ESIA-MHPP

Environmental and Social Impact Assessment - Madyan Hydropower Project (207MW)

PEDO
18 December 2023

ABBREVIATIONS AND ACRONYMS

Reference	Definition
ACI	American Concrete Institute
AEP	Annual Exceedance Probability
AED	Estimated Annual Discharge
AFI	Availability for Inspection
AHs	Affected Households
AIS	Air Insulated Switchgear
AOI	Area of Influence
AP	Affected Person
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
BC	Benefit Cost (Ratio)
BHU	Basic Health Unit
BOQ	Bill of Quantities
CPPA	Central Power Purchasing Agency
CCPP	Combined Cycle Power Plant
CD	Circular Debt
C-ESMP	Contractor's Environmental and Social Management Plan
CHS	Community Health & Safety
CIA	Cumulative Impact Assessment
CO	Carbon monoxide
CoC	Code of Conduct
COx	Cyclooxygenase
CPEC	China Pakistan Economic Corridor
CSC	Construction Supervision Consultant
dB (A)	decibel
DC	Direct Current
DCS	Distributed Control System
DSM	Digital Surface Model
EA	Environmental Assessment
ECP	Environmental Code of Practices
EFA	Environmental Flow Assessment
EHSGs	Environmental Health & Safety Guidelines
EHS	Environment, Health & Safety
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMF	Electromagnetic Force
EMP	Environmental Management Plan
EN	Endangered
EOO	Extent of Occurrence
EPA	Environmental Protection Agency
EQS	Environmental Quality Standards
ERS	Electric Resistivity Survey
ESIA	Environmental & Social Impact Assessment
ESMF	Environment & Social Management Framework
ESMP	Environmental and Social Management Plan
ESU	Environment & Social Safeguard Unit
FGD	Focused Group Discussion
FIRR	Financial Internal Rate of Return
FS	Feasibility Study
GAP	Gender Action Plan

Reference	Definition
GBV	Gender Based Violence
GENCOs	Generation Companies
GHGs	Greenhouse Gases
GI	Geotechnical Investigations
GIB	Gas Insulated Busduct
GIS	Gas Insulated Switchgear
GKHPP	Gabral Kalam Hydropower Project
GLOF	Glacial Lake Outburst Flood
GoKP	Government of Khyber Pakhtunkhwa
GoP	Government of Pakistan
GPS	Global Positioning System
GRC	Grievance Redressal Committee
GRM	Grievance Redressal Mechanism
GSI	Geological Strength Index
GWh	Gigawatt per Hour
HEC-RAS	Hydrologic Engineering Centre's River Analysis System
HFL	High Flood Level
HHs	Households
HPP	Hydropower Project
HRT	Headrace Tunnel
HSE	Health, Safety and Environment
IBAT	Integrated Biodiversity Assessment
ICB	International Competitive Bidding
ICNIRP	International Commission on Non-Ionizing Radiation Protection
ICOLD	International Commission on Large Dams
IEA	International Energy Agency
IEE	Initial Environmental Examination
IFC	International Finance Corporation
ILO	International Labour Organization
IPC	Interim Payment Certificate
IPoE	Independent Panel of Experts
IRR	Internal Rate of Return
ITA	International Tunneling Association
IUCN	International Union for Conservation of Nature
JHA	Job Hazard Analysis
KE	Karachi Electric
km	Kilometer
KP/KPK	Khyber Pakhtunkhwa
KPEQS	Khyber Pakhtunkhwa Environmental Quality Standards
KPHREP	Khyber Pakhtunkhwa Hydropower and Renewable Energy Development Project
kv	Kilovolt
LAA	Land Acquisition Act
LC	Least Concern
LRIP	Livelihood Restoration and Improvement Plan
LV	Low Voltage
m/s	Meter per second
m^3/s	Cubic meter per second
M&E	Monitoring & Evaluation
MCE	Maximum credible Earthquake
Mg/l	Milligram per liter
MHPP	Madyan Hydropower Project
MSIP	Management Strategies and Implementation Plans
mm	Millimeter

Reference	Definition
MPR	Monthly Progress Report
MRS	Market Rate Schedule
mSoP	Meter Survey of Pakistan
MVA	Mega-volt-amperes
MW	Mega Watt
NCS	National Conservation Strategy
NEPRA	National Electricity Power Regularity Authority
NEQS	National Environmental Quality Standards
NFP	National Forest Policy
NGO	Non-Government Organization
NHA	National Highway Authority
NIC	National Identity Card
NOx	Nitrogen Oxides
NSBD	Non-Segregated Bus ducts
NPV	Net Present Value
NT	Near Threatened
NTDC	National Transmission and Dispatch Company
OBE	Operating Basis Design Earthquake
O&M	Operation and Maintenance
OFWF	Oil Forced Water Forced
OH	Over-Head
OHS	Occupational Health & Safety
OHSMP	Occupational Health & Safety Management Plan
OP/BP	Operational Policy/Bank Procedure
OPD	outpatient department
OPL	Official Poverty Line
OSHA	Occupational Safety and Health Administration
PAPs	Project Affected People
PD	Project Director
PDCA	Plan-Do-Check-Act
PEC	Pakistan Engineering Council
PEDO	Pakhtunkhwa Energy Development Organization
PIC	Project Implementation Consultants
PKR	Pakistani Rupee
PM	Project Manager
$PM_{2.5}$	particulate matter 2.5 micrometers or less in size
PM_{10}	particulate matter 10 micrometers or less in size
PMD	Pakistan Meteorological Department
PMF	Probable Maximum Flood
PMO	Project Management Office
ppb	Parts per billion
PPE	Personal Protective Equipment
PSHA	Probabilistic Seismic Hazard Assessment
ppm	Parts per million
RAP	Resettlement Action Plan
RFI	Request for Inspection
RHC	Rural Health Centre
RNLG	Regasified Liquefied Natural Gas
RQD	Rock Quality Designation
SF_6	Hexafluoro sulfur
SCS	Soil Conservation Service
SDP	Social Development Plan
SEA	Sexual exploitation and abuse

Reference	Definition
SH	Sexual Harassment
SOP	Survey of Pakistan
SOx	Sulphur Oxides
SSMP	Site-Specific Management Plan
SWSMMP	Sustainable Water Supply Management & Monitoring Plan
TBM	Tunnel Boring Machine
TBT	Toll Box Talk
TMP	Traffic Management Plan
TRA	Tunnel Risk Assessment
UFS	Updated Feasibility Study
$\mu g/m^3$	Microgram per cubic meter
UNFCCC	United Nations Framework Convention on Climate Change
USBR	United State Bureau of Reclamations
USD	United State Dollar
USEPA	United State Environmental Protection Agency
VECs	Valued Environmental & Social Components
VU	Vulnerable
WAPDA	Water and Power Development Authority
WB	World Bank
WBG	World Bank Group
WHO	World Health Organization

Executive Summary

A. Project Setting

The Pakhtunkhwa Energy Development Organization (PEDO) intends to construct a 207-megawatt (MW) run-of-river hydropower plant (referred to as "Project") at Madyan, in the Swat District of Khyber Pakhtunkhwa (KP) Province, Pakistan. The Project called Madyan Hydropower Project (MHPP) is located on the Swat River about 12 kilometers (km) upstream of the town of Madyan and in the village of Kedam.

The Project is funded by the World Bank (WB) through the 'Khyber Pakhtunkhwa Hydropower and Renewable Energy Development Program' (hereinafter referred to as 'the Program' or KHRE). Therefore, all environmental and social instruments prepared under this project are in compliance with both locally applicable regulations and WB's Operational Policies and Guidelines. The present Environmental and Social Impact Assessment (ESIA) has been conducted in order to address the potentially negative environmental and social impacts of the proposed project in compliance with the local regulatory and WB policy requirements.

PEDO is already implementing the Gabral Kalam hydropower project (GKHPP) on Swat River upstream of the MHPP under KHRE.

B. Project Components

The Project consists of the following main structural components, as shown in Figure ES-1:

- 16.2 m high weir, with 107m long crest. It will be a concrete gravity structure, ogee shaped, with overflow spillway, fish ladder and under sluices;
- One 72.9m long power intake, proposed at the left abutment of weir;
- Two underground desander chambers, proposed at the left abutment of weir;
- 910 m long approach tunnel to connect power intake to the desander chambers;
- Underground powerhouse (with two units of 86.6 MW and one unit of 33.8MW) and a 220-kilo volt (kV) gas insulated switchgear system;
- 11.18 km long headrace (pressure) tunnel from the desander to the power house;
- 01 km long 220 kV transmission line;
- a new bridge crossing the Swat River connecting between N95 highway at right bank and the new construction road at left bank;
- Several sites to dispose excavated materials;
- Project colony with necessary water supply and sanitation facilities for approximately 50 operation and maintenance (O&M) staff.

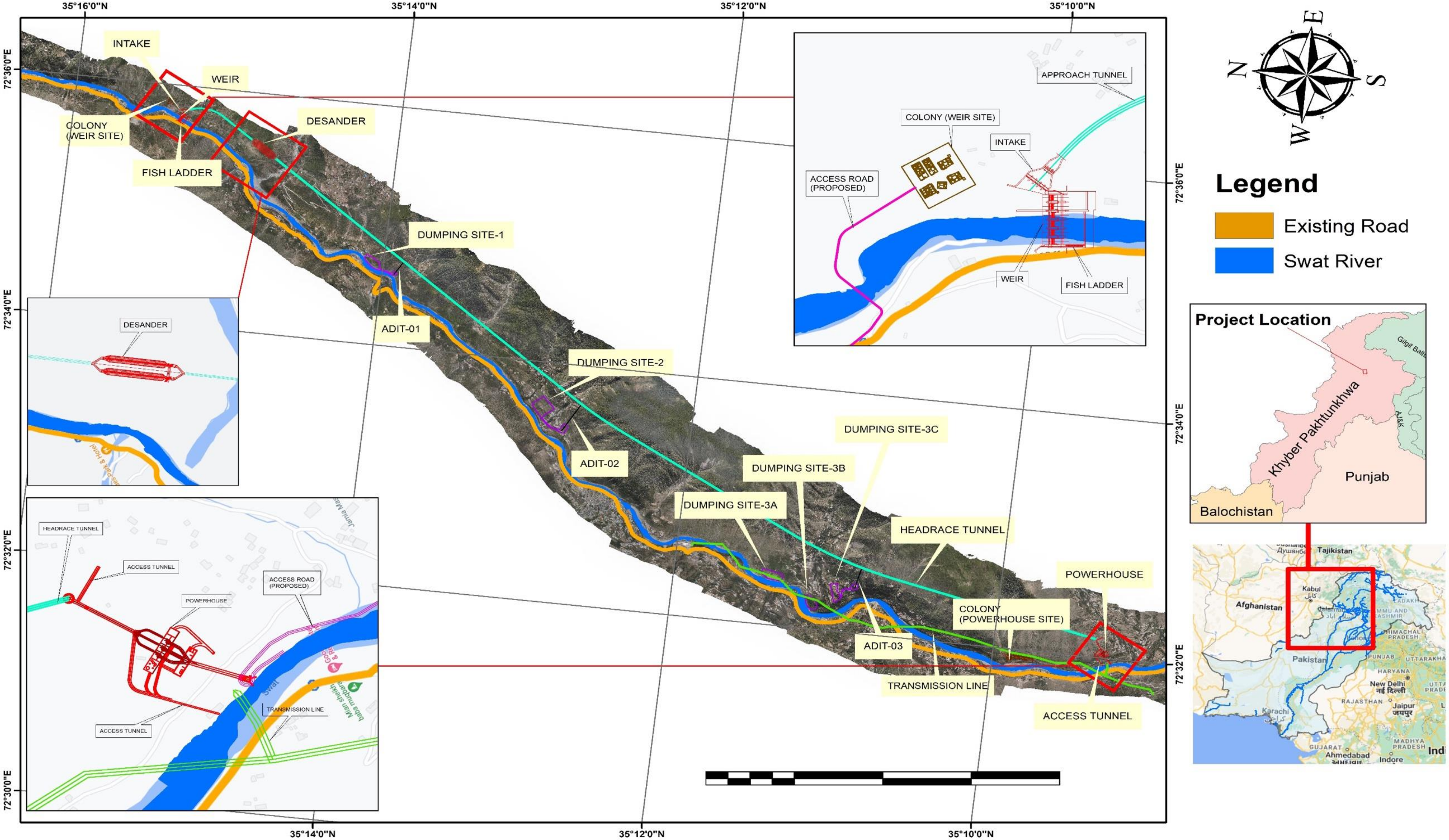


Figure ES-1: Project Location

C. Regulatory and Institutional Framework

The Khyber Pakhtunkhwa Environment Protection Act-2014 is applicable to the project. In accordance with this Act, the development of hydropower infrastructure needs to be approved by the KP Environmental Protection Agency (KP EPA) following the procedures given in the Pakistan Environmental Protection Agency (Review of Initial Environmental Examination (IEE) and environmental impact assessment (EIA) Rules, 2021). According to these Regulations, development of hydropower projects of more than 50 MW capacity falls under Schedule II that requires EIA to be conducted for environmental clearance. Hence, this ESIA will be submitted to KP EPA for obtaining the environmental approval for the Madyan hydropower Project.

The Project will also comply with WB's Environmental Assessment requirements in order to obtain financing from the Bank. Therefore, this ESIA of the Project has been prepared in compliance with the WB applicable environmental safeguard operational policies: (i) Environmental Assessment (OP/BP 4.01); (ii) Natural Habitats (OP 4.04); (iii) Involuntary Resettlement (OP/BP 4.12); (iv) OP/BP 4.11 - Physical Cultural Resources and; and (v) Safety of Dams (OP 4.37). The World Bank Group's environment, health and safety guidelines (EHSGs) will also be applicable for the project.

D. Analysis of Alternatives

The following project alternatives were considered with respect to their technical, financial, environmental and social aspects:

Without Project Scenario. In Pakistan, the total installed power generation in 2022 was 43,775 MW. The share of renewable energy including hydropower was 24.7%., wind 4.8%, solar 1.4% and biogas was 0.9%.[1] The maximum total demand from residential and industrial sectors stood at nearly 31,000 MW, whereas the transmission and distribution capacity was approximately 22,000 MW. Presently, the electricity deficit is about 9,000 MW when the demand is at its peak. Lack of access to electricity and power shortages result in long hours of load shedding, impacting households, as well as industrial and commercial activities. About 68 percent of the total installed power generation capacity in the country originates from fossil fuel power plants. Without adding renewable power generation capacity in the country, the present situation described above is likely to continue and even further deteriorate. Therefore, the "without project" alternative is not realistic, because Pakistan will have to build additional renewable generating sources to eliminate power shortages, and reduce reliance on imported fuel. Given the increasingly high costs of fuel, oil-based electricity generation has become very expensive. The proposed Project will help reduce Pakistan's Circular Debt by lowering the cost of electricity generation through the development of renewable energy solutions. The development of Pakistan's hydropower resources at a variety of scales represents the only reasonable prospect of eliminating these shortages.

Weir: Various alternatives were considered for the weir location and design. The final selection was made on the basis of the river flow and flood levels. The rainfall-runoff modelling found higher flood levels than initially estimated, accordingly, changes to the design of weir parameters have been made to ensure that the weir can withstand future flood events in the Swat River. Additionally, the location of the weir was also changed since the the Swat River is wider at the new location and there will be more space for the water to flow during high flow seasons.

Selection of Powerhouse Location and Type: Various alternatives were considered for powerhouse location and design. Underground powerhouse was finally selected for the proposed project on the basis of technical, environmental and social considerations. Underground powerhouse allows greater operating heads and thus improving power output and efficiency. For underground powerhouse, comparatively more spoils are generated as deep excavation is required but construction noise will be intercepted by the rock layers, thus less noise will escape. Underground Powerhouse will also be less damaging to the flora and fauna and land requirements are much lower.

E. Environment and Socio-Economic Baseline

a) Area of Influence (AOI)

The area of influence (AOI) (or the project area) for environmental and social impact assessment of the proposed Madyan Hydropower Project comprises the following: **(i) Primary Project Site:** the primary project site or primary impact zone is considered as 16km long stretch of area along the Swat River where most of the physical works will be carried out. Most of the proposed works are envisaged on the left bank of the swat River within 200m distance from the riverbed and therefore; width of the AOI for this ESIA is considered as 2km (0.5km from the bank of the river on right bank and 1.5km on left bank of the river from the active riverbed) along the Swat River. **(ii) Related facilities:**

[1] https://www.finance.gov.pk/survey/chapter_22/PES14-ENERGY.pdf

these include staff colony, access road to 3 adits, five dumping sites identified for the disposal of excavated material, access roads for desander, construction camps and other temporary facilities established by the contractor. These related facilities will be situated within the area earlier discussed for Primary Project Site. The sites where livelihood restoration activities will be carried out, will also be considered in the AOI.

b) Physical Environment

The Project area lies adjacent to the meeting point of three big mountain ranges, i.e., Himalayas, Hindu-Kush and Karakorum. The Swat River and its tributaries generally pass through deep and narrow gorges having steep slopes in the project area and its surroundings. The mountains are mostly covered with primary soils, except along the river and nullahs where the beds are almost devoid of soil material primarily because of steep slopes and the scouring action of the river/nullahs flows. The project area is located at the valley floor.

Baseline environmental quality monitoring was conducted during August 2022 for River Swat water, ground water, ambient air quality and noise in Kedam, Darolai, and Kalagay villages. The ambient air quality and noise level monitoring results revealed that all the parameters were within the permissible limit of national environmental quality standards (NEQS).

The water quality of rivers and springs in Kedam, Darolai, and Kalagay villages was analyzed during August 2022, and the results revealed that quality was generally good, with total dissolved solids ranging from 721 to 828 parts per million (ppm), however E. coli and Fecal Coliform at weir and powerhouse site were not within permissible limits. The existing pollution sources include the disposal of solid and liquid wastes into the river by the settlements, hotels and restaurants located along the river.

The main surface water resource of the project area is the Swat River. Swat River mainly originates in the form of Ushu and Gabral Rivers in the northern mountains of Khyber Pakhtunkhwa and takes the name of Swat River at Kalam at the confluence of Ushu and Gabral rivers. The area also has many springs and tributaries with perennial and non-perennial flows discharging into the Swat River. The springs located in the project area are on both sides of the mountains, which are being used for drinking and irrigation purposes by the local communities. The consumptive requirements of the communities are generally met from the spring water. There is no extraction of groundwater in the area either through open wells or bore wells for the drinking and irrigation uses.

c) Biological Environment

Types of Habitats: There are six types of habitats found in the AOI of the proposed project. These comprise: the active river, riverbank/riparian, agriculture fields, scrub forest, dry temperate forest, and settlements. However, no terrestrial critical habitat or threatened or unique ecosystem has been identified in the AOI. The terrestrial habitats in the AOI of the project are homogenous and widespread. Except for Swat River and its tributaries that are habitat for three fish species, the remaining habitats are not considered of significance for the survival of endemic or restricted-range species.

Terrestrial Ecology: The biological resources of the project area include plants, reptiles, avian fauna, mammalian fauna and fish species. Overall, 196 plant species belonging to 60 families were identified in the project area. Out of the recorded floral species, 35 species (18 %) were trees, 18 species (9.2 %) shrubs, 116 species (59.1 %) herbs, 18 species (9.2 %) grasses, 08 species (4 %) climbers and 01 species (0.5%) were sedges. Fruit trees like Oriental persimmon (*Diospyrose kaki*) and Caucasian persimmon (*Diospyros lotus*) are attractive for large mammals like Rhesus monkey (*Macaca mulatta*) and Asiatic black bear (*Ursus thibetanus*) especially during fruiting season in autumn and winter. Fruits of Caucasian persimmon or wild persimmon (Diospyrose lotus) locally called “Amloke” also provide food to different resident and winter visiting birds.

Among the recorded reptiles, Brown cobra (*Naja oxiana*) and Indian Rock Python (*Python molurus)* have been categorized as “Near Threatened” while remaining 10 species have been categorized as “Least Concern” according to International Union for Conservation of Nature (IUCN) Red List of Threatened Species (IUCN, 2023). One lizard species, North-Pakistan Agama (*Laudakia pakistanica*), is Endemic to Pakistan but commonly found in all of its distribution range in the northern mountainous region in Pakistan.

A total of 91 avian species belonging to 14 orders were identified in the project area. These include 30 resident birds, 20 winter visiting birds, 36 summer breeders and five species of passage migrant birds.

Overall, 12 species of mammals belonging to six orders, nine families and 11 genera were recorded from the study area. These include eight species of small mammals and four species of large mammals. The four large mammals include Asiatic black bear (*Ursus thibetanus*-Vulnerable), Indian wolf (*Canis Lupus*-Least Concern), Asiatic jackal (*Canis Aureus*-

Least concern) and Rhesus monkey (*Macaca mulatta*). Only the Asian Black Bear is reported close of the project area. The habitat of the Black Bear is on high altitude but in winter season when the food is not available at higher altitudes, the species moves down for hunting local livestock.

Aquatic Ecology: The Swat River and its tributaries are characterized by relatively steep gradients, fast-flowing and turbulent waters with high flows and more sediments during summer and low flows and low sediments during winter. The findings of the aquatic biodiversity surveys of the project area shows that two species including Brown trout (*Salmo trutta fario*-Least Concern) and Snow carp (*Schizothorax plagiostomus*-Vulnerable) were found in the main river while the third fish *species Nangra robusta* (Endangered) was found only in the tributaries of the Swat River. Snow carps are short-distance migrants and mainly migrate within the tributaries. From April to September (spring and summer, high flows), they prefer upstream headwaters habitat at higher elevations. During September to April (low flows and winter), they prefer lower elevations. The triggers for migrations are high flows and low temperatures.

d) Socio-Economic-Environment

The project area falls in the rural area of KP and is located in Tehsil Bahrain of District Swat. All the components of the MHPP will be constructed on the left side of the River Swat, up to about 200 m distance from the riverbed. Twenty villages/ settlements with a total population of 80,573 persons fall in the AOI on both sides of the Swat River. The socio-economic survey findings reveal that out of total population, 50% of the males and 48% of the females were literate. The project area has poor educational facilities.

The major source of livelihood is agriculture. Other occupations and income generating activities being practiced in the project area include employment in government and private sectors, daily wage labor, operating businesses such as running a grocery shop and working abroad. About 45% of the respondents earn from multiple professions. Based on the sources of livelihood, the average annual income per surveyed family is Pak Rupees (PKR) 665,021. The income distribution analysis reveals that about 49% of the surveyed families are living below the official poverty line (OPL).

There is evidence of large-scale sand and cobble mining at and immediately downstream of weir site. Sand mining in the Swat River was observed intensively and frequently in the anticipated dewatered stretch of the Swat River. River sediments in the Swat River are both a valuable environmental and economic resource. Apart from the provision of habitats for riverine biota, the sediment is mined from the river for use in buildings, road construction and other related activities. Sands and silts are used directly, and cobbles and boulders are crushed to create aggregate material.

F. Potential Environmental and Social Impacts and Risks during Construction

Environmental and social impacts and risks of the proposed project have been evaluated within the defined area of influence (AOI); a brief summary of the key environmental and social impacts and associated mitigation measures is presented in the following table.

Table ES-1: Summary of the Potential/Key Environmental and Social Impacts & Mitigation Measures

Impact	Mitigation/Enhancement Measures
Potential Environmental & Social Impacts due to Project Settings	
Sedimentation of the Reservoir	It is ensured in the design that the structures will be functional at different sedimentation loads. The reservoir operations are designed with regular flushing of sediments through under sluices and from the desander channels during high flow season.
Acquisition of 131.175 acres of land permanently including relocation of 37 households, uprooting of trees 4,391 (including 2,321 fruit trees and 2,070 timber trees) & impacts on livelihood	MHPP Project specific resettlement action plan (RAP), social development plan (SDP) and livelihood restoration and improvement plan (LRIP) have been prepared in line with the World Bank Operational Policy (OP) 4.12 and land acquisiton act (LAA), 1894. RAP, SDP and LRIP will be implemented before commencement of the physical works. SDP and LRIP will be implemented during the construction phase. The compensation will be paid to the affected households in line with the RAP. About 44,000 number of trees (10 trees for each tree cut) will be replanted under the compensatory plantation plan. Tree plantation plan will be prepared and implemented in consnultation with the forest department of Khyber Pakhtunkhwa (KPK).
Environmental and Social impacts and risks during construction	
Impact of increased traffic and transportation on N-95	The Traffic Management Plan (TMP) will be prepared and implemented by the contractor.
Impacts on Swat River Ecology	The construction of cofferdam shall be inspected regularly to ensure the safe passage of fish. The controlled flow of wastewater and sediment releases to river will be adoptedparticularly in the section of cofferdams. The release of silt, sediment, sediment-laden water, raw concrete, concrete leachate, or any other deleterious substances into the river will be prevented. The spill containment kit readily accessible onsite will be ensured in the event of a release of a deleterious substance to the environment.
Impacts on Water Springs	Considering 500 m buffer around the underground headrace tunnel in the uphill direction and up till the Swat River, it is expected that no spring will be affected by Tunnel construction as all are located more 500 m distance from the headrace tunnel. However, to avoid any potential impacts on water springs, the contractor will analyze the tunnel's expected interference with underground water and technical solution will be devised to maintain the flow without disruption in line with the applicable good international practices and guidelines. A Sustainable Water Supply Management and Monitoring Plan as part of the SDP has been planned to develop water supply schemes for the communities. This plan can also assess the anticipated impacts and risks of the tunnel excavation of the anticipated risks of disconnection of sources of the reported springs. The quality and quantity of tunnel effluent streams discharged to the environment, including storm water, leach pad drainage, process effluents and overall tunnel works drainage will be managed and treated to meet the applicable effluent discharge guideline. In addition, discharges to surface water will be avoided in contaminant concentrations exceeding the national water quality criteria (NEQS).
Security Risks	The PMO will conduct a security assessment of the project area and will prepare a security management plan before the mobilization of the contractors.
Generation of about 2.75 million m^3 of spoils (excess excavation materials) and their disposal	Before commencement of construction works, site specific environmental and social due diligence will be carried out.
Generation of construction waste including hazardous waste	The contractor will prepare and implement a Waste Management Plan.

Impact	Mitigation/Enhancement Measures
Wastewater discharges from the construction camps, sites, and batching plants	As discussed above, the contractor will prepare and implement a Waste Management Plan. Monitoring of wastewater quality to ensure compliance with NEQS prior to disposal to the natural streams will be ensured.
Potential risk of soil and water pollution by construction works	The storage of fuels and chemicals in contained facilities will be ensured. Availability of spill kits and trained personnel for immediate cleanup of any oil spills will be ensured. Information of all spills will be notified to PMO immediately. The contaminants will be confined immediately after accidental spillage and clean-up of oil spills using spill kits will be ensured.
Risk of Landslides	The contractor will develop and implement a Blasting, Explosives, Vibration Management & Monitoring Plan.
Occupational & Community Health & Safety	An occupational health and safety plan will be prepared and implemented in line with the following guidelines and KP acts and regulations; • World Bank (WB) Environment, Health & Safety (EHS) Guidelines[2]; • Internationmal Tunneling Assocaition (ITA) guidelines; • applicable occupational safety & health administration (OSHA) and international labour organizaiotn (ILO) guidelines; • Compliance of Government of Khyber Pakhtunkhwa (GoKP) regulations on Factory Act 2013, KP Occupational Health and Safety Act 2022, Industrial Relations Act 2013, and Workers Compensation Act 2013. Accessibility for firefighting, ambulance, medical and rescue vehicles and medical facilities at the site for implementation of the Emergency Response Plan will be ensured by the contractor. In addition, compliance to KP Workers Compensation Act, 2013, in case of for injury or death by accident to their employees, the MHPP contractor(s) will be liable to provide compensation.
EHS Risks & Impacts associated with Tunnel & Underground Powerhouse Works	**The summary of the applicable mitigation measures are; (i) A tunnel risk assessment** (TRA) will be conducted by the contractor and environment, health and safety (EHS) plan for tunnel and powerhouse works as well as emergency response plans will be prepared and implemented by contractor. (ii) **Signages in hazardous and risky** areas, safety measures, emergency exits, and other such areas will be in accordance with international standards, well known and easily understood to workers, visitors, and as appropriate to the general public. (iii) **Blasting activity** will be permitted with issuance of "Permit to Work" by the PIC and Contractor's Health Safety & Environment Team. (iv) **Specific warning devices** and procedures will be implemented before each blasting activity to alert all workers and third parties in the surrounding. (v) **Air Quality Monitoring after** every blast will be carried out before workers and staffs are allowed to re-enter the tunnel and powerhouse. (vi) **Ventilation system will be ensured at t**he workplace to enable workers to carry out work without risk to health and safety. (vii) **Methane Detection tests** will be conducted regularly**. (viii) Respiratory** personal protective equipment (PPE) will be provided to prevent people inhaling hazardous dust or other airborne contaminants at the concentration and duration of the exposure. (ix) **Heat Stress risks** during tunnel work will be monitored**. (x) the risks of Fire** at Project site due to combustible materials will be managed with good housekeeping measures as per health safety and environment (HSE) plan. Provision of firefighting facilities will be ensured along with training of firefighting to all tunnels staff including casual labors. (xi) **Visibility and lighting** at Project will

[2] https://documents1.worldbank.org/curated/en/157871484635724258/pdf/112110-WP-Final-General-EHS-Guidelines.pdf

Impact	Mitigation/Enhancement Measures
	ensure provision of adequate lighting arrangement inside the tunnel and powerhouse works. (xii) **Electrical safety due to e**lectrical equipment will be protected from these exposures. (xiii) ITA guidelines will be implemented.
Air and Noise pollution from construction and traffic	Dust suppression techniques for roads and work areas, optimization of traffic patterns, and reduction of travel speeds will be followed. In case of blasting impacts on ambient air, blasting will be carried out at a time when workers are not expected to enter the affected area of the headrace tunnel and powerhouse for the next hour or so, this allows some dust to settle out and the rest to be carried away by the ventilation system. As more than 90% of the blasting would be carried out in confined environment; therefore; the impacts on aboveground ambient air is minimal and is only anticipated during construction of headrace and powerhouse portal portions. In case of drilling dust emissions from drilling activities needs to be controlled at the source by dust extractors, collectors, and filters, wet drilling and processing will be adopted[3]. At this stage of the project, the contractor's type of drilling technology, plan and methodology of drilling is not available. Therefore, different options for drill dust control are proposed for this ESIA and whichever is effective, efficient and feasible for contractor can be adopted; (i) the most common method of drill dust control is a **dry dust drill collector** with the intake at the tip of the drill bit. This arrangement provides excellent dust control if the collector is maintained properly. (ii) in hard-rock mines and tunnels, **water injection through the drill steel** has been effectively used globally to control dust for many years. (iii) **foam injection** through the drill steel also can be used in those applications where excessive water can create a problem[4]. (iv) **wet drilling systems** pump water into the bailing air from a water tank mounted on the drill. The water droplets in the bailing air trap dust particles as they travel up the annular space of the drilled hole, thus controlling dust as the air bails the cuttings from the hole. The drill operator will control the flow using a control valve located in the cab. Some drills are equipped with a flow meter to give the operator a visual sign of the flow rate. Raising the water flow will improve dust capture but too much water causes operational problems. Because of this, the drill operator must exercise care in finding the best water flow rate. (v) **Dry Collection** systems require an enclosure around the area where the drill stem enters the ground. This enclosure is constructed by hanging a rubber or cloth shroud from the underside of the drill deck. The enclosure is then ducted to a dust collector, the clean side of which has a fan. The fan creates a negative pressure inside the enclosure, capturing dust as it has the hole during drilling. The dust is removed in the collector, and clean air is exhausted through the fan.
Vibration impact of tunnel construction	The contractor will conduct a pre-construction survey of structures at risk of vibration. If they are located close to the blasting area (100 m) then they need to be relocated temporarily, if the distance is more than 100 m, awareness will be created and residents must be notified in advance prior to every blast. After completion of the blasting, the survey will be repeated to determine the condition of the buildings and verify that they are safe for re-occupation. The Blasting will be scheduled during the daytime only, local communities will be informed of blasting timetable/schedule in advance. Theunscheduled blasting will be strictly prohibited in any case. The contractor will also develop a Vibration Monitoring Plan that will include monitoring of vibration levels and frequency around the blasting sites.

[3] IFC Environmental, Health, and Safety Guidelines for Construction Materials Extraction available on https://www.ifc.org/wps/wcm/connect/dad17995-66be-4280-86da-b438cf9fbefc/Final%2B-%2BConstruction%2BMaterials%2BExtraction.pdf?MOD=AJPERES&CVID=nPtfjTM&id=1323162191491

[4] Source: NIOSH Handbook on Dust Control in Mining. Can be accessed on https://www.cdc.gov/niosh/mining/userfiles/works/pdfs/2003-147.pdf

Impact	Mitigation/Enhancement Measures
	Commensurate to the Khyber Pakhtunkhwa Explosive Substances Act, 2013, the legal procedure and approval from the KP Government entity will be obtained by PEDO/Contractor for the use of explosive substance[5] handling and transportation will be followed.
Fly Rock from Blasting	A minimum buffer of 500m will be provided between the settlements and point of blasting.
Impacts from Quarry Activities – Sourcing of aggregates for concrete works	The excavated material will be resused to the extent feasible. Use of quarry sites that are licensed by the provincial government and approved by the project management unit/Implementation Consultants will be ensured.
River Protection	In compliance to KP Rivers Protection Ordinance, 2002, t**he contractor facilities like camp and batching plant shall be located away from the river and it is important that Project-related activities do not pollute the river and that all construction activities along the river banks be carried out within the area designated for the project** and waste management plan will be implemented.
Potential ESHS Impacts and Risks in O&M and Mitigation Measures	
Impact on aquatic Habitat of the Indus and its Tributaries through the Creation of Reservoir	A Fish Management Plan will be prepared and implemented to manage any potential risks on and related to the fishes. The fish management plan will be applicable for the O&M stage of the project. The eFlow of 3.5 m3/s is determined in the ESIA to maintain fish movement up and downward migration and ensure river connectivity. This flow will be ensured throughout the year. A Fish ladder is designed based on the requirements of snow trout, brown trout and other indigenous species. Water will be released continuously through the fish ladder at all times. For monitoring performance of the fishway/fish pass, the cameras will be placed on the ladder and monitored to count the fish and assess the effectiveness of the ladder. Installation of trash rack at the intake to prevent the fish from entering water intakes and protect the fish against entrapment. Regular removal of deposited sediments from the ladder. Supporting the fisheries department for upgrading their snow trout hatchery at Nagoha Shamozai, and annually releasing the fish both upstream and downstream of the weir.
Barrier effect on fish migration	A Fish ladder is designed based on the requirements of snow trout, brown trout, and other indigenous species. Water will be released continuously through the fish ladder at all times. For monitoring performance of the fishway/fish pass, cameras will be placed on the ladder and monitored to count the fish and assess the effectiveness of the ladder. Installation of trash rack at the intake to prevent the fish from entering water intakes and protect the fish against entrapment. Regular removal of deposited sediments from the ladder. Supporting the fisheries department for upgrading their snow trout hatchery at Nagoha Shamozai and annually releasing the fish both upstream and downstream of the weir. A Fish Management Plan will be prepared and implementation will be ensured.
Reduced water flow between weir and tailrace during low flow season	Hydrological modelling conducted by PIC confirmed that the minimum flow to be maintained in Swat River will be 3.5 m3/s. various literature reviews were conducted for snow trout requirements and concluded that the minimum flow requirements for snow trout is 2.5-3.5 m3/s during the migratory season (March-April and September-October). A Fish Management Plan will be prepared to address the issues and provide tailored mitigation measures.

[5] Under this act, an explosive substance" means and includes any material for making any explosive substance, also any apparatus, machine, implement or material used, or intended to be used, or adapted for causing, or aiding in causing, any explosion in or any explosive substance; also, any part of any such apparatus, machine or implement

Impact	Mitigation/Enhancement Measures
Reduction of sediment load in the downstream water flows from the reservoir	Release of environmental flows and excess flows through sluices to release the sediments in the high flow season. Schedule the flushing of sediments during high flow season from the desanders. Synchronize the flushing of sediments with other hydropower plants up and downstream so that cumulative impacts are minimal.
Waste generation from the plant and staff colony	The waste management plan will be implemented.

G. Institutional Arrangements

The Pakhtunkhwa Energy Development Organization (PEDO) is the implementing agency of the Project. PEDO has already established a Project Management Office (PMO) to manage, monitor and coordinate all project implementation activities. PMO will be responsible for overall project management and the procurement of two consulting teams, one for construction supervision and the second one for monitoring and evaluation (M & E). The PMO is headed by the Project Director (PD) and also includes an Environment and Social Unit (ESU). In addition, the Project Implementation Consultants (PIC) will act as the Engineer. The PIC will be responsible for supervising the contractors for the implementation of C-ESMP. For this purpose, the PIC will appoint dedicated environmental, social, health and safety (ESHS) staff to ensure the implementation of environmental and social management plans during the project. They will supervise the contractor for the ESMP implementation, particularly the mitigation and control measures. They will also be responsible for implementing the monitoring the effects of these measures.

H. GRM

A Project-specific grievance redress mechanism (GRM) for Gabral Kalam Hydropower Project (GKHPP) under KHRE has already been established and is fully functional. Based on the same model, a project specific grievances redressal mechanism for MHPP will be established to receive, evaluate, and facilitate the resolution of affected parties concern, complaints, and grievances about the environmental and social performance of the Project. The GRM will have three tiers; the first tier will be established at the project site, the second tier will be established at the PMO level, whereas the third tier will be at the PEDO level.

I. Environmental and Social Management Plan

An ESMP containing mitigation and monitoring plan has been developed and presented in the ESIA. ESMP also includes Environmental Code of Practices (ECPs) and site or topic specific environmental and social management sub-plans to address generic impacts associated with hydropower construction. As described earlier, prior to construction, the Contractor will prepare the C-ESMP with site-specific management plans. The contractor will be required to conduct regular training for its workers on various aspects, including occupational health and safety, environmental protection, and awareness to the construction workers on avoiding gender-based violence.

The ESMP of the Project will be included in the contractors' bid and contract documents. The technical specifications of the bid and contract documents will clearly state that contractor will need to comply with the mitigation and control measures provided in the ESMP, ECPs, OHS Plan, World Bank Group EHS General Guidelines and NEQS.

J. Stakeholder Consultations and Disclosure

For Madyan HPP, consultations with the local community, affected persons, institutional stakeholders, and women of the project area have been conducted. Detailed consultations were carried out with the (i) primary stakeholders including people settled in villages falling in the AOI including women, and (ii) secondary stakeholders including relevant KP Government Departments, NGOs, and expert. Consultations have been done in an open environment, in which the community expressed their view freely without any coercion or intimidation. The consultation is a continuous process and will be continued during construction, completion and during the O&M of the project.

To summarize, the feedback of male community members recorded during consultation included (i) dam construction would increase water levels and reduce the downstream flow of driftwood that is primarily used as fuel wood by locals; (ii) disturbances due to construction activities; (iii) loss of agricultural land; (iv) requested for appropriate compensation in case of land acquisition and involuntary resettlement (v) social issues due to movement of labor; (vi) pollution related Issues; and (vii) grievance redressal mechanism for the project. The project informed the stakeholders about the specific mitigation measures devised in the draft ESIA to address these concerns.

The viewpoints recorded during consultation with women participants included (i) concerns related to loss of any property/assets, crops/trees and requested for compensation; (ii) concerns for disturbance of access to the agriculture land; (iii) requested for provision of community development programs in the project; (iv) employment of women for office works; and (v) requested for family members employment during construction and O&M stages of the project. Most of these concerns have been addressed in the mitigation plans prepared for the proposed project.

Consultation with the secondary stakeholders were carried out in 2008 during feasibility study preparation and then in 2022. To summarize, the viewpoints recorded during consultation included (i) risk of glacial lake outburst flood (GLOF); (ii) noise and vibration; (iii) impacts on tourism and historical and archaeological sites; (iv) release of minimum eFlow; (v) impacts on standing crops, irrigation system, fisheries, wildlife and forest protection, Swat River ecology and appropriate compensation to affectees. The project informed the stakeholders that based on the MHPP feasibility studies, there is no risk of GLOF in the project catchment. For the remaining aspects, the mitigation measures are devised to be adopted during the design, construction and O&M stages of the project to address these concerns.

Disclosure. This ESIA and its Executive Summary will be disclosed on the PEDO website and will be sent to the World Bank for disclosure on its website. The ESIA summary in Urdu will also be uploaded on the PEDO's website, and hard copies of these documents will be made available at Assistant Commissioner (AC) office Tehsil Bahrain for public access.

Table of Contents

List of Figures

List of Tables

1 Introduction

1.1 Background

The Pakhtunkhwa Energy Development Organization (PEDO) intends to construct a 207-megawatt (MW) run-of-river hydropower plant (referred to as "Project") at Madyan, in the Swat District of Khyber Pakhtunkhwa (KP) Province, Pakistan. The Project called Madyan Hydropower Project (MHPP) is located on the Swat River about 12 kilometers (km) upstream of the town of Madyan and in the village of Kedam.

The Project is funded by the World Bank through the 'Khyber Pakhtunkhwa Hydropower and Renewable Energy Development Program' (hereinafter referred to as 'the Program' or KHRE). Therefore, all environmental and social instruments prepared under this project are in compliance with both locally applicable regulations and World Bank's Operational Policies and Guidelines. The present Environmental and Social Impact Assessment (ESIA) has been conducted in order to address the potentially negative environmental and social impacts of the proposed project in compliance with the local regulatory and World Bank (WB) policy requirements.

Under KHRE, PEDO is already implementing the 88-MW Gabral Kalam hydropower project (GKHPP) on Swat River upstream of the MHPP. A separate ESIA has been conducted and a resettlement action plan (RAP) has been prepared for that project.

1.2 Project Overview

The MHPP includes, (a) 06 m high weir (above the riverbed) and 100 m long ogee shaped structure (geocoordinates N 3903782.68, E 281101.57) discharging into stilling basin, with spillways, under sluices, fish ladder, outlet structures, and sand trap; (b) 222 m long connecting channel, (c) two desander chambers with effective length of chamber 204 m, width of chamber 28 m, average depth of chamber 41.55 m, mean velocity 0.2 m/s, and grain size to be excluded 0.20 mm., (d) 12.9 km long and 7 m diameter headrace tunnel from the desander to the powerhouse; (e) underground powerhouse (L55m x W19 m x H42 m) with surge tank (23 m diameter and 78 m depth); (f) 2.0 km long 220 kilovolt (kV) transmission line and (g) Project colony with a necessary water supply and sanitation facilities.

The Project will help reducing Pakistan's Circular Debt by lowering the cost of electricity generation through the development of renewable energy solutions. The development of Pakistan's hydropower resources at a variety of scales represents the only reasonable prospect of eliminating these shortages. The MHPP is designed to produce gross annual average energy of 839.74-Gigawatt hours (GWh). Figure 1-1 shows the project layout and location.

1.3 Environment and Social Impact Assessment (ESIA)

A 2009 Feasibility Study[6] (2009 FS) conducted to assess technical, economic, environment and social assessment for MHPP. An environmental & social impact assessment (ESIA) report was prepared based on preliminary design (2009 FS ESIA). This ESIA has been conducted based on the information presented in the 2009 feasibility study (FS) and proposed design updated in September 2022 and Pre-Feasibility Project Configuration of November 2022. This ESIA is in compliance with the mitigation hierarchy (avoid, minimize, restore and offset) and hierarchy of controls as per the Deming's Plan, Do, Check, and Act (PDCA) cycle.

1.4 ESIA Objectives

- The objective of this ESIA is to Identify and assess the potential environmental and social impacts (direct, indirect and cumulative) and risks stemming from the Project in the planning, construction and operation phases.
- Design appropriate mitigation, management, and monitoring measures to implement an environmentally sustainable and socially responsible project without compromising its technical and economic feasibility and to help determine crucial elements that facilitate the making of choices and decisions as per World Bank's Operation Policies.

[6] **Source: Fitchner (2009), Feasibility Study Report, Madyan Hydropower Project, PEDO.**

- Analyze occupational and community health and safety during construction and operation stages and ensure corresponding measures using hierarchy of controls as per World Bank Group's Environmental, Health and Safety General Guidelines[22] (EHSGs), and section 1.2 of the IFC Environment, Health and Safety Guidelines for Mining and Khyber Pakhtunkhwa Occupational Safety and Health Act, 2022.
- Provide complete documents that will satisfy the requirements of KP Environmental and Protection Agency (EPA) and World Bank's Operation Policies.
- Analyze impacts on people and the environment to be considered at the earliest possible stage in the engineering design and decision-making processes.
- Assess the capacity of the implementation agency in environment, social, health and safety and recommend measures to strengthen the capacity in terms of human resources, logistics, skills development, and training.
- Carry out consultations with the key stakeholders to obtain their views and concerns on the project and its impacts on environment and people.
- Prepare an environment and social management plan (ESMP) addressing implementation arrangements and various mitigation and enhancement measures.

1.5 Area of Influence

The area of influence (or the project area) for environmental and social impacts or risks assessment of the proposed Madyan Hydropower Project is:

i. **Primary Project Site:** the primary project site or primary impact zone is considered as 16km long stretch of land along the Swat River where the proposed physical works will be carried out.[7] This includes (a) 16.2 m high weir with spillway, under sluices, fish ladder, intake, outlet structures, and sand trap; (b) connecting tunnel, (c) two desander chambers, (d) 11.18 km long and 7m diameter headrace tunnel from the desander to the powerhouse; (e) underground powerhouse with surge tank (23 m diameter and 78 m depth); (f) approximately 01 km long 220 kV transmission line and (g) project colony with necessary water supply and sanitation facilities. Most of the proposed works are envisaged on the left bank of the Swat River within 200m distance from the potential riverbed and therefore; width of the AOI for this ESIA is considered as 2km (0.5km from the bank of the river on right bank and 1.5km on left bank of the river from the active riverbed) along the Swat River. Mostly, the right bank of the river will be used for access to the project site;

ii. **Related facilities:** these are required for the project and contractor and include colony, access road to 3 adits and five (05) dumping sites identified for the disposal of excavated material, access roads for desander, construction camps and other temporary facilities to be established by the contractor. These related facilities are situated within the area of Primary Project Site described earlier. The sites where livelihood restoration activities will be carried out, will also be considered in the AOI. The AOI is shown in Figure 1-2.

[7]Fichtner (2009), Environmental Impact Assessment (EIA), Madyan Hydropower Project, Report No. 7166P02, February 2009
1km reservoir area, 14km weir to Powerhouse and 1km downstream of Powerhouse.

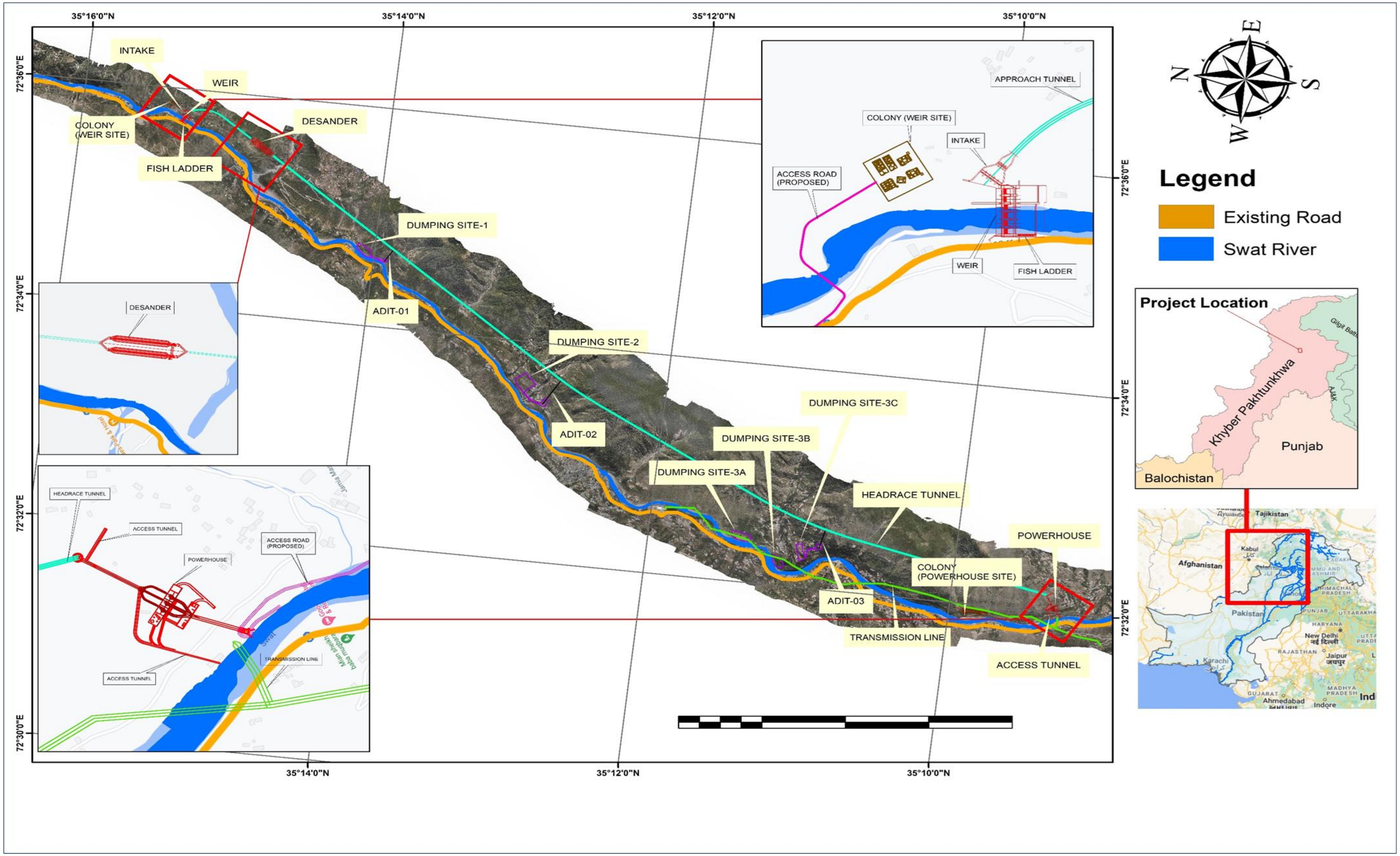


Figure 1-1 Project Location and Layout

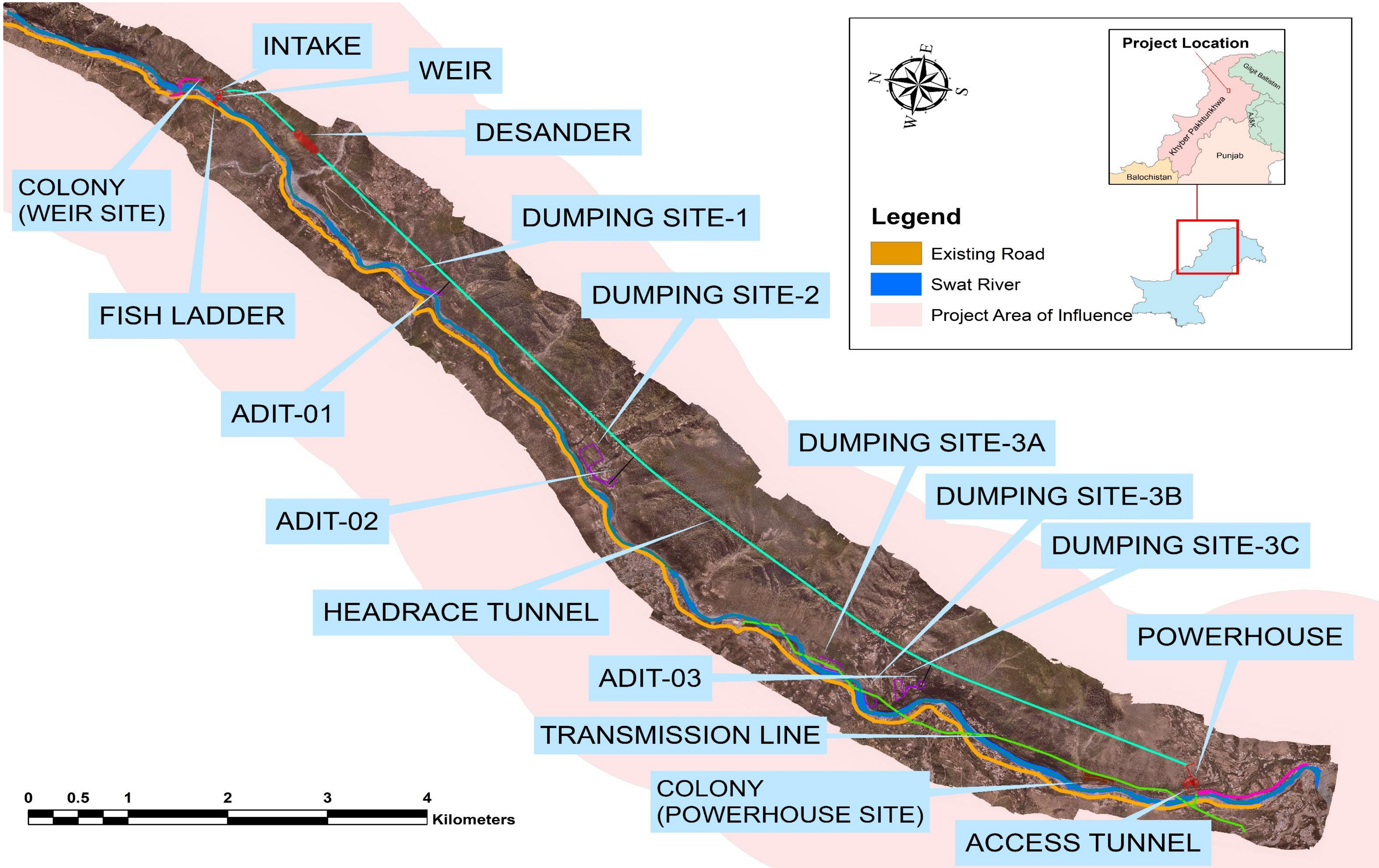


Figure 1-2: Project Area of Influence

1.6 ESIA Study Team

This ESIA was prepared by a team of environmental and social specialists:

- Mr. Sardar Kakar Lead ESIA Expert (Revised & updated the ESIA report)
- Dr. Masud Karim, Chief Environmental Specialist (International) (Authored the CIA chapter)
- Dr. Akhtar Iqbal, National Environmental Specialist (cried out baseline surveys, consultation and originated the draft ESIA)
- Dr. Waseem Khan, National Ecologist (carried out seasonal biodiversity surveys)
- Muhammad Khalil, National Social Development and Resettlement Specialist (contributed to Socio-economic baseline and involuntary resettlement section of ESIA)
- Altaf Hussain, Environmentalist. (Carried out baseline surveys, consultations and contributed in the preparation of draft ESIA report)

1.7 ESIA Methodology

For the preparation of the ESIA, following methodologies were adopted;

- **Screening and Scoping:** To determine the appropriate extent and type of environmental and social assessment, screening of the MHPP was carried out and categorized the MHPP in the light of World Bank safeguard policies, KP Environmental Protection Act, 2014 and the Khyber Pakhtunkhwa Environmental Assessment Rules, 2021. For the identification of key environmental and social issues associated with the MHPP and to decide how they will be appraised before the assessment is begun – scoping exercise was carried out. Following the findings of screening and scoping, the detailed environmental and socio-economic baseline and undertaking public consultation was commenced in 2022. A land use map was prepared showing various land use categories of the project area along with the spatial extent were marked on the map and explained in the text accordingly.

- **Literature Review:** The previous MHPP feasibility and updated feasibility studies, ESIA report 2009 were reviewed thoroughly. In addition, a number of documents were reviewed during preparation of the ESIA. The purpose of reviewing published literature was to gather information on the environmental settings and the works already carried out in the area. The relevant literature was of the previous studies conducted in the project area or in areas with a similar geographical and ecological settings.

- **Review of Legal and Regulatory Framework**: Commensurate to the World Bank safeguard policies and KP acts and regulations requirements, the World Bank safeguard polices and applicable provincial, federal acts and regulations were also reviewed. The World Bank safeguard policies, provincial as well as national acts and other regulations applicable to the MHPP project are discussed in Chapter-2 of the ESIA.

- **Determination Area of Influence (AOI)**: The area of influence (AOI) for the MHPP was identified based on the project layout and proposed physical elements/components and facilities that are likely anticipated impacts on ambient environment and social attributes. This area of influence encompasses, the area likely to be affected by (i) the project activities and facilities that are directly owned, operated or managed by PEDO (including by contractors) and that are a component of the project; (ii) impacts from unplanned but predictable developments caused by the project that may occur later or at a different location; or (iii) indirect project impacts on biodiversity or on ecosystem services. The Area of Influence for social impacts assessment was considered the area of Influence for direct impacts and Area(s) of Influence for indirect impacts. The Areas of Influence for direct impacts was considered the households and communities that will be affected by the MHPP Project Footprints due to their settlements or economic activities within the proposed Project Footprint; their location within the Area(s) of Influence. For the anticipated environmental impacts, such as air or water quality, noise and vibration; impacts on livelihood resources that will be affected by the Project (agricultural land). The Area(s) of Influence will also typically consider populations that will experience indirect or induced impacts that may not be within the direct control of the Project, such as: economic opportunities associated with employment; interaction with the workforce; use of services by the workforce; and in-migration.

- **Field Surveys**: For the preparation of ESIA, field surveys and consultations with the locals were conducted by the consultant to collect primary data of the project area. Baseline information on prevailing environmental and social attributes/conditions was collected from both primary and secondary sources. Primary data on flora, fauna, fisheries, water quality and noise levels were collected through site visits and surveys. The baseline river water quality at three (03) locations, ambient air quality (NO_x, SO_x, CO_x, Noise, PM_{10}, $PM^{2.5}$) and noise level at five (05) locations of MHPP was measured through an independent monitoring certified laboratory during November 2022.The four seasonal biodiversity surveys were conducted for the MHPP by PIC Biodiversity Expert. The detailed methodology for seasonal biodiversity surveys is given in Chapter-6. Standard methodology for collection of data through field survey as explained in Chapter-6, was used to obtain objective data and to determine the baseline conditions aiming at the assessment of expected/resultant impacts of the Project. Accordingly, the findings are reflected in the Chapter-6.
- **Impacts Assessment Methodology:** for the environmental and social impacts assessment, standard methodology for the anticipated environmental and social impacts ranking was categorized as major, moderate, minor or minimal based on consideration of the parameters such as: i) duration of the impact; ii) the spatial extent of the impact; iii) reversibility; iv) likelihood; and v) legal standards and established professional criteria. In addition, for assessment of cumulative impacts, cumulative impacts were carried out for the impacts that result from the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted.
- **Stakeholders Consultation:** Stakeholders were considered to be individuals or organizations which have an interest in the proposed project or knowledge that would provide insight into issues or affect decision making related to the proposed project. On the basis of interest and role criteria, there are two types of stakeholders the primary and secondary stakeholders. The primary stakeholders were considered primarily the project affected persons and general public including women residing in the project area of influence. Secondary Stakeholders were considered the institutional stakeholders – for instance, related government department/agencies, local government, and organizations that may not be directly affected by the project; however, they may influence the project and its design. The guiding principle underlying consultations was in line with the requirements of the World Bank OP 4.12 and Bank's Access to Information Policy (2010), which give high priority to public consultation and participation in designing and implementation of a socially and environmentally compliant project. In addition, compliance to KP EPA Act, 2014, public hearing will also be carried out for the project. As part of the present ESIA, detailed consultations were carried out through village-wise meetings, individual meetings, and focus group discussions (FGDs) with the communities, including women in the project area.
- **Data Analysis & ESIA Compilation:** During the ESIA study, efforts have been made to evaluate potential Environmental, Social, Health and Safety (ESHS) risks and impacts associated with the design, construction, and operation of the project. The analysis is based on biophysical environmental, social, and seasonal biodiversity surveys, site visits, review of the available secondary information, stakeholder's consultation, professional knowledge and judgment drawn from similar projects. The key sensitive receptors were identified in the AOI of the project and each receptor was analyzed to understand how sensitive it is to a change in its external environment. Each potential change which will be caused by the project and hazard posed by project activities are analyzed to understand the extent to which it might impact the receptors and risk the workers and the community in the project area. The two factors are combined to estimate the significance of each impact to each receptor. For social impacts assessment, both qualitative and quantitative approaches were used. The ESIA study was based on relevant primary and secondary sources of data.
- **ESMP Preparation:** based on assessment of anticipated environmental and social impacts (Chapter-7), the Environmental and Social Management Plan (ESMP), which is part of the ESIA, describes the measures and controls developed in line with the mitigation hierarchy for the management of the impacts identified during the impact assessment process, determines the roles and responsibilities, reporting and monitoring requirements. Each of the management plans included in the ESIA (Annexure II), defines in detail the environmental and social impacts management guidelines and code of practices to ensure compliance with the relevant World Bank safeguard policies and KP EPA Act, 2014. For the implementation of the ESMP, appropriate budget is estimated.

1.8 Document Structure

Chapter 1: Introduction- The overview and background of the project along with the history of project are discussed. The brief of the project description, project activities, objectives, methodology, influence area, study team and ESIA document structure are addressed concisely.

Chapter 2: Policy, Legal and Institutional Framework- The legal provisions related to environmental protection relevant to the planning stage and operational activities of the Project are identified and discussed under the scope of the ESIA study. World Bank's Operational Policies and environment, health and safety guidelines (EHSGs) are introduced along with the OP and key sections of Environmental Act triggered due to the implementation of the Project.

Chapter 3: Project Description- The details of the technical features of the MHPP have been presented in this chapter based on the 2009 FS and the PIC Reports, (a) Feasibility Study Review and Assessment Report for MHPP, September 2022, (b) Concept Study Report Madyan MHPP, October 2022, and (c) Project Pre-Feasibility Configuration for MHPP. The details include the project overview, project components with salient features, locations and description of the sites, power evacuation arrangements, resources required and waste to be generated, costs and implementation schedule of the project.

Chapter 4: Analysis of Alternatives- The alternatives considered during project planning and design phase have been discussed in this chapter. It also includes a comparison between the project and without project alternatives.

Chapter 5: Environment and Socioeconomic Baseline – Baseline environmental conditions covering the climatic conditions, physical environment including land, air, water, noise, aesthetic, waste, and traffic conditions in the project area of influence. This chapter also included baseline of socio-economic and demographic indicators against which to measure the impacts of the Project over time, assesses the influence area against a number of social economic indicators, such as agriculture, health care, education, infrastructure, gender relations, and labor rights.

Chapter 6: Biodiversity Baseline Condition - Biodiversity of the project area covering ecosystem, protected areas, habitats of important species, description of flora and fauna, mammals, birds, fish and invertebrates are discussed in this chapter.

Chapter 7: Assessment of Environment & Social Impacts and Risks - This chapter assessed potential risks and impacts of the project on physical, biological and socioeconomic environment using the mitigation hierarchy.

Chapter 8: Cumulative Impact Assessment - This chapter presents an assessment of the cumulative impacts resulting from the development of proposed and existing hydropower projects in the Swat River basin and other development projects either construction of in advance planning stage in the CIA boundary.

Chapter 9: Environmental and Social Management Plan- This chapter depicts the environmental and social management plan (ESMP) of the project which is based on ESMP implementation practices in other bank funded projects in the region and other good international industry practices. The basic objective of the ESMP is to manage adverse impacts and risks of proposed project interventions in a way that minimizes the impact and risk on the environment, workers, and community. The chapter also presents the implementation mechanism of the ESMP, institutional arrangements and capacity building and training of the PMO and the description of arrangements of PMO, consultant, and contractor.

Chapter 10: Stakeholders Consultations- Stakeholder engagement is an inclusive process that involves stakeholders into meaningful consultations throughout the project life cycle. In this line, this chapter describes the stakeholder consultations carried out involving stakeholders for determining the environmental and social impacts and risks associated with project implementation, along with the feedbacks/concerns/views on the Project.

2 Policy, Legal, and Institutional Framework

2.1 General

This Chapter summarizes the applicable national, provincial and the World Bank environmental, health, safety and social legislation, regulations, standards, and treaties relevant to this ESIA of the Project. The footprint of the Project is located in the administrative boundaries of the district Swat, in the province of KP. Hence, the rules, regulations and standards applicable in KP are also applicable to this project. World Bank's Operational Policies (OPs) relevant to this project are duly described in this Chapter. World Bank's EHS Guidelines shall also be followed to make the project implementation in compliance with these guidelines.

2.2 Review of Applicable National and Provincial Acts & Regulations

The applicable national and provincial Environmental and Social legislations and regulations are briefly summarized in Table 2-1.

Table 2-1: Applicable National and Provincial Acts, Ordinances, Rules & Policies

National/Provincial Acts (Year of implementation)	Relevance/Applicability
Khyber Pakhtunkhwa Environment Protection Act-2014	The KP Environmental Protection Act 2014 is applicable to a broad range of issues and extends to air, water, industrial liquid effluent, and noise pollution as well as to the handling of hazardous wastes. The articles of KP Act 2014 that have a direct bearing on the proposed Madyan Hydropower Project are listed below: • Section 11 (Prohibition of Certain Discharges or Emissions) states that "Subject to the provisions of this Act and the rules and regulations made thereunder, no person shall discharge or emit, or allow the discharge or emission of, any effluent or waste or air pollutant or noise in an amount, concentration or level which is in excess of the Environmental Quality Standards." ECP-1 (Annex-I) and waste management plan (Annex-II) will be implemented. • Section 13-I No proponent of a project shall commence construction and operation unless he has filed with the Agency an initial environmental examination or where the project is likely to cause an adverse environmental effect, an environmental & social impact assessment, and has obtained from the Agency, environmental approval in respect thereof." The EIA of the Madyan Hydropower Project will be submitted by PEDO for KP EPA approval. • Section 13-2 b (Review of IEE and EIA): The KP Environmental Protection Agency shall review the EIA report and accord its approval subject to such conditions as it may deem fit to impose, or require that the EIA be re-submitted after such modifications as may be stipulated or rejected, the project as being contrary to environmental objectives. As discussed above, the EIA of Madyan HPP will be submitted by PEDO to KP EPA for review and approval. • Section 15 (Handling of Hazardous Substances) requires that "Subject to the provisions of this Act, no person shall generate, collect, consign, transport, treat, dispose of, store, handle, or import any hazardous substance except (a) under a license issued by the EPA and in such manner as may be prescribed; or (b) in accordance with the provisions of any other law for the

National/Provincial Acts (Year of implementation)	Relevance/Applicability
	time being in force, or of any international treaty, convention, protocol, code, standard, agreement, or other Instrument to which Pakistan is a party." Enforcement of this clause requires the EPA to issue regulations regarding licensing procedures and to define 'hazardous substance.' ECP-2 (Annex-I) and waste management plan (Annex-II) will be implemented. • Section 16 (Regulation of Motor Vehicles): Subject to provision of this clause of the Act and the rules and regulations made thereunder, no person shall operate a motor vehicle from which air pollutants or noise are being emitted in an amount, concentration or level which is in excess of the EQS, or where the applicable standards established under clause (g) of subsection (1) of Section-6 of the Act. ECP-10 and ECP-11 (Annex-I) and traffic management plan (Annex-II) will be implemented. • Section 18 (Penalties): Whoever contravenes or fails to comply with the provisions of section 11, 12, 13, or section 16 or any order issued thereunder shall be punishable with fine which may extend to one million rupees, and in the case of a continuing contravention or failure, with an additional fine which may extend to one hundred thousand rupees for every day during which such contravention or failure continues: Provided that if contravention of the provisions of section 11 also constitutes contravention of the provisions of section 15, such contravention shall be punishable under sub-section (2) only. • Section 19 (Offences by Bodies Corporate): Where any contravention of this Act has been committed by a body corporate, and it is proved that such offense has been committed with the consent or connivance or, is attributed to any negligence on the part of, any director, partner, manager, secretary or other officers of the body corporate, such director, partner, manager, secretary or other officers of the body corporate, shall be deemed guilty of such contravention along with the body corporate and shall be punished accordingly. **For Madyan Hydropower Project, Khyber Pakhtunkhwa EPA (KP EPA) is the relevant agency for the approval of this EIA. Accordingly; this EIA has been prepared in response to this action. EIA has been submitted by PEDO to KP EPA for review and approval.**
Khyber Pakhtunkhwa Environmental Assessment Rules, 2021	This regulation establishes the framework for the preparation, submission, and review of the IEE and EIA. The regulations categorize development projects for IEE and EIA into following three schedules; i. Schedules II: Categories of projects requiring Environmental Impact Assessment (EIA); ii. Schedule III: Categories of projects requiring Initial Environmental Examination (IEE) and; iii. Schedule IV: Categories of Projects requiring General Environmental Approval5. Commensurate to the KP environmental assessment rules, 2021, preparation of a complete EIA is required for Schedule II projects.

National/Provincial Acts (Year of implementation)	Relevance/Applicability
	The following hydropower development projects fall under Schedule II: • Hydroelectric power generation over 50 MW • Transmission lines 11 kV and above, and grid stations. **The proposed project's power generation capacity is over 50MW and therefore; falling in Schedule II and this EIA has been prepared commensurate the KP Environment Protection Act-2014.**
Environmental Standards	National Environmental Quality Standards KP EPA is yet to formulate the Khyber Pakhtunkhwa Environmental Quality Standards (KPEQS) as per Article 6 (v) of the KP Act 2014. So, the National Environmental Quality Standards (NEQS) will be applicable to the Project. Article 11(1) of the PEPA 1997 states that "Subject to the provisions of this Act and the rules and regulations made thereunder no person shall discharge or emit or allow the discharge or emission of any effluent or waste or air pollutant or noise in an amount, concentration or level which is in excess of the National Environmental Quality Standards." NEQS have been established for gaseous emission, liquid effluent, ambient air quality, noise and drinking water. From the date of enforcement of the NEQS, all projects, whether in operation on the date or constructed later, are required to comply with these standards. **The MHPP Project needs to comply with all applicable standards, and Project proponents and contractors will ensure that no activity will result in the emission of pollutants and effluents exceeding limits as prescribed in the NEQS. The following standards of NEQS are applicable to the MHPP and the contractor will ensure all the activities compliance to these standards;** • Municipal and liquid industrial effluents (32 parameters) • Industrial gaseous emissions (18 parameters) • Motor vehicle exhaust and noise (used and new vehicles) • Ambient air quality (9 parameters) • Drinking water quality (32 parameters) • Noise (four zones during day and night).
Land Acquisition Act of 1894	The national law governing land acquisition is the Land Acquisition Act 1894 (LAA 1894) and successive amendments to it. The LAA 1894 regulates the land acquisition process and enables the government to acquire private land for public purposes through the exercise of the right of eminent domain. Land acquisition is a provincial responsibility in Pakistan and provinces also have their own province-specific implementation rules. The LAA 1894 and its implementation rules require that, following an impact identification and valuation exercise, land and crops are compensated in cash at the current market rate to titled landowners. In addition to the market–value of the land a sum of 15% of the amount as compulsory acquisition surcharge (CAS) is also paid to the affected persons (APs). The APs, if not satisfied, can go to the Court of Law to contest the compensation award of the LAC.

National/Provincial Acts (Year of implementation)	Relevance/Applicability
	The proposed MHPP project will affect 141 families/households. The population of the affected households (AHHs) is 1,110 persons, including 576 males and 534 females. Moreover, there are 49 AHHs whose income is below the official poverty line (OPL) and are categorized as vulnerable. Among the affected families, about 98% are severely affected[8]. The total land to be acquired for MHPP is calculated to be about 131 acres as per the revised design of the project. The land acquisition will impact about 80 acres of cultivated land, about 37 residential structures that will need to be demolished, and about 4,391 privately owned trees (fruit and timber) that will need to be felled. Therefore; in compliance to this OP, a RAP including LRIP has been prepared that will be fully implemented before any civil works are started. Therefore; this act is relevant to the MHPP and **the land for the proposed project will be acquired compliance to this Act (while also following WB requirements detailed in the Project RAP).**
The Telegraph Act (1885)	The Telegraph Act (1885) was enacted to define the authority and responsibility of the Telegraph Authority. The law covers, among other activities, installation, and maintenance of telegraph lines and posts (poles). National Transmission & Dispatch Company (NTDC) is the responsible agency for developing and operating transmission line networks in the country and it has been following this Act for building transmission line towers throughout the country. (For the project, provisions of this Act and the Project RAP will be followed for the compensations related to the transmission line works.)
Forest Ordinance, 2002	The Forest Ordinance, 2002 has been instated to protect, conserve, manage and sustainably develop forests and other renewable natural resources. The ordinance empowers the government to declare any forest land as reserved or no longer reserved, designate reserve forests for village communities to use, declare forest land or wasteland as Protected Forests or remove protected status, control Guzara Forests, Mazri and Mazri produce, as well as timber and timber produce. Under the ordinance the government is granted powers forest management, with authority given to forest officers. The government, through its officers, has the right to exercise penalties on violations on prohibitions as laid out in the ordinance. Certain plant species are protected under the Act when found in reserved forests, protected forests and protected wastelands. A list of these species is provided in Schedule I of the Act. The Project is not expected to impact any protected or critical habitat like reserve Forests, Protected Forests or wetland. In Biodiversity seasonal baseline survey, a total of 35 tree species were recorded from the project area and none of the recorded species is "Threatened" according to the IUCN Red List of Threatened Species. Out of the recorded 35 species, 11 species are enlisted in "The List of Protected Trees" in "The Khyber Pakhtunkhwa Forest Ordinance 2002". But according to this Ordinance, such species will be

[8] A severely affected is a land owner whose affected land is 10% or more than 10% of his total land.

National/Provincial Acts (Year of implementation)	Relevance/Applicability
	considered "Protected" only when found in Reserve Forests, Protected Forests and Protected Wetlands. The Project will be required to follow the provisions of this Ordinance and protect the forest to the extent possible.
Forest Development Corporation Ordinance, 1980	The Forest Development Corporation has been established under this ordinance. The corporation functions to "make suitable arrangements for the (i) economic and scientific exploitation of forests; (ii) sale of forest produce; (iii) establishment of primary wood-processing units; (iv) regeneration in areas to be specified by Government; and (v) performance of such other functions as may be assigned to it by Government." **It will be ensured that Project staff do not engage in activities that are under the jurisdiction of this corporation for example in the trade of forest products.**
Forestry Commission Act, 1999	The Act is aimed at establishing a Forestry Commission to improve the protection, management sustainable development of forests in KP. Under this Act, the Commission established is empowered and entrusted to further this aim by taking steps such as giving vision and a framework for the sustainable development of forests in KP, guiding and overseeing the process of institutional and legislative reforms in the Department, advocating policies for sustainable development of forests
Protection of Trees and Brushwood Act, 1949	The Act provides protection for trees and brushwood. Under this Act, it is illegal to clear trees and brushwood belonging to the local government. **The Project is being developed by PEDO; therefore, the Project-related activities will only be undertaken on land acquired for the Project. They will not clear trees or brushwood outside the acquired area.**
The Khyber Pakhtunkhwa Antiquities Act, 2016.	This law is related to the protection, preservation, development and maintenance of antiquities in the Province of the Khyber Pakhtunkhwa and to encourage researches related to antiquities. No antiquities were reported during the baseline surveys and consultation with stakeholders. However; as per Section 57 (1) of this act, in case any site well-known to contain buried cultural property is to be dug up in the course of construction work or for purposes other than the investigation of the buried cultural property, the owner or for that matter any other person or organization intending to excavate such site, shall report it to the Director in wiring at least sixty days prior to the day on which the said excavation is to be commenced. The Director may, when he deems it positively necessary for the protection of buried antiquities, give necessary instructions with regard to the excavation to be undertaken under supervision of an officer or a team of officers of the Directorate, or may prohibit the excavation or order its suspension or discontinuation for reasons to be conveyed in writing to the owner. **The project will have to follow the provisions of this Act particularly relating to the Chance Finds. The Chance Find procedures have been included in the ESMP.**

National/Provincial Acts (Year of implementation)	Relevance/Applicability
Khyber Pakhtunkhwa Wildlife and Biodiversity (Protection, Preservation, Conservation and Management) Act, 2015.	The Act has been instated to consolidate the laws relating to protection, preservation, conservation and management of wildlife in KP. Its aims include the following: "(a) strengthening the administration of the organization to effectively manage wild animals and their habitats; (b) to holistically manage Protected Areas in a sustainable manners for the best interest of the indigenous communities and local stakeholders; (c) securing appropriately the goods and services produced from wild animals and their habitats at the level of local communities; (d) fulfilling the obligations envisaged under the biodiversity related multilateral environmental agreements ratified by the Government of Pakistan; (e) promotion of public awareness and capacity building for proper appreciation of the environmental significance and socio-economic values of wildlife; and (f) conservation of biological diversity and realization of its intrinsic and extrinsic values through sustainable use and community participation." The Act empowers Wildlife Officers to enforce the laws relating to wildlife conservation and management and to use reasonable force to do so, if necessary. It places restrictions on hunting, possession and display of wildlife, trade and trafficking of wildlife or wildlife products, and protected areas. Wildlife offences and penalties for those offences are provided in the Act. This law is applicable to the MHPP as the "seasonal biodiversity survey" conducted in the project area during preparation of this ESIA report shows the presence of **Asiatic Black Bear** and some other species that are scheduled in the Khyber Pakhtunkhwa Wildlife and Biodiversity (Protection, Preservation, Conservation and Management) Act, 2015. The Act will be relevant to the Project if there is violation of the rules pertaining to the reported wildlife. This will be the case if staff engage in activities prohibited under the Act such as hunting, possession and display of wildlife, trade in wildlife and wildlife products, introduction of alien invasive species and so on. To ensure compliance with law, staff will report any wildlife sightings to the concerned government department. As the proposed Madyan Hydropower project activities will be carried out far away from the reported key wildlife habitat areas, therefore, the project is not likely to contravene any provisions of the Act. The proponent of the project will comply with the requirements of this act to preserve, protect and conserve the wildlife of the area. In addition, ECP-12-ECP-14 (Annex-I) will be implemented.
The Khyber Pakhtunkhwa Fisheries and Aquaculture Act, 2022	This act is pertinent to the preservation, conservation, regulation and management of fisheries biodiversity and aquaculture in the KP province. This act empowers the government by notifying any public water to be a sanctuary in respect of such fish species mentioned in the second column of the first schedule for a period which may be

National/Provincial Acts (Year of implementation)	Relevance/Applicability
	specified. Use or employment for killing or capture of any fish species in any public water or sanctuary during the prohibited period in respect of such species under the fourth column of first schedule is an offence. The Snow Carp (*Schizothorax plagiostomus*), Brown Trout (*Salmo trutta fario*) and Cold-Water Catfish (*Nangra robusta*) are reported in the Swat River and its tributaries. **The trout species are listed in the first schedule in which fishing is prohibited from 10th October to 9th March.** In the second schedule of the act, destruction of fish by poisoning of water, **destruction of fish by explosives and destruction of fish by diverting of the flow of water is a punishable offence**. **This law is applicable to the MHPP, the use of explosives, risk for contamination of water during construction period and diverting of water persists. Therefore; mitigation measures related to avoid poisoning of water, careful use of explosives and provision of fish pass/fish ladder** (Figure 3.13) **are proposed in the design of the project to maintain the connectivity of the river. The provision of fish ladder and maintaining eFlow will be ensured operational and maintenance (O&M) stages of the project. In addition,** ECP-14 (Annex-I) and fish management plan (Annex-II) will be implemented. PMO KHRE environment section has already secured the no objection certificate (NoC) for Gabral Kalam Hydropower Project (GKHPP) and the same process of NoC will be carried out for MHPP after finalization of this ESIA and resubmission of revised EIA to Khyber Pakhtunkhwa Environmental Protection Agency (KP EPA).
Rivers Protection Ordinance, 2002	The ordinance has been instated to provide for the protection of **aquatic ecology, water quality, economic and environmental value of rivers** and their **tributaries** in KP. The ordinance has been instated keeping in view the increasing developments along rivers in KP and the need to maintain the quality of the rivers for public use. The rules set out will be applicable on any length of a particular river or stream or any part of a river or its tributary that has been specified by the Government. The ordinance prohibits (i) construct, or undertake any related physical works of any commercial building or non-commercial building, or undertake any other developmental work, within **two hundred feet** on either side of the rivers or their tributaries or on a space within the limits between the banks of a river; (ii) **place or deposit or release, directly or indirectly, any substance into the river or their tributaries, in excess of the National Environmental Quality Standards (NEQS)** notified by Government from time to time; and; (iii) **dispose, directly or indirectly, any solid waste or hazardous waste or other additional substances** specified and notified by Government into rivers or their tributaries.**, the contractor facilities like camp and batching plant shall be located away from the river and it is important that Project-related activities do not pollute the river and that all construction activities along the river banks be carried out within the area designated for the project as per proposed ESMP of this report. In addition,** ECP-1, ECP-2, ECP-3, ECP-4, ECP-6 (Annex-I) and waste management plan (Annex-II) will be implemented.

National/Provincial Acts (Year of implementation)	Relevance/Applicability
The Khyber Pakhtunkhwa Occupational Safety and Health Act, 2022 (Khyber Pakhtunkhwa Act No. XV of 2022)	This Act provides guidelines for making provisions regarding occupational safety and health of all persons at workplaces in the Province of the Khyber Pakhtunkhwa. This act outlines the duties of employers and workers for maintaining a safe workplace. The different OHS related requirements for workplaces, such as maintaining an accident register, and how to deal with accidents are outlined in this act as well. As the project requires around 400 employees (skilled and unskilled), therefore; this act is applicable to the project.; the Occupational and Community Health and Safety Plan (Annex-III) has been prepared for this project, as well as day-to-day operations will comply with this Act. ECP-18, ECP-19 (Annex-I) and occupational health and safety management plan (Annex-III) will be implemented.
KP Factories Act, 2013	This act provides regulation for labor rights in the Province of KP and for matters related to worker's safety and protection, for any activity in the KP province. As the project requires around 400 workers in peak periods (skilled and unskilled), therefore; this act is applicable to the project. As the project requires around 400 employees (skilled and unskilled), therefore; this act is applicable to the project. Therefore; the Occupational and Community Health and Safety Plan (Annex-III) prepared for this project, as well as everyday operations will comply with this Act. In addition, ECP-16, ECP-18, ECP-19 (Annex-I), camp management and occupational health and safety management plans (Annex-III) will be implemented.
KP Industrial Relations Act, 2010	An Act to regulate formation of trade unions, regulation, and improvement of relations between employers and workmen and the avoidance and settlement of any differences or disputes arising between them and ancillary matters. As the project requires around 400 workers in peak periods (skilled and unskilled), therefore; this act is applicable to the project. The MHPP project will comply with the provisions of this Act by ensuring the relationship between workers and employers. ECP-16 (Annex-I) and camp management plan (Annex-II) will be implemented.
KP Bonded Labor System (Abolition) Act, 1995	The Bonded Labor System (Abolition) Act defines the `Bonded Labor System' as a system of forced, or partly forced, labor under which a debtor enters, or is presumed to have entered into an agreement with the creditor. **As the project is Labor Intensive; therefore; it is integral part of the ESMP, that the use of all forms of forced labor and child labors for MHPP project construction activities shall strictly be prevented by contractors.**
Khyber Pakhtunkhwa Minimum Wages Act, 2013	This act provides for the regulation of minimum rates of wages and various allowances for different categories of workers employed in certain industrial and commercial undertakings and establishments. **As the project requires around 400 workers in peak periods (skilled and unskilled) labors, therefore; the Project needs to ensure that all workers are paid at least minimum wages to ensure that this**

National/Provincial Acts (Year of implementation)	Relevance/Applicability
KPK Workers Compensation Act, 2013	The Act provides for workers or their legal heirs compensation for injury or death by accident. **The MHPP and its contractors will be liable to provide compensation if personal injury is caused to a worker by accident during the course of his/her employment.**
The Khyber Pakhtunkhwa Prohibition of Employment of Children Act, 2015.	This Act disallows child labor in the province. This act envisages that no child shall be employed or permitted to work in any establishment. Provided that a child[9] not below the age of 12 years may be engaged in the light work, alongside his family member, for a maximum of two hours per day mainly for the purpose of acquiring skills, in a private undertaking, or in any school established, assisted or recognized by Government for such purpose. The Project will not employ children or adolescents[10] for any Project-related activities. **The Project will not employ children or adolescents for any Project-related activities.**
The Protection Against Harassment of Women at the Workplace Act, 2010	There is not provincial act related to harassment of women at workplace; therefore; the Protection Against Harassment of Women at the Workplace Act, 2010 is adopted by the Government of KP as legislative Act in Province that seeks to protect women from sexual harassment at their place of work, and equally applicable to this project. This Project will ensure the protection and safety of women against harassment and will encourage the women's role under this Act[11]**. The project will implement gender action plan (Annex-II).**
Disabled Persons (Employment and Rehabilitation) Act 2015	The Disabled Persons (Employment) and Rehabilitation (Amendment) Act 2015 seeks to reinforce the rights of people with disabilities in Pakistan in terms of their employment and everyday livelihood benefits, under the domain of this project activities. The Project will ensure the rights of the people with disabilities during construction and operation stages.
Khyber Pakhtunkhwa Local Government (Amendment) Act, 2019	The project will avoid (i) damaging or polluting physical environment, inside or outside private or public premises, in a manner to endanger public health; and; (ii) will not create unnecessary release or disposal dirty water pools affecting physical environment and breeding of mosquitoes. The project will ensure through implementation of the ESMP, strict compliance with relevant provisions of this Act regarding environment and shall follow the provisions related to environmental control, including control of air, water, and soil pollution.
KP Right to Information Act, 2013	The Act ensures the access of citizens to information in government departments and thus create a transparent and corruption free environment conducive for the growth of democracy. **This ESIA will be disclosed on PEDO website**
Khyber Pakhtunkhwa Explosive Substances Act, 2013	Explosive substance[12] for blasting for tunnels will be required. Therefore, this Act have implications on the project and provides

[9] Per this act, a "child" means a person who has not completed his fourteenth year of age.
[10] Per this act, an "adolescent" means a person who has completed fourteenth but has not completed his eighteenth year of age.
[11] http://kpcode.kp.gov.pk/uploads/THE_PROTECTION_AGAINST_HARASSMENT_OF_WOMEN_AT_THE_WORKPLACE_ACT_2010.pdf
[12] Under this act, an explosive substance" means and includes any material for making any explosive substance, also any apparatus, machine, implement or material used, or intended to be used, or adapted for causing, or aiding in causing, any explosion in or any explosive substance; also, any part of any such apparatus, machine or implement

National/Provincial Acts (Year of implementation)	Relevance/Applicability
	regulations for the handling, transportation, and use of explosives during quarrying, blasting, and other purposes. The quarrying of stone for rip rap or concrete aggregates may need blasting at the quarry site. In such events, these regulations will be applicable to this project. The mitigation measures in line with this act are proposed in the ESMP and shall be implemented.
KP Mines and Minerals Act (2017)	This Act provides regulatory procedures for the quarrying and mining of construction material on the public as well as private lands. The PMO has already secured the NoC of Mines and Minerals Development Department for GKHPP and the same process will be followed for obtaining NoC for MHPP.

