistant Director Agricultural,
District Office Agriculture,
Rajanpur

Subject: STAKEHOLDER CONSULTATION - FEASIBILITY STUDY, DETAILED ENGINEERING DESIGN, PREPARATION OF TENDER DOCUMENTS & PC- I OF MURUNJ DAM PROJECT (MDP)

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(Engr. Barkat Ali)
Chief Engineer-II (Hydro) Planning

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Pakistan
Water and Power Development Authority

Tele: 042-99202691
Fax: 042-99202700
Email: cehydroplanning@gmail.com

Chief Engineer-II (Hydro) Planning
WAPDA, Sunny View Estate,
Kashmir Road, Lahore

No. CE-II(H)P/Works/1068/794

Date-: 01-12-2021

Chief Engineer Irrigation
Irrigation Department,
D.G. Khan

Subject: STAKEHOLDER CONSULTATION - FEASIBILITY STUDY, DETAILED ENGINEERING DESIGN, PREPARATION OF TENDER DOCUMENTS & PC- I OF MURUNJ DAM PROJECT (MDP)

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Tele: 042-99202691
Fax: 042-99202700
Email: cehydroplanning@gmail.com

Chief Engineer-II (Hydro) Planning
WAPDA, Sunny View Estate,
Kashmir Road, Lahore

No. CE-II(H)P/Works/1068/790

Date-: 01-12-2021

Assistant Director Environment
Environment Protection Department,
Rajanpur

Subject: STAKEHOLDER CONSULTATION - FEASIBILITY STUDY, DETAILED ENGINEERING DESIGN, PREPARATION OF TENDER DOCUMENTS & PC- I OF MURUNJ DAM PROJECT (MDP)

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Email: cehydroplanning@gmail.com

Chief Engineer-II (Hydro) Planning
WAPDA, Sunny View Estate,
Kashmir Road, Lahore

No. CE-II(H)P/Works/1068/791 **Date-:** 01-12-2021

Deputy Director Agriculture (OFWM)
District Office-On Farm Water Management,
Rajanpur

Subject: **STAKEHOLDER CONSULTATION - FEASIBILITY STUDY, DETAILED ENGINEERING DESIGN, PREPARATION OF TENDER DOCUMENTS & PC- I OF MURUNJ DAM PROJECT (MDP)**

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Pakistan
Water and Power Development Authority

Tele: 042-99202691
Fax: 042-99202700
Email: cehydroplanning@gmail.com

Chief Engineer-II (Hydro) Planning
WAPDA, Sunny View Estate,
Kashmir Road, Lahore

No. CE-II(H)P/Works/ 1068/792 **Date-:** 01-12-2021

Deputy Director, SW&BM
District Office Social Welfare,
Rajanpur

Subject: STAKEHOLDER CONSULTATION - FEASIBILITY STUDY, DETAILED ENGINEERING DESIGN, PREPARATION OF TENDER DOCUMENTS & PC- I OF MURUNJ DAM PROJECT (MDP)

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Chief Engineer-II (Hydro) Planning
WAPDA, Sunny View Estate,
Kashmir Road, Lahore

No. CE-II(H)P/Works/1068/793 **Date-:** 01-12-2021

District Officer
Revenue Department,
Rajanpur

Subject: STAKEHOLDER CONSULTATION - FEASIBILITY STUDY, DETAILED ENGINEERING DESIGN, PREPARATION OF TENDER DOCUMENTS & PC- I OF MURUNJ DAM PROJECT (MDP)

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Chief Engineer-II (Hydro) Planning
WAPDA, Sunny View Estate,
Kashmir Road, Lahore

No. CE-II(H)P/Works/1068/795

Date-: 01-12-2021

Political Assistant
Border Military Police (BMP),
Rajanpur

Subject: STAKEHOLDER CONSULTATION - FEASIBILITY STUDY, DETAILED ENGINEERING DESIGN, PREPARATION OF TENDER DOCUMENTS & PC- I OF MURUNJ DAM PROJECT (MDP)

Water & Power Development Authority (WAPDA) has hired the services of M/s NESPAK as a Consultant in carrying out the Feasibility Study, Detailed Engineering Design, Preparation of Tender Documents & PC-I of Murunj Dam Project. Murunj Dam is planned to be constructed on Kaha Hill Torrent to meet the irrigation water requirements of the downstream cultivable area and to mitigate flood damages in the project area. The proposed project will irrigate an area of about 114,000 acres and power generation will be a by-product.

As a part of Environmental Impact Assessment study, stakeholder consultation is a mandatory requirement to ensure that the concerns and suggestions of all stakeholders is considered. Moreover, any published data, map, and reports may be shared with the consultant to make the project sustainable. In this regard, M/s NESPAK relevant team will also coordinate and visit relevant departments/offices to discuss and collect the required information.

As a standard practice, Environmental & Social Team visits the stakeholder and conduct consultation meetings/interview/gathering. It is requested to please depute relevant persons representing your department/organization for consultations on subject matter.

Best regards,

(Engr. Barkat Ali)
Chief Engineer-II (Hydro) Planning

Copy to:

1. Project Manager (MDC) NESPAK House,1-C, Block N Model Town Extension Lahore.
2. Engr. M. Shariq Ahmed, CE/Head ERSD/GT & GE Division, NESPAK House.
3. APS to General Manager (Hydro) Planning, WAPDA, Sunny View, Lahore.

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Pakistan
Water and Power Development Authority

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Chief Engineer-II (Hydro) Planning
WAPDA, Sunny View Estate,
Kashmir Road, Lahore

No. CE-II(H)P/Works/1068/796 **Date-:** 01-12-2021

Deputy Commissioner
Rajanpur

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ANNEX-V

List of Participants in Village Level Consultations

ANNEX-V LIST OF PARTICIPANTS

Sr. No.	Name of Participants	Occupation
Mouza Matt Kund		
1	Ali Murad s/o Bagh Ali	Farmer
2	Bagh Ali s/o Ali Murad	Farmer
3	Nawaz Ali s/o Ali Murad	Farmer
4	Qasim s/o Ali Murad	Farmer
5	Khadim Hussain s/o Ali	Farmer
6	Dil Murad s/o Bagh Ali	Farmer
7	Jawaan Saal s/o Dil Murad	Farmer
8	Kundha s/o Dil Murad	Farmer
Basti Shikar Khan		
1	Talib Hussain s/o Haji Wazir	Farmer
2	Riaz Ahmad s/o Sindhi Khan	Student
3	Shikar Khan s/o Rindho	Farmer
4	Khair Din s/o Muhammad Khan	Farmer
5	Amanullah s/o Shikar Khan	Farmer
6	Ahmad s/o Jalal Khan	Farmer
7	Shah Din s/o Shikar Khan	Farmer
8	Hazoor Khan s/o Rindho	Farmer
9	Allah Diwaya s/o Sheena	Farmer
Lundi Syeddan		
1	Sherbaz s/o Ramzan	B.M.P Employee
2	Ibadat Ali	Farmer
3	Gul Muhammad s/o Din Muhammad	Farmer
4	Noor Muhammad s/o Taj Muhammad	Farmer
5	M. Shafique s/o Budha Khan	Farmer
6	M. Aslam s/o Dur Muhammad	Farmer
7	Ataullah s/o Rindo Khan	Farmer
8	Safdar s/o Haji Ayaz Khan	Farmer
9	M. Saleem s/o Ameer Muhammad	Business
10	Subedar s/o Ramzan Khan	Farmer
11	Nabi Bakhsh s/o Qadir Bakhsh	Farmer
12	Nusrat Shah s/o Umar Shah	Restaurant
13	Sher Kaleem s/o Ghani Muhammad	Farmer
14	Javed Iqbal s/o Gul Zaad	Farmer
15	Mahar Bakhsh s/o Qadir Bakhsh	Farmer
16	M. Amir s/o Ghulam Shabir	Butcher
17	Munawar Hussain s/o Ameer Hamza	Laborer
18	Ameer Muhammad s/o Kaalu	Laborer

Sr. No.	Name of Participants	Occupation
Laal Garh		
1	M. Aslam s/o M. Usman	Farmer
2	Shahid Hussain s/o Faiz	Driver
3	Allah Rakha s/o Allah Diwaya	Laborer
4	Talib Hussain s/o Raheem Bakhsh	Shopkeeper
5	M. Jamal s/o Hazoor Bakhsh	Farmer
6	Abdul Wahab s/o Mehmood Ahmad	Laborer
7	M. Ajmal s/o Raheem Bakhsh	Shopkeeper
8	Junaid Fareed s/o Fareed Bakhsh	Laborer
9	Talib Hussain s/o Ameer Muhammad	Driver
10	M. Sohail s/o Khumaisa	Laborer
11	M. Sheraz s/o Sadaqat Ali	Business
12	Nawab Ali s/o Allah Wasaya	Farmer
13	M. Asif s/o Mureed Hussain	Hotel
14	Imam Bakhsh s/o M. Ilyas	Farmer
15	Abdul Ghani s/o Eiden	Laborer
Basti Noshehra Gharbi		
1	Dilawar Hussain s/o Noor Muhammad	Farmer
2	Abid Hussain s/o Adil	Shopkeeper
3	Shafqat s/o Inayat ullah	Business
4	Rab Nawaz s/o Khadim Hussain	Shopkeeper
5	Aziz ur Rehman s/o Ghulam Hussain	Laborer
6	Abdur Rehman s/o Hashim Shah	Private Job
7	Ameer Bakhsh s/o Qadir Bakhsh	Farmer
8	Allah Diwaya s/o Allah Wasaya	Farmer
9	Nazar Muhammad s/o M. Bakhsh	Farmer
10	M. Abdullah s/o Hashim Shah	Student
11	M. Mohsin s/o Nazir Ahmad	Student
Tibbi Solgi		
1	Nazir Ahmad s/o Hafiz Muhammad	Teacher
2	M. Asghar s/o Manzoor Ahmad	Teacher
3	Mujeeb ur Rehman	Patwari
4	Ghulam Yaseen s/o Ghulam Hussain	Farmer
5	Abdul Shakoor s/o Zafar Hussain	Farmer
6	Bilal Ahmad s/o Ali Hassan	Student
7	Fareed Bakhsh s/o Jamal Din	Farmer
8	Izzat Bakhsh s/o Jamal Khan	Farmer
9	M. Ramzan s/o Jamal Khan	Farmer
10	Mahar Ghulam Hussain s/o Ramzan	Farmer
Basti Zafar Khan		
1	Muhammad Asif	Farmer

Sr. No.	Name of Participants	Occupation
2	Khizar Muhammad	Shopkeeper
3	Haamid Khan	Farmer
4	Muhammad Inayat	Farmer
5	Muhammad Hussain	Farmer
6	Abubakar s/o Ali Muhammad	Farmer
7	Pervaiz Ahmad	Farmer
8	Shabir Ahmad	Farmer
9	Khair Muhammad	Laborer
10	Haji Usman	Farmer
11	Muhammad Siddique	Business
12	Ali Nawaz s/o M. Arshad	Farmer
13	M. Rizwan s/o Talib Hussain	Farmer
14	Aabid Hussain s/o Sher Muhammad	Farmer
15	Fazal Din s/o Khair Din	Farmer
16	Rasheed Ahmad s/o Nazir Ahmad	Farmer

ANNEX-VI

Guideline Quarry Management Plan

GUIDELINE QUARRY MANAGEMENT PLAN

1.0 Introduction

After the completion of construction phase of the proposed project, it is the responsibility of the contractor to restore the site that has been disturbed due to construction activities. Karachi Metropolitan Corporation (KMC) should ensure that the environmental value of the project area is maintained for future generations to appreciate.

2.0 General Quarry Planning and Progressive Rehabilitation

A well-considered quarry development plan prior to starting work, or when opening up new areas will greatly reduce the effort required to achieve appropriate leading practice environmental and safety outcomes for quarry rehabilitation and closure.

The selection of a site, sequencing of quarrying and rehabilitation and final land-use should all be carefully planned prior to commencement of work at a quarry or borrow pit.

2.1 Progressive Rehabilitation

Progressive rehabilitation refers to the rehabilitation of completed parts of a quarry while extractive operations continue in other parts of the quarry. As new quarry sections are opened, worked out areas should be progressively rehabilitated to avoid increasing the total disturbed area of a quarry. Overburden and topsoil can be stripped from areas being opened up and placed directly onto worked out areas which are being rehabilitated. This will avoid double handling of materials and prevent degradation of the topsoil.

Progressive rehabilitation helps to minimize the visual impact of a quarry, control dust and erosion. It also assists in fostering good landowner and community relations.

Recommended progressive rehabilitation practices are:

- Agree on the final land form and use of a site with the relevant landowner.
- Rehabilitate in accordance with the intended final use of the land.
- Plan and develop the quarry in stages towards terminal areas so that progressive rehabilitation works can commence as soon as possible).
- Once the final landform is established, re-vegetate areas to stabilize the landform and to give the vegetation maximum time to establish while the quarry is still in operation.

2.2 Re-vegetation

Establishing a self-sustaining cover of vegetation is the best way to stabilize disturbed sites in the long term. Re-vegetation also minimizes the visual impact of quarries. Generally, the vegetation type which existed before the disturbance, or a similar vegetation type will regenerate most successfully.

Prior to the commencement of a quarrying activity the type of re-vegetation should be agreed with the landowner, and should be consistent with the proposed final land-use.