2.3 Applicable National and Provincial Policies

Pakistan has a comprehensive policy framework for the protection of the environment and people. This section is structured around the constitutional foundation and legislative hierarchy. An overview of relevant national policies is presented, followed by separate discussion of national and provincial environmental and social legislation applicable to the project and supporting guidance documents. National and provincial regulatory authorities with mandate to oversee implementation of and compliance with, environmental and social legislation are introduced at the end of the section. The full list of relevant policies is provided in Table 2.2.

Table 2-2: Applicable National and Provincial Policies

National Policies (Year of implementation)	Relevance / Applicability
National Conservation Strategy (NCS), 1992	The NCS requires the project to show the compliance of all 14 core areas specified in the policy for environmental protection, conservation of natural resources and environmental sustainability through efficient use of resources.
Pakistan Energy Policy 2019	This policy aims to boost the share of electricity generated from renewable sources from around 5% at present to 20% by 2025 and 30% by 2030. This project is aligned to the goals and objectives of this policy.
National Environment Policy, 2005	This policy gives directions for addressing environmental issues and provides means for promoting conservation and environmental protection in line with international obligations and following the principles of sustainable management of resources and economic growth.
KP Labor Policy, 2018	This policy aims at decent working conditions following the international labor standards and asks for improvement in health and safety of workers and timely payment of wages.
Khyber Pakhtunkhwa Women Empowerment Policy 2017	The Objectives of the policy are: 1. To create a conducive socio-cultural, economic, political, and legal environment to allow women to practice their fundamental rights and participate fully in all spheres of public and private life. 2. To effectively mainstream women empowerment policy into sectoral policies, strategic planning, structures, processes, projects, human and financial resource allocation, performance monitoring, reporting, and decision making at all levels. 3. Building and strengthening stakeholders' participation and partnership for women empowerment. 4. Strengthening monitoring, evaluation, audit, and data system and reporting to bridge the gaps.
National Forest Policy (NFP), 2010	The NFP establishes emphasizes on restoration, development, conservation and sustainable management of forests and allied natural resources. It seeks the project to ensure the sustainability of ecosystem functions, services and benefits for present and future generations.
Khyber Pakhtunkhwa Climate Change Policy, 2017 and Revised Policy, 2022	Emphasizes the vulnerability to climate change and how to take protective measures such as adaptation and mitigation in relevant sectors of the economy. It also emphasizes the need to streamline climate change initiatives in various sectors of the economy and development projects in the province in order to achieve sustainable development and resilience to natural disasters. The MHPP project has been designed keeping in view the anticipated potential climate change risks and vulnerabilities.
National Power Policy, 2013	The policy aims to build a power generation capacity that can meet Pakistan's energy needs in a sustainable manner. The project is being implemented in pursuance with the core objectives of this policy.
National Water Policy, 2002	Objectives of this policy include, efficient management and conservation of existing water resources, optimal development of potential water resources and improved flood control and protective measures. This project has considered the goals of this policy.

National Policies (Year of implementation)	Relevance / Applicability
Guidelines for Sensitive and Critical Areas, 1997	These Guidelines aim for protection of critical ecosystems such as biosphere reserves, national parks, wildlife sanctuaries and preserves, and archaeological sites. The project has considered the objectives of the policy.
Guidelines for Public Consultation, 1997	Public involvement can lead to a better and more acceptable decision for project implementation; hence, the project has considered these guidelines for preparatory work.
THE KHYBER PAKHTUNKHWA LABOUR POLICY, 2018	As the project requires around 400 employees (skilled and unskilled), therefore; the KP Labor Policy 2018 shall be also being applicable to the project. In addition, Labor rights in Pakistan specified under Article 11 and 17 of the constitution of Pakistan, shall be applicable to the proposed project. More specific laws are described separately.

2.4 Comparison of NEQS Standards

The comparison of noise standards provided in
Table 2-3 shows that Pakistan NEQS are equal or more stringent in most of the defined zones as compared to World Bank standards except in industrial areas for noise are more stringent in comparison to the Pak NEQS standards.

Table 2-3: Noise Standards Comparison

Receptor	One Hour LAeq (dBA) WHO Standards		Pak NEQS-2012	
	Daytime (07:00-22:00)	Night Time (22:00-07:00)	Day Time	Night Time
Residential Area	55	45	55	45
Commercial Area	70	70	65	55
Industrial Area	70	70	75	65
Silence Zone	NGVs	NGVs	50	45
Institutional	55	45	NGVs	NGVs

NGVs: No Guideline Values.

A comparison of applicable local and international guidelines for air quality has been provided in **Table 2-4**. In general, the NEQS standards for air quality are most stringent in comparison to USEPA, WHO and the World Bank standards. The only exception is the TSP parameter for the annual mean where the World Bank standard (100 ug/m^3) is more stringent than the NEQS standard (360 ug/m^3). Apart from this one exception, the NEQS standards will be used for the proposed project. In general, the most stringent standards and guidelines will be used for the proposed project.

Table 2-4: Comparison of International and Local Air Quality Standards

Pollutants	USEPA		WHO		World Bank		Pak. NEQS	
	Avg. Time	Standard	Avg. Time	Standard	Avg. Time	Standard	Avg. Time	Standard
SO2	24 hrs	365 ug/ m^3 (140 ppb)	24 hrs	90 ug/ m^3 (34 ppb)	Annual Mean	100 ug/ m^3 (38 ppb)	Annual Mean	80 ug/ m^3
				350 ug/m3	24 hrs	500 ug/ m^3	24 hrs	120 ug/ m^3
			1 hr					
CO	8 hrs	35 mg/ m^3 (10 ppm)	8 hrs	10 mg/ m^3 (8.7 ppm)	-	-	8 hrs	5 mg/ m^3
		40 mg/ m^3					1 hr	10 mg/ m^3
	1 hr							
NO2	Annual Mean	100 ug/ m^3 (53 ppb)	1 hr	190-320 ug/m3	Annual Mean	100 ug/m3 (50 ppb)	Annual Mean	40 ug/ m^3
							24 hrs	80 ug/ m^3
O3	1 hr	235 ug/ m^3	8 hrs	120 ug/ m^3	-	-	1 hr	130 ug/ m^3
			1 hr	200 ug/ m^3				
TSP	24 hrs	260 ug/ m^3	24 hrs	150-230 ug/ m^3	Annual Mean	100 ug/ m^3	Annual Mean	360 ug/ m^3
					24 hrs	500 ug/ m^3	24 hrs	500 ug/ m^3
PM10	24 hrs	150 ug/ m^3	-	-	-	-	Annual Mean	120 ug/ m^3
							24 hrs	150 ug/ m^3
$PM^{2.5}$	-	-	-	-	-	-	Annual Average	15 ug/ m^3
							24 hrs	35 ug/ m^3
							1 hr	15 ug/ m^3

2.5 Environmental Approval Requirements of the Project

According to EIA / IEE regulations 2021 of KP EPA, the projects with hydroelectric power generation over 50 MW and transmission lines 11 kV and above fall under Schedule II and require submission of EIA for environmental clearance from KP EPA. In pursuance of this requirement, PEDO will submit the EIA of the proposed project to KP EPA for their review and issuance of NoC.

2.6 International Treaties and Conventions

Pakistan is a signatory to a number of international environment and social related treaties, conventions, declarations and protocols. The following are the relevant international treaties and conventions to which Pakistan is a party:

- Convention on the Conservation of Migratory Species of Wild Animals, 1983
    - Conserve terrestrial, aquatic and avian migratory species throughout their range.
    - Migratory species threatened with extinction are listed in Appendix A of the Convention.
    - Strive towards strictly protecting these animals, conserving or restoring the places where they live, mitigating obstacles to migration and controlling other factors that might endanger them.
- Convention on Wetlands of International Importance
- Convention on the Control of Trans-Boundary Movements of Hazardous Wastes and their Disposal
- Convention concerning the Protection of World Culture and Natural Heritage
- Convention on the International Trade in Endangered Species
- International Plant Protection Convention
- International Covenant on Economic, Social and Cultural Rights
- Kyoto Protocol to the Convention United Nations Framework on Climate Change
- Stockholm Convention on Persistent Organic Pollutants
- Convention on Biological Diversity
    - Conservation of biological diversity,
    - Sustainable use of its component, and;
- Fair and equitable sharing of benefits arising from genetic resources United Nations Convention on the Rights of the Child.
- UNFCCC.

ILO's Fundamental Conventions – Ratifications for Pakistan

The following ILO's fundamental convention shall be applicable:

- Forced Labor Convention, 1930 (Convention No. 29)
- Freedom of Association and Protection of the Right to Organize Convention, 1948 (Convention No. 87)
- Right to Organize and Collective Bargaining Convention, 1949 (Convention No. 98)
- Equal Remuneration Convention, 1951 (Convention No. 100)
- Abolition of Forced Labor Convention, 1957 (Convention No. 105)
- Discrimination (Employment and Occupation) Convention, 1958 (Convention No. 111)
- Minimum Age Convention, 1973 (Convention No. 138) Minimum age specified: 14 years
- Worst Forms of Child Labor Convention, 1999 (Convention No. 182)

2.7 World Bank Safeguard Policies and Guidelines

The World Bank has developed a number of Safeguard Policies to ensure that all possible impacts are considered, and mitigation measures are spelled out prior to the implementation of any proposed project. These policies ensure that the quality of operations is uniform across different settings worldwide. If the decision is taken that a Safeguard Policy will be applied, mitigation measures and plans must be developed and in place before the implementation of a proposed project.

The Bank requires environmental screening and classification for all investment projects proposed for Bank financing, to help ensure that they are environmentally and socially sound and sustainable. Screening and classification take into account the natural environment (air, water, and land); human health and safety; social aspects (especially involuntary resettlement and presence of Indigenous Peoples); cultural property; and transboundary and global environmental aspects.

The objectives of environmental screening and classification are to evaluate the environmental risks associated with a proposed operation, to determine the depth and breadth of Environmental Assessment (EA), and to recommend an appropriate choice of EA instrument(s) suitable for a given project. The Bank recognizes that environmental screening and classification is not absolute and involves professional judgment on a case-by-case basis. When screening, careful consideration needs to be given to potential environmental impacts and risks associated with the proposed project. Judgment is exercised with reference to the policy expectations and guidance; real impacts on the ground; and established regional and Bank-wide precedence and good practices. The following World Bank policies are triggered for the MHPP.

2.7.1 Environmental Assessment (OP/BP 4.01)

EA requirement. The World Bank requires environmental assessment (EA) of projects proposed for Bank support to ensure that they are environmentally sound and sustainable, and to improve decision making. The Bank Policy OP/BP 4.01 considers that EA is a process whose breadth, depth, and type of analysis depend on the nature, scale, and potential environmental impact of the proposed project. EA evaluates a project's potential environmental risks and impacts in its area of influence; examines project alternatives; identifies ways of improving project selection, siting, planning, design, and implementation by preventing, minimizing, mitigating, or compensating for adverse environmental impacts and enhancing positive impacts; and includes the process of mitigating and managing adverse environmental impacts throughout project implementation. ESIA takes into account the natural environment (air, water, and land); human health and safety; social aspects (involuntary resettlement, indigenous peoples, and physical cultural resources); and transboundary and global environmental aspects. The Bank Policy also envisages that the borrower Government is responsible for carrying out the EA and the Bank advises the borrower on the Bank's EA requirements. The present ESIA has been prepared in compliance to WB OP/BP 4.01.

EA classification. The World Bank classifies the proposed project into one of four categories, depending on the type, location, sensitivity, and scale of the project and the nature and magnitude of its potential environmental impacts.

As the project falls into category-A being anticipated to have significant adverse environmental impacts during construction phase on the Swat River, have negative impacts on ambient air, surface water resources, local population and risk to the health and safety labor force; therefore; a full ESIA has been carried out including an examination of the potential positive and negative environmental impacts, a comparison of alternatives, measures to reduce impact.

2.7.2 Natural Habitats (OP 4.04)

This policy highlights the importance of conservation of natural habitats, like other measures that protect and enhance the environment, for long-term sustainable development. The Bank, therefore, supports the protection, maintenance, and rehabilitation of natural habitats and their functions in its economic and sector work, project financing, and policy dialogue. The Bank also supports and expects borrowers to apply a precautionary approach to natural resource management to ensure opportunities for environmentally sustainable development. The Bank promotes and supports natural habitat conservation and improved 111 by financing projects designed to integrate into national and regional development and promote the conservation of natural habitats and the maintenance of ecological functions. Furthermore, the Bank promotes the rehabilitation of degraded natural habitats. The Bank does not support projects that involve the significant conversion or degradation of critical natural habitats.

This policy is triggered due to the presence of Snow carp (IUCN Vulnerable species and Altitudinal Migrant), Brown Trout (Least Concern and Full Migrant) in the Swat River and Catfish (IUCN Endangered) in the tributaries of Swat River of the project area. These habitats have been considered while conducting this ESIA and appropriate mitigations measures have been proposed to ensure their maintenance, and enhancement where possible.

2.7.3 Physical Cultural Resources (OP 4.11)

This policy addresses physical cultural resources, which are defined as movable or immovable objects, sites, structures, groups of structures, and natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance. Physical cultural resources may be located in urban or rural settings and may be above or below ground, or underwater. Their cultural interest may be at the local, provincial or national level, or within the international community.

No known physical cultural resources have been identified within the project area or its surroundings. However, Chance Find Procedure have been added in compliance with this OP, to address discovery of any physical cultural resources during the construction activities particularly excavations.

2.7.4 Involuntary Resettlement (OP/BP 4.12)

The proposed MHPP project will affect 141 families/households. The population of the affected households (AHHs) is 1,110 persons, including 576 males and 534 females. Moreover, there are 49 AHHs whose income is below the official poverty line (OPL) and are categorized as vulnerable. Among the affected families, about 98% are severely affected[13]. The total land to be acquired for MHPP is calculated to be about 131 acres as per the revised design of the project. The land acquisition will impact about 80 acres of cultivated land, about 37 residential structures that will need to be demolished, and about 4,391 privately owned trees (fruit and timber) that will need to be felled. Therefore; in compliance to this OP, a RAP including LRIP has been prepared that will be fully implemented before any civil works are started.

2.7.5 Safety of Dams (OP 4.37)

When the Bank finances a project that includes the construction of a new dam, it requires that the dam be designed and its construction supervised by experienced and competent professionals. It also requires that the borrower adopt and implement certain dam safety measures for the design, bid tendering, construction, operation, and maintenance of the dam and associated works.

For large dams (dams of more than 15 m in height), the Bank requires

a) reviews by an independent panel of experts (the Panel) of the investigation, design, and construction of the dam and the start of operations;
b) reparation and implementation of detailed plans: a plan for construction supervision and quality assurance, an instrumentation plan, an operation and maintenance plan, and an emergency preparedness plan;
c) prequalification of bidders during procurement and bid tendering, and
d) periodic safety inspections of the dam after completion.

Dam safety policy has been triggered and the safety of the weir has been considered accordingly. As per this policy, PEDO has appointed an independent panel of experts (IPOE) to review the project designs. PEDO will monitor the dam's safety during the operational phase.

2.7.6 World Bank Group Environment, Health, and Safety Guidelines

The Environment, Health, and Safety (EHS) Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities or projects by existing technology at reasonable costs. In addition, there are also industry-specific EHS guidelines. The guidelines that are relevant to the Project are: General EHS Guidelines and Good Practice Note on EHS Approaches for Hydropower Projects[14].

2.7.7 Public consultation and disclosure requirements by World Bank

The Bank reaffirms its recognition and endorsement of the fundamental importance of transparency and accountability in the development process. Accordingly, it is the Bank's policy to be open about its activities and to welcome and seek

[13] A severely affected is a land owner whose affected land is 10% or more than 10% of his total land.
[14] https://www.ifc.org/wps/wcm/connect/29f5137d-6e17-4660-b1f9-02bf561935e5/Final%2B-%2BGeneral%2BEHS%2BGuidelines.pdf?MOD=AJPERES&CVID=nPtguVM

out opportunities to explain its work to the widest possible audience. According to ‘OP 4.01: Environmental Assessment of the World Bank, the following conditions apply to the Project.

Consultations. For all Category A and B projects, the borrower will consult with the project-affected groups and local nongovernmental organizations (NGOs) about the project's environmental aspects and take their views into account. The borrower will initiate such consultations as early as possible. For Category A projects, the borrower will consult these groups at least twice: (a) shortly after environmental screening and before the terms of reference for the EA are finalized; and (b) once a draft EA report is prepared. In addition, the borrower will consult with such groups throughout project implementation as necessary to address EA-related issues that affect them.

For Madyan HPP, consultations with the local community, affected persons, institutional stakeholders, and women of the project area have been conducted and are part of this ESIA report. The Final ESIA report will be shared with stakeholders during the Public Hearing of KP-EPA for MHPP and ESIA report will be updated based on this consultation.

Disclosure. For a Category A project, the borrower is required to provide relevant information on project interventions in a timely manner prior to consultation and in a form and language that is understandable and accessible to the groups being consulted. The borrower will provide a summary of the proposed project's objectives, description, and potential impacts for the initial consultation. For consultation after the draft EA report is prepared, the borrower will provide a summary of the EA's conclusions. In addition, for a Category A project, the borrower makes the draft EA report available in a public place accessible to project-affected groups and local NGOs. The borrower also ensures that EA reports for Category A subprojects are made available in a public place accessible to affected groups and local NGOs. The executive summary of the ESIA will be translated into Urdu. Public availability of the EA report for Category A projects in the borrowing country and official receipt by the Bank are prerequisites to Bank appraisal of these projects.

The ESIA and RAP (including translated versions of the executive summaries) will be disclosed on the PEDO website and will be sent to World Bank for the disclosure on its external website.

2.8 Gap Analysis of Applicable WB OPs and Local Regulations

The **Table 2-5** below summarizes the gaps identified between the applicable World Bank's OPs, and the relevant national and provincial laws and regulations.

Table 2-5 Comparison of Applicable World Bank Policies and KP Acts and Regulations for the MHPP Project

World Bank MHPP Applicable OPs	Relevant Local Regulations	Gaps Identified	Approach to Address Gaps
World Bank Op 4.01: this policy environmental screening process classifies projects into three categories as follows; I. Category-A requires full ESIA or a suitably comprehensive regional or sectoral EA), II. Category-B, the scope of EA for a Category B project may vary from project to project, but it is narrower than that of Category A EA. Like Category A EA, it examines the project's potential negative and positive environmental impacts and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance. III. Category C: A proposed project is classified as Category C if it is likely to have minimal or no adverse environmental impacts. Beyond screening, no further EA action is required for a Category C project. IV. Category FI: A proposed project is classified as Category FI if it involves investment of Bank funds through a financial intermediary, in subprojects that may result in adverse environmental impacts	I. KP Environmental Protection Act, 2014 II. Guidelines for Environmental Assessment, III. KP EPA Rules, 2021	The criteria mentioned in the Acts for classifying environmental and social risk is different than in the World Bank OP 4.01. The classification is Schedule-II (Cat-A requires EIA) and Schedule –I (Cat-B required IEE). Review of IEE and EIA Regulations, 2021 mainly focus on environmental assessment and management through Environmental Impact Assessment (EIA) and Initial Environmental Examination (IEE) whereas social assessment is cursory. The different methods and tools (EIA, environmental and social audit, cumulative impact assessment, ESMP, ESMF, regional and sectoral EIA and SESA) for Environmental & Social Impact Assessments, referenced in the WB OPs, are not part of the National and Provincial legislation.	Screening was carried out in compliance to World Bank OP 4.01 and the project is classified to Category-A. A full ESIA has been prepared in compliance to the applicable policies triggered. This ESIA also covered the compliance requirements of the KP applicable acts and regulatory requirements.
World Bank OP 4.11 Physical Cultural Resources: The Bank assists countries to avoid or mitigate adverse impacts on physical cultural resources from development projects that it finances. The impacts on physical cultural resources resulting from project activities, including mitigating measures, may not contravene either the borrower's national legislation, or its obligations under	The Khyber Pakhtunkhwa Antiquities Act, 2016.	KP Antiquities Act 2016, does not provide the projects classification during the environmental screening process as Category A or B, and are subject to the provisions of this policy: (a) any project involving significant excavations, demolition, movement of earth, flooding, or	The World Bank policies will be followed.

World Bank MHPP Applicable OPs	Relevant Local Regulations	Gaps Identified	Approach to Address Gaps
relevant international environmental treaties and agreements.		other environmental changes; and (b) any project located in, or in the vicinity of, a physical cultural resources site recognized by the borrower. Projects specifically designed to support the management or conservation of physical cultural resources are individually reviewed, and are normally classified as Category A or B	
World Bank OP4.12 I. Screen the project early on to identify past, present, and future involuntary resettlement impacts and risks. Determine the scope of resettlement planning through a survey and/or Census of displaced persons, including a gender analysis, specifically related to resettlement impacts and risks. II. Carry out meaningful consultations with APs, host communities, and concerned nongovernment organizations. III. Inform all displaced persons of their entitlements and resettlement options. Ensure their participation in planning, implementation, and monitoring and evaluation of resettlement programs. Pay particular attention to the needs of vulnerable groups, especially those below the poverty line, the landless, the elderly, women and children, and Indigenous Peoples (IP), and those without legal title to land, and ensure their participation in consultations. Establish a grievance redress mechanism to receive and facilitate resolution of the APs’ concerns. I. Support the Social and cultural institutions of APs and their host population. Where involuntary resettlement impacts and risks are highly complex and sensitive, compensation and resettlement decisions will be preceded by a social preparation phase.	Land Acquisition Act 1894 KP Land Acquisition (Amendment) Act, 2020	I. Screening is limited to physical survey of land, there is no consideration of social risks in the LAA. No formal stakeholder consultations required by the LAA, or in host communities in case of resettlement Consultations conducted during the preparation of present RAP; additional consultations will be carried out during the implementation per framework included in RAP. II. Grievance Redress Mechanism (GRM) included in the present RAP. III. No provisions are made for vulnerable groups in the LAA IV. No provisions for livelihood restoration and improvement, and no additional assistance beyond compensation for land acquired and loss of livelihood in the LAA V. Land assets and structures are valued at market value in the LAA, instead of replacement cost in the WB OP 4.12	I. Screened and categorized. Scope defined in RAP. II. Consultations conducted during the preparation of RAP; additional consultations will be carried out during the implementation per framework included in RAP. III. Grievance Redress Mechanism (GRM) has been included in the present RAP. Resettlement planning has addressed the needs of vulnerable groups. IV. The RAP addresses these requirements. A livelihood restoration plan has been prepared and included as a part of the RAP. V. The land value will be assessed based upon replacement cost or negotiated rates.

World Bank MHPP Applicable OPs	Relevant Local Regulations	Gaps Identified	Approach to Address Gaps
II. Improve, or at least restore, the livelihoods of all APs. through (I) land-based resettlement strategies when affected livelihoods are land based where possible or cash compensation at replacement value for land when the loss of land does not undermine livelihoods, (ii) prompt replacement of assets with access to assets of equal or higher value, (iii) prompt compensation at full replacement cost for assets that cannot be restored, and (iv) additional revenues and services through benefit sharing schemes where possible.			
World Bank OP 4.04 - Natural Habitats This policy classifies the habitats into following categories; *i. Natural habitats;* *ii. Critical natural habitats;* The policy also recommends IUCN categories are as follows: I--Strict Nature Reserve/Wilderness Area: protected area managed for science or wilderness protection; II--National Park: protected area managed mainly for ecosystem protection and recreation; III--Natural Monument: protected area managed mainly for conservation of specific natural features; IV--Habitat/Species Management Area: protected area managed mainly for conservation through management intervention; V--Protected Landscape/Seascape: protected area managed mainly for landscape/seascape conservation and recreation; and VI--Managed Resource Protected Area: protected area managed mainly for the sustainable use of natural ecosystems.	National Forest Policy, 2015 The Forest Act, 1927 KP Wildlife and Biodiversity Act, 2015 KP Forest Ordinance, 2002	Forest Ordinance does not provide regulatory basis enabling to meet social needs of forest dependent communities while preserving forest ecosystems, preventing forest degradation and depletion of its resources. Ecosystem services are not referred in the provincial legislation. Forest conservation practices do not meet with the international principles and criteria of sustainable forest management.	Critical habitat assessment was carried out. Robust seasonal biodiversity baseline survey was carried out. Mitigation measures to devised in the ESMP to mitigate the anticipated impacts on the reported key biodiversity; Fish ladder (Figure 3.13) is designed in the Weir to maintain river connectivity for the fish migration.
World Bank OP 4.37 - Safety of Dams I. This policy recommends for small dams, generic dam safety measures designed by qualified engineers are usually adequate.6 For large dams, the Bank requires II. reviews by an independent panel of experts (the Panel) of the investigation, design, and construction of the dam and the start of operations;	No such policy or act exist in Pakistan.	No such policy or act exist in Pakistan.	Services of IPOEs are hired by PEDO for the project. All provisions of the Policy will be implemented before/during the project construction and O&M phases.

World Bank MHPP Applicable OPs	Relevant Local Regulations	Gaps Identified	Approach to Address Gaps
III. preparation and implementation of detailed plans: a plan for construction supervision and quality assurance, an instrumentation plan, an operation and maintenance plan, and an emergency preparedness plan; IV. prequalification of bidders during procurement and bid tendering, an; V. periodic safety inspections of the dam after completion.			

2.9 Regulatory Authorities

2.9.1 Overview

The Project will be implemented and operated by PEDO with the involvement of provincial government departments and agencies, where they hold responsibilities relevant to the Project and / or represent key stakeholder interests. Private sector companies will also play a role particularly during construction.

2.9.2 Statutory organizations

A summary of the key regulatory institutions and their relationship with the project in accordance with national, provincial, and international requirements is provided in **Table** 2-6**.**

Table 2-6: Roles of statutory organizations

Organization	Roles/ Responsibilities
Pakhtunkhwa Energy Development Organization (PEDO)	The PEDO as the lead agency working under the KP energy and power (E&P) department Government of KPK will ensure that the necessary procedural documents and technical capacity are in place to comply with country and provincial systems. Responsible to provide least cost power generation, encourage private sector investment through full cost recovery and attractive rates of return, ensure fast track and transparent development of power projects, encourage and ensure participation of investors in the development and implementation of hydro power projects, ensure participation, development and welfare of all stakeholders, and provide green energy, distribution and sale of electricity, bulk distribution, marketing and sale of power and provision for related matters.
Ministry of Climate Change	The Environment Division of the Ministry of Climate Change at federal level is the focal agency for national policy, legislation, plans, strategies and programs with regard to disaster management and climate change including environmental protection and preservation. The division also deals with other countries, international agencies and forums for coordination, monitoring and implementation of environmental agreements. Policies set by the Ministry of Climate Change will influence the design and operation of the project.
Planning Commission	Responsible for state policy development initiatives and expansion of the public and state infrastructure of the country, Monitoring and evaluation of the implementation of major development projects and programs also falls with its remit.
KP EPA	Responsible for regulating the environment and environmental permitting of the Project and ensuring the implementation of government policies on the environment. Reviews environmental documentation to ensure compliance with the provincial environmental assessment requirements and procedures and, using its district-based staff, also monitors implementation of environmental management plans.
KP Forest Departments	The forest department is responsible for: Administration and enforcement of Provincial Forest Ordinances. Protection of forests, waste lands and its biodiversity from project interventions, denudation. Promotion of joint forest management and community, participation, development and forestry extension Conservation and improvement of ecology and natural habitat Promotion of eco-tourism and recreation Institutional, human resource management and capacity building and forestry training

Organization	Roles/ Responsibilities
KP Department of Fisheries	Fisheries department is responsible for: Extension services/fish farming/aquaculture development. Conservation, management, and development of natural resources. Production of fish seed under controlled conditions. Research and training activities. Introduction of new technologies for enhancing fish production. The Fisheries Department will be involved in case of any damage to any fish resources and fishponds caused by the project activities.
KP Agriculture Department	In case of an impact on crops and fruit and wood trees, the Agriculture Department is fully responsible for the assessment and valuation of losses.
Wildlife Department	The Wildlife Department is responsible for: Enforcing the National Wildlife (Protection, Preservation, Conservation and Management) Act of 1975 and the rules made there under Identifying, notifying and managing National Parks, Wildlife Parks, Wildlife Refuges, Wildlife Sanctuaries and Game Reserves Replenishing the depleted wildlife population through protection and/or reintroduction programs.
Revenue Department	The Revenue Department is responsible for the acquisition of land (permanent or temporary) including assessment, valuation, disbursement of compensation, and mutation in favor of PEDO.
Communication and Works (C&W) Department	The C&W will be involved in the assessment and valuation of losses in case of project impact on structures/ buildings and roads.
National Transmission and Dispatch Company (NTDC)	As a subsidiary of Pakistan Electric Power Company, its mission is to procure and distribute energy efficiently, safely and reliably in the country in a commercially viable manner. NTDC will ensure the viability of spare capacity in the existing substations close to the Project site, and interconnection arrangements, and confirmed with the Project Proponent on such arrangements.
Mines and Minerals Department	The Mines and Minerals department will be responsible for Issuing Permit, Licensing, and approval for aggregates and mining activities (explosive materials use for blasting activities for the excavation of headrace tunnel)
National Highway Authority (NHA)	The functions of NHA are to plan, promote, organize and implement programs for construction, development, operation, repairs and maintenance of national highways/ motorways and strategic roads[15]. The N-95 road will be used during construction period for material transportation and access to site. Traffic management plan is part of the ESMP and will be implemented during construction period in consultation with the NHA.
Peshawar Electricity Supply Company (PESCO)	PESCO is located in Peshawar providing services of power distribution over 4 million consumers of all districts of Khyber Pakhtunkhwa. PESCO maintains electricity distribution system via 132 and 66kilovolt (kv) sub-transmission lines, substations, and 11kv and 440volt low tension lines with distribution transformers that deliver electricity to the consumers[16]. In case of use of electricity by contractor or if unavoidable, dislocation of power poles, the PESCO will be coordinated.

[15] https://nha.gov.pk/sitepages/topic/25
[16] https://pesco.com.pk/about/what-we-do

Organization	Roles/ Responsibilities
National Electric Power Regulatory Authority (NEPRA)	The powers and functions of the Authority as delineated in the Regulation of Generation, Transmission and Distribution of Electric Power (Amendment) Act, 2018 [Act No. XII of 2018] are to grant of license, specify procedures and standards for registration of power services provided, aid and advise the Federal Government, in the formulation of national electricity plan, ensure efficient tariff structures and market design for sufficient liquidity in the power markets, specify procedures and standards for investment programmes by generation companies and persons licensed or registered, specify and enforce performance standards for generation companies and persons licensed or registered, specify accounting standards and establish a uniform system of account by generation companies and persons licensed or registered, specify fees including fees for grant of licenses and renewal thereof, review its order, decisions or determinations, settle disputes between licensees in accordance with the specified procedure, issue guidelines and standard operating procedures17. PEDO has applied for generation license of Madyan HPP and is in process.

[17] https://nepra.org.pk/About.php

3 Project Description

This chapter presents a simplified description of the proposed facilities in the Madyan Hydropower Project.

3.1 Project Layout

The proposed Project will divert part of the flow from Swat River using a weir and through a system of tunnels to the powerhouse, where the water is returned to the Swat River some 13 km downstream. The Project will construct a 207 MW run-of-the-river hydropower plant on the Swat River to generate about 865 GWh power generation annually. The main facilities of the Project include arrangements for power generation (gated weir structure, power intake on the left bank adjacent to the weir, desander basins, headrace tunnel, surge tank, vertical pressure shaft, horizontal pressure tunnel, manifold, powerhouse, tailrace, and powerhouse outlet) and facilities for power evacuation (switchyard and transmission line). The salient features are given in Table 3-1. A schematic of the proposed Project facilities is presented in **Figure 3-1. Figures 3-2** and **Figure 3-3** present project components and layout on google aerial view respectively.

Table 3-1: Salient Features of the Project

Description	Unit	Feasibility Study 2009	Updated Feasibility Study 2023
Hydrological Features at Weir Site			
Catchment Area	km^2	2,403	2,471
Mean Annual Flow	m^3/s	118.5	107
Diversion Design Flood	m^3/s	656	1,776
Design Discharge	m^3/s	129	153
$HQ_{1,000}$ (1,000 years return period)	m^3/s	1,450	5,234
$HQ_{10,000}$ (1,000 years return period)	m^3/s	2,002	6,300
Reservoir			
Normal Reservoir Operation Level	m SoP[18]	1,496.0	1514.1
Max. Weir Height	m above riverbed	18.0	16.2
Length of Weir Crest	m	77.0	107
Number of Gates		3	6
Width of Gate	m	7.6	13
Height of Gate	m	12	10.5
Desander			
Design Discharge	m^3/s	129	153
Design Particle Diameter	mm	0.2	0.2
Number of settling chambers		03	02 chamber (04 Basin)
Effective length of chamber	m without transition	206	204
Width of chamber	m	13.7	26.47
Average depth of chamber	m	16.80	22.74
Low-pressure Headrace Tunnel			
Length	km	11.80	11.17
Net Diameter	m	7.00	8
Max. Flow velocity	m/s	3.35	3.0
Surge Tank			

[18] meter survey of Pakistan)

Description	Unit	Feasibility Study 2009	Updated Feasibility Study 2023
Diameter:	m	21	20.50
Height:	m	69	65.87
Pressure Shaft Pressure Tunnel			
Total length (shaft and tunnel)	m	180.3	340
Length of vertical shaft	m	120.8	110
Diameter	m	5.80	5.75
Flow velocity	m/s	4.88	6
Diameter	m	5.40	5.7
Flow velocity	m/s	5.63	6
Steel lining	mm	20 – 28	25
Powerhouse:			
No. of units		3	3
Installed Capacity	MW	157.3MW (3 x 52.43)	207MW
Max. Turbine Design Discharge	m^3/s	43	64/25
Cavern Width	m	20	18
Cavern Length	m	70	95.5
Turbine Setting	amsl (SoP)	1,336	1,343
Electromechanical Equipment			
No of Transformers		9	3
Type of GIS Switchyard		SF6	SF6
Voltage	KV	220	220
Additional Project Parameters			
Mean Annual Energy Generation	GWh	767.5	840
Plant Factor		0.56	0.46
Total Project Costs	million US $	371.907	425,867

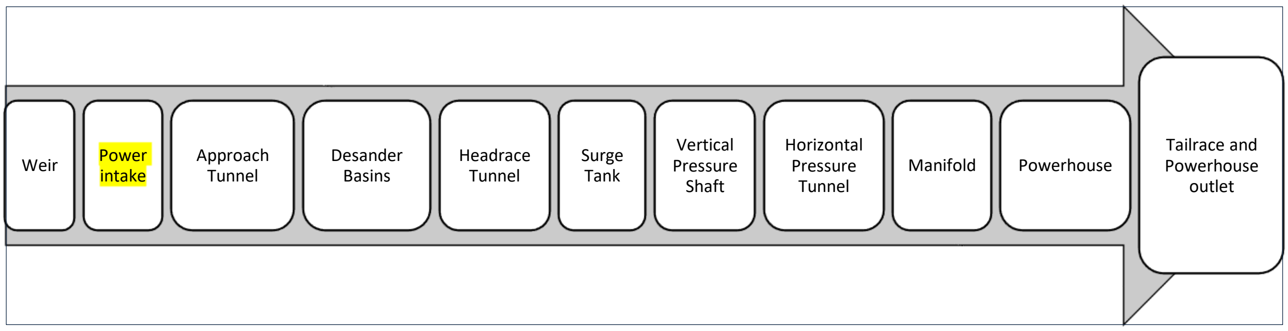


Figure 3-1: A schematic drawing of proposed project facilities

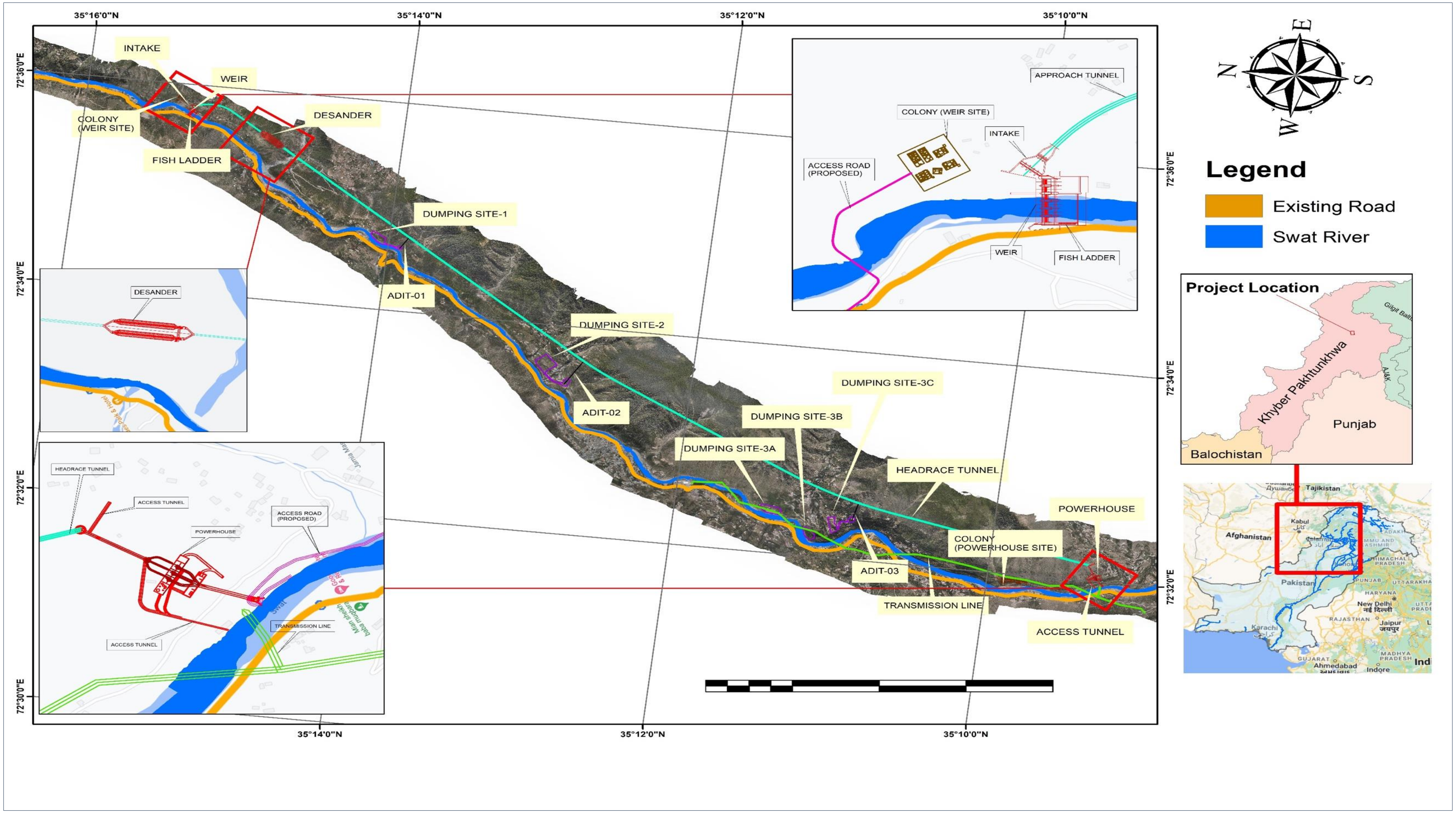


Figure 3-2: Location and layout of Project Components

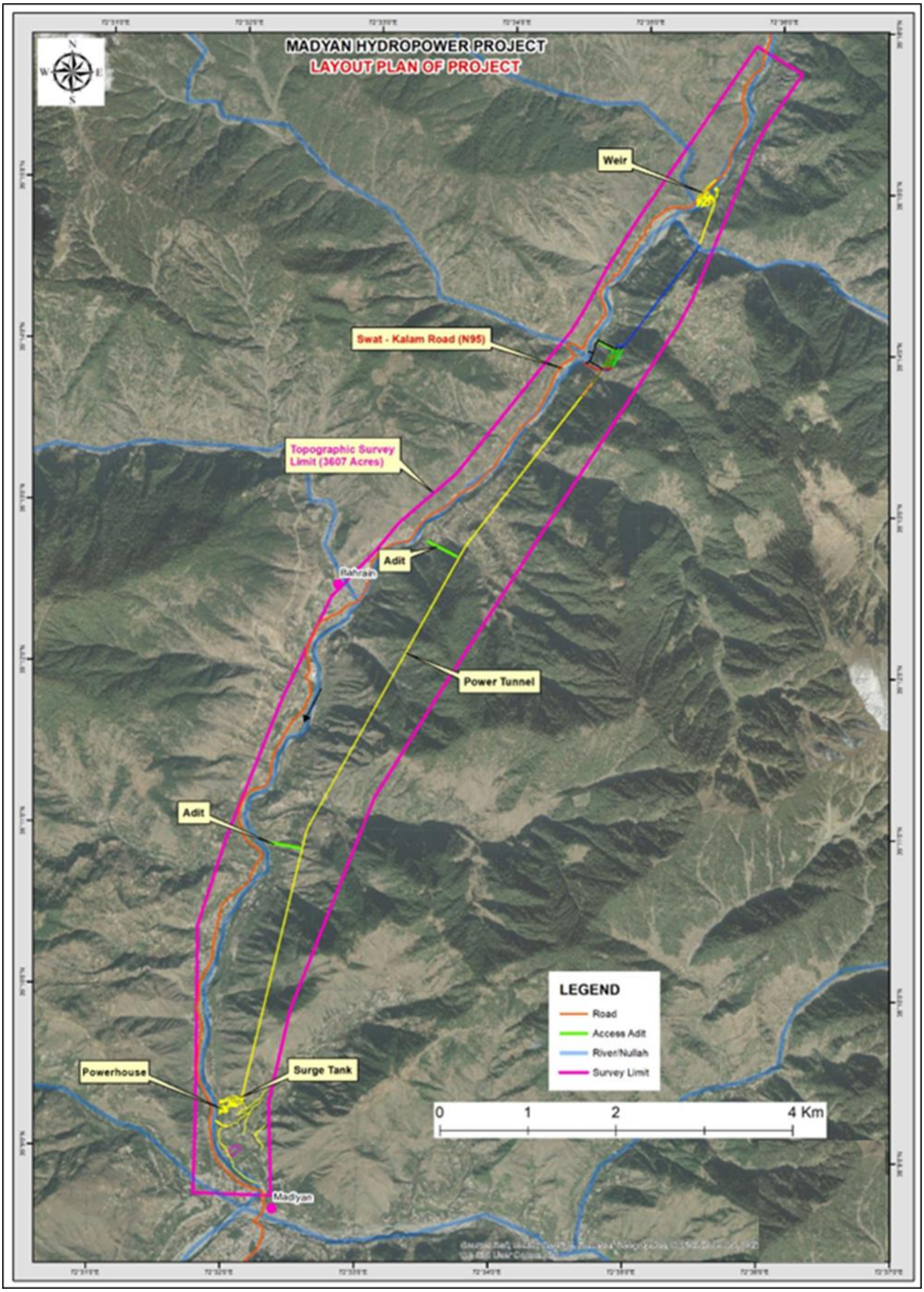


Figure 3-3: Project Layout (Aerial View)

3.2 Cofferdam Diversion System (Temporary Facilities)

The safety of the working area during the construction period is a key element for project completion. To provide a safe construction area for the concrete weir, a two-stage diversion system in Location 1- option 2 (6 gates) will achieve the temporary river diversion. A sheet pile protection barrier has been considered along the river for the first stage of the diversion system. The sheet pile will occupy less riverbed and provide more space for the river cross-section, while; the rockfill dyke will make the river narrower, and the water level will rise more than the sheet pile solution. For option 1 (4(12*10.5)), a rockfill cofferdam at the right side of the weir is proposed to divert the flow during the construction period. Whereas, in option 2 (6(13*10.5) and 3 (5(12*10.5)) stage-wise construction is proposed.

I. The First Stage of Diversion System

At the first stage of diversion, a sheet pile barrier (coffer dam) will be built along the river to protect the left bank of the river to construct the undersluices on the left bank, as shown in **Figure 3-4**. This first stage coffer dam will be built during the low flow season.

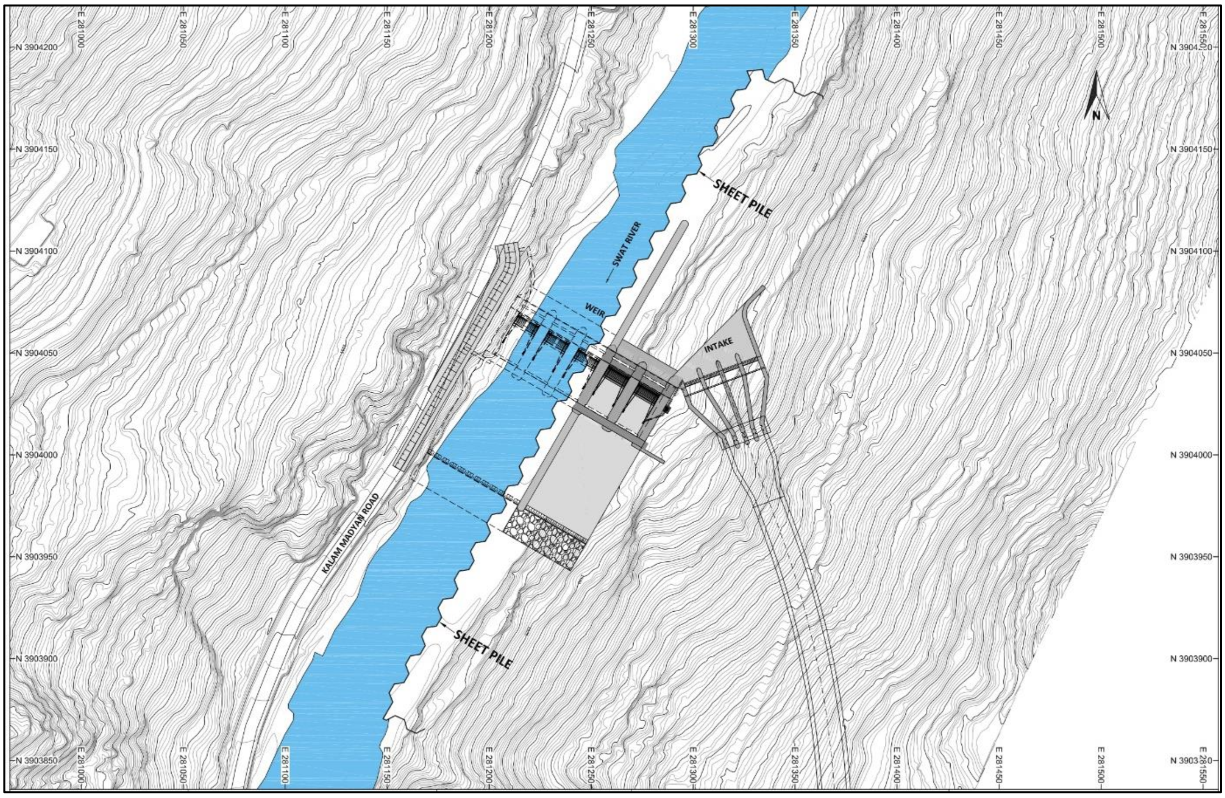


Figure 3-4: Plan view of river effective area in the first stage of diversion system using Sheet pile for the design discharge

II. The Second Stage of Diversion System

Once the undersluices on the left bank are completed (sheet piles will be removed), another coffer dam (2nd stage diversion) will be built during the second low flow season & the river will be diverted through undersluices already completed during first stage. During this phase of construction, remaining weir section on the right bank will be completed, as shown in the **Figure 3-5** below.

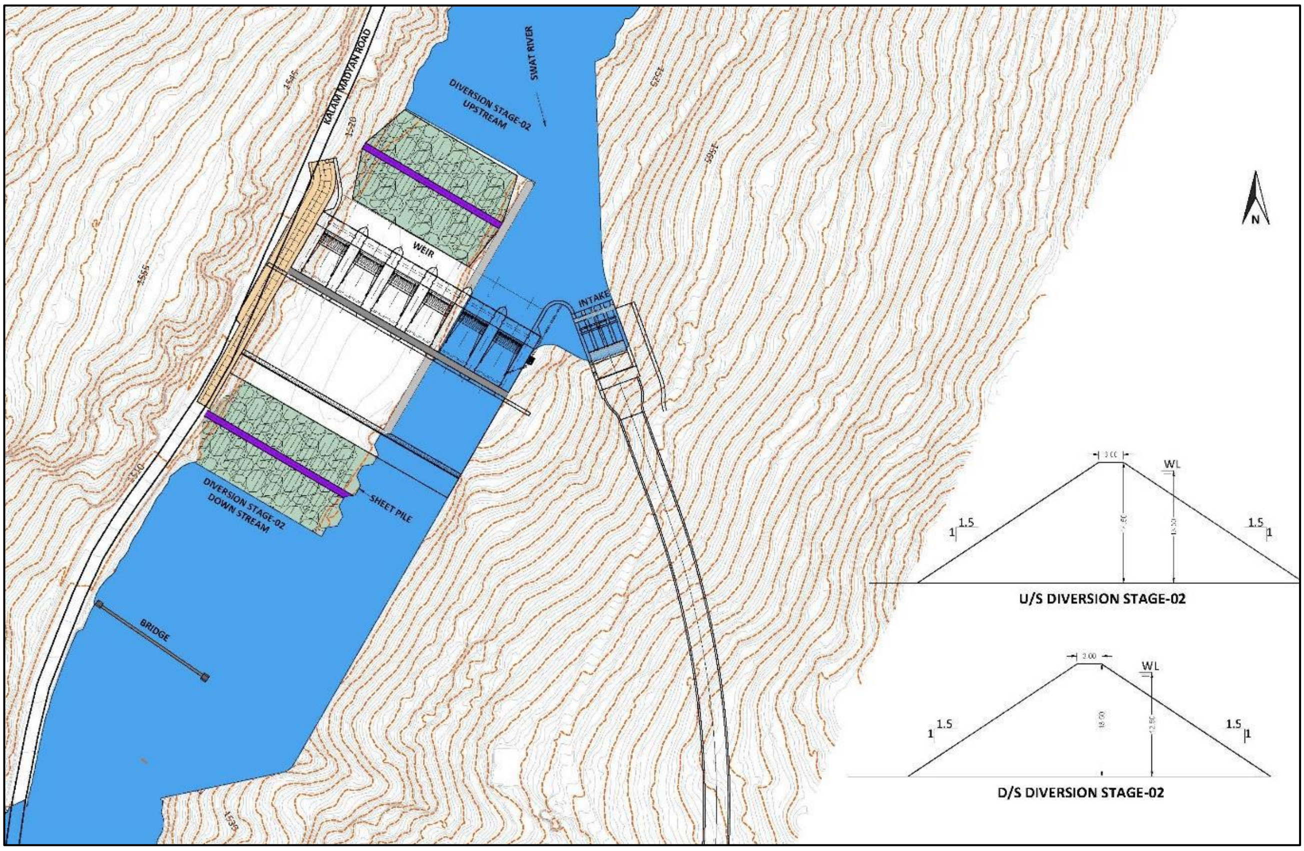


Figure 3-5: Plan view of river effective area in the second stage of diversion system

The maximum water level has been calculated based on the hydraulic performance of the two left bays in different scenarios of the number of bays and design floods. As per the results, the required height of the diversion channel will be higher than the main design of the weir for the 1-bay scenario. Therefore, this scenario has been discarded because of the deviation from the main design, and the 2 bays scenario has been selected for the second stage of the diversion system. The design features of the 2 left bays have been considered as per the requirement for sediment flushing in the project's operation period. The maximum water level will be 1510.3 amsl (above mean sea level) in the diversion channel, regarding the design flood, as per the hydraulic calculation results. The upstream cofferdam crest shall be set on this elevation to protect the working area in the second stage of diversion. The results also show that the required tailwater needs to be adequately fulfilled for the diversion channel in the design diversion flood considering the apron level as per their flushing purpose. Limited damages are expected in the apron and downstream channel in the design flood of diversion system, and these damages (if any) can be rehabilitated after commissioning the project. The maximum water level for the structural design of the bays as the second stage of the diversion system will be as follows as per the design flood:

- Upstream water depth from the riverbed = 12.4 m;
- Upstream Maximum Water El= 1510.3 amsl;
- Downstream water depth=15.8 m;
- Downstream water EL=1508.1.

3.3 Description of Key Project Permanent Facilities

3.3.1 Weir

Swat River's mean annual flow is 118.5 m³/s at the selected weir site, with high flow period being from May to September and low flow period being from December to March. In an average hydrological year such as the year 1995, daily river flow varied between 18.5 and 447.6 m³/s around the mean value of 118.5 m³/s. Weir crest level is 1499.4amsl. Weir structure is 117 m long ogee shaped structure discharging into a concrete stilling basin. The weir location coordinates are: E: 028 11 87.0; and N: 390 40 69.0, which is located at 910 m upstream of Kedam Nullah.

Tentative dimensions of weir are 16.2 m high, 117m long and width of weir along the flow is 79.5m. Weir is designed for a maximum discharge of 5,234 m^3/s. Weir crest level is El. 1499.4 m and High Flood Level (HFL) is 1514.1 amsl. The weir will be a concrete gravity structure ogee shaped with overflow spillway and under sluices. Concrete stilling basin has been made an integral part of the weir body. The weir site is accessible from N95 highway (Bahrain Road) along the right bank of the Swat River. The weir structure is designed to withstand safely floods up to a return period of 10,000 years and the design earthquake without major damages. At the left bank adjacent to the power intake, two under sluices are foreseen to evacuate sediments that may deposit in front of the power intake. The location and layout of project components is shown in **Figure** 3-6 and a cross-section of the weir is presented in **Figure** 3-7**.**

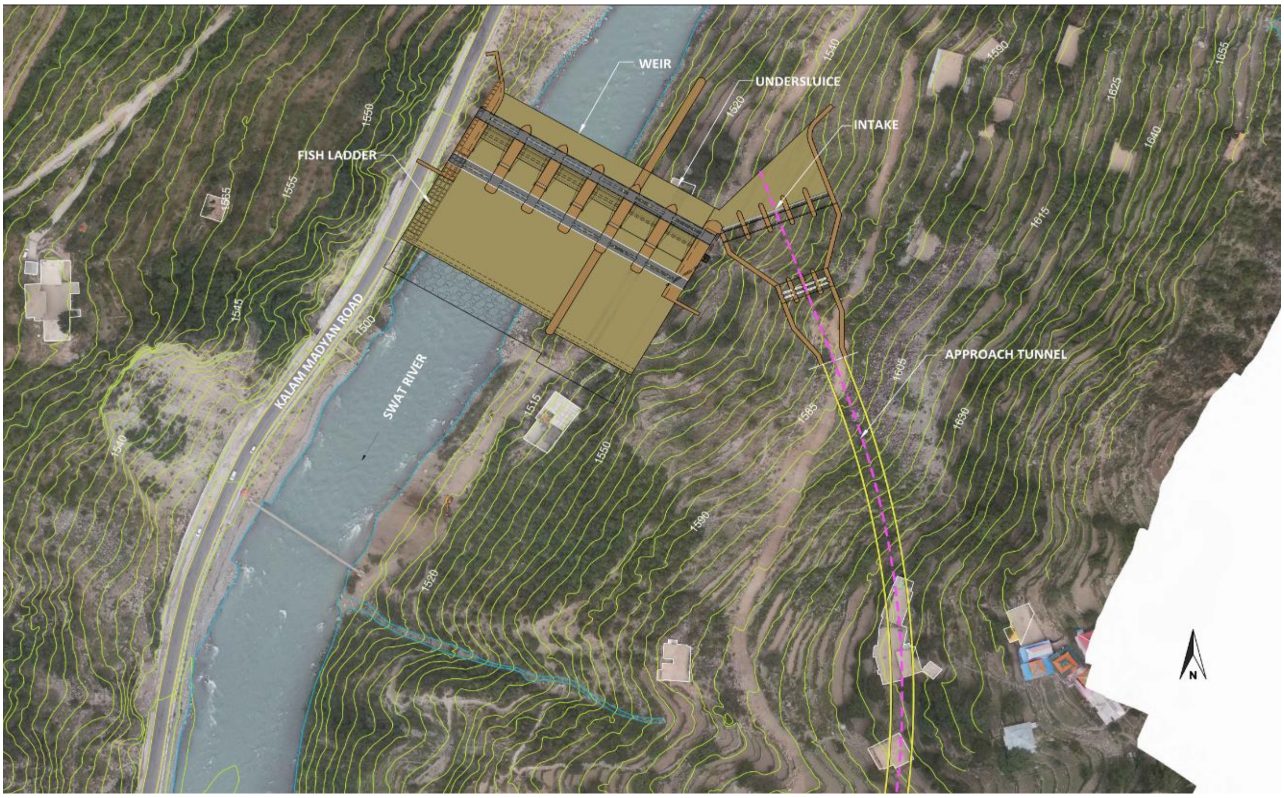


Figure 3-6: Weir Layout Plan

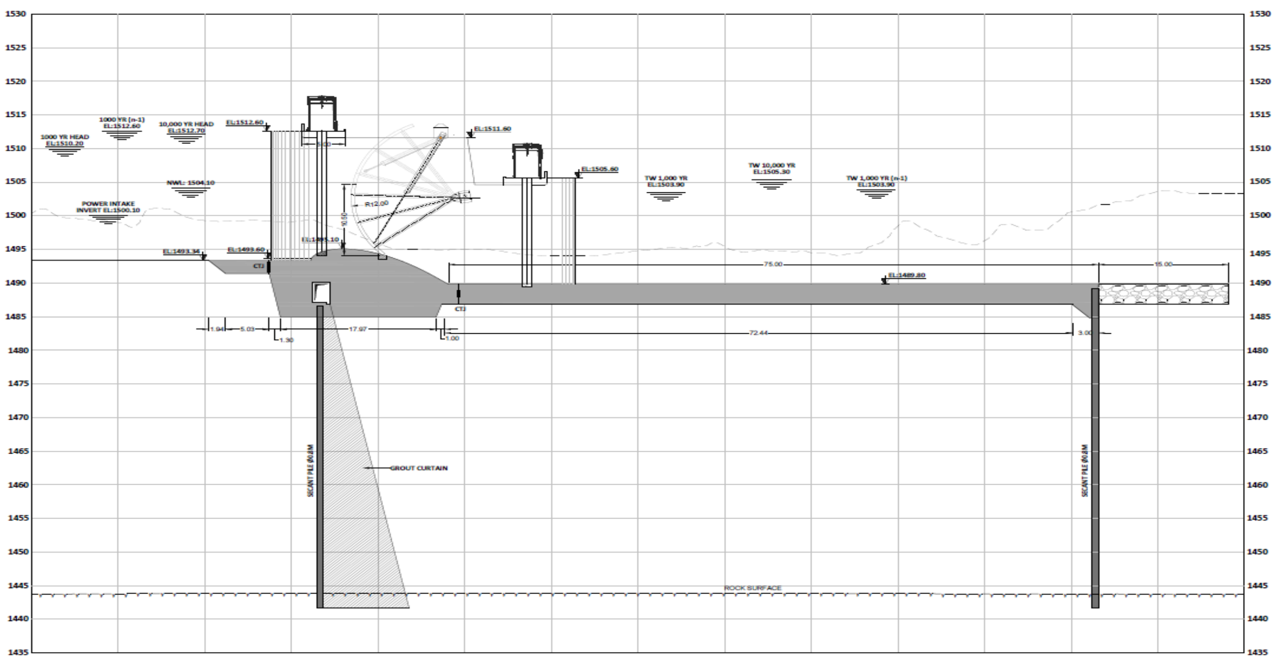


Figure 3-7: Cross-Section of Weir

3.3.2 Power Intake

The power intake provides a transition between the river and the approach tunnel/water way. The main design objectives are to exclude bedload sediments and floating debris and to minimize head losses. The required dimension of the intake will be 28*5.7 m (L*H). Since the higher height of the intake will lead to higher normal water levels and larger gates, the height of the intake has been taken to be 4 m to decrease the gates' height. The length was accordingly determined to be 40 m. Therefore, the selected dimension of the intake is (40*4) (L*H) m^2.

3.3.3 Approach Tunnel

The approach tunnel is designed based on gravity flow with a bed slope of 1 in 1000 with different design discharges. The concrete-lined tunnel will have a Manning roughness of 0.015. Free flow is assured with the provision of a 2m freeboard. Non-silting velocity is maintained in the tunnel and total length of the approach tunnel is 913m.

3.3.4 Headrace Tunnel

The headrace tunnel starts just 1213 m downstream of the intake and has a length of 11.18 km and internal diameter of 8.0 meters. It has a mean flow velocity of 3.013 m/s. Its alignment was selected for conventional drill and blast excavation method nearly parallel to the Swat River. Three adits (total length of 1,060 m) are planned to ensure tunnel construction within a reasonable period. Around 1,050,000 m³ of spoil, consisting of mostly rocky material will be generated. Large areas (around 186,000 m^2) for disposing the excavation material will be necessary. Headrace tunnel end up into the pressure tunnel. **Figure 3-8** shows the details.

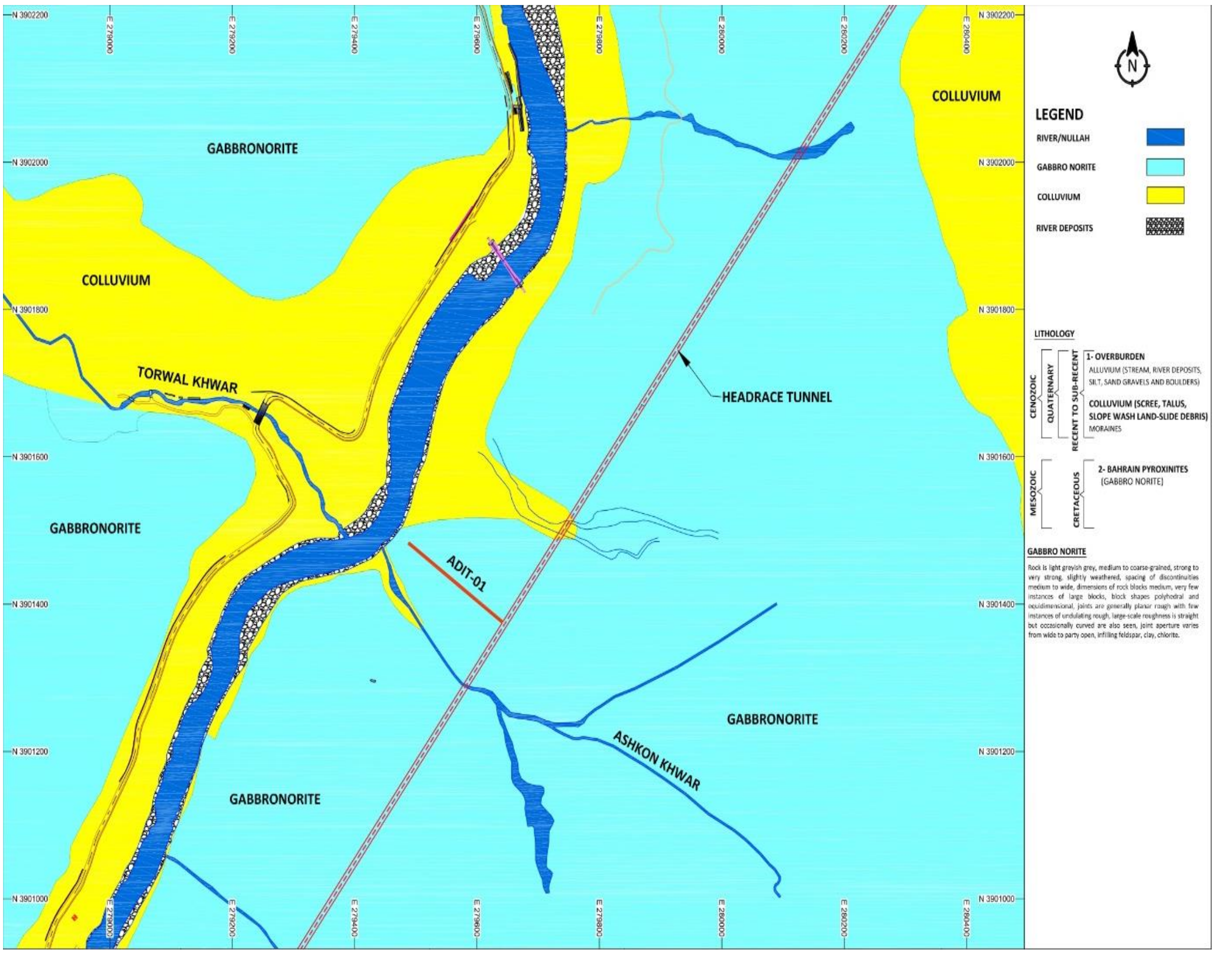


Figure 3-8: Headrace Tunnel Plan

3.3.5 Desander

Proposed Intake of conveyance system is demarcated at left side of the weir, end up into the approach tunnel. Two caverns of desander (L 230 m x W 28 m x H 42 m) are proposed in metamorphic rock, downstream of the power intake. Proposed facilities arrangement is presented in **Figure 3-9.**

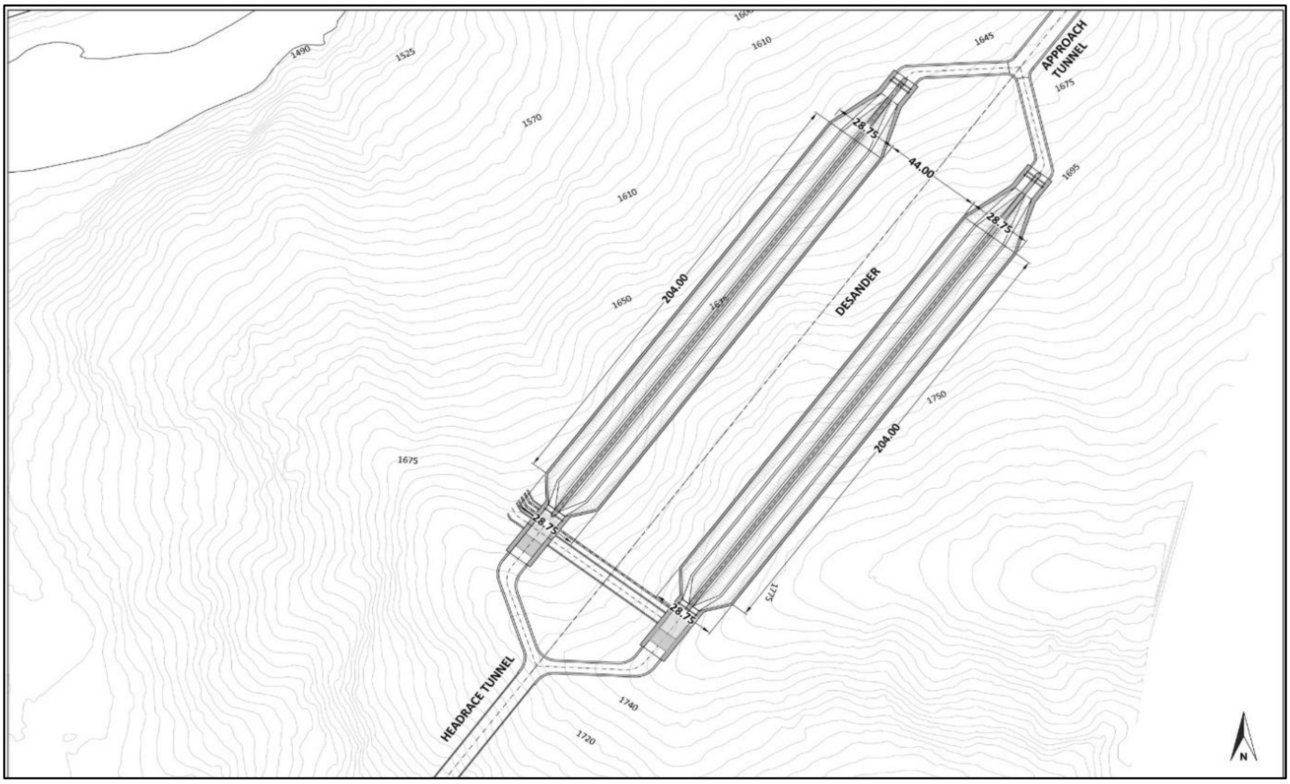


Figure 3-9: Desander Layout Plan

The desander facilities are arranged on sound rock at 983 m downstream of the weir and consist of two chambers with the corresponding ducts and gates for the evacuation of sediments.

During the high flow season, the Swat River has the potential to transport large quantities of sediments in suspension as well as bed load. Sediment concentrations of up to 10,000 ppm have been recorded in the Swat River. From the petrographic analysis of rock and sand samples, it can be assumed that quartz minerals may make up to 10 % of the suspended sediments.

The proposed design of the weir structure and the flushing outlets ensures that coarse sediments (sand, gravel, and cobble) can be prevented from entering the power intake and will be flushed through the sediment sluice. Sand and silt fraction will remain largely in suspension in the small reservoir of the Madyan HPP and unavoidably enter the power intake. Desander facilities are, therefore, required to remove most of the sediment particles larger than the design particle diameter of 0.2 mm. For fractions with larger particle size the removal rate approaches 100% and for particles of 0.1 mm diameter the removal rate is still above 50%. The design parameters details are given in **Table 3-2.**

Table 3-2: Design parameters of the desanders

Items	Unit	Value
Design discharge	m^3/s	153
Number of settling chambers	No.	2
Effective length of chamber	m (without transition)	202
Width of chamber (2 basins)	m	28.75
Average depth of chamber	m	37.09
Mean velocity	m/s	0.2
Grain size to be excluded	mm	0.20

The two desander chambers will be equipped with:

- two slide gates (3.5 m x 6.6 m) upstream of the desander cavern
- two slide gates (3.5 m x 6.6 m) downstream of the desander cavern
- desander device with auxiliaries
- four sluice valves DN500 for sediment flushing

Concrete lined manifold systems with 4.2 m diameter branch off the headrace tunnel upstream and return the flow downstream to the headrace tunnel again. Maintenance gates are arranged upstream and downstream of each desander chambers to enable inspection and maintenance of one chamber while the others are in operation.

3.3.6 Surge Shaft

From the headrace tunnel water enters the surge shaft (used as a pressure neutralizer in hydropower water conveyance system to resist excess pressure rise and pressure drop conditions). Relief valves are provided to relieve the detrimental effects of the water hammer produced because of a sudden load rejection/closure of the generating units. The surge tank will be arranged at the end of the headrace tunnel, some 50 m upstream of the transition to the pressure shaft; it will have an excavated diameter of approximately 22.5 m diameter and 78 m depth. The height of the surge shaft is 66 m and the diameter are 20.5 m. From the surge shaft, water enters the penstock, which comprises three branch pipes. The diameter of each pipe will be 3.75 m for large units and 2.5 m for small unit and the velocity of design discharge will be 5.17 m/s. **Figure 3-10** shows surge to powerhouse plan.

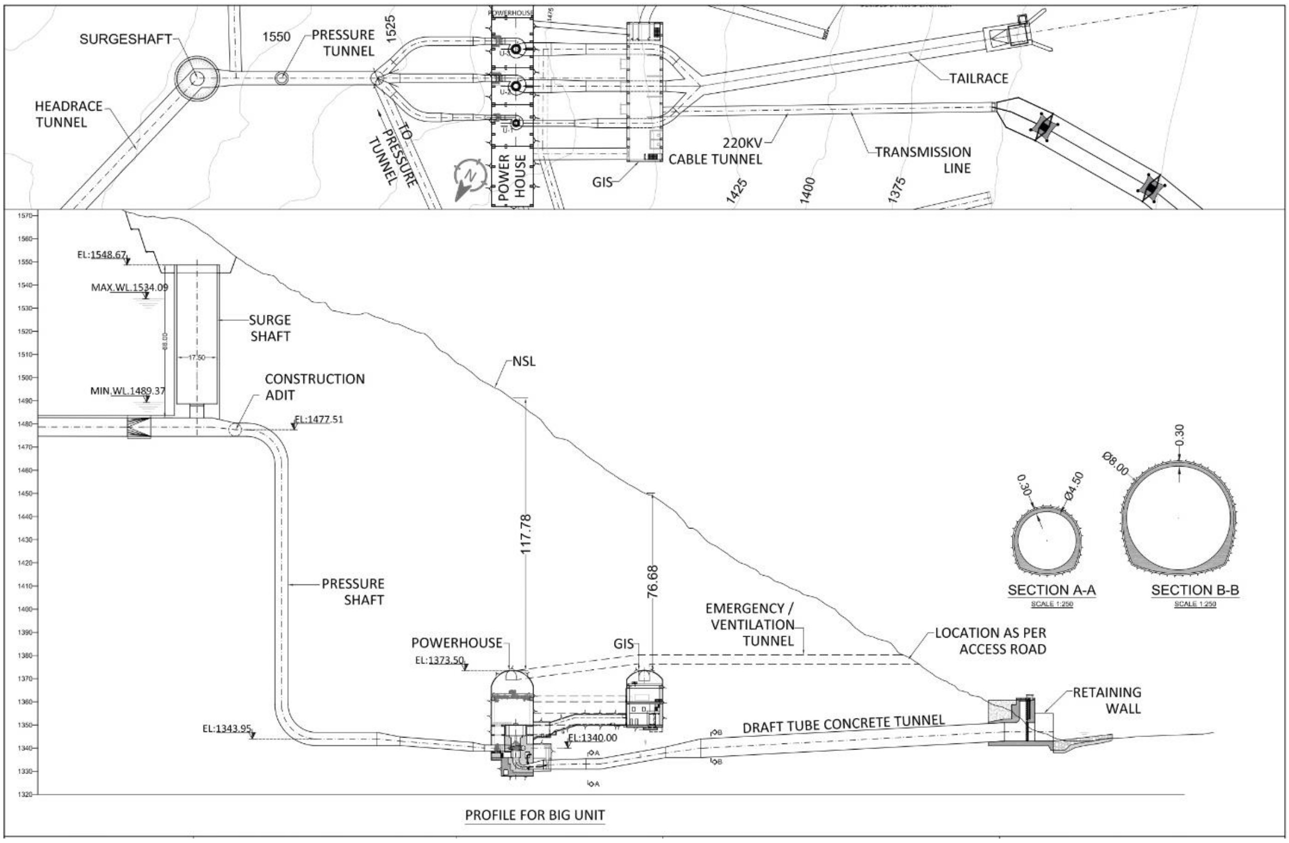


Figure 3-10: Surge to Powerhouse Plan

3.3.7 Pressure Shaft and High-Pressure Tunnel

From the surge tank, a vertical pressure shaft leads the flow to the elevation of the three Francis turbine units arranged in an underground powerhouse. Total length of the shaft and tunnel is 180 m. Length of the vertical shaft is 120.8 m. Diameter of the concrete lined section is 5.80 m and it has a flow velocity of 4.88 m/s. Meanwhile, the diameter of the steel lined section is 5.40m and it has a flow velocity of 5.99 m/s. 20-28 mm of steel lining is used in the shaft and tunnel structure.

3.3.8 Powerhouse

The proposed underground powerhouse is a conventional cavern structure for two big and one small Francis unit. Each of the big unit and one small unit have a rated capacity of 86.6 MW and 33.8MW respectively, the total installed capacity of three Francis turbines is 207 MW (2x86.6+1x33.8=207 MW). The maximum turbine design discharge is 64.0 m^3/s for big units and 25 m^3/s for small unit. After passing through the turbines, the water is discharged via the draft tube extending into the common tailrace tunnel and from there to the river.

The tentative dimensions of the powerhouse cavern are as L 95.5 m x W 18 m x H 44.25 m. The location and layout of the powerhouse is shown in **Figure** 3-11**.**

For access to the powerhouse cavern and further to the transformers cavern, a common access tunnel is provided with a width and height of ~ 5 m. Between the powerhouse and transformer caverns, the access tunnel is horizontal and inclined between the tunnel portal and the powerhouse cavern.

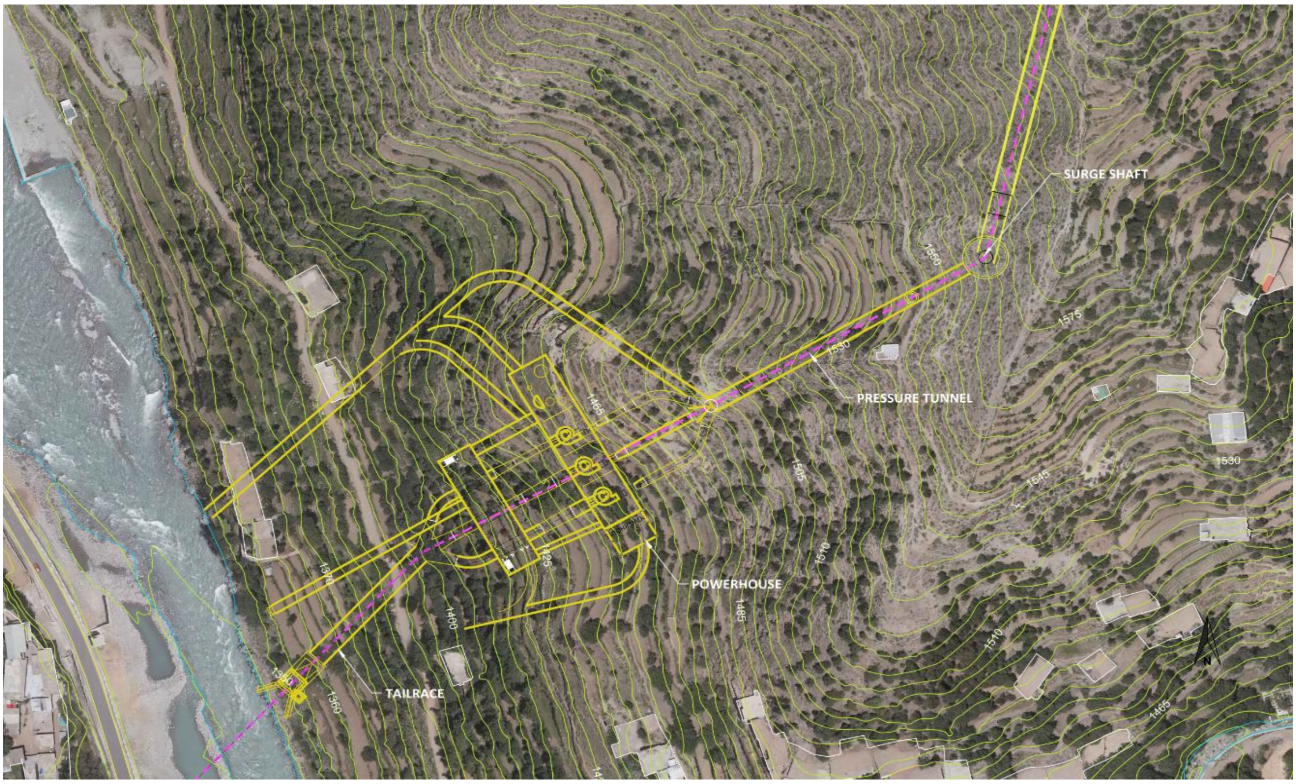


Figure 3-11: Powerhouse Layout

3.3.9 Tailrace

From the powerhouse cavern, a short tailrace tunnel releases the flow back to Swat River some 13 km downstream from the weir. The tailrace tunnel is arranged to convey the turbine discharge to the power outlet structure on the left bank of the Swat River. The dimensions of the draft tube and its rectangular exit cross-section are determined based on general turbine design principles for vertical Franci's turbine units. Each draft tube can be closed by a draft tube flap gate for maintenance or repair of a turbine unit. The three draft tube extensions join at the starting point of the tailrace tunnel. The concrete-lined draft tube extension tunnels have an equivalent diameter of 4.2 m to maintain the flow velocity at the draft tube exit. Similarly, the headrace tunnel diameter is selected for the design flow velocity of 3.04 m/s at rated conditions resulting in a tailrace tunnel diameter of 8 m. From its starting point to the portal of the outlet structure the length of the concrete lined tailrace tunnel is 128 m. The tailrace layout is presented in **Figure 3-12.**

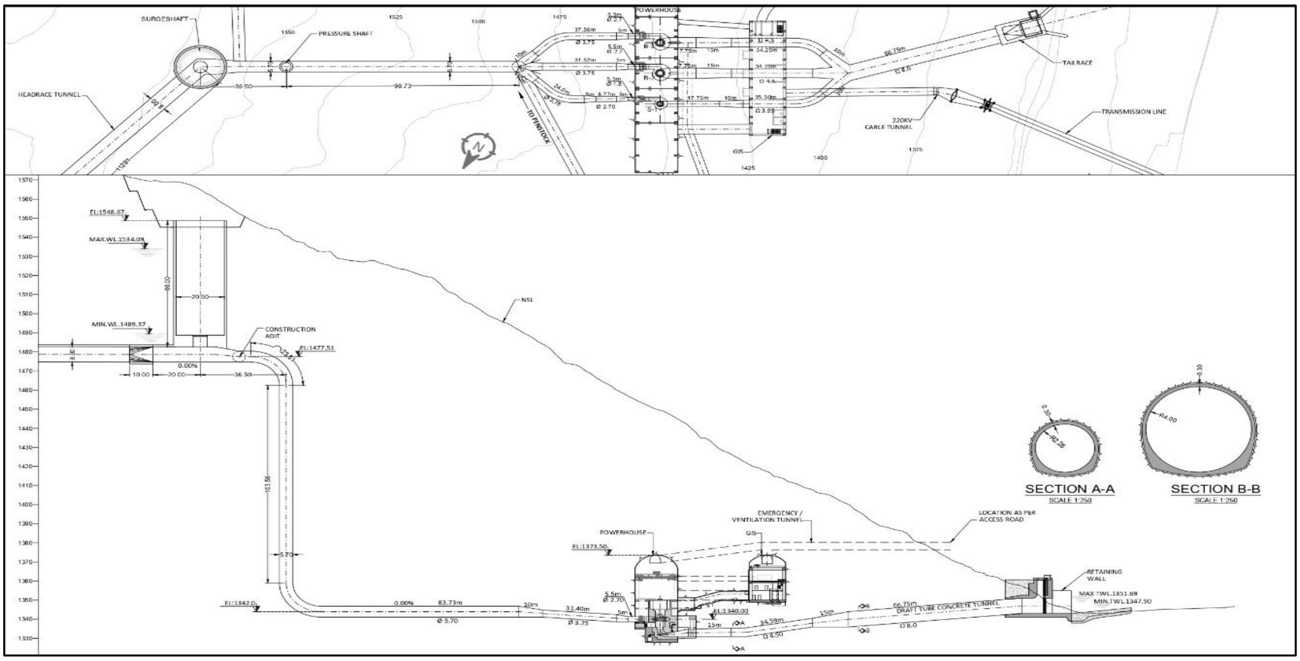


Figure 3-12: Tailrace Layout

3.3.10 Fish Ladder

A fish ladder will be built in the weir to allow the movement/migration of fish on both up and downstream. Fish ladder is proposed at low turbulence area, which is more suitable at right-side of the weir. Initial consultation has been completed with fisheries department by PIC and research has been undertaken to assess the requirements of eFlow for the snow trout. Additional consultation has been conducted on November 23, 2022 with fisheries department to share the design details of the fish ladder. They are satisfied with the proposed design specifications applicable for the indigenous species which require migration up and downstream.[19]

During the plant operation, a comprehensive monitoring regime will be implemented for the performance of fish ladder.

Design Parameters:

-Top Free Width (m) =1.5

-Flow Depth (m) = 0.5 to 1 (which is sufficient for fish movement through the fish ladder)

Channel Hydraulic Properties:

-Flow Quantity (m^3/s) =0.7 to 0.7596

-Channel Slope (No Unit) =0.0714

-Manning Roughness Coefficient (No Unit) =0.3

-Vetted Perimeter (m) =2.5 to 3.5

-Hydraulic Surface (m^2) =0.7 to 1.5

-Hydraulic Depth (m) =0.5 to 1

-Hydraulic Radius (m) =0.3 to 0.4286

-Flow Velocity (m/s) =0.5064 to 0.9

[19] The fish ladder at Gudu Barrage (https://sciknowpub.com/project-admin/books-file/Climate%20Change%20and%20Environmenal%20Effect%20on%20Production%20of%20Palla%20(Tenualosa%20ilisha)%20from%20Indus%20River.pdf), Taunsa Barrage, Kotri Barrage, Uri HPP on Jehlum River (Indian Kashmir) (https://inis.iaea.org/collection/NCLCollectionStore/_Public/28/042/28042061.pdf), and Amandara Headworks, are functional and successful, but there is no fish monitoring data available. At the Uri HPP in India (commissioned in 1997), some data is available from periodical observational monitoring and fish tagging surveys conducted in 1997,1998 and 1999 (https://cdn.sida.se/publications/files/sida47043en-uri-hydro-electric-project-india-evaluation-of-the-swedish-support.pdf).