Some indigenous plant species may not thrive in areas where soil conditions are substantially different after quarrying. If this is the case, and the objective is to re-establish vegetation, which fulfils the function of the original native vegetation, then some species from outside the quarry area, may have to be introduced. Care must be taken to avoid introducing a species, which could become an unacceptable fire hazard, invade surrounding areas of native vegetation or become agricultural weeds.

Where agriculture is the planned land-use then the species planted should be those commonly used for pasture or crops known to be successful on soils of similar texture, drainage status, pH and fertility. Suitable legumes should always be considered for their ability to improve soil fertility.

3.0 Rehabilitation of Borrow Pits

Borrow pits are areas either in a road reserve or adjacent land holdings that have been used to extract materials such as gravels and soils. They can vary considerably in size, depending on the quantity of material taken and the borrow pits' reserve body of remaining material. The variable size, shape and nature of borrow pits preclude very specific recommendations; however the following general conditions apply:

- Before extraction commences, licenses and permits should be checked and limits of disturbance and/or clearing must be clearly marked out on the site before any ground disturbing activity takes place; and
- At the completion of extraction, the former borrow pit must be made stable and safe. This usually requires the sides of the pit to be reshaped with gentle safe grades. All disturbed areas associated with borrow pits must be retopsoiled, seeded, fertilized and mulched (if appropriate) as part of the restoration plan. Main Roads has been discouraging the conversion of borrow pits to stock watering points.

Reinstatement of Borrow Pits

- Reinstatement will be completed prior to handover of the completed road section. This may include the following:
- Fill excavated site with overburden stockpiles and perimeter berms, and graded to the desired slope and drainage path;
- Spread topsoil on top of the overburden;
- Develop/construct suitable surface slopes, drainage ditches and conduits to prevent water from collecting at the sites;
- Establish a vegetation cover corresponding to at least 75%[1] of the cover present prior to excavation (supporting photographs) and maintain following the first rains after reinstatement;
- Minimize erosion by focusing vegetation cover on side slopes of the excavated area; and
- Any required seeding will make use of local plant varieties

[1] RAPID PROGRAM BORROW PIT MANAGEMENTGUIDELINES, USAID

All the above mentioned measures need to be followed by the Contractor before handing over the site (s) back to the owner.

ANNEX-VII

Tree Plantation Plan Guideline

TREE PLANTATION PLAN

The basic purpose of afforestation/plantation of suitable species in the project area is to reduce the risk been made due to cutting of trees for the proposed project and to enhance green cover and improve the overall environment of the area. Afforestation will not only reduce the risk been made but will also increase the carrying capacity of the area regarding many positive aspects.

Plantation will be done after the removal of trees during the construction work immediately. Plantation of indigenous trees species is highly important to maintain the biodiversity and ecological balance. It is also important to prevent global warming, soil erosion and pollution. Afforestation purifies the environment and helps in reducing the carbon dioxide level. Along with the importance of roads construction, the afforestation activity will further help in enhancing the socio-economic condition of the area and project sustainability.

IMPORTANCE OF TREE PLANTATION

- Trees contribute to their environment by providing oxygen, improving air quality, climate amelioration, conserving water, preserving soil, and supporting wildlife.
- Trees control climate by moderating the effects of the sun, rain and wind. Leaves absorb and filter the sun's radiant energy, keeping things cool in summer.
- Trees also preserve warmth by providing a screen from harsh wind.
- Trees also lower the air temperature and reduce the heat intensity of the greenhouse effect by maintaining low levels of carbon dioxide.
- Both above and below ground, trees are essential to the eco-systems in which they reside.
- Trees absorb and store rainwater which reduce runoff and sediment deposit after storms. This helps the ground water supply recharge, prevents the transport of chemicals into streams and prevents flooding.
- Trees, shrubs and turf also filter air by removing dust and absorbing other pollutants like carbon monoxide, sulfur dioxide and nitrogen dioxide.

OBJECTIVES

- To Restore native species
- To improve the quality of air and reduce its pollution
- To add color to the landscape and enhances the beauty of the environment
- To uplift the quality of our living environment through active planting, proper maintenance and preservation of trees together with other vegetation.
- To Protect and conserve flora and fauna of the project area.
- To attract rain which is a positive impact on the project area at all.
- To reduce sedimentation by plantation in the project area which will act as protection wall against wind born dust particles.

STUDY AREA ENHANCEMENT/REHABILITATION PLAN

The project area is not rich in natural vegetation. Due to the construction activities, approximately **6,183 numbers** of different trees may be cut down. The reforestation ratio of 1:10 for the tree cutting is considered. Compensatory planting of ten trees against each fallen tree of similar floral function should be planned which is about **62,000 numbers of plants**. These plants are recommended to be planted as a compensation of the ecological damage.

Note: *The compensation for trees may be notified by the Forest Departments with Ecologists consultant team after proper filed survey/assessment and consultation with local communities, for this purpose special team to be constituted under the approval of competent authority, to assess the losses and propose compensations.*

WHEN TO PLANT

Planting should be completed early in the rains in as short a time as possible. The trees must be given time to become well established prior to the dry season. A good rule of thumb is to start planting when the soil is moist to a depth of 15-25 cm or to the bottom of the planting hole. Failures because planting is too late are more common than failures because of planting too early. To obtain good results and avoid labor shortage in these areas considerable preparatory planning is needed. The size of the plantation might have to be adapted to the availability of labor. If dry sites cannot be planted in time, planting should be postponed until the next season.

WHERE TO PLANT

Plantation should be carried out preferably in protected forest located in command area which include “Ragistan Pachadi and Ragistan Shumali Protected Forest” in consultation and close coordination with district Forest Department. Apart of this, the plantation along the sides of proposed flood channels is preferable to not only protect the banks of channels but also enhance the plant diversity throughout the command area. Additionally, the plantation along the irrigation channels will be carried out in consultation with irrigation department and forest department of district Rajanpur.

SPECIES TO PLANT

Following type of species (native) should be plant in the proposed areas.

Sr. No	Common/English Name	*Botanical Name*
1	Van	Salvadora oleoides
2	Kikar	Acacia nilotica
3	Ber	Zizyphus mauritiana
4	Willow	Salix species
5	Frash	Tamarix aphylla
6	Karrir	Capparis decidua

COST ESTIMATE

Break-up of Expenditure per Avenue kilometer or 250 plants @ Rs. 1500/- per diem:

FIRST YEAR

Sr. No.	Item	Quantity	Rate	Amount (Rs.)
1.	Layout	1 Av.km	2 MD/Av.km	3000.00
2.	Digging of Pits 2.5 ft. each 2.5x250 = 625 cft.	625 cft.	5 MD/Av.km	7500.00
3.	Cost of Plants including	250 No.	Rs100/- plant	25,000.00
4.	Cost of planting of plants	250 No.	Rs. 25/- plant	6250.00
5.	Carriage of plants from private nursery to site including loading/unloading	250 No.	Rs. 10/- plant	2500.00
6.	Cost of Manure and Bhall (silt) including carriage	1 Av. Km		20,000.00
7.	H/watering 50 times 250x50 with water bowser, one driver and one coolie	12500 no.	5MD/per %0	100,000.00

Sr. No.	Item	Quantity	Rate	Amount (Rs.)
8.	Weeding twice 250x2	500 no.	2 MD/per %	15,000.00
9.	Reopening of Pits twice (250x2)/cft/pit	500 cft.	2 MD/per %	15,000.00
10.	Unforeseen			5750.00
			Total	200,000.00

SECOND YEAR

Sr. No.	Item	Quantity	Rate	Amount (Rs.)
1.	Cost of Plants 20% Restocking	50 No.	Rs.100/- plant	5,000.00
2.	Cost of planting	50 No.	Rs. 25/- plant	1250.00
3.	Carriage of plants	50 No.	Rs. 10/- plant	500.00
4.	H/watering 50 times with water bowser, one driver and one coolie	12500 no.	5MD/per %0	100,000.00
5.	Reopening of Pits twice (250x2)	500 cft.	2 MD/per %	1,5000.00
6.	Weeding twice 250x2	500 no.	2 MD/per %	1,5000.00
7.	Unforeseen			1250.00
			Total	1,38,,000.00

THIRD YEAR

Sr. No.	Item	Quantity	Rate	Amount (Rs.)
1.	Cost of Plants 10% Restocking 25 No.	25 No.	Rs.100/- plant	2500.00
2.	Cost of planting	25 No.	Rs. 25/- plant	625.00
3.	Carriage of plants	25 No.	Rs. 10/- plant	250.00
4.	H/watering 40 times x250 no.	10,000 no.	5MD/per %0	75000.00
5.	Reopening of Pits twice (250x2)	500	5MD/per %0	3750.00
6.	Unforeseen			2875.00
			Total	85,000.00

FOURTH YEAR

Sr. No.	Item	Quantity	Rate	Amount (Rs.)
1.	H/watering 30 times	7500 no.	5MD/per %0	56250.00
5.	Pruning and cleaning of plants	250 no.	5MD/per %0	1875.00
6.	Unforeseen			1875.00
			Total	60,000.00

Cost for raising 1 Av. Km and Maintenance or 250 plants in single row: = Rs. 483,000/-
For 4 years

Cost for raising and Maintenance of one plants = Rs. 1,932/-
For 4 years

Total cost for 62,000 plants and their maintenance = for 4 years	Rs. 119,784,000/- or say

Total Cost= 119.8 Million PKR

ANNEX-VIII

Guideline Occupational Health and Safety Plan

GUIDELINE OCCUPATIONAL HEALTH AND SAFETY PLAN

Occupational Health and Safety covers all personnel working under the project and will be in line with the World Bank EHS guidelines on health and safety.

The Occupational Health and Safety program will aim to ensure that the workplace is safe and healthy by: addressing the hazards and risks at the workplace; outlining the procedures and responsibilities for preventing, eliminating and minimizing the effects of those hazards and risks; identifying the emergency management plans for the workplace or workplaces; and, specifying how consultation, training and information are to be provided to employees at various workplaces.

Some of the risks/hazards associated with workplaces are due to working close to or at sites associated with the various project construction activities. Other risks associated with the project construction phase include risk of increase of vector borne and other different diseases.

The following sections will be implemented during the construction phase to address and ensure workers' health and safety.

1.1 SCREENING AND REGULAR UNANNOUNCED CHECKING OF WORKERS

As per the procedure for hiring workers, all contractors and labor agencies are required to make all prospective workers undergo medical tests to screen for diseases and sicknesses, prior to selection and employment of any worker. The contractor is also responsible for ensuring that no worker who has a criminal record is employed at the project site. It will be ensured that all workers undergo medical tests to screen diseases at source and at sites in consultation with the designated Health Officer.

In addition to this, the Project Management will also undertake sudden, unannounced checks on workers to look for diseases such as COVID-19, HIV, STDs, and hepatitis and take necessary steps as mandated by the Contractual agreement between the Contractor and the Worker(s).

1.2 MINIMIZING HAZARDS AND RISKS AT THE WORKPLACE

To ensure safety at all work sites, the following will be carried out:

i. Installation of signboards and symbols in risky and hazardous areas, to inform workers to be careful.
ii. Construction of barricades around construction sites and deep excavated pits, to cordon off and deter entry of unauthorized personnel and workers into these areas.
iii. Providing a safe storage site/area for large equipment such as power tools and chains, to prevent misuse and loss.
iv. Proper Housekeeping: Ensuring that materials are all stacked, racked, blocked, interlocked, or otherwise secured to prevent sliding, falling, or collapse. Brick stacks will not be more than 7 feet in height and for concrete blocks they will not be more than 6 feet high.
v. Removing all scrap timber, waste material and rubbish from the immediate work area as the work progresses.
vi. Where scaffolds are required, ensuring that each scaffold or its components shall be capable of supporting its own weight and at least 4 times the maximum intended load applied or transmitted to it. The platform/scaffold plank shall be at least 15 inches wide and 1.5 inches thick. The rope should be capable of supporting at least 6 times

the maximum intended load applied or transmitted to that rope. Pole scaffolds over 60 feet in height shall be designed by a registered professional engineer and shall be constructed and loaded in accordance with that design. Where scaffolds are not provided, safety belts/safety nets shall be provided;

vii. Ensure that all ramps or walkways are at least 6 feet wide, having slip resistance threads and not inclined at more than a slope of 1 vertical and 3 horizontal.

viii. Stacking away all excavated earth at least 2 feet from the pit to avoid material such as loose rocks from falling back into the excavated area and injuring those working inside excavated sites.

ix. Constructing support systems, such as bracing to adjoining structures that may be endangered by excavation works nearby.

x. Only a trained electrician to construct, install and repair all electrical equipment to prevent risks of electrical shocks and electrocution.

xi. Install fire extinguishers and/or other fire-fighting equipment at every work site to prepare for any accidental fire hazards.

1.3 PROVISION OF PERSONAL PROTECTIVE EQUIPMENT

Risks to the health and safety of workers can be prevented by provision of Personal Protective Equipment (PPEs) to all workers. This will be included in the construction cost for each Contractor. Depending on the nature of work and the risks involved, contractors must provide without any cost to the workers, the following protective equipment:

i. High visibility clothing for all personnel during road works must be mandatory.

ii. Helmet shall be provided to all workers, or visitors visiting the site, for protection of the head against impact or penetration of falling or flying objects.

iii. Safety belt shall be provided to workers working at heights (more than 20 ft) such as roofing, painting, and plastering.

iv. Safety boots shall be provided to all workers for protection of feet from impact or penetration of falling objects on feet.

v. Ear protecting devices shall be provided to all workers and will be used during the occurrence of extensive noise.

vi. Eye and face protection equipment shall be provided to all welders to protect against sparks.

vii. Respiratory protection devices shall be provided to all workers during occurrence of fumes, dusts, or toxic gas/vapor.

viii. Safety nets shall be provided when workplaces are more than 25 feet (7.5 m) above the ground or other surfaces where the use of ladders, scaffolds, catch platforms, temporary floors or safety belts is impractical.

The specific PPE requirements for each type of work are summarized below.

Table 1: PPE Requirement List

Type of Work	PPE
Elevated work	Safety helmet, safety belt (height greater than 20 ft), footwear for elevated work.
Handling work safety	Helmet, leather safety shoes, work gloves.
Welding and cutting work	Eye protectors, shield and helmet, protective gloves.
Grinding work	Dust respirator, earplugs, eye protectors.
Work involving handling of chemical substances	Dust respirator, gas mask, chemical-proof gloves. Chemical proof clothing, air-lined mask, eye protectors.
Wood working	Hard hat, eye protectors, hearing protection, safety footwear, leather gloves and dust respirator.
Blasting	Hard hat, eye and hearing protection.
Concrete and masonry work	Hard hat, eye protectors, hearing protection, safety footwear, leather gloves and dust respirator.

Type of Work	PPE
Excavation, heavy equipment, motor graders, and bulldozer operation	Hard hat, safety boots, gloves, hearing protection.
Quarries	Hard hat, eye protectors, hearing protection, safety footwear, leather gloves and dust respirator.

1.4 PROCEDURES TO DEAL WITH EMERGENCIES SUCH AS ACCIDENTS, SUDDEN ILLNESS AND DEATH OF WORKERS

First aid kits will be made available at all times throughout the entire construction period by the respective contractors. This is very important, because most work sites will be at some distance from the nearest hospital. In addition to the first aid kits, the following measures should be in place:

i. Provision of dispensaries by the individual EPC contractor.
ii. A vehicle shall be on standby from the Project Office so that emergency transportation can be arranged to take severely injured/sick workers to the nearest hospital for immediate medical attention.
iii. A designated Health Officer/worker for the Project will be identified as a focal person to attend to all health and safety related issues. This employee's contact number will be posted at all work sites for speedy delivery of emergency services. The focal person shall be well versed with the medical system and facilities available at the hospital.
iv. Communication arrangements, such a provision of radios or mobile communication for all work sites, for efficient handling of emergencies, will be made.

1.5 RECORD MAINTENANCE AND REMEDIAL ACTION

The Project Management will maintain a record of all accidents and injuries that occur at the work site. This work will be delegated by the contractor to the site supervisor and regularly reviewed every quarter by project management. Reports prepared by the contractor shall include information on the place, date and time of the incident, name of persons involved, cause of incident, witnesses present and their statements. Based on such reports, the management can jointly identify any unsafe conditions, acts or procedures and recommend for the contractor to undertake certain mitigative actions to change any unsafe or harmful conditions.

1.6 COMPENSATION FOR INJURIES AND DEATH

Any casualty or injury resulting from occupational activities should be compensated as per the local labor laws of Pakistan. Where compensation is sought by the injured party, proper procedures for documentation of the case will be followed, including a detailed report on the accident, written reports from witnesses, report of the examining doctor and his/her recommendation for treatment. Each individual contractor will be responsible for ensuring compensation for the respective workers.

1.7 AWARENESS PROGRAMS

The Project management will undertake awareness programs through posters, talks, and meetings with the contractors to undertake the following activities:

i. Dissemination sessions will clarify the rights and responsibilities of the workers regarding interactions with local people (including communicable disease risks, such as HIV/AIDS, COVID-19), work site health and safety, waste management (waste

separation, recycling, and composting), and the illegality of poaching.

ii. Make workers aware of procedures to be followed in case of emergencies such as informing the focal health person who in turn will arrange the necessary emergency transportation or treatment.

1.8 NOMINATION OF A HEALTH AND SAFETY FOCAL PERSON

Within each site (especially if different sites are being implemented by different contractors), a Health and Safety Focal Person will be appointed. The Terms of Reference for the focal person will mainly be as follows:

i. Function as the focal person/representative for all health and safety matters at the workplace;
ii. Responsible for maintaining records of all accidents and all health and safety issues at each site, the number of accidents and its cause, actions taken and remedial measures undertaken in case of safety issues;
iii. Be the link between the contractor and all workers and submit grievances of the workers to the contractor and instructions/directives on proper health care and safety from the contractors back to the workers;
iv. Ensure that all workers are adequately informed on the requirement to use Personal Protective Equipment and its correct use;
v. Also responsible for the first aid kit and making sure that the basic immediate medicines are readily available.

1.9 SUGGESTED CONTENTS OF OCCUPATIONAL HEALTH AND SAFETY PLAN

The suggested contents of Occupational Health and Safety Plan to be developed by the Contractor(s) are described below:

a Purpose
b Scope of Application
c Complying Basis
d Occupational Health and Safety Objectives
e Organization and Responsibility
  - Contractor's Project Manager
  - HSE Management Department of the Contractor(s)
  - Medical Treatment Room of the Contractor(s)
  - Subcontractor's Project Manager
  - Subcontractor's HSE Managers
  - Occupational Health and Safety
  - Community Health and Safety
f Health Plan
  - Labour Protection
  - Sanitary Epidemic Prevention
g Safety Plan
  - Summary
  - Qualification Review
  - Safety Training
  - Construction Plans and Documents
  - Control Measures
  - Monitoring Measures
  - Management of the Key Safety Accidents
h Public Security Plan
i Local Community Health and Safety

CONSTRUCTION HEALTH AND SAFETY CHECKLIST

GENERAL INTRODUCTION

This checklist identifies some of the hazards most commonly found on construction sites. The questions it asks are intended to help the safety supervisor decide whether the construction site is a safe and healthy place to work.

ACCESS ON SITE

- Can everyone get to their place of work safely?
- Are access routes free from obstructions and clearly signposted?
- Are holes protected with clearly marked and fixed covers to prevent falls?
- Are temporary structures stable, adequately braced and not overloaded?
- Will permanent structures remain stable during any refurbishment or demolition work?
- Is the site tidy, and are materials stored safely?
- Is lighting adequate, especially when work is being carried on after dark outside or inside tunnels?

WELFARE

- Are toilets readily available and are they kept clean and properly lit?
- Are there washbasins, hot and cold (or warm) running water, soap and towels?
- Are the washbasins large enough to wash up to the elbow and are they kept clean?
- Is there somewhere to change, dry and store clothing?
- Is there a place where workers can sit, make hot drinks and prepare food?
- Are drinking water and cups provided?
- Can everyone who needs to use them get to the welfare facilities easily and safely?

SCAFFOLDS

- Are scaffolds erected, altered and dismantled by competent people?
- Are all uprights provided with base plates (and where necessary, timber sole plates)?
- Are all uprights, ledgers, transoms and braces in position?
- Is the scaffold tied to the structure in enough places to prevent collapse?
- Are there double guard rails and toe boards or other suitable protection at every edge, to prevent falling?
- Are brick guards provided to prevent materials falling from scaffolds?
- Are the working platforms fully boarded and are the boards arranged to avoid tipping or tripping?
- Are there effective barriers or warning notices in place to stop people using an incomplete scaffold, e.g. where working platforms are not fully boarded?
- Is the scaffold strong enough to carry the weight of materials stored on it and are these evenly distributed?
- Does a competent person inspect the scaffold regularly, e.g. at least once a week if the working platform is two meter or above in height or at suitable intervals if less than two meter, and always after it has been altered or damaged and following extreme weather events?

- Are the results of inspections recorded and kept?
- Have proprietary scaffolds been inspected and are they being used in accordance with suppliers' instructions?
- Have the wheels of scaffolds been locked and outriggers deployed when in use and are the platforms empty when they are moved?

POWERED ACCESS EQUIPMENT

- Has the equipment been installed by a competent person?
- Are the operators trained and competent?
- Is the safe working load clearly marked?
- Is the equipment inspected by a competent person?
- Does the working platform of the powered access equipment have adequate, secure guard rails and toe boards or other barriers to prevent people and materials falling off?
- Have precautions been taken to prevent people being struck by the (i) moving platform; and (ii) falling materials?

TRAFFIC, VEHICLES AND PLANT

- Are vehicles and pedestrians kept apart? If not, do you:
- Separate them as much as you can and use barriers?
- Tell people about the problem, and what to do about it?
- Display warning signs?
- Can zero tail swing excavators be used or is there adequate clearance around slewing vehicles?
- Can reversing be avoided, e.g. by using a one-way system, or if not, are properly trained signallers used?
- Are vehicles and plant properly maintained?
- Have drivers received proper training and are they competent for the vehicles or plant they are operating?
- Are loads properly secured?
- Have you made sure that passengers are only carried on vehicles designed to carry them?
- Have you made sure that plant and vehicles are not used on dangerous slopes?

CRANES

- Is the crane suitable for the job?
- Has the lift been properly planned by an 'appointed person'?
- Is the crane on a firm, level base? Are the riggers properly set?
- Who is the appointed 'crane supervisor' responsible for controlling the lifting operation on site?
- Are the crane driver and signaller trained and competent?
- Is the load secure?
- Has the signaler and slinger been trained to give signals and to attach loads correctly?
- Have you made arrangements to make sure the driver can see the load or has a signaler been provided to help?

- Are people stopped from walking or working beneath a raised load?
- Does the crane have a current report of thorough examination and record of inspection?

EXCAVATIONS

- Is there adequate support for the excavation, or has it been sloped or battered back to a safe angle?
- Is there a safe method used for putting in the support, without people working in an unsupported trench?
- Is there safe access into the excavation, e.g. a sufficiently long and secured ladder?
- Are there barriers or other protection to stop people and vehicles falling in?
- Are properly secured stop blocks provided to prevent tipping vehicles falling in?
- Could the excavation affect the stability of neighboring structures or services?
- Are materials, spoil and plant stored away from the edge of the excavation to reduce the chance of a collapse?
- Is the excavation regularly inspected by a competent person?

MANUAL HANDLING

Are there heavy materials such as concrete lintels, curbstones or bagged products which could cause problems if they have to be moved by hand? If so, can you:

- choose lighter materials;
- use wheelbarrows, hoists, tail handlers and other plant or equipment so that – manual lifting of heavy objects is kept to a minimum;
- order materials such as cement and aggregates in 25 kilogram bags;
- Avoid the repetitive laying of heavy building blocks weighing more than 20 kilogram; and
- Have people been instructed and trained how to lift safely?

HAZARDOUS SUBSTANCES

- Have you identified all harmful substances and materials, such as asbestos, lead, solvents, paints, cement and dust?
- Have you checked whether a licensed contractor is needed to deal with asbestos on site?
- Have you identified and put into place precautions to prevent or control exposure to hazardous substances by:
    - Doing the work in a different way, to remove the risk entirely;
    - Using a less hazardous material; and
    - Using tools fitted with dust extraction?
- Have workers had information and training so they know what the risks are from the hazardous substances used and produced on site, and what they need to do to avoid the risks?
- Have you got procedures to prevent contact with wet cement (as this can cause both dermatitis and cement burns)?

- Have you arranged health surveillance for people using certain hazardous substances?

NOISE

- Have workers had information and training so they know what the risks are from noise on site, and what they need to do to avoid those risks?
- Have you identified and assessed workers' exposure to noise?
- Can the noise be reduced by using different working methods or selecting quieter plant, e.g. by fitting breakers and other plant or machinery with silencers?
- Are people not involved in the work kept away from the source of the noise?
- Is suitable hearing protection provided and worn in noisy areas?
- Have hearing protection zones been marked?
- Have you arranged health surveillance for people exposed to high levels of noise?

HAND-ARM VIBRATION

- Have workers had information and training so they know what the risks are from hand-arm vibration (HAV) on site, and what they need to do to avoid those risks?
- Have you identified and assessed risks to workers from prolonged use of vibrating tools such as concrete breakers, angle grinders or hammer drills?
- Has exposure to HAV been reduced as much as possible by selecting suitable work methods and plant?
- Are reduced-vibration tools used whenever possible?
- Have vibrating tools been properly maintained?
- Have you arranged health surveillance for people exposed to high levels of hand-arm vibration, especially when exposed for long periods?

ELECTRICITY AND OTHER SERVICES

- Have all necessary services been provided on site before work begins and have you also identified existing services present on site (e.g. electric cables or gas mains) and taken effective steps (if necessary) to prevent danger from them?
- Are you using low voltage for tools and equipment, e.g. battery-operated tools or low-voltage systems?
- Where mains voltage has to be used, are trip devices (e.g. residual current devices (RCDs)) provided for all equipment?
- Are RCDs checked daily by users and properly maintained?
- Are cables and leads protected from damage?
- Are all connections to the system properly made and are suitable plugs used?
- Are tools and equipment checked by users, visually examined on site and regularly inspected and tested by a competent person?
- Where there are overhead lines, has the electricity supply been turned off, or have other precautions been taken, such as providing goal posts or taped markers?
- Have hidden electricity cables and other services been located (e.g. with a locator and plans) and marked, and have you taken precautions for safe working?