Rectangular Section Geometrical Properties for stream with discharge of 3.5 cumecs:

-Top Free Width (m) =2.477

-Flow Depth (m) =0.8

*Channel Hydraulic Properties:

-Flow Quantity (m^3/s) =3.5

-Channel Slope (No Unit) =0.01

-Manning Roughness Coefficient (No Unit) =0.035

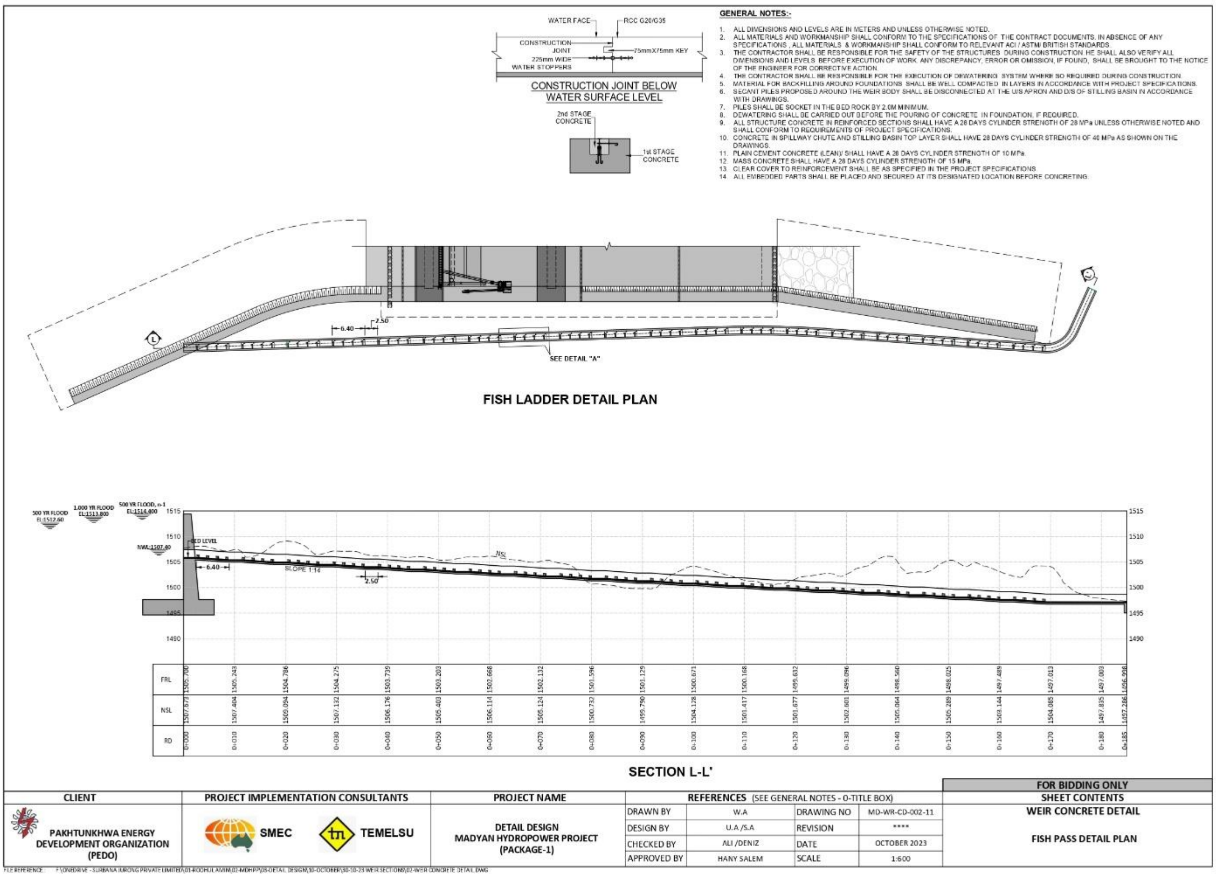
-Vetted Perimeter (m) =4.077

-Hydraulic Surface (m^2) =1.9816

-Hydraulic Depth (m) =0.8

-Hydraulic Radius (m) =0.486

-Flow Velocity (m/s) =1.7662



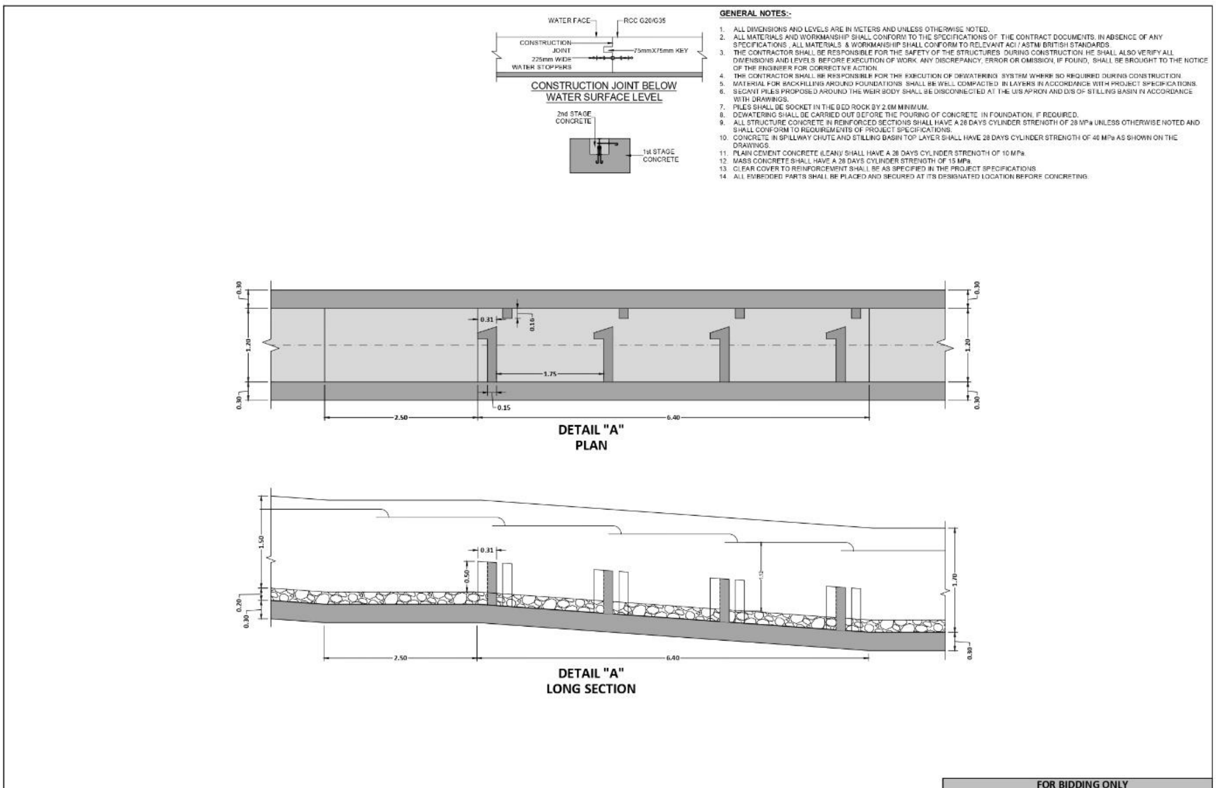


Figure 3-13: Fish Ladder Plan

3.3.11 Electromechanical Equipment

Generator

Three phase synchronous vertical shaft generators, self-ventilating, fully enclosed suitable for direct coupling to Francis's turbines shaft with maximum power output for big and small unit is 114.9 MVA and 45.4 MVA respectively

The generator will be connected to the three phases, by Non-Segregated Bus ducts (NSBD). All windings of stator and rotor will be copper and will be provided with a class F insulation system. As the long-term performance of the insulation system is affected by the maximum operating temperature of the windings, the rated output of the generators will be related to a temperature rise corresponding to class B insulation.

Considering the respective turbine power output, a typical generator efficiency of approx. 98.50% and at 0.8 power factor lagging and 0.9 power factor leading is considered.

Transformer

The main transformers, in three phase tanks, shall be core type, two winding, oil filled, Oil Forced and Water Forced (OFWF), installed in transformer cells within the transformer bay. The total number of main transformers shall be 3. The main transformer LV winding connection shall be by non-segregated bus ducts. The HV windings shall be connected by 220KV Gas insulated Bus duct from oil to SF6 gas high voltage bushing.

Two 115 MVA, one 46 MVA three phase, 220/ √ 3/13.8 kV, step-up Generator Transformer complete with all accessories, will be provided for transforming the generated voltage from 13.8 kV to 220 kV. The transformers will be located in transformer cavern at an elevation of 1350.0 m. The scope of work shall be a comprehensive functional system covering all supply and services

220 kV Gas Insulated switchgear system

The 220 kV GIS is arranged as in double bus single breaker system with a bus coupler circuit breaker. These buses include the following equipment:

- Two (2) 220kV GIS OHTL Bay connected to the outgoing 220KV transmission lines
- Three (3) 220 kV GIS Step-up Transformer Bay connected to the generator step-up transformers with gas insulated busducts (GIBs).
- One (1) 220kV GIS Bus Coupler Bay
- One (1) Measuring Bay.

Outdoor 220 kV Pothead yard and Transmission Line

The two outgoing 220kV transmission lines as shown on the main singe line diagrams and as specified in the 220KV GIS Switchyard. Following transmission line connections and ancillaries shall be provided under this:

- Six (06) single phase surge arrestors and associated surge counters connected to the 220KV outgoing lines.
- Six (06) wave traps on outgoing Transmission Lines.
- Six (06) set single phase capacitive voltage transformer in 220 KV outdoor pothead yard.
- Steel support structures and post insulators as required for mounting the above equipment.
- Steel line gantries suitable for terminating the outgoing transmission lines.
- OPGW termination enclosures on the line gantry for each transmission line.

Operation and Maintenance

During the operation of the hydropower scheme, there will be significant impacts resulting from the following:

- The long-term presence of some 300 professionally qualified operations and maintenance (O&M) staff from outside the local district.
- The potential additional local income from O&M jobs offered to the local workforce (mostly unskilled or low skilled) and from downstream businesses. The low level of skills presently available in the local community, if not improved, will limit the job opportunities to only unskilled candidates (laborer's, watchmen, messengers, cleaners and drivers.). However, the construction phase offers the local community the opportunity to expand their skills base to include carpentry, electrical installation, repair and maintenance, plumbing, car mechanics, bookkeeping, word processing, basic nursing, cooking and housekeeping.
- Flushing out accumulated sediment from the gates at the intake and in the weir will be opened from time to time as the need arises and sediments will be flushed into the river downstream of the weir. Other Permanent Facilities

3.3.12 Colony

Two colonies are proposed, one at weir site and the second one near the powerhouse (see **Figure** 3-14 and **Figure** 3-15). One of the colonies will be built for PEDO operation and maintenance (O&M) staff at the power house site and the other colony will be built at weir site. The colony will include residences for about 50 staff and facilities such as water supply and sanitation, roads, a primary school, a dispensary, a mosque, a park, a guest house, a community center, and shops.

Figure 3-14: Weir Site Colony Layout Plan

Figure 3-15: Powerhouse Colony Layout Plan

3.4 Construction Materials

Major construction materials required for the MHPP are cement and aggregates, reinforcement steel (including mesh/mattresses) for concrete, and shotcrete fabrication for all major structures including the lining of underground works. In addition, slope and riverbed protection works require the use of riprap, gabion mesh, and gabion fill material as well as geotextiles as a non-mineral filler. Surface boulder deposits available on the riverbed and river embankment on the pondage area of the weir will be used as aggregates. The estimated quantities of material are given in **Table 3-3.**

Table 3-3: Estimated Quantity of Required Construction Material

Item Description	Unit	Quantity
Plain Cement Concrete G-15	m^3	191
Concrete G-28 Stage-1	m^3	14,624
Concrete G-28 Stage-2	m^3	5,060
Steel Reinforcement	ton	44,322
Block Masonry	m^3	773
Plaster	m^2	16,827
Shotcrete	m^3	65,104
Concrete	m^3	337,751
Steel Ribs	ton	1,469
Concrete to Structures	m^3	79,185
Extra Transport crush stone	m^3/km	109,428
Grouting Open incl. cement	ton	1,534
Concrete for Piles	m^3	6,754

3.5 Construction Equipment

The estimated requirement for construction equipment is given in **Table** 3-4. In addition, about 40 to 60 trucks per day will be used by the Contractor for the supply of material during construction.

Table 3-4: Estimated Construction Equipment

Sl.	Type of Equipment	Quantity
1	Excavators	12
2	Tractors	5
3	Pavers	5
4	Dumpers	25
5	Batching Plants	2
6	Wheel loaders	4
7	Bulldozers	2
8	Rock Drill	10
9	Compressors	4
10	Diesel Generator	10
11	Water Sprinkler	2
12	Down-the-hole Drill	2
13	Fuel Truck	1
14	Crush Plant	1
15	Loaders	7

Sl.	Type of Equipment	Quantity
16	Graders	1
17	Compactors	5
18	Concrete Trucks	3
19	Concrete Cutting Machine	3
20	Cranes	2
21	Ambulance	1
22	Road Roller	2
23	Shotcrete Machines	2
24	Vibrators	4

3.6 Labor Requirement

About 400 workers, both skilled and unskilled, will be required throughout the construction period of five years. Out of which, about 200 will be outside workers (60 foreigners and another 140 will be from Pakistan but outside the project area), and about 200 laborers' will be recruited locally, mostly unskilled or semi-skilled labors. During the peak construction period, the requirement for local labor may increase up to 400. Contractor will assess and arrange medical requirements of his staff/workers and will incorporate in Contractor's Environmental and Social Management Plan (C-ESMP) accordingly.

3.7 Construction Camps

In principle, construction camps will be located away from the main settlements as well as closer to the major construction areas of the Project. Keeping this in view, one construction camp will be established near the weir site and one camp will be established near the powerhouse site. However, Contractor will decide a suitable location in consultation with PMO and approval from PIC. The camp near weir site is on the right bank of Swat River downstream of the confluence of Kedam village. The land available is about 3-4 acres between River Swat and main road N-95. There are just two structures adjacent to camp area which contractors may use (on rental basis) for their accommodation. The other potential area for the camp is near powerhouse, located on the left bank of Swat River downstream of the confluence of Madyan town at Damlai. There are no settlements in the area.

3.8 Spoil Disposal Sites

Overall, approximately 2.75 million m³ of excavated material will be generated from construction of weir, tunnel, powerhouse and other facilities, hence five locations close to weir site, adits and powerhouse are identified as disposal areas. The location of adits, dumping/spoil disposal areas are shown in **Figure 3-16.**

3.9 Access Road to Project Site

The best possible route from Peshawar to Madyan is through motorways M1 and M-16. This route starts from Peshawar, passes to the M1 motorway to Kernal Sher Khan interchange, then continues on the M-16 motorway, and then on N-95 along the Swat River towards the Madyan site. The approximate distance from Peshawar to the Madyan Hydropower Project site is 237 km.

Permanent Access Road to Powerhouse, Weir and Colonies

The Project falls in a terrain with high hills having steep slopes and narrow valleys in between. Though the weir and powerhouse sites lie close to the main N-95 road. As the proposed structures of the MHPP are on left bank of Swat River; therefore; the contractor will develop access road to connect the Project facilities to the main road on left bank. The contractor will construct a bridge on the river close to the powerhouse and from there the weir can be approached on existing shingle track. About 250 meters of this road will be located outside the Project site. The proposed road is shown in **Figure** 3-17.

Access to the powerhouse site, staff colony, dumping site (near powerhouse), and the corresponding camp shall be arranged preferably along an existing small road from Madyan town to Damlai village. After passing along with the newly built hotels and houses, the small road continues as a track for some 1200-1300m along the left bank of Swat River downstream to the powerhouse area. From there to the surge tank site, staff colonies, camp, and dumping site new access roads will be built.

Temporary Access Roads

The temporary shingle access roads are required to be provided by the contractor for the construction of project structures at weir and powerhouse and these roads play a vital role in the completion of the project.

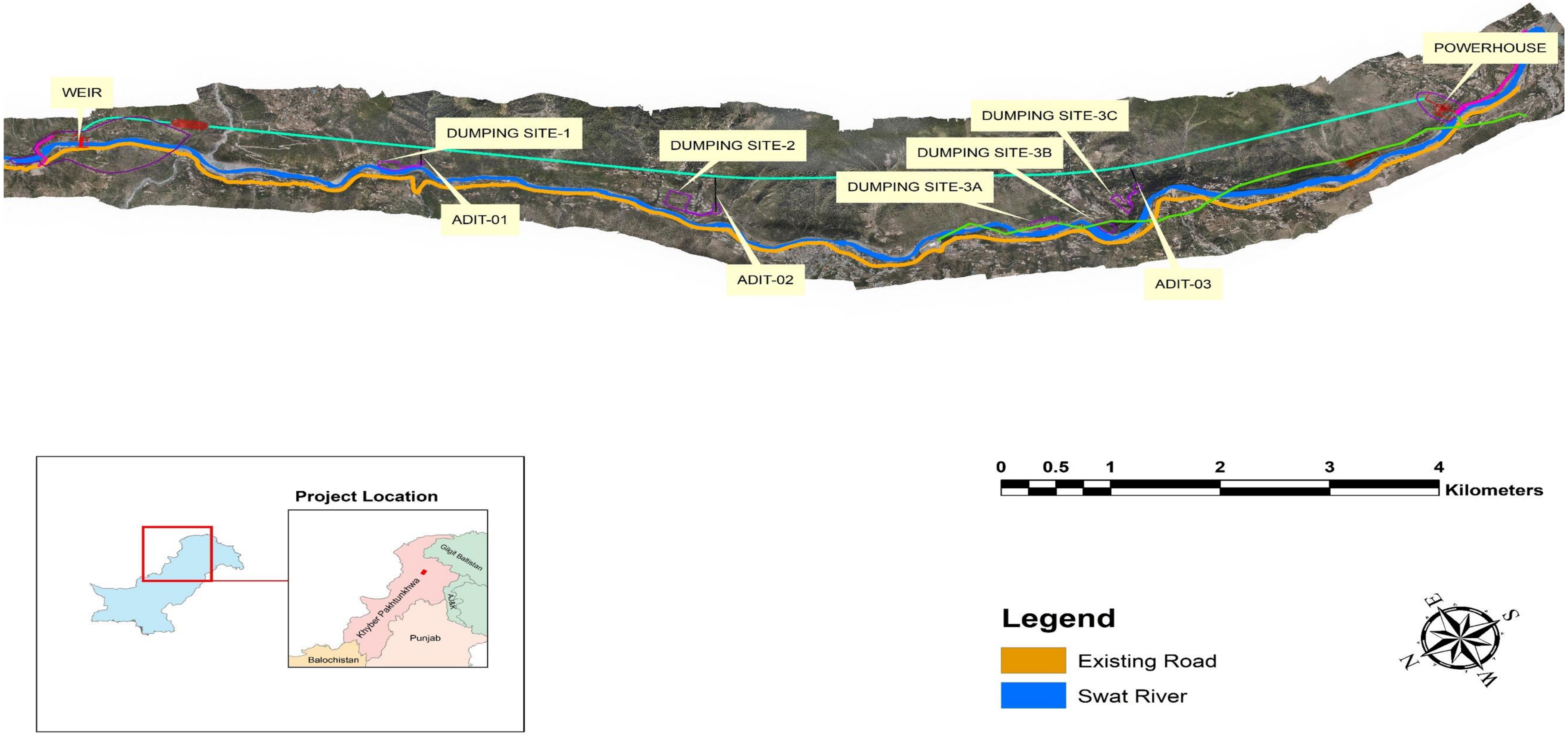


Figure 3-16: Spoils Dumping Sites for Excavated Materials

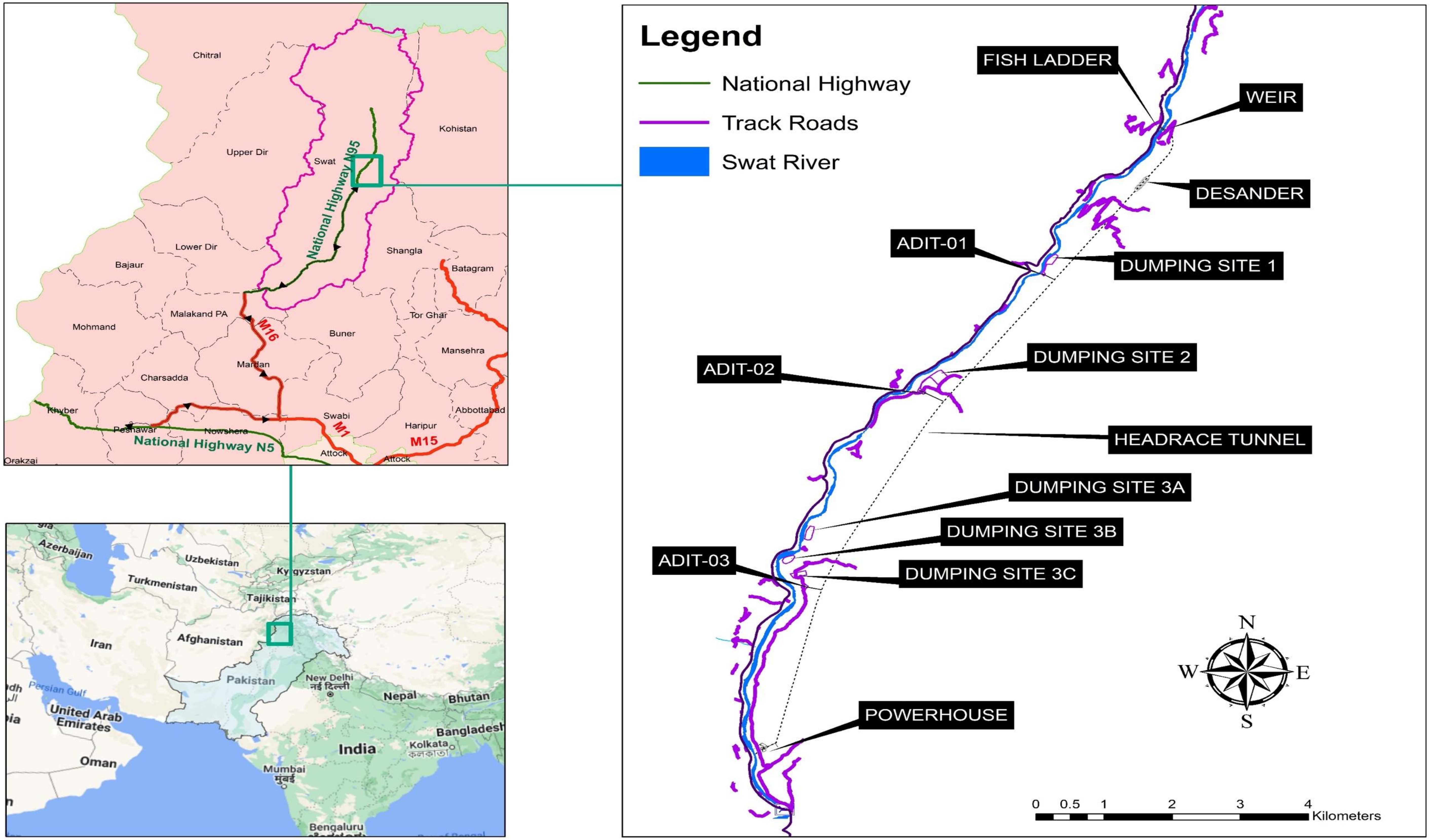


Figure 3-17: Access Road to Project Sites

3.10 Project Implementation Schedule

The implementation schedule **Figure 3-18** covers the whole period of the project implementation after the feasibility study. Main implementation phases are:

- Tender design sufficient for the purposes of international competitive bidding;
- Tendering and award of contract(s);
- Financial close;
- Mobilization and establishment of site infrastructure;
- Manufacturing and supply;
- Construction of the project, including execution of all civil works;
- Installation of electro-mechanical equipment and hydraulic steel structures;
- Commissioning and testing; and
- Defects liability period.

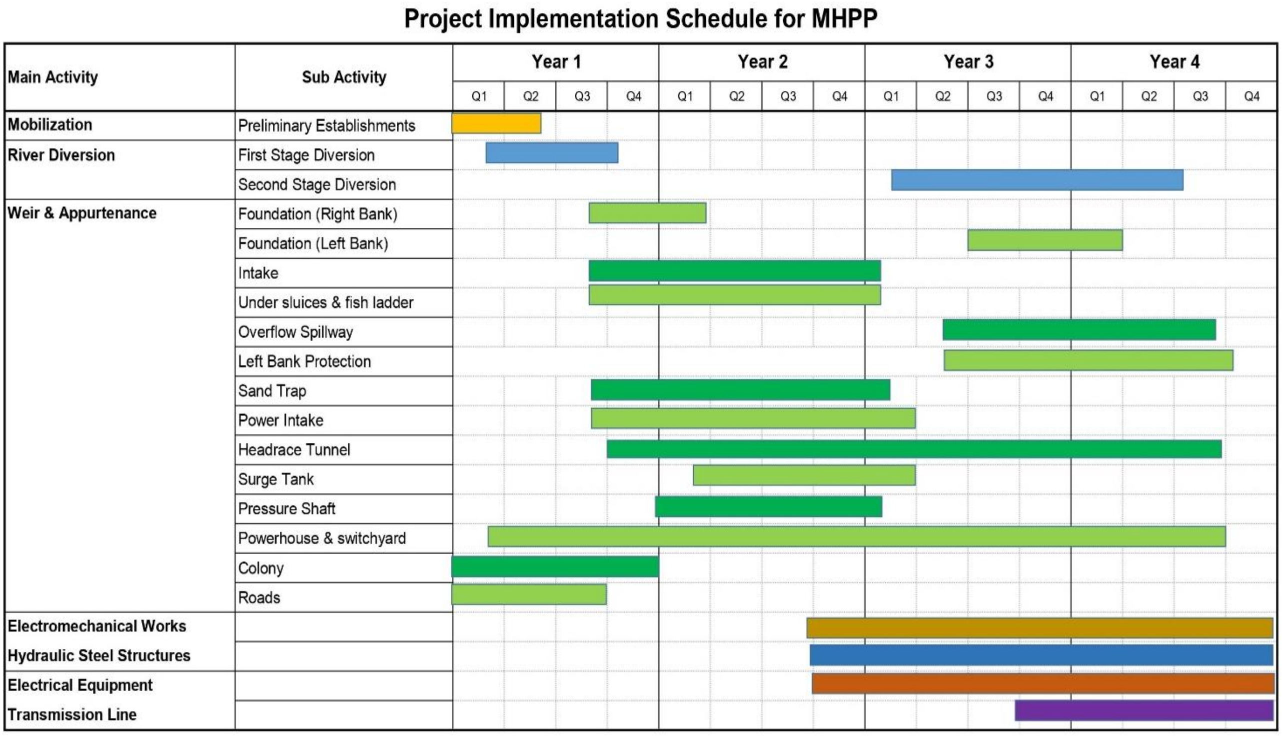


Figure 3-18: Project Implementation Schedule

3.11 O&M Activities/Operation Regime

The project is a run-of-river scheme depending on the direct flows of the river and no provision of peaking is considered due to its impacts on the downstream utilization of water, making sure necessary eFlows are maintained all around the year. The O&M activities mainly include the following:

- Weir operations including power intake.
- Sand trap flushing operation/monitoring.
- Powerhouse operation.
- Water discharges at tailrace.
- maintenance/operations of turbines/generators / power transformers / power controls / Supervisory Control and Data Acquisition (SCADA)/Geographical Information System (GIS).
- Monitoring of generated power and its evacuation to the national grid.
- Records maintenance of shutdowns.
- maintenance of housing quarters/offices.
- reporting to the PEDO management on all the issues and production.

4 Analysis of Alternatives

This chapter presents the analysis of various alternatives considered during the planning and design stages of the project and provides a comparative evaluation of their respective construction, cost, environmental and social impacts.

The first section includes an analysis of the no project option compared with the Project, followed by an analysis of alternative for headrace tunnel alignment, powerhouse type, number and size of turbine units, project infrastructure siting, and alternative for de-sanding facilities. The analysis of alternatives is conducted using the following criteria: constructability, cost, environmental and social impacts.

4.1 The Without Project Option

4.1.1 Background

Pakistan is suffering from an acute power and energy crisis, which is primarily caused by the increasing gap between the supply and the demand for electricity. The installed electric power generation capacity of Pakistan as of June 30, 2022 remained 43,775 MW, which includes 40,813-megawatt (MW) in Central Power Purchasing Agency (CPPA-G) System and 2,962 MW in K-Electric (KE) System. Similarly, the dependable capacity of Pakistan remained 40,532 MW which included 37,858 MW in Central Power Purchasing Agency (CPPA-G) System and 2,674 MW in KE System[20]. During financial year (FY) 2021-22, a peak demand of 28,253 MW was witnessed in the system during the month of June 2022 while in the winter season, the peak demand of the country came down to 15,962 MW during the month of December, 2021. Higher installed capacity as compared to demand in the system is certainly increasing the consumer end tariff owing to 'Take or Pay' and 'Must Run' compulsions. Pakistan's power needs are increasing with an estimated growth rate of 5.6 % during 2023 to 2027 (according to national electric and power regulatory authority (NEPRA), and the expected demand will be 32,276 MW by 2026-2027.

Hydropower production as a percent of total energy production declined from about 64 percent in the period 1970-1980 to about 24.3 percent in 2021-22, despite the huge hydropower potential in the country. Since the nineties, the power system in the country has steadily relied more and more upon thermal energy. In 2021-22, the total installed generation capacity of the country comprised of 26, 683 MW thermal (generation companies (GENCOs), independent power producers (IPPs), SPPs/CPPs, and Karachi Electric (KE), 10.635 MW hydroelectric, 1,838 MW wind, 630 MW solar, 369 MW bagasse, and 3,620 MW nuclear.[21] So, in 2021-22, about 60.95 percent of the total installed power capacity originated from fossil power plants, about 24.3 percent from hydropower production, and the remaining from other renewable and nuclear sources. The greater reliance on thermal sources also resulted in increasing dependency on imported fuel (oil, gas, and coal). As much as 85 percent of oil and allied products are imported. The imports result in the high cost of power production and these high imports require USD 4 billion in foreign currency in fuel payment for power generation.

4.1.2 Case of "Without Project Alternative"

In Pakistan, the total installed power generation in 2022 is 41,557 MW. The share of renewable energy including hydropower is 24.7%., wind is 4.8%, solar is 1.4% and biogas is 0.9%. The maximum total demand coming from residential and industrial estates stands at nearly 31,000 MW, whereas the transmission and distribution capacity is stalled at approximately 22,000 MW. Presently, the electricity deficit his leads to a deficit of about 9,000 MW when the demand peaks. Lack of access to electricity and power shortages result in long hours of load shedding, impacting households, industrial and commercial activities. About 68 percent of the total installed power capacity in the country originated from fossil power plants. The "without project" alternative is not realistic, because Pakistan will have to build additional renewable generating sources to eliminate power shortages, and reduce reliance on imported fuel. Given the increasingly high costs of fuel, oil-based electricity generation has become very expensive. The Project will help reducing Pakistan's Circular Debt (CD) by lowering the cost of electricity generation through the development of renewable energy solutions. The development of Pakistan's hydropower resources at a variety of scales represents the only reasonable prospect of eliminating these shortages. The above-mentioned negative effects of short supply and high demand for electricity in the country confirm that the gross annual average energy of 805.78 GWh net electricity generation is genuinely needed and will be easily absorbed in the National Grid to help ease the load-shedding up to some extent.

Keeping in view the above greenhouse gases (GHGs) emission by type of power plant technology, the hydropower generation system is more climate friendly as compared to other power generation systems. Hydropower will account for 16% of global electricity demand by 2023, according to the IEA, and so the sector plays a vital role in the implementation of the Paris Agreement. **Table 4-1** shows the comparison of GHG emissions.

Table 4-1: Comparison of GHGs Emission per 01 MW Power Generation by Type of Power Plant

Coal Fired PP	Solar Power Plant	Hydropower Plant	Wind Energy Power Plant	Geothermal Energy Power Plant
2,180 pounds CO2 per MWh[20]	No reliable data available	52.91 pounds per MWh[21]	No reliable data available	268.96 pounds per MWh[22]

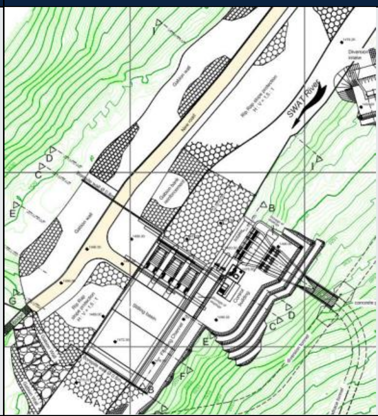
4.2 Analysis of Alternatives in Project Design

Various alternatives for project components are considered for comparative analysis using different criteria, which are presented in the sections below.

4.2.1 Alternative Weir Locations

For the maintenance of sustained water for the turbines, diversion of part of the river flow for power generation using a concrete weir (above riverbed) is required at Kedam village. In the central part of the weir structure a spillway with penstock will be arranged discharging into a stilling basin where the excess hydraulic energy is dissipated. At the weir structure, under sluices will be provided to evacuate sediments that may deposit in front of the power intake arranged on the side of the weir. **Table** 4-2 presents a comparison and analysis of two alternative weir locations based on the criteria discussed earlier.

Table 4-2: Alternative locations of weir

Parameter	Initial Proposed Weir Site	Final Weir Site
View of structure		
Description	The proposed weir site of the Madyan HPP is located on the Swat River some 14 km north of Madyan town and the powerhouse just 1.2 km upstream where the approximately 35 km long V-shaped gorge section of the Swat River ends and continues further as a river with wide flood plains.	A new location is proposed where the river valley offers a wider cross section, which is about 917 m upstream of the 2009 FS proposed weir axis.

NEPRA (2022), State of Industry Report, 2022, National Electric Power Regulatory Authority, Islamabad.
[20] U.S. Environmental Protection Agency. 2018 findings reflected in "Greenhouse Gas Reporting Program Industrial Profile: Power Plants Sector September 2019" available on chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.epa.gov/sites/default/files/2020-12/documents/power_plants_2017_industrial_profile_updated_2020.pdf.

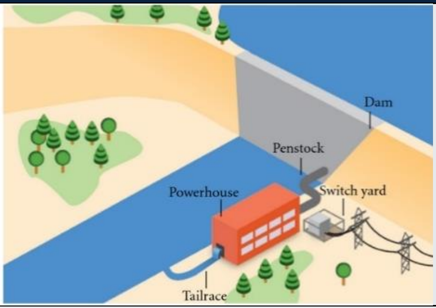
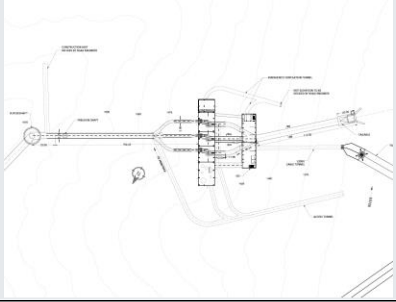
Parameter	Initial Proposed Weir Site	Final Weir Site
River Flow Rate	The mean annual river flow of Swat River is 118.5 m³/s at the selected weir site. River flow varies considerable around the year with a high flow (May to September) and low flow period (December to March). In an average hydrological year such as the year 1995, daily river flow varies between 18.5 and 447.6 m³/s.	Mean monthly flow between 1961-2010 at the weir site is estimated at 107 m³/s. River flow varies considerable around the year with a high flow between 98.22 to 313.75 m³/s (during May to September) and low flow period between 16.81 to 20.97 m³/s (during December to March). An average daily river flow varies between 4.64 and 447.84 m³/s by considering both 2010 and 2022 floods.
Peak Flood	2009 FS estimated peak flood as 744 m³/s at weir and 890 m³/s at powerhouse locations for 25 years return period.	2022 PIC Concept study estimated 1,776 m³/s at weir and 2,131.2 m³/s at powerhouse locations for 20 years return period
Constructability		
Unique factors	A 2022 geological investigation conducted by PIC shows that the left abutment of the weir axis consists of exposed Gabbro Norite. In contrast, the right abutment consists of overburden material, including alluvial and moraine deposits. The thickness of alluvium layer at the weir site in the riverbed is about 30m. The foundation of the weir and the intake structures will not be a major problem; however, given that part of the weir structure will be founded on rock and part of it on alluvium or at least leaving some of the alluvium in place, the design of the weir will require foundation treatment for the weir stability and control water seepage.	The proposed shifted location is favored by a steep slope on the right bank of the river where rock is encountered very close to the surface and by a slope on the left bank where the rock is only a few meters below the surface.
Swat River Width at the proposed weir location	Narrower, may be different to accommodate all associated structures.	Wider and will be able to accommodate all associated structures (e.g., spillway, stilling basin) effectively.
Impact of Kedam Nullah	This location is impacted by backwater from Kedam Nullah as it is too close to the stilling basin and spillway structures in the riverbed.	The physical constrains are removed by relocating the weir at 917 m upstream.
Height of weir	According to 2009 FS, a concrete weir of 19 m height (above riverbed) is considered	Swat Riverbed in the reach upstream of the original weir is 12.70 m higher than it was in 2007 and may be even higher after the August 2022 flood. A 16.1 m high diversion arrangement including 1.5m ogee shaped weir has been considered in the design.
Weir Crest	Based on 2009 FS the weir crest is estimated as 65 m length.	2022 study's 2D HEC-RAS modelling shows significantly higher tailwater levels along the river which necessitate a longer weir crest to overcome the downstream drowning effect of the dissipater structure and to provide adequate capacity to pass the increased flood flows.
Spillway	The Headwork's weir axis considered in 2009 FS does not seem to be positioned at the optimum location in terms of river width with regards to its adequacy to accommodate the spillway bays for passing the significantly increased floods.	Spillway location is better optimized against flood at the relocated weir in upstream.

Parameter	Initial Proposed Weir Site	Final Weir Site
Stilling basin	The 2009 stilling basin location would experience turbulence at the tailwater caused by the outflow from the tributary (Kedam Naullah) joining the main river at the downstream river junction.	The proposed weir location will allow for a longer stilling basin and more gates, which will help mitigate the higher flood levels.
Cost	Slightly cheaper construction cost due to narrow gorges. Based on 2009 FS the estimated cost for the concrete weir was US$13 million.	Slightly higher cost for wider river width and longer crest.
Environmental Impacts		
Flood	The recent flood flows of 2010 and 2022 would have a notable implication on the headworks layout and structure sizes proposed in 2009 FS.	The revised estimated flood level using rainfall-runoff modelling provides superior allowance of flood and corresponding design of weir parameters to withstand major flood in Swat River.
Hazard mitigation requirements	2009 FS grossly underestimated the peak flood flow for 25 and 10,000 years return periods. 2009 FS estimated design flood flow as 1,312 m^3/s for 10,000 years return period, whereas, observed flood flow on Khwazakhela bridge (downstream of Madyan HPP) was 6,977 m^3/s on August 26, 2022.	The weir structure will be designed to withstand major floods up to a return period of 10,000 years (considering 2010 and 2022 flood levels) using the flood flow data of Swat River at Kalam and the design earthquake without major damages. PIC estimated design flood for 10,000 years return period is 6,300 m^3/s at weir.
Impact on rock layers	In order to accommodate design flood flow, a taller weir height will be required. This would have higher bearing loads acting on the alluvial foundation, which might require special measures to improve the bearing capacity of the foundation. This would have additional impact.	On the other hand, the proposed relocated weir location is favored by a steep slope on the right bank in which rock is encountered very close to the surface and by a slope on the left bank where the rock is only a few meters below the surface. Therefore, no requirement for special measures or treatment.
Noise	Shorter construction noise due to smaller structure	Slightly higher noise for a longer construction period due to larger structure in a wider gorge
Disturbance to flora and fauna	During the construction of cofferdams both in up and downstream of the weir, river water will be diverted. Portion of the river will be dried up to initiate the construction of the weir, which will have impact on the aquatic ecology.	The proposed weir will be located in a wider section of the river and hence slightly larger aquatic habitat might be disturbed.
Social impact	Due to the smaller weir axis, less land might be affected	For a longer and larger foundation, higher quantity of land might be required.

4.2.2 Selection of Powerhouse Location and Type

Powerhouse accommodates turbines. The headrace tunnel starts at the power intake and has a length of 11.18 km. Three adits are considered to ensure tunnel construction within a reasonable period. At the downstream end of the low-pressure headrace tunnel a surge tank is arranged to limit pressure rise in the headrace tunnel and ensure the required flexibility of the hydropower plant in operation. A vertical pressure shaft leads the flow to the elevation of the three Francis turbine units arranged in an underground powerhouse. The steel lined pressure tunnel and manifolds are kept short to achieve an economic design. Transformer and Switchyard are arranged underground as well in a cavern parallel and at 30 m distance from the powerhouse cavern. From the powerhouse cavern a short tailrace tunnel releases the flow back to Swat River. **Table 4-3** presents various options for powerhouse.

Table 4-3: Options for Powerhouse.

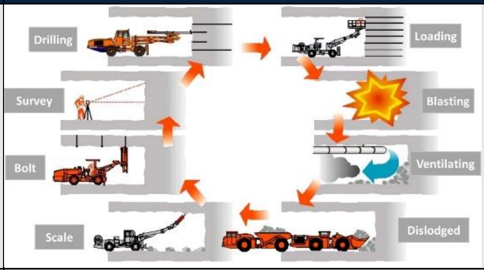
Parameters	Free Surface Powerhouse	Underground Powerhouse
View of structure		
Description	Powerhouse that's located on the surface, usually located at the dam toe, where water is conveyed through the dam/weir by means of penstock or at the far downstream area to take advantage of a steep gradient of the river between the dam and the tailrace.	An underground power station is a type of hydroelectric power station constructed by excavating the major components (e.g., machine hall, penstocks, and tailrace) from rock, rather than the more common surface-based construction methods. Cavern powerhouse is fully underground. A shaft powerhouse combines the advantages of an open air and under-ground powerhouse. Vertical shafts are excavated and concrete lined to accommodate the E&M electro-mechanical and electrical equipment.
Threats to the structure	There are potential for bomb attacks, rock and earth slips or snow avalanches, earthquakes, and vandalism for a free-surface powerhouse.	There are potential of earthquake effects and cave-ins for an underground powerhouse.
Constructability		
Unique factors	Depends on availability of space and stable slopes	Depends largely on the prevailing geological conditions.
Area requirement	Requires enough space along the river and associated land acquisition therefore not suitable for narrow river valley.	Greater flexibility when it comes to choosing where to place it.
Cost		
Capital cost	Generally lower, however, can be elevated by the requirements of steel lining for the horizontal high-pressure tunnel.	The length of the high-pressure tunnel can be kept short and instead a more economic (concrete lined) tailrace tunnel can be arranged. For the MHPP, the design concept with underground powerhouses requires slightly higher investment costs compared to the concept with a free-surface powerhouse, however, the difference is marginal. The additional costs for the underground powerhouse and the required access and cable tunnel are almost compensated by the savings in the steel lining for the

Parameters	Free Surface Powerhouse	Underground Powerhouse
		horizontal high-pressure tunnel for an open-surface powerhouse.
Supporting cost	Lower operating cost in terms of lighting and special ventilation. However, it will require additional maintenance for damages from weathering and natural events such as rain, wind and floods.	Higher due to requirements of increased lighting, special ventilation and air conditioning for the operation and control rooms.
Output	Due to the sitting of the free-surface powerhouse, design may have to compromise with the heads.	They allow greater operating heads and thus improves power output and efficiency.
Environmental Impacts		
Spoil generated	Less spoils generated due to surface construction.	More spoils generated as deep excavation is required in underground.
Dust	Less overall quantity of dust but construction is above-ground and will cause greater dispersal of particles may cause nuisance to the communities' close proximity of the site.	More dust generated but it will be underground and proper excavation can minimize the dust exposures to workforces.
Noise	High noise exposure and noise will travel longer distance due to the open-air construction.	Construction noise will be intercepted by the rock layers; thus, less noise will escape but there will be additional noise during excavation. All noise will be concentrated inside the work area due to limited dispersal. This means the workers will require greater noise protection.
Disturbance to flora and fauna	River valleys are usually fertile areas and an aboveground structure will need to take up parts of this ecologically valuable land.	Less damaging to the flora and fauna as long as the soil layers are not greatly disturbed and structural integrity of the area is maintained.
Impact on rock layers	Not intrusive and therefore impact is low	The penstock and surge tanks may be placed into rock since the excavation is in the hard rock.
Social Impact	Construction of free-surface Powerhouse will involve cutting of 5-6 types of orchard trees and 3.38 acres of land acquisition which will not be required in case of underground powerhouse.	Less quantity of trees will be felt and land requirement will be much lower. So underground powerhouse is socially more feasible compared to free-surface Powerhouse.
Selected alternative	The powerhouse will be located on the left bank of Swat River some 1.2 km upstream of Madyan town. Its outlet structure will be some 100 m upstream of the confluence of Kalaga Nullah with Swat River. The powerhouse will be constructed in an underground cavern, about 95.5 m long, 18 m wide and 44.25 m high. The total overburden above the powerhouse cavern will be about 100 m.	

4.2.3 Alternative Headrace Tunnel Constructions

The 2009 FS Consultant investigated alternative construction methods for tunneling works with the application of a Tunnel Boring Machine (TBM) and conventional drill and blast method. The headrace tunnel starts at the power intake and has a length of 11.18 km. **Table** 4-4 presents various options for headrace tunnel construction.

Table 4-4: Alternatives for headrace tunnel

Parameter	TBM	Conventional Drill and Blast
View of structure		
Description	The tunnels are bored using Tunnel Boring Machines (TBM). This method is often used for excavating long tunnels. TBM creates a circular tunnel by cutting and/or abrading the heading to full size in one operation.	This method uses explosives. Drilling rigs are used to drill blast holes on the proposed tunnel surface and explosives and timed detonators are placed in the blast holes. Following the blasting, the waste rocks and soils are transported out before further blasting. Adequate structural support measures are required for the tunnels. This is done using shotcrete, mesh, and concrete.
Tunnel alignment	A tunnel excavated by a TBM would have as much as possible a straight alignment aiming on the shortest possible tunnel length	Excavating the same tunnel by conventional drill and blast method requires a number of constructions adits to work in parallel at different tunnel reaches.
Constructability		
Unique factors	To construct an approximately 12 km long headrace tunnel with an excavated tunnel diameter of 7.0 to 8.0 m, the overall weight of a such a TBM would be in the order of 600 to 700 t. Majority of the components can be assembled on site but the shield would need to be transported. The heaviest and largest single piece that would require transport would be around 3.6m in width/height and 60-70 tons in weight.	In order to achieve a reasonable construction time by conventional drill and blast method, a total number of 4 tunnel reaches with a maximum length of 3.6 km is required to be constructed in parallel
Transportability	In 2009 FS, few bottlenecks were identified for transport of heavy and bulky equipment on the existing road network, due to their maximum clear width of 3.5 m and estimated carrying capacity not exceeding 30 tons.	There is no uniquely heavy equipment involved. The current infrastructure is adequate for transport construction equipment and machinery.
Area required for setup	At least 100 m of land, preferred would be 150 m. This means a modified starting point (at elevation approximately 1450 m) needs to be selected to achieve the required space for setting up the TBM.	No additional setup restrictions
Total Headrace Tunnel Length	11,893 m (single tunnel)	11,178m (tunnel with four reaches)
Total Adit Length	201 m (one adit)	1,060 m (three adits)
Operability	Primarily by TBM operators.	Requires unique skill sets and certification for blaster and jumbo jet operators.

Parameter	TBM	Conventional Drill and Blast
Progress speed	Generally, TBM excavation rate is 15-50 meters a day. 23 For the project area geology, in hard rock the average progress is estimated to be on average in the order of 15 - 20 m per day.	Generally, in drilling and blasting (D&B) excavation rate is 3-9 meters a day.23
Support requirements	Requires less structural support	Requires adequate structural support for ground stability in the tunnel
Flexibility	Inflexibility with regards to changes in diameter and small radius curves and challenging vertical and horizontal alignments.	Highly flexible and adaptable but requires careful planning of optimum selection of tunneling alternatives.
Environmental Impacts		
Spoil generated	About 615,989m³ of rocky material will be generated for the headrace tunnel boring and disposal of these materials will be necessary.	About 920,261.50 m³ of excavated material will be generated and disposal management of the spoils in terms of large disposal areas will be necessary.
Dust	Dust emission from excavation, storage of spoils, and transportation of spoils and machinery. There will be less dust generated as the force exerted is more uniform.	Dust emission from excavation, storage of spoils, and transportation of spoils and machinery. There will be more dust generated compared to TBM as the force of the blasts will cause larger volume of airborne particles.
Noise	Low noise and vibration but longer period	Blasting would significantly increase the noise in confined space, though the vibration level would be higher compared with TBM.
Cave-ins	Lower risk as there is higher tunnel stability (except in very poor rocks).	Comparatively higher risk of cave-in due to the unseen ground failure due to blasting.
Explosive handling	No explosives involved	Potential hazard associated with establishment of a temporary magazine site for overnight storage, transportation and handling and use of explosive and detonators.
Ventilation costs	Lower due to the typical time usage factor of a boring machine is 30%-50%. The remaining time is required, among others, for its displacement, material supply and maintenance. Taking into account these periods of inactivity, the necessary tunnel air cooling power may be reduced proportionally. The ventilation system design basis is thus significantly reduced due to the inactivity. This approach is justified by the thermal inertia of the rock, which releases the absorbed heat rather slowly.	Comparatively higher ventilation cost, as the natural air flow will be low and dust generation will be higher.
Disturbance to soil layer	Capable of boring without causing significant disturbance to the surrounding soil layers.	Cause significant disturbance in the adjacent soil layer and hence ground support is mandatory prior to further the construction
Social Impact	Can operate both in populated or unpopulated area without causing major disturbance. Suitable for the construction of	Typically, unpopulated or in populated areas with restrictions of public and traffic movement.

[23] Putzmeister. (2018, April 18). Excavation methods: Let's compare TBM and Drill & Blast. Putzmeister. Retrieved November 7, 2022, from https://bestsupportunderground.com/tbm-drill-and-blast/?lang=en

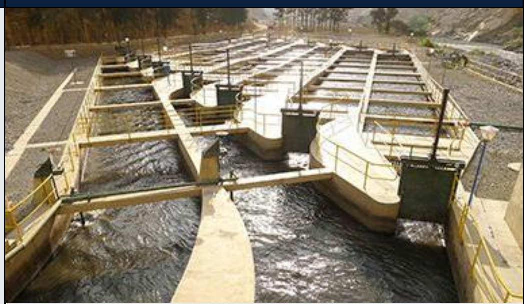
Parameter	TBM	Conventional Drill and Blast
	tunnels in high traffic areas and urbanized areas.[24]	
Selected alternative	Headrace tunnel alignment was selected for conventional drill and blast excavation method nearly parallel to the Swat River. The assessment of the conditions for the access to the project site revealed that transport of TBM equipment on the existing road network is not feasible. For this reason and in view of the higher cost per meter of tunnel construction by TBM, the Consultant decided to proceed with the feasibility design of the Madyan HPP based on the concept of excavating the headrace tunnel by conventional drill and blast method.	

4.2.4 Hydraulic Design of De-sanding Facilities

During the high flow season, the Swat River has the potential to transport large quantities of sediments in suspension as well as bed load. According to 2009 FS, sediment concentrations of up to 10,000 ppm have been recorded in Swat River. From the petrographic analysis of rock and sand samples it can be assumed that quartz minerals may make up to 10 % of the suspended sediments.

The proposed design of the weir structure and the flushing outlets ensures that coarse sediments (sand, gravel and cobble) can be prevented from entering the power intake and will be flushed through the sediment sluice. Sand and silt fraction will remain largely in suspension in the upstream pondage area of the Madyan Hydropower Plant and unavoidably enter the power intake. Desanding facilities are, therefore, required to remove most of the sediment particles larger than the design particle diameter of 0.2 mm. **Table** 4-5 presents various alternatives considering for desanding facilities.

Table 4-5: Alternative options for desanding facilities

Parameter	Aboveground Desander (FS2009)	Underground Desander (FS2022)
Typical View of structure/ location		
Description	Aboveground desander are a long and narrow above-ground sand catchment channel that runs along the preflood basin and rinses in the same direction as the main flow	Underground desander are below-ground in excavated rock caverns with rinsing against the direction of the water catchment, considered at the detailed design phase at the proposed relocated weir site, which is 2500m upstream of the location proposed in 2009 Feasibility Study.
Constructability		
Unique factors	Requires adequate space and slope stability. The topographical and geological conditions make the arrangement of above-ground desanding basins impossible, due to the narrow valley and steep valley slopes. The proximity of spillway crest elevation to the power intake elevation can cause large volumes of coarse materials to enter the power intake and desander settling chambers creating severe problems for sediment flushing from the desander.	Geological requirements must be met for site selection. For the design discharge of 153 m^3/s, the minimum number of desander caverns (basins) is considered two to avoid excessive large caverns which otherwise may exceed the cross-section of the powerhouse cavern.

[24] Dream Civil. (2020, 8 Apr). Tunnel Boring Machine: 2 Types of Tunnel Boring Machine: Advantages & Disadvantages of Tunnel Boring Machine. Hard Rock & Soft Ground TBM." Dream Civil: Civil Engineering & Construction Information. Retrieved from https://dreamcivil.com/tunnel-boring-machine/.

Parameter	Aboveground Desander (FS2009)	Underground Desander (FS2022)
Area requirement	Requires adequate space and slope stability, therefore not suitable for narrow valley and steep valley slopes, no space is available for arranging desanding facilities along with spillways.	More flexibility in placement due to more space underground. For MHPP, the optimum location of the desander caverns was found some 910 m downstream, which is upstream of Ashkon Nullah.
Cost	Cost of aboveground desander might be cheaper due to less drilling, blasting, and mucking operation.	Underground desanding cavern construction will be higher than the surface desanders. Some of the spoil generated during underground blasting operation can be recycled for construction purpose, hence reduce the cost of construction.
Environmental Impacts		
Spoil generated	Less quantity of spoil will be generated. Due to coarse sediment accumulation within the reservoir and close to the weir body, the entrance channel of flushing outlets would be disturbed by the large particle size of deposited materials moving from the reservoir to the flushing entrance channel during the outlet operation.	Higher quantity of spoil will be generated and the requirements of spoil disposal location will be required. Some of the spoil can be recycled for construction purpose.
Dust and Noise	Higher dust and noise generation due to aboveground construction. Noise generated from explosive blasting will be higher	Less ambient noise due to blasting in confined space. Dust concentration will be higher to due limited space.
Disturbance to flora and fauna	Significant impact on trees, wildlife habitats and birds and animals	No impact on flora and fauna due to underground construction
Impact on rock layers	Less impact on geology and rocks due to surface construction.	Potential to have major impacts due to underground construction.
Selected alternative	(1) For 2009 FS weir location, underground desander facility is considered at a distance of 910 m downstream of the weir, with the following features: (a) Design discharge 153 m^3/s, (b) Number of settling chambers 2 Nos., (c) Effective length of chamber 204 m (without transition), (d) Width of chamber 28 m, (e) Average depth of chamber 41.55 m, (f) Mean velocity 0.2 m/s, and (g) Grain size to be excluded 0.20 mm. (2) for the proposed relocated weir (873 m upstream of original weir location), aboveground desander channels are recommended due to easier and cheaper to construct, easier and simpler flushing arrangements, and lower geological risks.	

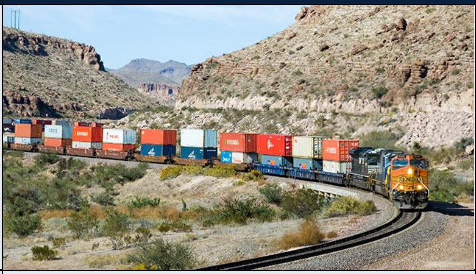
4.2.5 Alternatives for transportation of construction materials

Heavy equipment like, electro-mechanical, electrical and heavy steel structure equipment components will be imported and can be expected to arrive at Karachi Port. From Karachi the equipment shall be transported to the project area located north of Madyan Town, District Swat. In addition, huge quantity of and construction materials (steels and cement) will also be required and transported to the project site.

There are two general modes of transport which can be utilized for moving the equipment and materials to the project site either by road or by rail from Karachi to Nowshera or Dargai, and then on road. Table 4-6 presents various alternative options for transportation mode. A number of bridges are affected by 2022 flood and require strengthening in carrying heavy load. Consultation with the National Highway Authority will be required and rehabilitation of these bridges need to be dealt with priority before construction.

The potential option for transporting of heavy loads across streams close to the powerhouse location could be to ford or cross the rivers and smaller stream with a truss bridge during the low flow seasons to avoid narrow access roads starting from Madyan bridge. **Table** 4-6 presents various alternatives for transporting heavy equipment and materials to the Project site.

Table 4-6: Alternatives for transportation of materials and heavy equipment

Parameter	Train	Road
View of structure		
Description	Transport between Karachi and Nowshera can be done by either train or road	Transport between Karachi and Nowshera can be done by either train or road
Adaptability		
Unique factors	Requires more time and a more comprehensive logistics	The usual method of transport so it does not require as much planning
Time required for transport	involve extra loading and unloading and deployment of mobile cranes and storage facilities	No additional loading unloading time or requirement of extra equipment and storage
Cost		
Travel cost	Less costly, since rail can carry bulk quantities	More costly
Environmental Impacts		
Fuel efficiency	More efficient	Less efficient
Carbon footprint	Rail and waterborne transport have the lowest emissions per kilometer travel and unit transported.25	Higher emissions so higher carbon footprint
Dust	Less dust generated	More dust generated as it travels along roads and communities
Noise	Higher levels but more intermittent in nature due to distance from settlements	Varying frequency and level but impact on people is more regular as it will have to pass by populated areas.
Visuals	Does not have large impact as it will mostly pass by more secluded areas as that's where train tracks are placed	More visually unpleasant as it will travel through populated areas
Disturbance to flora and fauna	Using pre-built structures so no additional disturbance expected	Using pre-built structures so no additional disturbance expected
Impact on people	Not likely to impact people as much	There will be populated areas that the trucks will need to go, thus posing safety hazards for the communities' close proximity of road and increased traffic

[25] European Environment Agency (EEA). (2022, February 25). Rail and waterborne - best for low-carbon motorized transport. European Environment Agency. Retrieved November 8, 2022, from https://www.eea.europa.eu/publications/rail-and-waterborne-transport

4.2.6 AIS and GIS

Air insulated switchgear is a secondary power distribution device and is a high voltage switchgear that redistributes the power with the help of power transformer, AIS uses air as insulating medium.

The Gas-insulated Switchgear, often known as GIS, is a solid metal enclosed device that contains a variety of high-voltage components, including disconnections and circuit breakers. It uses Gas as insulating medium. The comparison of AIS and GIS shown in **Table 4-7.**

Table 4-7: Comparison of AIS and GIS

Parameter	AIS	GIS
View of structure		
Adaptability		
Unique factors	• AIS insulates using air as insulating medium. • AIS systems will be visually inspected every year to two years. • AIS systems require significantly more effort, especially due to the thoroughness of the inspections.	• GIS uses the chemical gas Sulphur hexafluoride • GIS systems are significantly easier to care for on a regular basis. They also contain their own integrated testing instruments. • GIS systems require less maintenance.
Area requirement	• AIS systems need busbar connections and boots on the switchgear. • AIS Systems require more space and time for installation.	• GIS systems are significantly smaller and weigh less (despite the gas weighing more than air). • The average installation time is reduced by approximately 30% with a GIS installation. • The physical footprint of a GIS is about 35% less than AIS.
Cost		
Overall cost	• Less Costly, AIS systems offer upfront cost savings, however they require more man-hours over the long run.	• GIS high voltage system requires a larger upfront investment, but their sealed technology means lower installation and maintenance costs. • GIS units tend to cost between 10% to 40% more than AIS.
Environmental Impacts		
	• One of the primary environmental impacts of AIS is related to its use of sulphur hexafluoride (SF6) gas as an insulating and arc-quenching medium. SF6 is a potent greenhouse gas with a global warming potential that is over 23,000 times higher than carbon dioxide. Although SF6 is contained within the switchgear during operation, leaks can occur during maintenance or if there is damage to the equipment. The release of SF6 gas into the atmosphere can contribute to climate change, making proper handling and management of this gas crucial.	• Gas-insulated high-voltage switchgear (GIS) is another type of substation equipment used for controlling and protecting power transmission and distribution systems. Like AIS, GIS also has certain environmental impacts associated with its life cycle. • One of the primary environmental impacts of GIS is related to its use of Sulphur hexafluoride (SF6) gas as an insulating and arc-quenching medium.

Parameter	AIS	GIS
	• AIS also has an impact on land use, as substations are typically located on large plots of land. These substations can disrupt natural habitats and ecosystems, and their construction can require the clearing of vegetation and wildlife habitats. The operation of substations can also generate noise pollution, which can have negative impacts on local wildlife and human communities.	• GIS also has an impact on land use, as substations are typically located on large plots of land. These substations can disrupt natural habitats and ecosystems, and their construction can require the clearing of vegetation and wildlife habitats. The operation of substations can also generate noise pollution, which can have negative impacts on local wildlife and human communities. • In addition to the environmental impacts associated with SF6 gas, GIS equipment also contains other materials that can have negative environmental consequences. For example, the production and disposal of GIS equipment can generate hazardous waste, such as heavy metals and PCBs, which can contaminate soil and water resources if not handled and disposed of properly.
However, it is worth noting that GIS has some advantages over AIS in terms of its environmental impact. For example, GIS equipment takes up less space than AIS equipment, which can help to reduce the amount of land needed for a substation. Additionally, GIS equipment tends to have a longer lifespan than AIS equipment, which can reduce the need for frequent replacement and disposal. Furthermore, there are ongoing efforts to reduce the environmental impact of GIS equipment by developing alternative insulating gases with lower global warming potentials and implementing more efficient gas recovery systems to minimize leaks. These efforts could help to reduce the impact of SF6 emissions from GIS equipment.		

4.2.7 Employer’s Facilities/Colony

A project colony will be established with offices, residential quarters, appurtenant facilities such as hostels, rest houses, schools, mosques, hospital, market and clubs. It was preferred to locate the MHPP colony as near to the project site as possible. However, since the Madyan town is narrow with small flat area which is use for agricultural purposes, hardly any suitable and flat area for establishing a large colony near to the powerhouse site was available. During the 2009 Feasibility Study, a site close to Madyan town was identified for the Project Colony. However, the PIC identified that the proposed location is not suitable for the project facility because the site is mainly agricultural land. During the site visit of the PIC-ESIA team, the local people informed that it is the only agricultural land of Madyan and agriculture is the only source of income for the communities. There are about 4,391 fruit and non-fruit trees. Development in the area will disturb the agricultural activities and a large number of trees (fruit and non-fruit) will be felt. Also, there are permanent structures (20-25 houses and a family guest house). To avoid/minimize environmental and social impacts, a suitable alternative site for the establishment of a Staff Colony was identified at the river terraces of the Damley Village. During the consultation with the local population, they agreed on the newly proposed site for project facilities. This identified location contains sufficient space with a relatively more or less levelled area on top of terraces. The site is located opposite to Madyan-Kalam Main Road and about 1km upstream of the proposed powerhouse. This site is accessible by a foot-track and in close proximity to the project facilities. The road widening, from Madyan town to the alternative site, needs to be carried out for easy access. **Table 4-8** presents the comparison of alternative sites for project colony.

Table 4-8: Alternative sites for Project Colony

Parameter	Site 1 (Close to Madyan Town)	Site 2 (Near Damley Village)
View of structure/location		
Description	During the Feasibility Study conducted in 2009, a site close to Madyan town was identified for the Project Colony	The site is located opposite to Madyan-Kalam Main Road and about 1km upstream of the proposed powerhouse. This site is about 1km upstream of the proposed powerhouse site. There is a 220kV transmission line in uphill close to the site.
Constructability		
Unique factors	Mostly agricultural land and about 15-20 houses are built in the location. The site is easily accessible from Madyan town; therefore, transportation of construction materials will be easier for this site.	This newly proposed location contains sufficient space with a relatively more or less levelled area on top of river terraces. Mostly barren land. This site will require a construction for accessibility. An access road is currently available for the proposed powerhouse location starting from Madyan bridge. An extension of the access road will be required to transport construction materials and equipment.
Cost	Building infrastructure might be cheaper due to less excavation cost, however, compensation for agricultural land and houses will be higher than the alternative site in Damley village.	Land compensation will be cheaper due to barren land, Infrastructure construction might be slightly higher due cut and fill in the mountainous slope.
Environmental Impacts		
Dust and Noise	During construction dust and noise will be generated and impact will be higher because the site is close proximity of the settlements	Impacts will be less due to the absence of community in close proximity of the site.
Disturbance to flora and fauna	Since the land is mostly agricultural land, impacts on flora and fauna will be significantly less.	Number of trees felt will be higher that alternative 1 and associated birds and animal habitat.
Social Impact	As this land is the only agricultural land in the area and agriculture is the only source of income for the affected community, this location would have an extremely high negative impact on the people. In addition, about 15-20 houses may require relocation, which will be major impact on the affected people.	Acquisition of barren land is required. There is an existing track in the mountain slope used by the community to travel to towns and their villages. This might require relocation.

5 Environment and Socioeconomic Baseline

This chapter presents a detailed overview of the physical and socio-economic environment of the project area and the results of the primary investigations and the review of secondary information carried out under the Project.

5.1 Physical Environment

5.1.1 Physiography

The physiography in the project area is dominated by mountainous terrain, narrow valleys of the Swat River and its tributaries, eroded river banks, and agricultural lands in the valleys and forests on the hill slopes. Based on topographic surveys of different cross sections of the river from weir to tailrace, the valley near the weir site is narrow (70 m wide at high flood level), but it gradually widens both upstream (130 m wide) and downstream (up to 550 m wide at Bahrain Town). The elevations along the Swat River, in the project area, range from 1,390 to 1,530 meters above mean sea level (amsl), while the elevations of the mountains range from 2,700 to 3,400 m amsl. The Swat River carries high water flows during the summer months due to the melting of snow and glaciers and very low flow during the winter months. River bank erosion from the high sediment flows during floods is observed on both banks of the river. The width of the river as weir location is given in Figure 5-1 and typical photograph of the project valley area is shown in **Figure** 5-2**.**

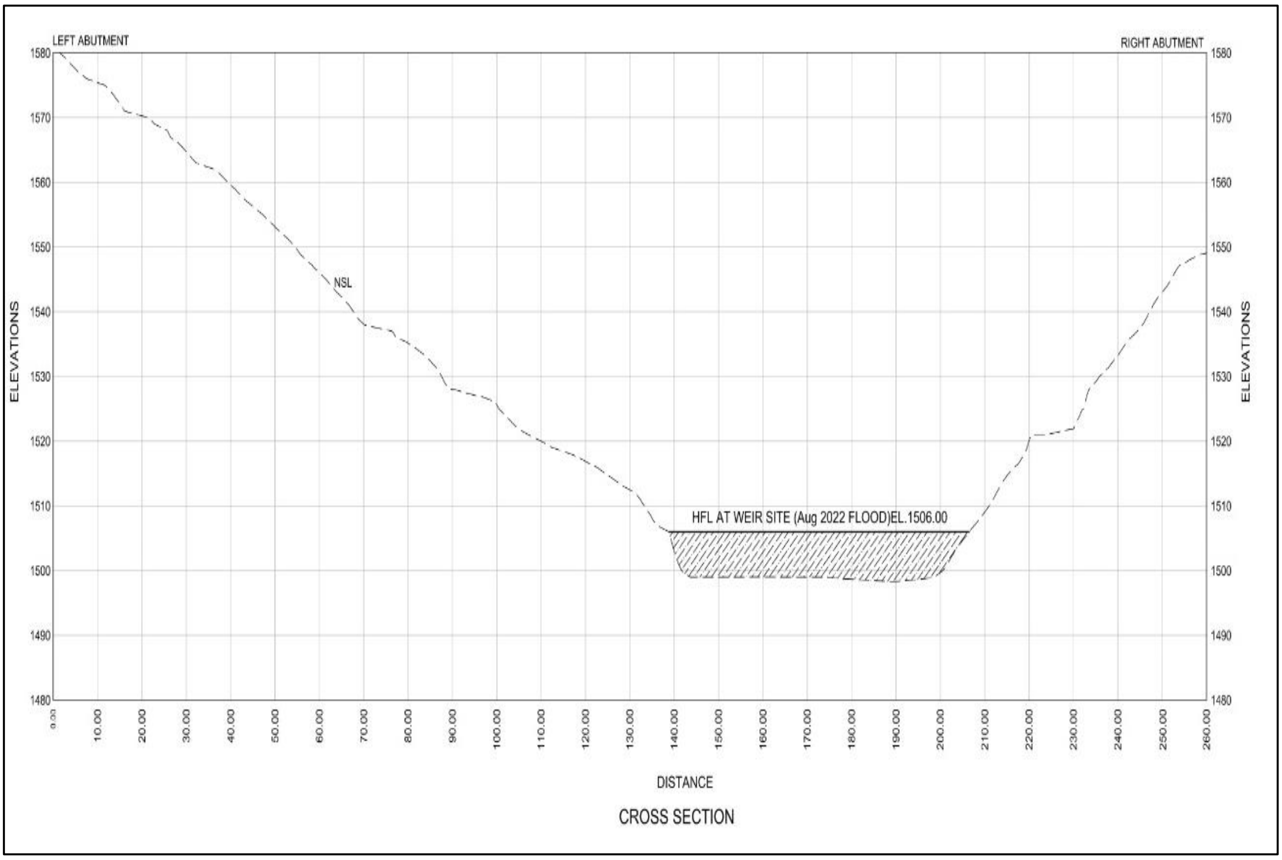


Figure 5-1: River Cross Section at Weir Site

Figure 5-2: A View of the Project Area (Bahrain town)

Physical Setting: The Project site is located in a rural setting (Weir site) and Sub-urban (Powerhouse site) with all lands in the valley along the river being extensively used for agricultural purposes, and the hills are covered with the forest vegetation. The major settlement in the project area is Madyan town; Bahrain is another major settlement in the project area, which is further divided into sub-villages (including Paler, Mahai, Rashnail, Sher Kally, and Chirat, which are located close to the project components). The nearest settlement close to the major construction site is Kedam village (which is located about 0.6 km away from the weir site, downstream) and Kalagy village (which is located adjacent to powerhouse site) and Ayeen village.

Land use: The land use pattern[26] in the overall project area is mixed type having forest cover, agricultural, and barren land. The main land use patterns of the AOI are presented in Table 5-1 and shown in Figure 5-3, which are tree cover (36.79%), barren land (32.7%), agriculture land (17.81%), river and streams (6.23%), and built-up area (5.27%).

Table 5-1: Land use Pattern in Overall Project Area

Land use Feature	Area (Acres)	Area (km^2)	% distribution
Built-up (Residential and Commercial)	263.81	1.07	5.27%
tree Cover	1,842.83	7.46	36.79%
Agriculture Land	891.85	3.61	17.81%
Graveyard	7.13	0.03	0.14%
Highway / Metaled Road	34.81	0.14	0.70%
Track / Unmetalled Road	18.47	0.07	0.37%
Nullah / Stream	37.99	0.15	0.76%
Active River (Dry)	207.25	0.84	4.14%
Riverbed (Dry)	66.61	0.27	1.33%
Barren Land	1,637.77	6.63	32.70%
Total	**5,008.52**	**20.27**	**100%**

[26] The proposed project is on a small stretch of land and the reported land use pattern is representing the area mostly beyond the project footprint.

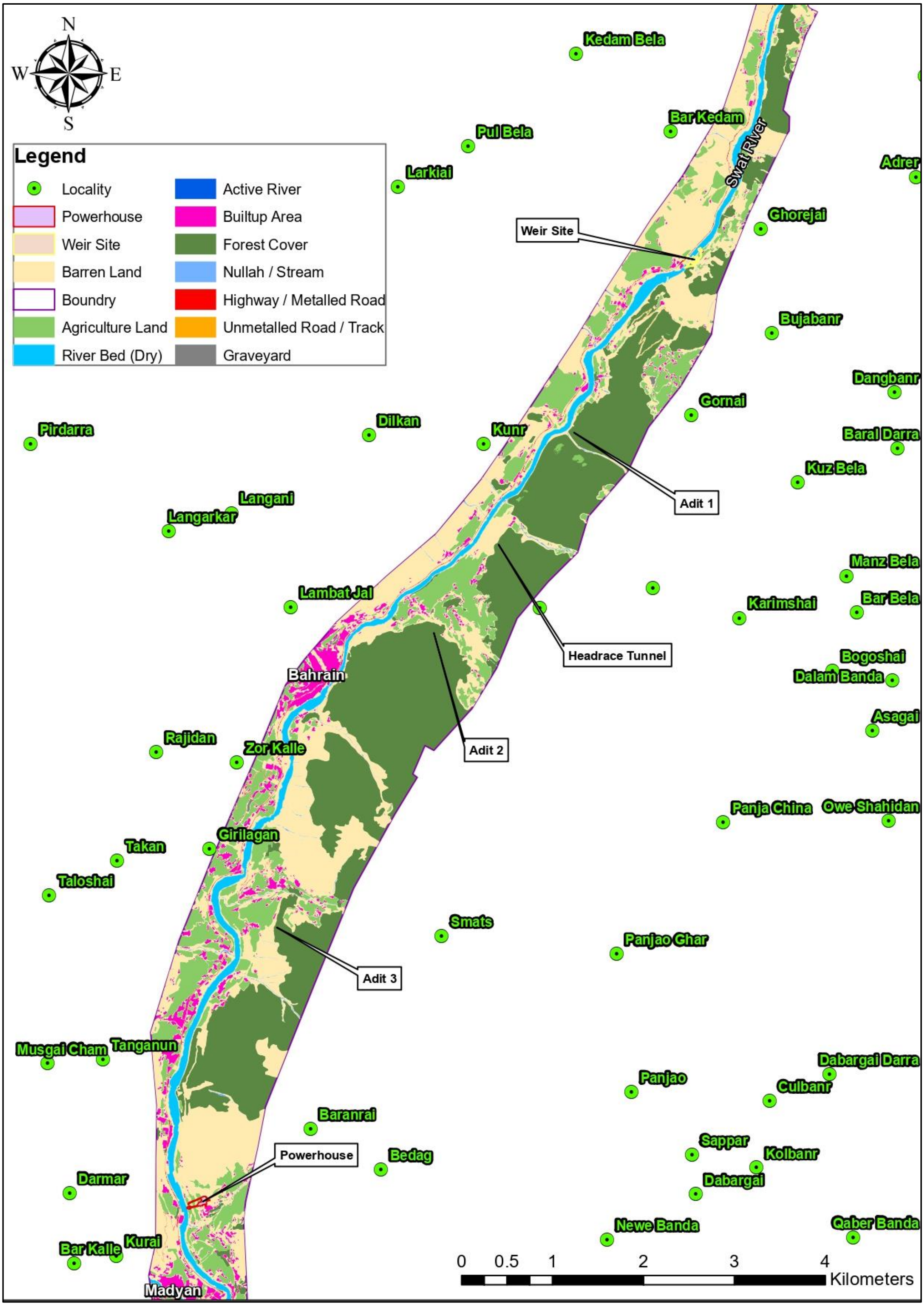


Figure 5-3: Land Use Map of the Project Area

5.1.2 Climate

Temperature: The climatic conditions in the project area are typical for high-altitude regions. The meteorological station at Kalam is located some 30 km upstream of the proposed weir site at an elevation of 1,921 amsl. Record of daily maximum and minimum temperature of Kalam has been collected from PMD and SWHP, WAPDA. The results indicate that maximum temperature is observed in the month of June with the value of 26.1 degrees centigrade (°C) and minimum temperature is observed at the month of January with the value of -8.4 °C at the PMD gauge. The results indicate that maximum temperature is observed in the month of June with the value of 26.51 °C and minimum temperature is observed at the month of January with the value of -6.88 °C at the WAPDA gauge. The mean monthly temperature at both the gauges are shown in **Figure** 5-4 and **Figure** 5-5.

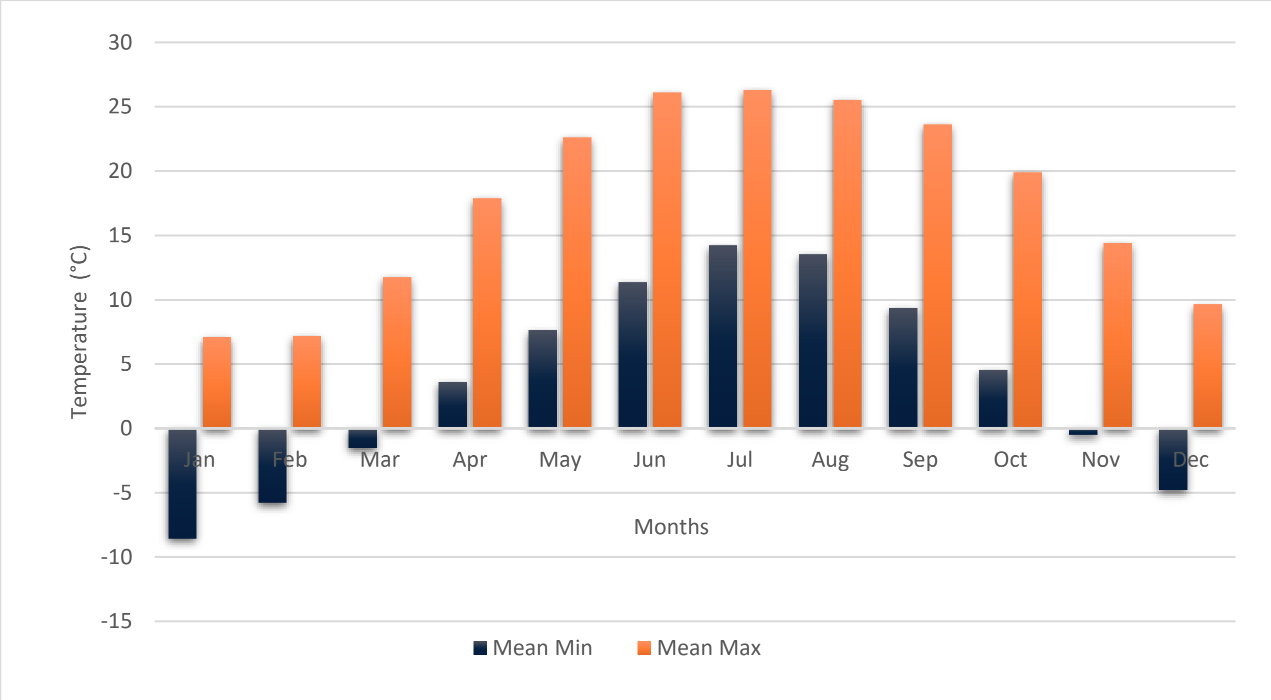


Figure 5-4: Mean Monthly Temperature at the Kalam 1984-2011 (Source: WAPDA)

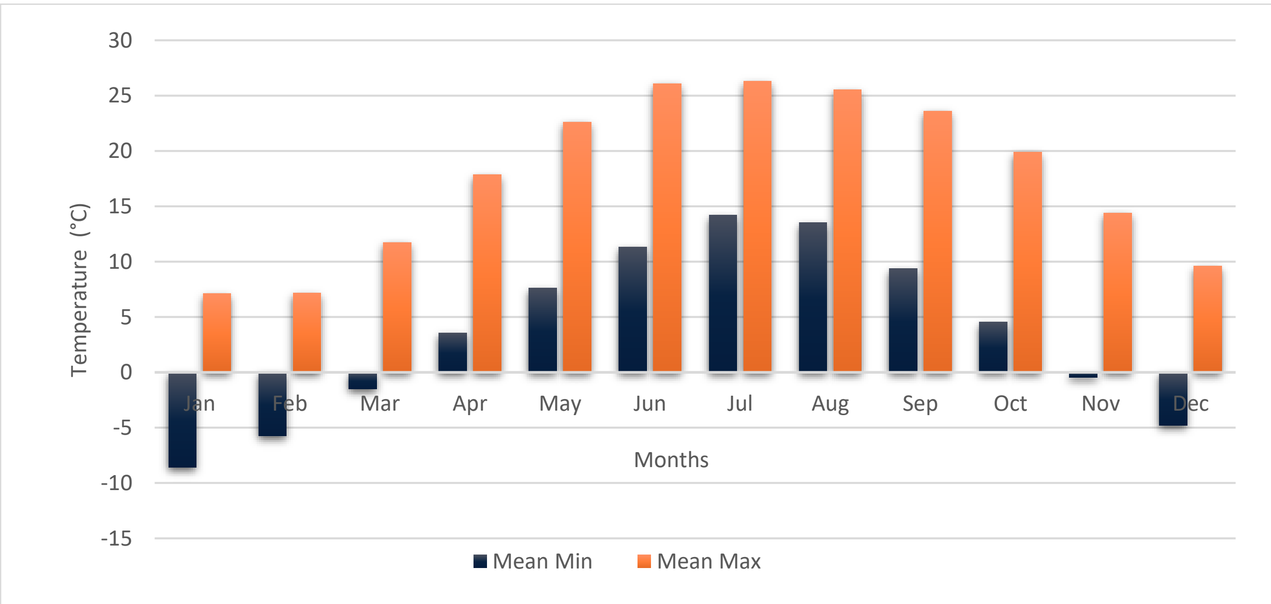


Figure 5-5: Mean Monthly Temperature at the Kalam 2005-2018 (Source: PMD)

Rainfall: The mean monthly rainfall graph is shown in Figure 5.6. The rainfall from January to March is considerably high compared to the monsoon period. The highest mean monthly rainfall occurred in March (171.01 mm), whereas the lowest mean monthly rainfall occurred in June (23.66 mm), as per the PMD gauge. The mean monthly rainfall graph is shown in **Figure** 5-6**.** The rainfall from January to March is considerably high compared to the monsoon period. The highest mean monthly rainfall occurred in March (171.01 mm), whereas the lowest mean monthly rainfall occurred in June (23.66 mm), as per the PMD gauge.

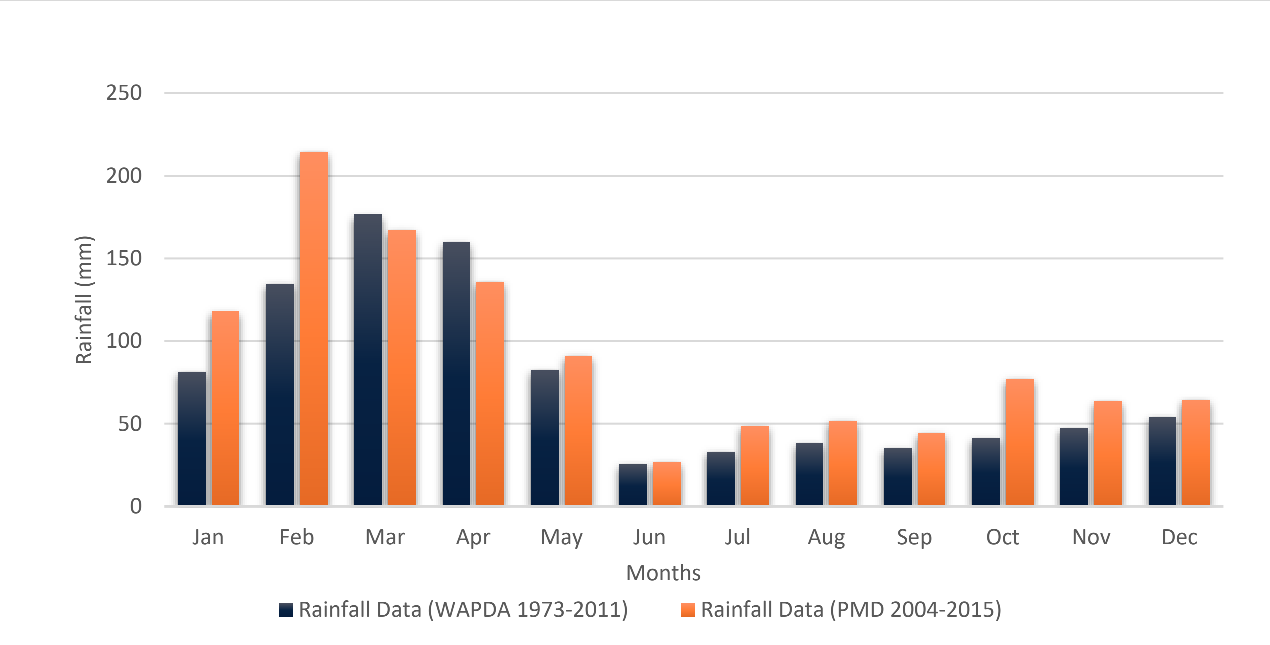


Figure 5-6: Mean Monthly Precipitation Pattern at Kalam (Source: Pakistan Meteorological Department PMD and WAPDA)

5.1.3 Hydrology

5.1.3.1 Hydrology of Swat River

Swat River is the major left bank tributary of Kabul River, joining it near Charsadda, approximately 32km downstream of the existing Munda Headworks. The river originates from the high mountains of Swat Kohistan in the form of Gabral and Ushu Rivers as the two principal tributaries with mean elevation as 4,500 meters above mean sea level. The tributaries join together at Kalam to form Swat River. The basin elevation gradually decreases from 4,500 to 1200m near Bagh Dheri and further downstream at Chakdara to 680m amsl. Panjkora River, originating from high mountains of Dir Kohistan, joins the river near Qalangai Post, about 41km downstream of Chakdara Bridge gauging station. Swat River catchment area up to its confluence with Kabul River is 13,645 Sq.km. Catchment area of the river at Kalam and Chakdara is 2020 and 5776 Sq.km respectively. **Figure** 5-7 and **Figure** 5-8[27] show catchment areas of the river up to its confluence with Kabul River.

Most of Swat River catchment area distributes from EL. 577m to over EL. 5,917m. Most of the catchment except river side and Kalam gauging station area is over EL. 3,000m. The river and river side distributed below EL. 3,000m, and locate at quite narrow area. Thus, the upper Swat River where the project locates flows in deep valley and shows high mountainous characteristics such as steep riverbed, rough terrain, deep valley, snowmelt and glacier. Considering these topographic characteristics of the Kalam catchment, it is highly required to study the effects of snow-melt, landslide, earthquake and glacier lake outburst flood. Northern Swat River catchment over EL. 4,500m is in the south-eastern Hindu Kush. From Hindu Kush to the southern Swat River catchment, the approximate average slope of topography is over 3%, and riverbed slope is approximately over 1%.

[27] **Source: https://www.researchgate.net/figure/Location-map-of-Swat-River-basin-https-doiorg-101371-journalpone0192294g001_fig1_323200957**

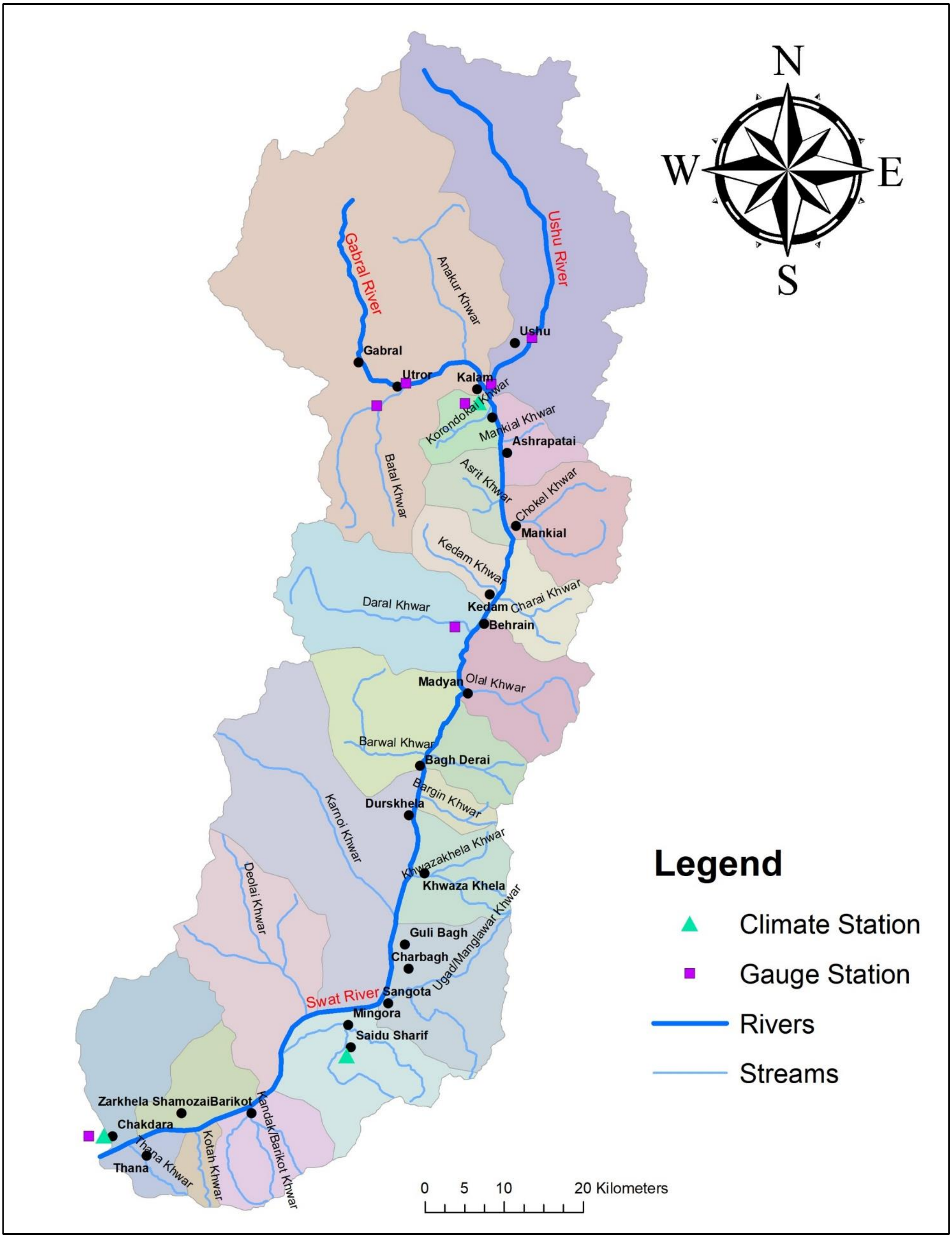


Figure 5-7: Catchment Area of the Swat River

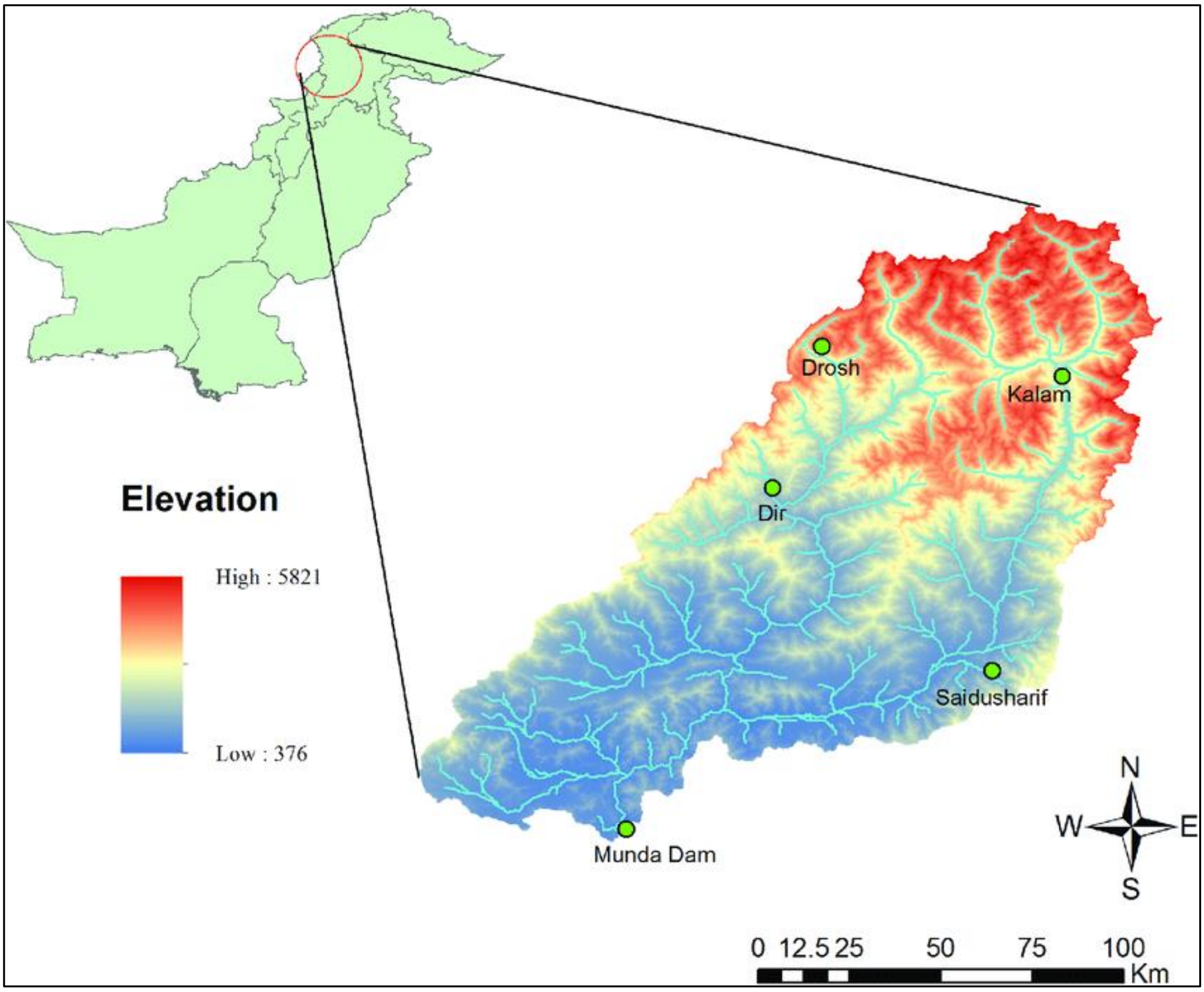


Figure 5-8: Swat River Basin Map

Streams (Khawar/ Nullah) and springs contribute flow to the Swat River joining it from left and right banks. These streams and springs are the primary source of water for irrigation and drinking, especially in areas located at higher elevations, as the Swat River requires pumping to reach them. Along the Mingora-Kalam Road, hotels, restaurants, and other businesses near the Swat River use springs and streams for their drinking water needs, except two hotels downstream of Bahrain, which obtain their water from the Swat River through pumping.

Just downstream of the MHPP weir site two major streams join Swat River, Kedam Nullah from the right bank and Gornai Nullah from the left bank. Mean monthly flows are given in **Table 5-2.**

Table 5-2: Mean Monthly Flows at Weir Site from 1961-2010

Mean Monthly flow at the Weir site from 1961 to 2020												
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Discharge (m^3/s)	17.97	16.81	20.44	58.20	160.84	304.04	313.75	205.23	98.22	43.65	28.11	20.97

Source: MHPP Hydrology and Sediment Study, 2023.

5.1.3.2 Sediment Concentrations of the Swat River

Total period of the suspended data is from 1963 to 2010. In SWAT river, sediment sampling has been performed at the Kalam gauging station by the Surface Water Hydrology Department (SWHD) since 1969. Between 20 to 30 samples are analyzed each year and the available record covers a wide range of discharges. The suspended sediment concentration is recorded in parts per million (ppm). The observed data of suspended sediment at Kalam, from 1963 to 2010 and is shown in the **Figure** 5-9**. Table 5-3** shows the suspended transport at weir site.

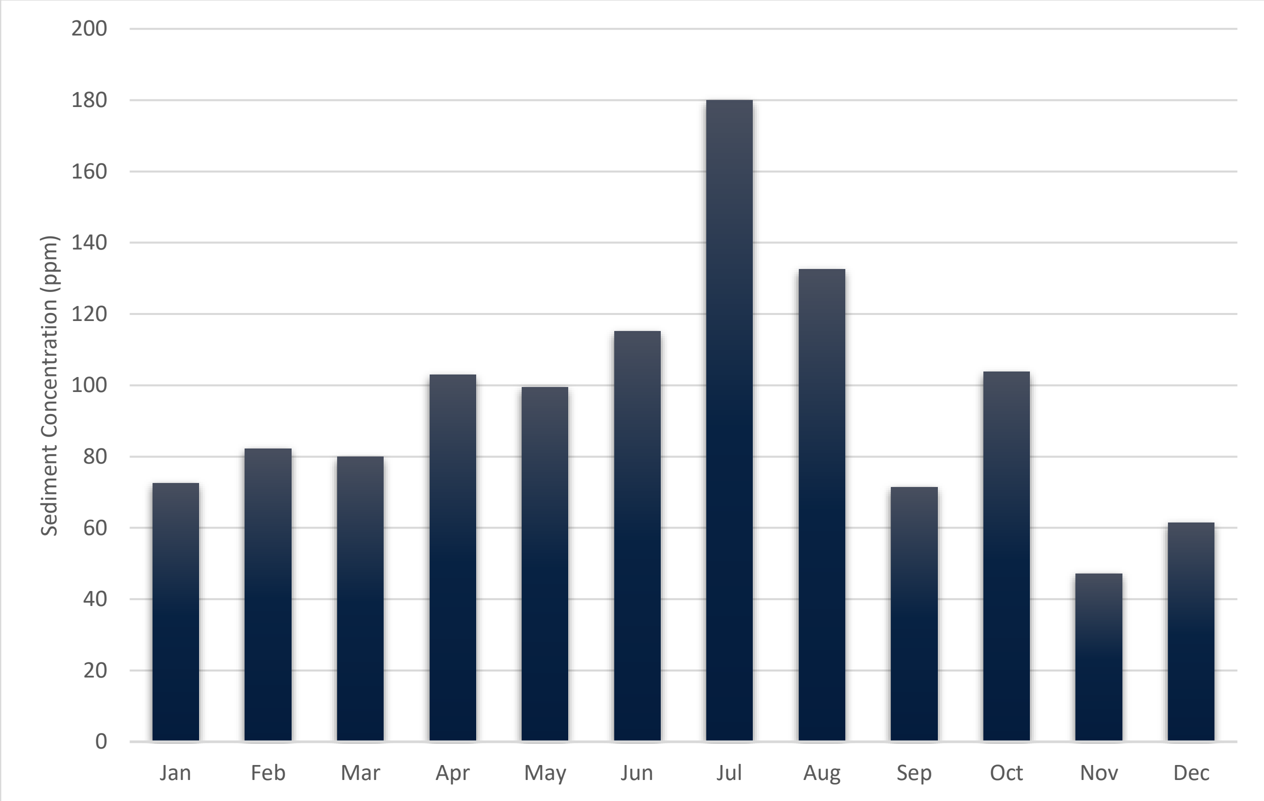


Figure 5-9: Monthly Sediment Concentration at Kalam Station

Table 5-3: Suspended Sediment Transport at Weir Site

Period	Sediment Transport (ton)	
	Mean	High
Jan	2,573	9,991
Feb	2,095	8,135
Mar	3,163	12,283
Apr	13,088	50,829
May	51,361	199,462
Jun	115,199	447,376
Jul	122,822	476,980
Aug	68,950	267,769
Sep	24,966	96,954
Oct	8,339	32,385
Nov	4,410	17,127
Dec	3,196	12,411
Total	**420,162**	**1,631,703**

5.1.3.3 Floods of the Swat River

The flood estimation has been carried out using flood frequency (24-hour maximum instantaneous floods) and rainfall runoff modelling. Swat experienced extremely high rainfalls in July 2010 and August 2022 resulting in heavy floods which caused vast devastation in the area both in terms of lives as well as infrastructure damages and Swat gauge was washed in this flood and is not functional from 2010. Due to this, flood estimation for this extreme event is missing. Therefore, flood frequency analysis may be depicting flood on lower side at Kalam. Therefore, Chakdara gauge data was used that is downstream of the project area and area ratio method was used to transpose the flood at the weir and powerhouse site. Furthermore, it is reported by Khyber Pakhtunkhwa Irrigation Department on 26.08.22 on their flood report that flood magnitude observed on Khawazakhela bridge (downstream of Madyan HPP) is 6,768 cumecs. The Project has carried out preliminary assessment of flood for the return periods whereas low return periods can be estimated using flood frequency analysis using Chakdara data despite the fact that rainfall runoff model cannot be calibrated due to lack of sufficient observed data. Furthermore, high frequency floods will be verified by PMF estimation and as per Franco Rodier diagram and using the coefficient of 5.4, Probable Maximum Flood (PMF) of the Madyan will be 7500 m^3/s and considering the 20% ratio for PMF to 10,000-year return period, check flood is taken as 6300 m^3/s. For diversion flood, storm pattern of average rainfall event is used that corresponds to value of 1770 m^3/s the design flood adopted for various return periods are shown in the **Table 5-4.**

Table 5-4: Results of Design Floods at the Weir Location

Return Period (Year)	Computed Flow (/s) at Weir	Remarks
20	1770	Diversion Flood
1000	5230	Design Flood
10,000	6300	Check Flood

Figure 5-10 shows the instantaneous peaks at Chakdara station.

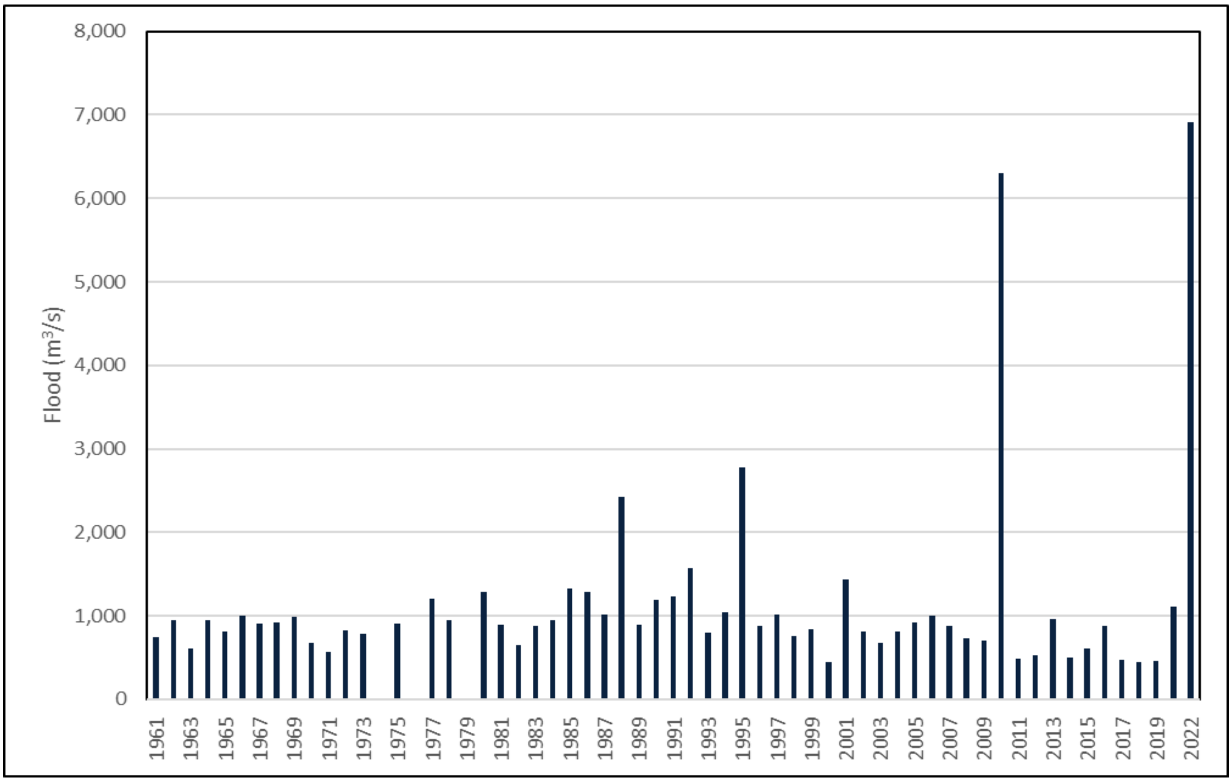


Figure 5-10: Instantaneous Peaks at Chakdara Station

5.1.4 Land sliding

Landslides are not common on the mountain slopes along the N-95. However; some cases of landslides are reported and can occur due to lubrication of rock support structure from rainfall or water seepage. The use of explosives to break rocks may also cause vibrations which can trigger landslides, as can earthquakes and tremors.

As per updated feasibility of MHPP, in any kind of artificial lake, the hazard of landslides moving into the weir has to be assessed. The major consequence of such a landslide would be a sudden enormous increase in the sediment concentration which would make it advisable to shut down the power plant after the occurrence of such an event. Another hazard may arise from the damming up of river, the infiltration of water into the slopes can lead to a reduction of the shear strength parameters of the slope material and/or buoyancy effects. This is especially the case where old landslides are present. Moreover; based on literature review, Tehsil Bahrain face landslides events in the winter season due to winter snowfall and heavy rainfall. In general, land clearing, excavation, tunnel boring and other construction activities may loosen the top soil in the Project area resulting in loss of soil and possible acceleration of soil erosion and land sliding, especially in the wet season.

Figure 5-11: Landslide along weir Location 2 at Right Bank

5.1.5 Ground Water

There is no extraction of groundwater in the area either through open wells or borewells for the drinking and irrigation uses. There are several springs located in the project area on both sides of the mountain, which are being extensively used for drinking and irrigation purposes by the local communities.

Considering 500 m buffer around the underground headrace tunnel in the uphill direction and up till the Swat River that to account for the distance to which the impact of the tunnel on ground water might possibly Extend, it is expected that no spring will be affected by Tunnel construction as all are located more 500 m distance from the headrace tunnel.

The ground water tables in relation to the location and elevation of the major underground structures are summarized in Table 5-5. As can be derived from the groundwater tables recorded in the vicinity of the planned underground structures, no extraordinary high external water pressure is to be expected which requires particular measures in the civil design of the underground works. In the area of the powerhouse cavern the ground water table was found to be approximately 40 m above the turbine setting, i.e., slightly above the cavern roof. Along the steel lined pressure tunnel and manifolds is does not exceed 500 kPa which represents an acceptable design value.

Table 5-5: Observed groundwater tables and invert of proposed structures

Hole No.	Location	Depth of Bore Hole in m	Elevation in amsl of		
			Natural Ground	Groundwater Table	Project Structure
MWD 5A	Power Intake	70	1525.42	1490.62	1483
MSD 1	Surge Tank	90	1539.6	not	1452.44
MPTD 2	Pressure Shaft	150	1526.71	encountered	1336
MPCD 3	Powerhouse Cavern	125	1464.91	1378.11	1336
MPD 5	Open air PH	40	1370.01	1342.8	1339
MWA 1A	Desander Cavern, Adit 1	130	1602.66	1530.66	1476
MWA 2	Headrace Tunnel Adit 2	85	1552.17	1491.07	1469.29
MWA 3	Headrace Tunnel Adit 3	95	1552	1496.5	1459.77

Source: Fitchner (2009), Feasibility Study Report, Madyan Hydropower Project, PEDO.

Along the headrace tunnel the water level was found in the order of 30 to 50 m above the planned tunnel invert level; drainage openings may be foreseen in the tunnel lining. At the desander cavern an external water pressure of 300 to 400 kPa may establish in the roof of the caverns.

5.1.6 Springs in the Project Area

Major source of drinking water in the project area is water springs. There are several springs located in the left side mountains of the river Swat. Springs details have been provided in the **Table 5-6** below:

Table 5-6: List of Spring in the Project Area

Sr. No	Village	Locations	Distance from the tunnel line (approx.) In meter	Seasonal/Perennial
1.	Gharijo Ramait	Shoba	2500	Perennial
2.	Phonkiya Girnai	Bar Bakhail	600	Perennial
3.	Gurnai Nall	Gurnai Nall	1220	Perennial
4.	Samar Bagh	Mulak Chai	610	Perennial
5.	Darolai	Koh	3950	Perennial
6.	Darolai	Namban	5500	Perennial
7.	Darolai	Shagemal	3650	Perennial
8.	Shagai	Chashma Shifa	760	Perennial
9.	Ashoka Ayeen	Ashoka Chashma	-	Perennial
10.	Bar Ayeen	Jam Baig	-	Perennial
11.	Ayeen Malik Abad Ayeen	Nigences Chashma	-	Perennial
12.	Darolai	Thaaat Chashma	-	Perennial
13.	Darolai	Khandar Chashma	-	Perennial
14.	Darolai	Khotain Chashma	-	Perennial
15.	Kalagay	Jaba Chashma	-	Perennial

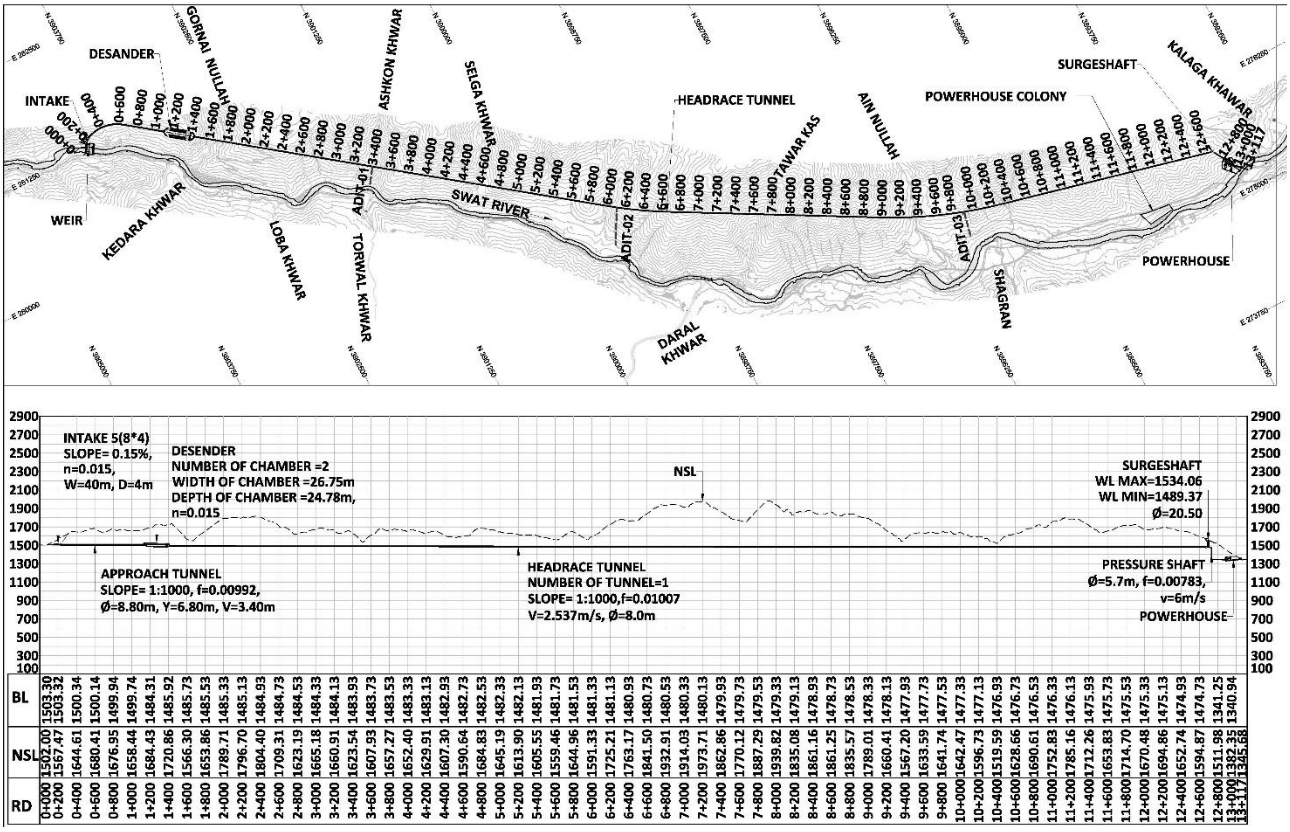


Figure 5-12: Springs Contributing Flow Discharge to the Dewatered Stretch Downstream of Proposed Weir

5.1.7 Seismicity

This section highlights the main findings of the study previously carried out in 2009 on seismic risks. The full report carried out at that time is presented in Volume III of the 2009 Feasibility Report’s Annexure titled “Seismic Hazard Assessment and Design Earthquakes”.

The parameters were proposed for the Maximum Credible Earthquake (MCE) as the safety level and the Operating Basis Design Earthquake (OBE) as the serviceability level for the Madyan Hydropower Project.

It appears that these earthquake parameters were selected based on the recommended guideline of the International Commission on Large DAMS (ICOLD) Bulletin 72 "Selecting Seismic Parameters for Large Dams" (ICOLD 1989).

The recommended annual probability of exceedance for MCE was taken at 1:10,000 as a conservative approach. The report says that this value is compatible with the recommendations of ICOLD and is commonly used in dam engineering practice. Lower values are only recommended if a risk assessment for the downstream area shows only marginal risks in case of a dam or weir failure.

For OBE, considerably lower values for the annual probability of exceedance are recommended in the ICOLD Bulletin 72 (ICOLD 1989), in the order of 1 / 100 years.

MCE level is safety-related. However, the OBE level is not safety-related rather it determines the functionality of the project structures after an earthquake occurs. Therefore, the selection of the OBE level appears to be a management decision. Two options were presented in the report:

- "OBE 1" level which corresponds to an annual probability of exceedance of 1 / 475. This level corresponds to the earthquake impact on structures in modern building codes.
- "OBE 2" level which corresponds to an annual probability of exceedance of 1 / 150. This approach accepts a higher residual risk compared to the OBE 1 level.

The report recommended the "OBE 1" level as the relevant level. This would correspond to the safety level in ordinary building codes.

The conclusions drawn from the study carried out were as follows:

i. The Probabilistic Seismic Hazard Assessment (PSHA) with a more detailed zonation gives an annual probability of exceedance of 1 / 475 values between 2 and 3.5 m/s2 for the peak ground acceleration (PGA) depending on the attenuation law and seismic model applied. This result is compatible with the Global Seismic Hazard Map (GSHAP) study and the Seismic Hazard Zones of Pakistan.

ii. The resulting value for horizontal peak ground acceleration at the Madyan Hydropower Project site is 0.48 g for MCE. For OBE, a value of 0.26 g for the annual probability of exceedance of 1 / 475 is recommended. The vertical components are taken as 2/3 of the corresponding horizontal components.

5.1.8 Geology

The region has been glaciated one or more times. Sediments of these epochs comprise morainic and glacio-fluvial deposits. The river valley attained V- to U-shape due to glaciers' movements and riverbed erosion. The largest superficial landforms are alluvial terraces intermixed with talus and moraines, as a result of sliding on the slopes of the river banks.

The right valley of the Swat River is covered predominantly by overburden material as compared to the left valley slopes. At the left valley, nullahs fanned out and deposited large quantity of alluvial material at the confluence with the Swat River. Talus and scree deposits are covering the valley slopes up to 15-to-25-meter elevations, concealing the bedrock underneath. Throughout the entire Swat valley terraces have been arranged on the slopes by the local population and cultivated. At higher altitudes, thick forests and vegetation also conceal the bedrock.

As mentioned above two main types of materials have been identified and mapped at the project site, i.e., overburden and gabbronorite as bedrock.

Overburden

Based on the mode of deposition or origin, there are four types of materials/deposits which are alluvium, colluvium, moraines, and terrace fields.

Bedrock Exposure

The bedrock exposures have been identified by field mapping. Along the Swat valley bedrock is covered by talus material up to 10-15 meters above the riverbed with few exceptions where bedrock is exposed such as at the selected weir sites. The main rock unit is gabbronorite with minor ultra-basic and ultra-mafic intrusive bodies, veins and dykes. The minor rock bodies include peridotite, dunite and pegmatites.

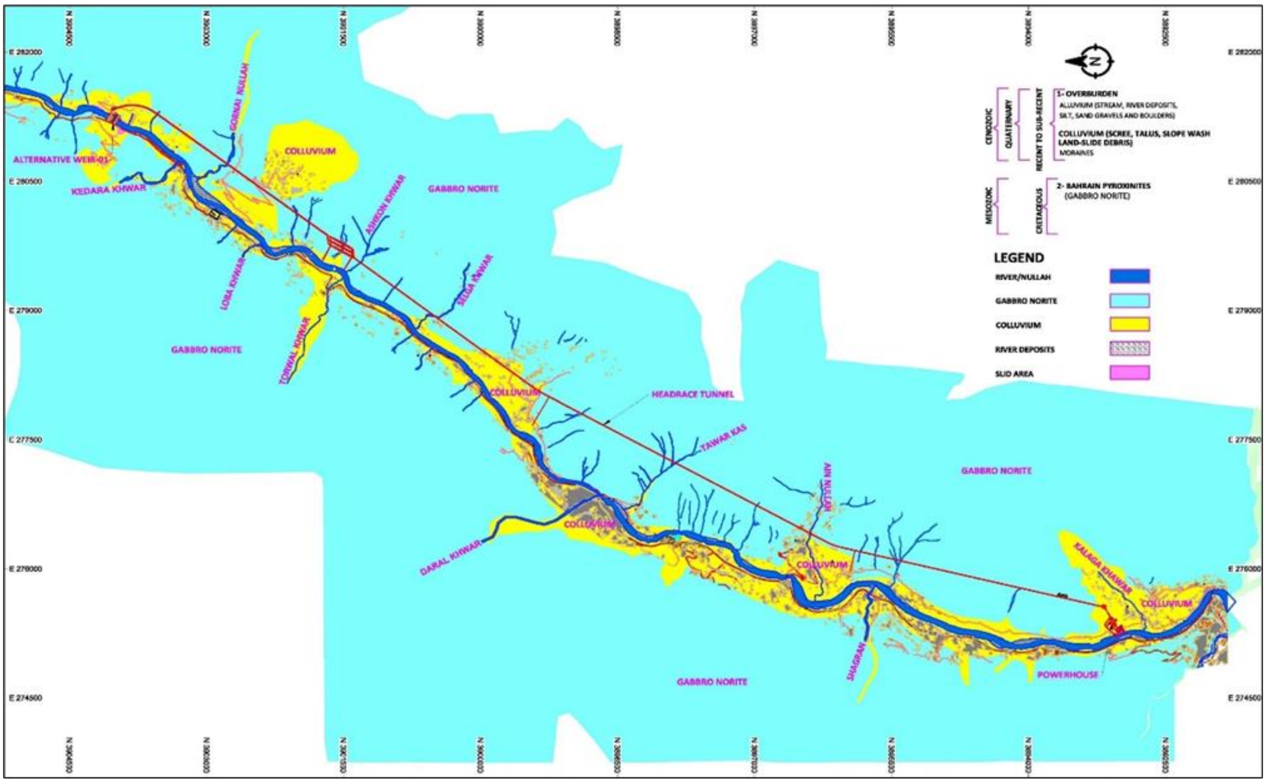


Figure 5-13: Surface Geological Map of the Project Area

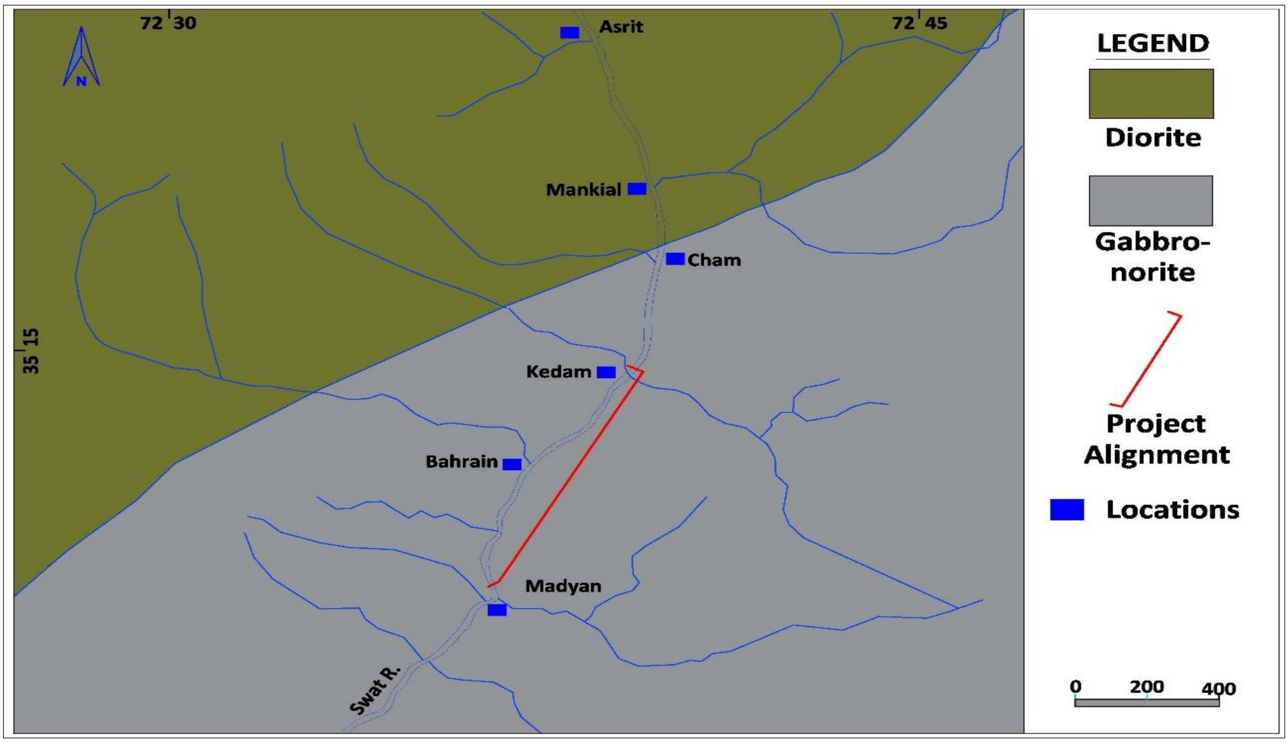


Figure 5-14: Lithologic sketch map of the project area, showing the contact zone between the two principal rock types passing north of the project area

5.1.8.1 Weir Site Geology

A geological map of the weir sites has been prepared at scale 1:5000. The area subject to geological mapping covers the river reach downstream of the weirs and in the upstream direction including both the banks of Swat River. Lithological boundaries between the overburden and bedrock exposures were recorded using a GPS. Joint orientations were taken using a Brunton Compass. The mapped area includes the right and left abutments of the weirs, the weir axes as well as the intake portals.

After the severe flood of August 2022, a task was assigned to the geology team of the Madyan Hydropower Project for the relocation of the weir site. The weir is proposed to be moved upstream from its location indicated in the previous Feasibility Study in order to cater for higher flood levels by including more gates and a longer stilling basin. This alternative location will remove the physical constraint of the Kedam Nullah being close to the stilling basin and spillway structures in the riverbed. The Kedam Nullah has backwater impacts on the proposed site in the Feasibility Study.

A detailed reconnaissance visit was performed along the right and left embankments of the Swat River at about 1km upstream area from the previous weir axis location proposed in the feasibility study. For this purpose, the geological team investigated 3 alternative potential weir site locations. The details about the geology and rock situation along these locations are explained in Volume IV Geology and Geotechnical Investigation of the revised feasibility report 2022.

Figure 5-15: Surface Geological Map of the Weir Sites Area

5.1.8.2 Headrace Tunnel Site

As mentioned above geological mapping was conducted based on the topographic map plotted from the digital terrain model at the scale of 1:10000. At several locations along the headrace tunnel alignment at locations with outcropping rock, joint orientations were measured. Figure 5-16 shows a section of the tunnel alignment, showing drill holes and Electrical Resistivity Survey (ERS) lines.

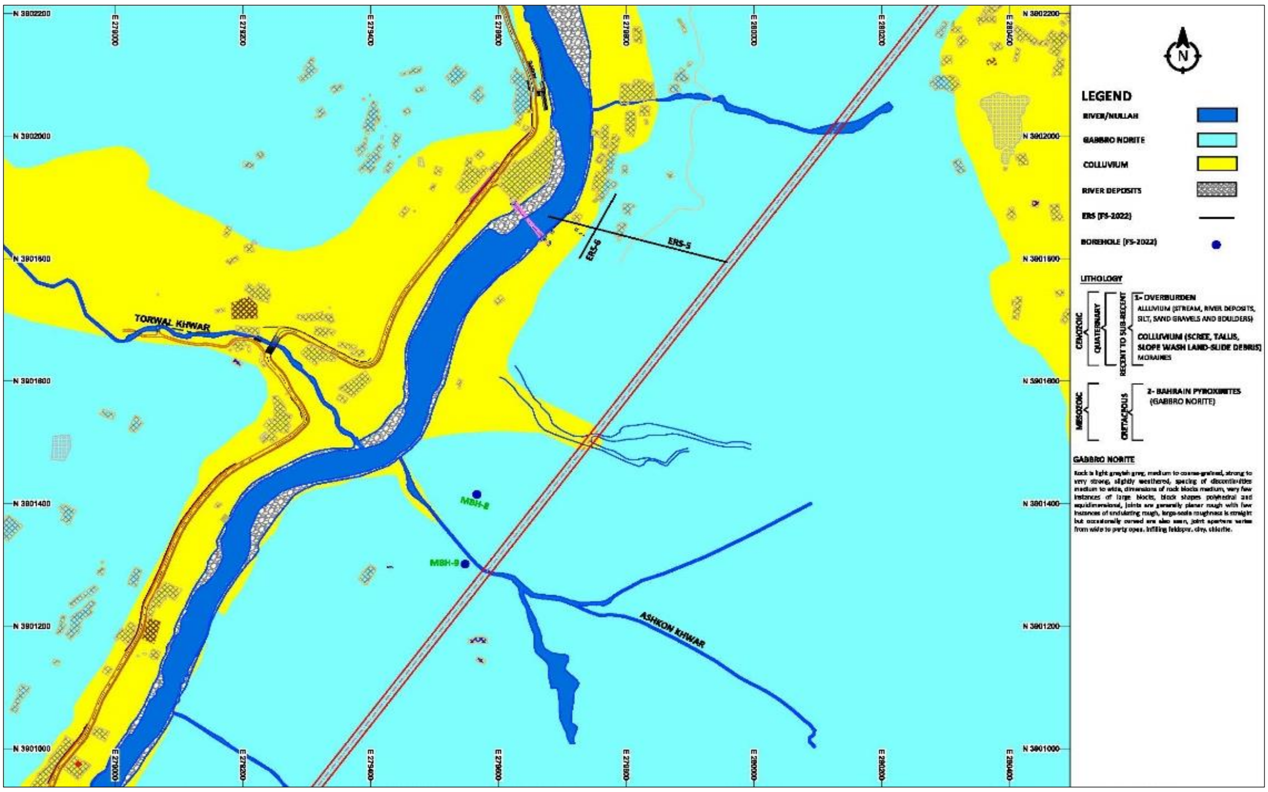


Figure 5-16: Surface Geological Map of HRT section at Ashkon Khwar

5.1.8.3 Powerhouse / Surge Tank Sites

Overburden

The geological conditions at the powerhouse site and the adjoining terraced area were mapped using the new topographic map. At the powerhouse site, the slopes in the western and southern directions are largely covered with terraces to maximize the cultivable area. The retaining walls of the terraces are 1.2 to 2.0 m high and made of crushed rock and boulders. Sandy silt and organic material is filled behind for farming purposes. Out of the total mapped area, some 85 - 90% are presently covered with overburden.

Bedrock is exposed in short strips along the Swat Riverbed at the left bank. Above elevation 1400 m bedrock was exposed in small patches from the location of the planned power outlet for some 150 m length in the upstream direction, however, not in continuous succession. At Kalagai Nullah (joining Swat River approximately 100 m downstream of the power outlet), both banks comprise alluvial material of angular to rounded gravels, cobbles and boulders embedded in silty sand. The consolidated strata and eroded sections show nearly vertical cuts.

Bed Rock

Gabbronorite is exposed along the riverbed at the left bank in the shape of a small strip, and accessible from a walking track. At the powerhouse site, the rock is light grey to dark grey, hard to very hard, medium to coarse grained, slightly to moderately weathered, jointed. The joints are open, in filling material presumed to be feldspar and joint planes are generally rough. Joint orientations were measured and a scan line survey was carried out.

At the surge tank location some 200 m above the riverbed, bedrock was found to be light grey with brown shades due to the presence of iron oxide. The rock is medium-hard to hard, moderately to distinctly weathered, closely to moderately fragmented and closely jointed. Joint orientation measurements and scan line surveys were carried out at several locations.

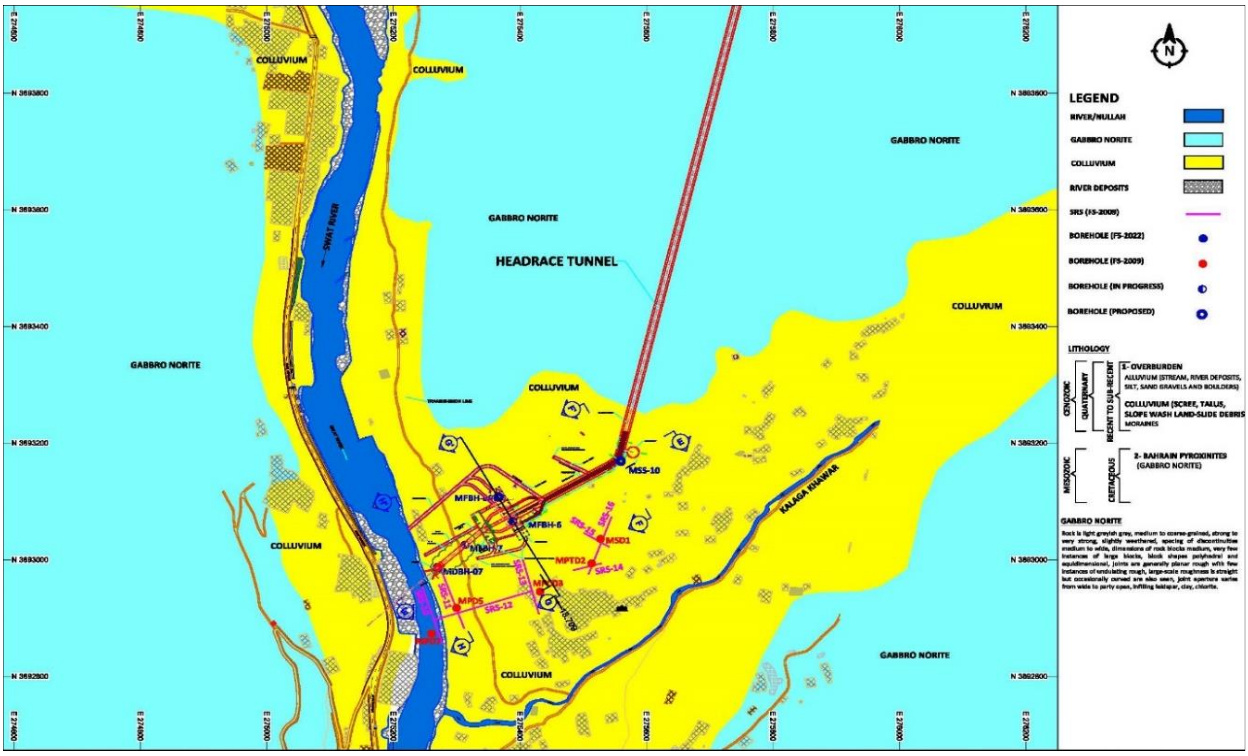


Figure 5-17: Surface Geological Map of Powerhouse Area

5.1.9 Soil of the Project Area

Permeability of soil mas was carried out by the Constant Head Method in which the water level in the test drill hole was maintained constant and the permeability was computed from the data of steady-state constant discharge. The permeability coefficient, k, is the water flow rate under laminar flow conditions through a unit cross-sectional area of a porous medium under a unit hydraulic gradient. The results of the Constant Head tests are summarized in **Table 5-7.**

Table 5-7: Summary of Soil Mass – Overburden Permeability

Location	Drillhole Reference	Rockhead, m	Depth, m	Permeability, k, cm/s	Remark
Alt-Weir-1	MW-01-1	Drilling ongoing	3	2.16x10-3	Soil
			6	1.13x10-1	Soil
			9	1.62x10-1	Soil
			12	6.95x10-1	Soil
			15		
	MW-01-2	Drilling ongoing	3	8.65x10-2	Soil
			6	6.03x10-2	Soil
			9	7.52x10-2	Soil
Alt-Weir-2	MF-BH-01	17	5	1.68×10-1	Soil
			8	5.62 ×10-1	Soil
			11	2.38 ×10-1	Soil
			14	2.61 ×10-1	Soil
			17	1.98 ×10-1	Soil
	MF-BH-02	38	5	1.12 ×10-2	Soil
			8	8.95×10-2	Soil
			11	2.22×10-1	Soil
			17	4.58×10-2	Soil
			20	2.623 ×10-2	Soil
			23	1.56×10-1	Soil
			26	9.751×10-1	Soil
			29	5.23×10-2	Soil
HRT	MBH-09	8	10	7.9×10-3	Soil/weathered rock
Tailrace Tunnel	MF-BH-07	3	5	1.03×10-1	Soil/weathered rock

The results indicate that the soil mass has good drainage characteristics and the permeability is high. A guideline for the permeability classification is presented in **Table 5.8.**

Table 5-8: Permeability Classification for Soils (Head, 1985)

Coefficient of permeability m/s	$k = 1$ – 10^{-1}	10^{-1} – 10^{-2}	10^{-2} – 10^{-3}	10^{-3} – 10^{-4}	10^{-4} – 10^{-5}	10^{-5} – 10^{-6}	10^{-6} – 10^{-7}	10^{-7} – 10^{-8}	10^{-8} – 10^{-9}	10^{-9} – 10^{-10}	10^{-10} – 10^{-11}	10^{-11} – 10^{-12}
Drainage characteristics	Good						Poor		Practically impervious			
Permeability classification	High			Medium		Low		Very low		Practically impermeable		
General soil type	Gravels		Clean sands		Fissured & weathered clays				Intact clays			
						Very fine or silty sands						

5.1.10 River Mining

There was evidence of large-scale sand and cobble mining at and immediately downstream of Weir Site. Mining in the Swat River was observed intensively and frequently in the anticipated dewatered stretch of the Swat River. River sediments in the Swat River are both a valuable environmental and economic resource. Apart from the provision of habitats for riverine biota, the sediment is mined from the river for use in building, road construction and other related activities. Sands and silts are used directly, and cobbles and boulders are crushed to create aggregate material. The mining techniques used range from crude, labor intensive methods, but larger mechanized operations are increasingly evident, particularly near urban areas.

5.1.11Environmental Quality

Baseline environmental quality monitoring was conducted during August 2022 for River Swat water, ground water, ambient air quality and noise in Kedam, Darolai, and Kalagay villages. The locations of the monitoring sites are presented in **Figure 5-18**

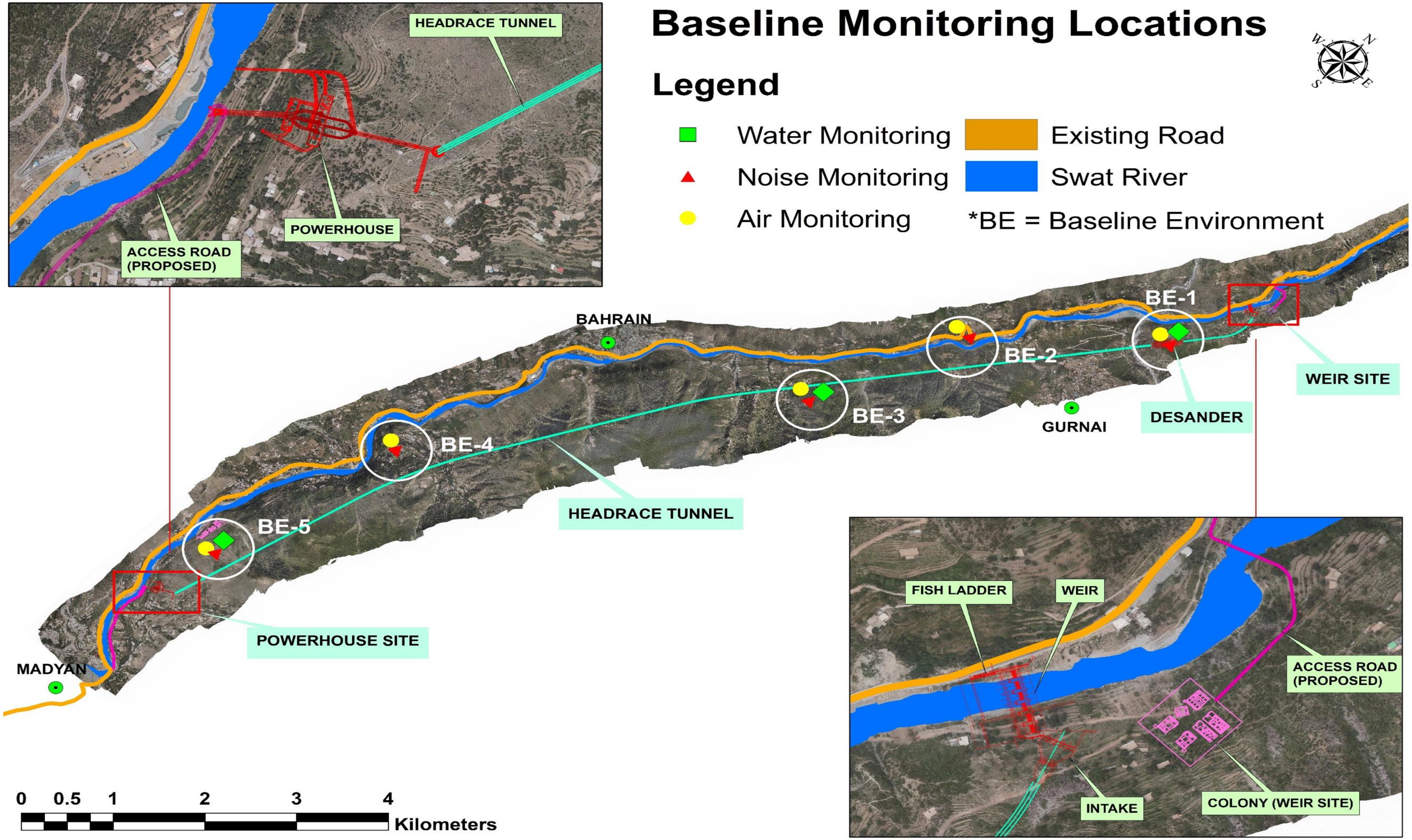


Figure 5-18: Baseline environmental quality monitoring locations

Ambient noise level and air quality measurements were conducted at five selected points which were representative of the closest sensitive receptors (settlements and educational institutions) to determine the existing baseline ambient air and noise levels. The monitoring was conducted on August 8-11, 2022 for 12 hours for ambient air quality. The identification of appropriate monitoring locations was finalized during the baseline survey and site walkover and visit to the surrounding areas. First and foremost, proximity to sensitive receptors was the criteria considered in the selection of locations for noise level and air quality monitoring. Brief description of these locations and receptors sensitivity is given in Table 5-9.

Table 5-9: Ambient Air and Noise Quality Monitoring Locations in the Project Area

Sl.	Location	Geo-coordinates	Location Characteristics
1	Weir Site	35°14'57.50"N 72°35'25.05"E	Rural, no major source of pollution and noise except N95 traffic.
2	Adit-1 of Headrace Tunnel	35°14'8.98"N 72°34'41.04"E	Rural, no major source of pollution and noise except N95 traffic.
3	Adit-2 of Headrace Tunnel	35°12'47.83"N 72°33'35.93"E	Rural, no major source of pollution and noise
4	Adit-3 of Headrace Tunnel	35°11'16.09"N 72°32'18.24"E	Rural, no major source of pollution and noise
5	Powerhouse	35° 9'10.07"N 72°32'2.10"E	Rural, no major source of pollution and noise

5.1.11.1 Water Quality

Water quality of the River Swat and springs (Kedam, Darolai, and Kalagay villages) was measured during August 2022, and the results are given in Table 5-10 and Annex-VII. The water quality is generally good, with total dissolved solids ranging from 721 to 828 ppm but E. coli and Fecal Coliform at Weir and powerhouse site are not within permissible limits. The existing sources of threats to the water quality are the disposal of solid and liquid wastes into the river by the settlements (houses and hotels/restaurants) located along the river, and mainly from the Kalam and Bahrain town.

Table 5-10: Surface and Drinking Water Analysis in the Project Area

Surface Water Analysis					
Sl.	Parameters	NEQS Limits	Kadam Village Near Weir Site	Darolai Village	Kalagay Village Near Powerhouse
01	**pH**	**6.5-8.5**	7.89	6.99	7.21
02	**Temp**	**-**	28 C	28 C	29 C
04	**COD**	**150 mg/l**	26	29	46
05	**BOD**	**80 mg/l**	18	19	23
06	**Dissolve Oxygen**	**-**	0 ppm	0 ppm	0 ppm
07	**Turbidity**	**≤ 5NTU**	4.67	4.31	4.11
08	**E. Conductivity**	**NGVS**	1976	1775	1832
09	**TDS**	**1000 ppm**	987	853	816
10	**Color**	**< 15 TCU**	0.0	0.0	0.00
11	**Odor**	**Odorless**	Unobjectionable	Unobjectionable	Unobjectionable
12	**Taste**	**Tasteless**	objectionable	objectionable	objectionable

Surface Water Analysis					
Sl.	**Parameters**	**NEQS Limits**	**Kadam Village Near Weir Site**	**Darolai Village**	**Kalagay Village Near Powerhouse**
13	**Total Alkalinity**	**< 500 ppm**	169	143	157
14	**Total Hardness**	**< 500 ppm**	187	151	176
15	**Lead**	**Mg/l 0.5**	0.0226	0.0121	0.0042
16	**Chromium**	**Mg/l 1**	0.053	0.057	0.039
17	**Sodium**	**≤ 200 ppm**	29.1	39.8	33.4
18	**Total Suspended Solid**	**mg/l ,1**	<1.0	<1.0	<1.0
19	**Sulphate**	**≤ 250 ppm**	15.5	27.3	26.8
20	**Chloride**	**≤ 250 ppm**	17.2	31.6	29.5
21	**Silver**	**mg/l 1**	0.032	0.029	0.038
22	**Cadmium**	**mg/l 0.1**	0.071	0.069	0.073
23	**Fluoride**	**≤ 1.5 ppm**	0.01	0.021	0.19
24	**Arsenic**	**≤ 0.01 ppm**	0.017	0.000	0.004
25	**Iron**	**≤ 2 ppm**	0.04	0.07	0.006
26	**Copper**	**≤ 2 ppm**	0.07	0.003	0.13
27	**Mercury**	**0.01 mg/l**	BDL	BDL	BDL
28	**Nickle**	**1 mg/l**	0.017	0.019	0.018
Drinking Water Analysis (spring water)					
01	**pH**	**6.5-8.5**	7.64	6.94	7.41
02	**Temperature**	**-**	26 C	26 C	26 C
03	**Dissolve Oxygen**	**-**	0 ppm	0 ppm	0 ppm
04	**Turbidity**	**≤ 5NTU**	2.22	2.01	3.66
05	**E. Conductivity**	**NGVS**	1441	1665	1554
06	**TDS**	**1000 ppm**	721	828	777
07	**Color**	**< 15 TCU**	0.0	0.0	0.00
08	**Odor**	**Odorless**	Unobjectionable	Unobjectionable	Unobjectionable
09	**Taste**	**Tasteless**	Unobjectionable	Unobjectionable	Unobjectionable
10	**Total Alkalinity**	**< 500 ppm**	98	101	95
11	**Total Hardness**	**< 500 ppm**	108	110	98
12	**Lead**	**Mg/l 0.5**	BDL	BDL	BDL
13	**Chromium**	**Mg/l 1**	BDL	BDL	BDL
14	**Sodium**	**≤ 200 ppm**	61.78	47.2	37.2
15	**Total Suspended Solid**	**mg/l ,1**	BDL	BDL	BDL
16	**Sulphate**	**≤ 250 ppm**	57.1	39.9	32.9

Surface Water Analysis					
Sl.	**Parameters**	**NEQS Limits**	**Kadam Village Near Weir Site**	**Darolai Village**	**Kalagay Village Near Powerhouse**
17	**Chloride**	**≤ 250 ppm**	51.6	37.2	30.1
18	**Silver**	**mg/l 1**	BDL	BDL	BDL
19	**Cadmium**	**mg/l 0.1**	BDL	BDL	BDL
20	**Fluoride**	**≤ 1.5 ppm**	0.19	0.17	0.18
21	**Arsenic**	**≤ 0.01 ppm**	0.001	0.009	0.008
22	**Iron**	**≤ 2 ppm**	0.06	0.05	0.006
23	**Copper**	**≤ 2 ppm**	0.8	0.07	0.1
24	**Mercury**	**0.01 mg/l**	BDL	BDL	BDL
25	**Nickle**	**1 mg/l**	BDL	BDL	BDL
26	**E. Coli**	**0 CFU/100 ml**	68	0.00	79
27	**Fecal Coliform**	**0 CFU/100 ml**	63	0.00	77

5.1.11.2 Air Quality

Air quality was measured at five locations (Kedam, Adit-1, Darlolai, Ayeen and Kalagay) in the project area during August 2022. National Ambient Air Quality Standards for mostly for 24 hour (daily) averaging time. However, the monitoring was conducted for 2 hours only. In order to compare the monitoring results with NEQS, the data is required to convert to appropriate averaging time. The twelve (12) hours air quality data is converted using the following Power Rule developed by the Ontario Ministry of Environment.

$$C^{long} = C^{short}\left(\frac{t^{short}}{t^{long}}\right)^{p}$$

where,
C^{long} = the concentration at the longer averaging period, t^{long}
C^{short} = the concentration at the shorter averaging period, t^{short}
p = power exponent equal to 0.28 is normally used for conversion.

The ambient air quality in the project area is generally good and well below the national standards (NEQS), as shown in Table 5-11..

Table 5-11: Air Quality in the Project Area

Sl.	Parameters	Unit	NEQS Limits (Daily Average)	Weir site Kedam Point (A)	Torwal village Point B (Adit 1)	Darolai village Point C (Adit 2)	Ayeen Village Point D (Adit 3)	Kalagay Village Powerhouse Point E
01	PM 2.5	µg/m3	35	16.31	17.46	14.58	18.45	14.91
02	PM 10	µg/m3	150	43.98	28.91	24.30	22.32	19.77
04	CO	µg/m3	5, 000 (8 hour)	1.20	0.92	1.18	0.76	0.00
05	NO2	µg/m3	80	35.50	24.38	25.53	41.51	24.46
06	SO2	µg/m3	120	9.89	7.42	5.78	2.53	3.33
07	NO	µg/m3	40	21.57	18.22	14.09	12.44	15.79
09	O3	µg/m3	130 (1 hour avg.)	0.00	0.00	0.00	00	0.00

5.1.11.3 Noise Level

Noise levels are measured at five locations (Kedam, Adit-1, Darlolai, Ayeen and Kalagay) in the project area during August 2022. Results of the ambient noise level are presented in the following table and Annex-VII. The ambient noise level in the project area is generally good and well below the national standards (NEQS).

Table 5-12: Measured Baseline Noise Level

Parameters	Unit	NEQS Limits	Weir site Kedam Point (A)	Torwal village Point B	Darolai village Point C	Ayeen Village Point D	Kalagay Village Powerhouse Point E
Noise level	dB (A)	**Residential Area:** Day time: 55 Night Time: 45 **Commercial Area:** Day time: 65 Night Time: 55	53.1	51.7	49.1	53.2	50.9

5.2 Socioeconomic Environment

5.2.1 Overview of the Area of Impact and Area of Influence (AOI)

The project area falls in the rural area of KP and is located in tehsil Bahrain of district Swat. The socioeconomic environment considers the Area of Influence (AOI) as defined in Section 1.4. The Area of Influence (AOI) refers to the adjacent areas to the Area of Impact boundaries where the project impacts may be felt during construction of project facilities. The area of influence is always larger than the area of impact that is confined to project footprints.

According to the final design, all the components of the MHPP will be constructed on the left side of the river Swat, at about 200m distance from the riverbed. The ESIA of the MHPP has taken the AOI as 2km wide (on Right Side, 0.5 km from the right bank of the river and on Left Side, 1.5 km from the left bank of the river), along the Swat River. For the assessment of potential project impacts outside the area of impact, the same AOI has been considered. Twenty villages/ settlements fall in the AOI on both sides of the Swat River. Of these, 06 villages fall on left side of the river and 14 villages are situated on right side of the river and fall in the AOI.

The offices of the village councils were visited to collect data on population and number of households (HHs) in the villages/ settlements falling in the AOI. A list of these villages/ settlements with their population and household numbers is provided in the Table 5-13. As depicted in the table, the number of households (HHs) in these villages is 10,238 with a population of 80,573 persons.

Table 5-13: Number of Households and Population in the Assumed AOI Along River Swat

S. No	Village Name	River Side	Village Council	Household (N0.)	Population (No.)
1	Kedam	Right	Kedam	400	3148
2	Ramait	Left	Mankyal	638	5,021
3	Darolai	Left	Ayeen	400	3,148
4	Gurnai	Left	Ayeen	679	3,770
5	Ayeen	Left	Ayeen	800	6,296
6	Kalagay	Left	Kalagay Baranvi	700	5,509
7	Cham Ghari	Right	Bala Kot	447	3518
8	Turwal	Right	Kedam	410	3227
9	Bahrain	Right	Bahrain	2,000	15740
10	Shagai	Left	Ayeen	180	1,417
11	Zoor Kalay	Right	Satalgahri	225	1,771

12	Punjegram	Right	Satalgahri	135	1,062
13	Ghari Lagan	Right	Satalgahri	156	1,228
14	Sattal	Right	Satalgahri	309	2,432
15	Cham Sattal	Right	Satalgahri	90	708
16	Damle	Right	Satalgahri	70	551
17	Koza Gharri	Right	Satalgahri	95	748
18	Gul Shah	Right	Satalgahri	100	787
19	Jhaga	Right	Satalgahri	104	818
20	Madyan	Both Side	Madyan	2,500	19,675
Total				10,238	80,573

The potential impacts within these AOI boundaries may be caused as a result of construction of headrace tunnel and powerhouse sites. The project includes the construction of 12.5 km long and 7m diameter headrace tunnel. Its construction will involve blasting. The vibration generated by the blasting may partially or totally affect the residential, educational and religious structures in the villages/ settlements situated in the AOI along the Swat River. Residents of these villages will be at a constant risk of damage to their properties during the construction of the tunnel and powerhouse, as the vibrations caused as a result of blasting will be unavoidable.

5.2.2 Socioeconomic Baseline Survey Methodology

The socioeconomic profile of the project area is based on the socioeconomic survey of the 20 villages comprising the Area of Influence. A survey in the Project area was carried out to develop a socio-economic baseline of the general population in the proposed AOI. A sample of 2,099 households based on 20% sample size was selected by applying simple random sampling technique. The sample also included already identified 141 affected households (AHHs) in the socioeconomic data from the six villages which are located within the area of impact. The key socio-economic aspects studied include the demography, housing patterns, nature of agriculture, availability of social infrastructure and amenities, livelihood opportunities, and economic well-being.

5.2.3 Overview of Project Area

The MHPP is situated in Madyan, District Swat in north of Khyber Pakhtunkhwa Province. The Swat River passes through the district in the middle dividing it into two distinguished parts. The district has been divided into seven Tehsils for administrative control. The gross area of the district is 5,337km². The total population of the Swat District during 2017 Census was 2,308,62 inhabitants. The male and female ratio is 59% and 41% respectively. The cultivation in Swat is spread over 97,281 hectares of area, while uncultivated area is 409,247 hectares. Forest is spread on 138,282 hectares.[28]. The population within the AOI are settled on both right and left bank of the Swat River. The entire population speak Pashto as their mother tongue.

5.2.4 Demography of Surveyed Households

A sample-based socioeconomic survey was carried out in the project area to collect the baseline information on various aspects of the social and socioeconomic aspects of the communities. The total population of the surveyed households is 2,099, comprising 1,103 males and 996 females. The proportion of male and female works out as 52% and 48%, respectively with a gender ratio of 1: 1.08. The age of the family members has been distributed into the various age brackets to understand their level of contribution to the household income keeping in view the adult equivalent. About 47% of the population is within the age range up to 18 years. The economically active age group within the age range of 19-50 years is about 41% of the population. This segment of the population is generally considered the bread earner of the household. The table reveals that about 60% of the population is economically dependent. The gender-segregated statistics of household members are given in **Table 5.14.**

[28] http://kpboit.gov.pk/swat-district/#:~:text=Cultivation%20in%20Swat%20in%20spread,is%20spread%20on%20138%2C282%20hectares.

Table 5-14: Gender Segregated Age Distribution

Age Range	Number of Respondents					
(In years)	Male	%	Female	%	Total	%
0 – 10	276	25.02	252	25.30	528	25.15
11 – 18	240	21.76	230	23.09	470	22.39
19 – 50	452	40.98	399	40.06	851	40.54
51 and above	135	12.24	115	11.55	250	11.91
Total	**1103**	**100.00**	**996**	**100.00**	**2099**	**100.00**

5.2.5 Education Facilities

The project area has poor educational facilities. The existing educational facilities in the villages are not satisfactory except for primary levels institutions. According to data collected through Village Profile Survey, there are total 48 schools (28 for boys and 20 for girls) in the AOI of the project. Of these institutions, 34 schools are primary level, 09 schools are middle level and 05 schools are matric level. The number of primary schools for male and female are 20 and 14 respectively. The number of high schools for male and female are 3 and 2 respectively. The number of male teachers available for the reported 20 primary schools are 96, middle schools are 32 and high schools are 48. The number of female teachers for the reported 14 primary schools are 36, middle schools are 22 and high schools are 15. The student teacher ratio at boys Primary, Middle and Matric level institutions work out as 43:1, 47:1 and 26:1, respectively. The ratios for girls' institutions works out as 46:1 at primary level, 22:1 at middle level and 38:1 at high level schools. The overall ratio comes to 38:1. There exists no inter or degree level college for boys and girls. There exist no institutions for professional education in the project area for males or females. Out of total population of 80,573 persons of the villages falling in the AOI (Table 5.15), the enrolled population comes to 6,841 for males and 2,690 for females thus showing access educational facilities to the 8% of male and 03% of the female segment of the total population. The information relating to educational facilities in the Project Area is furnished in **Table 5.15.**

Table 5-15: Number of Educational Institutions in the Project Area

Institution	No. of Schools		Enrolment (No.)		No. of Teachers		Student Teacher Ratio	
	Boy	Girl	Boy	Girl	Male	Female	Male	Female
Primary	20	14	4,111	1660	96	36	43.02:1	46.11:1
Middle	5	4	1,500	480	32	22	47.37:1	21.82:1
High	3	2	1,230	550	48	15	25.63:1	36.67:1
Total	28	20	6,841	2,690	175	71	39.04:1	37.89:1

5.2.6 Literacy Levels of Respondents

The survey has revealed that out of total population, male literacy rate in the project area is 79% and female literacy rate is 75.5%. The following Table 5-16 presents the male and female respondents literacy level. The male and female literacy level of the respondents were reported 21.28% and 24.5% respectively. The male and female middle level education is reported 6.76% and 3.95%, matric level education is reported 10.45% and 8.59% respectively. The master level education of male and female is reported 2.64% and 1.2% respectively. The Information in respect of literacy levels of the sample population is furnished in **Table 5-16.**

Table 5-16: Literacy Status of the Sample Respondents

Sr. No.	Education	Male %	Female %	Total %
1	Illiterate	21.28	24.5	22.89
2	Can do Signature	0.59	0	0.30
3	Read Quran	7.16	16.78	11.97
4	Primary	10.52	10.19	10.35
5	Middle	6.76	3.95	5.36
6	Matric	10.45	8.59	9.52
7	FA	5.52	4.1	4.81
8	BA	4.12	3.07	3.60
9	MA	2.64	1.2	1.92
10	LLB	0.2	0	0.10
11	Tech. Diploma	0.7	0.15	0.43
12	Dars e Nazami	1.6	0	0.80
13	Children up to 10	28.46	27.47	27.97
Total		**100.00**	**100.00**	**100.00**

5.2.7 Income and Livelihood Analysis

The major source of livelihood for the project population is agriculture. Other occupations and income generating activities are being practiced in the project area include farming, employment in government and private sectors, daily wage labor, operating businesses such as running a grocery shop and working abroad. About 45% of the respondents earn from multiple professions. Additionally, the family incomes are supported by the family members who have gone abroad. The income analysis reveals that about 43% of the total family income is contributed by the family members. Details of livelihood sources of sampled households are given in **Table 5-17.**

Table 5-17:Livelihood Sources of the Surveyed Households (in percent)

Professions	% of Total
Farming	43.4
Farming & Shopkeeper	7.90
Farming & Government. Service	5.98
Farming & Private. Service	15.10
Farming & Laborer	13.15
Farming & Livestock Keeping	1.42
Shopkeeper General	1.42
Farming/ Trading	1.26
Government. Service	1.13
Private Service	2.20
Laborer	2.50
Gone Abroad	1.42
Farming/ Driver	1.70
Trading	1.42
Total	**100.00**

Income from livestock also contributes to the agriculture income through milk production and the sale and purchase of animals. As depicted in **Table 5-18**, about 94% of the surveyed families have livestock (mainly cows and goats), with an average number of 03 cows and 05 goats/sheep per household, respectively. The average number of poultry birds per household is works out as 06.

Table 5-18: Livestock Inventory of Surveyed Families

Type of Animal	No. of HHs with Animals	No. of total Animals
Buffaloes	4	6
Cows	130	380
Donkey	30	30
Sheep, Goat	118	560
Poultry	140	820

5.2.8 Income and Poverty Levels

Based on the sources of livelihood, the average annual income of per surveyed family works out as PKR 665,021. The average monthly income comes to PKR 55418. The income was related to the Official Poverty Line (OPL). The OPL of Rupees (PKR) 3,030 per capita / month was estimated by the Planning Commission in 2014–201529. The latest estimate of inflation–adjusted poverty line per capita per month for 2021-2230 comes to PKR 4570 or PKR 35,966 per family per month (4570*7.87). The OPL for an average household in the project area works out to be PKR431,590 (4570x7.87x12=431590). The calculated average monthly income of PKR 55,418 per household (HH) is higher than the OPL. However, the income is 50% less than the World Bank estimated OPL of $ 1.90 per capita per day[31] (or PKR 475 per capita per day). The income analysis of the surveyed household (HH) is provided in **Table 5-19.**

Table 5-19:Income Analysis of the Surveyed HHs

Total Surveyed Families	264
Average Family Size (No.)	7.87
Total Annual Income of Surveyed Families (PKR)	175,565,617
Average. Annual Income Per Surveyed Family (PKR)	665,021
Av. Monthly Income Per Surveyed Family (PKR)	55,418
Av. Daily Income Per Surveyed Family (PKR)	1,847
Av. Daily Income Per Capita (PKR)	232.36

The income distribution analysis reveals that about 49% of the affected families are living below the OPL. The remaining 51% AFs have income greater than the OPL. These may be categorized as non-poor or rich. The income levels of the respondent households are shown in **Table 5-20.**

Table 5-20: Income of HHs within Different Income Brackets

Range of Income (PKR)	Affected Families	
	No.	Percentage
Up to 150,000	10	3.79
150,001 - 300,000	50	18.94
300,001 - 450,000 (Equal to OPL)	69	26.14
Above 450,000	135	51.14
Total	**264**	**100.00**

[29]http://www.finance.gov.pk/survey/chapters_16/Annexure_III_Poverty.pdf - Pakistan Economic Survey

[30] https://www.finance.gov.pk › PES07-INFLATION

[31] https://blogs.worldbank.org/opendata/september-2019-global-poverty-update-world-bank

5.2.9 Household Expenditure

The baseline information relating to the HH expenditure pattern in respect of the surveyed population is shown in **Table 5-21.**

Table 5-21:Average Monthly Expenditure of the Respondents

Expenditures	Total Monthly (PKR)	Total Annual (PKR)	%
Food Expenditure	26,750	321,000	59.16
Non-Food Expenditures	8,210	98,520	18.16
Utilities	1,990	23,880	4.40
Education of Children	2,570	30,840	5.68
Clothes & Shoes	2150	25,800	4.75
Occasional Expenditures	2,240	26,880	4.95
Healthcare	1,310	15,720	2.90
Total	**45,220**	**542,640**	**100**

The above information indicates that the expenditure on food items is about 59.16% and non-food items are 18.16%%. Utilities expenditures are calculated 4.40%, expenditures on children education are 5.68%, health care expenditures are 2.90%. Occasional expenditures and expenditures on clothes and shoes are calculated 4.95% and 4.75% respectively.

5.2.10Land Tenure, Land Use and Natural Resources

The project area falls in the settled area per revenue records. In general, the area is hilly/ mountainous and there is a scarcity of flat and arable land. The land use pattern in the area is mixed type having forest cover, agricultural, and barren land. Most of the surveyed households own the agriculture land. All of them own a piece of land on which their houses are built. In case of tenant farming, the tenant farmers take one-third of the total produce of the farm. Until the head of the family is alive, only residential land is allotted to the sons, and once the patriarch's head passes away, the agriculture land is divided. A majority of the households only distribute land in between the sons, and daughters rarely get a share. In cases the daughters are offered their share of agriculture land, they refuse to take it due to cultural reasons. Per land use analysis (Table 5-1), forest cover occupies 36.79%, barren land 32.7%, agriculture land 17.81%, river and streams 6.23%, and built-up area 5.27% of the total land use. The water streams are divided among communities or sub-tribes, and everyone knows who owns what piece of land.

5.2.11 Credit Levels of HHs

5.2.11.1 Status of Credit Obtained by the Households

The survey has revealed that generally, credit is obtained to supplement income of the households to meet routine and some occasional expenditure, including purchasing of house, construction and maintenance of the house, purchase of farm input/ livestock and investment on social needs. Credit is obtained from formal sources (banks/ institutions/ private money lender) and non-formal sources (like friends, relatives, and landowners). Based on survey analysis, four categories of credit brackets were constituted as presented in the following Table 5-22. Out of total surveyed population, the households who obtained credit up to Rs:20,000 are 8.33%, credit from Rs:20,000 to Rs:50,000 were 9.85% and the households who obtained credit more than Rs:50,000 were 14.77%. The households reported not obtained credit were 67.05%. Details are given in **Table 5-22.**

Table 5-22:Average Amount of Credit Obtained by the Surveyed Households

Amount of Credit Bracket	Households Obtained Credit	
	(Nos.)	%
< PKR 20,000	22	8.33
PKR 20,000 – PKR 50,000	26	9.85
>PKR 50,000	39	14.77
No Credit Obtained	177	67.05
Total	**264**	**100.00**

5.2.11.2 Source of Credit

The majority of the respondents had taken credit for investment purposes in some business activities and have taken a loan from their relatives. Among surveyed households who obtained credit, most of them have obtained it from non-formal sources. None of the surveyed households obtained credit from formal institutions due to the requirements of collaterals and payment of interest rates. The details regarding sources of credit are presented in **Table 5-23.**

Table 5-23:Sources of Credit

Sources of Credit	Households who Obtained Credit (Nos.)	Percentage (%)
Private money lender	35	40.23
Relatives	20	22.99
Shopkeeper	20	22.99
Other	12	13.79
Total	**87**	**100.00**

5.2.11.3 Purpose of Credit Obtained

The purpose of credit obtained is to supplement income to meet routine and some occasional expenditures of the household. Most of the households (about 50%) obtained credit for domestic matters (for meeting social obligations) and for health-related issues.

5.2.12 Housing Conditions

The ownership and housing condition are some of the key indicators for the assessment of the living standard and well-being of households. The main household structures consist of living rooms, animal shed/ room, and washroom. For analysis of the information related to housing condition of the surveyed households, seven class intervals were constituted and inferences are drawn. The survey findings reveal that the households who had one living room were 1.89% of the total population, the households who owned 2 living rooms were 18.94%, the households who owned 3 living rooms were 20.83%, households with 4 living rooms ownership were 18.94%, households owned 6 living rooms were 12.50% and households who owned more than 6 living rooms were 13.64%.

The survey also assessed the type of housing structures. As presented in the following Table 5-24, the Kacha houses were calculated 41.67%, Pakka type of houses were calculated 31.82% and Semi-Pakka were calculated 26.52%. in the survey findings, it was reported that 66.67% of the households have animal sheds and 41.67% have proper kitchen in their houses. About 100% of the households have bathrooms in their houses. The type of bathrooms structures was reported 41.67 Kacha, 31.82% Pacca and 26.52% Semi Pacca. About 100% of the households were reported having flush latrines in their houses.

The details regarding the type of construction/ housing conditions of different structures/ sub-structures are presented in **Table 5-24.**

Table 5-24: Details about Housing Types and Conditions

No & Type of Structure	No.	%
Houses		
With 1 Living Room	5	1.89
With 2 Living Rooms	50	18.94
With 3 Living Rooms	55	20.83
With 4 Living Rooms	50	18.94
With 5 Living Rooms	35	13.26
With 6 Living Rooms	33	12.50
More than 6 Rooms	36	13.64
Sub-Total:	264	100
Kacha	110	41.67
Pacca	84	31.82
Semi Pacca	70	26.52
Sub-Total:	264	100
Animal Sheds		
Kacha	88	33.33
No Animal Shed	176	66.67
Sub-Total:	264	100
Kitchens		
Kacha	110	41.67
Pacca	84	31.82
Semi Pacca	70	26.52
Sub-Total:	264	100
Bathroom	No.	
Kacha	110	41.67
Pacca	84	31.82
Semi Pacca	70	26.52
Sub-Total:	264	100.00
Latrine	No.	
Flush	264	100
Sub-Total:	264	100

5.2.13 Public Health Facilities

The common diseases in the project area include the seasonal diseases, diabetes, fever and cough. The healthcare facilities such as hospitals, Rural Health Centre (RHC), Basic Health Units (BHU) and rural dispensaries are non-existence in the area of impact of the project. There exists no hospital at tehsil headquarter Bahrain. There exists one RHC and one BHU at Bahrain. However, recently, Tehsil Headquarter Hospital at Madyan has been operationalized. It is spread over 8 acres of area and contains 5 emergency rooms, 6 private rooms, 01 labor room,10 OPD rooms, 05 houses for staff, 42 beds and hostel one each for nurses and paramedical staff. It is hoped that the hospital will provide relief to the local people in their health care. The other nearest place with medical facilities is at Mingora city which is about 56 km away from the project area. It is hoped that the operationalization of hospital at Madyan will help in providing the better medical facilities to the people of the area at their door step.

5.2.14 Employment and Business Opportunities for Locals

The economy of this mountainous area has attraction for tourists from the country and from abroad, hence provides a number of employment and business opportunities to the locals. Swat is famous for peach production mostly grown in the valley bottom plains. The supply starts from April and continues till September because of a diverse range of varieties grown. The local people of the proposed project area from all income groups are also associated with both these sectors for earning their livelihood and contribute their share in local economy. Besides, there are a number of employment and business opportunities for the locals. Farming is the main sector where 42% of the population is engaged. It also provides employment to 4% of the population as farm labor. About 07% of the population work in government and private sectors[32]. Men and women are also involved in animal rearing and wood cutting and collecting. With the improved agriculture these sectors are likely to provide more space for employing labor/ tenants for farm work and increase in the related business. Livestock also provides business opportunity in the area both to males and females by adopting improved dairy farming methods.

5.2.15 Prevalence of Conflict and Cohesion

People of the project area live in a commonly prevailed tribal, social and cultural system. Peace and solidarity prevail in the Project area. The community is homogeneous, and members are known to each other. There are not many serious issues or tensions in the local communities except few individuals having feuds and rivalries. In case of any dispute or feud, the local Jirga resolves the issues then and there. The most common causes of tensions are land and forest disputes. There is a constant tension between the Forest Department and the local population as the Forest Department wants people to inform the officials before the locals cut trees as the trees are legally owned by the Forest Department. However, the locals are of the opinion that the forest is owned by the locals and that they do not need to inform them before cutting trees. Tree cutting in the forest is illegal and the locals cut trees at night. Only the locals cut trees. The locals have demanded that they would stop cutting trees if the government was to provide them with free electricity to help them heat their houses and for cooking purposes.

The conflicts in the region are resolved through traditional Jirga system. The matters that are not resolved by the local Jirga are taken to the court of law. However, no disputes are reported by the respondents. In case of some dispute, Jirga is a commonly acceptable decision-making forum in the project area for conflict resolution, as reported by the overwhelming majority of the respondents. A jirga is a traditional assembly of leaders that make decisions by consensus and according to the teachings of Pakhtunwali. The Pakhtunwali is a traditional lifestyle of the Pakhtuns and interpreted as "the way of the Pakhtuns" or "the code of honor."

5.2.16 Seasonal Migration Trends in the Project Area

Bahrain and Madyan are tourist destinations during the summer and winter seasons and therefore, the men in the area are engaged in seasonal employment. These areas receive comparatively very less snowfall during winter months and provide an attractive spot for the tourists. Like Kalam and upper valleys, the people from Bahrain and Madyan do not migrate to down country plain areas. However, some of the well-off families in the area also own homes in the lower districts and move there in winter season at their choice but not as a weather-related compulsion. Their businesses and other income generation activities remain continued.

5.2.17 Physical Cultural Resources

Based on the environmental and social baseline surveys and stakeholder's consultation, no critical cultural heritage recognized internationally as cultural heritage or legally protected cultural heritage in the AOI of the MHPP project.

Since the Swat was one of the most significant centers of Gandhara civilization since, first century before Christ (BC33. The possibility of unexpected "chance finds" in the project area is high. Therefore; as per World Bank policies and Khyber Pakhtunkhwa Antiquities Act, 2016, procedures dealing with "chance finds" are to be included in the ESMP for the construction contracts. Tourism

The area is famous for lush green hills, thick forests and bestowed with mesmeric streams, meadows, and waterfalls which are worth seen features of the landscape. The valley of Madyan is situated about 56 kilometers to the north of

[32] Source: MHPP RAP, 2023.

[33] "The Uddiyana Kingdom: The Forgotten Holly Land of Swat" by Fazal Khaliq.

Mingora city. It lies on the main road that leads to Bahrain, Kalam and other beautiful valleys of Swat. Its riverside location and cool climate make it an attractive spot with rows of shops, hotels and restaurants queued along the road. A trout hatchery adds to its fascination. Local handicrafts, embroidery and antiques are displayed at roadside shops. There are about 13 hotels in Madyan. Almost every type of modern facility and amenity is available here, i.e., internet, cellular networks, cable and satellite TV, hotels, restaurants and other basic necessities of life.

About 8 km upstream from the Madyan, there lies a picturesque Bahrain town. This small riverside town is the most frequently visited resort because of its location on the road leading to other beautiful resorts. A humming bazaar with shops, eateries and hotels make it a popular place. Household traditional decoration items are available at shops. Nearby valleys full of lush green thick jungles offer hiking on narrow mountainous paths. The 2022 floods made a wide range destruction to the infrastructure of this valley. There existed about 30 hotels at this town before 2022 floods. Of these, 15 hotels that were located on the river bank were washed away by the flood. Both these sites are located within the area of influence of the project.

Besides, Kalam, Ushu (in the northeast of Kalam valley), Matiltan (location of large glaciers, thick forests, and lofty mountain peaks) and Utror (surrounded by snow-clad mountains) are the sites of tourists' attraction upstream of the project area. These sites are located outside the project influence area, and there will be no impact on these locations from the proposed project activities.

5.2.18 Security Situation in the Project Area

It is required for the success of a project that peaceful working conditions prevail in the project area and the construction site are safe from the malicious actions of the anti-social elements. The survey has revealed that presently, the security situation in the project area and surrounding areas is satisfactory and is under control of the local authorities. The people are peace loving, helpful and cooperative with the project staff. However, there are reports that security risks in the District Swat may arise in the near future due to terrorist activities. Furthermore, there may be security risk to foreign experts from groups with malicious intents. Under such situation, it is a pre-requisite that a Security Plan is prepared for MHPP with the active involvement of national security agencies, local administration, the security experts from PEDO, contractors and the PIC.

5.2.19 Natural Disasters in the Project Area

Floods, earthquakes, land and glacier sliding are the most common natural disasters in the Project area. In the last ten years, the project area has been flooded twice and has badly affected the local people and their assets. The natural disaster flood in August 2022 was the worst and severely affected large area of Swat. The disaster of this flood has badly affected countless resources and property of the masses of the area. The Bahrain and Madyan falling in the project area were among the worst affected areas. Seven bridges and five mosques and a several hotels and other infrastructures and property of the people were completely destroyed. Most of the hotels which were very near on the bank of the river were completely submerged in the floodwaters. The flood water overflowed on the narrow bazaar of Bahrain. The flood completely washed away 173 shops (112 in Bahrain and 61 in Madyan) depriving thousands of people from their livelihood. Beside 21 trout hatcheries at Madyan and one at Bahrain were completely washed away. In both towns 554 house (396 in Bahrain and 158 in Madyan) were fully or partially damaged. The flood also affected 37 drinking water supply (20 in Bahrain and 17 in Madyan). A total of 28 irrigation channels (13 in Bahrain and 15 in Madyan), sewerage system of Madyan and Bahrain bazar were almost completely damaged in the area. The road between Bahrain and Kalam which was built in 2018, was completely destroyed. Besides, 2 link roads were also damaged[34].

5.2.20 Use of Forest by Local Communities

The local communities use the forest for multiple purposes including fuel wood, construction, and for income generation purposes. Throughout the summers, the locals from middle income and low-income groups collet 500-600 kg of wood, and store this wood for the winter season. The wood is also used for construction purposes to manufacture doors, roofs, and windows of the houses. The wood is sold to better-off and middle-income households and thus becomes a source of income for the poorer families. The wood is also used to keep houses warm and for cooking purposes. The locals also produce furniture and make decoration pieces from wood. The locals believe that the forest keeps them safe from land

[34] MHPP RAP March 2023

erosion and land sliding. The women and girls collect fodder or bushes in the winters to feed animals, and use their branches as firewood and for fuel purposes.

5.2.21 Gender Assessment

5.2.21.1 General

In the present-day life, the gender is considered as one of the central determinants of differential access to, use of and control over economically productive resources (land, labor and capital) and opportunities. According to the results of 2017 population census, women constitute about 50% of the population of the country and the same ratio holds good for the KPK and at Project Area levels. The Pakistani women face numerous gender inequalities in the social context and therefore, it impacts their participation in water resources related debates, policy, programs and community-level initiatives. As per Human Development Report 2022, Pakistan. The country also ranks 178th on Gender Development Index out of 181 countries[35]., with a value of 0.544 and on the Gender Inequality Index ranks at 135 out of 192 and has a value of 0.534. As per the Global Gender Gap Report 2022, Pakistan ranks at 145 out of 146 countries and has a score of 0.564 points. The importance of empowering women across the board and mainstreaming women in the management and governance of water has been recognized at the global level since the 1980s, and Pakistan is a signatory to all the relevant water declarations and commitments. Gender inequalities are deeply rooted in the country's social and cultural norms and practices, resulting in discrimination with women and girls, which affect the quality of their life. Gender inequality in Pakistan in general and specifically in Khyber Pakhtunkhwa is characterized by the society and thereby, men on average are better positioned in social, economic, and political hierarchies.