CONFINED SPACES

- Do you work in confined spaces where there may be an inadequate supply of oxygen or the presence of poisonous or flammable gas? If so, have you taken all necessary precautions?
- Confined spaces include tanks, sewers and manholes; they do not have to look dirty to be dangerous?

TOOLS AND MACHINERY

- Are the right tools or machinery being used for the job?
- Are all dangerous parts guarded, e.g. gears, chains drives, projecting generator shafts?
- Are guards secured and in good repair?
- Are tools and machinery maintained in good repair and are all safety devices operating correctly?
- Are all operators trained and competent?

FIRES AND EMERGENCIES

General

- Are there emergency procedures, e.g. for evacuating the site in case of fire or for rescue from a confined space?
- Do people on site know what the procedures are?
- Is there a means of raising the alarm, and does it work?
- Is there a way to contact the emergency services from site?
- Are there adequate escape routes and are these kept clear?
- Is there adequate first-aid provision?

Fire

- Is the quantity of flammable materials, liquids and gases on site kept to a minimum?
- Are they properly stored?
- Are suitable containers used for flammable liquids?
- Are flammable gas cylinders returned to a ventilated store at the end of the shift?
- Are smoking and other ignition sources banned in areas where gases or flammable liquids are stored or used?
- Are gas cylinders, associated hoses and equipment properly maintained and in good condition?
- When gas cylinders are not in use, are the valves fully closed?
- Is flammable and combustible waste removed regularly and stored in suitable bins or skips?
- Are suitable fire extinguishers provided?

PROTECTING THE PUBLIC

- Is the work fenced off from the public?
- Are the public protected from falling material?

- Have you provided a safe route through road works or pavement scaffolding for people with prams, wheelchair users and visually impaired people?
- When work has stopped for the day:
    - Is the boundary secure and undamaged?
    - Are all ladders removed or their rungs boarded so that they cannot be used?
    - Are excavations and openings securely covered or fenced off?
    - Is all plant immobilized to prevent unauthorized use?
    - Are bricks and materials safely stacked?
    - Are flammable or dangerous substances locked away in secure storage places?

ANNEX-IX

Guidelines to Combat with COVID-19

PRECAUTIONARY ACTION AGAINST THE POTENTIAL RISK OF NOVEL CORONAVIRUS - COVID-19

INTRODUCTION

On February 11, 2020 the World Health Organization announced an official name for the disease that is causing the 2019 novel coronavirus outbreak, first identified in Wuhan China. The new name of this is coronavirus disease 2019, abbreviated as COVID-19. In COVID-19, 'CO' stands for 'corona,' 'VI' for 'virus,' and 'D' for disease. Formerly, this disease was referred to as "2019 novel coronavirus" or "2019-nCoV".

Coronaviruses are a large family of viruses. Some cause illness in people, and others, such as canine and feline coronaviruses, only infect animals. Rarely, animal coronaviruses that infect animals have emerged to infect people and can spread between people. This is suspected to have occurred for the virus that causes Coronavirus Disease 2019 (COVID-19). Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS) are two other examples of coronaviruses that originated from animals and then spread to people.

The risk of exposure to COVID-19 is no different for employees of Employer, Engineer, Contractor, and suppliers than for the general population. Contractor, therefore, must consider the physical well-being and safety of all the persons entitled to be on the Site and follow reasonable guidelines and recommendations of Government authorities and healthcare professionals. As experience has shown in other countries, confirmed cases of COVID-19 expand exponentially if health and safety controls are left unheeded.

Contractor should enforce all health and safety procedures at Site including sanitary protocols, proper hygiene, social distancing, use of personal protective equipment (PPE), toolbox talks on special COVID-19 requirements, and prompt reporting of health issues related to COVID-19. Contractors must put safeguards in place to keep workers exposed to COVID-19 away from Site for at least 14 days after the last potential exposure.

WHO declared the COVID-19 as a Public Health Emergency of International Concern (PHEIC) in January 2020 and afterwards announced the COVID-19 outbreak as pandemic on 11th March 2020 due to the widespread of the disease in 114 countries at that time. WHO Director General urged the countries to take action now to stop the disease.

The rapid spread of COVID-19 hits all the provinces of Pakistan Sindh, Balochistan, Punjab & Khyber Pakhtunkhwa including the Gilgit Baltistan and Azad Jammu & Kashmir. The prevailing virus creates the menacing and distressing situation when it arrived around the closed proximities of the Project Area.

Government of Pakistan has launched the National Action Plan for COVID-19 Pakistan to combat the challenge of prevailing virus, also available at https://www.nih.org.pk/wp-content/uploads/2020/03/COVID-19-NAP-V2-13-March-2020.pdf. The Government of Pakistan has launched the real-time data portal for COVID-19 http://covid.gov.pk/. These measures are mostly relating to the containment and awareness and capacity building. Besides this COVID-19 daily situation report is also available at https://www.nih.org.pk/wp-content/uploads/2020/04/COVID-19-Daily-Updated-SitRep-03-April-2020.pdf.

All the stakeholders are on board to jointly prevent/ limit/ control the spread of COVID-19. All of the staff is required to take precautionary measures as well as maintain social distances. The use of thermal guns for checking every single person body temperature, placement of

relevant flyers and disinfection spray inside of all the containers are few of the measures to combat COVID-19.

OBJECTIVE

Following are the objectives of this report to jointly prevent / limit/ control the spread of COVID-19 at Site that can hamper the progress of proposed Project:

1. To enhance understanding of the evolving COVID-19;
2. To share knowledge on COVID-19 and preparedness measures being implemented at Site;
3. To generate recommendations for adjusting COVID-19 containment and response measures; and
4. Outline the measures taken at Site. The advised measures will help all the stakeholders to plan their work continuity in response to the COVID-19.

Due to the evolving situation of the COVID-19, this document should be read in conjunction with the latest relevant advisories issued by WHO (especially "Getting your workplace ready for COVID-19, 3 March 2020") and Government of Pakistan.

WHAT IS CORONA VIRUS (COVID-19)

The COVID-19 belongs to a family of viruses known as the Coronaviruses, which can cause illnesses ranging from the common cold to more severe diseases, such as the Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS)[1].

SYMPTOMS

The symptoms of the COVID-19 are similar to that of regular pneumonia. Typical symptoms include;

- Fever;
- Cough;
- Difficulty in breathing;
- Pneumonia;
- Runny nose;
- Sore throat; and
- Feeling of being unwell.

MODE OF SPREAD

Infected person – person transmission; Infected people can spread COVID-19 through their respiratory secretions via droplets produced when an infected person coughs or sneezes, similar to how influenza and other respiratory pathogens spread. The spread from person-to person is most likely among close contacts (about 6 feet);

- Infected animals' dead or Alive;
- Air by coughing and sneezing;
- Close personal contact, such as touching or shaking hands;
- Touching an object or surface with a virus on it; and
- Touching your mouth nose or eyes before washing your hands.

[1] Source: World Health Organization

GENERAL STANDARDIZED PRECAUTIONARY MEASURES

Following measures/recommendations are suggested as a general guidance to be followed for the protection of potential impacts of COVID-19:

Since, there is no vaccine available to protect against human Coronavirus infections. Therefore, transmission can be prevented through following measures:

- Cover your mouth while cough or sneeze;
- Avoid close contact with people who are sick;
- Avoid the use of hard soap;
- Wash your hands often with liquid soap and water for at least 20 seconds;
- All the employees should ensure sanitization of hands at appropriate time;
- Avoid touching your eyes, nose, and mouth with unwashed hands;
- If you are concerned about your symptoms you should see your health care provider at site or in office;
- Use of Personal Protective Equipment (PPE) according to risk (a surgical or N95 mask);
- Do not spit, wrap your oral and nasal secretion with tissue and throw it in a covered dustbin;
- Balance your nutrition and exercise moderately;
- Sterilization / disinfection of medical devices at Site dispensaries; and
- Do not touch, buy or eat wild animals (gamey). Try to avoid visiting markets that sell such animals.

PROJECT SITE SPECIFIC PRECAUTIONARY MEASURES

Measures for protecting staff and labour from exposure to, and infection with, the COVID-19 depend on the type of work being performed and exposure risk, including potential for interaction with infectious people and contamination of the work environment. Regardless of specific exposure risks, following are the main actions that have been jointly taken at Site to combat the COVID-19:

Employer's Side

Employer should issue the notification containing the precautionary measures in the light of GoS guidelines to be implemented at Site. Upon receiving the Employer notification all the mentioned precautionary measures will be communicated to Engineer staff for compliance. Employer technical staff is also complying with the GoS guidelines and Contractor suggestion to control the spread of COVID-19 at Site in the best interest of the Project and country.

Consultant's Side

Consultant's top management will issue the orders in the light of GoS guidelines containing the precautionary measures to control the spread of COVID-19 for the staff working at Site.

Consultant staff at Site will fully complying with the orders including photographic evidence. Considering the severity of the prevailing virus Engineer devised the Standard Operating Procedure (SOP) containing precautionary action against the potential risk of novel corona virus.

Besides, above Consultant will ensure the following precautionary measures at Site.

- Adequate signage and information at all entrances and exits showing what is Corona Virus, how it spreads, what are the symptoms, standard precautions;

- The awareness session for the Contractor staff is equally important as of Consultant staff to combat the COVID-19 at Site. The Consultant will ensuring that Contractor is arranging such session at Site from time to time to reduce the potential risk of COVID-19. Further, all the newly inducted and existing staff have been given HSE training by the Consultant & Contractor.

Contractor's Side

Contractor will communicate various precautionary measures to Employer and Engineer through letters to control the spread of COVID-19 at Site. Following are the major steps to be taken by the Contractor:

- Contractor will convey the instructions and requirements of its superior unit for the prevention and control of COVID-19 epidemic at Site.
- Contractor will establish a special organization for epidemic prevention and control on the Project Site that is responsible for arranging, implementing, publicizing and supervising the epidemic prevention and control measures.
- Launch the plan for epidemic prevention and control on the project Site that includes:
    - All personnel in temporary camp are required to wear masks;
    - Contractor personnel incharge of Site to wear masks;
    - Arranged special personnel to measure and record the temperature of all personnel when entering or leaving the temporary camp;
    - If any person with fever, cold and other symptoms are found, they will be admonished to go home for isolation and asked about the development of the disease every day; and
    - Propagate and implement the epidemic prevention measures for the staffs and labours and warn them not to go outside and home as much as possible.
- All these meetings should carried out through video conference.

Contractor is not limited to the above precautionary measures but practicing and implementing the following;

- Contractor will prepare a pamphlet for the awareness of Site staff to combat the COVID-19. It will also place/posted at strategic points at Site.
- Launch awareness campaign to inform all the staff and labour about the coronavirus, to use facemask, hand hygiene, cough etiquette, and avoidance of close contact with animals and consumption of their raw products.
- Everyday awareness speech in English and Urdu in the temporary camp.
- All the employees are not allowed to go outside of the Project Area or on vacation to their homes and on daily basis visit to sites;
- Contractor will provide medical masks and antibacterial liquid hand wash to all personnel.
- Contractor will prepare the isolation facility at Site and provided three isolated rooms for such patients inside the temporary camp. Each room have three beds, oxygen cylinder, sanitizers, isolation kit, hand wash.
- Thermal scanning will be carried out continuously in the morning for everybody at the main gate of temporary camp.
- Record will be maintained for everyone that includes the temperature value of each person with their names, every morning and afternoon go to each department for scanning separately and noted down their name with temperature values.
- Contractor carry out disinfectant spray on daily basis morning and afternoon in each office and rooms and all the area of the camp.
- SSWMB and Consultant staff will also requested by Contractor to do not interact physically rather through electronically by emails or video conferencing.

RECOMMENDATIONS FOR THE CONTROL OF COVID-19 AT SITE

To Avoid Transmission

For all personnel at Site, it is always a good to practice the following precautionary measures:

- Workers to remain at least two meters apart from each other at all times (social distancing) – i.e. spread out and reduce the number of people working together in one area of the site;
- Avoid eating lunch in the form of group in available mess/canteens at Site;
- Close site canteens/ food preparation and eating areas (avoid gatherings) – workers to bring their own prepared lunch to site and eat alone e.g. in their van, car, or in an open space;
- Avoid in-person meetings if possible. In the case that an in-person meeting is unavoidable, make sure to have it in a well-ventilated area with sufficient space for attendees to distance themselves from one another. For meetings such as toolbox talks, consider breaking them up into smaller group meetings versus one large meeting;
- Introduce enhanced cleaning procedures across the Site and touch points e.g. office equipment, plant and machinery controls, taps/toilet/washing facilities, handrails;
- Stagger start times on site to avoid congestion in entrance areas;
- Reduce the number of people on site inductions at any one time and hold them outdoors if possible;
- Stop workers moving across various sites (potential for cross contamination);
- No outsiders should be at the Project Site;
- Contractor, Consultant and Employer personnel are advised to avoid travelling and in case traveling is unavoidable, prior approval from the management should be essential. In case of travelling, the above mentioned measures need to be strictly followed by the traveller;
- Prompt identification and isolation of potentially infectious individuals is a critical first step in protecting workers and other Site staff. An isolated area should be available at Site to immediately isolate suspected person, as it is most important to stop its spread at Site.
- Rapid Response Team should be formed and be informed immediately in case of suspect and confirmed case of COVID-19.
- Medical team at Site should separate the suspected person displaying fever, cough or difficulty breathing from other personnel; and
- If a person has had close contact with an individual that has confirmed COVID-19, that person will not be allowed to return to the Site until he/she has been symptom free for 14 days.
- Clean and fumigate all the workplaces at Site on daily basis;
- Ask people to stay at home if they have fever, cough, difficulty in breathing, runny nose, sore throat as per organizational rules;
- An immediate replacement of solid soap with liquid anti-bacterial soap bottles may be appropriate.
- Provision of alcohol-based hand sanitizer need to available for all staff;
- Clean the religious places carpets and rugs. Have them washed in place over the weekend and then do regular cleaning;
- Have the cleaners/ maintenance crews regularly clean surfaces that are touched frequently by personnel with disinfectants such as in and out doors;
- Fresh medical tests of staff working should be carried out at Site;
- Dispose of all contaminated waste (gloves, paper, swab handles, etc.) into biohazard waste bags for disposal;

- Ensure that panic is not created. In fact the posters should start with statements such as do not panic and fear the virus but know and prevent; and
- Ensure proper ventilation system for all the personnel at Site.