Gender assessment seeks to understand the distinct culturally and socially defined roles and tasks that woman and men assume both within the family and household system and in the community. The gender perspective recognizes that some issues and constraints related to project success are gender specific, and stem from the fact that men and women play different roles, have different needs, and face different constraints on a number of different levels. The gender assessment is based on the findings of the socioeconomic and gender surveys, consultations with the elders and general people, discussions with the project office staff, with officials of the line departments and other key stakeholders. Gender surveys were carried out in the project impacted villages from June 2022 to October 2022. The objectives of the surveys aimed at to hold discussions with groups of women to understand their issues, priorities, challenges and participation in the project. Gender roles are constructed on the basis of the concepts of production and reproduction. The unequal gender roles are reinforced and maintained and influence male and female life circumstances. Women and girls experience differential access to food, education, medical care and access to resources and opportunities; their general and reproductive health is negatively affected due to restrictions on decision making and their mobility. Most of the women's roles are limited to family and are excluded from main decision making at household and society level. Lack of sufficient time, gender bias, social and cultural norms as well as family responsibilities are the most significant challenges women face to achieve balance in a patriarchal society. The sections below document the outcome of gender assessment. As a result of gender assessment, a Gender Action Plan (Annex-II) has been developed for gender mainstreaming in the Project.

5.2.21.2 Education Facilities

Education facilities in the project area are very meagre. The number of female primary schools 14, middle schools are 04 and high schools are 02. The number of male teachers available for the reported 20 primary schools are 96, middle schools are 32 and high schools are 48. The number of female teachers for the reported 14 primary schools are 36, middle schools are 22 and high schools are 15. There exists no inter or degree level college for girls. There exist no institutions for professional education in the project area for females.

People of the area are aware of the importance of education, especially for girls. They are of the view that by getting a formal education, girls to become good wives, mothers, and daughters and thus become aware of their duties, rights, and responsibilities in society. They are also aware that education helps them improve their lifestyles and provide them with a ray of hope to get out of the darkness towards light.

[35] https://www.pc.gov.pk/web/gender#:~:text=The%20country%20also%20ranks%20178th,Platform%20for%20Action%20(1995).

5.2.21.3 Health Issues & Facilities for Women

As discussed earlier, the healthcare facilities such as hospitals, Rural Health Centre (RHC), Basic Health Units (BHU) and rural dispensaries are non-existence in the area of impact of the project. There exists no hospital at tehsil headquarter Bahrain. There exists one RHC and one BHU at Bahrain. However, recently, Tehsil Headquarter Hospital at Madyan has been operationalized. The other nearest place with medical facilities is at Mingora city which is about 56 km away from the project area.

The analysis had further revealed that women are the most vulnerable due to this situation and are in dire need of medical facilities. Even in case of delivery, traditional birth attendants are not available in the nearby localities. According to the information gathered, very few women of better income families receive treatment from antenatal care centers outside the project area; similarly, a very negligible number of women receive any form of post-natal care from skilled birth attendants. To get any type of treatment, they have to travel a long distance to the health facilities, lack of roads and financial constraints, and social pressures.

The gender survey has revealed the women of the area have multiple health issues. The most common illnesses among women are joint pain, anemia, seasonal fever, and depression. Women described that bearing of children without any break is a cause of concern for their health and is also added a financial burden on the household. There are no registered traditional Birth Attendants, Midwives available within the project area and people turn to local midwives and, in case of emergencies, either visit the RHC or BHU at Bahrain.

5.2.21.4 Participation and Role of Women in Decision Making

According to the socioeconomic survey, the participation rate of women in various activities relating to the household economy in the project area is generally high, however, their participation remains limited to domestic matters only. Women are generally excluded from decision-making processes. A male elder, often also the head of the household is in control. He makes all decisions regarding the household income and its sources, education, health, marriage, and conflicts. When needed, he consults with other male members. However, within the household, women wield much influence in the decision making. The head matriarch is often the person who selects the brides for the family's sons and holds authority over younger wives. Information in respect of women participation and decision making in the routine socio-economic life at household level is presented in **Table 5-25.**

Table 5-25: Decision Making by Women in Different Socioeconomic Activities

Activities	Participation (%)	Decision Making (%)
Household Activities	96	90
Child Caring	100	75
Farm/Crop Activities	15	08
Livestock Rearing	45	15
Sale & Purchase of Property	35	10
Social Obligation	88	55
Political Representation/ Participation	02	-

Gender inequalities in the project area are pronounced and entrenched, particularly in the arena of participation and decision-making. This exclusion translates through to the economic realm where it contributes to the impoverishment of women as well as to inefficiencies and lost productivity, negatively impacting the whole society. Employing a gender perspective from design to monitoring and evaluation offers insights that allow for better targeting and improved efficiency of the MHPP.

5.2.21.5 Mobility of Women

Women visit families, friends, and weddings and go out for shopping. However, as the markets are an average of 4.5 km away from the villages, and the women are accompanied by either an elderly woman or a male member of the family or a male child. Women travel for up to 30 minutes, 3-4 times a day to collect water from nearby streams and springs and use the water for drinking, cooking and cleaning and washing purposes. They also help the male members of their families in agriculture fields, which are generally next to their homes. However, women go in pairs and do not travel alone. Women always accompany the male members of the households to the BHU and to the hospital. Women rear animals and collect wood. It is pertinent to mention here that the women are allowed to visit their relatives and family friends on their own tribe within or outside of their villages. Women rarely go out for the purchase of grocery items and grocery shopping is mostly done by the male members of the family.

5.2.21.6 Availability of Skill Centers

There are no technical or vocational training centers for the women in the project area or in other nearby towns. The local artisans, both male, and female prepare many items from the local wood, including decoration pieces, beaded bracelets, and other such items. Some of the women are engaged in embroidery, but their products are taken to the market by men for selling. About 30 % of women of affected households are involved in stitching for women and children's clothing and earn up to PKR 200 per suit. On a monthly basis, a woman earns up to PKR 5000. About 25% of women from households' stitch clothes of female members of their families and children.

5.2.21.7 Concerns of Women about the MHPP

Consultation was carried out with the women. During consultation, it was found that majority of the female participants were illiterate. Most of them belonged to poor families and living in small houses. When asked that whether they knew about the MHPP many of the participants exclaimed that they had heard about the construction of the MHPP, but they had no detailed knowledge about it. When explained by the social team about the compensation and SDP that project has planned to provide in the project area, they generally showed a welcoming behavior toward the project. Local women identified the following problems in their area for the interventions through the Project.

Table 5-26: Key Concerns & Addressal

Key Concerns	Addressal
Women participation in the activities outside the home is limited. However, in case of loss of any property/assets, crops/trees, compensation will be provided.	Compensation will be provided to the eligible and entitled PAPs including women and vulnerable people in accordance with the entitlement matrix of compensation given in the present RAP/entitlement matrix covering the current market rates and replacement cost. Entitlements and compensation issues were also discussed with women. Women will be entitled for the compensation.
In some cases, local women are working in agricultural fields, so their routine activities will not be disturbed due to the construction activities.	• Liaison with the community will be maintained during construction activities. • The construction staff will be provided trainings regarding local norms. • The construction staff will comply with code of conduct. • A grievance redress mechanism (GRM) will also be established to address community complaints.
Females of the community were eager to know if there will be any provisions in the project for area development.	A social development plan (SDP) has been designed and SDP will be implemented as provided in the RAP to cater to the priority development needs of the area. Gender inclusion will be ensured and a dedicated Gender Action Plan will be
The local community will be allowed to collect the wood material from the trees cut.	• Compensation for any tree to be chopped will be paid to the owner. • The owner will be allowed to take the fallen trees.

Key Concerns	Addressal
Resettlement issues will be discussed in the presence of whole local community/local population including female.	• Extensive consultations with women have been carried out while preparing the present RAP • Finalized summary of RAP will be disclosed and an Urdu translation will also be shared with the communities and women. • RAP implementation will be carried out in a participatory manner as explained in the present RAP. • Affected persons (APs) both for men and women will be established to
Females of the project area will be employed during project implementation stage for undertaking some office work/file management.	Contractor will maximize employment of the locals and preference will be given to the PAPs including women.
Family male members will be employed in the project related jobs so that they can get the jobs in their own city/village instead of moving towards other cities for jobs. In this way their social safety could be enhanced.	One member from the affected family will be selected for skills training under livelihood restoration and improvement plan (LRIP). After getting training he may find suitable job at the project. Contractor will maximize employing the locals and preference will be given to the project affected persons (PAPs).

5.2.21.8 Women's Participation in Income Generating Activities

Women are involved in several household and income generation activities, including:

- Employment as private and government school teachers, lady health visitors/ workers and traditional birth attendants.
- Poultry, cleaning cot, supervise hatching, feeding, and animal rearing.
- Other household chores include washing clothes, fetching water and firewood, cooking, child caring, cleaning and repairs of household items, participation in social obligations/ marriages and gathering.
- Agricultural and farming activities such as harvesting, picking of vegetables and drying fruits.
- Livestock rearing, collection of fodder, grazing, washing buffaloes, processing the milk products.

5.2.21.9 Women Issues & Needs Assessment

Due to the patriarchal tribal structure in the project area, women generally lack access to and control over the productive resources. Women's marginalization within and outside the household is mirrored in the social life patterns in the project area. They are not considered by the males in making the decisions about various socio-economic matters, particularly relating to activities which require interaction with others such as decisions about children education, farm business, sale and purchase of livestock or property and participation in the political activities/ process. About this attitude, the male respondents were of the view that women had nothing to do with the outside world. They are required to remain within their houses and look after the children. Traditionally, the males have been undertaking out outside home responsibilities and according to them, the females have not exposure or courage to deal and decide upon such matters. This attitude is a source of social deprivation, stress for the women of the tribal society and render them socially excluded.

Women Empowerment refers to increased and improved social, economic, political and legal strength to ensure equal-right to the socially excluded segment of the society (the women), and to make them confident enough to claim their rights. Women are key agents for achieving the transformational economic, environmental and social changes required for sustainable development. But in the tribal society, they stand socially excluded. The situation may be improved by empowering the women[36]. This requires that, i) their access to services, resources and materials is increased, ii) they are provided with information on merits and demerits of hydropower development with special reference to the MHPP via the most appropriate medium, iii) their abilities are improved to present their issues at the proper forums, iv) their self-confidence and self-respect are stimulated, and v) they organize themselves for group work.

A Gender Action Plan (GAP) provided in this ESIA (Annex-II) will be implemented. GAP includes various actions to ensure the empowerment and inclusion of the women and. The development needs of the women will be addressed in the SDP based on broader consultations with the communities. During consultation and detailed needs assessment of the women, cumulatively the following **(Table 5-27)** needs were raised by the women of the project area.

Table 5-27: Ranking of Development Needs of the Surveyed Households

Rank their needs on the scale	Road	Water Supply	Health Care Centre	Primary and High school for girls	Vocational Centre for Women
Less than 1	-	-	-	-	-
Between 1 and 5			22.00%	19%	28%
5 and above	67%	75%	62%		

5.2.21.10 Routine Activities of Women and their Employment Status

The survey has revealed that there are very few occupational opportunities available for the women in the area. Very few women are doing jobs, due to social and cultural pressure. A few of them are teachers. Some women from the lower income group working in the agriculture fields, alongside the male members of the household. The cash crop of the project area is vegetable and maize. Women are mostly busy in their household activities such as cooking, cleaning of houses, fetching water and taking care of their children as well as other family members. Due to heavy load of household work, it is very difficult for women to have any leisure time. But whenever they find some time, they stich, do embroidery, and sew clothes. Some girls keep themselves busy in making decoration items in different designs.

According to the findings of the survey, the situation relating to employment of women is not encouraging in the project area. The survey has revealed that out of total population of 1110 persons, only 04 women (0.28%) were reported serving in different institutions. The serving women constitute only a fraction of the total sample population. The employment status of the women in the project area is shown in **Table 5-28.**

Table 5-28: Employment Status of Women

Sr.No.	Village	Age (Years)	Education Attained	Department	Monthly Earnings
1	Kedam	50	Matric	Govt. School Teacher	40,000
2	Kedam	48	MA	Private School Teacher	45,000
3	Ayeen	49	Matric	Govt. School Teacher	40,000
4	Kalagay	45	Middle	Private Hospital (Dai)	20,000

The project offers great opportunity to positively work towards improving the lives of both women and men. However, without adequately taking into consideration the stark gender inequalities in the project area, the implementation of the project activities may have unintended negative consequences. Gender inequalities in the project area are pronounced and entrenched, particularly in the arena of participation and decision-making. This exclusion translates through to the economic realm where it contributes to the impoverishment of women as well as to inefficiencies and

[36] The important indicators to understand different components of social empowerment include:
- level of participation in self-help groups,
- participation in decision making at home,
- freedom from domestic violence,
- level of self-confidence,
- self-esteem,
- freedom of movement,
- increased awareness

lost productivity, negatively impacting the whole society. Employing a gender perspective from design to monitoring and evaluation offers insights that allow for better targeting and improved efficiency of the MHPP.

6 Biodiversity Baseline

This chapter presents baseline about biological diversity, status of floral and faunal elements, **(Annex IV)** and study area for biological diversity is given in the following Figure 6-1.

6.1 Methodology for the Biodiversity Survey

Biological environment covers floral and faunal resources including all types of vegetation in different habitats in the study area, aquatic life including fishes and terrestrial vertebrate species including amphibians, reptiles, birds and mammals. Biological baseline studies in the project area were planned to be conducted in four field visits covering spring, summer, autumn, and winter seasons. Biodiversity surveys of spring, summer, and autumn seasons were conducted during April, July, and November 2022 respectively while the winter survey was conducted during January 2023.

6.1.1 Secondary Data Review

To record the existence of every possible wildlife species in the study area, available literature was collected and reviewed. A number of research articles and books were consulted during literature review, and it is not possible to add all those references here in the main report. Based on the available literature, checklists of different floral and faunal species were prepared which were then confirmed through observing different species directly during the field visits.

A detailed biodiversity baseline of the catchment area up to Bhann Game Reserve including Gabral HPP till the end of the Madyan HPP is in progress[37]. However, for the MHPP project specific biodiversity surveys were conducted in the Biodiversity Study Area or Ecologically Appropriate Area of Analysis (EAAA)[38] which is broader than the area defined as AOI of the project.

Based on multiple season biodiversity survey, the Study Area for aquatic fauna was defined to include about 2km wide and 16km long stretch of Swat River upstream from Weir to tailrace including the tributaries arising from both sides of main river. As shown in the Figure 6-1, most of the tributaries were surveyed for aquatic fauna.

Sampling points for the aquatic resources of the Study Area are shown in the **Figure 6-1.**

[37] Annex 4: TOR for Biodiversity Studies and Monitoring During Construction available on https://documents1.worldbank.org/curated/en/296181599061060117/pdf/Pakistan-Gabral-Kalam-Hydropower-Project-Environmental-and-Social-Impact-Assessment-Executive-Summary.pdf

[38] Biodiversity study area (BSA) of ecologically appropriate area of analysis" (EAAA) is the geographical area which is broader than the AOI. The BSA or EAAA was determined keeping in view both direct and indirect impacts analysis of the project.

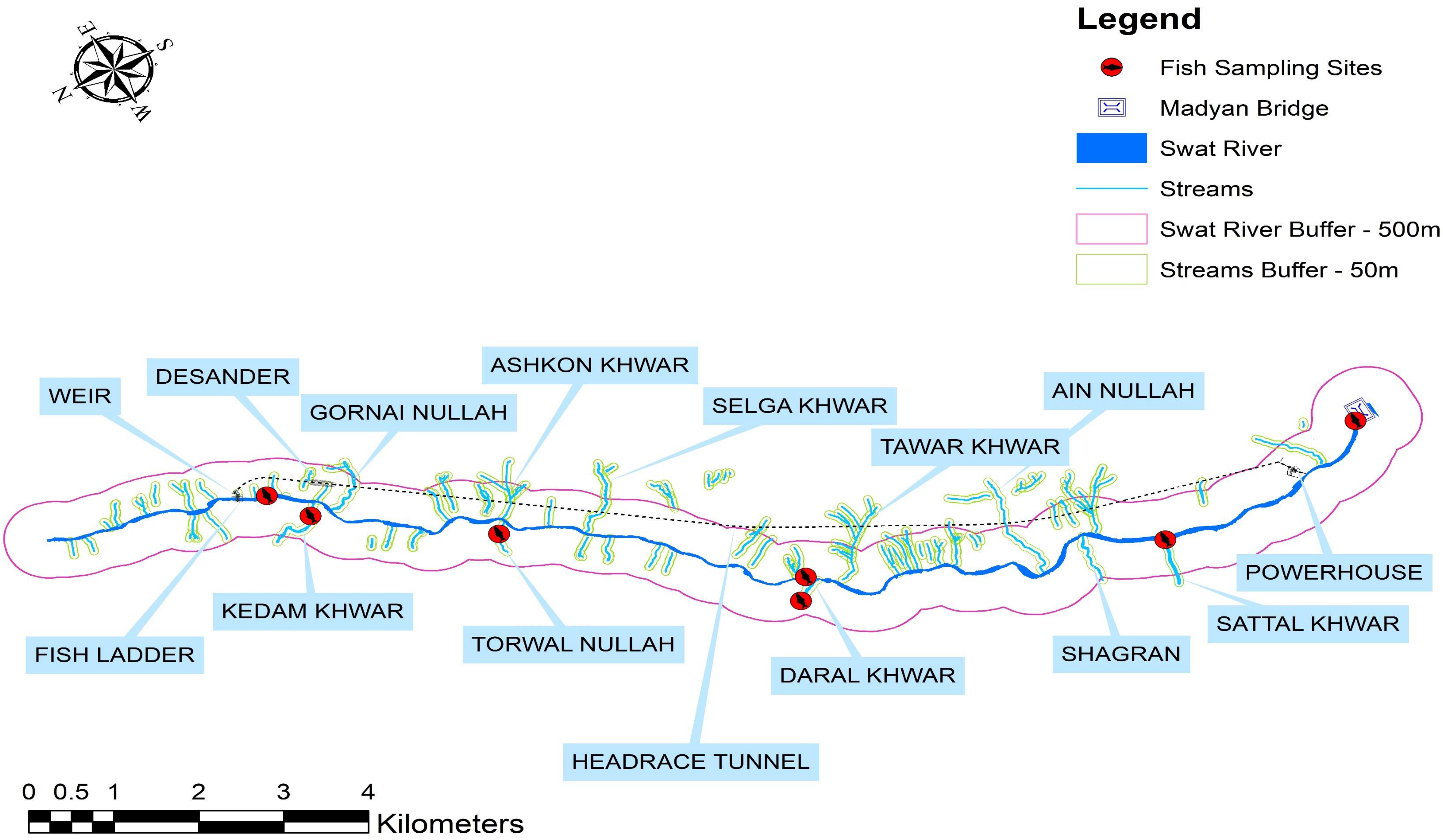


Figure 6-1: Study Area for Biological Diversity

6.1.2 Interviews with Local Residents

To have an idea about the existing wildlife in the project area, different people were interviewed including officials of KP fisheries department, KP wildlife department, local residents, fishermen, hunters, shopkeepers and fish sellers in the local market. This practice gave an idea about the existing wildlife species in the area. To interview relevant people, two different questionnaires were developed and used during field visits. One questionnaire was developed to collect data about overall wildlife species while the other questionnaire included the questions about existence of Markhor in the project area **(Annexure IV).**

6.1.3 Methodology for Flora

To assess the vegetation in the study area, line transact method was used. However, to have an idea about dominant plant species in different habitats, Ocular Estimation Method was applied. Most of the plant species were identified on the spot; whereas; samples of unidentified and ecologically, economically, and medicinally important plant species were collected, tagged, and pressed in the wooden plant presser by using blotting papers. Such plants species were later identified up to species level using taxonomic keys in the lab.

6.1.4 Methodology for Fish Fauna

Cast nets were used at different locations to collect the fish. Collected fishes were identified following the keys given by Dr. Ramzan Mirza (Mirza, 2003) (Ref. Mirza, M. R. 2003. *Checklist of Freshwater Fishes of Pakistan*. *Pakistan J. Zool*. Suppl. Ser., No. 3. pp. 1-30, 2003). In addition, while conducting the field visits, different fish hunting parties and individuals were approached, and their fish catches were observed. This exercise was found to be very effective, and the survey team was able to record a maximum number of fish species. Fish sampling was made during summer and winter visits.

6.1.5 Methodology for Amphibians

The study area represents different types of habitats and similarly, some of the amphibians are nocturnal in feeding habits whereas others are diurnal; therefore, different direct and indirect methods were applied to study various groups of amphibians in the study area. Field visits were carried out between 9:00 am and 4:00 pm for diurnal species and for two hours just after dusk for the nocturnal species. Since amphibians are cold blooded animals and remain in hibernation during winter season, therefore, the field visit to study amphibians was conducted during summer season when all the amphibians have come out of hibernation and also, they are in their breeding season. Different indirect evidences of existence of different amphibians were searched including amphibian eggs, tadpoles and their mating calls. An effective way to search the amphibians is active searching particularly during the daytime. This method is equally applicable for both nocturnal and diurnal species. The study area was actively searched especially the breeding areas of amphibians like small water pools, water channels, roadside ponds and puddles and suitable microhabitats of amphibians e.g., stones, pond bunds, crevices, leaf litter, debris and rotten logs. These places were deliberately uncovered to find out amphibians hiding under such covers. Amphibians were also observed during daytime as well as at night around their feeding grounds like light posts and grassy fields and around their breeding sites like ponds, puddles and streams where they advertise their presence by their crocks. For identification and confirmation of different amphibians, *Amphibians and Reptiles of Pakistan* by Khan, M. S. (2006) was consulted. (Khan, M.S. 2006. *Amphibians and reptiles of Pakistan*. Krieger Publishing Company, Malabar, Florida. pp 311).

6.1.6 Methodology for Reptiles

Different direct and indirect methods were applied to study various groups of reptiles. Field visits were carried out between 09:00 am and 1:00 pm for diurnal species and for 2-3 hours just after dusk for the nocturnal species. Different habitats were searched for any reptilian species both during daytime and night. Stone turning, looking at and through bushes, searching basking agamas on stones and trees and walking along microhabitats were the means to find out all possible reptiles in the study area. All the reptiles encountered during the survey were identified on the spot, their photographs were taken and field notes for each specimen were recorded. Since reptiles are cold blooded animals and remain in hibernation during winter season, therefore, the field visits were conducted during spring and summer seasons when all the reptiles have come out of hibernation. For identification and confirmation of different reptiles, *Amphibians and Reptiles of Pakistan* by Khan, M. S. (2006) was consulted. (Khan, M.S. 2006. *Amphibians and reptiles of Pakistan*. Krieger Publishing Company, Malabar, Florida. pp 311). Field equipment to study reptiles included snake tongue, large forceps, GPS receiver to record global positioning system (GPS) coordinates, pit-fall trap and digital camera to record photographic evidences.

6.1.7 Methodology for Birds

To study the resident and migratory birds including summer breeding and winter visiting avian species, seasonal surveys were conducted during spring and summer, 2022 while the winter survey was conducted during January 2023. For recording the avian diversity in the study area, birds were watched in all the potential habitats. Visits were planned during dawn, early morning, in the afternoon and dusk mostly by walking through the core zones of bird habitats. Water fowls and waders were watched along the river and different nullahs by using binoculars. Birds that could not be identified at first look in the field were photographed using a zoom lens and identified after consulting the handbook for bird identification, Grimmett *et al.* (2008). (Grimmett, R., Roberts, T. and Inskipp, T. 2008. *Birds of Pakistan*. Christopher Helm Publishers Ltd, 38 Soho Square, London W1D 3HB. 256 pp) A checklist of all the recorded resident as well as migratory birds was prepared and the global conservation status of all the recorded birds was determined using international union for conservation of nature (IUCN) Red List of Threatened Species (IUCN, 2023). Summer breeding birds were observed during spring and summer visits, winter visiting birds were observed during winter season while resident birds were observed throughout the year in four seasonal surveys. Binoculars, GPS receiver, digital camera with 300 mm zoom lens, field guide book and a notebook were included in the field kit for avian studies.

6.1.8 Methodology for Mammals

Small mammals like mice, squirrels, mongooses were directly observed during daytime whereas for nocturnal small mammals like rats, bats, shrews, direct observations were made at night. Different techniques used to study nocturnal small mammals included *Spot Lighting Method* whereas for diurnal small mammals, active search was made during day time and active burrows, Fecal materials and fresh tracks of small mammals were observed and the existence of different species was confirmed on the bases of these indirect pieces of evidence. Folding Sherman Traps were used to trap the nocturnal small mammals like rats and mice. Traps were set at different locations in the evening and collected early in the morning before the sunrise and trapped specimens were released after identification and recording necessary morphological data. Small mammals were studied during spring and summer seasons.

Different large and medium-sized mammals show different feeding habits and some species are diurnal while others are nocturnal. Therefore, different direct and indirect methods were applied to locate various large and medium-sized mammals. These included Howling Record Method, Tracks and Trails study techniques, Fecal material study, body parts, dead animal remains, fur entangled in the bushes, feeding remains of animals and interviews with the local residents. Field kit for mammalian studies consisted of digital camera, GPS receiver, folding Sherman traps, searchlights and field guide books (1. Roberts, T. J. 2005 Field Guide to the Large and Medium Sized Mammals of Pakistan. Oxford University Press, Karachi) 2. Roberts, T. J. 2005 Field Guide to the Small Mammals of Pakistan. Oxford University Press, Karachi.)

6.2 Outcomes of the Biodiversity Survey

6.2.1 Overview

During four seasonal surveys in the project area, overall, 196 plant species belonging to 60 families were identified in the project area. Out of the recorded species, 35 species (18 %) were trees, 18 species (9.2 %) shrubs, 116 species (59.1 %) herbs, 18 species (9.2 %) grasses, 08 species (4 %) climbers and 01 species (0.5%) were sedges. Fruit trees like Oriental persimmon (*Diospyrose kaki*) and Caucasian persimmon (*Diospyros lotus*) are attractive for large mammals like Rhesus monkey (*Macaca mulatta*) and Asiatic black bear (*Ursus thibetanus*) especially during fruiting season in autumn and winter respectively. Fruits of Caucasian persimmon or wild persimmon (Diospyrose lotus) locally called “Amloke” also provide food to different resident and winter visiting birds.

Among the recorded reptiles, Brown cobra (*Naja oxiana*) and Indian Rock Python (*Python molurus)* have been categorized as “Near Threatened” while remaining all the 10 species have been categorized as “Least Concern” according to International Union for Conservation of Nature (IUCN) Red List of Threatened Species (IUCN, 2023). One lizard species, North-Pakistan Agama (*Laudakia pakistanica*) is Endemic to Pakistan but commonly found in all of its distribution range in the northern mountainous region in Pakistan.

A total of 91 avian species belonging to 14 orders were identified in the Madyan Hydropower Project (HPP) area. These include 30 resident birds, 20 winter visiting birds, 36 summer breeders and five species of passage migrant birds.

Overall, 12 species of mammals belonging to six orders, nine families and 11 genera were recorded from the study area. These include eight species of small mammals and four species of large mammals. The four large mammals include Asiatic black bear (*Ursus thibetanus*-Vulnerable), Indian wolf (*Canis Lupus*-Least Concern), Asiatic jackal (*Canis Aureus*-Least concern) and Rhesus monkey (*Macaca mulatta*). Only the Asian Black Bear is reported close of the project area. The habitat of the Black Bear is on high altitude but in winter season when the food is not available, the species moves down for hunting local livestock.

The Swat River and its tributaries are characterized by relatively steep gradients and substrate sizes, fast-flowing, and turbulent waters with high flows and more sediments during summer and low flows and low sediments during winter. Two of the recorded species including Brown trout (*Salmo trutta fario*-Least Concern) and Snow carp (*Schizothorax plagiostomus*-Vulnerable) were found in the main river while the third fish *species Nangra robusta* (Endangered). A cat fish belonging to the Family Salmonidae and Order Salmoniformes, was found only in the tributaries of the Swat River including Kedam Nullah near weir site, Torwal Nullah around 4 km downstream of the weir site and Draal Nullah joining the Swat River in Bahrain bazar. Snow carps are short-distance migrants and mainly migrate within the tributaries. From April to September (spring and summer, high flows), they prefer upstream headwaters habitat at higher elevations. During September to April (low flows and winter), they prefer lower elevations. The triggers for migrations are high flows and low temperatures. During spring, when flows started increasing in the rivers due to the melting of snow, the migration of the reported fish species are in the months of September, October and November and March.

6.2.2 Habitat Types in Study Area

There are six habitat types found in this AOI of the MHPP project in the MHPP project area including the active river or aquatic habitat, riverbank/riparian, agriculture fields, scrub forest, dry temperate forest and human settlements. However, no terrestrial critical habitat or threatened or unique ecosystem was identified in the AOI. The terrestrial habitats in the AOI of the MHPP are homogenous and widespread. Except Swat River and its tributaries reported as habitat for the reported three fish species, the remaining types of habitat's zones falling in the AOI hold no significance for the survival of endemic or restricted range species. Based on approximation and analysis, the **Table 6-1** represent the approximate area of each type of habitats in the AOI likely to be impacted.

Table 6-1: Types of Habitats likely to be Impacted (Approx %age).

S. No	Habitat Types	Area (Acres)	% distribution	Approx- Land to be Impacted (In Acres)	Percent of Land Type Impacted
1	Settlements	263.81	5.27%	2.45	0.9
2	Scrub Forest/Barren Land	3,480.60	36.79%	89	2.6
3	Agriculture Fields	891.85	17.81%	79.95	9.0
4	Dry Temperate Forest	0	0.14%	0	0.0
5	Active River (Aquatic Habitat)	207.25	4.14%	147	70.9
6	River Bank/Riparian	66.61	1.33%	13.11	19.7
	Total	**5,008.52**	**100%**	**367.16**	**7.3**

Source of Analysis: Table 5-1 of ESIA, Land Use Map, RAP & Active River Average Cross Section calculation based on medium flow.

6.2.2.1 Riverbank/Riparian Habitat

The Swat River is morphologically a single river type. There are some riparian zones, or areas where the river is braided. The riparian area is characterized by bedrock-controlled banks and bends. The wider reach has well sorted cobble lateral bars, but at the site there has been extensive removal of silt and sand at this site enabled by the road access. The lateral bars of cobble, boulders and gravels at the site are thus largely free of fine material; this being found only in very small lee deposits; but the upper banks of the river are composed of finer material (sand and silts) with underlying extensive cobble deposits. Trees and shrubs are present in this upper seasonally inundated zone of the riparian area **(see Figure 6-2).**


Figure 6-2: Riverbed/Riverian Habitat of Swat River

6.2.2.2 Agriculture Fields

Agriculture Fields are the most dominant habitat of the Biodiversity Study Area of MHPP. The agricultural fields mostly lie on left and right bank of the Swat River formed in terraces due to steep slopes. Agriculture Fields are the most dominant habitat for the terrestrial biodiversity. The floral diversity and density observed in this habitat are higher than Riverbank/Riparian zone as compared to Scrub Forest. **Figure 6-3** shows the fields on both sides.


Figure 6-3: Agriculture Fields & Settlements on Both Sides of Swat River

6.2.2.3 Aquatic Habitat

The Swat River is the habitat type categorized with high stony stream, flowing channel, riverbank/riparian habitat as pools/glides, riffles, and rapids. High flow months of May, June and flood conditions, the riverbanks/riparian zones submerge in water and disappears. After 2022 devastated flood, there are significant changes in the river course **(see Figure 6-4 and 6-5).**

This type of habitat is represented by river and its tributary nullahs including Kedam, Bara Dar and Daral Khwar. The river is mainly fed by the melting of snow and glaciers. The flow in the river is high during summer and the contribution from rainfall is very small. Quality of river water changes between the summer and winter seasons due to the sediment load, which is higher during summer. Besides supporting aquatic life including macro-invertebrates and fish, this habitat is characterized by grasses, herbs, shrubs and some trees along the river banks that provide refuge, shelter and food to a number of amphibians, reptilian, avian and mammalian species.

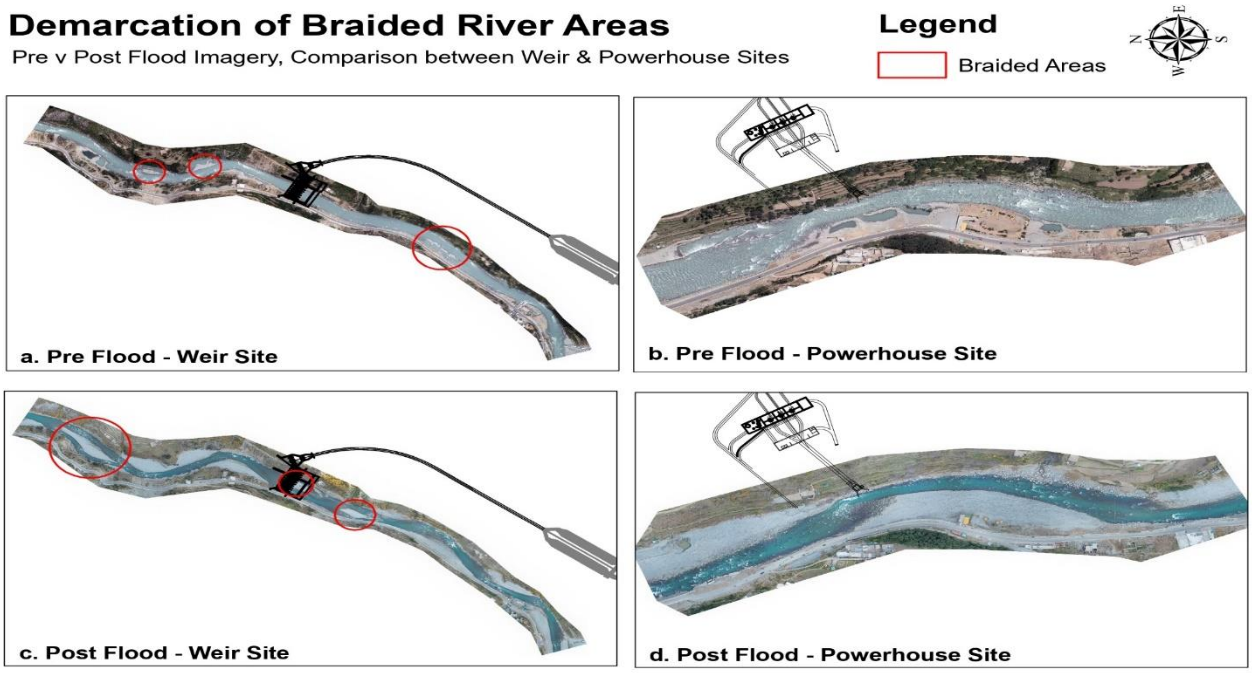


Figure 6-4: Pre-& Post Flood 2022 Impacts on Swat River Morphology

Figure 6-5: Aquatic Habitat

6.2.2.4 Scrub Forests

This type of habitat consists mainly of bushes (shrubs) and herbs along the wetlands and provides home to a number of amphibians, reptiles, birds and small mammals. This type of habitat is also characterized by some cultivated areas along slopes which also support different avian and mammalian species in different seasons in terms of food and refuge. This habitat is characterized by vegetation dominated by shrubs with some trees, grasses and herbs. The floral diversity and density observed in this habitat was higher than that recorded in Riverbank/Riparian and Agriculture Fields. **Figure 6-6** shows scrub forest in the project area.

Figure 6-6: Scrub Forest in Project Area

6.2.2.5 Dry Temperate Forests

This type of habitat is characterized by coniferous forests and the dominant tree species include *Cedrus Deodara* and *Betula pepyrifera*. It extends up to 2,700 m elevation and plays a vital role in the economy of the area through supply of timber, fuelwood, non-timber forest products and forage and grazing for livestock. It also plays an important role in providing refuge, shelter and food to different mammalian species like Rhesus monkey and Asiatic black bear especially during the winter season.

6.2.2.6 Settlements

Different villages are settled on both sides of the Swat River along the dewatered stretch, as shown in **Figure 6-7.**

Figure 6-7: Settlements on both Sides of Swat River

6.2.3 Assessment of Biological Diversity

Overall biodiversity studied during four seasonal visits includes 317 species with 196 species of plants, three species of fish, three species of amphibians, 12 species of reptiles, 91 species of birds and 12 species of mammals. Among the entire recorded species only one mammalian species; Asiatic Black Bear (*Ursus thibetanus*) is "Threatened" with having "Vulnerable" status and decreasing population trend according to IUCN Red List of Threatened Species. All of the remaining species are either Least Concern or have not yet been evaluated and registered by IUCN. One reptilian species; North-Pakistan Agama (*Laudakia pakistanica*) is Endemic to Pakistan but it is also a Least Concern species according to IUCN Red List of Threatened Species.

6.2.3.1 Recorded Plant Species

Overall, 196 plant species belonging to 60 families were identified in the project area (details of the species are presented in **Annex-IV**). Out of the recorded species, 35 species (18 %) were trees, 18 species (9.2 %) shrubs (Table 6-3-Annex-IV), 116 species (59.1 %) herbs, 18 species (9.2 %) grasses, 08 species (4 %) climbers and 01 species (0.5%) were sedges. Fruit trees like Oriental persimmon (*Diospyrose kaki*) and Caucasian persimmon (*Diospyros lotus*) are attractive for large mammals like Rhesus monkey (*Macaca mulatta*) and Asiatic black bear (*Ursus thibetanus*) especially during fruiting season in autumn and winter respectively. Fruits of Caucasian persimmon or wild persimmon (*Diospyrose lotus*) locally called Amloke also provide food to different resident and winter visiting birds. Maize crop in early winter also attracts Rhesus monkey and Asiatic black bear (*Ursus thibetanus*). According to local residents, these mammalian species create problems for local communities and cause damages to crops.

6.2.3.2 Recorded Fish Species

Three species of fish were identified belonging to three orders and three families (**Annex-IV**). Two of the recorded species including Brown trout (*Salmo trutta fario*) IUCN Red List Status of all the recorded Threatened species is given in 6.5 and also in the relevant table of each group. and Snow carp (*Schizothorax plagiostomus*) were found in the main river while the third fish species *Nangra robusta*, a cat fish belonging to the Family Salmonidae and Order Salmoniformes, was found only in the tributaries of the Swat River including Kedam Nullah near weir site, Torwal Nullah around 4 km downstream of the weir site and Daral Nullah joining the Swat River in Bahrain bazar. Aquatic habitat and the fish sampling sites are given in the **Figure 6.1**.

6.2.3.3 Recorded Amphibians

Three species of amphibians (frogs and toads) were identified belonging to the Order Anura and two families, Family Bufonidae including toads and Family Ranidae including frogs (**Annex-IV**). Family Bufonidae is represented in the project area by two toads, *Bufo stomaticus* (Indus valley toad) and *Bufo pseudoraddei* (Swat Green Toad) whereas; Family Ranidae is represented by one frog species, *Euphlyctis cyanophlyctis* (Skittering frog).

6.2.3.4 Recorded Reptiles

Overall, 12 species of reptiles including six lizards and six snakes were identified (**Annex-IV**). These belong to one order (Squamata) and six families. Among the recorded reptiles, Brown cobra (*Naja oxiana*) and Indian Rock Python (*Python molurus*) have been categorized as “Near Threatened” while remaining all the 10 species have been categorized as “Least Concern” according to IUCN Red List of Threatened Species (IUCN, 2023). One lizard species, North-Pakistan Agama (*Laudakia pakistanica*) is Endemic to Pakistan but commonly found in all of its distribution range in the northern mountainous region in Pakistan. Among snakes, Brown cobra is a deadly poisonous snake and considered a problem species in and around the project area.

6.2.3.5 Recorded Bird Species

A total of 91 avian species belonging to 14 orders were identified in the Madyan HPP area (**Annex-IV**). These include 30 resident birds, 20 winter visiting birds, 36 summer breeders and five species of passage migrant birds. Winter visiting birds were recorded during autumn and winter surveys, summer breeders were identified during spring and summer surveys while resident birds and passage migrants were observed throughout the year.

6.2.3.6 Recorded Mammals

Overall, 12 species of mammals belonging to six orders, nine families and 11 genera were recorded from the study area. These include eight species of small mammals and four species of large mammals. The four large mammals include Asiatic black bear (*Ursus thibetanus*), Indian wolf (*Canis lupus*), Asiatic jackal (*Canis aureus*) and Rhesus monkey (*Macaca mulatta*). These four-mammalian species are considered as problem species in the area because these species cause damages to crops, poultry and livestock. Black bear attacks on human beings have also been reported in the area.

6.2.3.7 Conservation Status of the Recorded Species

Overall, 121 faunal species were recorded from the study area including three fishes, three amphibians, 12 reptiles, 91 birds and 12 mammals. Out of the recorded 121 species, three species are having Threatened Conservation status according to IUCN Red List of Threatened Species (IUCN, 2023). These include; a catfish (*Nangra robusta)* which has been categorized as "Endangered" with decreasing population trend, Snow carp or Snow trout (*Schizothorax plagiostomus*) having "Vulnerable" status with decreasing population trend and Asiatic Black Bear (*Ursus thibetanus*) which has been categorized as "Vulnerable" with decreasing population trend. Four species have been categorized as "Near Threatened" including two reptiles; Indian rock python (*Python molurus*) and Brown cobra (*Naja oxiana*) and two birds; Northern Lapwing (*Vanellus vanellus*) and Himalayan Griffon vulture (*Gyps himalayensis*). Remaining all the 115 species have "Least Concern" status with stable population trend. One reptilian species, North-Pakistan Agama (*Laudakia pakistanica*) is an Endemic species. But this species has a vast distribution range in northern Pakistan and has been categorized as "Least Concern" by IUCN Red List of Threatened Species.

Among the snakes, Brown cobra (*Naja oxiana*) is important being a problem species in the area. It is a deadliest poisonous snake being neurotoxic in nature. Around 40,000 snake bite cases are registered every year in Pakistan and around 3,000 people die every year due to snake bites. After Common krait (*Bungarus chaeruleus*), Brown cobra (*Naja oxiana*) is the second major culprit of human deaths due to snake bites. There is a need to educate local communities about the nature of snakes and first aid tips to avoid and survive the snake bites.

6.3 Species of Special Concern

Some of the recorded species were found important from ecological, economical and conservation point of view. One species is endemic to Pakistan. Similarly, a few species were also found that are considered problem species in the project area. A brief description of such key species is given below.

Based on the multiple season's biodiversity baseline of the MHPP Project, the following key biodiversity species are reported in the project area and the project specific and key biodiversity species specific impacts are also briefly discussed in the following sections and **Table 6-2;**

Table 6-2: Key Biodiversity Species Reported in the Project Area

S. No	Name of Species	Movement Pattern	Spawning Period
Ichthyo-Diversity- {Total Reported Species-3}			
1	Brown trout (*Salmo trutta*) {LC}	Full Migrant	Spawning: November-December. Spawning: twice a year
2	Snow carp (*Schizothorax plagiostomus*) {VU}	Altitudinal Migrant or Short Distance Migration	No data available
3	Cat fish (***Nangra robusta (EN)***	Migrant	No data available
Amphibians- {Total Reported Species-3-LC}			
Reptiles- {Total Reported Species-13}			
1	*Indian* Rock Python (NT)	Not applicable	Not applicable
2	*Brown* Cobra (NT)	Not applicable	Not applicable
3	Pakistan Agama (*Laudakia pakistanica*) is an Endemic species	Not applicable	Not applicable
Ornithology- {Total Reported Species-91}			
1	*Northern* Lapwing (NT)	Not applicable	Not applicable
2	Himalayan Griffon vulture (NT)	Not applicable	Not applicable
Mammals {Total Reported Species-12}			
1	Asiatic black bear (VU)	Not applicable	Not applicable

6.3.1 Fishes

6.3.1.1 Snow Carp or Snow Trout (Schizothorax plagiostomus)

Snow carp (*Schizothorax plagiostomus*) has most recently been assessed in the IUCN Red List of Threatened Species as "Vulnerable" in 2022 under criteria A2b. Snow carp, locally called "Swati", is economically as well as ecologically important fish of the lower reaches of the River Swat. In upper reaches of the River Swat and in Gabral River its population has declined due to its competition with the introduced brown trout.

Distribution: Globally this species is found throughout Hindukush and Himalayan regions including Afghanistan, India, China and Pakistan. In Pakistan it is reported from different rivers, lakes and tributaries in Khyber Pakhtunkhwa, Northern Punjab, Baluchistan and AJK.

Food: It is Benthivores in nature depending on phytoplankton, diatoms, algae, zooplanktons rotifers and cyclops mostly at bottom rocks and stones.

Habitat: Thrive in snow fed river habitat of clear, shallow water of stony substratum with an average depth from 0.5 to 3 meters, and river flows with low to high velocities (0.5 to 1.5 m/s). Average temperature requirements are 4 to 20 °C.

Migration: It is an altitudinal migrant or short distance migratory fish which enters tributaries for breeding (Rai et al. 2002). A local migrant fish and migration distance in River Swat is much longer than the Brown Trout. At the start of autumn, when the air and water temperature start to drop at higher elevations, the fish start downstream migration till November. It descends down during backward migration to River Kabul and even to Attock area of River Indus. At the start of spring during March and April when high flow start, they start upward migration to the upper reaches of shallow waters where they breed.

Spawning: Spawning is thought to be linked to increases in temperature and can occur twice a year in clear gravelly or fine pebble beds 10-30 cm deep. It can weigh up to 2.5 kg and grow up to 60 cm in length, becoming sexually mature at 18-24 cm (Jan et al. 2017). Low water currents of 0.5- 1.5 m/sec, pH 7.5, dissolved oxygen concentration of 8-12 ppm and gravel sizes of 50-60 mm or less are the optimum conditions for spawning. Spawning is usually performed in a slightly warmer water of springs flowing into Main River.

Figure 6-8: Snow carp (Schizothorax plagiostomus)

6.3.1.2 Brown Trout *(Salmo truta fario)*

Brown trout was introduced in Swat in 1960's and a hatchery were established at Madyan, Swat from where the young seed was used to be stocked in the main River. This species is now well established and a dominant fish species in upper reaches of the River Swat. It is an economically important species and highly liked in the local market.

Habitat: The fish is found above 3000 ft (915 m) altitudes where the water temperature seldom rises above 12 °C. Such streams are with highly oxygenated and clean water. The average height of the project area is 1500 m or 4914 ft above sea level and average maximum and minimum temperature ranges are 26°C in summer and (-) 8°C in winter. Therefore, the project area offers ideal habitat for this species.

Feeding: It is a carnivorous fish and feeds on crustaceans, insects, insect larvae and other smaller fish in its habitat.

Breeding: This fish spawn in rivers and streams with swift water[39]. It breeds from November to February. Eggs are laid in slow running streams by making a pit in bottom gravel bed and the eggs hatch in 40-70 days. Brown trout share the same habitat for breeding with snow carp

Migration: This species is a full migrant species. The movement pattern of Brow trout is reported to be a full migrant species but migration period is not assessed by International Union for Conservation of Nature (IUCN). The fish species is reportedly spawns in rivers and streams with swift water. The Lacustrine populations reportedly migrate to tributaries and lake outlets, rarely spawning on stone, wave-washed lake shores. The spawning sites usually characterized by downward movement of water into gravel[40]. The upward migration takes place to shallow streams with adjoining spring water for breeding purposes while downward migration to deep waters takes place for feeding purposes. This species has now spread to Kaghan, Dir, Chitral and Gilgit Baltistan.

[39] https://www.iucnredlist.org/species/19861/9050312#habitat-ecology

[40] IUCN 2023.

Figure 6-9: Brown Trout

6.3.1.3 Nangra *(Nangra robusta)*

Nangra robusta locally known as "Chakora" belongs to the Family Sisoridae and was found in three tributaries (nullah or Khwar) of Swat River in the project area including Kedam Khawar, Torwal Khawar and Draal Khawar. This species has no economical value in the area except for a few local residents who use to catch everything found in the Khwar. This species was first described by Dr. Ramzan Mirza in 1973. According to the IUCN Red List of Threatened Species, this fish has been categorized as "Endangered" with decreasing population trend.

Nangra robusta is restricted in its distribution range in the river Indus, found in one site between Kalabagh and Chashma reservoir where it is threatened by a hydroelectric project. There is a single location based on this threat. It has also been reported from Panjkora River in Chitral. The extent of occurrence (EOO) is 1,700 km[41]. The cat fish and its distribution in Pakistan is shown in **Figures 6-10 and 6-11**[42].

Figure 6-10: Cat fish (Nangra robusta)

[41] https://www.iucnredlist.org/species/128723659/128723664#bibliography

[42] Source: https://www.iucnredlist.org/species/128723659/128723664#bibliography retrieved on 15th Feb, 2023

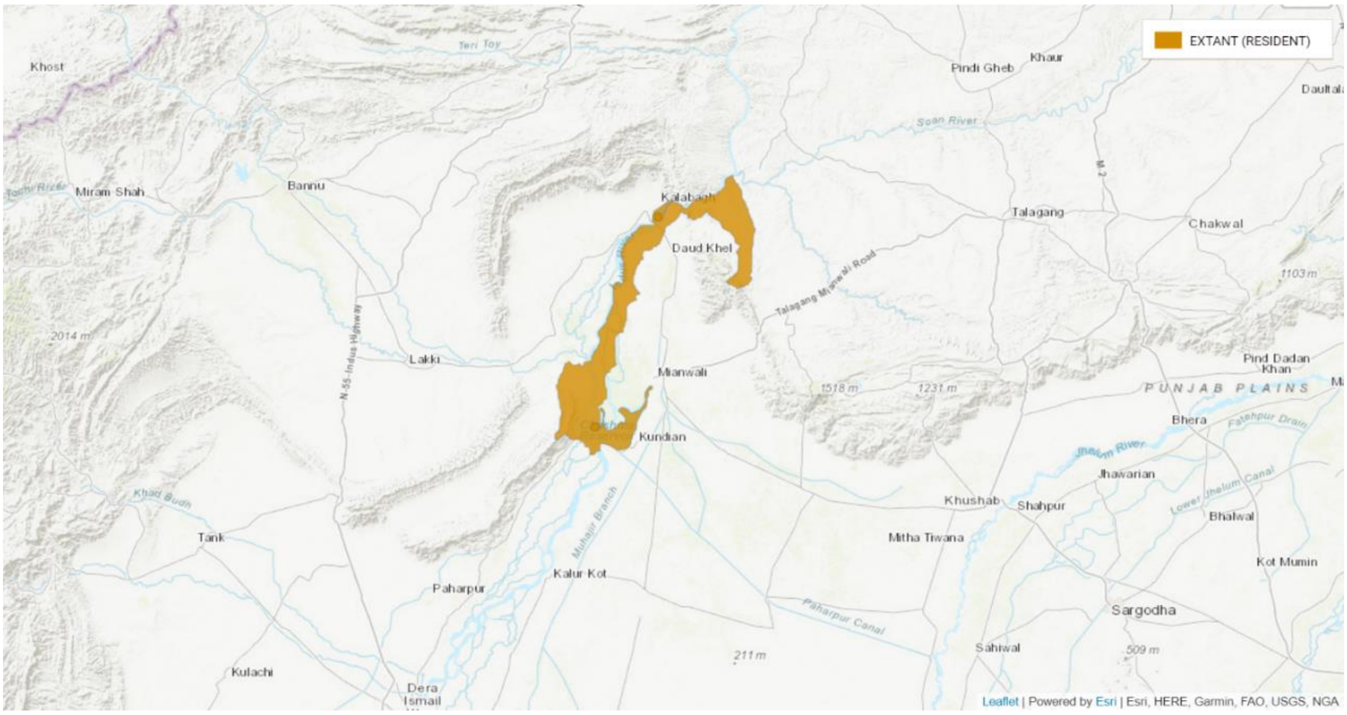


Figure 6-11: Distribution of cat fish *(Nangra robusta)* in Pakistan

6.3.2 Protected Areas

There is no national park or other protected areas including areas of specific scientific interest etc in the area of influence of the MHPP Project. The reported protected areas in Swat District are in the form of sites of special scientific Interest, public and community game reserves and conservancies of Mankial and Kalam are located away or at altitudes higher than the location of the project components[43]. Therefore; none of the aforementioned protected site is located in the AOI of the MHPP.

6.3.3 Critical Habitat Assessment

Based on integrated biodiversity assessment tool (IBAT) and multiple seasons biodiversity surveys, critical habitat assessment was carried out in the defined project "Study Area" or "Ecological Area of Analysis". As discussed above, the MHPP project is not located in any terrestrial or aquatic critical habitats (legally protected or internationally recognized areas) and the main Swat Rive is not habitat for any critically endangered or endangered species.

6.3.4 Correlation of Various Biological Resources

Out of the recorded three fish species, Brown trout and Snow trout share the same habitat in the project area in Swat River while the third species; *Nangra robusta*, is found only in the tributaries of the Swat River. Although the *Nangra robusta* has been categorized as an "Endangered" species by IUCN but the literature reveals that its distribution range is expanding. It was first reported by Dr. Ramzan Mirza in 1973 from Indus River in Punjab and was reported from Kalabagh in district Mianwali to Taunsa Barrage in district Dera Ghazi Khan. Later it was reported in Panjkora River in Chitral and now in Swat River during the present studies. This species is of no economic value but the local residents use to catch it for eating purposes. Although this species has no competitor fish in its natural habitat but it was found during the study that the Snow carp use to come up in the tributaries at night for feeding purposes and descend back to the main stream early in the morning to avoid be hunted by humans.

[43] https://kp.gov.pk/uploads/2022/09/KP_Wildlife_Protected_Areas.pdf

Introduced Brown trout has posed a very tough time to the indigenous Snow trout in the project area and has actually dominated the aquatic fauna. Brown trout has full support of humans in the sense there are number of trout hatcheries in northern Pakistan where its captive breeding occurs and seedlings are stocked in the rivers. Brown trout is also protected from natural predators like otters. But on the other hand, Snow carp is striving for its survival in its natural habitats in the presence of Brown trout and its supporting human beings. Although the feeding habits of both the sympatric fish species are different but Brown trout being a carnivorous fish also takes the fingerlings of Snow carp. Secondly, Brown trout do not allow other species to share its territory and habitat and hence Brown trout is expanding in the natural waters in the northern areas. On the other hand, Snow carp, an important biological component of the ecosystem in the northern areas, is continuously under pressure and facing tough competition especially regarding food, shelter/cover and space/home range. As a measure to its survival, Snow carp was found adapting to comparatively warmer waters in lower reaches in the project area away from the territories of Brown trout.

If the competition among both the sympatric fish species continues in the project area, the native Snow carp will face a threat of going extinct. The extinction of an important biological component of the natural ecosystem would mean a blow to the food web of that particular water body because the food chains and food webs have a delicate balance.

The ideal temperature for Snow carp is between 4-20°C and Brown trout flourishes in temperatures below 12°C. The average maximum and minimum temperature ranges in the project area are 26°C in summer and (-) 8°C in winter. Therefore, the project area offers ideal habitat for both the species. The temperature tolerance range for Snow carp is from 4 °C to 20 °C. It means Snow carp shows downwards migration during winter season when the average temperature drops below 4 °C in the project area and likewise it moves upwards in summer season when the temperature rises above 20°C in the project area. Similarly, the higher temperature tolerance range for Brown trout is maximum 12 °C. Brown trout shows local migrations due to temperature fluctuations in the project area. When the average temperature rises above 12 °C in summer in the project area, it starts moving upwards in colder water. It means the Brown trout will leave this area in summer when temperature rises above 12 °C and similarly, Snow carp will leave the area in winter when temperature will drop below 4 °C. But during spring and autumn seasons in moderate temperatures (4°C to 12°C), both the species will coexist and compete for the resources. During specific times when both the species coexist in the area, Brown trout being carnivorous and aggressive fish species, dominates the other species.

6.3.5 Brown Cobra (Naja oxiana)

Brown cobra (Naja oxiana) is listed as “Near Threatened” under criteria A2c of the IUCN Red List of Threatened Species. This snake is locally known as Cobra Maar or Naag and considered a deadly poisonous snake. This snake belongs to the Family Elapidae that includes deadly poisonous snakes. Different local residents, wildlife watchers and farmers interviewed during the survey pointed out its existence. The cobra venom is Neurotoxic i.e., it attacks the nervous system of the victim. Around 40,000 snake bite cases are registered every year in Pakistan and around 3000 people die of the snake bites. Brown cobra contributes the second highest number of mortalities after the Common krait (Bungarus chaeruleus) in Pakistan. This snake has a vast distribution in Pakistan. It is found throughout Khyber Pakhtunkhwa, north-eastern Baluchistan, north-western Punjab, Sindh and AJK. Having a vast distribution range, this species is not facing any threat to its survival.

This snake is found around scrub forest and around villages in the project area where agricultural practices are the major source of income for local communities. Such habitats due to cultivation of different crops are occupied by rodents like House mouse (Mus musculus) and House rat (Ratus ratus). These rodents make the major component of the snakes’ food. This snake species is considered a problem species in throughout its distribution range. Nevertheless, there is a dire need to educate local communities about the importance and ecological role of reptiles especially the snakes.

6.3.6 North-Pakistan Agama (Laudakia pakistanica)

North-Pakistan Agama (*Laudakia pakistanica*) is an Endemic species to Pakistan. But this species has a vast distribution range in northern Pakistan and has been categorized as “Least Concern” by IUCN Red List of Threatened Species. This species is typically associated with barren, Rocky Mountains with very sparse vegetation (Baig *et al*. 2012). This species has been found on rocks along streams (Khan 2012). **Figure 6-12** shows the distribution of North-Pakistan Agama[44] in Pakistan.

[44] **Source: https://www.iucnredlist.org/species/47752024/47752036**

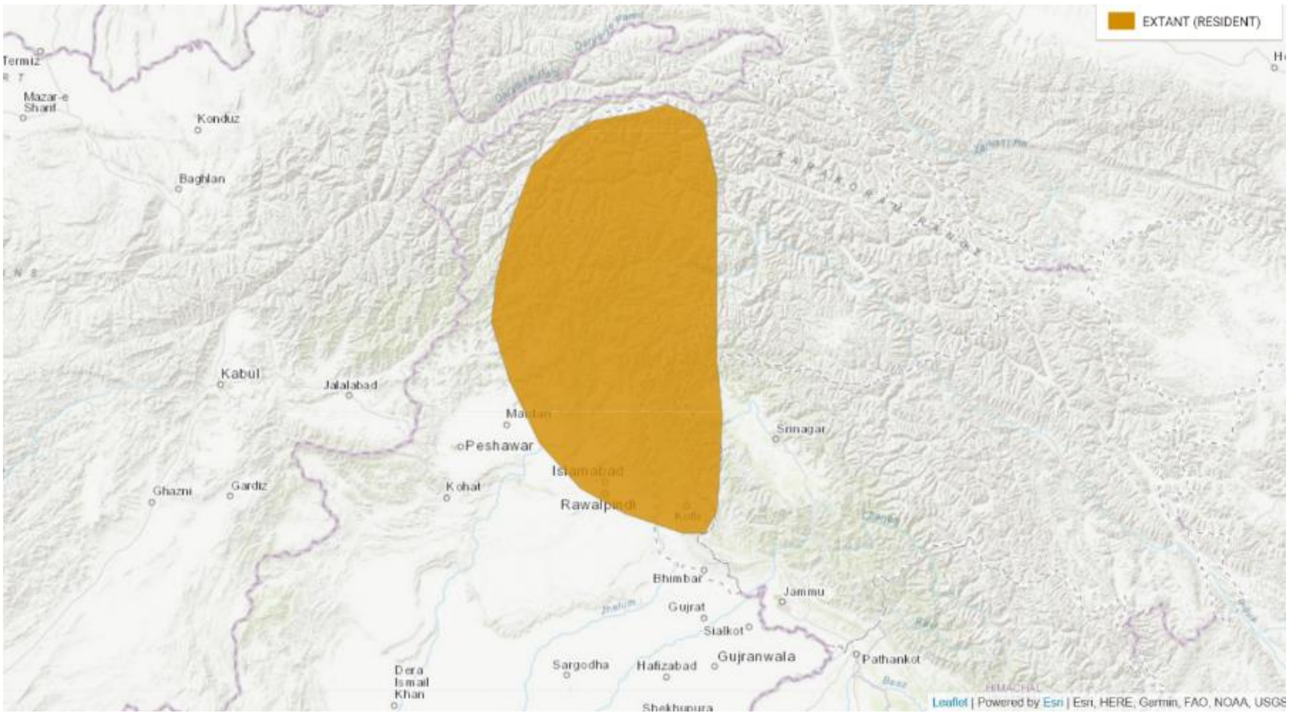


Figure 6-12: Distribution of North-Pakistan Agama in Pakistan

6.3.7 Asiatic Black Bear (Ursus thibetanous)

Asiatic black bear has been categorized as "Vulnerable" with decreasing population trend by IUCN. Although this species is globally threatened but locally it is common in its distribution range in Pakistan. In Pakistan, it is found in Chitral and Swat valleys in Khyber Pakhtunkhwa, Neelum valley in AJK, Gilgit Baltistan and Baluchistan. It is considered a problem species in throughout its distribution range. In the project area, a number of cases of Bear attacks on humans have been reported so far. This species is found in the Scrub and Dry Temperate Forests in the northern mountainous region in Pakistan. Its existence in the project area was recorded around villages about 2-3 km away from the Swat River. This species comes close to the project area during autumn and winter when it does not find food in its protected habitats at higher altitudes. Around the project area, it tries to feed on fruits of Oriental persimmon (*Diospyrose kaki*), Caucasian persimmon (*Diospyrose lotus*) and maize crops. So, it may be said that the habitat of Black bear starts from the project area and spreads hundreds of km away from the project area in all directions.

Habitat and Ecology

Asiatic black bear occupies a variety of forested habitats, both broad-leaved and coniferous, from near sea level to an elevation of 4,300 m. Individual bears move to different habitats and elevations seasonally (Izumiyama and Shiraishi 2004, Hwang *et al.* 2010), tracking changes in food abundance. In seasonal climates, foods include succulent vegetation (shoots, forbs, and leaves) in spring, turning to insects and a variety of tree and shrub-borne fruits in summer, and hard mast (nuts) in autumn (Bromlei 1965, Reid *et al.* 1991, Hashimoto 2002, Hwang *et al.* 2002, Huygens *et al.* 2003, Koike 2010). In Pakistan, this species occupies a very dry, sparsely forested landscape often called steppe forest or steppe woodland. This is the driest landscape inhabited by this species.

Figure 6-13 shows a local shephard who survived black bear attack in the project area.

Figure 6-13: A lucky local shepherd who survived black bear attack but lost one of his eyes and skin from face

6.4 IBAT Assessment

Integrated biodiversity assessment tool (IBAT) is a web-based map and reporting tool that provides fast, easy and integration access to three of the world's most authoritative global biodiversity datasets (i)IUCN Red List of Threatened Species, (ii)World Database on Protected Areas, and (iii) World Database of Key Biodiversity Areas.

It is a partnership among Birdlife International, Conservation International, International Union for Conservation of Nature, and UN Environment World Conservation Monitoring Centre. IBAT helps biodiversity considerations into key project planning and management decisions, including screening potential investments, siting an operation in a given region, developing action plans to manage for biodiversity impacts, assessing risks associated with potential sourcing regions, and reporting on corporate biodiversity performance. Data are presented in spatial and tabular formats, together with simple mapping functionality. In case of MHPP, the IBAT tool was applied to identify biodiversity risks and opportunities within or close to a project boundary and findings related to presence of biodiversity in the project area is presented in the following Table 6-1.

6.4.1 IBAT Reported Biodiversity of the Project Area

Based on the IBAT assessment, ecological screening exercise was carried out to identify the key biodiversity of the project area using an Integrated Biodiversity Assessment Tool (IBAT) developed by the International Union for Conservation of Nature (IUCN) and published literature. The overall biodiversity within the 50 km of the project area includes 245 species of plants, 41 species of fish, six species of amphibians, 18 species of reptiles, 283 species of birds and 70 species of mammals. However, the overall species observed/recorded from the project area include 196 plant species, three fish species, three amphibians, 12 reptiles, 91 birds and 12 mammalian species (Annex IV). The biodiversity along the valleys in the lower elevations is comparatively low due to the tremendous increase in the human population (annual growth rate 3.32). The undisturbed patches of vegetation /habitats are restricted to the higher elevations (above 3200 m), which are highly inaccessible due to the difficult nature of the terrain and geographic features.

The list of threatened species that can be found within the 50 km of the project area is presented Annex-IV. The Threatened species include four mammals (Himalayan musk deer, Common Leopard, Snow leopard and Black Bear), five birds (Pallas's fish-eagle, Egyptian vulture, Greater spotted eagle, White-headed duck and Indian skimmer) one fish species (Golden mahseer) and one plant species the Atlas daisy (Anacyclus pyrethrum).

The Threatened mammalian species are inhabitant of higher altitudes where there is no human disturbance but are reported to come down sometime to the project area during the winter season. The actual area of influence around the project site includes a River stretch of 16 km starting from Madyan Bridge and ending at Kedam village around 15 km upstream of the Madyan Bridge and a buffer zone of 1-2 km on either side of the main River. Three out of the four Threatened mammals; Himalayan musk deer, Common Leopard and Snow leopard have never been reported in the project area since the last three decades. These mammals are found at higher altitudes in dry temperate forests and alpine zone. Only the Black bear is reported around the project area during winter season when there are less anthropogenic activities. Although the Black bear is globally Threatened but locally it is common and considered a problem species that poses threats to human lives and causes huge damages to crops in project area.

IBAT assessment shows the national fish of Pakistan, Golden Mahseer in the project area. This is because the IBAT encompass 50 km radius while the project area covers only 16 km long and 03 km wide area of influence. The Golden Mahseer (Tor putitora) cannot exist in the project area because the water temperature in the project area is too low for Golden Mahseer to survive here. Only three fish species exist in the project area including Brown trout, Snow carp and Nangra robusta.

Regarding the five threatened bird's species in the project area, all the five birds are passage migrants and just pass by the project area especially the two winter visiting birds; White-headed duck and Indian skimmer. Pallas's fish-eagle, Egyptian vulture and Greater spotted eagle use the Swat River flyway or passage to reach their destination in the plain areas in Punjab and Sindh during winter season and similarly use the same passage in summer season to reach their breeding grounds in northern mountains. The project activities will not have any negative impacts on the birds that just fly over the project area making use of the Swat River as a navigation tool. By the construction of a water reservoir in the project area, this part of the river will represent an attractive staging area for so many migratory birds that use to fly over this area during their southward and northward migrations. Therefore, it is presumed that the project activities will have positive impacts on existing as well as migratory faunal species especially the birds, mammals and fishes. The key biodiversity reported based on the IBAT assessment are presented in the **Table 6-3;**

Table 6-3: A list of Threatened species is given below according to the IBAT Assessment.

Sr. No.	Species name	Common name	IUCN Category	Reported or Sighted in Project Area
A	**Mammals**			
1	*Moschus leucogaster*	Himalayan musk deer	EN	Not reported or sighted
2	*Panthera pardus*	Common Leopard	VU	Not reported or sighted
3	*Panthera uncial*	Snow leopard	VU	Not reported or sighted
4	*Ursus thibetanus*	Asiatic black bear	VU	Sighted
B	**Birds**			
5	*Haliaeetus leucoryphus*	Pallas's fish-eagle	EN	Not reported or sighted
6	*Neophron percnopterus*	Egyptian vulture[45]	EN	Not reported or sighted
7	*Clanga clanga*	Greater spotted eagle	VU	Not reported or sighted
8	*Oxyura leucocephala*	White-headed duck	EN	Not reported or sighted
9	*Rynchops albicollis*	Indian skimmer	VU	Not reported or sighted
C	**Fish**			
10	*Tor putitora*	Mahseer	EN	Not reported or sighted
D	**Plants**			
11	*Anacyclus pyrethrum*	Atlas daisy	VU	Not reported or sighted

EN=Endangered, VU=Vulnerable.

[45] Although this species is Endangered but it is found in the region only during summer season as summer breeder. Its breeding area comprises of whole western Boundary of Pakistan starting right from top in Gilgit Baltistan to KP and Balochistan.

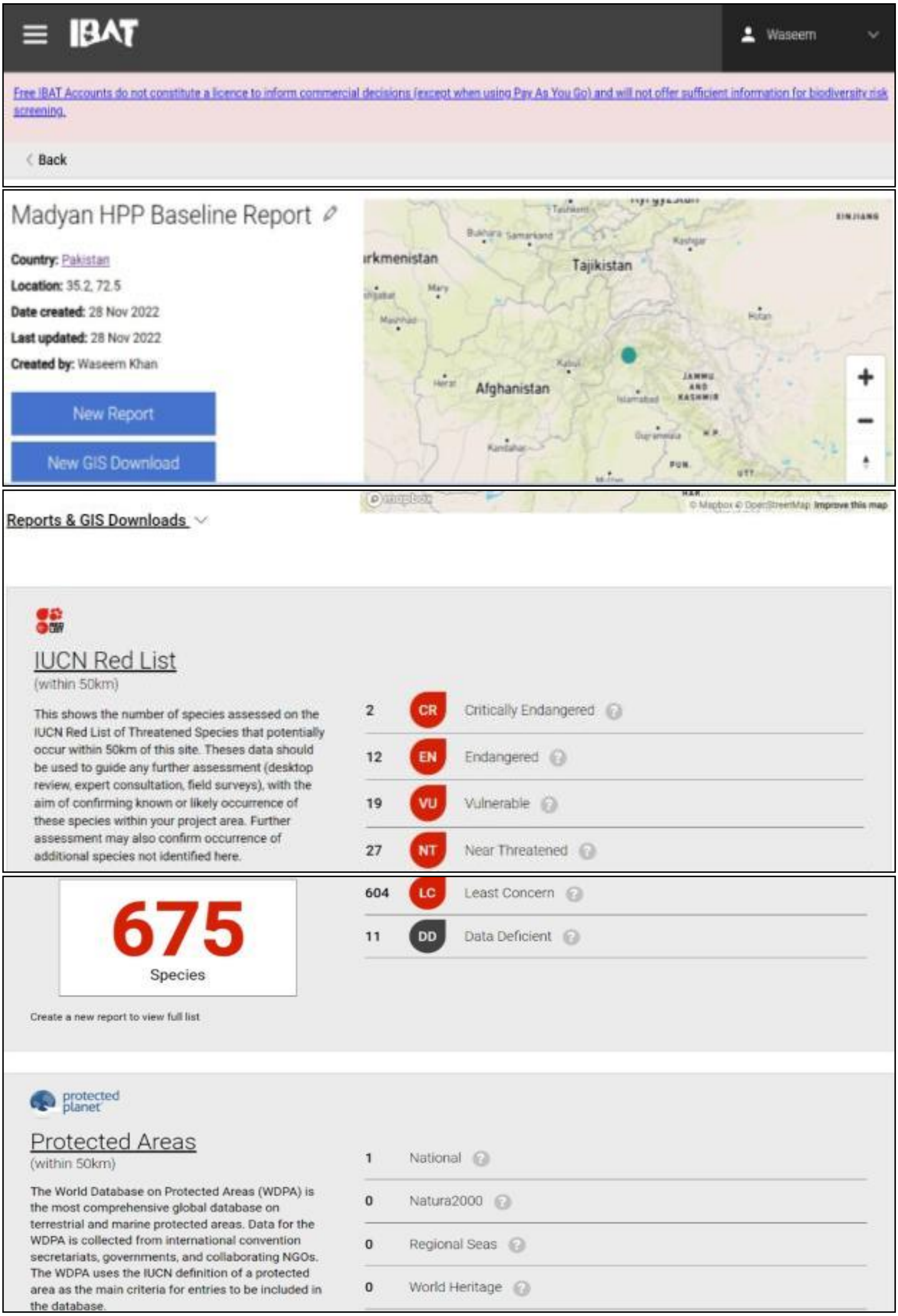


Figure 6-14: IBAT Reported biodiversity of project area

7 Assessment of Environmental and Social Impacts

7.1 Impact Assessment Methodology

Potential environmental and social impacts were identified on the basis of a review of feasibility study reports, field visits, stakeholder consultations, and experiences from the construction of Dasu and Tarbela 4th Extension Hydropower Projects (World Bank funded hydropower projects in Pakistan). The significance of potential impacts was assessed using the criteria and methodology given below.

Impact Magnitude

The potential impacts of the project have been categorized as major, moderate, minor or minimal based on consideration of the parameters such as: i) duration of the impact; ii) the spatial extent of the impact; iii) reversibility; iv) likelihood; and v) legal standards and established professional criteria.

The magnitude of the potential impacts of the project has generally been identified according to the categories outlined in Table 7-1.

Table 7-1: Parameters for Determining Magnitude

Parameter	Major	Moderate	Minor	Minimal
Duration of the potential impact	Long term Beyond the life span of the project	Medium Term The lifespan of the project	Limited to the construction period	Temporary with no detectable potential impact
The spatial extent of the potential impact	Widespread far beyond project's area of influence	Beyond immediate project components, project's area influence	Within project's area of influence	A specific location within project's area of influence with no detectable potential impact
Reversibility of potential impacts	The potential impact is effectively permanent, requiring considerable intervention to return to baseline	Baseline requires a year or so with some interventions to return to baseline	Baseline returns naturally or with limited intervention within a few months	Baseline remains constant
Legal standards and established professional criteria	Breaches national standards and or international guidelines/ obligations	Complies with limits given in national standards but breaches international lender guidelines in one or more parameters	Meets minimum national standard limits or international guidelines	Not applicable
Likelihood of potential impacts occurring	Occurs under typical operating or construction conditions (Certain)	Occurs under worst-case (negative impact) or best case (positive impact) operating conditions (Likely)	Occurs under abnormal, exceptional or emergency conditions (occasional)	Unlikely to occur

Sensitivity of Receptor

The sensitivity of a receptor has been determined based on a review of the population (including proximity/numbers/vulnerability) and the presence of features on the site or the surrounding area. Each detailed assessment has defined sensitivity in relation to the topic. The criteria for determining receptor sensitivity of the Project's potential impacts are outlined in **Table** 7-2**.**

Table 7-2: Criteria for Determining Sensitivity

Sensitivity Determination	Definition
Very High	The vulnerable receptor with little or no capacity to absorb proposed changes or minimal opportunities for mitigation.
High	The vulnerable receptor with little or no capacity to absorb proposed changes or limited opportunities for mitigation.
Medium	The vulnerable receptor with some capacity to absorb proposed changes or moderate opportunities for mitigation
Low	The vulnerable receptor with good capacity to absorb proposed changes and/or good opportunities for mitigation

Assigning Significance

Following the assessment of magnitude, the quality and sensitivity of the receiving environment or potential receptor have been determined and the significance of each potential impact established using the impact significance matrix presented in **Table** 7-3**.**

Table 7-3: Criteria for Determining Significance of Impacts

Magnitude of Impact	Sensitivity of Receptors			
	Very High	High	Medium	Low
Major	Critical	Major	Moderate	Minimal
Moderate	Major	Major	Moderate	Minimal
Minor	Moderate	Moderate	Minimal	Minimal
Minimal	Minimal	Minimal	Minimal	Minimal

7.2 Summary of Assessed Impacts

The project's potential impacts and their significance have been assessed using the methodology described in Section 7.2 above. A summary of these impacts and their significance are presented **Table** 7-4 along with the key mitigation measures. A detailed assessment of impacts and proposed mitigation measures are given in the subsequent sections. Environmental Code of Practices (ECPs) have been prepared to address all generic construction-related environmental impacts and social risks and presented in **Annex-I**.

Table 7-4: Potential Environmental and Social Impacts and their Significance

Impacts of various activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Key Mitigation and Enhancement Measure	Residual Significance
Environmental Impacts due to Project Siting					
Flooding	High	Major	Major	• In order to mitigate the risk of high flood levels, the weir location has been determined at 532 m upstream of Kedam Nullah, a wider section of the river gorge.	Moderate
Impact on fish migration and aquatic ecology	High	Major	Major	• A fish ladder is designed (Figure 3.13) considering the requirements of • snow carp, the indigenous fish species in the project area.	Minimal
Sedimentation of the Reservoir	High	Major	Major	• Sedimentation study is usually part of Hydropower project design for regular sediment phenomenon occurring due to sediments coming from the catchment. But considering the flood events, sediment phenomenon is considered abnormal due to flash floods, and transport of abnormal quantity of sediments. Sedimentation study has considered abnormal phenomenon by including 2010 and 2022 flood events to avoid project failure in the future.	Moderate
Coordination with all relevant departments for no objection certificates (NOCs) during Design Phase	Medium	Moderate	Moderate	• Coordinate with EPA and Ministry of Mines to obtain approval of EIA and explosives and blasting certificates.	Major (beneficial)
Greenhouse gases emissions from the proposed land clearing, construction, material life cycle, and power generation and transmission	Medium	Minor	Minimal adverse	• Net greenhouse gases emissions are minus 7.12 million tons when compared to other feasible options for power generation and transmission46.	Moderate (beneficial)

[46] The estimates are based on current per capita energy consumption 450 kwh per year, and the average household size in Pakistan (6.45 persons per household).

Impacts of various activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Key Mitigation and Enhancement Measure	Residual Significance
Social impacts due to Project siting					
The land to be acquired for MHPP is calculated about 131 acres as per revised design of the project. This land is owned by 141 land owners. About 13 acres of government owned land will also be acquired.	High	Major	Major	• RAP that has been prepared will be fully implemented before the commencement of civil works. • Income and livelihood restoration plan will be prepared and implemented • Social development plan will be prepared and implemented.	Moderate
Relocation of 37 households	High	Moderate	Major	• Adequate compensation will be paid to the affected households as per the entitlement matrix in the RAP.	Moderate
A total of 4,391 (including 2,321 fruit trees and 2,070 timber trees) will be felled	Medium	Moderate	Moderate	• Compensation will be paid to the affected households and cut down trees will be handed over to the owners. In addition, 44,000 trees (10 trees for each tree cut down) will be planted under the plantation program.	Minimal
Environmental and social impacts and risks during construction					
Impact of increased traffic on N-95 highway	High	Moderate	Major	• Contractor will prepare a Traffic Management Plan (TMP) TMP will be implemented during the construction phase.	Moderate
Impact on ecology of River Swat – downstream movement of reported fish species and their habitats during water diversion	Medium	Moderate	Moderate	• If any fish is stranded in the dry riverbed, it shall be relocated downstream • Control wastewater and sediment releases to river, particularly in the section between cofferdams • Prevent the release of silt, sediment, sediment-laden water, raw concrete, concrete leachate, or any other deleterious substances into the river. • Ensure equipment and machinery are in good operating condition (power washed), free of leaks, excess oil and lubricants, and grease. • Ensure machinery leaking fuel, lubricants, hydraulic fluids, or solvents are not used within the river.	Minimal

Impacts of various activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Key Mitigation and Enhancement Measure	Residual Significance
				• Keep a spill containment kit readily accessible onsite in the event of a release of a deleterious substance to the environment. Train onsite staff in its use. • Regular monitoring of the aquatic habitat and fish species during the construction activities • Maintain eFlow (3.5 m^3/s) as per the requirements of aquatic species throughout the year.	
Land sliding Risks	High	Moderate	Major	• Landslide prone areas will be identified and mitigation measures will be devised and implemented. • Any blasting activities required in these areas will be controlled and contained within a limited area. As much as possible explosives with a low intensity will be used. • Extreme care will be exercised to protect workers and the public from the dangers of sudden landslides, which may occur during excavation and blasting works. Particularly after heavy rainfall there may be increased risk of such incidents. Similarly, water seepage may occur if reservoir or tunnel walls not constructed according to standard engineering practices, that water may easily penetrate into surrounding loose soil and may lead to land slide and damage to project structures. • Actions may include, but not be limited to, land use management and reforestation as per compensatory tree planation plan to reduce long term erosion and risk of landslides and to meet community needs for fuel wood and timber, management of water use, and control of water quality. • Pro-active measures will be implemented to stabilize and protect slopes and to protect workers safety. Early warning systems will be introduced that will indicate when cracks appear, especially following heavy rainfall and allow any widening to be monitored. Access would be restricted during the periods that slope stability is not yet entirely secured and guaranteed by proper safety measures such as rock bolts, anchors, safety nets and gabion structures and any blasting activities in these areas will be controlled and contained within defined limits.	Minimal

Impacts of various activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Key Mitigation and Enhancement Measure	Residual Significance
				• Contractor will develop a Blasting and Explosives Management Plan and Vibration Monitoring Plan. A pre-construction survey of structures at risk of vibration impacts will be conducted and accordingly management plan will be developed in Contractor's ESMP (C-ESMP) prior to commence the work.	
Generation of about 2.75 million m^3 of spoils (excess excavation materials) and their disposal	High	Moderate	Major	• Transport and disposal of spoils and designated disposal sites of 32.62 acres identified and approved for land reclamation. Proper disposal and adequate compaction will be ensured to avoid dust and release back to the river. Handing over the reclaimed sites to the landowners. Landscaping of the areas after completion of works.	Minimal
Generation of construction waste including hazardous waste	High	Moderate	Major	• Contractor will prepare and implement a Waste Management Plan. • Containers of adequate size and numbers in place for collection of various types of wastes (metal, rubbers, used fuels and batteries.). Procurement of services of a waste management contractor for transport and treatment of recyclable and hazardous waste.	Minimal

Impacts of various activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Key Mitigation and Enhancement Measure	Residual Significance
Potential impacts on water springs in the area	Medium	Moderate	Moderate	• A Sustainable Water Supply Management and Monitoring Plan that will include monitoring of water springs that are used by the communities) will be developed to minimize impact to natural systems including water springs by managing water use, avoiding depletion of aquifers, and minimizing impacts to water users; • The quality and quantity of tunnel effluent streams discharged to the environment, including stormwater, leach pad drainage, process effluents, and overall tunnel works drainage will be managed and treated to meet the applicable effluent discharge guideline values; • In addition, discharges to surface water will be avoided in contaminant concentrations in excess of local ambient water quality criteria (NEQS). • For springs, water quantity and quality monitoring, monthly construction stage instrumental monitoring will be carried out; • Water supply schemes are proposed in the SDP.	Minimal
Wastewater discharges from the construction camps and construction plants	Medium	Moderate	Moderate	• Contractor will prepare and implement a Waste Management Plan. • Construction of wastewater treatment facilities at the campsite (e.g., septic tank and soak pit) and sedimentation tanks at the worksites (for batching plants and discharges from tunnels and site drainage). Monitoring of wastewater quality to ensure compliance with NEQS prior to disposal to the natural streams.	Minimal
Potential risk of soil and water pollution by construction works	Medium	Moderate	Moderate	• Storage of fuels and chemicals in contained facilities with double containment established over a concrete pad. Availability of spill kits and trained personnel for immediate clean-up of any oil spills. Information of all spills will be notified to PIC and PMO immediately.	Minimal
Air and noise pollution from construction and traffic	Medium	Moderate	Moderate	• Air and noise pollution control measures at the worksites and regular monitoring of ambient and noise quality to ensure compliance with NEQS will be carried out. • Compliance with NEQS on vehicle and machinery emissions will be ensured.	Minimal

Impacts of various activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Key Mitigation and Enhancement Measure	Residual Significance
Impacts on Biodiversity due to Construction Activities	Medium	Moderate	Moderate	• Construction and post-construction stage biological/ecological monitoring will be carried out to ensure that the habitats of the large animals are not degraded from the construction activities. The Fisheries Management Plan (Annex-II) will be implemented. • the existing hatcheries of KP Fisheries Department (devastated by flood 2022) will be restored. The existing trout hatcheries will allocate a portion for Snow carp breeding and ensure annual release of Snow carp seedlings in the natural water bodies for the safe survival of Snow carp and ultimately the fragile ecosystem. A fish ladder (Figure 3.13) is included in the project design for maintaining river connectivity and fish migration. • The felling of a tree which houses an active nest or eggs will be prohibited. The felling of such trees will be carried out in non-breeding seasons. • During construction, an avian risk assessment and management plan will be prepared as an outcome of this task and on the basis of this baseline study as well as a review of the alignment of proposed transmission lines. • Compensatory tree plantation, with a ratio 1:10, will be carried out. A tree plantation plan (Annex-II) has been prepared and a total of about 44,000 saplings will be planted. The post-construction ecological monitoring will also be carried out look at the status of the foraging and spawning grounds to ensure they are capable of supporting the species that rely on it during winter.	Minimal
EHS Risks and Impacts of construction activities including those associated with Tunnel and Underground Powerhouse Works	High	Major	Major	• the OCHSMP will be implemented, that will include risk assessment, staffing needs, training needs, accident reporting, standard operating procedures, and requirement of conducting job hazard analysis. • Regular site inspection and safety audits will be carried out • Regular OHS training programs for workers will be carried out. • Daily toolbox talks covering OHS will be arranged. • Incident investigation and reporting system will be established. • Use of relevant PPE will be ensured.	Minimal

Impacts of various activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Key Mitigation and Enhancement Measure	Residual Significance
				• The maximum allowed noise level according to national legislation is 85 dB(A). Monitoring of noise levels shall take place during the regular construction site audits. Where the noise level is exceeded, ear protecting devices shall be handed out to the workers. Warning signs shall be erected. • Conduct a Job Hazard Analysis (JHA) at the new construction site to identify potential hazards that may arise from the proposed works or working conditions to the project workers and implement necessary control measures. • A tunnel risk assessment (TRA) will be conducted before commencing the tunneling and underground works, • signages in hazardous and risky areas will be installed, blasting activities will be permitted with issuance of “Permit To Work” by the PIC and Contractor’s • contractor will submit a blasting schedule in advance, specific warning devices (e.g. horn signals, flashing lights) and procedures shall be implemented before each blasting activity to alert all workers and third parties in the surrounding areas. • the tunnel and powerhouse workplaces will be ventilated well to enable workers to carry out work without risk to health and safety, static safety factors will be established based on the level of hazard for the operational phase of a facility and at closure, for machine and equipment safety, • use of contrast coloring on equipment / machinery, including the provision of reflective markings to enhance visibility will be ensured, regular air quality monitoring will be carried out, methane detection procedures will be adopted routinely, use of respiratory PPE will be ensured, • risk of heat stress during tunnel work will be strictly monitored, if unavoidable, • re-fueling in tunnels will be avoided to the extent possible. • In addition, fire and explosions hazards will be identified and visibility and lighting as well as electrical safety will be adopted in line with the best international practices and guidelines.	