Use of Personal Protective Equipment (PPEs)

- Necessary PPE should be available at Site all the times and are being issued to each personnel at Site;
- Practice of using masks is also being ensured by all parties at Site (a surgical or N95 masks);
- Re-usable PPE should be thoroughly cleaned after use and not shared between workers. Single use PPE should be disposed of so that it cannot be reused;

Outside Visitors

- Visitors should enter with strictly wearing visitors card;
- Ensure sanitization of hands;
- All parties should ensure that the sick persons should be wearing a surgical or N95 masks;
- Note down the complete information of outsiders before entrance;
- Proper screening should be carried out before entering the Site;
- Refrain from handshakes. Rather than shaking hands, visitors may explain why handshakes can contribute to the risk of spread;
- Attempt to maintain a general six (6) feet distance between themselves. This will be challenging to follow at all times but it is Engineer recommendation to follow;
- Refrain from and/or limit touching of workplace surfaces; and
- In addition to these on-site procedures, it is advised to follow their respective organizational instructions related to Site visits.

ANNEX-X

Guideline Emergency Response Plan

GUIDELINE EMERGENCY PREPAREDNESS AND RESPONSE PLAN

1.1 PURPOSE

The purpose of this Emergency Response Procedure is to provide measures and guidance for the establishment and implementation of emergency preparedness plans for the project. The aim of the Emergency Response Procedure is to:

i. Ensure all personnel and visitors to the office/job sites are given the maximum protection from unforeseen events.
ii. Ensure all personnel are aware of the importance of this procedure to protection of life and property.

1.2 EMERGENCY PREPARATION AND RESPONSE MEASURE SCOPE

The emergency management program is applied to all Project elements and intended for use throughout the Project life cycle. The following are some emergencies that may require coordinated response.

i. Construction Accident
ii. Road & Traffic Accident
iii. Hazardous material spills
iv. Structure collapse or failure
v. Trauma or serious illness
vi. Sabotage
vii. Fire
viii. Environmental Pollution
ix. Loss of person
x. Community Accident

1.3 RESPONSIBILITIES

The detailed roles and responsibilities of certain key members of the Emergency Response team available to assist in emergency are provided in **Table 1** below.

Table 1: Emergency Response Team

Action Group	Responsibility
Emergency Coordinator	▪ Overall control of personnel and resources. ▪ The Emergency Coordinator will support and advise the Site Safety Supervision as necessary. ▪ Serves as public relations spokes persons, or delegates to some staff member the responsibility for working with news media regarding any disaster or emergency. Also assure proper coordination of news release with appropriate corporate staff or other designated people.
Site Safety Supervision (Emergency Commander)	▪ Overall responsibility for activating emergency plan and for terminating emergency actions. ▪ Be alternative of emergency response chairpersons. ▪ Disseminates warnings and information as required to ensure all people in the immediate area have been warned and evacuated either by alarms or by word of mouth. ▪ Supervise the actions of the Emergency Response Team to ensure all persons are safe from the danger. ▪ Notify outside authorities if assistance is required. ▪ Carries the responsibility for coordinating actions including other organizations in accordance with the needs of the situation.

Action Group	Responsibility
	▪ Ensure maximum co-operation and assistance is provided to any outside groups called to respond to an emergency. ▪ Establish and appoint all emergency organization structure and team. ▪ Assures adequate delegation of responsibilities for all key positions of assistants on the Project to assist with any foreseeable emergency. ▪ Ensure resources available to purchase needed emergency response equipment and supplies. ▪ Assures that all persons on the Emergency Response Team aware and fully understand their individual responsibilities for implementing and supporting the emergency plan. ▪ Establish the emergency drill schedule of all identified emergency scenarios, track the status and evaluate the emergency. ▪ The Emergency Commander shall ensure that senior management personnel have been reported of the emergency as soon as practical after the event.
Security Team	▪ Ensure that the exit route is regularly tested and maintained in good working order. ▪ Maintain station at the security gate or most suitable location to secure the area during any emergency such that only authorized personnel and equipment may enter, prevent access to the site of unauthorized personnel. ▪ Assist with strong/activation of services during an emergency. ▪ Ensure vehicles and obstructions are moved to give incoming emergency vehicles access to the scene, if ambulance or emergency services are attending the site, ensure clear access and personnel are located to direct any incoming emergency service to the site of emergency.
Rescue & Medical Team	▪ Protect the injured from further danger and weather. ▪ Provide treatment to the victim(s) to the best of their ability by first aid and then transfer to hospital. ▪ Remain familiar with the rescue activities and rescue apparatus. ▪ Assist outside medical services personnel when they arrive
General Administration Team	Response to support any requested general facilities for assisting Emergency Response Team in their work.
Government Relation Team	▪ Coordinate with local government on a matter of concerned in the emergency response plan to liaise with local officers in their affair for support Emergency Response Team. ▪ Coordinate emergency plan with the government authorities, local community.
Environment Team	In case of emergency related to the environmental pollution such as the chemical spill, oil spill into the ambient, the environment team will support the technical advice to control and mitigate the pollution until return to the normal situation.
Department Heads	▪ Call up of personnel into the safe location for protective life and property. ▪ Take immediate and appropriate action while Emergency Response Team is being mobilized. ▪ Keep in touch with the Emergency Commander ▪ Control and supervise operators and contractors on the implementation of this procedure, with consultation with Safety Team as necessary. ▪ Provide and maintain emergency equipment of their responsible areas.

Action Group	Responsibility
Other Staff and Employees	▪ All other staff and employees will remain at their workstations or assembly point unless directed otherwise from Emergency Response Team. ▪ Each supervisor will ensure that all members of his work group are accounted for and keep in touch with each of their Department Head.

1.4 PROCEDURE

Emergency situation and injuries to person can occur at any time or place either on Project site or elsewhere. The most two common types of emergencies on site are fire and serious accident.

Figure 3.1 Emergency Procedures for Fire

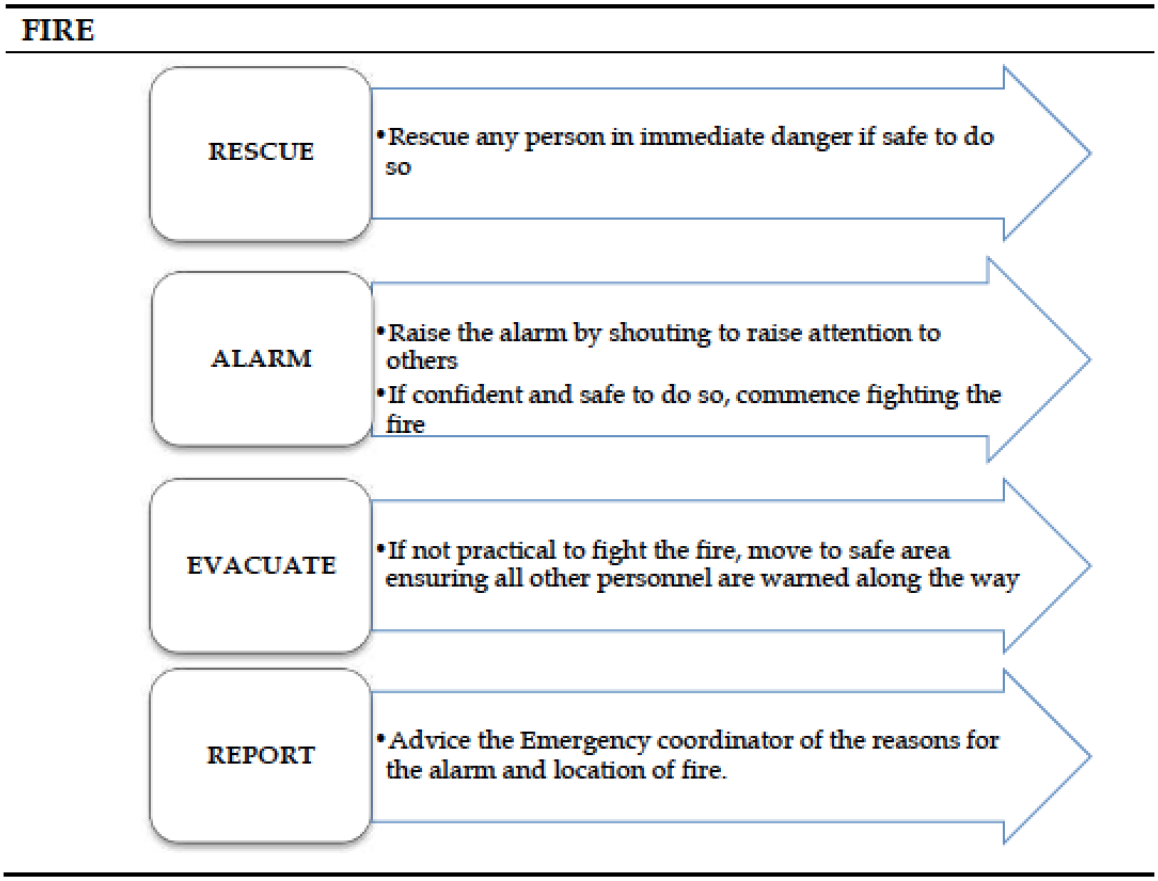
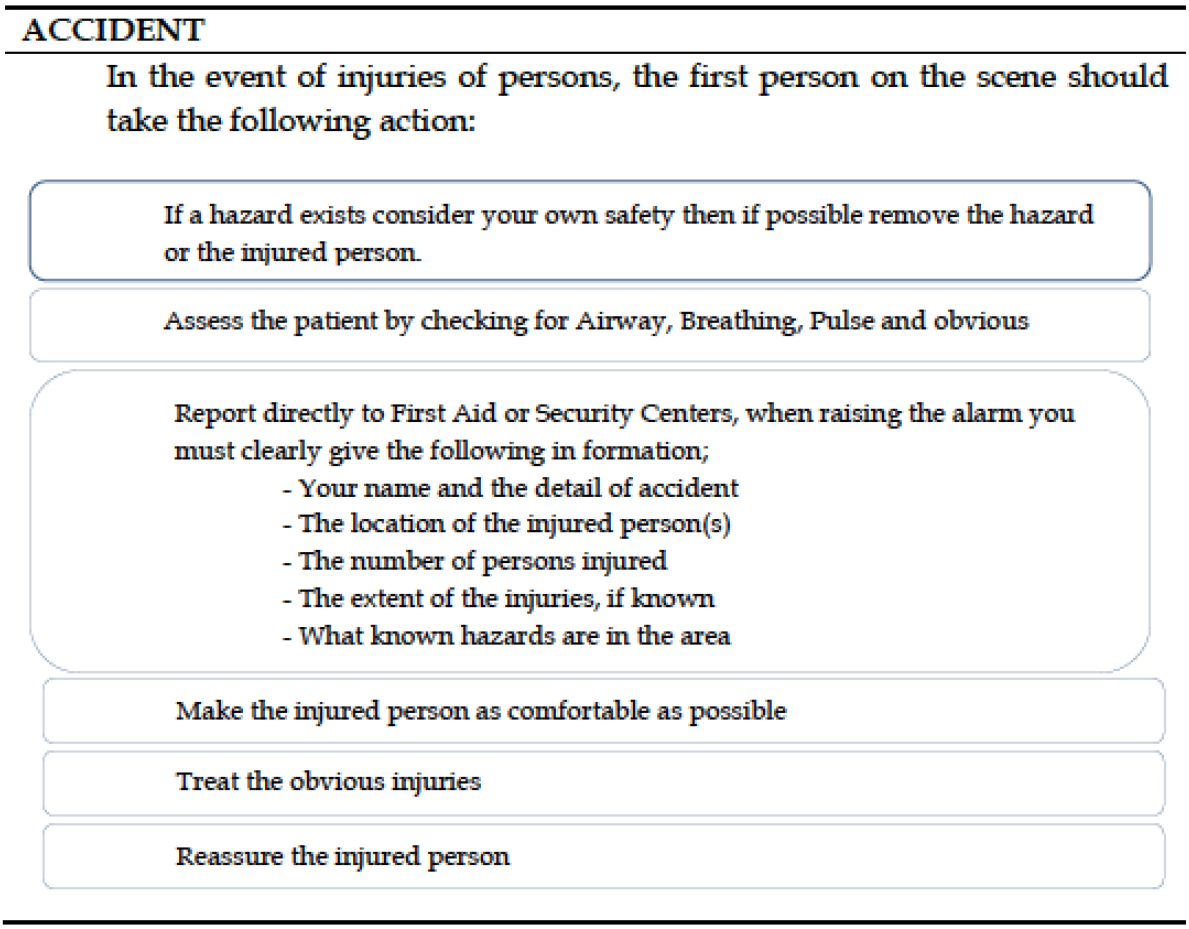


Figure 3.2 Emergency Procedures for Serious Accident



3.5 COMMUNICATION WITH AUTHORITIES / PRESS AT SITE

In the event of an accident or incident, only senior staff is permitted to give factual information to the authorities for resource of liability exposure. The press must be avoiding politely, at all costs, with the terse comment that “the matter is under investigation and relevant information when available will be provided by our Head Office” Do not ever give your opinion or story.