Impacts of various activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Key Mitigation and Enhancement Measure	Residual Significance
				• In addition, guidelines of international tunneling association (ITA) will be followed. • Implement the mitigation measures and emergency response plans given in ECP 18 (Annex-I and Annex-III): Worker Health and Safety, ECP 19: Tunneling and Underground Construction Works, and ECP 20: Instream Construction Works.	
Blasting & Vibration impact of tunnel construction	High	Moderate	Major	• Conduct a pre-construction survey of structures at risk of vibration impacts on houses and other structures. If they are located close to the blasting area (100 m) then they need to be relocated, if the distance is more than 100 m, awareness will be created and residents must be notified in advance prior to every blast. Following completion of the blasting, the survey will be repeated to determine the condition of the buildings and verify that they are safe for re-occupation. Contractor will prepare Blasting Management Plan (Annex-II) prior to construction and obtain approval. • A minimum buffer of 500 m will be provided between the settlements and point of blasting. Community awareness will be carried out. Barricading will be fixed where possible • Conduct a pre-construction survey of structures at risk of vibration impacts households. Following completion of the blasting, the survey will be repeated in the Structural Damage Risk Zone to determine the condition of the buildings and verify that they are safe for re-occupation.	Minimal
Impacts from Quarry–Sourcing of aggregates for concrete works	Medium	Moderate	Moderate	• Reuse of excavated material to the extent feasible. Use of licensed quarry sites. Source the material from the boulders from the eroded riverbanks in the proposed reservoir area (which are found to be suitable for aggregates).	Minimal
Impact on tourism	Medium	Moderate	Moderate	• Construction activities may affect tourist activities in Swat valley. However, hotel managers do not expect severe negative impacts on the number of tourists. There is the hope that projects like MHPP will bring more stability to the region. Mitigation measures include efforts not to increase the traffic in Bahrain town more than absolutely necessary. Furthermore, it is important	Minimal

Impacts of various activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Key Mitigation and Enhancement Measure	Residual Significance
				to maintain spoil piles and properly dispose of wastes to ensure the visual environment is not negatively affected.	
Community exposure to work hazards	Very high	Moderate	Major	• Barricade the work areas (near the settlements) with hard fencing to prevent the entry of community in the construction areas. • Placing adequate signboards and flagmen to divert the community away from the construction works. • Construct access roads for the communities to avoid exposure of construction hazards. • Community awareness programs on construction-related hazards, including awareness programs for community leaders, Imams, and in schools for both teachers and students.	Moderate
Impacts from labor influx and potential cultural conflicts between communities and workers; Risk of sexual exploitation and abuse (SEA), and sexual harassment (SH) by 200 migrant workers (60 foreigners and another 140 will be from Pakistan but outside the project area)	High	Moderate	Major	• Contractor will prepare a Code of Conduct (CoC); all site personnel will be given orientation on this CoC; each site personnel will be required to sign the CoC at the time of employment. The CoC will cover clauses related to avoid sexual exploitation and abuse, and sexual harassment. The CoC will be translated into Urdu and disseminated among the workers. The code of conduct will be included in the worker's contract agreement, and any violation of the code of conduct will lead to termination of employment.; • contractor will initiate a program to promote awareness among construction workers about respecting the local community. Construction camps will be built in the designated areas, located away from the local settlements. • The Contractor's monthly training program will cover topics related to CoC such as sexual harassment particularly towards women and children, violence, including sexual and/or gender-based exploitation. • The awareness activities will cover posting of CoC standards in public spaces in Urdu, trainings and sensitization sessions, providing information on GRM, awareness of suspicious situations and signs of SEA/SH and other related aspects.	Minimal

Impacts of various activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Key Mitigation and Enhancement Measure	Residual Significance
				• Gender Action Plan (GAP) has been prepared (Annex-II) that cover SEA/SH risks.	
Socioeconomic benefits	High	Moderate	Major (beneficial)	• The project will act as an economic catalyst bringing an additional demand for resources and offering employment opportunities during construction and operation phases of the project. During construction phase, jobs for unskilled labor will be available and the local surplus labor force would be used in the construction activities. The availability of jobs within the area would reduce the out-migration of the labor force and would enable most of them to stay at home. Prices of forest products, livestock and agricultural produce are expected to increase during the construction phase. As the project area becomes more developed, the value of the land in the project area will also increase. The local unskilled labors are likely to become skilled or semi-skilled after gaining experience in the project.	Major (beneficial)
Temporary accommodation related health risks	Medium	Moderate	Moderate	• The contractor will develop and implement a Camp Management Plan (Annex-II) and/or follow ECP 16: Labor Influx Management and Construction Camp Management (**Annex-II**) • The construction camp will be built with all adequate facilities (safe drinking water and sanitation, kitchen and rest areas.) including entertainment facilities so that there will be minimal interaction between them and local communities • A medical clinic, with a medical doctor and attendants, will be established at the campsite. Regular health check-ups of the workers will be carried out. • The Contractor shall establish a mechanism to collect the complaints from the workers and address those complaints by the approved GRM plan	Minimal
Security Risks	High	Moderate	Major	• PMO will prepare a Security Plan for the Project. This Plan will be implemented during the construction phase. Frequent consultation with local community leaders to identify and resolve any social frictions before they become inflamed. Arrange security of foreign staffs before moving to the Project area.	Minimal

Impacts of various activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Key Mitigation and Enhancement Measure	Residual Significance
Environmental Impacts during Operational Stage					
Reduced water flow and impact on aquatic habitat of the Swat River and its tributaries through the creation of reservoir/pondage	Medium	Moderate	Moderate	• eFlow will be maintained throughout the year • A Fish Management Plan (Annex-II) will be developed to manage any potential risks on and related to the fishes.	Minimal
Generation of low carbon and environmentally friendly power generation. Supply of an additional 207 MW (805.78 GWh) of electric power to the national grid of Pakistan	High	Major	Major (beneficial)	• Quick implementation of the Project including resettlement action plan (RAP) and ESMP to mitigate the anticipated E&S impacts associated with the construction of the project and secure delivery of the electricity to the entire nation.	Major (beneficial)
Barrier effect on fish migration	High	Moderate	Major	• A Fish ladder is designed (Figure 3.13) based on the requirements of snow trout, catfish, and other indigenous species. During the plant operation, a comprehensive monitoring regime will be implemented for the performance of fish ladder. • With the eflow of 3.5m3/s, the water depth in the river channel will be 0.8m. The eFlow of 3.5m3/s will be divided between mini-turbine (2.8 m3/s) and fish pass (0.7 to 0.76 m3/s), ensuring 0.5m to 1m water depth in the fish pass. A trash rack is integrated in the mini-turbine to avoid entrapment of the fish into the mini-turbine. The calculations are as follows. **Design Parameters:** -Top Free Width (m) =1.5 -Flow Depth (m) = 0.5 to 1 **Channel Hydraulic Properties:** -Flow Quantity (m^3/s) =0.7 to 0.7596 -Channel Slope (No Unit) =0.0714 -Manning Roughness Coefficient (No Unit) =0.3 -Vetted Perimeter (m) =2.5 to 3.5 -Hydraulic Surface (m^2) =0.7 to 1.5	Minimal

Impacts of various activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Key Mitigation and Enhancement Measure	Residual Significance
				-**Hydraulic Depth (m) =0.5 to 1** **-Hydraulic Radius (m) =0.3 to 0.4286** **-Flow Velocity** (m/s) =0.5064 to 0.9 • Rectangular **Section Geometrical Properties for stream with discharge of 3.5 cumecs:** -Top **Free Width (m) =2.477** **-Flow Depth** (m) =0.8 Channel Hydraulic Properties: -Flow **Quantity** (m^3/s) =3.5 -**Channel** Slope (No Unit) =0.01 -**Manning** Roughness Coefficient (No Unit) =0.035 -Vetted **Perimeter** (m) =4.077 -Hydraulic Surface (m^2) =1.9816 -**Hydraulic** Depth (m) =0.8 -**Hydraulic** Radius (m) =0.486 -Flow **Velocity** (m/s) =1.7662	

Impacts of various activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Key Mitigation and Enhancement Measure	Residual Significance
				• Installation of trash rack at the intake to prevent the fish from entering water intakes and protect the fish against entrapment. Regular removal of deposited sediments from the ladder. • Supporting the fisheries department for upgrading their snow trout hatchery at Nagoha Shamozai, and annually releasing the fish both upstream and downstream of the weir. A Fish Management Plan (Annex-II) will be prepared and implementation will be ensured. Additional mitigation measures devised in the ESMP along with ECP 13 will be implemented. • After the construction of the weir and with an ecological flow of 3.5 cumecs, the water depth in the mainstream/river will be 0.8m. The sanctioned eflow 3.5m3/s will be bifurcated at the Weir site as 0.7m3/s flow will be released through fish pass and remaining 2.8m3/s will be released through mini-turbine. A trash rack is integrated in the design at mini-turbine to avoid entrapment of the fish into the mini-turbine. In this scenario, the water depth in the FISH LADDER of Madayn HPP will be 0.5m to 1m while discharging of 0.7 cumecs. The fish ladder is designed (Figure 3.13) with a maximum depth and discharge of 1m and 0.7 cumecs respectively.	
Emission of Greenhouse Gases	Medium	Minimal	Minimal	• Most of the few organic materials as trees, shrubs. will be removed before filling the reservoir. This reduces the generation of greenhouse gases to a minimum. Compared with oil or coal-fired power plants, the emission of CO2 can be neglected.	Minimal
Risk of bird collision and electrocution from the transmission line	Medium	Minor	Minimal	• There is no known bird migration route in the Project area. Insulation of exposed parts of the tower structure. Installation of bird markers to divert migratory birds to prevent collision and electrocution can be considered in the design.	Minimal
Reduction of sediment load in the downstream water flows from the reservoir	Medium	Minor	Minimal	• Release of environmental flows and excess flows through sluices to release the sediments in the high flow season. • Schedule the flushing of sediments during high flow season from the desanders. Synchronize the flushing of sediments with other hydropower plants up and downstream so that cumulative impacts are minimal. Avoid flushing at the same time.	Minimal

Impacts of various activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Key Mitigation and Enhancement Measure	Residual Significance
Workers' health and safety during routine operation and maintenance	Medium	Moderate	Moderate	• Implementation of Standard Operating Procedures.	Minimal
Exposure of toxic SF6 or arc products during maintenance of Circuit breakers and transformers	High	Moderate	Major	• Faulted SF6 will be handled carefully ensuring standard industry practices. World Bank Group's General EHS Guidelines will also be followed to handle SF6. Maintenance staff will observe the following guidelines during the maintenance of circuit breakers and transformers: • Do not breathe the vapors where arcing or corona discharges have occurred in the gas. • Evacuate the faulted SF6 gas and flush with fresh air before working. • Arc products which do not recombine, or which combine with any oxygen or moisture present, are normally removed by the molecular sieve filter material.	Minimal
Electrocution from overhead power lines, damaged tools and equipment, inadequate wiring and overloaded circuits, exposed electrical parts, improper grounding, damaged insulation, and wet conditions.	High	Moderate	Major	• Conduct a job hazard analysis to identify the hazards. Follow PEDO's standard operating procedure for repair and maintenance. Only, qualified persons using proper test equipment and personal protective equipment must adhere to limited approach boundary with a distance of 7.25 m for 220 kV voltage. Must comply with the working space requirement for the equipment. Receptacles and cord connectors used in damp or wet locations must be designed for use in wet or damp locations and, unless approved for submersion, must not be allowed to lie in water.	Minimal
Waste generation from the plant and staff colony	Medium	Moderate	Moderate	• Implement a waste management plan	Minimal
Social Impacts during Operation Stage					
Community health and safety	Very high	Minor	Moderate	• Complied with World Bank recognized standards on EMF through design considerations. • Review of weir designs by an independent panel of experts	Minimal
Improved livelihood opportunities from the development of tourist attractions	High	Moderate	Major (beneficial)	• PEDO will provide preference to affected persons in establishing small businesses in designated tourist areas established at the Project sites to improve their livelihood.	Major (beneficial)

Impacts of various activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Key Mitigation and Enhancement Measure	Residual Significance
Adverse impacts on community due to tourism from waste generated by the tourists	Moderate	Moderate	Moderate	• The tourist facilities will include waste collection bins and public toilets (separately for men and women), which will be maintained regularly by PEDO/NHA. The solid waste management system adopted for the PEDO colony and offices will be used for the collection, storage, transportation and disposal of solid waste from the tourist facilities. • Information posters could be hung around the Project-related tourist facilities about the proper etiquette to follow when encountering locals, especially women.	Minimal
Water-related Vector Diseases	High	Moderate	Major	• The Contractor shall provide adequate sanitary facilities within the construction sites to prevent workers from excreting into the river • PEDO will create and maintain sanitation facilities near tourist areas created because of the MHPP • During construction and operation, minimize the presence of stagnant water and puddles by improving the drainage facilities.	Minimal

7.3 Environmental Issues Mainstreamed in the Project Design

Environmental and social aspects have been considered in the planning and design of the Project facilities. These include:

- Location of worker camp site and dumping area near powerhouse proposed at feasibility stage (2009) has been changed to avoid the inundation of valuable agricultural land, orchard trees and houses of Kalgay Village.
- A fish ladder has been designed (Figure 3.13) based on the requirements of snow carps and will be included in the weir
- The project will be operated as a 'true run-of-river' for baseload power generation without any peaking operation
- Tourist-attraction facilities will be in-built in the project design (hiking ways, and parks)
- Dumping sites are selected close to the adits on the left river bank helping to reduce transportation routes.
- The sand of the desander will be flushed regularly during times of high flow of water. In winter time flushing will not be required.
- From about 2.75 million m^3 of excavated material generated, about 0.9 million m^3 can be deducted for use as gabion fill and concrete aggregates and riprap for slope protection in the reservoir area upstream of the weir.

7.4 Impacts of Project Siting

7.4.1 Environmental Impacts from Project Siting

7.4.1.1 Flooding

The project area is highly prone to flooding. The peak flood rate is much higher than initially estimated in 2009 **(Table 7-5).** The recent flood (August 2022) of the project area was historical and has caused inundation of surrounding land and road, land sliding, and destruction of a lot of mini hydropower plants, bridges, houses, hotels, River Swat has changed its course in the project Area (Bahrain) which may further affect its capacity to contain flood. This Impact is of Major significance. Floods are partly caused by the amount of rain falling, partly by the moisture that is already in the ground, and partly by the capacity of rivers to contain water within their channels. Furthermore, the recent flood also destroyed a number of hatcheries managed by the Fisheries department. Flooding therefore also has impact on the future of the local fish species. Proper estimation or management of the magnitude of flooding is necessary.

Table 7-5: Peak flood flow predicted by PIC

Return Period (Years)	Weir Site	Powerhouse
	Peak Flood (m^3/s)	
25	2,389	2,494
1,000	4,799	5,020
10,000	6,265	6,560

Mitigation Measures

In order to mitigate the risk of high flood levels, the weir location has been moved 400 m upstream. As the width of the Swat River is wider at the new location, there will be more space for the water to flow during high flow seasons. This will also reduce stress on structures and make the structures better suited for flood conditions. All structures are designed to cope with peak flood flow of the 10,000 years return period, which are 6,265 m^3/s at weir and 6,560 m^3/s at powerhouse.

The flood Impact area and current flood water levels in the project area will be continuously updated prior to starting the design of the project and will be included in the project design through Flood studies to account for any more changes.

7.4.2 Sediments in the Reservoir and Desanders

The total annual sediment load of the Swat River near the project site is 378,499 ton with majority of the load occurring during the summer months (June-August). The lowest sediment load is observed during February (3,043 ton), with the November to February being similar in load. The maximum load was observed during the month of July (134,750 ton). The sediment load is therefore lower near the beginning of the year and slowly increases until it reaches the maximum in July and then begins to slowly return to the lower values again as the end of the year approaches. The sediment load coming into the reservoir and desanders channel will therefore be different throughout the year. During floods, the sediment load will be much higher and the reservoir and desanders need to be designed to deal with the sudden increases. The impact has a Major significance.

Mitigation Measures

It is ensured in the design that the structures will be functional at different sedimentation load. The reservoir operations are designed with regular flushing of sediments through under sluices and from the desander channels during high flow season. However, even with regular sediment flushing, the life of the reservoir is estimated to be 60 years. Therefore, the residual impact significant is Moderate.

7.4.2.1 Coordination with all Relevant Departments for NOCs

Potential Impact

Under the current mandates of various departments, the proposed Project will need approvals and NOCs from various government departments, e.g., KP-EPA, Mines and Minerals and Fisheries department. These approvals take substantial time and cause delays in project implementation and undue cost overruns. This impact would be of Moderate significance.

Mitigation Measures

The most important measures would be adequate level of interdepartmental coordination. The draft EIA will be officially submitted to KP-EPA for their review and a Public Hearing will be scheduled with the support from KP-EPA.

The meeting will discuss and finalize the role and contribution of various departments in the project. This will be in line with the advice given by various stakeholders during consultations. By adopting the above measure, the impact would be of Low significance.

7.4.2.2 Low Carbon Power generation and Economic Improvement in the Region

The Project would supply about 805 GWh of electric power annually to the national grid. This additional electric power supply would address the current energy crisis in the country by eliminating the load shedding and power cuts and would lead to economic growth and increased employment. The Project generates clean energy enough to power the equivalent of about 280,241 homes per year in the country[47]. The estimated greenhouse gases from the Project are minus 563-721 tons annually as per previous feasibility. The significance is therefore Major but beneficial.

7.4.3 Greenhouse Gases Emissions

Greenhouse gases emissions are expected from the proposed land clearing, construction, material life cycle, and power generation and transmission. Net greenhouse gases emissions are minus 7.12 million tons when compared to other feasible options for power generation and transmission[48].

7.4.4 Social Impacts from Project siting

7.4.4.1 Land acquisition, Resettlement, and Livelihood

As per RAP of MHPP, the number of affected families/households is 141. The population of the affected households (AHHs) is 1,110 persons, including 576 males and 534 females. Moreover, there are 49 AHHs whose income is below the official poverty line (OPL) and are categorized as vulnerable. Among the affected families, about 98% are severely affected[49]. The total land to be acquired for MHPP is calculated to be about 131 acres (including dumping sites for excavated material) as per the revised design of the project. The land acquisition will impact about 80 acres of cultivated land, about 37 residential structures that will need to be demolished, and about 4,391 privately owned trees (fruit and timber) that will need to be felled[50]. The summary of the impacts on land acquisition is given in **Table** 7-6**.**

[47] The estimates are based on current per capita energy consumption 450 kwh per year, and the average household size in Pakistan (6.45 persons per household).
[48] The estimates are based on current per capita energy consumption 450 kwh per year, and the average household size in Pakistan (6.45 persons per household).
[49] A severely affected is a land owner whose affected land is 10% or more than 10% of his total land.
[50] *Source: RAP MHPP, March, 2023.*

Table 7-6: Summary of Resettlement Impacts

Sr. No.	Category of Impacts	Affected Land (Acres)		AHHs (Nos.)	PAPs (Nos.)	Remarks
A. Permanent Land Acquisition						
i)	Cultivated/Arable land	79.95		103	811	• Permanent acquisition of private Land • Cultivated and Residential land with multiple ownership with barren land.
ii)	Barren (Un-cultivated land)	35.65		01	8	
iii)	Residential Land	2.44		37	291	
iv)	Riverbed	13.11				Land under permanent impacts
	Total	131.17		141	1110	
B. Affected Cropped Area						
i)	Permanent impact	79.95		103	811	Permanent Loss of cropped area
	Total	79.954		103	811	
C. Affected Structures						
i)	Residential structures (Nos.)	37		37	291	Permanent Loss of residential structures
	Total	37		37	291	
D. Affected Trees (Private)						
i)	Affected wood/ timber trees	348		14	110	Permanent Loss
ii)	Affected fruit trees (Nos.)	363		31	244	
	Affected Timber Plus Fruit Trees	3680		58	456	
	Total	4391		103	811	
E. Project Affected Household						
i)	Total permanent AHHs			141	1110	These AHHs have multiple impacts as
ii)	AHHs facing loss of livelihood and severe impact			138	1086	
iii)	AHHs losing permanent Cultivable/Arable	-		103	811	

Sr. No.	Category of Impacts	Affected Land		AHHs (Nos.)	PAPs (Nos.)	Remarks
		(Acres)				
iv)	AHHs losing structures	-		37	291	
v)	AHHs losing trees (Nos.)	-		103	811	
vi)	AHHs having livelihood related			103	811	
vii)	Vulnerable AHHs	-		49	386	

Source: RAP MHPP, March, 2023.

Mitigation Measures

The RAP has been prepared, covering all the impacts listed in **Table 7.6**, as per the statutory requirements of GOP and the World Bank OP 4.12. The RAP will be implemented before commencement of the physical works.

Adequate compensation for affected households will be provided as per the entitlement matrix given in the RAP.

Compensation will be paid to the affected households and cut down trees will be handed over to the owners. In addition, 44,000 trees (10 trees for each tree cut down) will be planted under the plantation program.

Livelihood restoration program will be prepared and implemented under the resettlement action plan.

Social development plan will be prepared and implemented.

7.5 Environmental and Social Impacts and Risks during Construction

For this section, detailed explanation and mitigation measures are given for the impacts/groups of impacts that are deemed as requiring additional explanation.

7.5.1 Impacts due to Increased Traffic and Transportation

The use of vehicle fleets for transport of workers and construction materials are mainly expected during the construction phase of Madyan. As the area is remote and mountainous with a precarious road infrastructure which have potential risk for road traffic, accident and fatalities. For removal and transportation of excavated material, the existing access gravel roads will be used for each adit to the dumping site and if required additional temporary access roads will be developed. All these access roads are on the left bank of river, however; during the mobilization of the contractor, traffic along N-95 highway and in the Madyan and Bahrain cities will also increase for transportation of construction material to the proposed Weir and camp sites. During the mobilization of the contractor, traffic along N-95 highway and in the Madyan and Bahrain cities will increase. This will lead to congestion at certain places like main streets, central markets and bus stops. Apart from congestion, there will be increased air pollution and noise at these places. This might result in friction with shopkeepers, hotel/restaurant owners, and general public, as the project area is a hotspot for tourist activities. Road safety will decrease and risk of accidents will increase. The location and alignment of temporary access roads will be finally decided by the construction contractor in coordination with the project developer and his supervising engineer.

As mentioned earlier, one of the main impacts on the environment during the construction period will be the need to dump more than 1 million m^3 of material resulting from the excavation of the headrace tunnel and other underground structures. This impact includes the transport of this material to the specified dumping sites. Overall, more than 1.0 million m^3 of excavation material will have to be transported. Consequently, the main focus was given to reducing the transport of excavation material along the Madyan-Kalam Road as much as possible, which would also positively affect noise and air quality, especially in towns/villages like Bahrain and Madyan. This impact evaluated as of Major significance.

Mitigation Measures

- The contractor will prepare a Traffic Management Plan (TMP), including community awareness and safety measures. The contractor will update the TMP if required. TMP will be implemented during the construction phase.
- The location and alignment of temporary access roads will be finally decided by the construction contractor in coordination with the project developer and his supervising engineer. All the access roads required on the left

bank for access to adits and dumping sites will be identified and its impacts shall be reflected in the Contractor's ESMP and TMP.

- Coordinate and control vehicle operations from one central authority during the construction phase.
- Establish procedures and signages, and position traffic safety personnel to achieve separation of light and medium vehicles from heavy vehicles.
- Equip light and medium vehicles with devices (for example, a pole-mounted flag) to improve their visibility to other operators.
- Require defensive driving training for all drivers, including contractors and subcontractors.
- Implement traffic safety procedures to coordinate safe transport of workers to and from the workers' camp.
- Construct and maintain roads, particularly emphasizing major slopes, to ensure slope stability and the safety of heavy vehicle operation.
- Inform affected communities about potential traffic-related safety risks and issues, such as vibration and dust. Implement specific measures to ensure pedestrian safety (that is, define crossing areas and speed limits in populated areas like Bahrain) and use best efforts to avoid heavy traffic during in-and-out school times or during major harvesting events or cultural or religious festivities and gatherings, as well as monitoring of potential impacts (such as, preconstruction surveys of buildings, infrastructure, and structures, including photographic and video image recording).
- Prepared safety measures for controlling speed, in the densely populated areas and safety arrangements for pedestrian crossing points.
- PMO will facilitate establishment of traffic management committee with the relevant stakeholders (traffic agencies, local governments along N-95, and contractors).
- PMO will hold a one-day workshop(s) with the stakeholders to devise a plan for traffic management along N-95 during construction period.
- The dumping sites were selected as close as possible to the tunnel construction adits, weir site, and powerhouse site (see Chapter 3);
- The dumping sites are selected on the left Swat River bank in order to avoid transport crossing the river;
- No transport of rock material through towns (Bahrain, Madyan);
- No transport of large amount of excavation material through Bahrain;
- Use of conveyors where economically feasible;
- Producing concrete on site;
- Proper transport management to reduce truck movements;
- Transportation of material is allowed only during daytime (from 6.00 am to 6.00 pm);
- Speed limit of trucks crossing populated areas.

7.5.2 Impacts on Ecology of River Swat

During the construction period, the ecology of the Swat River will be mainly influenced by activities near the weir site. The second point of construction activities near the Swat riverbed is the power outlet located some 100 m downstream of the underground powerhouse and 1.6 km upstream of Madyan town.

At both sites, weir site and power outlet, the river will only be influenced marginally by drilling, blasting, and excavation activities. The construction pit will be protected by small cofferdams enclosing the working area for weir construction. The phases of construction at the weir site are as follows: (i) erection of cofferdams, (ii) construction of the weir, (iii) removal of cofferdams. During the time of construction of the upstream cofferdam, some increased sediment run-off will take place for 1-2 weeks.

Pre-construction and construction activities have the potential to adversely affect aquatic biota by the release of high concentrations of sediment during the construction of cofferdams, use of explosives, and accidental spillage of fuels. Sediment concentrations above natural levels can cause mortality of biota directly; for fish, damaged gills and sediment clogging of gill chambers eventually leading to death. The flow of the river will not be blocked completely and hence the migration of the fish will not be affected. This impact will be of Moderate significance.

. For about 1-2 weeks, an increased sediment run-off might take place during river closure.

Mitigation Measures

- The construction of cofferdam shall be inspected regularly to ensure the safe passage of fish.
- If any fish is stranded in the dry riverbed, it shall be relocated downstream.

- Control wastewater and sediment releases to river, particularly in the section between cofferdams
- Prevent the release of silt, sediment, sediment-laden water, raw concrete, concrete leachate, or any other deleterious substances into the river.
- Ensure equipment and machinery are in good operating condition (power washed), free of leaks, excess oil and lubricants, and grease.
- Ensure machinery leaking fuel, lubricants, hydraulic fluids, or solvents are not used within the river.
- Keep a spill containment kit readily accessible onsite in the event of a release of a deleterious substance to the environment. Train onsite staff in its use.
- Maintain eFlow (3.5 m3/s) as per the requirements of aquatic species throughout the year.
- Regular monitoring of the aquatic habitat and fish species during the construction activities
-

With the above mitigation measures, the residual impacts have been assessed as Minimal.

7.5.3 Increased Risk of Landslides

During construction, there is an increased risk of landslides and collapse of slopes. Landslides in freshly-cut slopes can occur due to lubrication or saturation of rock support structure by rainfall or by water seepage. The use of explosives to break the rock will have the capacity to generate vibrations that can trigger a landslide. Landslide-prone areas in the project area have been identified and classified on basis of potential risks. The major consequence of such a slide would be a sudden enormous increase in the sediment concentration which would make it advisable to shut down the power plant after the occurrence of such an event. Another hazard may arise from the damming up of river, the infiltration of water into the slopes can lead to a reduction of the shear strength parameters of the slope material and/or buoyancy effects. This is especially the case where old landslides are present. Furthermore; the sensitive receptors in this case are the Contractor workers, villages located on the left side of Swat Rive within AOI.

This impact has been assessed as Major.

Mitigation Measures

- Any blasting activities in these areas will be controlled and contained within defined limits. As much as possible explosives with a low intensity will be used.
- Landslide prone areas will be identified and mitigation measures will be devised and implemented.
- Pro-active measures will be implemented to stabilize and protect slopes and to protect workers safety. Early warning systems will be introduced that will indicate when cracks appear, especially following heavy rainfall and allow any widening to be monitored. Access would be restricted during the periods that slope stability is not yet entirely secured and guaranteed by proper safety measures such as rock bolts, anchors, safety nets and gabion structures and any blasting activities in these areas will be controlled and contained within defined limits. Contractor will develop a Blasting and Explosives Management Plan and Vibration Monitoring Plan. A pre-construction survey of structures at risk of vibration impacts will be conducted and accordingly management plan will be developed in Contractor's ESMP (C-ESMP) prior to commence the work.
- Ensure affective utilization of personal protective equipment (PPE).
- Regular monitoring by the contractor will be required.
- Extreme care will be exercised to protect workers and the public from the dangers of sudden landslides, which may occur during excavation and blasting works. Particularly after heavy rainfall there may be increased risk of such incidents. Similarly, water seepage may occur if reservoir or tunnel walls not constructed according to standard engineering practices, that water may easily penetrate into surrounding loose soil and may lead to land slide and damage to project structures.

Even with the mitigation measures in place, residual risk is assed as Moderate as the risk still remains.

7.5.4 Impacts on Water Springs

Major source of drinking water in the project area is water springs. There are several springs located in the left side mountains of the river Swat which may be affected due to construction of headrace tunnel. The anticipated impacts are as follow;

- Contamination of springs water;
- Disruption of spring water due to change inn geomorphological profile in the tunnel zone.

Mitigating Measures

To avoid any potential impacts on water springs, the contractor and PIC will analyze the tunnel's expected interference with underground water and technical solution will be devised to maintain the flow without disruption, in line with the applicable good international practices and guidelines.

A Sustainable Water Supply Management and Monitoring Plan (that will include monitoring of water springs that are used by the communities) will be developed to minimize impact to natural systems by managing water use, avoiding depletion of aquifers, and minimizing impacts to water users;

The quality and quantity of tunnel effluent streams discharged to the environment, including storm water, leach pad drainage, process effluents, and overall tunnel works drainage will be managed and treated to meet the applicable effluent discharge guideline values;

In addition, discharges to surface water will be avoided in contaminant concentrations in excess of local ambient water quality criteria (NEQS).

For springs water quality monitoring, monthly construction stage instrumental monitoring will be carried out. In addition, water supply schemes are also proposed in the Social Development Plan (SDP) that will be implemented in the project area as part of MHPP.

7.5.5 Generation of spoils

As Madyan HPP has a run-of-river design with a long headrace tunnel, huge quantity of material to be excavated are estimated at the feasibility stage of the MHPP Project is about 2.75 million cubic meters of rock material from excavation[51]. The major portion of excavated material will be generated due to excavation for Weir that will generate about 0.99 m3 (35.88%), headrace tunnel 0.92million m3 (33.3%), desander is 513,267 m3 (18.53%), tailrace tunnel is 0.53 million m3, approach tunnel is 86,893 m3, and powerhouse 79,813 m3 million cubic meters. Depending upon the quality of the excavated material, some quantity about 18% (0.9 million m3) of the total volume of excavated material will be reused to meet the requirement of aggregate rock fill for the construction of project structural elements like weir, cofferdam, tunnel, tailrace. The area for disposal of surplus excavated material is mostly constituted of high hills that are generally occupied by community forests, limited area of nearly flat benches that are occupied partly by settlements and partly used for cultivation, and narrow river and tributaries. The topography of the land in vicinity of the project structures and in the surroundings is such that limited area is available for disposal for the surplus excavated material. Disposal of such a huge amount of excavated material has impacts on many issues such as air quality, noise aspects, traffic, landscape, flora and fauna, tourist activities. To mitigate these impacts, some of the material will be reused as concrete aggregates, for the aforementioned structures as well as gabions and slope protection. As a mitigation measure, disposal sites are selected close to the adits on the left river bank helping to reduce transportation routes. Transport of excavated material through the City of Bahrain to be avoided. The spoil dumping areas identified in **Figure 3-16** will be used to deposit the surplus excavated material. Details of rock material to be excavated are given in **Table 7-7.**

Table 7-7: Estimated Excavated Materials from Project

Item No.	Item Description	Excavation Quantity (m^3)	Required Area (Acre)
1	Powerhouse	79,813.72	1.06
2	GIS and Transformer Hall Cavern	26,680.39	0.35
3	Access Tunnel	10,287.00	0.14
4	Cable Tunnel	2,689.00	0.04
5	Draft Tube Tunnel	5,197.00	0.07
6	Tailrace Tunnel	9,168.87	0.12
7	Tailrace Outlet	53,350.00	0.71
8	Headrace Tunnel	920,261.50	12.22
9	Approach Tunnel	86,893.93	1.15
10	Desander	513,267.24	6.82

[51] detailed project component wise excavated material quantities and reuse volume will be carried out during detail design stage of the project.

Item No.	Item Description	Excavation Quantity (m^3)	Required Area (Acre)
11	Pressure Shaft	5,229.18	0.07
12	Pressure Tunnel	3,775.68	0.05
13	Surge Tank	29,833.44	0.40
14	Manifold	3,552.00	0.05
15	Intake Structure	21,306.00	0.28
16	Weir Structure	991,081.40	13.16
Total		**2,762,386.35**	**36.68**

The project component wise excavated material generation in percentage are presented in the following graph; see **Figure 7-1.**

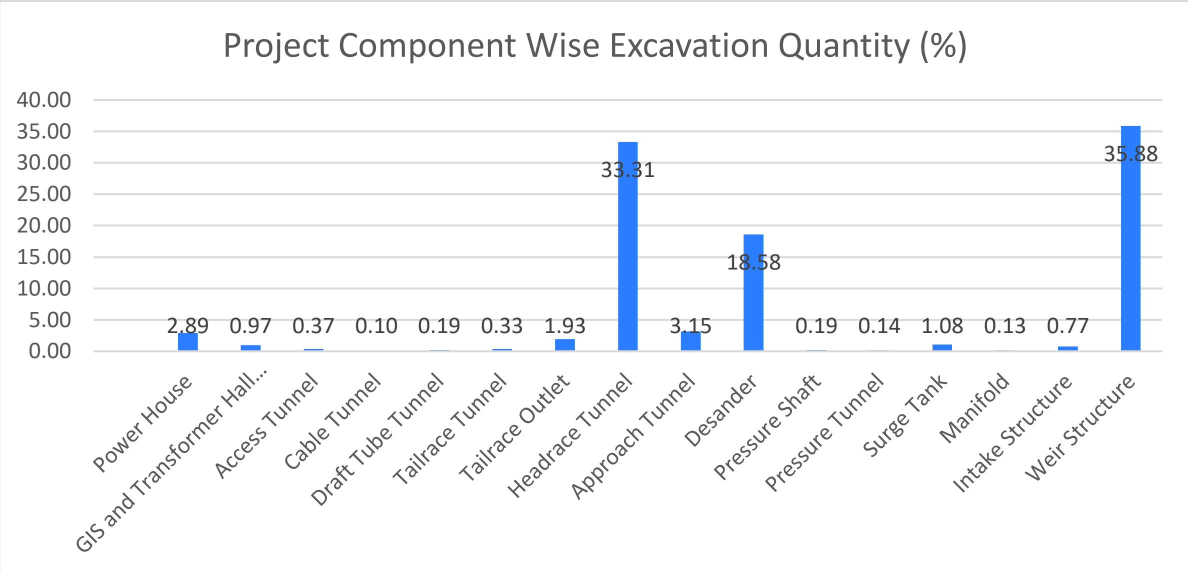


Figure 7-1: Project component wise excavated material

Dumping of this large amount of excavated material is one of the biggest challenges of the project from an environmental point of view. The amount of excavated material is reasonable based on the design concept of a run-of-river hydropower project with a low weir structure and a long headrace tunnel. This issue will significantly affect different aspects such as land acquisition, use of terrestrial habitats, traffic, noise, air quality and tourist activities. The impact of dumping excavated material has to be evaluated as being Major. The land will be acquired for Muck Disposal on temporary basis.

Mitigation Measures

Environmental and social due diligence (ESDD) will be carried out by environment, social and engineering team of PIC for the identification of dumping sites, potential environmental and social impacts will be determined and mitigation measures will be devised before commencing disposal. Adaptive management approach will be adopted and the mitigation measures devised in this ESMP as well as ESDD report will be implemented by the contractor. In case, one of the sites for disposal was not feasible, another site will be identified keeping in view the following parameters;

i. The identified disposal/dumping sites will be selected at a lower elevation than the existing settlements, thus avoiding any land slide or land slipping risks.
ii. The disposal shall not be in the active Swat River bed, tributary, creek, freshwater bodies or any water course.

iii. Away from the settlement.

iv. Not in the settlement, agriculture or private land. In case, the disposal in the private land is unavoidable, the affectees will be compensated in line with the MHPP RAP/LRIP.

After completion of the disposal process, the following operation stage mitigation measures' will be adopted;

Considering the site conditions and the various erosion control methods like vegetation and forestation are the most effective and economical measures. These methods are recommended as the preferred options for erosion control. Furthermore, land construction slope should be kept as flat as reasonably possible. Methods such as slope rounding, terracing or contouring to minimize erosion and to promote plant growth will be adopted. The commonly available erosion control processes are listed below:

- Grading
- Compaction
- Vegetation
- Surfacing and pitching
- Soil stabilization
- Hydrographic modification (channeling, diversion, culverts, stream crossing) and
- Retaining structures and terracing.

In addition, the following construction stage mitigation measures will be adopted;

- The identified disposal/dumping sites will be selected at a lower elevation than the existing settlements, thus avoiding any land slide or land slipping risks.
- Disposal sites will include containment structures (retaining walls) where needed before muck/excavated material is disposed.
- Excavated material disposal sites will be selected for practicality of operation and avoidance of critical habitat and local settlements.
- Slope stability analysis will be conducted for the spoil tip, natural slope ratio as required for slope stability will be maintained for the area.
- Disposal site will be located above the flood line.
- Disposal Sites in the water ways shall be avoided.
- Before commencing the construction activities, the contractor will be required to prepare a Spoil Management Plan and submit it to the PMO for their review and approval.
- Minimize the generation of spoils by recycling the excavated rock to the maximum extent possible by using them as fill for gabions, to use them as riprap for slope protection and as concrete aggregates
- Proper dumping and adequate compaction of soil/muck will be carried out to avoid dust and release back to the river
- On the request of the local community, the land will be levelled to enable them to reuse these lands for agriculture after construction activities. These lands can also be used for commercial activities.
- Landscaping of the spoil sites will be carried out where practical, after completion of works.

With the above mitigation measures, the residual impacts have been assessed as Minimal.

7.5.6 Generation of Construction and Hazardous Waste

The construction works generate large quantities of excess materials from construction sites (concrete, discarded material,.) and wastes from field camps and construction yards, including other debris. In addition, small quantities of hazardous waste will also be generated mainly from the vehicle maintenance activities (liquid fuels; lubricants, hydraulic oils; chemicals, such as anti-freeze; contaminated soil; spillage control materials used to absorb oil and chemical spillages; machine/engine filter cartridges; oily rags, spent filters, contaminated soil,). It is imperative that such waste is responsibly disposed of to avoid adverse environmental and human health impacts. The impact is of Major significance.

Mitigation Measures

- the contractor will prepare and implement a Waste Management Plan and waste management will be handled by a licensed contractor.

- Guidelines for the management of wastes, including solid and hazardous wastes, are given in ECPs (See ECP1 on Waste Management and ECP 2 on Fuels and Hazardous Substances Management in **Annex-I** for detailed mitigation measures).
- The contractor will place containers of adequate size and numbers in place for the collection of various types of wastes (metal, rubbers, used fuels, batteries,.) from the worksites, and transport these wastes regularly to a centralized facility.
- The contractor will procure the services of a waste management contractor for transport and treatment of hazardous waste, and management of recyclable waste.
- For disposal of inorganic construction waste, the contractor will build a waste disposal site or place them in the spoil disposal areas.

With the above mitigation measures, the residual impacts have been assessed as Minimal.

7.5.7 Wastewater Discharges from Construction Sites and Construction Camps

The wastewater discharges from the batching plants contain high sediment loads and high pH value. Although the groundwater was not encountered in the test boreholes drilled up till now along the tunnel alignment, there is a possibility groundwater may ingress through joint planes and discontinuities, creating dripping and moist conditions in some stretches of the tunnel. The discharges from the tunnel may contain high suspended sediments and can have pH significantly different from receiving surface water bodies. These discharges will impact the aquatic environment if they are discharged without any prior treatment. The groundwater located within the riverbed would be affected by the wastewater discharges. Other wastewater discharges from the project include sanitary effluents from two worker's camps (up to 250 workers in peak periods) and vehicle, construction plants (crushing & batching plants) and machinery washing facilities. The impact is of Moderate significance.

Mitigation Measures

- Contractor will prepare and implement a Waste Management Plan.
- Sedimentation ponds, of adequate size and capacity, will be built for the treatment of discharges from the batching plants and the tunnels to allow the sediments to settle. Final discharges from the sedimentation ponds shall comply with NEQS for wastewater discharges into the rivers. The pH values will be frequently monitored and if the pH values are high, additional buffering solutions will be added to settlement ponds for control of pH. The settled sediments will be periodically removed and will be disposed of at the designated spoil disposal sites.
- Construction of appropriate wastewater treatment facilities at the campsite (e.g., septic tank and soak pit) and site drainage).
- The contractor will be required to take appropriate measures to avoid and contain any spillage and pollution of the water.
- Quarterly monitoring of wastewater quality to ensure compliance with NEQS.
- Preparation and implementation of waste management plan.

With the above mitigation measures, the residual impacts have been assessed as Minimal.

7.5.8 Risk of Soil and Water Pollution from Construction Works

During construction, there is a high risk of accidental spills and leakages from fuel and oil tanks, vehicles, machinery and stored chemicals that are used in construction areas, yards, batching plants, worker camps, and storage sites. Earthworks for site preparation and foundation during rainy periods may carry the sediment load to the river. Other potential sources of soil, surface water and groundwater pollution are improper storage and handling of materials, including hazardous materials, discharges from the construction sites and material storages, lack of proper drainage facilities, spillage of fuels, erosion from material stockpiles. The impact significance is Moderate.

Mitigation Measures

- Storage of fuels and chemicals in contained facilities and take appropriate measures to avoid and contain any spillage. Double containments will be arranged for such substances in addition to concrete pad and coverage from rainfall.
- Confine the contaminants immediately after accidental spillage and clean-up of oil spills using spill kits.
- Collect contaminated soils, treat and dispose of them as hazardous waste
- Topsoil from cultivated lands in the construction areas are to be stripped and stockpiled where practical for restoration of spoil disposal sites.

- Temporary stockpiles to be protected from erosion.
- Additional mitigation measures are given in ECP 3: Fuels and Hazardous Goods Management, ECP 3: Water Resources Management, ECP 5: Soil Quality Management, and ECP 7: Erosion and Sediment Control.

With the above mitigation measures, the residual impacts have been assessed as Minimal.

7.5.9 Air Quality

Potential Impacts

The current air quality in the project area is within the NEQS standards. The activities that could contribute to air pollution are construction of weir, powerhouse, headrace tunnel, and earthworks. An increase during construction stage in dust particles in air, carbon monoxide, Sulphur dioxide, oxides of nitrogen, and particulate matter is expected throughout the project area. The activities that could contribute to air pollution are drilling and blasting for about 11.8km long headrace tunnel and excavation for powerhouse activities (to be carried out underground), earthwork, transportation and dumping of excavated material, crushing and batching plant and emissions from construction-related traffic and equipment. In addition, construction material has to be brought in along the main road crossing Madyan and Bahrain. The sensitive receptors are the contractor's workers, nearest residences in Kedam village which is located within vicinity of weir site and villages Daroli, Ayeen, Ponkia and Gorejo which are located near adit and dumping sites, where most of the construction works will be carried out. The dust likely to be raised from the above activities will also have impacts on crops and animals.

Construction machinery, diesel generators, and project vehicles will release exhaust emissions containing carbon monoxide (CO), Sulphur dioxide (SO_2), oxides of nitrogen (NO_X), and particulate matter (PM). These emissions can deteriorate the ambient air quality at the project site and along the haulage roads leading to the sites.

An increase in carbon monoxide, Sulphur dioxide, oxides of nitrogen, and particulate matter is expected throughout the project area, however, this increase will be mainly focused at the work sites and in the vicinity of the above-mentioned villages. The dust raised from the above activities will have impacts on crops, animals, and public health. This impact will be of Moderate significance.

Mitigation Measures

- Dust suppression techniques (e.g., wetting down, use of all-weather surfaces) for roads and work areas, optimization of traffic patterns, and reduction of travel speeds will be followed.
- In case of blasting impacts on ambient air, blasting will be carried out at a time when workers are not expected to enter the affected area of the headrace tunnel and powerhouse for the next hour or so, this allows some dust to settle out and the rest to be carried away by the ventilation system. As more than 90% of the blasting would be carried out in confined environment; therefore; the impacts on aboveground ambient air minimal and is only anticipated during construction of headrace and powerhouse portal portions.
- In case of drilling dust emissions from drilling activities needs to be controlled at the source by dust extractors, collectors, and filters, and wet drilling and processing will be adopted[52]. At this stage of the project, the contractor's type of drilling technology, plan and methodology of drilling is not available, therefore; different options for drill dust control are proposed for this ESIA and whichever is effective, efficient and feasible for contractor can be adopted; (i) the most common method of drill dust control is a **dry dust drill collector** with the intake at the tip of the drill bit. This arrangement provides excellent dust control if the collector is maintained properly. (ii) in hard-rock mines and tunnels, **water injection through the drill steel** has been effectively used to control dust for many years. (iii) **foam injection** through the drill steel also can be used in those applications where excessive water can create a problem[53]. (iv) **wet drilling systems** pump water into the bailing air from a water tank mounted on the drill. The water droplets in the bailing air trap dust particles as they travel up the annular space of the drilled hole, thus controlling dust as the air bails the cuttings from the hole. The drill operator controls the flow using a control valve located in the cab. Some drills are equipped with a flow meter to give the operator a visual sign of the flow rate. Raising the water flow will improve dust capture, but too much water causes operational problems. Because of this, the drill operator must exercise care in finding the best water flow rate. (v) **Dry Collection** systems require an enclosure around the area where the drill stem enters the ground. This enclosure is constructed by hanging a rubber or cloth shroud from the

[52] IFC Environmental, Health, and Safety Guidelines for Construction Materials Extraction available on https://www.ifc.org/wps/wcm/connect/dad17995-66be-4280-86da-b438cf9fbefc/Final%2B-%2BConstruction%2BMaterials%2BExtraction.pdf?MOD=AJPERES&CVID=nPtfjTM&id=1323162191491

[53] Source: NIOSH Handbook on Dust Control in Mining. Can be accessed on https://www.cdc.gov/niosh/mining/userfiles/works/pdfs/2003-147.pdf

underside of the drill deck. The enclosure is then ducted to a dust collector, the clean side of which has a fan. The fan creates a negative pressure inside the enclosure, capturing dust as it exits the hole during drilling. The dust is removed in the collector, and clean air is exhausted through the fan.

- In addition, for storage for dusty materials, the materials will be enclosed or operated with efficient dust suppressing measures; loading, transfer, and discharge of materials will take place with a minimum height of fall, and be shielded against the wind, and consider use of dust suppression spray systems and the contractor will monitor the ambient air levels regularly at the nearby villages and other sensitive receptors to ensure that these do not exceed NEQS and World Health Organization (WHO) standards.
- Construction sites where Sensitive receptors (Kedam, Daroli, Ayeen, Ponkia and Gorejo villages) are located within 500 m will water sprinkled regularly by the Contractor
- Water all access roads used for any vehicular traffic (close to sensitive receptors) at least twice per day during active operations and restrict vehicle speed to 20 kmph.
- Crushing and batching will be located a minimum 500 m away from sensitive receptors (Mosque, Schools, residential houses) and will have appropriate dust/emission suppression mechanisms such as wet scrubbers
- Ensure that all vehicles and machinery are fitted with appropriate emission control equipment, maintained properly, and serviced according to the manufacturer’s specifications;
- Smoke from internal combustion engines will not be visible for more than ten seconds;
- Fit and maintain appropriate mufflers on earth-moving and other vehicles on the site;
- During windy conditions, stockpiles of fine material will be wetted or covered with plastic;
- Take dust suppression measures, such as promptly watering exposed areas when visible dust is observed
- Implement a program for sprinkling water on the roads under use for movement of construction machinery/equipment/labor.
- Personal Protective Equipment (PPE) such as dust masks will be made available to the construction workers at the site to avoid potential health hazards;
- Schedule deliveries to the site in day-time so that disruption to local community and traffic are minimized;
- Idling of delivery trucks or other equipment will not be permitted during periods of unloading or when they are not in active use;
- In no case, loose earth will be allowed to pile up along the approach roads;
- All vehicles and other equipment used during construction will be properly and regularly tuned and maintained;
- All permanently deployed vehicle exhausts will be monitored against NEQS/WHO guidelines;
- Regular monitoring of air quality to ensure compliance with NEQS on ambient air quality
- Possibility of excessive dust generation may be reduced by adopting the best construction practices, and precautions such as periodic watering, covering of construction material and usage of low emission equipment during construction; and
- Adhere to the following project-specific construction stage mitigation actions:
  a) The works along the sensitive receptors (nearby settlements) shall not be carried out during night. If the works require more time, the sound/noise barriers shall be installed by the Contractor to avoid any disturbance to students and residents.
  b) Generators will only be operated on a standby basis for short periods. Electricity will be used where a connection from the Utility (PESCO) is available.

The implementation of the above measures will generate impacts of Minimal significance.

7.5.10 Noise

During baseline survey, the ambient noise level was recorded as 53.1 dB(A) at weir site, 51.7 dB(A) at Kedam Point, 49.1 dB(A) at Torwal village, 53.2 dB(A) at Darolai village, 50.9 dB(A) at Ayeen Village, respectively. These ambient noise levels are below the acceptable limit of 55 dB(A) at day time. When the Project activities would start, it is very likely that the existing noise level would be amplified. The amplified noise levels will be temporary in nature and easily mitigated. The sensitive receptors are the contractor’s workers, nearest residences in Kedam village which is located within vicinity of weir site and villages Daroli, Ayeen, Ponkia and Gorejo which are located near adit and dumping sites, where most of the construction works will be carried out. At most of the construction sites, there are no major biological sensitive receptors except for some native reptiles that may inhabit the proposed sites. Schools and Basic Health Units do not fall in RoW of the project and are at a reasonable distance from construction camps. There will be insignificant impact on schools. The hospital is at safe distance from construction camps and there would be no noise issues. The nearest residences are located within vicinity of weir site in Village Kedam, where most of the construction works will be carried out.

Noise will be generated from vehicular movement, excavation machinery, concrete mixing, and construction activities during the construction phase. The sources of noise during construction will be excavators, generators, concrete batching plant, and other construction machinery and vehicles. Increased noise and vibration levels during construction activities can be a source of nuisance for locals and a source of disturbance to wildlife.

The impact of noise is determined in the MHPP project area as minor in terms of duration (five years along a linear project which means about less than 1 year at a particular location) and the situation will return to the baseline after completion of the construction activities. For the construction of MHPP blasting is required. At seven of the locations close to receptors with increased noise levels during construction will be monitored and compared with the pre-project (baseline) noise levels. The impact is of Moderate significance.

Mitigation Measures

- reduction of noise from drilling rigs by using downhole drilling or hydraulic drilling may be adopted.
- Stationary noise sources such as batching plants will be kept at least 300 meters away from the nearest community
- Noise levels will be monitored on a regular basis at the key receptors (Kedam, Daroli, Ayeen, Ponkia and Gorejo villages) in order to take timely corrective measures, if needed.
- Additional mitigation measures such as noise barriers will be implemented at sensitive receptors (Kedam, Daroli, Ayeen, Ponkia and Gorejo villages), as required.
- Impose speed limits on construction vehicles to minimize noise emission along areas where sensitive receptors are located (Houses, Mosque, schools)
- The contractor shall provide equipment only of the size/power required to complete each task
- The contractor shall plan his operations to be completed preferably based on a six-day working week from 6:00 am to 6:00 pm. Will the contractor require additional working hours, or weekend work, he shall submit a request to the Engineer and Environmentalist for permission to work extended hours, giving full reasons for the requests. Approval to such requests will not be granted for works close to the populated areas
- The contractor will monitor the noise levels regularly at the nearby villages and other sensitive receptors to ensure that these do not exceed NEQS and WHO standards. Contractors will adopt appropriate noise attenuation measures, such as sound barriers, to reduce the noise generated from construction activities.
- Construction activities that are close to settlements will be stopped during night times if high noise values are observed.
- All vehicles used in the construction activities will comply with NEQS and WHO standards exhaust and noise standards (85 dBA at 7.5m from the source)
- Construction activities close to nearby schools and hospitals will be timed to coincide with school vacations or long holidays. Noise barriers (or other appropriate arrangements) will be used where required.
- High noise emitting equipment, if any, will be fitted with noise reduction devices such as mufflers and silencers wherever possible;
- For protection of construction workers, earplugs would be provided to those working very close to the noise-generating machinery;
- High noise emitting equipment, if any, will be used during regular working hours so as to reduce the potential of creating a noise nuisance during the night;
- Regular inspection and maintenance of the construction vehicles and equipment will be carried out;
- Replacement of worn out and noise-producing parts of construction machinery will be carried out in a timely manner;
- The Community Liaison Officer shall notify affected people and communities prior to undertaking especially noisy work activities;
- Implement the additional mitigation measures provided in ECPs to address air and noise quality impacts (see ECPs 10 and 11 in **Annex-I** for air and noise quality management).

The implementation of the above measures will generate impacts of Low significance.

7.5.11 Blasting & Vibration Impacts of Tunnel Construction

Blasting for construction results in noise as well as ground vibrations that cannot be confined to the site. As blasting is an occasional activity it does not affect the ambient noise limits evaluated, but can be disturbing to local communities with short-term noise exceeding 85 db. The sensitive receptors are the contractor's workers, nearest residences in Kedam village which is located within vicinity of weir site and villages Daroli, Ayeen, Ponkia and Gorejo which are located near adit and dumping sites, where most of the construction works will be carried out. Single noisy events such as blasting can be audible over a large area. Although each incident is short-term in nature, the repetitiveness of the noise may give rise to complaints if not managed properly. The subjective reaction to a single disturbing noise event will depend on the activities being undertaken by the receptor and the manner in which the program for noisy events is communicated to identified receptors. For example, a large noise event at night-time may give rise to complaints, whereas at any other time it would be accepted. Extensive blasting will be undertaken during the construction of the headrace tunnel. Impact will be of Major significance.

Fly rock is an unexpected projection of material from the blast site to any area beyond the designated safety area. Fly rock occurs when the amount of explosive energy is greater than that required to break the mass of rock between the blast position and the free face; the excess energy projects the rock debris beyond the safety area. Uncontrolled fly rock from blasting can travel hundreds of meters, with known cases up to 1,000 m.

Use of large diameter blast holes for small benches, variation in burden due to over break of toe or back crack that results in uneven face, drilling deviation, inadequate burden and narrow space are the possible causes of fly rock. Despite the fact that fly rock consumes only 1% of the explosive energy used in a blast, it is more serious in nature than any other damage caused by blasting. This impact is of Major significance.

Mitigation Measures

The vibrations created by blasting for headrace tunnels will damage walls of residential houses of nearby communities and sensitive receptors (school, Mosque) that will be mitigated by adopting following measures

I. Conduct a pre-construction survey of household structures at risk of vibration impacts.
   - A survey will be undertaken to determine the pre-blasting conditions of the buildings. The survey will be commissioned by the Supervision Consultant and will identify and record any existing damage to the structures. The survey will cover the following aspects:
     - Overall condition of the structures, both exterior and interior.
     - Documentation of defects observed in the structure using digital imagery along with notes, measurements, and sketches.
     - Documentation of pre-existing cracks using digital imagery along with notes, measurements, and sketches.

II. Following completion of the blasting, the survey will be repeated to determine the condition of the buildings and verify that they are safe for re-occupation. If the buildings are safe, the residents will be allowed to return to their houses following any necessary damage repairs. If the buildings are damaged beyond repair, compensation will be managed under ESMP.

III. Following are key mitigation measures for the management of blasting:
   - Using noise control devices, such as temporary noise barriers and deflectors for impact and blasting activities.
   - A minimum buffer of 500 m will be provided between the settlements and point of blasting. Community awareness will be carried out. Barricading will be fixed where possible
   - Blasting will be scheduled during the day only.
   - Local communities will be informed of blasting timetable in advance and will be provided adequate notice of when blasts are required outside of the planned schedule.
   - A Blasting Management Plan (Annex-II) will be developed by the Construction Contractor. The Plan will be reviewed and approved by the Supervision Contractor before the initiation of the blasting work.
   - Throughout the blasting activity, vibration sensors will be installed at strategic locations to monitor the impact of blasting and to ensure that the vibration levels are within the adopted criteria. The monitoring plan will be part of the Blasting Management Plan (Annex-II).
   - Unscheduled blasting will be strictly prohibited in any case.

IV. Meaningful consultation with the community shall be maintained and their grievance shall be attended to in a timely manner. In this regard:

- A meaningful Consultation plan will be developed to address how consultation will take place during implementation[54]. The plan will cover identifying the affected community; the key contact persons; frequency of engagement; the information to be shared; the responsibilities to manage the plan; and the notice period to be given to the community for various blasting-related generating activities.
- The Grievance Redress Mechanism will be used to record, investigate, and respond to any complaints. Investigation of the complaints will be undertaken by the Supervision Consultant.

V. Develop a Vibration Monitoring Plan (Annex-II) that will include monitoring of vibration levels and frequency around the blasting sites. The objectives of the monitoring will be to:

- Ensure that vibration levels in the communities are within the adopted criteria levels;
- Maintain a record of vibration to settle any potential conflicts; and
- Monitor changes in the vibration levels due to possible changes in the rock formation and take appropriate corrective actions.

VI. Following are key mitigation measures related to fly rock from blasting are:

- Sensitive receptors (residential houses, mosque, schools are located in the vicinity of construction sites so a minimum buffer of 500 m will be provided between the settlements and point of blasting.
- Blasting methods will be selected to minimize dust and fly rock emissions.
- Traffic management plan near the blasting sites will be implemented
- Fly rock can also be controlled by using blasting mats or soil cover to retain the exploded rock. It's important that the Blaster make sure that all personnel are outside the blasting area where fly rock can be expected

VII. Others;

- Sensitive Receptors: Additional mitigation measures such as vibration barriers will be implemented at sensitive receptors (Kedam, Daroli, Ayeen, Ponkia and Gorejo villages), as required.
  - ITA guidelines: ITA guidelines will be implemented.

The implementation of the above measures will low the impacts to Low significance.

7.5.12 Impacts on Key Biodiversity due to Construction Activities

Overview of the Area and Anticipated Impacts

Six types of habitats were identified in the MHPP area including aquatic habitat, scrub forest and dry temperate forests. Construction of Project infrastructure such as the underground powerhouse and power/headrace tunnel have anticipated disturbance to the floral and faunal species in the Primary Zone of Impact/primary project sites around the Project facilities due to blasting, noise, vibrations, traffic movement and illumination. Pollution may increase due to vehicles and machinery movement for excavation and disposal of excavated material, spillage of fuels or chemicals, emissions and noise.

The habitats identified in the vicinity of the Project site including Scrub Forest, Agricultural Fields and Riparian are likely to be affected. The Area of Habitat Loss is defined to include the areas that will be submerged under water due to creation of the weir reservoir. Site clearance for construction of the proposed structures on land surface structures like weir, dumping sites and access roads weir, will disturb for a short duration the terrestrial habitats in the immediate vicinity of the Project footprints and ancillaries. The ecological receptors i.e., floral species (44,000 trees) will be lost in that limited area and the terrestrial ecosystems will be disturbed in the limited area of impacts. As the area (terrestrial zone) along the footprints of the MHPP project is completely modified due to agriculture and residential developments by the local population. Therefore, no terrestrial critical habitat was identified in the Zone of Impact and it does not contain any threatened or unique ecosystem. Moreover, the key ecological features observed along the MHPP project footprints are homogenous and widespread. The total submerged area (including the present river) will be approximately 12.3 acres. The submerged area is the active riverbed and no terrestrial habitat will be impacted.

[54] World Bank Stakeholder Consultations in Investment Operations Guidance Note available on https://documents1.worldbank.org/curated/en/830941468323985308/pdf/671210WP00PUBL0ultations0Note0web20.pdf

During disturbances, the wild animals retreat in protected habitats and come back as the disturbance is over. Although the construction works damage the natural habitats within AOI but at the same time such activities also develop the Ruderal Habitats. In newly developed ruderal habitats, a succession process starts and the species love to occupy newly developed habitats where they do not face any kind of competition with any other species. So, negative impacts of the project activities are for a short period of time but the positive impacts due to newly developed ruderal habitats will last for longer periods. As far as the Threatened mammalian species Black bear (*Ursus thibetanus*) is concerned, it is resident of sub-alpine regions far away from the project area. It descends down to the project area only during winter season when its food is not available at higher altitudes.

The anticipated impacts on the key biodiversity are discussed below.

Anticipated Impacts and Risks on Swat River Ichthyo-diversity

To study the biological diversity in the project area and to assess the possible impacts of the project activities on the existing biodiversity, core zone and the buffer zones in the project area were identified in line with the overall AOI of the project E&S impacts assessment. However; for ichthyo-diversity impact assessment, the core zone is the main river and its tributaries where fish fauna exists while a buffer of 2 km on the Swat River was considered as the project impact zone where terrestrial fauna may have some impacts from the proposed project.

Among the reported key ichthyo-diversity species, Catfish (Nangra robusta) is locally called “Chakora” has been reported in Pakistan from Indus River system in Punjab from Kalabagh in District Mianwali to District Dera Ghazi Khan, Panjkora River in lower and upper Dir districts and in Chitral. During the present studies, it was found in the tributaries of Swat River around Madyan and Bahrain town. Outside of Pakistan, this species has been reported from North-western Rajasthan in India. This species is not an economically important species. Modifications in natural systems and habitat deterioration are the major threats to this species. Since in the project area, Cat fish is found only in the tributaries of Swat River and main river is devoid of it, therefore there will be no negative impact of project activities on this fish species. The other species is the Snow carp which is vulnerable (IUCN Red list). During the breeding season, this fish migrates into the tributaries (nullahs) of the Swat River for spawning. The operation of the Hydropower Project will lead to the creation of a reservoir. The aquatic ecological resources of the Swat River may be negatively impacted if the river waters are polluted due to discharge of untreated wastewater or solid waste from camp sites.

Construction of water reservoir will have positive impacts both on aquatic and terrestrial ecosystem. A slow movement of water in project reservoir instead of fast flow in the river will not have any negative impacts on fish fauna. Brown trout is an economically important species in the area. It is a common observation that this species attains bigger size in fish farms but does not attain larger size in fast running water in the project area. Deep and slow-moving water of the proposed water reservoir will increase the populations of phytoplankton and other aquatic vegetation. Brown trout is a column feeder insectivorous fish and deep and slow-moving water of project reservoir will support and promote the growth of this species.

Food chain and the ecosystem in the project area seems somewhat disturbed due to lack of natural top predators like Eurasian otter (*Lutra lutra*). The role of top predators in an ecosystem is to control, regulate and maintain the populations of all other species at lower trophic levels. With the increased fish population in the proposed reservoir, the lacking top predators will also return back to complete the food chain and this will be a very positive impact of the proposed project.

Native fish species in the area is Snow carp whose population is already on decline in the project area due to uncontrolled fishing practices. Snow carp is a bottom feeder herbivorous species whereas the introduced Brown trout is not bottom feeder rather it is column feeder fish. Deep and slow running water in the proposed reservoir will support the production of submerged aquatic plants which make the food for indigenous Snow carp. Therefore, the construction of a water reservoir will not only increase the habitat for the fish fauna but also increase the food resources for indigenous fishes. Hence, the construction of weir and development of reservoir will have overall positive impacts on aquatic life and the native Snow carp will find safe refuge and breeding grounds and hopefully its population will increase gradually.

Anticipated Impacts and Risks on Avian Diversity

The construction related activities will lead to a localized reduction in food, shelter and range for mammals, birds and herpeto-fauna (reptiles and amphibians). Surface stripping will result in the removal of vegetation cover and may cause accidental death of reptiles and amphibians. However, such fauna may be mobile and may move away from the area prior to preliminary earthworks. Food supplies in the form of seeds, vegetation and prey species will be negatively affected on a localized basis (only within the Project infrastructure facilities and its ancillaries). Land disturbance will not significantly affect the birds of conservation importance (Northern Lapwing (NT) and Himalayan Griffon vulture (NT)). The habitats being disturbed are not considered critical to the breeding, nesting or feeding of these vulture species. The birds also react to disturbance and are likely to avoid the area once construction activities begin.

As far as avian species are concerned, the construction of a weir reservoir will not have any negative impacts on resident as well as migratory birds. Rather it will have positive impacts on the migratory species. Birds during southwards migration in September-October and northwards migration in February-March mostly follow the water channels on the ground for navigation purposes. Most of the winter visiting waterfowl entering Pakistan follow the Indus Flyway for navigation purposes. After travelling thousands of kilometers in a single stretch, when such birds enter Pakistan, they are exhausted and have lost much of their stored energy and try to find some water body as staging area. Birds use to land on such water bodies for one or two days and if they find some food, they stay but if they do not find proper food they start their journey to their final destination in the south mostly the wetlands in south Punjab, Sindh and the coastal areas which offer plenty of food to these migratory birds. Therefore, development of proposed weir reservoir in the project area with plenty of available food will add to the staging areas for waterfowl and other migratory birds and will have positive impacts on the resident as well as migratory avian biodiversity.

Anticipated Impacts and Risks on Mammalian Diversity

Large migratory mammals have not been observed in the area except Asiatic Black bear. The Asiatic Black Bear has vast home range in high altitudes and visit the project area only during winter season in search of food around the human settlements. This species is considered a “Problem Species” in the area and a number of cases of bear attacks on humans, livestock and crops especially during winter season have been reported. Therefore, the project activities will not have any negative impact on the habitat of Black bear.

Anticipated Impacts and Risks on Reptilian Diversity

Among the “Near Threatened” reptilian species, Brown cobra is considered a problem species in and around the project area whereas; Rock python is found in rocks with loose soil usually around cultivated areas where springs or water channels are available. Evidences of Rock pythons were found around Kedam and Torwal villages around 900 ft above the Swat Riverbed. The project activities will not have any adverse impacts on these two avian species as these species use to traverse thousands of kilometers and keep moving throughout the year and spend time at different suitable habitats in northern and southern hemispheres.

Mitigation Measures

During construction phase, a strict policy of ‘no hunting, no trapping, no harassment, no fishing’ will be implemented. The site personnel will be provided awareness about the local biodiversity. Any significant wildlife sighting will be reported.

During and post construction stages biological/ecological monitoring will be performed to ensure that the habitats of the large animals were not degraded from the construction activities. The post-construction ecological monitoring will also look at the status of the foraging and spawning grounds to ensure they are capable of supporting the species that rely on it during winter. Construction stage biological/ecological monitoring will be on quarterly basis to ensure that the ruderal habitats are being populated by native vegetation and not being taken over by invasive species.

Fisheries Management Plan will include provisions for the protection of catfish. The management plan is for the conservation of Snow carp in the area. This management plan is proposed for the long term. The existing trout hatcheries will allocate a portion for Snow carp breeding and ensure annual release of Snow carp seedlings in the natural water bodies for the safe survival of Snow carp and ultimately the fragile ecosystem. The 3rd recorded fish species Nangra robusta is although found only in the tributaries of Swat River but its habitat is also shared by the indigenous Snow carp. Snow carp use to move up in the nullahs for feeding at night and moves back in the main river in the early morning. This seems an adaptation to feed freely avoiding the Brown trout in the main river and returning back in the early morning again to avoid predation by humans in the day time. However, a fish ladder is proposed (Figure 3.13) for maintaining river connectivity and fish migration. In addition, a fish management plan (Annex-II) is proposed for the project to be implemented during construction.

Construction and post-construction stage biological/ecological monitoring will be carried out to ensure that the habitats of the large animals are not degraded from the construction activities. The Fisheries Management Plan (Annex-II) will be implemented.

The existing hatcheries of KP Fisheries Department (devastated by flood 2022) will be restored. The existing trout hatcheries will allocate a portion for Snow carp breeding and ensure annual release of Snow carp seedlings in the natural water bodies for the safe survival of Snow carp and ultimately the fragile ecosystem. A fish ladder is included in the project design (Figure 3.13) for maintaining river connectivity and fish migration.

- The felling of a tree which houses an active nest or eggs will be prohibited. The felling of such trees will be carried out in non-breeding seasons.
- During construction, an avian risk assessment and management plan will be prepared as an outcome of this task and on the basis of this baseline study as well as a review of the alignment of proposed transmission lines.

Compensatory tree plantation, with a ratio 1:10, will be carried out. A tree plantation plan (Annex-II) has been prepared and a total of about 44,000 saplings will be planted.

Compensatory plantation of ration 1:10 is proposed and budget is estimated in the ESMP. A tree plantation plan (Annex-II) is proposed and total 44,000 saplings will be replanted.

With the above mitigation measures, the residual impacts have been assessed as Minimal.

7.5.13 EHS Risks and Impacts including those associated with Tunnel and Underground Powerhouse Works

General Construction works. Workers are exposed to considerable noise levels when constructing a weir, tunnel, and other construction activities. Main sources of noise will be blasting, piling and operation of heavy construction equipment, several of them often running at the same time. The maximum allowed noise level according to national legislation is 85 dB(A). Monitoring of noise levels shall take place during the regular construction site audits.

Some of the other occupational health and safety risks which are likely to arise during the construction phase are typical to many large construction sites, which include: exposure to physical hazards from use of heavy equipment including cranes; working at height and electrical equipment; trip and fall hazards; exposure to dust, vibrations; falling objects; exposure to hazardous materials; and exposure to electrical hazards from the use of tools and machinery. Key construction activities with potential OHS hazards in the project are working in the river, underground tunnels, and on mountain slopes. The major risks associated with instream construction and work on slopes include the risk of drowning in the river and the risk of falling from slopes. The major risks associated with tunneling works are depletion of oxygen from poor ventilation and exposure to excessive heat and fumes leading to acute or long-term health problems, the release of toxic gases, fumes and vapors, and release of dust and silica from drilling and blasting activities. The overall risk rating is therefore Major.

Underground works. For the MHPP Project, a conventional drill and blast method is adopted in the feasibility study for headrace tunnel and underground powerhouse. This method uses explosives. Drilling rigs are proposed to drill blast holes on the proposed tunnel surface and explosives and timed detonators will be placed in the blast holes. Following the blasting, the waste rocks and soils will be transported out before further blasting. In general, potential health and safety risks and hazards associated with the tunnel works are experienced globally. Hazards in this work include hard physical labor, noise, vibration, diesel engine exhaust, chemical vapors. Underground workers are at risk for serious and often fatal injuries. These include being struck by specialized machinery or being electrocuted, being buried by roof falls or cave-ins and being asphyxiated or injured by fires or explosions. In addition, as the feasibility stage of the MHPP project, there are potential risks for community safety issues, and specifically vibrations relating to tunneling activities. Many houses on the left bank are located close to above the proposed headrace tunnel. Therefore; the issue of stability of the houses located above the worksites is required. Likewise, pre-construction surveys would be required within 500m radius of any blasting activities, even if underground. Therefore, the health and safety risks to environment, community, workers and project management staff are assessed as major significant.

Mitigation Measures

- Regular site inspection and safety audits.
- Regular OHS training for workers.
- Daily toolbox talks covering OHS.
- Incident investigation and reporting.
- Use of relevant PPE.
- Each contractor will be required to prepare, obtain approval of, and implement an occupational health and safety (OHS) plan. These plans will be prepared in compliance with the World Bank Group's EHSGs, KPK Occupational Health and Safety Act 2022, International Tunnel Association, ECPs in **Annex-I**, GoKP regulations on Factory Act 2013, Industrial Relations Act 2013, and Workers Compensation Act 2013. If these guidelines cannot address any specific aspect of OHS, international good practices such as OSHA and ILO will be applied. OHS Plan will contain general guidance for all identified hazards under each work activity, and site-specific OHS hazard and risks during construction, and control and preventive measures proposed by the Contractor. The Plan shall be reviewed and updated if there any changes in the construction methodologies.
- The OHS plan will be reviewed and approved by the Construction Supervision Consultant and the World Bank.
- Conduct a Job Hazard Analysis (JHA) at the new construction site to identify potential hazards that may arise from the proposed works or working conditions to the project workers and implement necessary control measures. The JHA will be part of the Contractor's method statements, which will be reviewed and approved by the OHS Specialists of the Supervision Consultants. The specialists will also visit the construction sites, prior to the start of construction, to ensure the control measures are in place.
- Regular site inspections and safety audits by the construction supervision team, both by the OHS specialists and the site engineers. Since the site engineers will be present at the worksites all the time, they will be trained by their OHS team on monitoring safety aspects of the construction works.
- Regular training program for workers on occupational health safety (monthly training and daily toolbox talks). Special attention will be focused on safety training for workers to prevent and restrict accidents and on the knowledge of how to deal with emergencies.
- Incident investigation and reporting, including a complete record of accidents and near misses, will be maintained.
- In order to protect all project personnel and visitors, the Contractor will provide personal protective equipment (PPE) for workers, such as safety boots, helmets, masks, gloves, body harness, protective clothing, goggles, fully face eye shields and ear protection. The Contractor will also provide training to workers on how to use them and maintain them in a sanitary and reliable condition, and replace the damaged ones immediately with new ones.
- Accessibility for firefighting, ambulance, medical and rescue vehicles and medical facilities at the site for implementation of an Emergency Response Plan (Annex-I & III)
- Adequate water supply and mobile toilets, medical and first aid care facilities at the worksites
- Contractors will have dedicated and qualified staff for ensuring compliance with the OHS Plan
- Awareness-raising material will be used including posters, signage, booklets, and others at the worksites
- Implement the mitigation measures and emergency response plans given in ECP 18 (Annex-I & Annex-III): Worker Health and Safety, ECP 19: Tunneling and Underground Construction Works, and ECP 20: Instream Construction Works.

A tunnel risk assessment (TRA) will be conducted by the contractor and environment, health and safety (EHS) plan for tunnel and powerhouse works as well as emergency response plans will be prepared, approved and implemented by contractor. ITA guidelines will be implemented.

Define and map areas where drill and blast are likely to be used.
Undertake, or specify in Civil Works Technical Specifications, pre-construction dilapidation surveys of housing located within a minimum radius (vertical and horizontal) of 500m around worksites which are subject to blasting, documented by a bailiff.
Undertake a preliminary Blasting Risk Assessment, which demonstrates that blasting vibrations would not (i) affect the houses located above the tunnel, or close to the worksites where blasting would be needed, and (ii) trigger landslides or other natural hazards which would represent a safety issue for nearby communities and roads.
Signage in hazardous and risky areas, installations, materials, safety measures, emergency exits, and other such areas will be in accordance with international standards (including standards of cleanliness, visibility and reflectance in the areas potentially poor illumination or sources of dust and pollution), be known and easily understood by workers, visitors, and as appropriate the general public.

Blasting activity will be permitted with issuance of "Permit to Work" by the PIC and Contractor's Health Safety Environment Team. The contractor will submit a consistent blasting schedule, minimizing blast-time changes. Only blasting team fulfilling all the requirements of blasting will be conducting blasting as per blasting plan. Health Safety Team of Contractor will be monitoring the blasting activity by completing inspection checklist for every blast activity inside headrace tunnel. During blast and post blast safety requirements will be fulfilled by inspecting. **Specific warning devices** (e.g., horn signals, flashing lights) and procedures will be implemented before each blasting activity to alert all workers and third parties in the surrounding areas (e.g., the resident population). Warning procedures may need to include traffic limitation along local roadways. A minimum buffer of 500 m will be provided between the settlements and point of blasting. Community awareness will be carried out. Barication will be fixed where possible

Ventilation System at MHPP project site the tunnel and powerhouse workplace will be ventilated well to enable workers to carry out work without risk to health and safety. Due to the nature of tunneling and powerhouse works, contaminants generated in one area of the tunnel and powerhouse will move readily to other areas. Protection against airborne hazards will be provided to workers. Control measures needs to be implemented to eliminate or minimize, so far as is reasonably practicable, the risks associated with atmospheric contaminants.

For waste dumps, fills and other containment structures, static safety factors will be established based on the level of hazard for the operational phase of a facility and at closure. Accurate assessment of worksite safety from rockfall and/or landslide needs to be conducted. Particular attention needs to be given after heavy rainfall, seismic events and after blasting activities. Risks needs to be minimized by appropriate bench and pit slope design, blast pattern design, rock scaling, protective berms and minimizing traffic.

Machine and Equipment Safety: Use of contrast coloring on equipment / machinery, including the provision of reflective markings to enhance visibility;

- Use of moving equipment / machinery equipped with improved operator sight lines;
- Issuing workers high visibility clothing;
- Use of reflective markings on structures, traffic junctions, and other areas with a potential for accidents (e.g., walls in static locations will be whitewashed for improved reflectance);
- Use of appropriate illumination for the immediate operating areas of frequently turning and reversing equipment / machinery.

Air Quality Monitoring: After every blast, tests need to be carried out before workers and staffs are allowed to re-enter the tunnel and powerhouse. The tunnel and powerhouse will be monitored throughout the work period in accordance with a suitable procedure. The workplace will be examined by suitably qualified people using detection and measuring equipment. The monitoring will include air testing for:

- flammable fumes or gases;
- oxygen deficiency and the presence of asphyxiant gases;
- unsuitable temperature and humidity, and;
- airborne contaminants like toxic gases, fumes or respirable dusts. No worker is to be exposed to a substance or mixture in an airborne concentration exceeding the exposure standard for the substance or mixture. Exposure standards are usually set for a standard 8 hour working day. Therefore, during periods of extended work, like shift work or overtime that requires working longer than 8 hours per day or more than 40 hours in a week, exposure standards will be determined by the contractor.

Ventilation: The workplace must be ventilated to enable workers to carry out work without risk to health and safety. The consequences of poor ventilation include:

- exposure to: excessive heat;
- fumes, substances or mixtures which can lead to unconsciousness, acute or long-term health problems and even death;
- oxygen depletion, and;
- fatigue and impaired judgment.

Methane Detection: The following minimum methane detection procedures are required:

- Testing for methane to be carried out continuously during drilling or boring operations.
- Continuous methane monitoring device(s) to be provided in ventilation columns with automatic alarm system.

- Regular methane inspections of headings and tunnels whether discontinued or in use for access to the rearward of the advancing face are to be carried out. i. Acceptable Concentrations of Methane.

Respiratory PPE: Where higher order control measures fail to eliminate or minimize, so far as is reasonably practicable, hazardous chemicals or respirable dust exposures the lower order control measure of PPE may have to be used. When respirators are supplied, they will be capable of preventing people inhaling hazardous dust or other airborne contaminants at the concentration and duration of the exposure.

Use of Respirators: During Tunnel construction works all Contractor and Sub Contractors staff or whoever owes business inside tunnel will ensure proper use of Personal Protective Equipment. In this regard where, higher order control measures fail to eliminate or minimize, so far as is reasonably practicable, hazardous chemicals or respirable dust exposures the lower order control measure of PPE may have to be used. When respirators are supplied it will be ensured that they are capable of preventing workers inhaling hazardous dust or other airborne contaminants at the concentration and duration of the exposure

Heat Stress During tunnel work: there is chance of heat stress due to;

- Environmental conditions like air temperature, radiant heat, high humidity and air flow;
- Physical work e.g., strenuous or light work;
- Work organization e.g., exposure to heat and time of day, and;
- PPE and clothing like heavy protective clothing, is worn by workers. Therefore, multiple factors may cause heat stress in the Contractor's staff.

Re-fueling in Tunnels: In tunneling works at MHPP Project will be ensured that proper refueling procedures are adopted by the operators while working at site.

Fire at MHPP Project site: fire and explosions hazards will be identified. Fire underground rapidly consumes oxygen and produces noxious fumes and gases. The fire will reduce and, in some cases, eliminate visibility. There is a significant risk the fire will block at least one tunnel exit forcing workers to seek an alternate exit or a place of safety. Therefore, combustible materials will be managed with good housekeeping measures as per HSE Program of MHPP. In addition, hot work procedures as per HSE program will be adopted in MHPP Tunnel and powerhouse work. Provision of firefighting facilities will be ensured along with training of firefighting to all tunnels staff including casual labors. Control measures will be implemented to eliminate or minimize, so far as is reasonably practicable, the risks associated with fire and plant and equipment.

Visibility and lighting: the contractor at MHPP Project will ensure provision of adequate lighting arrangement inside the tunnel and powerhouse works. Lighting will be provided that:

- Allows workers and others to move and work safely within the workplace;
- Does not create excessive glare, and;
- Allows safe entry and exit from the workplace including emergency exits. According to TRA, Control measures will be implemented to eliminate or minimize, so far as is reasonably practicable, the risks associated with poor visibility and lighting.
- **Illumination**: The Contractor will install, operate and maintain a lighting system in the underground works until completion of the Works. All hazards will be clearly illuminated at all times. The first 50 m from the portal of each adit will be lit to double the above intensity. Suitable high intensity movable lamps will also be provided by the Contractor to illuminate any area in the underground works where the Engineer may wish to carry out testing or other inspection e.g., at a monitoring station or to inspect geological features. No person will work or travel in any underground working unless a light is carried. All safety helmets used underground will be equipped with suitable brackets for mounting the light. The light will be a sealed lamp of an approved type.

Electrical safety: As per TRA (to be conducted by contractor), electrical hazards with residual risk may remain in tunnel and powerhouse construction works. Electrical equipment in tunneling and powerhouse work can be damaged from high temperature, pressure, humidity, dust, from hazardous and explosive chemicals and the effects of blasting. Electrical equipment will be protected from these exposures. Safety critical plant and equipment like firefighting equipment, pumps, ventilation, communications and atmospheric monitoring will remain operational even in an explosive atmosphere and where there is an explosion.

Eye Injury: During Tunnel works, activities and process may give rise to particles such as flying particles which may pose threat of eye injuries to workers involved during construction works or engineers and visitors.

With the above mitigation measures, the residual impacts have been assessed as Minimal.

7.5.14 Impacts from Quarry

A huge number of aggregates (fine and coarse aggregates) will be required for construction activities. Improper siting and extraction of these construction materials will have significant impacts on the physical and biological environment of the quarry. The impact is of Moderate significance.

Mitigation Measures

- Use only quarry and borrow sites that are licensed by the provincial government and approved by the project management unit/Implementation Consultants
- Identify new borrow and quarry areas in consultation with Project Director, if required.
- The use of explosives will be used in as much minimum quantity as possible to reduce noise, vibration and dust.
- Reuse excavated material from the construction sites to the extent feasible
- Although the material is widely available, the quarrying/mining activities will be limited to fewer areas to reduce the area of extent affected by quarrying activities. If any mining activities are to be carried out outside the project area, they will not be located in any sensitive areas. A survey of the area to identify sensitive receptors and permission from the PMO must be obtained before mining in any unplanned locations.
- Maintain a buffer zone of 5 to 10m between the low flow channel and the mining operations to minimize the downstream impacts and limit the excavation activities to the low flow season.
- Implement the generic measures and best practices on quarry areas development and operation that are given in ECP 9 (**Annex-I**) and World Bank Group EHS Guidelines for Construction Materials Extraction.

With the above mitigation measures, the residual impacts have been assessed as Minimal.

7.5.15 Impacts on Tourism

The Swat valley offers a popular tourist attraction to the country. Extensive tourist infrastructures in form of large number of hotels, guesthouses and restaurants exists in the project area towns of Bahrain and Madyan. Such tourist infrastructure becomes operational in the summer months from the beginning of June to end of August. Tourists from in-country and abroad use these towns as stop-overs before they travel further on to Kalam to enjoy the beautiful landscape and the famous Sufaid, Kondol, Paryen and Izmiz lakes situated near Utror. According to interviews of hotel owners and managers (e.g., Liberty Hotel), it is not expected by them that the construction will affect tourism activities negatively. However, the construction activities and increase in traffic could have some negative impacts. The construction activities will be visually unappealing to some and the increase in traffic may make it difficult to travel in the area. As such, the overall risk rating is Moderate.

Mitigation Measures

Construction activities will affect tourist activities in Swat valley. However, hotel managers do not expect severe negative impacts on the number of tourists. There is the hope that projects like Madyan HPP will bring more stability to the region. Mitigation measures include efforts not to increase the traffic in Bahrain more than absolutely necessary. Furthermore, it is important to maintain spoil piles and properly dispose of wastes to ensure the visual environment is not negatively affected. With the above mitigation measures, the residual risk is Minimal.

7.5.16 Community Exposure to Work Hazards

Communities of Villages Kedam, Gorejo, Pnkia, Daroli, Ayen, Kalagy will be exposed to construction-related hazards due to excavation, heavy vehicular movements, and blasting activities. These risks will be more at the construction works located close to the existing road and settlement (near the proposed colony and access roads). The impact is of Major significance.

Mitigation Measures

- Barricade the work areas with hard fencing to prevent the entry of the community into the construction areas.
- Placing of adequate signboards and flagmen to divert the community away from the construction works.
- Implementation of Traffic Management Plan near the blasting sites
- Community awareness programs on construction-related hazards, including awareness programs in school. Construction activities such as blasting and excavation, may pose safety risks to the nearby population.
- Ambulance and first aid medical facilities will be made available at the worksite.
- Community liaison will be maintained.

With the above mitigation measures, the residual impacts have been assessed as Minimal.

7.5.17 Impacts from Labor Influx

For the proposed project activities, the average labor requirement per day may be 250-300. Unskilled workers will be mainly hired locally; however, the skilled workers will be brought by the Contractor from other parts of Pakistan or abroad. It is estimated that about 200 migrant workers will work on this project. Labor influx may lead to negative impacts on the host community. Pre-existing social issues in the host community can easily be exacerbated by the influx of labor. The potential risks associated with labor influx are social tension arising between the local community and the construction workers, which may be due to competition for local resources, an increase in the rate of crimes and/or perception of insecurity by the local community, increased burden on and competition for public service provision, and influx of people potentially bringing communicable diseases to the project area, including sexually transmitted diseases (STDs), or the incoming workers may be exposed to diseases to which they have low resistance. The impact is assessed to be Major.

Mitigation Measures

- an awareness campaign will be implemented at the beginning of the construction phase. The Contractors will be aware of the possibility and risks of miscommunications between local residents and workers, which could easily lead to conflicts. This will be prevented by raising awareness and implementing a Code of Conduct for the workers. The Contractor shall develop a Worker Code of Conduct to govern the behavior of workers on-site, in camps, and in local communities.
- The awareness campaign will also be aimed at the risk of interaction between the resident population and the construction workforce, including the spreading of sexually transmitted diseases such as HIV/AIDS.
- The contractor will prepare a Labor Influx Management Plan prior to construction works for approval of PEDO.
- The Contractor’s Code of Conduct shall cover the program to promote awareness among the construction workers on respecting the local community.
- Construction camps will be built in the designated areas, located away from the local settlements
- The contractor will ensure local water usage will not be affected by water usage by project or compete with water requirements of the local community. The Contractor will reuse water wherever safe to do so to reduce water usage.
- The Contractor’s monthly training program will cover topics related to respectful attitude while interacting with the local community
- Gender Action Plan (Annex-II) will be implemented in the project area.