1.5 FIRST AID PERSONS

Upon advice of medical emergency, make immediate assessment to response required and if necessary, advise security to summon ambulance or medical assistance, the qualified first aid attendant should also,

- Provide treatment to the victim(s) to the best of his/her ability.
- Ensure the safety of victims by ceasing any work activity in the area.
- Protect the injured from further danger and weather.
- Assist medical services personnel when they arrive.

1.6 GENERAL ADMINISTRATION TEAM

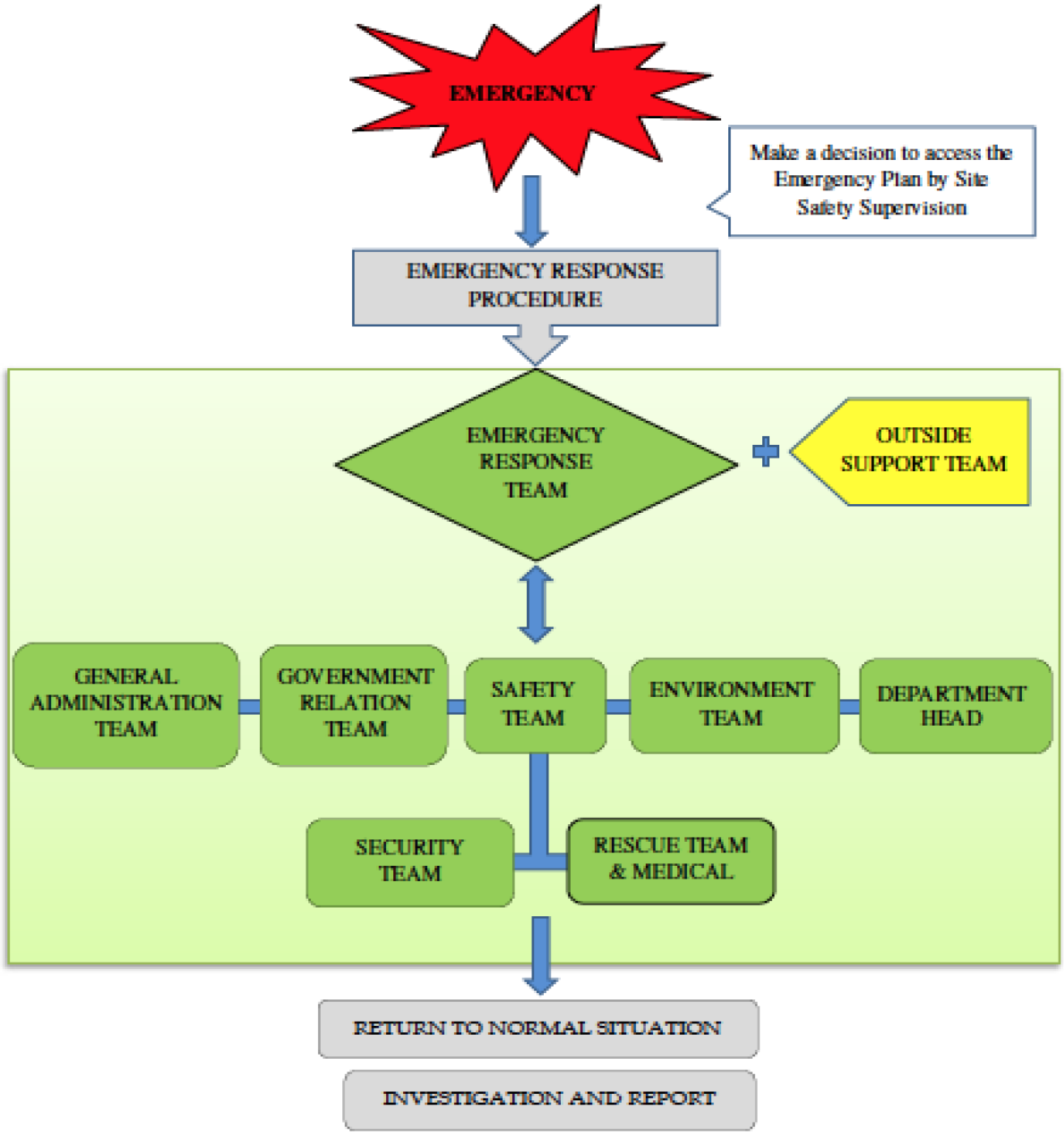
Upon advice of medical emergency, maintain contact with first aid personnel and summon ambulance if required.

1.7 SECURITY TEAM

- If ambulance or emergency services are attending the site, ensure clear access and personnel are located to direct vehicle closest to the scene.
- Prevent access to the site of unauthorized personnel (press, etc.).

1.8 EMERGENCY COORDINATOR

- The Emergency Coordinator shall assist emergency personnel at the scene as required through allocation of company resources.
- The Emergency Coordinator shall ensure next-of-kin are properly notified as soon as possible and give whatever company support and assistance is necessary to assist them bundle the situation
- The Emergency Coordinator shall ensure that senior management personnel are advised of the emergency as soon as practical after the event.



Note: Name of contact person and call number from Owner/Contractor to be determined.

1.9 INCIDENT AND ACCIDENT REPORT

Section A: Identification Data

Report No:	Date of Reported:	Reporter:	Sign:
Job Title:		Company Name:	

Section B: Violence Rate

Accident Violence: ☐ 01-Death ☐ 02-Serious Injury ☐ 03-Lost Time Injury ☐ 04-First Aid ☐ 05- Not Injury ☐ 06-Near Miss

Property Damage Cost: ☐ 1-2,000 USD ☐ 2,001-10,000 USD ☐ 10,001-50,000 ☐ > 50,001

Section C: Environmental Impact

Affected area	☐ Construction area	☐ Public area	
Receptor	☐ None	☐ Workers	☐ Community
Type of pollution	☐ Physical	☐ Chemical	☐ Biological
Toxicity	☐ Non-toxic	☐ Low - toxic	☐ High - toxic
Return to Normal	☐ 1 day	☐ 1 day to 1 week	☐ ≥ 1 week
Cumulative impact	☐ Non-cumulative	☐ Cumulative	

Section D: Injured/Illness Employee

1.Name:	Sex: ☐ Male ☐ Female	Date of Birth: Month / Day / Year	Age:	Regular Job Title:	Experience: In this job title Years Weeks	In this Project Years Weeks

Site:	Company:	Reference:	Phone No:	Social Security Numbe

Part of Body Injured or Affected:

☐ Head	☐ Hands	☐ Face	☐ Nose
☐ Eyes	☐ Legs	☐ Teeth	☐ Neck
☐ Trunk	☐ Toes	☐ Elbow	☐ Shoulder
☐ Back	☐ Ankle	☐ Wrist	☐ Foot
☐ Arms	☐ Thump	☐ Fingers	☐ Internal

Remark: .....

Nature of Injury or Illness:

☐ Laceration	☐ Amputation	☐ Puncture	☐ Fracture
☐ Strain & Sprain	☐ Burns	☐ Contusion	☐ Dry Heat Friction
☐ Hernia	☐ Foreign Body	☐ Chemical	☐ Contamination
☐ Skin (Occupationnel)	☐ Rash	☐ Irritation	

Remark: .....

2.Name:	Sex: ☐ Male ☐ Female	Date of Birth: Month / Day / Year	Age:	Regular Job Title:	Experience: In this job title Years Weeks	In this Project Years Weeks

Site:	Company:	Reference:	Phone No:	Social Security Numbe

Part of Body Injured or Affected:

☐ Head	☐ Hands	☐ Face	☐ Nose
☐ Eyes	☐ Legs	☐ Teeth	☐ Neck
☐ Trunk	☐ Toes	☐ Elbow	☐ Shoulder
☐ Back	☐ Ankle	☐ Wrist	☐ Foot
☐ Arms	☐ Thump	☐ Fingers	☐ Internal

Remark: .....

Nature of Injury or Illness:

☐ Laceration	☐ Amputation	☐ Puncture	☐ Fracture
☐ Strain & Sprain	☐ Burns	☐ Contusion	☐ Dry Heat Friction
☐ Hernia	☐ Foreign Body	☐ Contamination	☐ Chemical
☐ Skin (Occupationnel)	☐ Rash	☐ Irritation	

Remark: .....

Section E: Accidents/incident Details

Date Accident/Incident Occurred:	Time Accident/Incident Occurred:	Exact Location of the Accident / Incident:

Details of the actual Job Being done at the time:

Details of Accident / Incident / What actually happened?

Section F: Accident Cause (Basic cause mark X / Contributing cause, if any mark O)

UNSAFE CONDITIONS		UNSAFE ACTS	
1	☐ Inadequately Guarded	1	☐ Operating Without Authority / Training
2	☐ Unguarded	2	☐ Operating at Unsafe Speed
3	☐ Defective Tools, Equipment, or Subetance	3	☐ Marking SHE Device Inoperative
4	☐ Unsafe Design or Construction	4	☐ Using Unsafe Equipment or Equipment Unsafely
5	☐ Hazardous Arrangement	5	☐ Unsafe Loading, Placing, Mixing
6	☐ Unsafe Illumination	6	☐ Taking Unsafe Position
7	☐ Unsafe Ventilation	7	☐ Working on Moving or Dangerous Equipment
8	☐ Unsafe Clothing	8	☐ Distraction, Teasing, Horse Play
9	☐ Insufficient Instruction	9	☐ Failure to use Personal Protective Devices
10	☐ Lack of system of work	10	☐ Lack of effective instruction or supervision

Why was the unsafe act committed? _____ Why did the unsafe condition exist? _____

Section G: Guide to Corrective Action (Base on the cause checked above, I am taking the following corrective action)

UNSAFE ACT	UNSAFE CONDITION	If Supervisor can't handle, then recommend to
☐ Stop the Behaviour	☐ Remove	☐ Site Engineer, or
☐ Study the job	☐ Guard	☐ Site Manager, or
☐ Instruct (tell-show-try-check)	☐ Warn	☐ Project Manager, or
☐ Follow Up	☐ Supervisory Training	☐ Safety Committee
☐ Enforce		

Detail below any immediate remedial actions that have been taken:

Detail below any corrective and preventative actions that could be taken to prevent future re-occurrence:	Responsible	Completion Date

Section H: Witness Statement	
Witness Name	**Interviewer Name**

Section I: Reviewed & Recommend by			
Recommendation:			
Reviewed By:	Position:	Signature:	Date:

Remarks : If Accident or Incident happened with lost time injury and affected to the publicity must further report to Safety Department;
: First Aid Cases will not applicable to this form;
: The accident report shall submit to Safety Department within 3 days
: Attached the photograph or sketch the location of accident / incident;

1.10 SUGGESTED CONTENTS OF EPRP

The Contractor should prepare the EPRP based on the guidelines provided in the above sections. The suggested structure of the EPRP is listed below:

1. Purpose
2. Applicable Scope
3. Preparation Basis
4. Emergency Response System
   - 4.1 Generals
   - 4.2 Emergency Response System
   - 4.3 Responsibilities
5. Major Safety Risks
6. Precautionary Measures
   - 6.1 Training and Exercise
   - 6.2 Hazard Source Monitor
   - 6.3 Alert Action
   - 6.4 Management Measures
7. Control Measures
   - 7.1 Response
   - 7.2 Response Procedures
   - 7.3 Emergency Response
   - 7.4 Emergency Completion and Restoration
8. Emergency Response Report and Settlement
9. Supporting Measures
   - 9.1 Communication
   - 9.2 Emergency Team
   - 9.3 Funding for Emergency
   - 9.4 Provisions and Resources
10. Records

ANNEX-XI

Guideline Resources Conservation Plan

RESOURCE CONSERVATION PLAN

1. Introduction:

The resources in this world are not infinite. We are completely dependent on the resources of the earth to fulfill all our day to day requirements. Sustainable development calls for the need to conserve resources, especially the non-renewable resources.

2. Objective of the plan:

The Resource Conservation Plan is intended to make an effort towards achieving sustainable development. The objective of the resource conservation plan is to:

- Minimize the use of natural resources; and
- Mitigate/ prevent pollution contaminating the natural resources.

3. Planning:

Careful estimations of quantities of material, fuel, water and energy required directly or indirectly shall be done to avoid excessive or unnecessary wastage of these materials. In addition to this, pollution prevention strategies shall also be devised to prevent contamination of resources.

- The estimations include the following:
    1. Estimation of construction material required for the project
    2. Estimation of fuel consumption for construction machinery, construction vehicles and generators etc.
    3. Estimations of the energy requirements during all the stages of the project
    4. Estimations of water consumption for construction activities and construction camp sites.
- Strategies shall be planned to reduce loads on the identified resources to be consumed;
- Best management practices shall be devised to control or reduce pollution resulting from the activities during different stages of the project; and
- An inspector shall be assigned responsibility to oversee the ongoing activities to check the compliance of the planned strategies.

4. Execution of the plan:

The planned strategies shall be implemented to conserve the natural resources including but not limited to the following:

Material

- Material supplied shall be in conformance with the estimated quantities and excess material shall be returned to the supplier;
- Material wastage shall be avoided by using best management practices;
- Waste produced during the project execution shall be disposed off safely to the designated disposal sites through approved contractors; and
- Reuse of the materials shall be appreciated.

Fuel/Energy

- Reduce trips and optimize routes to and from the construction site for all kinds of activities;
- Regular maintenance of equipment and vehicles to avoid leaks and sustain efficient fuel consumption;
- Switch off/plug off idle equipment and vehicles to avoid wastage of fuel;
- Minimize warm up time, unnecessary acceleration and deceleration of the construction equipment and vehicles;
- Avoid unnecessary burning of fuel for cooking in construction camps;
- Avoid unnecessary heating/cooling systems during extreme weathers;
- Construction shall start in early hours of the day to avoid heat in summers and utilization of day light; and
- Alternate energy sources shall be considered for electricity generations during construction and operation to conserve fossil fuel as it is non-renewable resource.

Water

- Avoid using potable water for sprinkling, curing and washing of equipment/vehicles. Surface water or treated effluent can be used instead;
- Wastage of water should be controlled through providing proper valves and through controlling pressure of the water;
- Unnecessary equipment washings should be avoided;
- Awareness amongst workers shall be raised to conserve water and immediately report for any leaks detected; and
- Ensure protection of canal water from contamination resulting from construction activities.

Pollution:

- Emissions shall be reduced/controlled as far as possible and direct discharges to air shall be avoided by strictly adhering to the mitigation measures outlined in ESIA report;
- Waste water shall not be discharged directly into the canal and must be managed as per the recommendations presented in ESIA; and
- Construction & demolition waste and municipal solid waste shall not be dumped/ burnt openly and shall be handled according to the preventative measure given in ESIA study.

5. Checking and Corrective Actions

The proponent shall bind the construction contractor through contract agreement to comply with the strategies outlined in the Resource Conservation Plan. The proponent shall also appoint an Inspector who shall monitor the daily onsite activities and shall report any issues/ concerns raised in relation to Resource Conservation Plan. The inspector shall recommend adequate corrective actions to mitigate the issues raised.

ANNEX-XII

Guideline Waste Management Plan

CONSTRUCTION SPOIL AND WASTE MANAGEMENT PLAN

1. GENERAL INTRODUCTION

Construction work refers to a wide range of materials depending on their origin; they are categorized as excavation material, demolition materials, spoil and worksite waste material. Construction waste material and spoil of the proposed project consists mainly of concrete, bentonite, masonry, limestone, sandstone, metal, and wood. In addition to this, significant amount of municipal waste will also generate from the construction camps.

2. ORIGINS AND CAUSES OF CONSTRUCTION WASTE

Origins of Waste/Spoil	Causes of Waste/Spoil Material
Contractual	▪ Errors in contract documents; and ▪ Contract documents incomplete at commencement of construction.
Design	▪ Design changes; ▪ Design and detailing complexity; ▪ Design and construction detail errors; ▪ Unclear and unsuitable specifications; and ▪ Poor coordination and communication (late information, last minute client requirements, slow drawing revision and distribution).
Procurement	▪ Ordering errors (i.e. ordering items not in compliance with specification); ▪ Over allowances (i.e. difficulties to order small quantities); and ▪ Supplier errors.
Transportation	▪ Damage during transportation; ▪ Difficulties for delivery vehicles accessing construction sites; ▪ Insufficient protection during unloading; and ▪ Inefficient methods of unloading
On-Site Management and Planning	▪ Lack of on-site waste management plans; ▪ Improper planning for required quantities; ▪ Delays in passing information on types and sizes of materials and components to be used; ▪ Lack of on-site material control; and ▪ Lack of supervision.
Material Storage	▪ Inappropriate site storage space leading to damage or deterioration; ▪ Improper storing methods; and ▪ Materials stored far away from point of application.
Material Handling	▪ Materials supplied in loose form; ▪ On-site transportation methods from storage to the point of application; and ▪ Inadequate material handling.
Site Operation	▪ Accidents due to negligence; ▪ Unused materials and products; ▪ Equipment malfunction; ▪ Poor craftsmanship; ▪ Use of wrong materials resulting in their disposal; ▪ Time pressure; and ▪ Poor work ethics.
Residual	▪ Waste from application processes (i.e. over preparation of mortar); ▪ Off-cuts from cutting materials to length; ▪ Waste from cutting uneconomical shapes; and ▪ Packaging.
Other	▪ Weather ▪ Vandalism ▪ Theft

3. CONSTRUCTION WASTE MANAGEMENT PLAN

i) Waste Management Goals

The contractor established goal that this project will generate at least 50 percent less waste into landfills and the processes shall be employed to ensure that this goal is met. These shall include prevention of damage to materials to be incorporated into the work due to mishandling, improper storage, contamination, inadequate protection, minimizing poor quantity estimation, and through design.

ii) Responsibility

a) The Contractor shall be responsible for the implementation of the administrative portions of this program, including the notification of subcontractor management, the training of the site supervisor and the onsite posting of this plan.
b) The site supervisor shall be responsible for the implementation of the onsite portions of this program including the training of subcontractor personnel.

iii) Waste Prevention Planning

a) In addition to other requirements specified herein it is a requirement for the work of this project that the contractor comply with the applicable city waste disposal requirements.
b) Of the inevitable waste that is generated, the waste materials designated in this specification shall be salvaged for reuse and or recycling where practical and possible. Waste disposal in landfills shall be minimized as much as possible.
c) Project Construction Documents: The Contractor will contractually require all subcontractors to comply with the Construction Waste Management Plan (WMP)". A copy of the WMP will accompany all subcontractor agreements and require subcontractor participation.
d) The "Construction Waste Management Plan" shall be implemented and executed as follows and as on the chart:
    i) Salvageable materials will be diverted from disposal where feasible;
    ii) There will be a designated area on the construction site reserved for materials that can be recycled;
    iii) Areas shall be marked to designate what recycle materials are to be stored there; and
    iv) Hazardous waste shall be managed by a licensed hazardous waste vendor.

iv) Communication and Education Plan

a) This Waste Management Plan will be posted onsite;
b) Each subcontractor will be made aware of the intent of this project with respect to reduction of waste and recycling. Onsite recycling containers and/or areas will be plainly marked;
c) The subcontractor will be expected to make sure all their crews comply with the Waste Management Plan;
d) All recycling containers and areas will be clearly marked;
e) Lists of acceptable and unacceptable materials will be posted at the site; and
f) All subcontractors will be informed in writing of the importance of non-contamination with other materials or trash.

v) Motivation Plan

The Contractor will conduct a pre-award meeting for subcontractors. Subcontractors under consideration will be required to attend the meeting to review project goals and requirements with the project team. Attendance will be a prerequisite for award of subcontracts. This document will be an attachment to every subcontract. Copies of the attachment will be posted prominently at the job site.

vi) Expected Project Waste, Disposal, and Handling

The following chart identifies waste materials expected on the proposed project, their expected disposal methods and handling procedures. New items may be added as needed.

Material	Disposal Method	Handling Procedure
Land Clearing Debris	Keep separate for reuse and or wood sale. Suitable materials may be delivered to a composting site. Separate topsoil and rock for future landscaping use.	Keep separated in designated areas onsite.
Clean Dimensional Wood and Palette Wood	Keep separate for reuse by on-site construction or by site employees for either heating stoves or reuse in home projects. May be offered to public.	Keep separated in designated areas onsite.
Painted or Treated Wood	Reuse, off site recycle, and landfill.	Keep separated in designated areas onsite. Place in “Trash” container.
Concrete	Recycle when possible.	Keep separated in designated areas onsite.
Concrete Masonry Units	Keep separate for re-use by on-site construction or by site employees	Keep separated in designated areas onsite
Metals	Recycle off site when possible. Separate copper wire when possible.	Keep separated in designated areas onsite. Place in “Metals” container.
Gypsum drywall (unpainted)	Recycle with supplier when possible.	Keep scraps separate for recycling – stack on pallets in provided onsite. All scrap drywall should be taken back by contractor to drywall supplier
Paint	Reuse onsite; donate to Habitat for Humanity Restore.	Keep separated in designated areas onsite
Insulation	Reuse and landfill.	Keep separated in designated areas onsite.
Glass	Recycle locally.	Keep separated in designated areas onsite.
Plastics	Plastic Bottles: recycle locally; be aware of plastics that are acceptable to recycle facility.	Keep separated in designated areas onsite.

vii) Recycle Hauler

a) To be determined;
b) Contact Address; and
c) Some or all recycle may be hauled by the authorized representative.

viii) Possible Recycle Locations and Acceptable Materials

a) Coordinate with companies in concerned districts or which are registered with Metropolitan Corporation Quetta that accept materials for recycle; and
a) Using the above as a resource, a list will be kept indicating local opportunities for recycle of expected materials. New locations should be added as needed.

ANNEX-XIII

Guideline Sanitation Plan

GUIDELINE SANITATION PLAN

INTRODUCTION

This plan outlines the measures that can improve conditions of sanitation at construction sites during construction and operation phase.

1. PURPOSE OF THE PLAN

The plan intends to ensure sanitation including the control of water supplies, excrete and wastewater disposal, refuse disposal, vectors of diseases, housing conditions, food supplies and handling, atmospheric conditions, and the safety of the working environment.

2. MANAGEMENT OF SANITATION DURING CONSTRUCTION PHASE

i) Responsibility

The Health and Safety Inspector designated by construction contractor shall also inspect sanitation conditions and ensure safe working environment for workers.

ii) Location of Camp Sites

The accommodation and ancillary facilities for labor shall be constructed and maintained to standards and scales approved by the Resident Engineer.

The camps must be located such that the drainage from and through the camps shall not endanger any domestic or public water supply.

All sites must be managed to avoid ditches and depressions to minimize nuisance due to stagnant water.

iii) Water Supply

An adequate and convenient water supply, approved by the appropriate health authority, must be provided in each camp for drinking, cooking, bathing and laundry purposes.

Potable water supply systems for labor camps occupants shall meet the drinking water quality standards of SEQS, 2016. In addition, the design of water system facilities shall be based on the suppliers Engineer's estimates of water demands. The drinking water must be monitored regularly for drinking water quality parameters.

At all construction camps and other workplaces, good and sufficient water supply shall be provided and maintained to eliminate chances of waterborne diseases to ensure the health and hygiene of the workers.

iv) Toilet Facilities and Hygiene

According to health and safety guidelines OR-OSHA number of toilets required at construction site is as one toilet for 20 workers. **Table 1** shows the number of toilets required in accordance with the number of employees at construction site. The total numbers of employees at construction site are estimated to be 220 persons.

Table 1: Number of Toilets Required for Employees at Construction Site

No. of Employees	No. of Toilets and Urinals by OSHA	Total No. Toilets and Urinals Required at Construction Site
Up to 20 Employees	1 Toilet	5 Toilets
Up to 40 Employees	1 Urinal	2 Urinals

Within the premises of every workplace, toilets and urinals shall be provided in an accessible place, and the accommodation, separately for each of these, as per standards prevailing in the province and country.

Toilet facilities adequate for the capacity of the camp must be provided. Each toilet room must be located, so as to be accessible.

A toilet room must be located within 200 feet of the camp. No toilet may be closer than 100 feet to kitchen and sleeping area.

These toilets must be distinctly marked by signs printed in native language of the persons occupying the camp, or marked with easily understood pictures or symbols.

Urinals troughs in privies must drain freely into the pit or vault, and the construction of this drain must be such as to exclude flies and rodents from the pit.

Proper facility for hand washing and other cleaning activities to be provided as follows:

- Provide individual hand towels from a sanitary dispenser and receptacles for disposing of waste towels;
- Providing hand soap and industrial hand cleaner for removing paints and other contaminants;
- Prohibited use of gasoline or solvent for hand washing; and
- Keep the floor of facilities dry to prevent spills and falls.

v) Waste Disposal

The sewage system for the camp must be designed, built and operated in compliance with the relevant legislation so that no health hazard occurs and no pollution to the air, ground or adjacent watercourse takes place.

Garbage bins must be provided in the camps and regularly emptied and the garbage disposed of in a hygienic manner.

Unless otherwise arranged for by the local sanitary authority, arrangement for disposal of excreta should be done in the already existing sewerage system in the area.

On completion of the works, all such temporary structures shall be cleared away, all rubbish burnt, excreta tank and other disposal pits or trenches filled in and effectively sealed off and the outline site left clean and tidy, at the Contractor’s expense, to the entire satisfaction of the engineer.

vi) Maintenance of Sanitary Facility

Proper maintenance of toilets and other sanitary facilities should assure by health and safety inspector. Toilets and other sanitary facilities shall be cleaned at least four times daily and at least twice during working hours and kept in a strict sanitary condition. Receptacles shall be tarred inside and outside at least once a year.