With the above mitigation measures, the residual impacts have been assessed as Minimal.

7.5.18 Risk of SEA/SH

During consultations with the women, the women reported that domestic violence is not common in the project area except for a few exceptional cases, but no one reports it as it is not socially acceptable to do so. No rape cases have been reported in the past years. Women visit relatives and family friends of their own tribe within or outside of their villages. Women also go out for shopping. However, as the markets are on an average of 4.5 km away from the villages, the women are accompanied by either an elderly woman or a male member of the family, or a male child. Some women travel for up to 30 minutes, 3-4 times a day to collect water from nearby springs for drinking, cooking and cleaning, and washing purposes. They also help the male members of their families in agriculture fields, which are generally next to their homes. However, women go in pairs and do not travel alone. Women always accompany the male members of the households to the hospitals located in Kalam town and Mingora city. Women rarely go out for the purchase of grocery items and grocery shopping is mostly done by the male members of the family. The girls of better-off and middle-income households are allowed to go out to get an education while in lower-income households, they are not allowed to go out without a male member of the household accompanying them.

The interaction between the Project construction labor force and the communities are expected to be limited, particularly with women due to the conservative culture in the region. The current level of SEA/SH risk is Moderate in the Project, and the likelihood of SEA/SH risk from the proposed project is also not expected significant due to the employment of local labor in construction works and only skilled workers will be hired from outside. The risk assessment has been made based on the country and legal context, gender norms and beliefs, and national capacity to respond. In addition, several project-specific factors including project location, type of infrastructure to be constructed, accessibility of women for consultations, poverty levels, accessibility for the supervision of project, and others were also considered for determining the risk levels.

Mitigation Measures

- Inclusion of clause on SEA/SH behavior obligations in the employment contracts of all employees and construction workers aimed at strengthening measures to address and prevent SEA/SH in the workplace and construction areas.
- Translation of code of conduct (COC) into Urdu and dissemination of the principles laid out in CoC and the consequences (warnings, penalties, termination, and legal actions) of its breach to all employees and workers.
- Awareness training of PEDO, CSC, contractor, sub-contractor, and service providers staff to sensitize them about GBV, SEA, and SH, and their responsibilities to prevent them.
- Posting of CoC standards in public spaces at contractor's work camps and living areas, and village information centers and public places of adjoining/neighboring communities in the Urdu language
- Raising awareness that GBV SEA/SH is prohibited
- Provide information on the use of GRM to report cases of SEA/SH, Code of Conduct breaches, and assist victims of SEA/SH, if signs of SEA/SH are identified/a victim approaches them to complain about SEA/SH.
- Awareness to communities, particularly women, and male and female children to understand the risks of SEA and SH and the roles and responsibilities of parties involved in project implementation on SEA and SH prevention, processes for reporting incidents of project-related SEA/SH, and the corresponding accountability structures.
- Strengthen the Contractors' obligations and capacity to public health and safety risks and ensure contractor supervision capacity to monitor the mitigation of these risks.
- Preparing code of conduct for PEDO, PMO, Contractors, Sub-contractors, and service providers (such as security agencies, catering, transport, or any other services) on SEA/SH prevention and by integrating these measures/clauses in bidding documents.
- Proactive SEA/SH prevention measures will be put in place, such as SEA/SH related training to sensitize workers and the local population along the project implementation area and ensuring that GRM for the project will also address the GBV related issues if any.
- The workers will still be given awareness training to prevent any conflict. The training will focus on the appreciate behaviors near local women to prevent any unintentional disrespectful conduct in the event of any interaction.
- The Contractor will employ their skilled staff and apply unskilled construction labor from the local population as far as possible to minimize an influx of outsiders into the communities.
- The PMO will ensure compliance with the GoKP Act and policy and WB requirements related to SEA/SH.
- The third-party monitoring agency of the project will also cover the monitoring of SEA/SH prevention measures.
- Measures for receiving, reviewing, and acting as appropriate on SEA/SH concerns at the project management level.
- Documentation and reporting of prevention and response in the progress reports of the project.
- In all instances, the priority will be to protect the victims and keep the identity of the victim anonymous to prevent any backlash on the victim.
- Gender Action Plan (Annex-II) will be implemented in the project area.

With the above mitigation measures, the residual impacts have been assessed as Minimal.

7.5.19 Temporary Accommodation Related Health Risks

Potential health issues on workers associated with the use of temporary accommodation sites include those relating to sanitation, disease, fire, cultural alienation, sleeping space, quality and quantity of food, personal safety and security, temperature control and recreation, amongst others. The risk is deemed to be of Moderate significance.

Mitigation Measures

- The contractor will develop and implement a Camp Management Plan (Annex-II) and/or follow ECP 16: Labor Influx Management and Construction Camp Management (**Annex-I**)
- The construction camp will be built with all adequate facilities (safe drinking water and sanitation, kitchen, rest areas.) including entertainment facilities so that there will be minimal interaction between them and local communities
- A medical clinic, with a medical doctor and attendants, will be established at the campsite. Regular health check-ups of the workers will be carried out.
- The Contractor shall establish a mechanism to collect the complaints from the workers and address those complaints by the approved GRM plan.

With the above mitigation measures, the residual impacts have been assessed as Minimal.

7.5.20 Security Risks

It is a prerequisite for the construction of the project that the project area will be safe from a security point of view. There could be conflict between the locals and the migrant workers, which can lead to dangerous situation for both. Furthermore, there may be security risk to foreign experts from groups with malicious intents.

Mitigating Measures

The project will conduct a security assessment of the project area and will prepare a security management plan before the mobilization of the contractors. The Plan will address security risk to the project and its personnel and also risk to the communities from the security personnel. This plan will be implemented during the construction phase. A similar plan will be prepared for the O&M stage of the project.

7.6 Environmental impacts during Operational stage

7.6.1 Impact on Aquatic Habitat of the Swat River and its Tributaries

The character of the river Swat and its valley bottom will change from a fast-flowing uncontrolled sediment-laden river with steep rocky slopes into a narrow-controlled water reservoir. Reservoir ecology will not be typical of a natural lake environment and will undergo a rapid reduction in size caused by rapid sedimentation. Water velocities along the length of the reservoir will generally be lower than in pre-reservoir river conditions. Although reservoir features will be lake-like, surface water velocities will be high compared to most lakes and storage reservoirs. The relatively high-water velocities suggest that conditions may be mainly compatible for riverine fish species, particularly along the reservoir shoreline. This impact has been assessed as Moderate

Mitigation Measures

Food chain and the ecosystem in the project area seem somewhat disturbed due to lack of natural top predators like Eurasian otter (*Lutra lutra*). The role of top predators in an ecosystem is to control, regulate and maintain the populations of all other species at lower trophic levels. With the increased fish population in the project reservoir, the lacking top predators may also return back to complete the food chain and this will be a very positive impact of the proposed project reservoir. However, in the event no top predator returns, other control methods must be utilized to keep the population at a sustainable level. A Fish Management Plan (Annex-II) will be prepared to manage any potential risks on and related to the fishes. By following the guidelines set out in the Fish Management Plan (Annex-II), the residual risk is expected to be Minimal.

7.6.2 Barrier Effects on Fish Migration

By constructing the 6m high (above riverbed) weir in the Swat River, a barrier in the river will be created and this will impair the ecological connectivity in the river, including the migration of snow trout. The snow trout production in the Swat River within the project area is low, the main reason being the introduction of brown trout. No other long-distance migratory fishes are present in the project that could be affected by the weir. There is also a risk that fish may pass through the tunnels and be injured by the turbines. The impact is deemed as Major.

Mitigation Measures

- A Fish ladder is designed (Figure 3.13) based on the requirements of snow trout, catfish, and other indigenous species (see **Section 3.3.10** for fish ladder design parameters).
- Water will be released continuously through the fish ladder at all times.
- With the eflow of 3.5m^3/s, the water depth in the river channel will be 0.8m which is more than the minimum depth required for fish movement. EFlow of 3.5m^3/s will be divided between mini-turbine (2.8 m^3/s) and fish pass (0.7 to 0.76 m^3/s), ensuring 0.5m to 1m water depth through the fish pass. A trash rack is integrated in the mini-turbine to avoid entrapment of the fish into the mini-turbine.
- During the plant operation, a comprehensive monitoring regime will be implemented for the performance of fish ladder.

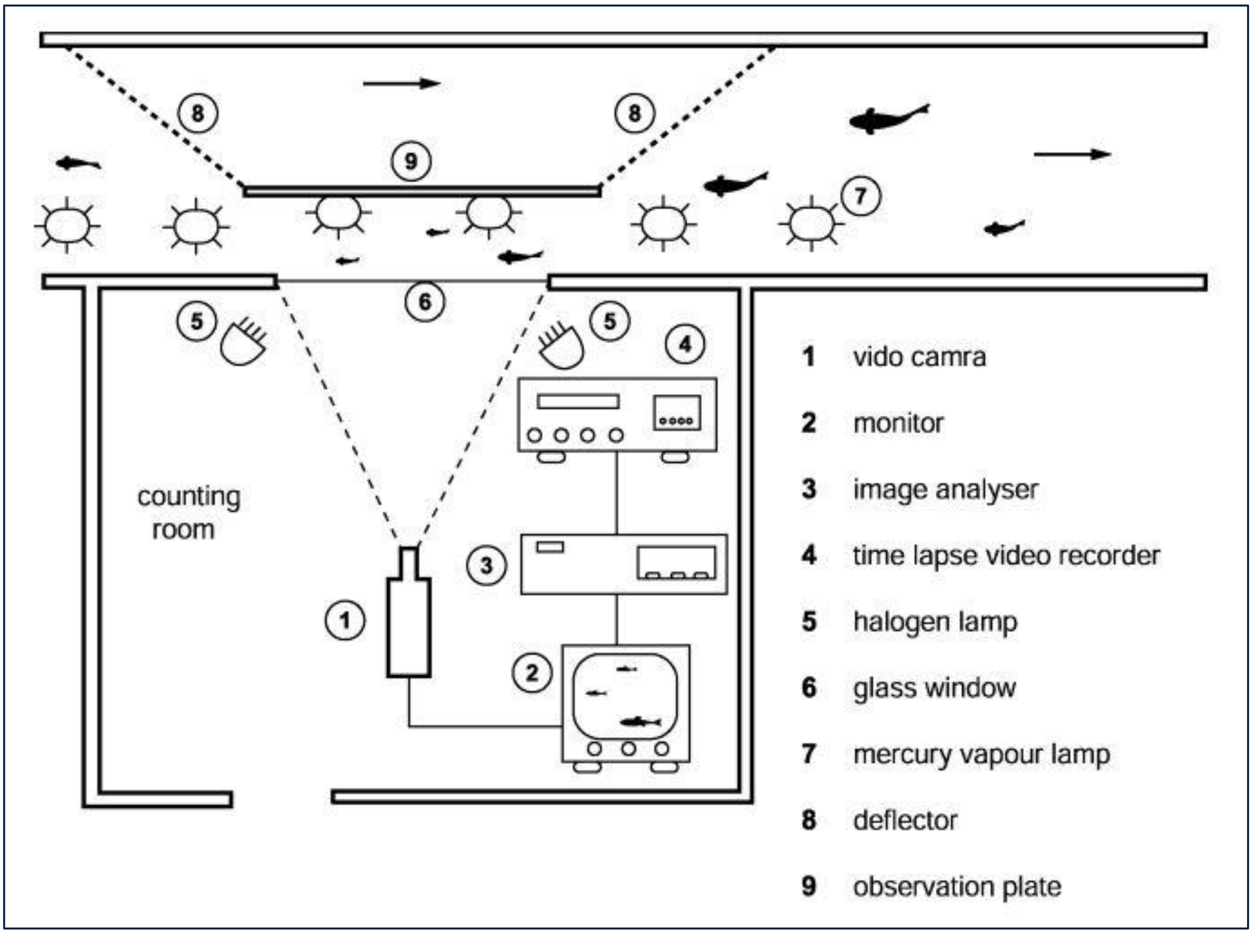


Figure 7-2: Uri HPP Fish Pass Camera Monitoring Plan retrieved from

Source: Uri HPP Fish Pass Camera Monitoring Plan retrieved from https://www.kmae-journal.org/articles/kmae/pdf/2002/04/kmae2002364s166.pdf

- Sensors and underwater video cameras[55] will be placed on the ladder and monitored to count the fish and assess the effectiveness of the ladder[56]. Installation of trash rack at the intake to prevent the fish from entering water intakes and protect the fish against entrapment. Regular removal of deposited sediments from the ladder.
- Supporting the fisheries department for upgrading their snow trout hatchery at Nagoha Shamozai, and annually releasing the fish both upstream and downstream of the weir. A Fish Management Plan (Annex-II) will be prepared and implementation will be ensured. Additional mitigation measures devised in the ESMP along with ECP 13 will be implemented.

- Installation of trash rack at the intake to prevent the fish from entering water intakes and protect the fish against entrapment.
- Regular removal of deposited sediments from the ladder.
- Monitor the effectiveness of the fish ladder and take adaptive measures to improve the performance of the fish ladder.
- Supporting the fisheries department for upgrading their snow trout hatchery at Nagoha Shamozai, and annually releasing the fish both upstream and downstream of the weir.
- A Fish Management Plan (Annex-II) will be prepared and implementation will be ensured.
- Sufficient budget will be allocated in the project budget for the above measures. Details of activities to be implemented under this budget will be worked out during the project implementation by the ESU staff of the PEDO in consultation with the fisheries departments, and the final list of activities will be shared with the World Bank prior to their implementation.
- The Fisheries department will create an observation office near the entrance to the fish ladder to prevent illegal fishing and monitor licensed fishing activities (the recently passed Fisheries Act, 2022 allows the KP fisheries

[55] Also proposed for Gabral Kalam HPP.
[56] ESIA Gabral Hydropower Project https://documents1.worldbank.org/curated/en/828001577945660144/pdf/Environmental-and-Social-Impact-Assessment.pdf.

department to develop fisheries parks and issue fishing licenses. Officials suggested that they will utilize the newly established water reservoir / lake as fishing point for tourists).

With the above mitigation measures, the residual impacts have been assessed as Minimal.

7.6.3 Environmental Flow Assessment

Impacts

The weir will create a barrier resulting in fragmentation of habitat. The habitat downstream of the weir will be exposed to lower flows due to diversion of the river flow into the power generation tunnels. The reduced river flows may also contribute to the degradation of downstream fish habitats due to its reduced capacity of flushing of sediments deposited on the spawning areas.

To determine the required flow for maintaining river connectivity and migration of the reported fish species, a prescriptive approach was adopted which includes an assessment of the flow by both hydrological and hydraulic methods by analyzing the hydrological data coupled basic hydraulic parameters (Annex-V) like average velocity, average and maximum depth and wetted perimeter. The mean annual flow and mean monthly flows were estimated along with the requirement of ecosystem and downstream riparian needs. On the basis of analysis of historical hydrological data and basic hydraulic parameters, the river morphological features and existing aquatic ecosystem, the downstream releasable was determined 3.5 m^3/s. The Kadam nullah that is located just 800 meters downstream of the weir will contribute the flow 1 m^3/s to 10 m^3/s therefore the critical reach is only 800 meters and minimum flow recommend is 3.5 m3/s for the critical reach. For the 800 m reach up to the Kedam tributary, a minimum flow of 3.5 cumecs will be released throughout the year to facilitate the fish movement. The dewatered stretch is a narrow gully where the ecological flow will pass concentrated through a depressed section.

It is reported that from the last week of May to mid-August of the year, when the average river flow is higher than 129 m^3/s (the flow required to run all turbines), the excess water will be discharged through the under sluices/spillways thus maintaining about 62.7 m^3/s of flow in the May, 169.38 m^3/s of flow in the June, 173.92 m^3/s of flow in July and 98.33 m^3/s of flow in August in dewater section of the river. However, from September to May, when the average flow is less than 129m^3/s, and during this period, if all water will be diverted to the powerhouse, there will be no release of water for the downstream release.

Two tributaries Kedam and Bara Dar River joins the Swat River in this reach, about 0.8km and 7 km downstream of the weir, respectively. The average discharges of Kedam and Bara Dar during low flow season varies from 0.31 to 3.41 m^3/s and 0.47 to 5.19 m^3/s, respectively, during low flow season, which indicates that there will be minimal impact on the flows downstream of these tributaries[57]. The reduced water inflow in in the dewatered section will increase with Kadam Khwar (0.8km downstream of weir) which can significantly improve the required ichthyological depth and velocity for the reported fish species and overall aquatic ecology of the river. In addition, there are 13 perennial springs reported in the stretch and discharging into the river.

Mitigation

Minimum required ecological flow downstream of the weir has been calculated as above will be 3.5 m^3/s. Together with the contribution from the tributaries Kedam Nullah and Bara Dar (Gornai Nullah), which join the Swat River just downstream of the weir, the required ecological releases from the weir are computed. The monthly average values are given in **Table** 7-8**8** and presented in **Figure** 7-3.

Table 7-8: Computed Ecological Discharge Downstream of the Madyan Weir

Months	Determined Ecological Flow (m^3/s)	Average Monthly Estimated Discharge between Weir & Kedam Tributary	Average Monthly Estimated Discharge of Kedam (m^3/s)	Average Monthly Discharge in Dewatered Stretch of Swat River (after 1km of Weir)	Average Monthly Discharge of Bara Dar (m^3/s)	Discharge in Dewatered Stretch of Swat River (after 7km of Weir)
Jan	3.5	3.5	0.31	3.81	0.47	4.28
Feb	3.5	3.5	0.38	3.88	0.57	4.45
Mar	3.5	3.5	0.96	4.46	1.45	5.91
Apr	3.5	3.5	3.44	6.94	5.19	12.13

[57] Feasibility Study Madyan HPP,2009.

Months	Determined Ecological Flow (m^3/s)	Average Monthly Estimated Discharge between Weir & Kedam Tributary	Average Monthly Estimated Discharge of Kedam (m^3/s)	Average Monthly Discharge in Dewatered Stretch of Swat River (after 1km of Weir)	Average Monthly Discharge of Bara Dar (m^3/s)	Discharge in Dewatered Stretch of Swat River (after 7km of Weir)
May	3.5	3.5	7.85	11.35	11.86	23.21
Jun	3.5	3.5	8.24	11.74	12.45	24.19
Jul	3.5	3.5	4.58	8.08	6.93	15.01
Aug	3.5	3.5	2.58	6.08	3.89	9.97
Sep	3.5	3.5	1.13	4.63	1.71	6.34
Oct	3.5	3.5	0.99	4.49	1.49	5.98
Nov	3.5	3.5	0.62	4.12	0.93	5.05
Dec	3.5	3.5	0.38	3.88	0.57	4.45

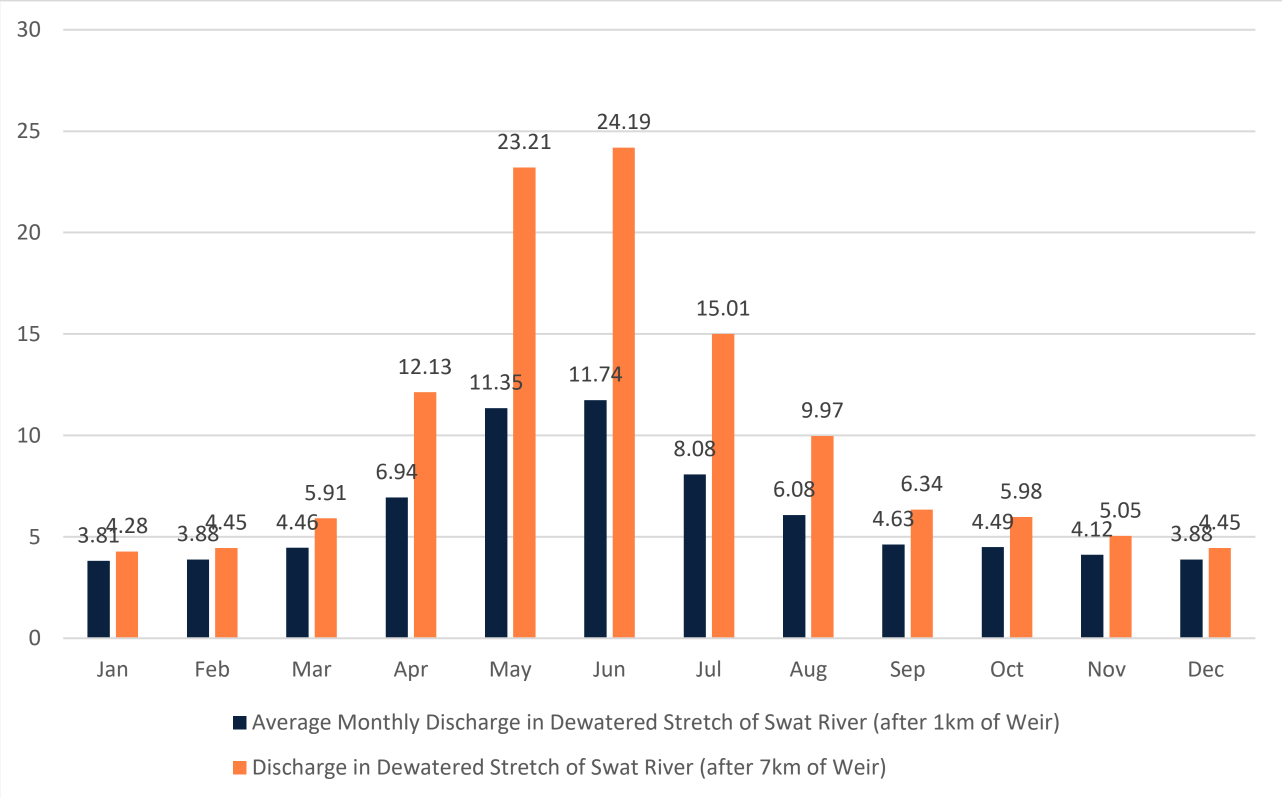


Figure 7-3: Average Monthly Discharge in Dewatered Stretch (m^3/sec)

On the basis of analysis of historical hydrological data and basic hydraulic parameters, the river morphological features and existing aquatic ecosystem, the downstream releasable was determined 3.5 m^3/s. The Kadam nullah that is located just 800 meters downstream of the weir will contribute the flow 1 m^3/s to 10 m^3/s therefore the critical reach is only 800 meters and minimum flow recommend is 3.5 m3/s for the critical reach. For the 800 m reach up to the Kedam tributary, a minimum flow of 3.5 cumecs will be released throughout the year. The dewatered stretch is a narrow gully where the ecological flow will pass concentrated through a depressed section.

The movement pattern of Snow Carp is reported altitudinal migrant and its migration on Swat River and its tributaries are reported in the months of September, October and November and March to April. The spawning is reported to be linked to increases in temperature and can occur twice a year in clear gravelly or fine pebble beds 10-30 cm deep[58].

[58] IUCN,2023.

Brown trout spawns in rivers and streams with swift water. Lacustrine populations migrate to tributaries and lake outlets, rarely spawning on stone, wave-washed lake shores. Spawning sites usually characterized by downward movement of water into gravel[59].

The reported Catfish (*Nangra robusta*-EN) is reported in the tributaries and its movement pattern as well as spawning time is not reported/assessed by IUCN.

By addition of the Kedam and Bara Dar average monthly discharge into the dewatered stretch and reported migratory fish species, it is assumed that the contribution of the reported tributaries for the downstream will achieve the required ichthyological depth and it is anticipated that the project will retain the longitudinal river connectivity throughout the year.

Mitigation Measures

Hydrological modelling was conducted to determine the minimum flow to be maintained in Swat River as 3.5 m^3/s. Various literature reviews were also conducted for snow trout requirements and concluded that the minimum flow requirements for snow trout is 2.5-3.5 m^3/s during the migratory season (March-April and September-October). These flows will be maintained to reduce negative impacts.

A Fish Management Plan (Annex-II) will be prepared to address the issues and provide tailored mitigation measures. However, even with recommended eFlow, the losses in fish populations cannot be completely eliminated in this river segment. These losses will be offset by gains in other segments of the river. The provisions for offsetting the impacts will be included in the Fish Management Plan (Annex-II).

With the above mitigation measures, the residual impacts have been assessed as Minimal.

7.6.4 Emission of Greenhouse Gases

All freshwater systems, whether they are natural or man-made, emit greenhouse gases (GHG) due to decomposition of organic material. This means that lakes, rivers, estuaries, wetlands, seasonally flooded zones and reservoirs emit GHG. In general, in cool and temperate regions, GHG emissions from reservoirs are higher just after impoundment, but decline within the first years to reach levels similar to those of natural lakes, if properly managed.

If the inundated land is heavily wooded and not sufficiently cleared prior to flooding, decomposition will deplete oxygen levels in the water. This affects quality of life and may result in fish kills. Products of anaerobic decomposition also include hydrogen sulphide, which corrodes weir turbines and is noxious to aquatic organisms. Also, methane, which is a very effective greenhouse gas, will also be generated. The reservoir area of the Madyan reservoir is barely covered by vegetation with exception of a few shrubs and cultivation of a few terraces on the left river bank.

Madyan Hydropower Project will in fact contribute towards improvement of air quality at National and International levels. According to an estimate, an oil-fired steam unit would produce, depending on the plan efficiency, between 0.7-0.9 tons of carbon dioxide for each MWh of energy generated. The mean annual net energy output of Madyan Hydropower Project is 805.78 GWh and when it is connected to the national grid it will reduce carbon dioxide emission (GHG) in air by 562-721 tons annually.

Mitigation Measures

Most of the few organic materials as trees, shrubs. will be removed before filling the reservoir. This reduces the generation of greenhouse gases to a minimum. Compared with oil or coal-fired power plants, the emission of CO_2 can be neglected.

7.6.5 Risk of Bird Collision and Electrocution due to Transmission Line

The length of the proposed 220 kV transmission line in the project is 1 km. There are no staging areas for the migratory birds in the project, and birds continue to fly over the river without descending down, and hence no bird collision is expected. However, if the migratory birds start to use the reservoir as resting grounds, there may be a risk of collision. There also will be no electrocution risk for the large birds due to wider space between two vertical conductors (about 6m) since the maximum wingspan of the birds is generally within 3m. However, closely spaced exposed equipment, such as jumper wires on transformers, poses an electrocution risk to small birds. The overall impact is of Minimal significance.

[59] IUCN 2023.

Mitigation Measures

In order to prevent collision of birds with the transmission lines, large diameter wires and wires with high visibility will be used. The exposed coverings and parts of the transmission line towers will be insulated to avoid any electrocution of birds.

Maintaining 1.5 meter (60-inch) spacing between energized components and grounded hardware or, where spacing is not feasible, covering energized parts and hardware;

installing elevated perches or insulating jumper loops;

placing obstructive perch deterrents (e.g., insulated" V's"), changing the location of conductors, and / or using raptor hoods;

Installing visibility enhancement objects such as marker balls, bird deterrents, or diverters after regular intervals

Construction of cage box on conductors to prevent the reported eagles and other low altitude flying birds from sitting or making nest on the towers;

Placing colorful/fluorescent tape on the towers to make them conspicuous;

ensuring sufficient phase-to-phase and phase-to ground wire spacing.

By implementing the planned mitigation measures, the residual impacts will be Minimal.

7.6.6 Impact on Downstream Sediment Load

The Swat River carries about 420,162 tons of sediment load annually, in which about 91.23% of the load is carried during five months of high flow season (May to September), and only 8.77% of the load is carried during seven months of the low flow season (October to April). After the construction of the weir, the sediment will be trapped behind the weir if there will be no flushing of the sediments from the reservoir. Even with the regular sediment flushing, the life of the reservoir is estimated at about 60 years. Hence the reservoir operations are designed with regular flushing of sediments through under sluices and from the sand trap during high flow season. Hence the sediment concentrations in the downstream waters of the weir will be maintained during high flow season. However, during the low flow season, the sediment concentrations will be reduced due to the lack of flushing operations. The impacts associated with low sediment concentrations in the low flow season is Minimal since the river generally carries low sediment load during low flow season, and there is no existing mining industry for the extraction of river sediment material on the downstream of the weir. Flushing of sediments is proposed during high flow or wet season and it will avoid deposition of the fine sediments in the cobbles. Sediment flushing during high flow season will reduce the risk of anoxic sediments moving downstream, blanketing river habitats or smother gills, embeddedness of riffles, and disturbance of water quality for a long time.

Mitigation Measures

PEDO will routinely carry out the following activities during O&M for sediment management:

- Sediments will be flushed from the reservoir through under sluices during high flow season
- Sediments from sand traps will be flushed regularly during high flow season
- Environmental flows will be released through under sluices to allow some sediment flows during low flow season as well

The residual impact is Minimal.

7.6.7 Significant OHS Hazard Risks during O/M – Routine O/M risks

The general potential OHS risks associated with the O&M stage of hydropower plants are (i) exposure to higher levels electric and magnetic fields (EMF) than the general public because of working in proximity to electric power generators, equipment, and connecting high-voltage transmission lines, and (ii) exposure to high noise levels from the turbines and generators. The noise pollution will not be significant since the turbines and generators will be located in enclosed building structures for protection against the elements, thus significantly attenuating noise pollution. Workers may be exposed to higher levels of EMF by working near or with the electrical components. The risk is of Moderate significance.

Mitigation Measures

Occupational EMF exposure will be prevented or minimized by preparing and implementing an EMF safety program that includes the following components:

- Identify potential exposure levels in the workplace, including surveys of exposure levels in new projects and the use of personal monitors during working activities.
- Train workers in the identification of occupational EMF levels and hazards
- Establish and identify safety zones to differentiate between work areas with expected elevated EMF levels compared to those acceptable for public exposure and limiting access to properly trained workers.
- Implement action plans to address potential or confirmed exposure levels that exceed reference occupational exposure levels developed by international organizations such as the International Commission on Non-Ionizing Radiation Protection (ICNIRP). The recommended EMF exposure levels by ICNIRP (also referred in WB EHSGs) are 10 kV/m for electrical field and 1000 µT for magnetic field
- Personal exposure monitoring equipment will be set to warn of exposure levels that are below occupational exposure reference levels (for example, 50 percent).
- Implement actions to minimize occupational exposure, which include limiting exposure time through work rotation, increasing the distance between the source and the worker, when feasible, or using shielding materials
- Workers always use personal noise protective gear when working in high noise areas (typically areas with noise levels greater than 85 dBA).
- Transmission line workers will be provided with adequate PPE and training on the safe use of equipment.

An Occupational Health and Safety Plan will be created and include the above-mentioned mitigation measures, along with more detailed guidelines. The residual significance will be Minimal.

7.6.8 Significant OHS Hazard Risks during O/M - Handling of Faulty SF6

The MHPP will use SF6-based switchgear. Toxic decomposition products are formed when SF6 gas is subjected to an electric arc. The decomposition products are metal fluorides and form a white or tan powder. Toxic gases are also formed which have the characteristic odor of rotten eggs.

Because of the arc-quenching ability of SF6, corona and arcing in SF6 does not occur until way past the voltage level of onset of corona and arcing in air. SF6 will slowly decompose when ex posed to continuous corona. All SF6 breakdown or arc products are toxic. Normal circuit breaker operation produces small quantities of arc products during current interruption which normally recombine to SF6. The impact is of Major significance.

Mitigation Measures

Faulted SF6 will be handled carefully ensuring standard industry practices. World Bank Group's General EHS Guidelines will also be followed to handle SF6. Maintenance staff will observe the following guidelines:

- Among other mitigation strategies, these include upgrading equipment to SF_6-free circuit breakers to reduce SF_6 use and leaks, establishing lifecycle approach for SF_6 management, ensuring good management of SF_6 acquisitions and gas inventory, training employees annually in SF_6 handling and in using the necessary equipment, recycling SF_6 gas at equipment servicing or disposal, implementing leak detection and repair strategies, and decommissioning equipment properly[60].
- Do not breathe the vapors remaining in a circuit breaker where arcing or corona discharges have occurred in the gas.
- Evacuate the faulted SF6 gas from the circuit breaker and flush with fresh air before working on the circuit breaker.
- Arc products which do not recombine, or which combine with any oxygen or moisture present, are normally removed by the molecular sieve filter material within the circuit breaker.

An Occupational Health and Safety Plan (Annex-III) will be created and include the above-mentioned mitigation measures, along with more detailed guidelines. The residual significance will be Minimal.

7.6.9 Significant OHS Hazard Risks during O/M - Electrocution risk during Maintenance

Workers may be exposed to occupational hazards from contact with live power lines during maintenance and operation activities. The impact is of Major significance.

[60] https://www.epa.gov/eps-partnership/sf6-mitigation-opportunities#:~:text=Among%20other%20mitigation%20strategies%2C%20these,and%20in%20using%20the%20necessary

Mitigation Measures

Prevention and control measures recommended in World Bank Group's General EHS Guidelines associated with live power lines include:

- Only allowing trained and certified workers to install, maintain, or repair electrical equipment;
- Deactivating and properly grounding live power distribution lines before work is performed on, or in close proximity, to the lines;
- Ensuring that live-wire work is conducted by trained workers with strict adherence to specific safety and insulation standards. Qualified or trained employees working on transmission or distribution systems will be able to achieve the following:
    - Distinguish live parts from other parts of the electrical system
    - Determine the voltage of live parts
    - Understand the minimum approach distances outlined for specific live line voltages
    - Ensure proper use of special safety equipment and procedures when working near or on exposed energized parts of an electrical system
- Workers will not approach an exposed energized or conductive part even if properly trained unless:
    - The worker is properly insulated from the energized part with gloves or other approved insulation; or,
    - The energized part is properly insulated from the worker and any other conductive object; or,
    - The worker is properly isolated and insulated from any other conductive object (live-line work).
- Where maintenance and operation are required within minimum setback distances (7.25 m for 765 kV connection), specific training, safety measures, personal safety devices, and other precautions will be defined in a health and safety plan;
- Workers not directly associated with power transmission and distribution activities who are operating around power lines or power substations will adhere to local legislation, standards, and guidelines relating to minimum approach distances for excavations, tools, vehicles, pruning, and other activities;
- Minimum hot stick distances may only be reduced provided that the distance remaining is greater than the distance between the energized part and a grounded surface.
- PEDO will prepare an SOP based on the guidelines above for all maintenance work.

An Occupational Health and Safety Management Plan (Annex-III) will be created and include the above-mentioned mitigation measures, along with more detailed guidelines. The residual significance will be Minimal.

7.7 Social impacts during Operational stage

7.7.1 Waste Management

The potential sources of waste during operation are domestic solid waste from the staff colony and offices, and hazardous wastes such as turbine and transformer oil, and maintenance materials or chemicals (such as paints, solvents). Nonhazardous wastes may include office waste, packing materials, and domestic waste from workers and work camps. The impact is of Moderate significance.

Mitigation Measures

PEDO will implement a Waste Management Plan for collection and disposal of organic waste, recyclables, garbage and hazardous waste following the principles given in ECPs 1 and 2 on waste management and hazardous waste management. The residual impact will be Minimal.

7.7.2 Community Health and safety

Operational stage potential risks to the community will be the risk of dam/weir break and exposure to electrical and magnetic fields (EMF) from the transmission line. The recommended limits (by ICNIRP, which are endorsed by the World Bank) of community exposure to EMF are 5 kV/m for the electrical field and 200 µT for the magnetic field.

Other major community risks associated with hydropower projects during operation are weir failures due to different reasons ranging from seepage, piping (internal erosion), insufficient freeboard, liquefication due to earthquakes. The impact is of Moderate significance.

Mitigation Measures

The PEDO hired services of International Panel of Experts (IPOE) for reviews of the feasibility, design, and construction of the dam and the start of operations;

An emergency preparedness plan (ERP) will be prepared for the operation stage of the project;

PEDO will be responsible for periodic safety inspections of the dam after completion, and implementation of measures will be integrated in the ERP and O&M of the project to address safety deficiencies.

Exposure to EMF levels from the proposed transmission will be well below the recommended levels by ICNIRP. The EMF exposure levels within 10 m from the center of the transmission line alignment is estimated as 2.72 kV/m for the electrical field (standard is 5 kV/m) and 8.9 µT for the magnetic field (the standard is 200). Beyond the 10m from the center of the transmission lines, the EMF levels will start to decrease.

To address the potential risks associated with the weir failure, the PEDO will appoint a team of the international and independent panel of experts to review the proposed designs. The panel includes experts in the weir, tunnel and geology, and hydrology, hydraulic structures, and sediment management. PEDO will install an instrumentation network to monitor the behavior of the weir, its foundations, and its abutments. In addition, PEDO will carry out a weir break analysis and prepare an emergency response plan (Annex-I & Annex-III): for approval of the World Bank. The residual impact will be Minimal.

7.7.3 Improved Livelihood Opportunities from the Development of Tourist Attractions

The Project site is located near the Madyan and Bahrain towns, which are major tourism hubs in the region. Due to the tourism potential in the project area, tourist facilities will be provided near the project sites.

There will be development of parks and viewpoints near the weir site and walking tracks near the powerhouse. These facilities will act as an added attraction to the tourists and may attract more tourists to the project area. The overall impacts of the proposed tourist attractions around the weir sites are expected to be positive due to its contribution to the livelihood of the local communities and tourism industry in the region. There would be increased employment and business opportunities for the local communities.

Enhancement Measures

An artificial pond (1.46 km) will be formed upstream of the weir, which will become an attraction for tourists and locals. The Project will develop tourist lookout, locally called selfie point, parking area and may be washrooms to support tourism on the N95 (Bahrain Road) in association with Department of Culture, Sports, Tourism and Youth Affairs (DoT). The Contractor camp near the pond will be handed over to its owner, after restoration to its original condition, which can be used for different kinds of livelihood activities such as small eaters, agriculture.

PEDO will provide preference to affected persons in establishing small businesses in designated eco-tourism spots. It will help affected households to formalize their small businesses and benefit from the promotion of local tourism.

PEDO will make efforts, in collaboration with the DOT to promote responsible/eco-tourism to be socially, economically and environmentally responsible for avoiding impacts on the local socio-cultural situation and environment of the area around the weir.

The information communication material will be displayed at the tourist spots to promote responsible tourism.

7.7.4 Adverse Impacts on Community due to Tourism from Project-related Facilities

The adverse impacts associated with the tourist facilities may include the generation of solid waste, poor maintenance of public toilets, and inadequate housekeeping. Although tourism is not new to this area, there could be some adverse potential social impacts associated with tourists visiting the project sites such as social-cultural conflicts with local communities and the privacy of local women. This impact is of Moderate significance.

Mitigation Measures

The tourist facilities include waste collection bins and public toilets (separately for men and women), which will be maintained regularly by PEDO/NHA (National Highway Authority). The solid waste management system adopted for the PEDO colony and offices will be used for the collection, storage, transportation and disposal of solid waste from the tourist facilities. Information posters could be hung around the Project-related tourist facilities about the proper etiquette to follow when encountering locals, especially women. With the planned mitigation measures, the residual impact will be Minimal.

7.7.5 Water-related Vector Diseases

During community consultations, diseases related to water-borne infections like diarrheal diseases were reported by about 50% of the interviewees, particularly children. This is attributed to the present lack of safe drinking water supply in the project area. Furthermore, the sanitation facilities assessed in terms of sanitary based wastewater and solid waste management including human excreta disposal are not satisfactory. The creation of relatively slow-moving water in the form of impounding the Swat River upstream the weir structure is likely to promote disease vector’s breeding. The mosquito Anopheles, for example, the transmitter of malaria has its breeding habitat in stagnant water and hence the new reservoir will be a potential new habitat for this disease vector. This impact is of Major significance.

The problem of water-related vector diseases is an issue that cannot be seen isolated from the Madyan HPP. There are actual cases of malaria in Swat valley and the situation might become worse after implementing HPPs with its reservoirs. Solving this problem, however, cannot be issue of the owner/operator of the power plants alone.

Mitigation Measures

- The Contractor shall provide adequate sanitary facilities within the construction sites to prevent workers from excreting into the river
- PEDO must create and maintain sanitation facilities near Project-related tourist areas
- During construction and operation, minimize the presence of stagnant water and puddles by improving the drainage facilities.
- Ensure water flow of the river is not distrusted in order to prevent water sitting in the reservoir for too long.

With the planned mitigation measures, the residual impact will be Minimal.

7.8 Socioeconomic benefits

The project will act as an economic catalyst bringing an additional demand for resources and offering employment opportunities during construction and operation phases of the project. During construction phase, jobs for unskilled labor will be available and the local surplus labor force would be used in the construction activities. The availability of jobs within the area would reduce the out-migration of the labor force and would enable most of them to stay at home. Prices of forest products, livestock and agricultural produce are expected to increase during the construction phase. As the project area becomes more developed, the value of the land in the project area will also increase. The local unskilled labors are likely to become skilled or semi-skilled after gaining experience in the project.

7.9 Physical and Cultural Sites, Archaeological Remnants

From discussions with the tourist department and with people living in the area it became obvious that no historical and cultural sites exist in the area that might be affected by the Project. If any archaeological remnants are found during construction (e.g., by excavation activities), the work will be ceased immediately and the responsible archaeological authority will be informed, based on Chance Find Procedure and relevant regulations.

8 Cumulative Impact Assessment

8.1 Background

Cumulative impacts are those that result from the incremental impact of a project or developments when assessed in combination with other existing and reasonably foreseeable future developments in a rationally set geographical and temporal scale. The overall objectives of cumulative impact assessment (CIA) studies are to:

- Assess the potential impacts and risks of a proposed development over time, in the context of potential effects from other developments and natural environmental and social external drivers on a chosen Valued Environmental and Social Component (VEC).
- Verify that the proposed and likely future developments' cumulative social and environmental impacts and risks to not exceed a threshold that could compromise the sustainability of VECs;
- Confirm that the proposed and future developments' value and feasibility are not limited by cumulative social and environmental impacts and risks;
- Support development of governance structures for decision making and managing cumulative impacts at the appropriate geographic scale (e.g., airshed, river catchment, town, regional landscape);
- Ensure that the concerns of affected communities about the cumulative impacts of a proposed development are identified, documented, and addressed; and
- Manage potential reputation risks.

8.2 Methodology

The overall methodology of the CIA is illustrated in Figure 8-1, as proposed by IFC Good Practice Handbook – CIA[61] and Management that includes six steps. This CIA is largely involved in a feasibility level analysis and based on extensive expert and community consultations to identify VECs, hydrological modelling to determine water availability and eFlow, field surveys, and the environmental assessment reports of various projects.

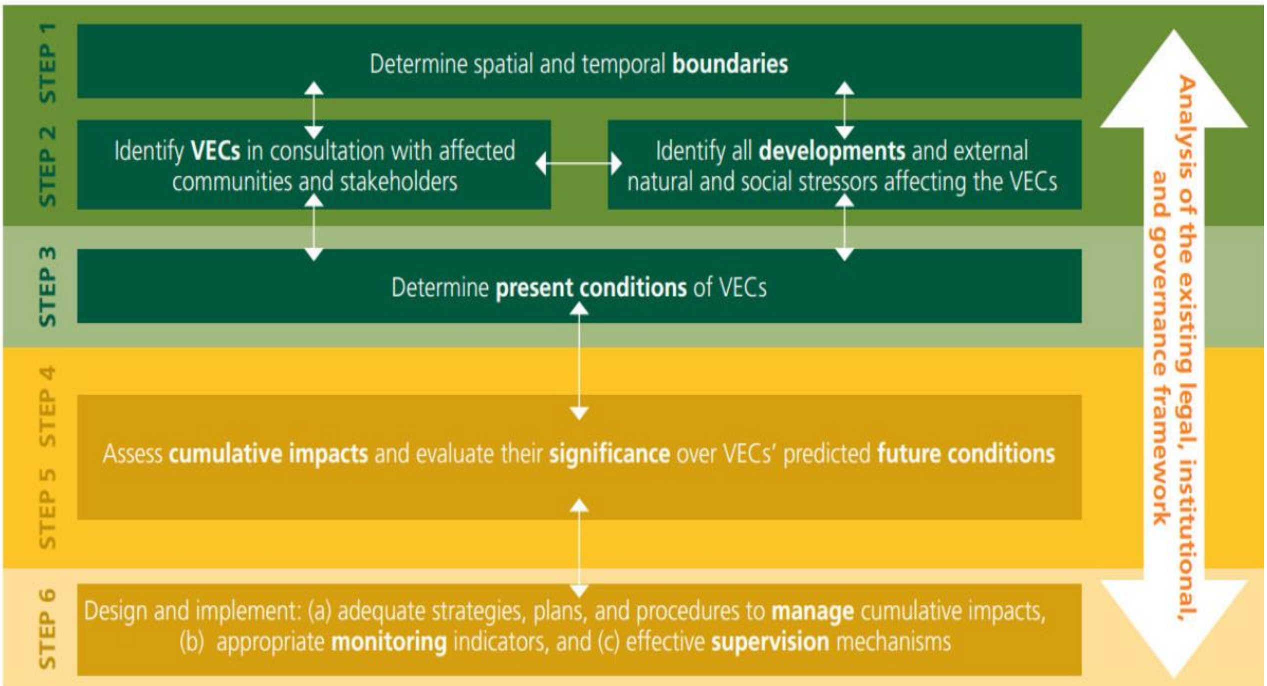


Figure 8-1:Six steps methodology of CIA Study

61 Source: International Finance Corporation. Good Practice Handbook—Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets. 2014

8.3 Cumulative Impacts of MHPP

As part of this ESIA, the cumulative impacts of the proposed project have been assessed employing the 6-Step methodology shown in **Figure 8-1**. These steps and the cumulative impacts determined on the basis of these steps are described below.

8.3.1 Step 1: Study Boundaries

The spatial boundary considered for this CIA is the whole Swat River Basin with a total catchment area of 14,000 km^2. Swat River originates in the form of Ushu and Gabral streams in the northern mountains of Khyber Pakhtunkhwa and takes the name of Swat River at Kalam at the confluence of Ushu and Gabral rivers. The temporal boundary has been taken up till the next 25 years as proposed projects will be expected to be completed by 2048.

8.3.2 Step 2A: Identify VECs in Consultation with Stakeholders

Series of consultation meetings with communities, line departments, and known experts were arranged during July and October 2022 to identify and validate the VECs. A summary of these consultations is presented in **Table** 8-1 and community consultation outcomes are presented in Chapter 11. Moreover, a series of interviews were conducted with officials of PEDO and line departments of provincial government to assess the E&S risk management and capacity of PEDO under this ESIA. The resulting response helped to identify VECs and the management actions to mitigate cumulative impacts on the selected VECs. In addition, a consultative workshop was organized on January 23, 2023 with all developers of hydropower projects in Swat Basin to present preliminary CIA outcome, any concerns they have on preliminary VECs, and constructive feedback through discussions and brainstorming.

Table 8-1: Summary of expert consultations to verify the VECs

Date	Person Consulted/Organization	Issues Discussed / Suggestions / Concerns
October 5, 2022	University of Peshawar	▪ Consider appropriate environmental flow (eFlow). ▪ Impacts on Snow Trout due to the implementation of all hydropower projects in the Swat River System. ▪ Project Impact on tourism, if project is launched sustainably than it may lead to increase in tourism activities of the project area ▪ Construction of dams / weirs will create barrier effects for fish fauna and affect their spawning and migration. ▪ Brown trout and their spawning grounds will be affected since this species is dominant in Swat River system due to 24 dams in a row.
October 6, 2022	Project Director, Pakhtunkhwa Culture and Tourism Authority	▪ Promote eco-tourism during the implementation of hydro-power development. ▪ Tourists' facilities (look-out or locally popular selfie points, tuck-shop, parking area) will be developed in N95 or other suitable locations to watch birds in the reservoir and aesthetic beauty of water in the reservoir/ pondage areas of all hydropower projects.
October 6, 2022	Director General & Manager PPP Khyber Pakhtunkhwa Culture and Tourism Authority	▪ Construction/access road will be constructed on priority basis to facilitate smooth movement of tourists in N-95. ▪ Traffic Management Plan will be implemented during the construction phase.
October 6, 2022	Chief Conservator, Forests Malakand Division, & Director	▪ The accumulated alluvial deposits in the desanders will be flushed in a coordinated way from all 24 powerplants, as they carry important nutrients for the aquatic species.

Date	Person Consulted/Organization	Issues Discussed / Suggestions / Concerns
	Forest Department Govt. of Khyber Pakhtunkhwa	
October 7, 2022	Deputy Director, Fisheries, KP Fisheries Department. Govt. of Khyber Pakhtunkhwa	▪ Maintain appropriate eFlow, especially in the winter season from all hydropower plants. ▪ Construction of dams in a row, will affect the upstream movement of Snow Trout especially during breeding and migration season. ▪ Fish ladder has been designed (Figure 3.13) by considering the migration pattern and fish characteristics (e.g., depth, flow, temperature of water to migrate.) so that effective migration using the fish ladder can take place.
October 7, 2022	Director, NHA, North, KP, Peshawar.	▪ Cumulative impacts must consider the construction material transport from all 24 powerplants and other planned projects in the region on the existing road and the impact on the N-95 infrastructures and associated traffic management. ▪ Alternate road will be provided for tourists during the construction work.
November 23, 2022	Deputy Director, Headquarters & Deputy Director, Madyan	▪ It was suggested to establish monitoring point / guard room near the ladder because fish will move upstream or downstream and will be vulnerable due to easy access of the hunters especially during night time. ▪ Recently, Fisheries Act, 2022 has been approved by KP government which allows the department to develop fisheries parks and issue fishing licenses. Officials suggested that they are interested to utilize the newly established water reservoir / pond as fishing point for tourists.

Based on the desktop analysis of Government's Plans, similar project documents, earlier studies (e.g., ESIA of the Madyan Feasibility Study of 2009), and ESIA reports of the largescale interventions in the Swat River (e.g., Gabral Kalam, Asrit-Kalam, Gorkin Matiltan Hydropower Projects.), several VECs were primarily identified. During institutional and expert consultations additional VECs were identified. The list was then screened as per the expert judgment of the study team and was validated by a transparent and meaningful consultation with external subject matter experts and hydropower developers in July and October 2022 and January 2023. During the screening process, the VEC which would be negatively impacted by the MHPP were considered in the CIA for further assessment. **Table** 8-2 lists the VECs and results of screening with rationale.

Table 8-2: Preliminary Selection and Screening of VEC

Preliminary selected VEC	Screening with Relevance to MHPP and Cumulative Implication	Conclusion
Water availability for irrigation in downstream canals	All hydropower projects in Swat River basin will be run-of-the-river and if all the projects operated for baseload power generation, the river flows at Chakdara (which is 90 km downstream of Madyan), will remain the same as a baseline, and there will be no reduction in the irrigation releases to the Upper Swat Canal and also there will be no reduction in the Lower Swat Canal for the implementation of upstream HPPs. MHPP will not contribute to any reductions to both Upper and Lower Swat Canals due to the joining of the Panjkora river at 20 km downstream of the Chakdara and the river flows of	Screened out

Preliminary selected VEC	Screening with Relevance to MHPP and Cumulative Implication	Conclusion
	Panjkora could meet the requirements of the Lower Swat Canal. In addition, immediately downstream of the weir Kedam Nullah Bara Dar Nullah will enhance the flow regime in Swat River.	
Land acquisition and resettlement	All hydropower projects require land acquisition and resettlement for the project foot-print and establishment of temporary facility development. It is estimated that MHPP will require the acquisition of 131.175 acres will be permanently acquired consequently will affect 141 families/households. On the aforementioned permanent land acquisition, 79.95 acres cropped area will be affected, about 37 residential structures will be permanently impacted, and 4,391 (including 2,321 fruit trees and 2,070 timber trees) will be cut. Similarly, land and resettlement will be required by other projects as well. Most of the land is in the mountain terrain and barren with very limited agriculture and forestry. In addition, reservoir and pondage will also affect land. However, since most of the hydropower plant will have low height weir, land submersion will be minimal with moderate cumulative impacts.	Screened out
Terrestrial Ecology	There is no designated or protected forest in the Project Influence Area. Therefore, forest cover is very limited near the Project sites. About 4,391 trees would need to be felled, mostly fruits (2,321) and timber (2,070) trees in the settlements. These homestead trees and the habitats are already disturbed by the populations and therefore, impacts on wildlife are expected to be minimal. The implementation of MHPP will not affect the terrestrial ecology significantly.	Screened out
Environmental Flow considering all Hydropower Projects in the Swat River System	In case of Madyan Hydropower Project, on the basis of analysis of historical hydrological data and basic hydraulic parameters, the river morphological features and existing aquatic ecosystem, the downstream releasable was determined 3.5 m3/s. The Kadam nullah that is located just 800 meters downstream of the weir will contribute the flow 1 m3/s to 10 m3/s therefore the critical reach is only 800 meters and minimum flow recommend is 3.5 m3/s for the critical reach. For the 800 m reach up to the Kedam tributary, a minimum flow of 3.5 cumecs will be released throughout the year which is sufficient to achieve the depth and velocity required for the reported fish species. The dewatered stretch is a narrow gully where the ecological flow will pass concentrated through a depressed section.PIC also conducted various literature review for snow trout requirements and came to the conclusion that the minimum flow requirements for snow trout is 2.5-3.5 m3/s during the migratory season (March-April and September-October). These flows will be required to reduce negative impacts on aquatic species. The biggest challenge will be to maintain the estimated eFlow from all hydropower plants in Swat River system especially during extremely low flow season. Therefore, eFlow has been considered in the CIA which has potential to impact negatively.	Screened to the CIA. Additional rationales are provided below.
Aquatic Ecology	Conversion of a lotic (flowing) into a lentic (slow or motionless) pond ecosystem and defragmentation of aquatic habitats, which can cause significant impacts in migration patterns of indigenous species and affecting spawning grounds.	Screened to the CIA.
Impacts Associated with Project Induced Labor Influx	Construction of 18 proposed hydropower projects, transmission lines, tourism infrastructure, flood emergency infrastructure rehabilitation and road construction are expected to exacerbate the situation, by aggravating existing threats and introducing new challenges for the species survival. The cumulative impacts of all these developments may be significant on the very limited common infrastructures available in the Project area, like hospitals and dispensaries, schools, water supply and sanitation scheme, local road, food and fuel supply, forests and wildlife of the area. Further, there is a large influx of 26,500 workers including construction workers, operational staffs, and business people together with their dependents to work in these projects will add tremendous pressures on the common facilities and have adverse	Screened out

Preliminary selected VEC	Screening with Relevance to MHPP and Cumulative Implication	Conclusion
	social and environmental impacts on local communities, especially if the communities are rural, remote or small. During flood emergencies and due to delayed construction of detour realigned of N95, N95 has to accommodate both construction and public traffic during an extended period of time. And N95 being the only access for transportation of goods, road closure will significantly affect the life of the communities exacerbated with the food demand of migrant workers in the Project area, especially on the daily essentials. Current trend of construction suggests that project implementation is extremely slow in Pakistan and this may continue. Therefore, schedule conflicts with various projects may be unlikely.	
Impacts associated with Induced construction traffic in N95	Currently there are about 250 to 350 trucks per day using the existing N95 to supply cement, steel, fuel and other construction materials to different locations. It will become 650-950 per day during MHPP construction. Additional construction traffic using N95 and exceptional heavy transports of turbines and transformers required for MHPP construction will also cause traffic congestions, potential road damage and safety hazards. Construction materials for the implementation of other hydropower projects under PEDO will also use the existing N95. In addition, after the commencement of the construction of GKHP, KP Integrated Tourism Development Project and other projects, additional traffic will be added to the over pressured N95. The condition of the existing N95 in many locations are very poor due to the recent flood including some bridges. The condition will be further aggravated due to increasing volume of heavy loaded construction traffic. Current trend of construction suggests schedule conflicts with various projects may be unlikely and emergency food assistance project funded by the Asian Development Bank and other development partners will reconstruct road infrastructures prior to the construction of MHPP and other hydropower projects.	Screened out
Alluvial Deposits with Excessive Nutrients	The region was glaciated one or more times. Sediments from these epochs include morainic and glacial-fluvial deposits. Nutrient rich alluvial sediments will be deposited at the weir base and desander channels. It is estimated that average annual suspended sediment yield is about 0.76 million metric tons, corresponding to a specific yield of approximately 353t/km². The bedload is assumed as 20% of the suspended sediment loads in Swat River[62]. Similar quantity will also be deposited in other hydropower projects in the upstream Swat River. When all hydropower plants are constructed, a coordinated effort for the synchronization of sediment discharge will be needed to avoid over-discharge in the river and as a result destruction of aquatic habitats.	Screened to the CIA. Additional rationales are provided below.
Enhanced Recreation and Tourism in the Region due to Hydropower Development	Swat district is often referred to as the Switzerland of Pakistan for its scenic valleys and pleasant weather in the summer. Each year as the temperatures soar in the plains of the Punjab and Sindh, hundreds of thousands of domestic tourist's head to the district to cool off in Malam Jabba, Madyan, Bahrain, Kalam, Utror, Mahudhand or hill stations in Upper Swat. Between 400,000 and 500,000 tourists onboard 197,000 vehicles visited Swat in the three days of Eid-ul-Fitr holidays in June 2019.[63] Tourist influx in Malam Jabba during August 2021 to December 2022 was recorded as 197 foreigners and 1,052,571 domestics.[64] Hydropower projects can attract many tourists due to the formation of waterbodies and fishing activities, if facilities are designed as tourist friendly. Department of Tourism showed interest to cooperate with PEDO to harmonize hydropower development and recreation and tourism.	Screened to the CIA. Additional rationales are provided below.

[62] MHPP Hydrology and Sedimentation Study.
[63] Of lush green meadows, The News on Sunday, https://www.thenews.com.pk/tns/detail/865539-of-lush-green-meadows, Site visited on December 12, 2022.
[64] KP Tourist Influx State, August 2021 – December 2022, Government of Khyber Pakhtunkhwa.

8.3.3 Step 2B: Proposed and Forecasted Developments in the Swat River Basin

Overview of the Swat River

The Swat River is a perennial and meandering river commences in the Kalam Valley of Swat, Kohistan with the confluence of two main tributaries Ushu and Gabral and runs through mountainous terrain and narrow gorge up to Baghdheri. The average width in this reach is around 30-40 meters. The river enters in the plain areas of Swat Valley and become wider with an average width of 400 meters in the extreme south and receives the hydrological flow of the entire valley. The river flows southwards and then westwards; once again, it enters a narrow gorge and joins the Panjkora River at Qalangi. The river then flows southwestward into the Peshawar Plains and joins the Kabul River at Charsadda after a 320 km course. The Kabul River then joins Indus River at Attock (Punjab) below the Tarbela reservoir. The Swat River basin comprises all the areas drained by Swat River and its tributaries, and the total catchment area is 14,000 km^2.

The Proposed Hydropower Projects

The hydropower potential of the Swat River Basin was studied under the "Hydropower Development Master Plan for Northern Areas of Khyber Pakhtunkhwa," which was carried out during 1990-1995 by PEDO and German Agency for Technical Corporation. The hydropower projects identified by the study are given in Table 8-3.

Table 8-3: A Summary Hydropower Development in the Swat River Basin

Main River	Proposed HPPs on Main Rivers	Proposed HPPs on Tributaries	Existing HPPs on Canals
Gabral	• Chota Jabbar – 90 MW • Gabral Utrol – 50 MW • Gabral Kalam – 88 MW (Total: 183 MW)	• Swati – 8 MW • Batal Khwar – 8 MW • Bhan Khwar – 25 MW (Total: 41 MW)	-
Ushu	• Javaid – 45 MW • Artistic – 55 MW • Gorkin Matiltan – 84 MW (under construction) • Ushu II – 20 MW (Total: 204 MW)	Kalam – 3 MW (Total: 3 MW)	-
Swat	• Kalam Asrit – 197 MW • Asrit Kedam – 215 MW • Madyan – 157 MW • Mohmand – 800 MW (under construction) (Total: 1369 MW)	• Choken Khwar – 12 MW • Kedam Khwar – 17 MW • Barel Dare – 9 MW • Daral – 36 MW (existing) • Kalkot-Barikot-Patrak – 47 MW • Patrak – Shringal – 22 MW (Total: 143 MW)	• Jaban – 22 MW • Dargal – 20 MW • Malakand III – 81 MW
Total	**1,756 MW**	**193 MW**	**123 MW**

In general, each project located on the main rivers (Swat, Gabral, and Ushu) has a capacity of more than 45 MW (except one project), and each project located on the tributaries has a capacity of less than 25 MW (except two projects). All these projects are runoff river projects except Mohmand Dam Hydropower (the most downstream project in the Swat River), which involves storage (1,600 million m3) for power generation and irrigation.

Locations of Hydropower Projects

Locations of the hydropower projects in the Swat River Basin are given in **Figure 8-2.**

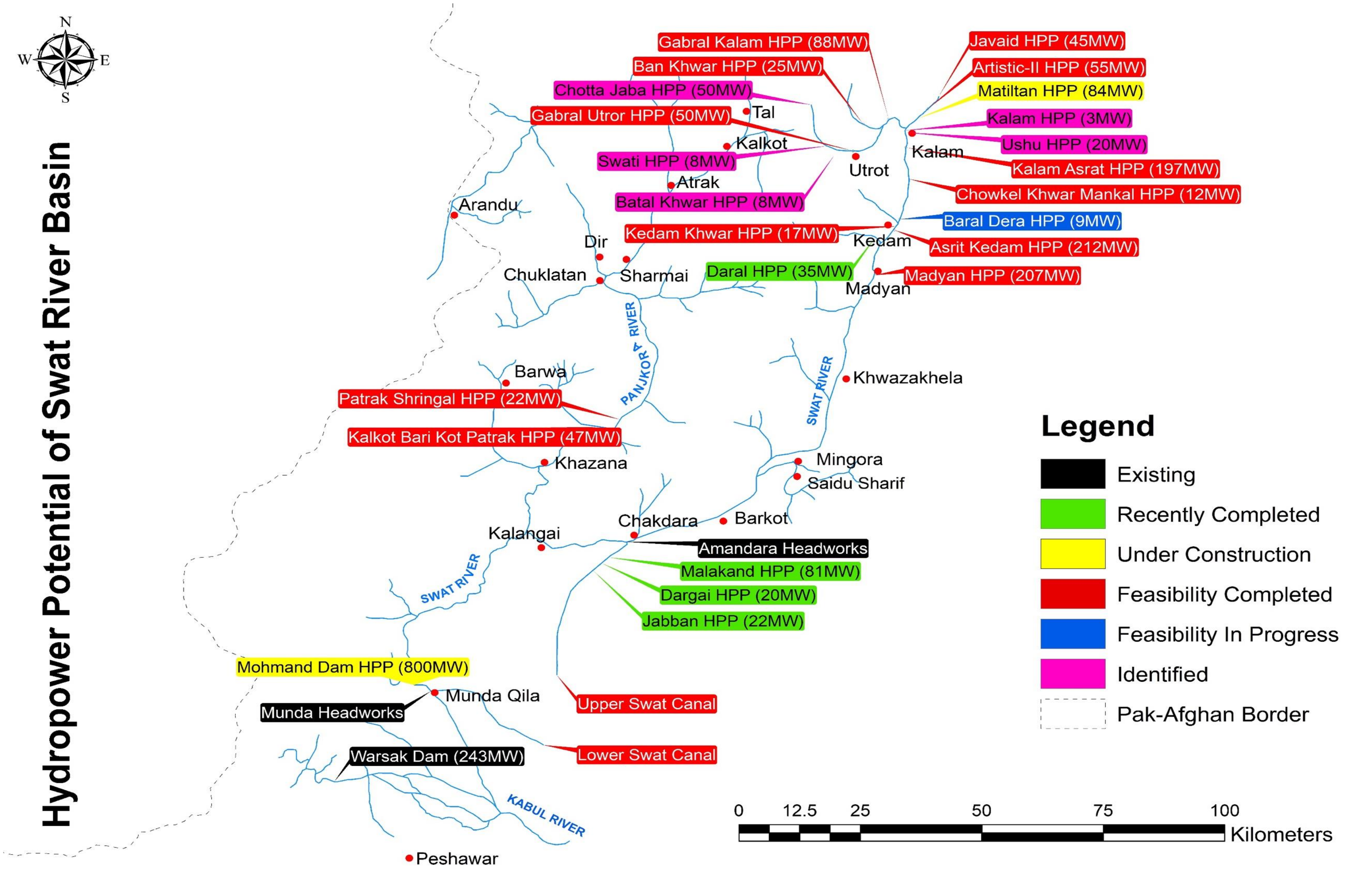


Figure 8-2: Locations of the Potential Hydropower Projects in the Swat Basin

Schematic View of Hydropower Development in the Swat River Basin

A schematic drawing (without scale) showing the locations of the existing, under construction and proposed hydropower projects in **Figure 8-3**. for an easy reference for the discussion given in this chapter.

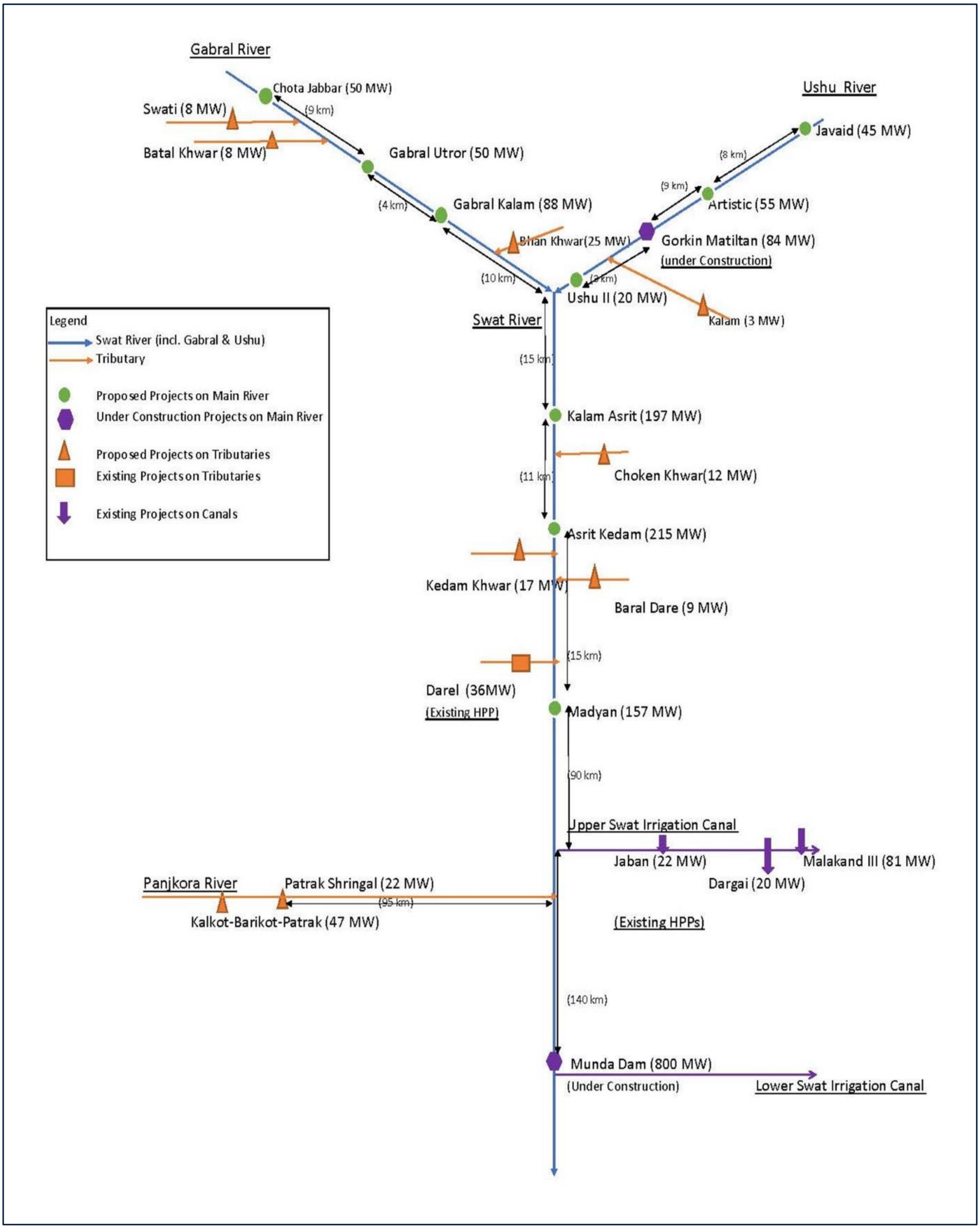


Figure 8-3: A Schematic View of Hydropower Development in the Swat River Basin

Other Development Projects

In addition, there are several projects KP Government has been considering and they are under preparation. Following projects are considered under this CIA study:

1. Khyber Pakhtunkhwa Integrated Tourism Development (KITE) Project: The project development objective is to improve tourism-enabling infrastructure, enhance tourism assets, and strengthen destination management for sustainable tourism development in the province.
2. Provincial Roads Improvement Project: The proposed project will (i) rehabilitate 214 km of provincial roads in the Province of Khyber Pakhtunkhwa (KP); (ii) pilot two performance-based maintenance (PBM) contracts covering 104 km of provincial roads; and (iii) enhance road asset management. This Project intends to rehabilitate Shahmozai to Baghdheri Road in District Swat.
3. KP Government is constructing road projects amounting to Rs11 billion to provide an easy access to tourists to explore the archaeological and tourism treasures of Khyber Pakthunkhwa including Swat. KP Tourism and Archaeology Department’s Culture and Tourism Authority (KP C&TA) has been working on a number of development projects for promotion of tourism and uplift of new potential destinations to reduce tourists’ load in existing destinations on Kalam, Nathia Gali and Naran-Kaghan. A new tourism valley “Ganool” carrying splendid natural beauty, is being introduced to reduce load on existing tourists’ resorts.
4. To strengthen roads’ connectivity imperative for bolstering of tourism and alleviation of poverty in KP, Kalam-Kumrat Road, Aywon-Kalash, Bamborat and Rambor valley and Chitral-Garam Cheshma Road will be constructed to open up Malakand division for tourists and adventure sports lovers.
5. Rs 4.8 billion will be spent on roads’ development in tourist areas of Malakand division, Rs 4.5 billion on Hazara’s access roads, Rs 3.04 billion for construction of approach road to Sheikh Badin DI Khan’s tourist resort and Rs 2.2 billion for development of tourist spots in the province. Jeepable tracks costing Rs500 million in touristic’ areas will also be constructed.
6. Work on DI Khan-Peshawar and Dir motorways, the two mega communication infrastructure projects of the Government with a proposed allocation of Rs 276.5 billion, has been entered into advanced stage and practical work on it was expected to launch in 2022. Out of Rs 276.5 billion allocation for both the mega projects, the 30 km long Dir Motorway will be constructed with an estimated cost of Rs 33.5 billion, which will convert the entire Malakand division comprising seven districts including Upper Chitral, Lower Chitral, Dir Upper, Dir Lower, Swat, Shangla and Buner into a hub of tourism, trade and investment.
7. Dir Motorway will be initially four lanes and later to be extended to six lane full-fledged motorway to be constructed on a public private partnership basis. Dir motorway will start from Chakdara to Rabat town and after completion will reduce distance between these cities by 27 km. Two tunnels and three interchanges will also be constructed on Dir Motorway. New tracks including Thandyani-Nathiagali (40 km) track covering Bringali, Dagri Bangla, Miranjai Top having over 150 years-old trees and Thandyani-Tastu Bangla constructed in 1902 during colonial era will be developed.

8.3.4 Steps 3 to 6: Present and Future Conditions of Valued Environmental and Social Components

Nine (09) valued Environmental and Social Components (VECs) have been studied as stated in Table 8-2 and four (04) of them are taken for the CIA study. These are (i) eFlow, (ii) Aquatic Ecology, (iii) Alluvial Deposits and their Flushing Schedule, and (iv) Harmonization of Hydropower Development and Recreation and Tourism.

VEC 1: Environmental Flows

Baseline

Water availability at the weir site was determined using the catchment area ratio method. The flow rate from 1961 to 2009 was estimated with the catchment area factor of 1.23. The flow rates from 2010 to 2021 is extended using the regression analysis. The daily flow data of Swat River at Kalam and Chakadara from period of 1961 to 2010 are considered in the analysis. Two gauging stations, Pashmal and Mankial were installed and operated by KOAK. Pashmal gauging station locates at the upstream of the dam while Mankiyal gauging station locates at the downstream of the dam. The period of the collected flow data in this study is from April 2019 to Oct. 2021 which has only 1 whole year of 2020. It is noted that the new data is not sufficient for a hydrological analysis, but it is helpful to compare with the past data and evaluate variability of the latest flow data. The feasibility study of the Asrit Kadam indicates that water availability for the Asrit Kadam Hydropower Project is around 6 to 11% greater compared to the observed Kalam flows. With only the flow rate of 2020, it is not convinced that the pattern of the flow rate is increased. However, it is assured that the flow rate estimated by catchment area ratio and past flow rates of 2011 to 2020 are within reasonable range. Although basin runoff is dependent on snow melt and rainfall, a positive correlation was estimated for annual runoff coefficient. Mean 10th daily flow at weir is presented in **Figure 8-4.**

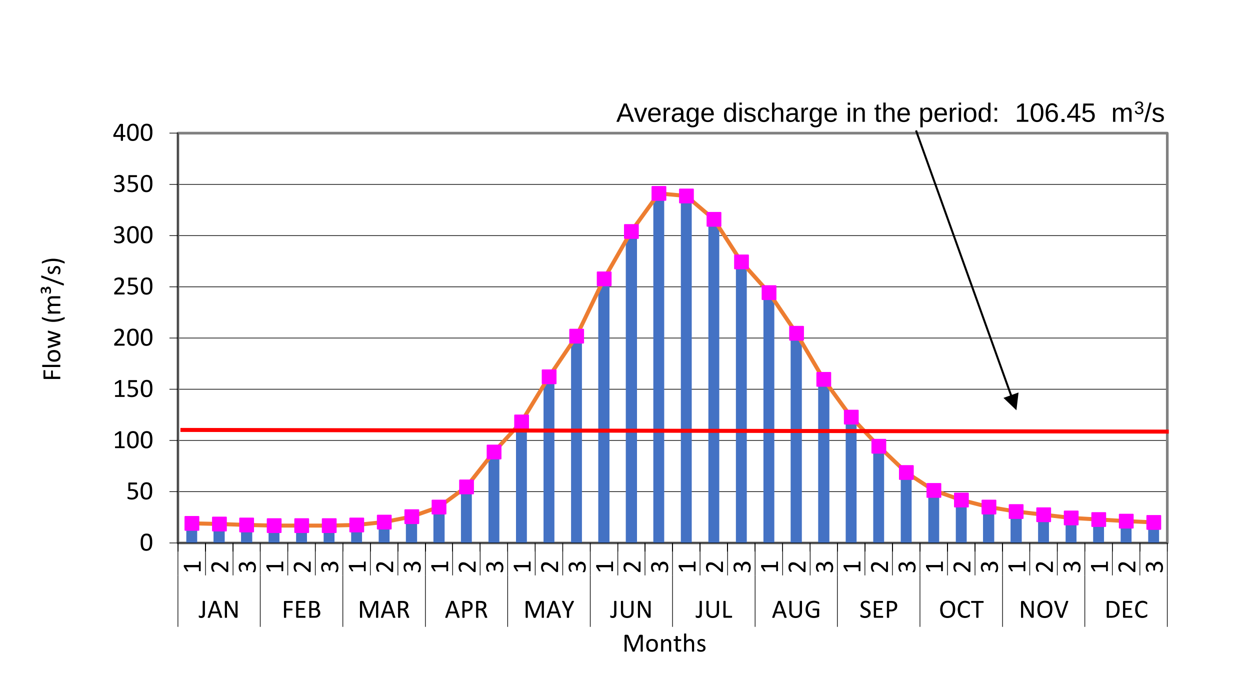


Figure 8-4: Mean 10th daily flow at the MHPP weir site from 1961-2020

Availability of flows at the proposed weir was checked using detailed flow duration curve analysis. A flow duration curve (FDC) shows relationship between magnitude and frequency of stream flows for a particular river basin at a particular location. FDC provides estimation of cumulative percentage of time that a given quantity of flow is equaled to or exceeded which helps in planning and capacity sizing of a power plant. It is very important that number of dry, wet and average years to be determined in the long-term data series.

The 5-year moving average was estimated to determine the dry, wet and average year flows. The years above 5-year average year flows were categorized as wet year, less than 5-year average flows were considered as dry years and flows approximate to 5-year average was taken as average year flows. The 5-year moving average flows are shown in the Figure 8.5.

The results indicate that difference of flows for wet, dry and average year is for 50 to 100% of time, whereas the basin response is quite similar for the flows between 0 to 50% as shown in the **Figure 8-6.**

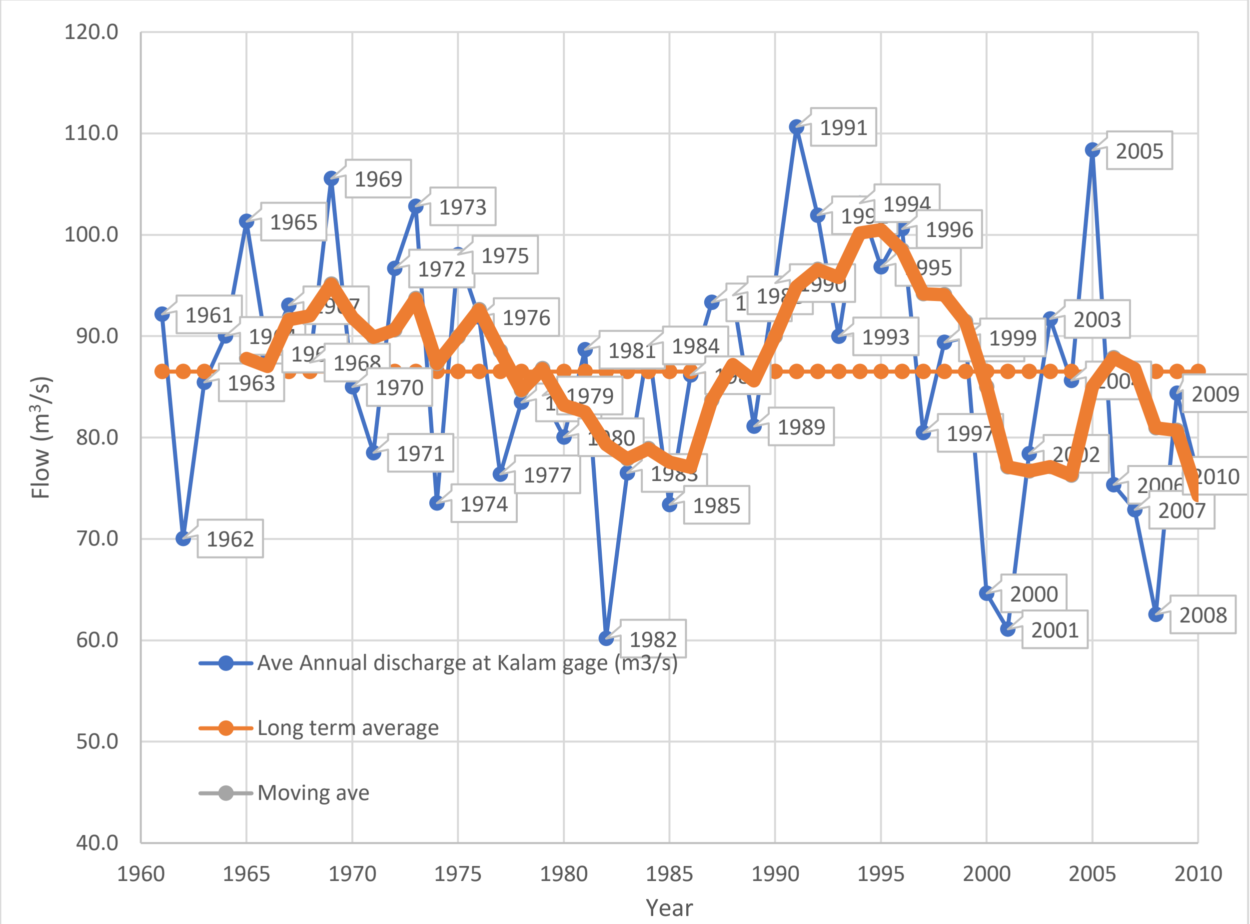


Figure 8-5:5 Year Moving Average Flow at the Kalam station

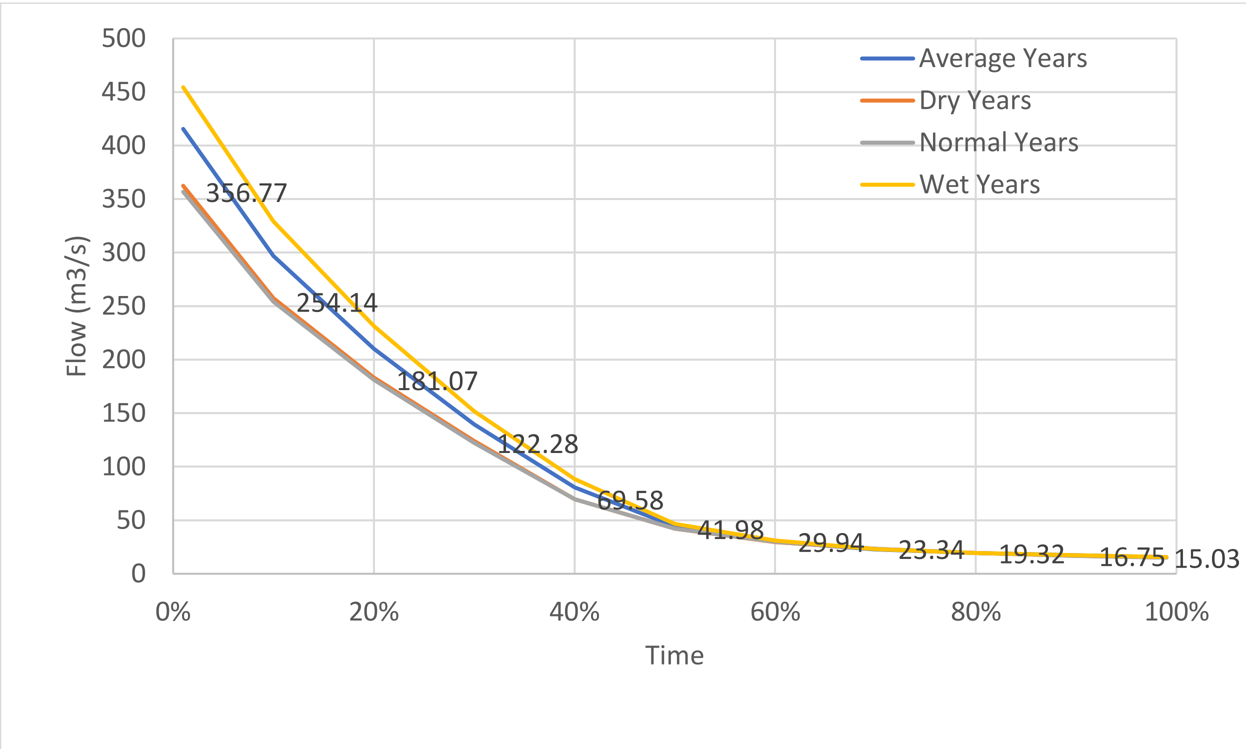


Figure 8-6: Comparison of Average, Dry, Normal and Wet Years

Cumulative Impacts

During construction and operation, each hydropower project will have localized impacts on its dewatered sections between the weir and the tailrace. If there are any water uses (irrigation and drinking.) during these stretches, they will be affected if all the water is diverted for power generation without releasing any flows. Since most of the projects are located on a hilly terrain, there is not much irrigation demand from the rivers due to the presence of limited agricultural areas around the project sites, and the irrigation requirements are generally met from the springs (in MHPP project area. The springs are used for irrigation, and there is no direct use of river water either for irrigation and drinking). Among all proposed projects, only Madyan has agricultural lands in its dewatered section (about 12 km between the weir and tailrace), which also use spring water for irrigation. In the dewatered sections of all hydropower projects, aquatic habitats will be negatively affected without the eFlow. Most of the hydropower projects under planning are located upstream of MHPP, except Mohmand dam and hence no known irrigation or water supply scheme available using river waters. **Table 8-4** presents the estimated eFlow and minimum flow availability from all hydropower projects under planning starting from upstream towards downstream in Gabral, Ushu and Swat Rivers and their tributaries.

Table 8-4: Estimated eFlow and minimum water availability in various hydropower scheme

Project Name	Capacity (MW)	River/ Tributaries	Q_{mm} (m^3/s)	Q_{av} (m^3/s)	Estimated eFlow (m^3/s)	Minimum Available (m^3/s)
Main Rivers						
Gabral-Utror	50	Gabral	2.72	16.42	0.36	1.59
Gabral-Kalam	88	Gabral	21.61	42	1.43	5.2
Artistic-II	55	Ushu	3.47	20.36	0.45	3.2
Kalam-Asrit	197	Swat	14.10	88.49	2.58	15.2
Asrit-Kedam	215	Swat	15.30	96.4	2.89	10
Madyan	207	Swat	16.92	106.45	3.5	15.03
Tributaries						
Bankhwar	35.6	Gabral Tributary	0.94	5.64	0.12	0.55
Kedam Khwar	17.1	Kedam Khwar	0.34	2.17	0.04	0.21
Daral Khwar-II	9.5	Daral Khwar	4.80	17.6	0.41	2.54

The most upstream project in Gabral River is Gabral Utror hydropower project with a capacity of 82.92 MW. The estimated eFlow is 0.36 m^3/s and minimum available water is planned at 1.59 m^3/s, which is lower than the minimum required water flow of 2 m^3/s during November to February for snow trout, when the species stays in pool. All other powerplants will maintain more than 2 m^3/s of the minimum flow, except the plants located in the tributaries. Since, snow trout uses main rivers during migration, water availability in tributaries will not affect the migration patterns during March-April and September-October. During migration of the snow trout a minimum water flow required in main rivers is 2.5-3.5 m^3/s.

Actions to Address Cumulative Impacts

PEDO will take the following actions to avoid potential impacts on the aquatic habitats and eFlow releases:

- All hydropower projects in the Swat River Basin will be operated for baseload power generation with an agreed and scientifically correct eFlow, especially during the extreme low flow season (November to February).
- During the detailed engineering design of all hydropower projects, extreme care shall be taken during the ESIA preparation to correctly estimate all water uses (storage and diversion for power generation) and the release and communicate with the downstream developers. In the dewatered sections of each hydropower project, eFlow regime must be estimated based on the aquatic species and their requirements. This eFlow regime is important to sustain the ecological health of receiving waters especially during the extreme low flow season.
- PEDO shall make policy decisions on compulsory consultations to identify VECs with line departments and known experts in the country during the ESIA preparation.
- All hydropower projects will be regularly monitored whether the released eFlow meets the requirements of flow regime important to sustain the ecological health and will adjust the release to meet the seasonal variations of eFlow requirement (if needed).