All buildings, rooms and equipment and the grounds surrounding them shall be maintained in a clean and operable condition, and be protected from rubbish accumulation.

All necessary means shall be employed to eliminate and control any infestations of insects and rodents within all parts of any labor camp.

3. Management of Sanitation During Operational Phase:

A proper sanitation plan is to be adopted for maintaining the hygienic conditions during the operational phase of the project. These includes

- Site Clearance;
- Sewage Pipe Clearing, and
- Solid Waste Management.

i) Site Clearance

The construction contractor shall assure the clearance of construction machinery, vehicle and other equipment used during the construction period after the completion of the project.

ii) Solid Waste Management

Municipal solid waste and medical waste produced along the road should be collected and managed properly by the concerned department. Waste bins should be placed along the road side; regular cleaning of the road should be carried out using mechanical sweepers and at least two to four sweepers should be deputed for the whole proposed road to assure regular cleaning.

iii) Awareness and Training

A training and awareness sessions shall be conducted for workers before commencement of the Project. The implementation of sanitation plan would be more effective if the importance of hygiene; sanitation and safety are known to the workers.

ANNEX-XIV

Traffic Management Plan

GUIDELINE TRAFFIC MANAGEMENT PLAN

1. Need for Plan

During the construction period of the project, considerable vehicular movement carrying large amounts of material and machinery is expected. This will definitely interrupt the local traffic and is therefore important to manage the traffic to avoid the nuisance to local residents in terms of noise, dust, congestion and inconvenience.

2. The plan

The objective of Traffic Management Plan (TMP) is to define the requirements that should be implemented to mitigate any potential negative risks to the environment, workers or the community resulting from construction traffic.

The TMP will advise and inform site Contractors and external suppliers of equipment and materials of access and entry points along with other key information such tipping areas and wash-out areas. It is intended to compliment and work alongside relevant EMP. The TMP will be classed as “live” and therefore be subjected to updates as required.

The Contractor, at the time of the execution of the project, will prepare a comprehensive TMP in coordination with local traffic police department, WSD, emergency services and local administrative department. WSD and CSC will review and approve the Contractor’s TMP. The Contractor’s TMP shall include following mitigation measures during its preparation:

- Undertake a road conditions assessment prior to and following the peak construction period, to assess any damage to road infrastructure that can be attributed to Project development.
- Repair damage as appropriate or enter into a voluntary agreement with the relevant roads authority to reimburse the cost of any repairs required to the public road network as a result of the Project.
- Spoil dumpsites located close to project site to minimize journey distance and limit movements to site access roads.
- Construction of worker accommodation on site to reduce light vehicle movements relating to travel to/ from the site.
- Provision of bus/minibus services for personnel living in nearby settlements.
- Movements of construction workers will be planned to avoid the busiest roads and times of day when traffic is at its greatest.
- Schedule deliveries and road movements to avoid peak periods.
- Driver training for HGV drivers and refresher course every six months for project drivers.
- Speed restrictions for project traffic travelling through communities (to be agreed with National Highway Authority).
- Run a safety campaign to improve the people’s knowledge of the traffic hazard on their roads, public information and other activities to address the issues.
- Run a pedestrian awareness programme.
- Temporary signage

The traffic management plan for the project corridor is provided below.

3. Other Recommendations

It is important to manage public access routes during construction because it can cause delay to local traffic and create a safety hazard both on and offsite. People working and living near the tower sites would be annoyed by the emissions, noise and visual intrusion of queuing vehicles. Some important factors involved in access routes and site traffic are as follows:

3.1. Public Access Routes

The use of public road for site access may be restricted in terms of:

- Vehicle size, width and type of load
- Time limits
- Parking
- Pedestrian conflicts

Contractor should have consultation with the local police or local authority to address these issues and to effectively manage them before the beginning of the construction.

3.2. Site Workers Traffic

Site personnel should not be permitted to park vehicles right on the road; this will lead to disruption in material deliveries. Designated parking areas with appropriate parking space will be needed for this purpose; any plain area near construction site can be used for this purpose.

3.3. Site Rules

- Access to and from the site must be only via the specified entrance.
- On leaving the site, vehicles must be directed to follow the directions given.
- Drivers must adhere to the site speed limits.
- All material deliveries to site must keep allocated time limits.
- No material or rubbish should be left in the loading-unloading area.
- Develop a map for alternate routes showing material delivery services.
- Assign designated personnel on site to receive deliveries and to direct the vehicles.
- Monitor vehicle movement to reduce the likelihood of queuing or causing congestion in and around the area.
- Project vehicles should have a unanimous badge or logo on windscreen displaying that they belong to the project.

4. Contractor’s Obligation

The traffic management plan of the Contractor should be safe enough and widening of any access roads and construction of the detours (as applicable and practical) must be completed prior to start of project construction activities so that heavy vehicular transportation for construction activities do not hinder the normal course of traffic lanes. Contractor must ensure that road closures are carried out by a competent person. The Contractor obligation must include the display of traffic signs according to the need to divert

the traffic volume and to guide the road users in advance. The traffic sign, traffic light should be placed from any diverting route or road marking.

The Contractor should consider the environmental and social impacts of the traffic during construction. It will be sole responsibility of the Contractor to implement a plan which produces minimum nuisance to the local people and to the environment. Safety of the people should be given due importance. It will be under Contractor obligation to notify the traffic management plan and its later changes to CSC, WSD, emergency services and Traffic Police, and also publish weekly programme in the local newspaper.

ANNEX-XV

Chance Finds Procedure

CHANCE FIND PROCEDURE

1. BACKGROUND

The purpose of this document is to address the possibility of archaeological deposits becoming exposed during ground altering activities within the project area and to provide protocols to follow in the case of a chance archaeological find to ensure that archaeological sites are documented and protected as required.

The Antiquities Act, 1975, protects archaeological sites, whether on Provincial Government owned or private land. They are non-renewable, very susceptible to disturbance and are finite in number. Archaeological sites are an important resource that is protected for their historical, cultural, scientific and educational value to the general public and local communities. Impacts to archaeological sites must be avoided or managed by development proponents. The objectives of this 'Archaeological Chance Find Procedure' are to promote preservation of archaeological data while minimizing disruption of construction scheduling It is recommended that due to the moderate to high archaeological potential of some areas within the project area, all on site personnel and contractors be informed of the Archaeological Chance Find Procedure and have access to a copy while on site.

2. POTENTIAL IMPACTS TO ARCHAEOLOGICAL SITES

Developments that involve excavation, movement, or disturbance of soils have the potential to impact archaeological materials, if present. Activities such as road construction, land clearing, and excavation are all examples of activities that may adversely affect archaeological deposits.

3. RELEVANT LEGISLATION

It ensures the protection, preservation, development and maintenance of antiquities in the provinces of Pakistan. The Act defines "antiquities" as ancient products of human activity, historical sites, or sites of anthropological or cultural interest, national monuments, etc. The Act is designed to protect these antiquities from destruction, theft, negligence, unlawful excavation, trade, and export. The law prohibits new construction in the proximity of a protected antiquity and empowers the relevant provincial governments to prohibit excavation in any area that may contain articles of archaeological significance. Under the Act, the subproject proponents are obligated to ensure that no activity is undertaken in the proximity of a protected antiquity, report to the Department of Archaeology, any archaeological discovery made during the course of the project.

4. REMEDIES AND PENALTIES

The Antiquities Act, 1975 provides for heritage inspection or investigation orders, temporary protection orders, civil remedies and penalties to limit contraventions. These powers provide:

''A contravention of any provision of this Act or the rules shall, where no punishment has been specifically provided be punishable with rigorous imprisonment for a term which may extend to two years, or with fine up to rupees ten hundred thousand, or with both. ''

5. ARCHAEOLOGICAL 'CHANCE FIND' PROCEDURE

If you believe that you may have encountered any archaeological materials, stop work in the area and follow the procedure below:

The following 'chance-find' principles will be implemented by the contractor throughout the construction works to account for any undiscovered items identified during construction works:

i. Workers will be trained in the location of heritage zones within the construction area and in the identification of potential items of heritage significance.
ii. Should any potential items be located, the site supervisor will be immediately contacted and work will be temporarily stopped in that area.

iii. If the site supervisor determines that the item is of potential significance, an officer from the Department of Archaeology (DoA) will be invited to inspect the site and work will be stopped until DoA has responded to this invitation.
iv. Work will not re-commence in this location until agreement has been reached
v. between DoA and WAPDA as to any required mitigation measures, which may include excavation and recovery of the item.
vi. A precautionary approach will be adopted in the application of these procedures.

6. DETAILED PROCEDURAL STEPS

- If the Director, department of Archaeology receives any information or otherwise has the knowledge of the discovery or existence of an antiquity of which there is no owner, he shall, after satisfying himself as to the correctness of the information or knowledge, take such steps with the approval of the Government, as he may consider necessary for the custody, preservation and protection of the antiquity.
- Whoever discovers, or finds accidentally, any movable antiquity shall inform forth with the Directorate within seven days of its being discovered or found.
- If, within seven days of his being informed, the Director decides to take over the antiquity for purposes of custody, preservation and protection, the person discovering or finding it shall hand it over to the Director or a person authorized by him in writing.
- Where the Director decides to take over an antiquity, he may pay to the person by whom it is handed over to him such cash reward as may be decided in consultation with the Advisory Committee.
- If any person, who discovers or finds any movable antiquity contravenes the provisions of the Act, he shall be punishable with imprisonment for a term which may extend to five (05) years, or with fine not less than fifteen hundred thousand rupees or with both and the Court convicting such person shall direct that the antiquity in respect of which such contravention has taken place shall stand forfeited to Government.
- The Director or any officer authorized by him with police assistance may, after giving reasonable notice, enter into, inspect and examine any premises, place or area which or the sub-soil of which he may have reason to believe to be, or to contain an antiquity and may cause any site, building, object or any antiquity or the remains of any antiquity in such premises, place or area to be photographed, copied or reproduced by any process suitable for the purpose.
- The owner or occupier of the premises, place or area shall afford all reasonable opportunity and assistance to the Director.
- No photograph, copy of reproduction taken or made shall be sold or offered for sale except by or with the consent of the owner of the object of which the photograph, copy or the reproduction has been taken or made.
- Where substantial damage is caused to any property as a result of the inspection, the Director shall pay to the owner thereof reasonable compensation for the damage in consultation with the Advisory Committee.
- If the Director after conducting an inquiry, has reasonable grounds to believe that any land contains any antiquity, he may approach the Government to direct the Revenue Department to acquire such land or any part thereof and the Revenue Department shall thereupon acquire such land or part under the Land Acquisition Act, 1894 (I of 1894), as for a public purpose.

PHOTOLOGS

	
Govt. Primary School in Command Area	Darbar Hazrat Maeer Hamza Sultan in Command Area
	
Ghost School in Project Reservoir Area	Local Mosque (Basti Shikar Khan) in Reservoir Area
	
Graveyard along the Access Road to the Propsoed Dam Site and Reservoir Area	Grave of Sahab e Rasool “Hazrat Sahal Bin Adi (R.A)”

	
The Irrigation Wah in Reservoir Area (NGO Constructued)	Settlements (Basti Shikar Khan and Wazir Khan) within the Reseroir Area along with the Wheet Storage Tanks by Locals
	
A Mature Wan Tree within the Reseroir Area	Assessment of Trees in Reservoir Area
	
Sampling plot for Floral Assessment in Project Area	Herons Observed in Proposed Command Area

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<tr><td colspan="2">   </td></tr>
<tr><td colspan="2">A View of Kaha River</td></tr>
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<tr><td>Presentation of Green Cover in the Reservoir Area</td><td>Floral Diversity Observed in Propsoed Construcion Camp</td></tr>
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<tr><td>Joint Visit Conducted with the Representative of Forest Department in Ragistan Pachadi Protected Forest</td><td>Floral Diversity in Ragistan Shumali Protected Forest</td></tr>
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Consultation with Assistant Commissioner Rajanpur	Consultation with Addl. Deputy Commissioner Revenue
	
Consultation with Political Assistant/ BMP Commandant	Consultation with Official of Livestock & Dairy Development
	
A View of Consultation with official of Agriculture Extension	A View of Consultation with official of EPA Rajanpur



Meeting with Officials of Water Management Rajanpur



Consultation with Agriculture Department Statistical Officer



Consultation with Assistant Director Fisheries



Consultation with Assistant Director Wildlife Rajanpur



Consultation with DFO and SDFO of Forest Department Rajanpur



Consultation with Branch Manager of NGO Akhuwat (Rajanpur)

	
Community Consultation at Matt Kund	Community Consultation at Basti Shikar Khan
	
Community Consultation at Lundi Syeddan	Community Consultation at Tibbi Solgi
	
Community Consultation at Noshehra Gharbi	Community Consultation at Basti Zafar Khan

	
A view of Socioeconomic Survey	A view of Socioeconomic Survey
	
A view of Socioeconomic Survey	Community Consultation at Laal Garh
	
Group Photo with Participants of Consultation	A view of Socioeconomic Survey

	
A View of Socioeconomic Survey	A View of Socioeconomic Survey