- In the absence of a regulatory framework on CIA in Pakistan, PEDO can require all developers to comply with the requirements of Good International Industry Practices (e.g., IFC Guidelines on CIA).
- KP Government can develop Water Resources Policies and include eFlow requirements. Policy will provide for the following:
  - Legal standing for environmental water allocations.
  - Inclusion of environmental water provisions in basin water resources plans.
  - Assessment of all relevant parts of the water cycle when undertaking eFlow Assessments (EFAs).
  - A method or methods for setting environmental objectives in basin plans.
  - Attention to both recovery of overallocated systems and protection of unstressed systems.
  - Clear requirements for stakeholder involvement.
  - An independent authority to audit implementation.
  - A mechanism for turning value-laden terms into operational procedures.
- Inclusion of eFlow in Basin and Catchment Plans. The analysis of basin and catchment water resources plans will include the following:
  - Recognition of eFlow in water resources policy and legislation provides important backing for including eFlow in basin or catchment plans.
  - Demonstrate the benefits from environmental water allocations after plans are implemented.
  - Explain the term "eFlow" at an early stage to minimize confusion and mis-understanding.
  - Tailor the need of participatory methods to suit stakeholder capacity.
  - Establish a range of EFA techniques to suit different circumstances.
  - Establish essential ecological monitoring to provide information for adaptive management.
- Inclusion of eFlow in Infrastructure Projects and review lessons learnt from dams and water restoration projects in assessing and implementing eFlow, such as:
  - Engineering improvements combined with reoperations to provide the volume of water needed for major ecosystem restoration.
  - Inclusion of eFlow in water resources policy to simplify the application of EFAs at the project level.
  - Environmental outcomes linked closely to social and economic outcomes.
  - EFAs conducted for all components of the hydrological cycle.
  - Traditionally trained water resources professionals may find it difficult to grasp eFlow concepts, therefore, continuous education and training will be planned under development projects' capacity building program.
  - Water resources plans can provide benchmarks for water allocations during project assessments.
  - Active monitoring will be planned to enforce flow allocation decisions and undertake adaptive management.
  - Present information in such a way that are comprehensible to decision makers.
  - Economic studies will be conducted to support arguments for downstream water allocations.
  - Ensure whether EFAs are fully mainstreamed into all ESIAs, since, the cost of conducting EFAs constitutes a small fraction of overall project costs.
  - Ensure that ESIAs are always or adequately identified issues associated with downstream water provisions.

VEC 2: Aquatic Ecology

Baseline Aquatic Ecology

The aquatic ecosystem in the Swat basin can be classified as (i) cold water ecosystem and (ii) semi cold-water ecosystem. The fish diversity of the rivers in the basin depends on the respective ecosystem.

- **Cold Water Ecosystem**. Upper part of River swat from Baghdheri and upward have water temperature seldom rising above 12°C; therefore, cold water fish species like Salmo trutta fario (Brown trout), Onchorhynchus mykiss (Rainbow trout), Schixothorax plagiostomus (Snow trout), Cat fish (Nangra robusta) Schizothorax esocinus (Chunr), Schizothorax labiatus (Bota), Racoma labiat, Glyptothorax species are found. None of these species listed in the IUCN red-listed category. All hydropower projects in the Swat River Basin (except the Mohmand and the projects on the Upper Swat Canal) are located in the cold-water ecosystem and the snow trout is the most common species.

The snow trout is an indigenous fish species of the Himalayan region and widely distributed in the cold waters of Pakistan, Nepal, and India.

- **Semi Cold-Water Ecosystem**. The lower reaches of the Swat River, starting from the downstream of the confluence with the Panjkora river, exhibits this ecosystem. Mohmand Dam and hydropower projects in the Upper Swat Canal are located in this ecosystem. The Swat River before the confluence with the Kabul represents an ideal habitat for aquatic fauna, especially the fish due to plenty of food availability like macroinvertebrates, freshwater mussels, algae, and several other species of aquatic flora. During floods, both the rivers bring down a variety of organic matter acting as fertilizer. This increases phytoplankton's and zooplanktons population providing a rich baseline for a rich food chain in the river. This results in a wide variety of fish populations downstream. Micro-invertebrate species recorded in these waters include Planaria, Leech, Caddis fly, Mayfly, Stonefly, Dragonfly, Dame's fly, Water strider, Chironomous, Water beetles and Water scorpions. These macro-invertebrates contribute a lot to the food chain and hence an integral part of the ecosystem. About 38 fish species are reported in this ecosystem belonging to six orders, nine families and 24 genera. Cyprinidae was recorded to be the richest family represented by 20 species, Nemachilidae by four, Sisoridae by six, Chanidae and Schilbidae by two species each and Mastacembilidae, Schilidae, Belonidae and Chandidae by single species each. Mahseer (tor putitora) is an endangered and commercially important fish species in this ecosystem.
- **Currents threats to Aquatic Ecosystems.** The riverine ecosystem in the Swat basin, particularly near the towns (e.g., Mingora. Saidu Sharif, Madyan, Kalam,.), is affected by the release of untreated municipal sewerage along with disposal of solid waste into the river. The waste from all the settlements located along the river, particularly near the tourist areas (e.g., Kalam and Bahrain) is also being thrown directly into the river. Other major impacts on the aquatic ecosystem are the mining activities in the adjoining hills, particularly marble production in Mingora, Barikot and Batkhela areas, which releases high sediment loads and heavy metals into the river. It is observed that the populations of Snow trout and Cat Fish (an endangered species) have decreased during the last two decades due to several factors including pollution and over-exploitation.

Cumulative Impacts

General impacts of hydropower dams on the aquatic environment, and their relevance to the hydropower development in the Swat River Basin, and overall cumulative impacts are given in **Table 8.6**. The potential cumulative impacts are summarized below:

- **Habitat Destruction.** Construction of dams/weir causes fragmentation of habitats in both feeding and breeding grounds, which leads to potential biodiversity loss. Weir/dam block the natural flow of water, reducing water discharge in the downstream. Flowing water is vital as it cleans interstitial spaces of pebbles, gravel, and boulders and prepares spawning substrate for fish. In the absence of water flow after diversion, the spawning ground is covered by sediment that limits fish recruitment. In addition, urban sewage discharges in the river also contribute significantly in destroying aquatic habitats and species in concern. Snow trout are reported to be affected by the destruction of their spawning beds[65]. These impacts are significant in the dewatered sections (between the weir and tailrace) of the hydropower projects. More than 20% of the main stem of the Swat River (including Gabral (24%) and Ushu) will have eFlow that will be released from all hydropower projects during the extreme low flow season in certain section of the river.
- **Obstacles in Fish Migration.** The snow carps migrate upstream and downstream in response to water temperature. The proposed hydropower developments in Swat River will construct a series of physical barriers. These structures will have potential to prevent fish species from migrating to cold and semi-cold ecosystems and may fragment their traditional areas of spawning and feeding, leading to changes in the composition of upstream and downstream species.
- **Fish Injury**. Mortality resulting from fish passage through hydraulic turbines or over spillways during downstream migration is unavoidable. Bottom feeders such as Snow trout and Cat fish may be pulled in the intake and killed by the hydropower turbines. Even riverine fish adapted to fast current may be affected.
- **Fisheries.** Trout Fish Farm at Madyan is one of the biggest trout hatcheries in Pakistan. It is located on the Chail Road Madyan Swat. Swati Trout is very famous for their tastes. There are two types of trout species in Swat River, one is snow trout (indigenous) and one is brown trout (introduced species). Brown trout is very delicious, but it is little bit expensive from the indigenous one. Livelihood of many people is dependent on trout either as fishers or work in the hatcheries (both public and private sectors). There have been significant damages in all hatcheries

[65] T.K. Shrestha (2019). Conservation and Management of Fishes in the Large Himalayan Rivers of Nepal (https://www.researchgate.net/publication/266862560_Conservation_and_Management_of_Fishes_in_the_Large_Himalayan_Rivers_of_Nepal.)

during 2022 flood, therefore, fisheries-based livelihood will depend on fish catch in Swat River and hence, measures will be taken to increase fish population in Swat River for the improvement of livelihood.

Table 8-5: Overall Impacts of the Swat Hydropower Development on Aquatic Environment

Direct Impact	Indirect Impact	Secondary Impact	Cumulative	Relevance to the Swat Basin Development
Conversion of a lotic into a lentic pond ecosystem	Fragmentation of habitat (in both feeding and breeding grounds due to reduction of water discharges on the downstream of the weirs)	• Eutrophication of reservoir • Effect of exotic and invasive fish species • Effect on food chain • Effect on fish health and growth	Potential loss of movement path, blockage in inter-connected pathways of migratory fish in the rivers due to the fragmentation of habitats by the barriers, potential extirpation of fish species.	The height of the proposed hydropower weirs is generally less than 15 m (above riverbed) with limited pondage area, and hence impacts associated with water quality changes are not expected to be significant.
The potential downstream riverine environment from the weir to become a dry stretch	• Low flow • Habitat fragmentation • Decrease of spawning bed impacts on fish breeding • Restriction of fish migration • Extirpation of important species	• River aggradation • Increase inshore erosion • Change in water quality		The aquatic environment of about 20% of the main Swat River (including Gabral and Ushu) will be affected by dewatered sections between dam and tailrace and will have environmental flows that will be released from all hydropower projects. About 10% of the Panjkora River will be affected by dewatered sections and will have environmental flows that will be released from all hydropower projects.
Obstruction of fish migration	Impact on fish breeding	Decrease in fish population	Fish breeding is taken place in the Nullahs. The existing fish species migrate to Nullahs from upstream during March to April and September to October, as they are the major source of water as well as breeding and feeding grounds.	Snow trout's migration and its population will be affected. Snow trout and Cat fish migration will be affected by the weir construction

Source: see footnote[66] for the source of first four columns

[66] D.E. McAllister, J.F. Craig, N. David Source: D.E. McAllister, J.F. Craig, N. Davidson, S. Delany, and M. Seddon. 2001. Biodiversity Impact of Large Dams, Background Paper No. 1, Prepared for IUCN/UNEP/WCD

A recent study of the Asian Development Bank[67] has assessed potential impacts of the dams on the snow trout and other species in Nepal rivers, and made the following recommendations based on the review of successful mitigation measures adopted in the Southeast Asia and South Asia regions:

- Projects can take various mitigation measures to facilitate fish movement across dams (such as providing fish ladder, fish passage, natural fish bypass channel.) or
- Compensatory measures to maintain fish population such as (i) breeding fish in hatcheries and annually releasing them upstream and downstream of the weir/dam to maintain their populations, (ii) improvement of spawning grounds, and (iii) catch and haul arrangement.

The study also assessed the effectiveness of environmental mitigation measures adopted in the operation of eight dam projects in Nepal. Despite the implementation of many mitigation measures, the fish population reduced in Kali Gandaki and Babar irrigation project. The main reasons are found to be the lack of adequate monitoring and compliance on the eFlow releases, limited budget for the operation of hatcheries, and non-maintenance of the fish ladders (removal of silt deposits).

The potential cumulative impacts of all hydropower projects on the aquatic environment of Swat River will be minimized and compensated by the construction of fish ladders and their monitoring for their effectiveness, the release of eFlow as per the design to meet the requirement of fish habitats in the dewatered sections, monitoring the effective eFlow regime, and the release of native fish species into the rivers through fish hatcheries. Some hatcheries along the banks of River Swat have already been established by the KP Fisheries Department, one for Mahseer at Chakdara, one for Snow trout at Nagoha Shamozai, and one for Brown trout at Madyan. Some of these hatcheries are destroyed during 2022 flood and require assistance in reconstruction and upgrade to be more efficient and productive.

Actions to Address Cumulative Impacts

PEDO will take the following actions to minimize and compensate for the impacts on aquatic ecology:

- Fish ladders will be built into the design of all weirs in the Swat River to facilitate the movement and migration of fish on both upstream and downstream of the reservoir. The design must be made in consideration of the flow, slope, drops/pool length, and pool wall width. Ladder design must be approved by the fisheries department.
- Year-round functionality of the fish ladder will be ensured by always releasing the water and removing the sediment deposits in the ladder.
- Fish movement and migration through the fish ladders will be monitored regularly to assess their adequacy (using sensors and underwater video cameras) and modify the designs if needed.
- To assess the effectiveness of the fish pass, monitoring mechanism will be implemented.
- The effectiveness of fish ladder operation will be documented in the MHPP to improve the fish ladder designs for other future hydropower projects.
- Appropriate screen devices will be installed at the intake to divert fish from entering water intakes and protect the fish against entrapment.
- eFlow will be assessed based on the requirements of all water users (fish, riparian habitats, drinking, tourism and cultural.) in the dewatered sections (river-reach between the weir and tailrace) of all projects. The power generation of the projects will be optimized based on the requirements of eFlow.
- PEDO will work with the local administration to prevent direct discharge of sewage from urban areas (Madyan, Bahrain and Kalam.) and strictly monitor sewage and solid waste disposal in the streams during the construction phases of all hydropower projects.
- The quality of the water will be monitored from the reservoir and flows from under sluices.
- The Environmental and Social Unit of PEDO will closely work with the fisheries department to foster a mechanism to augment their fish hatcheries for the breeding of Trout and Cat fish and annually releasing them upstream and downstream of the weirs to maintain their population.
- Align with the National Climate Change Policy of 2021 and take appropriate measures to preserve the ecology of de-watered river reaches of the Swat Basin.

[67] Asian Development Bank, 2018. Impact of Dams on Fish in the Rivers of Nepal

- Promote integrated water shed management including ecological conservation practices in uphill watersheds.
- Assess potential threats to the fishing sector in all hydropower ESIA and develop appropriate adaptation measures including the promotion of aqua culture.
- Build capacities of local communities and specifically the Fishermen Cooperative Societies to monitor and report changes in river flow, temperatures, and fish stock movement to help understand impacts of the hydropower construction.

VEC 3: Alluvial Deposits with Excessive Nutrients

Baseline Condition

During expert consultations in October 2022 with the Department of Forest, formation of alluvial deposits and their management came out under discussion and it was advised that the flushing schedule will be coordinated among the powerplants. Dams are widely reported to play a substantial role in sediment trapping because of decreased water current velocity and prolonged retention time. River damming (e.g., construction of dam and weir) and reservoir/pondage operation alter hydrological process, raising concerns over far-reaching influence on fluvial water, biogeochemistry and sediment fluxes due to the common occurrence of fragmented river landscapes around the world.[68] Reservoirs, barriers and weirs make the world a fragmented river landscape, though their numbers are conservatively estimated.[69] While human development gain enormous benefits from reservoirs, recent studies have found that damming rivers has profound effects on flow and freshwater ecosystems by fragmentation, nutrient trapping, and hydrologic alteration.[70] Damming rivers threatens freshwater biodiversity,[71] downstream wetlands, water environment[72] and ecosystem evolution, as well as regulating biogeochemical cycling of nitrogen and carbon.[73] Through the formation of reservoir and pondage in upstream MHPP weir, average sediment load will drastically be reduced by an estimated 59,029 ton/year during the post-MHPP, which accounts for only 13% of the average annual sediment load (454,199 ton/year) during the period of 1961–2020.

Cumulative Impacts

Cumulatively, sediment inflow at eight hydropower reservoirs is estimated as a total of 2.4 million tons **(Table 8-7)** and sediment outflow (i.e., downstream of the MHPP) is estimated as 0.31 million ton, resulting in a total of 2.1 million-ton (or 87%) sediment trapped in the reservoirs/pondages. The reservoir water is geochemically dominated by Ca2+ and HCO3− with low-moderate mineralization and excess nutrients. Concentrations of carbon, nutrients and major ions differ notably in response to reservoir operations with the highest nitrogen level under the sluicing/flushing period (SP). Major cations concentrations are low in the low water level period (LWLP), while major cations and Cl- and SO4-- concentrations reach high in the SP/flushing season. Concentrations of Cl-, SO4--, and Na++K+ increase 2-3-folds, increasing their relative abundance by a factor of 1.5–2.[68] Nutrients show overall increases with considerable alteration of dominance for dissolved and particular species due to damming and anthropogenic inputs. The findings of various studies imply great effects of river damming and reservoir regulation on sediment transport, nutrient levels and major ion chemistry.

Table 8-6: Sediment load in all under planned hydropower projects

Project Name	Sediment Base Load (ton)
Artistic-II	159,114
Asrit-Kedam	621,992
Bankhwar	102,990
Daral Khwar-II	27,483
Gabral-Utror	144,649

[68] Siyue Li, Y. Jun Xu, Maofei Ni (2021), Changes in sediment, nutrients and major ions in the world largest reservoir: Effects of damming and reservoir operation, Journal of Cleaner Production, Volume 318, 128601, ISSN 0959-6526, https://doi.org/10.1016/j.jclepro.2021.128601.
[69] Belletti et al., 2020, More than one million barriers fragment Europe's rivers. Nature 588, 436–441.
[70] Magilligana, F.J., Nislow, K.H., 2005. Changes in hydrologic regime by dams. Geomorphology 71, 61–78.
[71] Barbarossa et al., 2020, Impacts of current and future large dams on the geographic range connectivity of freshwater fish worldwide. Proc. Natl. Acad. Sci. U. S. A. 117, 3648–3655.
[72] Zhang et al., 2019, A framework estimating cumulative impact of damming on downstream water availability. J. Hydrol. 575, 612–627.
[73] Ollivier et al., 2019, Punching above their weight: large release of greenhouse gases from small agricultural dams. Global Change Biol. 25, 721–732.

Project Name	Sediment Base Load (ton)
Gabral-Kalam	254,583
Kalam-Asrit	569,918
Kedam Khwar	49,470
Madyan	454,199
	2,384,400

Actions to Address Cumulative Impact

The regulation of reservoir water level plays a role on nutrient, carbon and geochemical conditions in the reservoir water. Spatially, from the reservoir upstream to downstream, total phosphorus and major ion concentrations displays a declining trend, while dissolved phosphorus and carbon dioxide show an opposite tendency. Long-term accumulation of alluvial deposits in the pondages can increase Cl-, SO4--, Na++K+ and nutrient concentrations, and the excess nutrients are impairing water quality with potential of algal blooming. These accumulations demonstrate that reservoir building and operation play an important role on the transport of sediment, nutrient, carbon and geochemical variables.

It is recommended that PEDO will conduct the following:

- Develop strategies and policy decisions and project level management practices for effective reservoir operation to reduce sediment retention.
- Development of basin-wide best management practices for agricultural nutrient, nutrients for aquatic species and urban sewage control to improve water quality and prevent pollution and harmful algal blooms.
- Monitor nutrients during pre-construction and operation stages to assess potential alteration of dominance for dissolved and particular species due to damming and anthropogenic inputs. Monitoring will be conducted for dissolved inorganic nitrogen. The findings imply great effects of river damming and reservoir regulation on sediment transport, nutrient levels and major ion chemistry.
- Dedicated monitoring programs, which may reveal changes in nutrient dynamics, primary productivity and species composition that were not foreseen at the ESIA preparation stage. PEDO will make a policy decision to extend monitoring requirements for all developers in Swat Basin to have an integrated understanding of the environmental impacts of dams and reservoirs in the Swat River systems. An improved scientific understanding of these environmental impacts is much needed, given that hydropower exploitation can contribute to energy supply and poverty alleviation in economically less developed countries.
- Coordinate with all developers for the establishment of management practices to sequence flushing of desanders and sluicing periods of all hydropower plants in a way so that alluvial deposits and nutrients are not excessively infiltrated in rivers and do not become a threat for downstream ecosystems.

VEC 6: Enhanced Recreation and Tourism due to Hydropower Development

Baseline Condition

Swat district is very rich due to its scenic valleys and pleasant weather in the summer and considered as Switzerland of Pakistan. When summer temperature rises in the plains of Punjab and Sindh, hundreds of thousands of domestic tourists travel to Swat district to cool off in Malam Jabba, Madyan, Bahrain, Kalam, Utror, Mahudhand and hill stations in Upper Swat. Tourist influx in Malam Jabba and Kalam together during August 2021 to July 2022 was estimated as 178 foreigners and 1,121,926 domestics.[74] Table 8-8 presents a trend of tourist's growth since 2017 in Kalam and Malam Jabba. There has been an annual growth of about 28% since 2017. Construction of Swat Motorway provided faster access to these sites and has been instrumental for the growth of tourists in Swat district.

[74] KP Tourist Influx State, August 2021 – December 2022, Government of Khyber Pakhtunkhwa.

Table 8-7: Trend of tourists in Kalam and Malam Jabba

Year	Current Tourists	
	Foreign	Domestic
2017		417,950[75]
2018		534,976
2019		684,769
2020		876,505
2021	178	1,121,926

The winter tourism has witnessed great boom in Kalam and Malam Jabba after construction of Swat Motorway, which made a positive impact on tourism related businesses in Swat district where a record 1.5 million tourists had visited during Eidul Azha's holidays in 2021 in all destinations. Hotels and transport sectors have witnessed a great boom in Khyber Pakhtunkhwa where a record Rs 66 billion revenue generated and Rs 27 billion businesses achieved by the rural economy following the arrival of record 2.77 million tourists during two Eid vacations in 2021.[76] **Figure 8-7** show the winter festival and ski resort in Malam Jabba[77].

Figure 8-7: Ski resort in Malam Jabba

Kalam is blessed with 50 lakes including the famous Mahodand lake covering two-kilometer area and 2,865 m above the mean sea level at Usho valley, attracting tourists and snow lovers from across Pakistan and limited number of foreigners in winter season. Kalam's adjoining scenic hilly area (including Matiltan, Ushu, Utror, Gabral and Mohdand-Kundol lakes) hotels are jam-packed with tourists amid hide and seek between sun and clouds besides snowfalls over the mountains taking them into state of ecstasy. Besides the splendid natural beauty, Swat is a home to Ghandhara civilization and archeo-religious sites, attracting tourists, archeologists, Buddhists and monks from across the world to explore its archaeological treasures. KP Government has decided to setup camping pods projects in 10 new scenic places and search for five new suitable sites are in progress. A tourism survey in all seven tribal districts of merged areas has been conducted for establishment of camping pods, picnic spots, making tourism areas accessible through roads connectivity, rest houses, tourism and cultural activities, organizing festivals and many other planned schemes will make erstwhile Swat valley a hub of tourism (see **Figure 8-8**).

[75] QSEBCON (2018) Business / Entrepreneurship Development through Tourism Promotion in Punjab and KP, The World Bank.
[76] Daily Times, January 3, 2022, https://dailytimes.com.pk/863244/kalam-malam-jabba-attract-snowfall-lovers-as-winter-tourism-gets-boom-in-swat/
[77] Source: https://www.insaf.pk/tabdeeli-ka-safar/tourists-attended-snow-festival-malam-jabba

Figure 8-8: Malam Jabba during winter Cumulative Impacts

Hydropower Projects can attract many tourists due to the formation of waterbodies, boating in the reservoir, public viewing of fish migration through fish ladders, and fishing activities, if hydropower facilities are designed for the tourism[78]. It is assumed that hydropower projects and associated waterbodies will attract an additional 5% growth of tourists per year, plus the current growth trends of 28% due to the construction of Swat Motorway and other roads and establishment of tourist facilities. The forecasted number of tourists visits to Kalam and Malam Jabba are presented in Table 8-8. It is not out of subject to mention that there are huge potentials to attract foreign tourists, however, this can only be possible through improved security and safety of foreigner.

Table 8-8: Forecasted tourists in Kalam and Malam Jabba

Year	Forecasted Tourists		Revenue (In billion PKR)[79]
	Foreign	Domestic	
2027	530	3,343,339	197
2028	589	3,713,575	218
2029	648	4,083,811	240
2030	707	4,454,046	262
2031	765	4,824,282	284

Source: PIC Estimates, 2023

Actions to Address Cumulative Impact

Department of Tourism shown interest to cooperate with PEDO to harmonize tourism with hydropower development. Harmonization between KITE initiatives of Department of Tourism with PEDO's Khyber Pakhtunkhwa Hydropower & Renewable Energy Development can boost tourism sector in generating revenue for the businesses and government in the form of bed and sale taxes. Swat district has many rivers, mountains, and wetlands offering scenic vistas to nature lovers and eco-travelers, backpackers, birdwatchers, skiers, and fishers. To attract more tourists and benefit the culture and tourism sector, PEDO with the support of tourism department can engage in the following:

- Dams and rivers with their unique scenery and special attractions, have great potential to grow and develop hydro tourism of Khyber Pakhtunkhwa. Promote the perception that hydropower reservoirs could represent a source of value added to the communities through the development of tourist projects (Figure 8-9).
- The ancillary infrastructures during hydropower development, such as, access road, contractor's facility, essential for the implementation of the hydropower development, are the main vectors of tourism development in mountain

[78] *Source*: https://www.bolnews.com/latest/2022/02/the-malam-jabba-affair/

[79] Forecasted total generated revenue from tourism in Khyber Pakhtunkhwa

valleys. Most of these infrastructures can be designed with durability and can be extended for the use by the tourists in high altitude. The roads can become major links for tourist flows and worksite contractor's housing can be converted into mountain refuges or chalet-hotels offering accommodation to numerous hikers and skiers. This can give rise to a type of high mountain mass tourism, with such accommodation providing the logistical support that is indispensable in this respect. At the same time, the infrastructures can become a means to change the way in which high mountain landscapes are regarded and are testament to the close links that exist between the exploitation of natural resources and tourism development.

- Establish service area, toilet, tuck shop, look-out (selfie points) with eco-tourism concept.
- Develop designated covered public viewing area along the fish ladders in all hydropower plants.
- Develop boating and fishing facilities and sell controlled fishing license in the reservoir area.
- Provide improved security and safety of foreigner. Provincial Government must work with the Federal Administration to ensure the security through check-posts, engagement of enhanced security forces in the tourist places, and international standard accommodation, and tourist attractions.
- The ancillary infrastructures during hydropower development, such as, access road, contractor's facility, essential for the implementation of the hydropower development, are the main vectors of tourism development in mountain valleys. Most of these infrastructures can be designed with durability can be extended for the use by the tourists in high altitude. The roads can become major links for tourist flows and worksite contractor's housing can be converted into mountain refuges or chalet-hotels offering accommodation to numerous hikers and skiers. This can give rise to a type of high mountain mass tourism, with such accommodation providing the logistical support that is indispensable in this respect. At the same time, the infrastructures can become a means to change the way in which high mountain landscapes are regarded and are testament to the close links that exist between the exploitation of natural resources and tourism development.
- Hydro or water tourism involves traveling to places specifically to take part in water-based activities. Some individuals who do not wish to partake in water-related activities embark on water tourism trips so that they can visit tourist sites that sit close to bodies of water such as lakes, rivers and dams. Water tourists are regularly independent travelers, although some travel businesses do organize group trips. Water trips occasionally involve inland destinations such as lakes and rivers. Holidaymakers can sail or swim on lakes while many rivers are ideally suited to white water rafting. Additionally, some leisure businesses operate water parks that contain swimming pools, water slides, and areas for kayaking or canoeing.

Source: https://www.colbun.cl/en/corporate/community-and-society/programs-and-social-projects/hydro-tourism

Figure 8-9:Tourism in hydro reservoir

8.4 Existing Legal and Institutional Framework

8.4.1 CIA Governance Gaps

Pakistan has no policy or legal framework for CIA and no regional planning or collaborative resources management mechanisms. In such a scenario, following two step procedures were followed:

- Identify and use any sources of partial information about policy or regulatory limits to development (e.g., policy statements, strategic or sectoral assessments, national and/or regional development actions plans and targets, including those referenced under international agreements and conventions); use sustainability, irreplaceability, and vulnerability as proxies to define acceptable limits for all policy and regulatory gaps. Nationally available technical expertise was utilized to understand and apply sustainability and vulnerability concepts in CIA, and

- Share CIA purpose, process, and requirements with government and third parties early on and discuss their participation in CIA (including implications and benefits of participating in this process); discuss environmental and social permitting requirements with government authorities and ensure ESIA and CIA provide the government with the information it needs for decision making; assess the level of involvement feasible for the government and third parties (private developers) and reach agreement with them about their participation and their roles and responsibilities; encourage the participation of government, third parties, and representatives of affected communities in scoping, review of CIA findings, proposed management strategies, and impact monitoring.

8.4.2 Roles and Responsibilities by Parties

Gaps between national regulatory framework and international guidance can be identified by comparing the ideal scenario presented in Table 8-9 with the actual situation for a proposed development. In general, there are two approaches for managing gaps in roles and responsibilities. First, clarify and gain acceptance for all roles and responsibilities: clearly define the roles and responsibilities of the client as opposed to those of government, third parties, affected communities, and the public, and ensure the parties understand their roles. Second, as part of the CIA engagement process, make sure to communicate the established roles and responsibilities widely - inform stakeholders, NGOs, and other potentially interested groups from within and outside the project's AOI and the region.

Table 8-9: Roles and Responsibilities of Participants in CIA under Ideal Governance Conditions

Roles and Responsibilities by Party	Scale	Purpose
Government		
▪ Establish policy and legal framework for resource management and cumulative impact management. ▪ Establish and lead regional planning structures and collaborative mechanisms for managing and mitigating (e.g., aggregated offset strategies) resource developments and cumulative impacts. ▪ Implement permitting process that considers cumulative impacts of all developments and pressures and conforms to values and limits given regional plans and national frameworks. ▪ Design and conduct CIA study of geographic area which includes the baseline (historical) conditions and predicts the future baseline, based on the carrying capacity of the VECs. ▪ Issue approvals to individual private sector projects to be developed on the basis of this information. ▪ Lead development and implementation of regional cumulative impact monitoring program that analyzes development pressures and impacts at regional scale and compares results to values and/or acceptable limits for resource development.	National, Provincial, regional, and/or local.	▪ Define values and acceptable limits for resource development. ▪ Define locations for acceptable types and limits of developments. ▪ Identifies contribution of each development to cumulative impacts in the region gives public and proponent assurance that proposed developments are within acceptable limits set by legal framework and regional plans and processes. ▪ Gives information on state of VECs in region and assurance that cumulative impact values and development objectives are being met; provides database for project-level CIA and makes sure this information is freely and publicly available.

Roles and Responsibilities by Party	Scale	Purpose
Private Sector Project Proponent		
▪ Design and conduct CIA study of the incremental impacts of the project building on the CIA study conducted by the government. Monitor and manage cumulative impacts and risks related to the development for its life span. ▪ Provide project-level cumulative impact monitoring data to regional cumulative impact monitoring program. ▪ Support regional planning structures and collaborative mechanisms for managing cumulative impacts to prevent their limits from being reached; actively participate as needed in collaborative systems with government, private sector and public.	Provincial, Regional, local, and/or site.	▪ Gives financial institutions and decision makers information about cumulative impact for evaluating the project. ▪ Conforms to CIA commitments and/or permit conditions; manages development to prevent it from causing VECs to reach limits. ▪ Gives the government project-related cumulative impact data it needs to manage the uncertainty of impact predictions and prevent VECs from reaching limits. ▪ Enables effective monitoring and management of cumulative impacts at appropriate scale; supports collaborative multi-stakeholder solutions for CIA.
Third Parties (existing and future developments and/or resource users)		
▪ Similar to proponent but covering existing or future developments. ▪ Assess and manage cumulative impacts of existing developments. ▪ Assess and manage cumulative impacts of any future developments; prepare ESIA and CIA for permit decision makers if needed. ▪ Collect and provide data for regional cumulative impact monitoring program. ▪ Participate in regional planning structures and collaborative. mechanisms for managing CIA at regional or larger scales.	Regional, local, and/or site.	▪ Provides project proponents and other developers, decision makers and regional monitoring program with details about impacts of existing developments. ▪ Provides proponent and other developers, government and other stakeholders with details about proposed developments (i.e., project description, impact analysis, ESIA/CIA). ▪ Provides project-level data needed for regional cumulative impact monitoring program. ▪ Enables effective regional management of cumulative impacts; supports collaborative multi-stakeholder process.
Affected Communities and Public		
▪ Public participates in value setting for policy and/or legal frameworks and regional resource management plans. ▪ Affected communities participate in CIA of individual projects. Public participates in collaborative management of cumulative impacts.	Regional, local, and/or site.	▪ Ensures regional resource development limits and conditions reflect public values. ▪ Allows values of affected people to be reflected in scoping and valuation of project-level CIAs. ▪ Fosters public ownership of cumulative impact management objectives and results.

Source: IFC Good Practice Handbook of CIA

9 Environmental and Social Management Plan

This chapter describes how the identified impacts and risks (refer to Chapters 8 and 9,) will be managed, with mitigation and control measures as well as monitoring. The ESMP is organized by management plans, institutional setup, capacity building and training, and presents key monitoring and performance indicators.

For each topic, this chapter identifies mitigation and control measures. Where feasible, the mitigation hierarchy and hierarchy of controls are followed. The following sections present management measures and monitoring requirements for the impacts and risks.

9.1 Contractors' Qualification

It is recommended that all contractors procured under the Project be compliant with ISO 9001 Quality Management, ISO 14001 Environmental Management, and ISO45001 Occupational Health and Safety Management. This will be achieved by PEDO imposing the requirements of ISO certifications during prequalification or technical evaluation of contractors. In addition, all subcontractors under the major contractors will also be subject to ISO 14001 and ISO45001 audit provisions by the main Contractor during the course of the Project.

9.2 Various Mitigation and Control Measures

The ESMP includes different types of mitigation and control measures and subplans for significant impacts and risks: (i) Project-specific and, to the extent possible, site-specific mitigation measures for major and higher impacts and risks are presented in Chapter 7 and 8 (ii) general and non-site-specific measures in the form of Environmental and Social Codes of Practices (ECPs) presented in **Annex-I** to address general construction and operation matters; the ECPs are to be used by the Contractor along with the mitigation measures provided in Chapter 7; (iii) construction environmental and social management plan (C-ESMP) with site-specific and contract-specific management plans to be prepared by the Contractor; (iv) OCHSMP Management System Processes and Standard Operating Procedures to be prepared by the Contractors, a framework is presented in **Annex-III**; and (v) proposed plans in this ESMP to address significant and cumulative impacts (identified in Chapter 8).

9.3 Environmental and Social Codes of Practices for Construction

The ECPs will provide guidelines for best-operating practices and environmental management guidelines to be followed by the contractors for sustainable management of all environmental and social issues. These ECPs have been prepared based on the experiences in the construction of hydropower projects, including World Bank-funded hydropower projects in Pakistan and also in conformity with the WBG EHSGs and Good International Industry Practices. The ECPs are presented in **Annex-I** and will be included in the bidding and contract documents to ensure their implementation.

The list of ECPs prepared for the Project is given below.

- ECP 1: Waste Management
- ECP 2: Fuels and Hazardous Goods Management
- ECP 3: Water Resources Management
- ECP 4: Drainage Management
- ECP 5: Soil Quality Management
- ECP 6: Erosion and Sediment Control
- ECP 7: Topsoil Management
- ECP 8: Topography and Landscaping
- ECP 9: Quarry Areas Development and Operation
- ECP 10: Air Quality Management
- ECP 11: Noise and Vibration Management
- ECP 12: Protection of Flora
- ECP 13: Protection of Fauna
- ECP 14: Protection of Fish

- ECP 15: Road Transport and Road Traffic Management
- ECP 16: Construction Camp Management
- ECP 17: Cultural and Religious Issues
- ECP 18: Workers Health and Safety
- ECP 19: Construction and Operation Phase Security

9.4 Constructor’s Environmental and Social Management Plan

The Contractor will prepare a ‘Constrictor’s Environmental and Social Management Plan’ (C-ESMP) demonstrating the manner in which they will comply with the requirements of Site-Specific Management Plans, ECPs and the mitigation measures proposed in this ESIA Report. The C-ESMP will be submitted before the start of any construction activities (maximum of 90 days) or Contractor’s mobilization and be approved by the Engineer/Project Implementation Consultant. The C-ESMP will form part of the contract documents and will be used as supervision tool for compliance. Violation of the compliance requirements will be treated as non-compliance leading to the corrections or otherwise imposing penalty on the Contractor. The following sub-plans will be part of C-ESMP;

1) Tree plantation plan
2) Traffic Management Plan
3) Sustainable Water Supply Management and Monitoring Plan (SWSMMP)
4) Blasting Management Plan (Annex-II)
5) Occupational Health and Safety management Plan (OHSMP)
6) Emergency Response Plans
7) Camp Management Plan
8) A Fish Management Plan (Annex-II)
9) Waste management plan
10) Spoil Management Plan
11) Consultation Plan
12) Vibration Monitoring Plan
13) Labor Influx Management Plan.
14) Undertake tunnel risk assessment (TRA), prepare and implement environment, health and safety (EHS) plan for tunnel and powerhouse works as well as emergency response plans.

9.5 Occupational and Community Health and Safety Plan

The Contractor will also prepare an Occupational and Community Health and Safety management (OCHSMP Plan OCHSMPMP) devising the general guidelines for the identified hazards and control measures along with the OHS Management Processes and Standard Operating Procedures presented in **Annex-III** of this ESIA. The OCHSMP shall comply with World Bank General Environmental Health and Safety Guidelines, Chapter 2: Occupational Health and Safety, 2007; KP OHS and Labor Acts; and ILO Safety and Health in Construction Industry, 2022, Safety and Health in Construction Industry. If the guidelines stated before cannot address a specific OCHSMP management in the project, Good International Industry Practices, such as OSHA and ISO45000 and ISO 45001, will be applied. Review and update of the OCHSMP plan will be carried out,

a) when there is a change in the scope of the project,
b) there is a change in construction methodology/technique based on site condition,
c) following significant OCHSMP hazard or a major incident, and
d) at the end of the Project (to allow for improvements in subsequent projects).

OCHSMP Plan will contain general guidance for all identified hazards under each work activities. It also contains management system processes and standard operating practices. Processes and SOPs will be presented in three discrete headings, (a) Contractor’s Standards on the identified hazard management, (b) Expected Site specific OHS hazard and risks during construction, and (c) Control Measures proposed by the Contractor.

9.6 Inclusion of Relevant Components of ESMP in Contract Documents

The ESMP of the Project along with the ECPs and occupational hazards and risks will be included in the contractors' bid and contract documents. The technical specifications of the bid and contract documents will clearly state that contractor will need to comply with the mitigation and control measures provided in the ESMP, ECPs, OHS Plan, World Bank Group EHS General Guidelines and NEQS.

PMO will include the following Environmental, Social, Health and Safety (ESHS) Conditions in the bidding and contract documents:

- Past performance of the Contractor on ESHS aspects including sexual exploitation and abuse and gender-based violence;
- ESHS Staff with the Contractor;
- Performance Security;
- Mitigation measures to address construction impacts;
- Payments for implementation of ESHS measures;
- Code of conduct of Contractor's Personnel;
- Management Strategies and Implementation Plans (MSIP) to manage the ESHS Risks.

Each of the above conditions is elaborated in

Table 9-1**.**

Table 9-1: ESHS Conditions in the Bidding Documents

Condition	The rationale for the inclusion of this Condition in the Contract	Specifications to be included in the Bidding Documents	Responsibility	
			Bidders	PMO
1. Past performance of the Contractor on ESHS is one of the eligibility criteria for the shortlisting process	The contractor's past performance on compliance with ESHS is an indicator of the contractor's commitment and capability for implementation of the ESMP	• The Bidder shall "declare any civil work contracts that have been suspended or terminated and/or performance security called by an employer for reasons related to the non-compliance of any environmental, occupational health and safety or social (including sexual exploitation and abuse (SEA) and sexual harassment (SH) or health or safety requirements or safeguard in the past five years."	Bidder to make the Declaration and include copies of signed certificates from the ongoing and ex-clients.	PMO use this information to seek further information or clarifications in carrying out its due diligence

Condition	The rationale for the inclusion of this Condition in the Contract	Specifications to be included in the Bidding Documents	Responsibility	
			Bidders	PMO
2. Contractor shall propose adequate ESHS staff in his team	The Contractor's staff will include an ESHS Manager who is responsible for the implementation of all mitigation measures on ESHS risks and compliance with ESMP with the following support staff (i) Environmental Officer, (ii) OHS Officer, (III) Social Officer, and (iv) adequate ESHS Site Supervisors	• The bidder shall propose adequate EHS staff, which shall include at a minimum an International EHS Manager, an Environmental Specialist, an OHS Specialist, a Community Relations Officer, one Social Specialist (including SEA/SH), 6 EHS Supervisors, 9 flagmen, 2 PMC registered Medical Doctors, and 2 Medical Technicians. • • The Bidder shall provide details of the proposed International EHS Manager, including academic qualifications and work experience. • The EHS Manager will have a minimum bachelor's degree in engineering or a master's degree in sciences related to environmental management with 15 years of international experience including hydropower construction and acceptably fluent in the English language. The Specialist will have 10 years of experience working on monitoring and managing ESHS risks related to hydropower projects.	The bidder to submit the CV of the proposed staff	PMO will review and approve
3. Contractor shall submit ESHS Performance Security for compliance with ESHS obligations	The Contractor will have a financial implication if he could not comply with ESHS requirements. Hence performance security will be collected from the contractor	• The Bidder shall submit the ESHS Performance Security in the form of a "demand guarantee" in the amount of three percent (3%) of the Contract amount.	The bidder will submit a Performance Security	

Condition	The rationale for the inclusion of this Condition in the Contract	Specifications to be included in the Bidding Documents	Responsibility	
			Bidders	PMO
4. Implement Mitigation Measures to Address Construction-Related Impacts given in ESMP	The mitigation measures to address potential ESHS risks and impacts will be included in the bidding documents. The contractor shall be made responsible for the implementation of the mitigation measures through the necessary conditions in the contract.	PMO will include Table 9-1 (on environmental permits), Table 9-3 (measures during pre-construction), Table 9-4 (measures during construction), Table 9-5 (monitoring measures during construction) and ECPs (**Annex-I**) of the ESMP in the General Specifications of the Bidding Document, and the reference to these tables will be provided in the Conditions of the Contract as follows: • The Contractor shall implement the mitigation and monitoring measures given in the ESMP to address ESHS risks associated with the construction works. The Consultant shall refer to the ESIA of the Project, which is available on the PEDO website for further guidance. • The Contractor shall comply with the World Bank Group's General Environmental Health and Safety Guidelines and Environmental and Social Code of Practices (**Annex-I**)		PMO will include this condition in the bidding document
5. Payments for implementation of ESHS Mitigation and Monitoring Measures	BOQs on ESHS implementation are included in the Bidding Documents	• The budget will be allotted for the preparation and implementation of C-ESMP (including OCHSMP plans), and monitoring plans. The items given in the ESMP budget will be included in the BOQ, and the bidder shall quote the amount against these items.	Bidder will quote for the ESHS Management	PMO will include this in the general specifications of the bid document
6. Code of Conduct for Contractor's Personnel	All workers hired by the Contractor will sign a code of conduct to ensure compliance with ESHS obligations of the Contract	The Bidder shall submit the Code of Conduct that will apply to the Contractor's employees and subcontractors. The Code of Conduct will state that the workers will comply with the following ESHS requirements: • Wearing of Personal Protective Equipment (PPE) in the workplace at all times	Bidder shall submit Code of Conduct with the bid documents	

Condition	The rationale for the inclusion of this Condition in the Contract	Specifications to be included in the Bidding Documents	Responsibility	
			Bidders	PMO
		• Non-discrimination in dealing with the local community by race, ethnicity, gender, religion, disability, sexual orientation, gender identity, social, or health status • Respectful attitude while interacting with the local community • Prohibit sexual harassment, particularly towards women and children • Prohibit violence, including SEA/SH • Respecting the reasonable work instructions • Protection and Proposer use of the property • Awareness raising, communication and dissemination of information campaigns for employees, workers and communities residing in AOI on SEA, SH and GRM.		
7. Contractor's Management Strategies and Implementation Plans (MSIP) to manage the ESHS Risk	The Contractor proposal will include his/her understanding of the ESHS requirements of the project and the proposed strategies to manage the ESHS risks	The Bidder shall submit Management Strategies and Implementation Plans (MSIP) to manage the following key ESHS risks: • Strategy for the protection of workers and community from the construction-related hazards inside the terminal • Pollution prevention (wastewater, air and noise emissions) and management • A waste management plan for proper collection and disposal of waste • Traffic management plan to ensure the safety of local communities from construction traffic	The bidder will submit MSIP along with the Bid Documents	

Condition	The rationale for the inclusion of this Condition in the Contract	Specifications to be included in the Bidding Documents	Responsibility	
			Bidders	PMO
		• Hazardous material management plan safe storage and handling • Strategy to address labor influx impacts on the local communities • SEA/SH prevention and response action plan • Emergency response plan and early warning system The Contractor shall be subsequently required to submit (before mobilization) Contractor's Environment and Social Management Plan (C-ESMP) by the above strategies and Condition 4 of this Table.		

9.6.1 BOQs & Bidding Documents

The following items will be included in the bills of quantities (BOQs) of bidding documents

- After the award of the contract and before mobilization, the Contractor will prepare and submit two separate plans, C-ESMP and OCHSMP Plan in compliance with this ESIA, World Bank Group (WBG), Environment, Health and Safety (EHS) Guidelines and NEQS. The preparation and their revisions and updates will also be quantified and presented as line items in the Contract.
- Quantities of personal protective Equipment (PPE) for all project staffs (including contractor, PMO, the Engineer/PIC and M & E Consultant), first-aid boxes, ambulance, health care facility with Pakistan Medical Commission licensed doctors and nurses.
- Provision of Environmental and OHS Staffs for the entire construction period. Detail staff requirements are presented in Section 9.7.6.
- Providing and maintenance of Dust Measurement Meters for spot measurements (3 number).
- Spot monitoring of atmospheric parameters (O2, CO, H2S, CO, CH4, and Crystalline Silica) inside tunnel.
- Quarterly 24-hour Ambient Air Quality Monitoring of PM_{10}, $PM_{2.5}$, NO_2, SO_2, and CO at 5 locations.
- 15 minutes continuous noise monitoring at 5 sites close proximity of settlements during the construction work.

9.6.2 Job Hazard Analysis

Job hazard analysis (JHA) will be conducted by Contractor for each construction component focusing on job tasks as a way to identify hazards before they occur. It will focus on the relationship between the worker, the task, the tools, and the work environment. Ideally, after identifying uncontrolled hazards, steps will be taken to utilize hierarchy of control: elimination, substitution, engineering controls, administrative controls and personal protective equipment, to minimize them to an acceptable risk level. Many workers are injured and killed at the worksite every day. The JHA will be one of the major components of the larger commitment of the Contractor's health and safety management system. The JHA will be conducted on many jobs in the worksite. Priority will be given to the following types of jobs:

- Jobs with the highest injury or illness rates;

- Jobs with the potential to cause severe or disabling injuries or illness, even if there is no history of previous accidents;
- Jobs in which one simple human error could lead to a severe accident or injury;
- Jobs that are new or complex to the construction or have undergone changes in construction processes and procedures; and
- Jobs complex enough to require written instructions.

9.6.3 EHS in Method Statement

The Contractor will include an EHS Chapter in each Method Statement. This EHS section will be based on the JHA and other provisions of OHS Plan and environmental issues of the site and specific to construction methods to be followed by the Contractor. This section will be reviewed by the EHS Specialists of the Project Implementing Committee (PIC) and confer approval along with other technical parameters to be reviewed by the engineering team of the PIC. Each revision of the method statement shall also be reviewed by the EHS Specialists and their concurrence will be required to get the method statements approved.

9.6.4 Payment Mile Stones

Payments to contractors will be linked to environmental, health and safety performance, measured by completion of the prescribed environmental and social mitigation measures in the C-ESMP and control measures described in the OHS plan. In addition, for any non-compliance causing damages or material harm to the natural environment, workers, public or private property or resources, the Contractor will be required to either remediate / rectify any such damages in a timeframe specified by and agreed with the engineer (PIC), or pay IA for the cost (as assessed by IA) of contracting a third party to carry out the remediation work. For repeated non-compliance the Contractor will be penalized. The penalty of non-compliance of the requirements of the CESAP and OHS Plan will be 3% of the total Civil Works in the Interim Payment Certificate (IPC). The penalty will be imposed after all contractual instruments are applied and a Non-compliance Report (NCR) is issued by the Engineer.

9.6.5 Field Engineer's EHS Oversight

There will only be a select number of supervision staffs available in EHS to cover all project sites and project shifts in the project. Therefore, it will be extremely difficult to supervise and monitor EHS parameters in every site in a continuous basis. Hence, site engineers can be delegated certain EHS oversight. Engineers monitoring forms including Request for Inspection/ Availability for Inspection (RFI/AFI) and Daily Monitoring Forms and checklists will be designed to include EHS aspects. EHS will be made also a key responsibility of site engineers.

Training program will be devised by PIC on engineers' oversight in EHS and will be offered by EHS specialists of PIC to address EHS immediately when identified and raise it to EHS specialists if further action is required. The training on engineers' oversight will convey the following messages:

- Engineers would assume greater responsibility for overseeing the EHS as part of their daily routine work, Engineers would review and approve each site's readiness to commence the work as per the design specifications, certifying whether Contractors are meeting the requirements of the Method Statements, and withholding funds from them that are not complied with.
- Engineers would impose financial penalties on the Contractor with non-existent or non-compliant EHS matters; and

  Engineers will assist workers in recognizing environment friendly and safe work measures and procedures necessary to protect the natural environment and occupational health and safety of workers and prevent illnesses, injuries and fatalities during construction.

9.6.6 Request for Inspection

Poor temporary structures such as scaffold, access walkways, stairs, and ladders are some of the major causes of the accidents in construction industry. For technical verifications of the temporary structures, specifications in the bidding documents define the material, stability, strength and deflections of each temporary structure.

However, this clause is often ignored in construction industry as the main focus is the permanent structures. Therefore, Request for Inspection (RFI) or Availability for Inspection (AFI) for temporary structures will be required, as a pre-requisite for the readiness of site. Along with the technical requirements (e.g., complete drawings, calculations relating to stability, strength, and deflections), health and safety parameters will also be inspected for all temporary structures. During these RFI/AFI, both technical and EHS personnel of the PIC will inspect the requirements and certify the technical quality and the readiness of the site to commence the permanent work.

9.7 Institutional Arrangements for ESMP Implementation

9.7.1 Project Management Office

Pakhtunkhwa Energy Development Organization (PEDO) is the implementing agency of the Project. PEDO has already established a Project Management Office (PMO) to monitor and coordinate all project implementation activities. PMO will be responsible for the procurement, two consulting teams, one for construction supervision and the second one for monitoring and evaluation (M & E). The PMO is headed by the Project Director (PD) and includes an Environment and Social Unit (ESU). PMO will be responsible for the following:

- Ensure that all project activities are well-managed and coordinated.
- Procurement of works and goods.
- Payment of compensation to the project affectees prior to the mobilization of the Contractor.
- Recruitment and supervision of Project Implementation Consultants (PIC) /The Engineer.
- Recruitment of third-party M & E Consultant.

The Institutional arrangements for the implementation of ESMP are given in **Figure 9-1.**

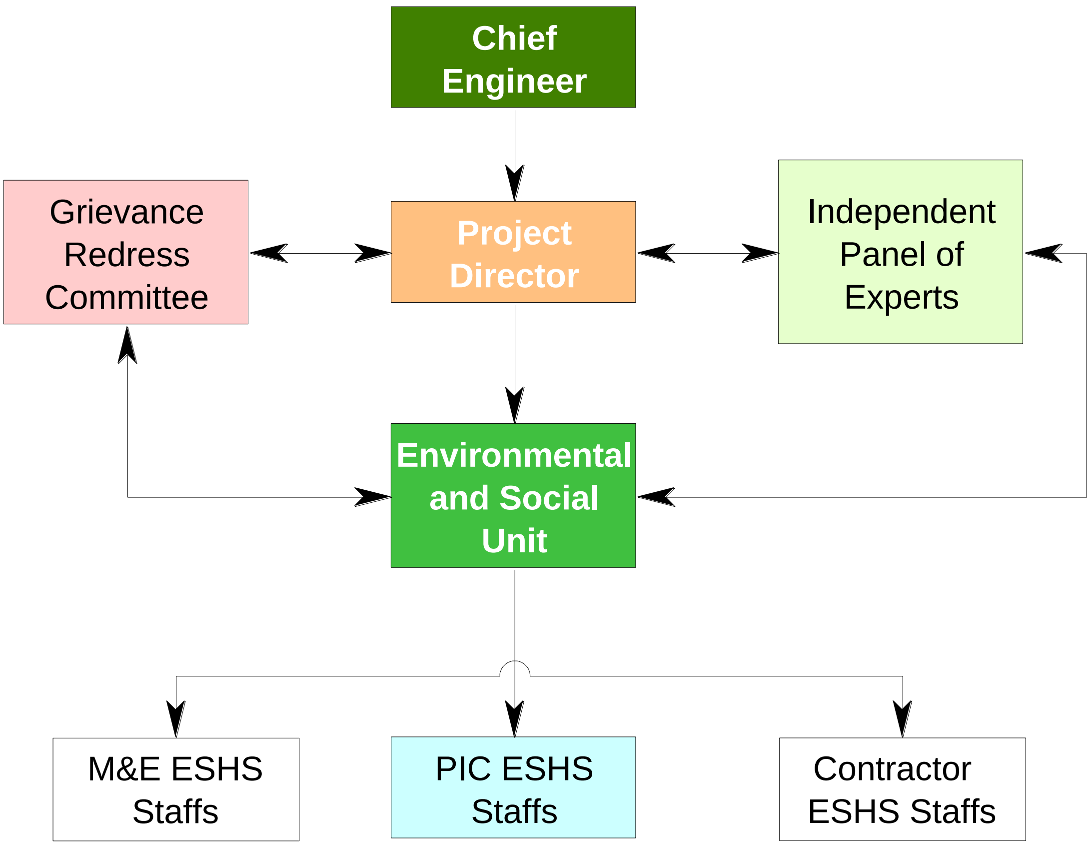


Figure 9-1: Organogram for Environmental and Social Management of the Project

9.7.2 Environmental and Social Unit/PMO

PEDO has an existing 'Environmental and Social Unit, for the management of environmental and social impacts of the Program. PEDO will depute these specialists to PMO to ensure the effective implementation of ESMP. Details of environmental and social staffs are summarized below:

- Two Directors (one for the environment and one for social)
- Three Deputy Directors (one each for the environment, OHS, Social Development)
- Six Assistant Directors (two per each Deputy Director)

The responsibilities of the environmental and social staff of ESU are:

(i) supervising, facilitating and coordinating the implementation of environmental, social, health and safety plans and RAP;
(ii) inclusion of ESMP in the contract documents and preparation of relevant specifications and conditions, and review the bidding documents
(iii) ensuring that contractors follow KP EPA regulations, World Bank Safeguard Policies, and other requirements mentioned in the ESMP and RAP;
(iv) identifying any issues of non-compliance and report them;
(v) suggesting mechanisms to link contractor performance in relation to the ESMP at the time of Interim Payment Certificate, incentives or penalties;
(vi) interacting with stakeholders for their concerns about the construction activities,
(vii) development of social development programs,
(viii) implementation of livelihood restoration and improvement plan, and
(ix) prepare quarterly monitoring reports on ESMP implementation.

9.7.3 Project Implementation Consultant or the Engineer (PIC)

The Project Implementation Consultants (PIC) will act as the Engineer. The PIC will be responsible for supervising the contractors for the implementation of C-ESMP. For this purpose, the PIC will appoint dedicated environmental, social, health and safety (ESHS) staffs to ensure the implementation of environmental and social management plans during the project. They will supervise the contractor for the ESMP implementation, particularly the mitigation and control measures. They will also be responsible for implementing the monitoring of the effects of these measures.

PIC will have the following environmental and social safeguard staffs during construction:

- Environment Expert
- Chief Social and Resettlement
- Resettlement and Social Development Specialist
- Resident OHS and Safety Specialist
- Assistant Resident Engineer LADP / Social Development Specialist
- Gender Specialist
- Assistant Engineer Health and Safety
- Social Development Expert
- Junior Environmentalists/HSE
- Jr. Sociologists
- Environmental, Social, and Health and Safety (ESHS) Inspectors (six staff)

The ESHS staff of PIC will closely supervise the construction works to ensure that all ESHS commitments are incorporated into the construction activities and work processes. Specific responsibilities of these staff include:

- Supervising and supporting contractors in achieving their responsibilities as outlined in the C-ESMP
- Review and approve the Contractor's site-specific plans on C-ESMP and OCHSMP Plan
- Regular safety audits at the worksites;
- Issuing engineer's instructions and non-compliance report to the contractors
- Providing input, advice, and approval on activity-specific work plans relating to C-ESMP and OCHSMP Plan
- Supervising the implementation of activity-specific work plans

- Regularly reviewing and assessing ESHS risks throughout the construction phase;
- Identifying and preparing environmental and OCHSMP induction and training materials;
- conducting ESHS trainings;
- Assist PMO in addressing and resolving ESHS complaints and grievances
- Responding to environmental incidents as required;
- Managing compliance reporting as it relates to the Project, and preparing monthly ESHS compliance reports; and
- Liaise with PMO for effective environmental, social, health and safety management at the site;

9.7.4 Monitoring and Evaluation Consultant

The Monitoring and Evaluation Consultant (M & E Consultant) support in project management and carrying out day to day activities of PEDO. M & E Consultant will support various departments of PEDO in operation of a variety of functions:

- Oversee Budgetary and financial Management;
- Prepare and assist in implementing Quality Control and Quality Assurance Plan;
- Provide contractual advice, variation orders, and settlement of disputes claims;
- Support in implementation of the safeguard plans.
- Independent monitoring of the implementation of C-ESMP.
- Carry out annual third-party auditing of C-ESMP and OHS Plan and make further modifications if required.

The M & E Consultant will have the following specialists:

1. Team Leader/EHS Specialist
2. Environmental Specialist
3. OHS Specialist
4. Social Specialist
5. EHS Supervisors
6. Social Surveyors

9.7.5 Planning Consultant

The Planning Consultant will work for the overall Program of KHRE to develop a Comprehensive Plan for Hydropower and Energy Systems in KP through:

(i) Assessment and Appraisal of potential hydropower and alternative renewable energy sites in KP, and preparation of a long-term integrated plan for development of renewable energy and hydropower resources in the province, and

(ii) (ii) Sequencing of the investment program over 10 years, 20 years and 30 years periods considering priorities, objective agreed criteria, demands and implementation constraints. and electricity price for the generators and consumers. The Consultant will also carry out feasibility studies for some priority subprojects.

9.7.6 Contractor

The contractor is also required to appoint the following environmental staff for the implementation of ESMP in the field, particularly the mitigation measures.

The contractor will develop various plans directed towards health, safety, the environment and social issues and get them approved by the PIC and PMO. The Contractor will also be responsible for communicating with and training of its staff in the ESHS aspects before the commencement of the physical works on site. The Contractor's ESHS team will include the following team members:

- International EHS Manager
- Environmental Specialist
- Social Specialist (SEA/SH)
- OHS Specialist
- Security & Community Relations Officer
- EHS Supervisors
- Flagmen
- Medical Doctor
- Medical Technician

9.7.7 Environmental Approvals and Permits Required for Project Implementation

Environmental clearances and permits required during the implementation of the Project are given in Table 9-2. PEDO and its Contractor will obtain these approvals from the relevant government departments during implementation.

Table 9-2: Environmental Approvals and Permits Required during Implementation of the Project

Sl.	Details of Approval and Permits	Issuing Authority	Requirements	Responsible Agency	Timing
1	**Environmental Approval:** for the overall construction of the Project	KP EPA	Submission of the EIA	PEDO	Prior to Construction of the Project
2	**Environmental Approval** for establishing crushing plants	KP EPA	Submission of IEE/EIA Application	Contractor	During the construction phase
		Industries Department	Submission of Request with layout and location maps	Contractor	During the construction phase
		Mines and Mineral Department	Submission of Request	Contractor	During the construction phase
3	**Permit** for storage of blasting material	Deputy Commissioner of District Swat	Submission of a request with the location map of the explosive storage	Contractor	During the construction phase
4	**Permit** for the transport of blasting material	Chief Inspector of Explosives	Submission of a request along with a recommendation letter from the Employer	Contractor	During the construction phase
5	**Permit** for cutting of forest trees (if required)	Forest Department	Submission of a request	PEDO	During the construction phase
6	**Permit** for the use of quarry and excavated material	Mines and Mineral Department	Submission of a request with the location map of the quarry area	PEDO will sign the lease agreement and handover it to the contractor	During the construction phase
7	Batching Plant	KP-EPA	NOC is not required for establishing a batching plant, but the project has to inform EPA about the facility with a surety that all mitigation measures to	Contractor	During the construction phase

Sl.	Details of Approval and Permits	Issuing Authority	Requirements	Responsible Agency	Timing
			control pollution will be adopted.		
8	**Environmental Approval** for the operation of the Project	KP EPA	Submission of a compliance report on the implementation of conditions and recommendations given in the Environmental Approval for construction.	PEDO	After completion of the Construction and prior to operation

9.8 Construction Stage Site Specific Management Plans

The Contractor will be required to prepare site specific management plans and include in the C-ESMP along with the ECPs, prior to his mobilization and commencement of construction works, for approval of PMO and PIC. The key sub-plans are described below.

- **Spoil Management Plan** will be prepared by the Contractor to prevent accidents during transportation, disposal and storage. The plan will address specific details on the site conditions transportation and disposal approaches, the exact route to be followed and the conditions of the road. It is recommended that Contractor propose alternative routes for review and approval by the Engineer. A commitment must be made by the Contractor to repair the road to its original condition, if any local road is damaged due to the heavy loaded traffic of the Project.
- **Pollution Prevention Plan** will be prepared as part of C-ESMP and implemented by the contractors on the basis of the ECPs and WBG EHS Guidelines that will be part of the bidding documents. The Plan will be submitted to the PIC for their review and approval before contractor mobilization.
- **Construction Camp Management Plan** (Annex-II) will be prepared as part of C-ESMP by the contractor based on ECP 16. The Plan will include the camp layout, details of various facilities including supplies, storage, and disposal. The Plan will be submitted to the PIC for their review and approval before camp establishment.
- **Emergency Preparedness Plan** (Annex-I & Annex-III): will be prepared by the contractor after assessing potential risks and hazards that could be encountered during construction.
- **Communication Plan** to deal with the interaction of the community, complaints management, workers recruitment, notice of works and workers conduct with locals.
- **Labor Influx Management Plan** to deal with the interaction of the workers and the local community. The Plan will be prepared as part of C-ESMP and implemented by the contractors on the basis of the ECPs and WBG EHS Guidelines that will be part of the bidding documents. The Plan will be submitted to the PIC for their review and approval before contractor mobilization.
- **Blasting Management Plan (Annex-II)** will be created by the Contractor to deal with expected and unexpected risks and impacts of blasting. This Plan will be prepared as part of C-ESMP and implemented by the contractors on the basis of the WBG EHS Guidelines that will be part of the bidding documents. The Plan will be submitted to the PIC for their review and approval before contractor performing any blasting activities.

9.9 Environmental and Social Management during Construction

9.9.1 Design/Siting Stage Mitigation Plans

The Design/Siting stage consists of planning the specification of the different physical components of the Project, such as dimensions, location, position, materials to be used. The main impacts and mitigation measures are included in Table 9-3.

Table 9-3: ESHS Conditions in the Design/Siting Stage

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
Environmental Impacts due to Project Siting				
Sedimentation of the Reservoir	• It is ensured in the design that the structures will be functional at different sedimentation load. The reservoir operations are designed with regular flushing of sediments through under sluices and from the desander channels during high flow season.	Implement measures in the following ECPs: ECP 3 ECP 6 ECP 7	PIC	PMO,
Coordination with all relevant departments for NOCs during Design Phase	• Coordinate with EPA and Ministry of Mines to obtain approval of EIA and explosives and blasting certificates.	Implement measures given in the ECP 3.	PIC	PMO,
(Beneficial Impact) Generation of low carbon and environmentally friendly power generation. Supply of an additional 207 MW (NET generation 805.78 GWh) of electric power to the national grid of Pakistan	• Quick implementation of the Project including RAP and ESMP to mitigate impacts associated with the construction of the project and secure delivery of the electricity to the entire nation.	Implement measures given in the ECP 12.	PIC	PMO,
Social impacts due to Project siting				
Acquisition of 131.175 acres of land permanently including relocation of 37 households	• MHPP Project specific RAP, SDP and LRIP have been prepared in line with the World Bank OP 4.12 and LAA Act, 1894. RAP will be implemented before commencement of the physical works. SDP and LRIP will be implemented during the construction phase.	Prepared and will implement RAP, LRIP & SDP in line with WB OP 4.12 and LAA Act,1894.	PMO	PMO PIC
4,391 (including 2321 fruit trees and 2070 timber trees) will be uprooted	• Compensation will be paid to the affected households in line with the RAP and felt trees will be handed over to the owners. In addition, 44,000 number of trees (10 trees for each tree felt) will be planted under the plantation program.	As above and Implement measures in the following ECPs:	PMO	PMO PIC

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
		ECP 7 ECP 12. Prepare and implement tree plantation plan given in Annex-II.		
Impacts on livelihood due to the acquisition of 79.95 acres of cropped land	• Livelihood restoration program has been prepared under the resettlement action plan and will be implemented.	As above.	PIC	PMO

9.9.2 Construction Stage Mitigation Plans

Detailed mitigation plans for construction stage impacts have been prepared on the basis of the detailed impact assessment covered under Chapter 7 and presented in Table 9-4. These plans are project-specific, and to the extent possible, site-specific, however, contractors will be required to carry out further detailing of the key aspects, to prepare site-specific management plans as part of C-ESMP for review and approval of PMO.

Table 9-4: ESHS Impacts and Risks in Construction and Mitigation Measures

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
Environmental and Social impacts and risks during construction				
Impact of increased traffic and transportation on N-95	• Traffic Management Plan will be prepared, approved by PIC and implemented in line with the ECP 15 (Annex-I) and traffic management plan (Annex-II) by the contractor, including community awareness and safety measures. • PMO will facilitate establishment of traffic management committee with the relevant stakeholders (traffic agencies, local governments along N-95, and contractors). PMO will hold a one-day workshop(s) with the stakeholders to devise a plan for traffic management along N-95 during construction period. • The location and alignment of temporary access roads will be finally decided by the construction contractor in coordination with the project developer and his supervising engineer. All the access roads required on the left bank for access to	Implement measures in the ECP 15 (Annex-I) and traffic management plan (Annex-II)	Contractor	PIC, PMO

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	adits and dumping sites will be identified and its impacts shall be reflected in the Contractor's ESMP and TMP. • Coordinate and control vehicle operations from one central authority during the construction phase. • Establish procedures and signages, and position traffic safety personnel to achieve separation of light and medium vehicles from heavy vehicles. • Equip light and medium vehicles with devices (for example, a pole-mounted flag) to improve their visibility to other operators. • Require defensive driving training for all drivers, including contractors and subcontractors. • Implement traffic safety procedures to coordinate safe transport of workers to and from the workers' camp. • Construct and maintain roads, particularly emphasizing major slopes, to ensure slope stability and the safety of heavy vehicle operation. • Inform affected communities about potential traffic-related safety risks and issues, such as vibration and dust. Implement specific measures to ensure pedestrian safety (that is, define crossing areas and speed limits in populated areas like Bahrain) and use best efforts to avoid heavy traffic during in-and-out school times or during major harvesting events or cultural or religious festivities and gatherings, as well as monitoring of potential impacts (such as, preconstruction surveys of buildings, infrastructure, and structures, including photographic and video image recording). • Prepared safety measures for controlling speed, in the densely populated areas and safety arrangements for pedestrian crossing points. • PMO will facilitate establishment of traffic management committee with the relevant stakeholders (traffic agencies, local governments along N-95, and contractors). • The dumping sites were selected as close as possible to the tunnel construction adits, weir site, and powerhouse site (see Chapter 3); • The dumping sites are selected on the left Swat River bank in order to avoid transport crossing the river; • No transport of rock material through towns (Bahrain, Madyan); • No transport of large amount of excavation material through Bahrain; • Use of conveyors where economically feasible;			

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	• Producing concrete on site; • Proper transport management to reduce truck movements; • Transportation of material is allowed only during daytime (from 6.00 am to 6.00 pm); • Speed limit of trucks crossing populated areas.			
Impacts on Swat River Ecology	• The construction of cofferdam shall be inspected regularly to ensure the safe passage of fish. • If any fish is stranded in the dry riverbed, it shall be relocated downstream • Control wastewater and sediment releases to river, particularly in the section between cofferdams • Prevent the release of silt, sediment, sediment-laden water, raw concrete, concrete leachate, or any other deleterious substances into the river. • Ensure equipment and machinery are in good operating condition (power washed), free of leaks, excess oil and lubricants, and grease. • Ensure machinery leaking fuel, lubricants, hydraulic fluids, or solvents are not used within the river. • Keep a spill containment kit readily accessible onsite in the event of a release of a deleterious substance to the environment. Train onsite staff in its use. • Regular monitoring of the aquatic habitat and fish species during the construction activities • Maintain eFlow (3.5 m3/s) as per the requirements of aquatic species throughout the year. • Compliance to the Khyber Pakhtunkhwa Fisheries and Aquaculture Act, 2022, • PMO has already secured the NoC from Fisheries Department for GKHPP and the same process of NoC will be carried out for MHPP. • The existing hatcheries of KP Fisheries Department (devastated by flood 2022) will be restored. The existing trout hatcheries will allocate a portion for Snow carp breeding and ensure annual release of Snow carp seedlings in the natural water bodies for the safe survival of Snow carp and ultimately the fragile ecosystem. A fish ladder is included in the project design for maintaining river connectivity and fish migration.	Implement measures given in the following ECPs of Annex-I: ECP 3 ECP 6 ECP 14; and; Implement the fish management plan (Annex-II).	Contractor	PIC, PMO
Disturbance to wildlife.	• Construction and post-construction stage biological/ecological monitoring will be carried out to ensure that the habitats of the large animals are not degraded from the	Implement measures in the	Contractor	PIC, PMO

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	construction activities. The Fisheries Management Plan (Annex-II) will be implemented. • Compensatory tree plantation, with a ratio 1:10, will be carried out. A tree plantation plan (Annex-II) has been prepared and a total of about 44,000 saplings will be planted. • Compensatory plantation 1:10 is proposed and budget is estimated in the ESMP. A tree plantation plan (Annex-II) is proposed and total 44,000 saplings will be replanted. • The staff of the project and contractor will be avoided from hunting, possession and display of wildlife, trade in wildlife and wildlife products, introduction of alien invasive species and so on. To ensure compliance with law, staff will report any wildlife sightings to the concerned government department.	following ECPs of Annex-I: ECP 12 ECP 13 ECP 14 and implement fish management plan given in Annex-II.		
Impacts on Water Springs	• To avoid any potential impacts on water springs, the contractor and PIC will analyze the tunnel's expected interference with underground water and technical solution will be devised to maintain the flow without disruption, in line with the applicable good international practices and guidelines. • a Sustainable Water Supply Management and Monitoring Plan as part of the SDP has been planned to develop water supply schemes for the communities and this plan can also assess the anticipated impacts and risks of the tunnel excavation of disconnection of sources of the reported springs; • The quality and quantity of tunnel effluent streams discharged to the environment, including storm water, leach pad drainage, process effluents, and overall tunnel works drainage will be managed and treated to meet the applicable effluent discharge guideline values; • In addition, discharges to surface water will be avoided in contaminant concentrations in excess of local ambient water quality criteria (NEQS). • For springs water quality monitoring, monthly construction stage instrumental monitoring will be carried out; water supply scheme is also proposed in the SDP schemes.	the contractor and PIC will analyze the tunnel's expected interference risk with underground water and in case if there is any probability will be devised technical solution to maintain the flow without disruption in line with the applicable good international practices and guidelines.	PIC/PMO	PMO
Security Risks	• The project will conduct a security assessment of the project area and will prepare a security management plan before the mobilization of the contractors. The Plan will address security risk to the project and its personnel and also risk to the communities from the security personnel. This plan will be	Implement measures in the following ECP: ECP 19	Contractor	PIC, PMO

<table>
<tr><th rowspan="2">Impact</th><th rowspan="2">Mitigation/Enhancement Measures</th><th rowspan="2">Generic Mitigation Measures</th><th colspan="2">Responsibility</th></tr>
<tr><th>Implementation</th><th>Supervision</th></tr>
<tr><td></td><td>implemented during the construction phase. A similar plan will be prepared for the O&M stage of the project.</td><td></td><td></td><td></td></tr>
<tr><td>Generation of about 2.75 million m³ of spoils (excess excavation materials) and their disposal</td><td>The excavated material will be re-used for the construction of access road sub-base course, cofferdam construction.

The extra/surplus material not suitable for construction purposes will be stockpiled in Disposal Areas (as identified).

Environmental and social due diligence (ESDD) will be carried out of the dumping sites, potential environmental and social impacts will be determined and mitigation measures will be devised before commencing disposal. Adaptive management approach will be adopted and the mitigation measures devised in this ESMP as well as ESDD report will be implemented by the contractor. In case, one of the sites for disposal was not feasible, another site will be identified keeping in view the following parameters;
i. The identified disposal/dumping sites will be selected at a lower elevation than the existing settlements, thus avoiding any land slide or land slipping risks.
ii. The disposal shall not be in the active Swat River bed, tributary, creek, freshwater bodies or any water course.
iii. Away from the settlement.
iv. Not in the settlement, agriculture or private land. In case, the disposal in the private land is unavoidable, the affectees will be compensated in line with the MHPP RAP/LRIP.
After completion of the disposal process, the following operation stage mitigation measures' will be adopted;

i. Considering the site conditions and the various erosion control methods like vegetation and forestation are the most effective and economical. These methods are recommended as the preferred options for erosion control. Furthermore, land construction slope should be kept as flat as is reasonably possible. Methods such as slope rounding, terracing or contouring to minimize erosion and to promote plant growth will be adopted. The commonly available erosion control processes are listed below:</td><td>Implement measures in the following ECPs:
ECP 1
ECP 5
ECP 6
ECP 10.
Prepare and implement spoils management plan (Annex-II).</td><td>Contractor</td><td>PIC, PMO</td></tr>
</table>

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	1. Grading 2. Compaction 3. Vegetation 4. Surfacing and pitching 5. Soil stabilization 6. Hydrographic modification (channeling, diversion, culverts, stream crossing) and 7. Retaining structures and terracing. In addition, the following construction stage mitigation measures will be adopted; • The identified disposal/dumping sites will be selected at a lower elevation than the existing settlements, thus avoiding any land slide or land slipping risks. • Disposal sites will include containment structures (retaining walls) where needed before muck/excavated material is disposed. • Excavated material disposal sites will be selected for practicality of operation and avoidance of critical habitat and local settlements. • Slope stability analysis will be conducted for the spoil tip, natural slope ratio as required for slope stability will be maintained for the area. • Disposal site will be located above the flood line. • Disposal Sites in the water ways shall be avoided. • the contractor will prepare and implement a Spoils Management Plan (Annex-II); • Before commencing the construction activities, the contractor will be required to prepare a Spoil Management Plan and submit it to the PMO for their review and approval; • Minimize the generation of spoils by recycling the excavated rock to the maximum extent possible by using them as fill for gabions, to use them as riprap for slope protection and as concrete aggregates; • Given the topography of the area, unprotected excavations on sloping grounds may lead to landslides, especially during the rainy season. Major landslides will disturb the slopes of the area and may also alter the bed of Swat River. Proper dumping and adequate compaction of soil/muck to avoid dust and release back to the river			

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	• On the request of the local community, the land will be levelled to enable them to reuse these lands for agriculture after construction activities. These lands can also be used for commercial activities. • Landscaping of the spoil sites that were in the permanently acquired lands, after completion of works. • Proper disposal and adequate compaction will be ensured to avoid dust and release back to the river. • Handing over the reclaimed sites to the landowners.			
Generation of construction waste including hazardous waste	• the contractor will prepare and implement a Waste Management Plan (Annex-II); • Guidelines for the management of wastes, including solid and hazardous wastes, are given in ECPs (See ECP1 on Waste Management and ECP 2 on Fuels and Hazardous Substances Management in Annex-I for detailed mitigation measures). • The contractor will place containers of adequate size and numbers in place for the collection of various types of wastes (metal, rubbers, used fuels, batteries,.) from the worksites, and transport these wastes regularly to a centralized facility. • The contractor will procure the services of a waste management contractor for transport and treatment of hazardous waste, and management of recyclable waste. • For disposal of inorganic construction waste, the contractor will build a waste disposal site or place them in the spoil disposal areas. • Containers of adequate size and numbers in place for collection of various types of wastes (metal, rubbers, used fuels and batteries.). Procurement of services of a waste management contractor for transport and treatment of recyclable and hazardous waste.	Implement measures in the following ECPS: ECP1 ECP 2	Contractor	PIC, PMO
Wastewater discharges from the construction camps, sites, and batching plants	• Contractor will prepare and implement a Waste Management Plan. • Sedimentation ponds, of adequate size and capacity, will be built for the treatment of discharges from the batching plants and the tunnels to allow the sediments to settle. Final discharges from the sedimentation ponds shall comply with NEQS for wastewater discharges into the rivers. The pH values will be frequently monitored and if the pH values are high, additional buffering solutions will be added to settlement ponds for control of pH. The settled sediments will be periodically removed and will be disposed of at the designated spoil disposal sites.	Implement measures in the following ECPs: ECP 3 ECP 4 ECP 16	Contractor	PIC, PMO

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	• Construction of appropriate wastewater treatment facilities at the campsite (e.g., septic tank and soak pit) and site drainage). • The contractor will be required to take appropriate measures to avoid and contain any spillage and pollution of the water. • Quarterly monitoring of wastewater quality to ensure compliance with NEQS. • Construction of wastewater treatment facilities at the campsite (e.g., septic tank and soak pit) and sedimentation tanks at the worksites (for batching plants and discharges from tunnels and site drainage). • Monitoring of wastewater quality to ensure compliance with NEQS prior to disposal to the natural streams.			
Potential risk of soil and water pollution by construction works	• Storage of fuels and chemicals in contained facilities. Double containments will be arranged for such substances in addition to concrete pad and coverage from rainfall. • Availability of spill kits and trained personnel for immediate cleanup of any oil spills. Information of all spills will be notified to PIC and PMO immediately. • Confine the contaminants immediately after accidental spillage and clean-up of oil spills using spill kits. • Collect contaminated soils, treat and dispose of them as hazardous waste • Topsoil from cultivated lands in the construction areas are to be stripped and stockpiled where practical for restoration of spoil disposal sites. • Temporary stockpiles to be protected from erosion. • Additional mitigation measures are given in ECP 3: Fuels and Hazardous Goods Management, ECP 3: Water Resources Management, ECP 5: Soil Quality Management, and ECP 7: Erosion and Sediment Control.	Implement measures in the following ECPs: ECP 3, ECP 5, ECP 6, and ECP 7	Contractor	PIC, PMO
Risk of Landslides	• Any blasting activities in these areas will be controlled and contained within defined limits. As much as possible explosives with a low intensity will be used. • Landslide prone areas will be identified and mitigation measures will be devised and implemented. • Pro-active measures will be implemented to stabilize and protect slopes and to protect workers safety. Early warning systems will be introduced that will indicate when cracks appear, especially following heavy rainfall and allow any widening to be monitored. Access would be restricted during the periods that slope stability is not yet entirely secured and guaranteed by proper safety measures such as rock bolts, anchors, safety	Implement measures in the following ECPs: ECP 5 ECP 6 ECP 7	Contractor	PIC, PMO

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	nets and gabion structures and any blasting activities in these areas will be controlled and contained within defined limits. Ensure affective utilization of personal protective Equipment (PPE). • Regular monitoring by the contractor will be required. • Access would be restricted during the periods that slope stability is not yet entirely secured and guaranteed by proper safety measures such as rock bolts, anchors, safety nets and gabion structures and any blasting activities in these areas will be controlled and contained within defined limits. • Extreme care will be exercised to protect workers and the public from the dangers of sudden landslides, which may occur during excavation and blasting works. Particularly after heavy rainfall there may be increased risk of such incidents. Similarly, water seepage may occur if reservoir or tunnel walls not constructed according to standard engineering practices, that water may easily penetrate into surrounding loose soil and may lead to land slide and damage to project structures. • Contractor will develop a Blasting and Explosives Management Plan and Vibration Monitoring Plan. A pre-construction survey of structures at risk of vibration impacts will be conducted and accordingly management plan will be developed in Contractor's ESMP (C-ESMP) prior to commence the work.			
Occupational & Community Health & Safety	• Develop and implement occupational health and safety plan. A risk assessment will be carried out for various construction activities and risk levels will be assigned to each activity. Appropriate control measures will be defined in this risk assessment. In addition, job hazard analysis will be carried out before initiating any construction activity. • Regular site inspection and safety audits. • Regular OHS training for workers. • Daily toolbox talks covering OHS. • Incident investigation and reporting. • Use of relevant PPE • As the project requires around 400 employees (skilled and unskilled) and aligned close to the existing settlements, therefore; the EHS Guidelines are technical reference documents with general and industry-specific examples of Good International	Implement measures in the following ECPs: ECP 16 ECP 18 ECP 19 (Annex-I) and implement occupational health and safety management plan (Annex-III)	Contractor	PIC, PMO

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<tr><th rowspan="2">Impact</th><th rowspan="2">Mitigation/Enhancement Measures</th><th rowspan="2">Generic Mitigation Measures</th><th colspan="2">Responsibility</th></tr>
<tr><th>Implementation</th><th>Supervision</th></tr>
<tr><td></td><td>Industry Practice (GIIP). Components of The General EHS Guidelines include Environment, Occupational Health and Safety, Community Health and Safety, and Construction and Decommissioning.
• Each contractor will be required to prepare, obtain approval of, and implement an occupational health and safety (OHS) plan. These plans will be prepared in compliance with the World Bank Group’s EHSGs, KPK Occupational Health and Safety Act 2022, International Tunnel Association, ECPs in Annex-I, GoKP regulations on Factory Act 2013, Industrial Relations Act 2013, and Workers Compensation Act 2013. If these guidelines cannot address any specific aspect of OHS, international good practices such as OSHA and ILO will be applied. OHS Plan will contain general guidance for all identified hazards under each work activity, and site-specific OHS hazard and risks during construction, and control and preventive measures proposed by the Contractor. The Plan shall be reviewed and updated if there any changes in the construction methodologies.
• The OHS plan will be reviewed and approved by the Construction Supervision Consultant and the World Bank.
• Conduct a Job Hazard Analysis (JHA) at the new construction site to identify potential hazards that may arise from the proposed works or working conditions to the project workers and implement necessary control measures. The JHA will be part of the Contractor’s method statements, which will be reviewed and approved by the OHS Specialists of the Supervision Consultants. The specialists will also visit the construction sites, prior to the start of construction, to ensure the control measures are in place.
• Regular site inspections and safety audits by the construction supervision team, both by the OHS specialists and the site engineers. Since the site engineers will be present at the worksites all the time, they will be trained by their OHS team on monitoring safety aspects of the construction works.
• Regular training program for workers on occupational health safety (monthly training and daily toolbox talks). Special attention will be focused on safety training for workers to prevent and restrict accidents and on the knowledge of how to deal with emergencies.
• Incident investigation and reporting, including a complete record of accidents and near misses, will be maintained.</td><td></td><td></td><td></td></tr>
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Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	• In order to protect all project personnel and visitors, the Contractor will provide personal protective equipment (PPE) for workers, such as safety boots, helmets, masks, gloves, body harness, protective clothing, goggles, fully face eye shields and ear protection. The Contractor will also provide training to workers on how to use them and maintain them in a sanitary and reliable condition, and replace the damaged ones immediately with new ones. • Accessibility for firefighting, ambulance, medical and rescue vehicles and medical facilities at the site for implementation of an Emergency Response Plan (Annex-I & Annex-III): • Adequate water supply and mobile toilets, medical and first aid care facilities at the worksites • Contractors will have dedicated and qualified staff for ensuring compliance with the OHS Plan • Awareness-raising material will be used including posters, signage, booklets, and others at the worksites • Implement the mitigation measures and emergency response plans given in ECP 18 (Annex-I & Annex-III): Worker Health and Safety, ECP 19: Tunneling and Underground Construction Works, and ECP 20: Instream Construction Works. • compliance to the Khyber Pakhtunkhwa Occupational Safety and Health Act, 2022 (Khyber Pakhtunkhwa Act No. XV of 2022) and KP Factories Act, 2013; the Occupational and Community Health and Safety Plan (Annex-III) created for this project, as well as everyday operations is commensurate to the guidelines set out by this Act and World Bank general EHSGs. • In addition, compliance to KPK Workers Compensation Act, 2013, in case of for injury or death by accident to their employees, the MHPP contractor(s) will be liable to provide compensation.			
EHS Risks & Impacts associated with Tunnel & Underground Powerhouse Works	**A tunnel risk assessment** (TRA) will be conducted by the contractor and environment, health and safety (EHS) plan for tunnel and powerhouse works as well as emergency response plans will be prepared, approved and implemented by contractor. • Define and map areas where drill and blast are likely to be used. • Undertake, or specify in Civil Works Technical Specifications, pre-construction dilapidation surveys of housing located within a minimum radius (vertical and	TRA and environment, health and safety (EHS) plan for tunnel and powerhouse works as well as emergency	Contractor	PIC, PMO

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	horizontal) of 500m around worksites which are subject to blasting, documented by a bailiff. • Undertake a preliminary Blasting Risk Assessment, which demonstrates that blasting vibrations would not (i) affect the houses located above the tunnels (including the headrace tunnel), or close to the worksites where blasting would be needed, and (ii) trigger landslides or other natural hazards which would represent a safety issue for nearby communities and roads. **Signage in hazardous and risky** areas, installations, materials, safety measures, emergency exits, and other such areas will be in accordance with international standards (including standards of cleanliness, visibility and reflectance in the areas potentially poor illumination or sources of dust and pollution), be known and easily understood by workers, visitors, and as appropriate the general public. **Blasting activity** will be permitted with issuance of "Permit to Work" by the PIC and Contractor's Health Safety Environment Team. The contractor will submit a consistent blasting schedule, minimizing blast-time changes. Only blasting team fulfilling all the requirements of blasting will be conducting blasting as per blasting plan. Health Safety Team of Contractor will be monitoring the blasting activity by completing inspection checklist for every blast activity inside diversion tunnel. During blast and post blast safety requirements will be fulfilled by inspecting. **Specific warning devices** (e.g., horn signals, flashing lights) and procedures will be implemented before each blasting activity to alert all workers and third parties in the surrounding areas (e.g., the resident population). Warning procedures may need to include traffic limitation along local roadways. **Ventilation System** at MHPP project site the tunnel and powerhouse workplace will be ventilated well to enable workers to carry out work without risk to health and safety. Due to the nature of tunneling and powerhouse works, contaminants generated in one area of the tunnel and powerhouse will move readily to other areas. Protection against airborne hazards will be provided to workers. Control measures needs to be implemented to eliminate or minimize, so far as is reasonably practicable, the risks associated with atmospheric contaminants.	response plans preparation & implementation		

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	For waste dumps, fills and other containment structures, static safety factors will be established based on the level of hazard for the operational phase of a facility and at closure. Accurate assessment of worksite safety from rockfall and/or landslide needs to be conducted. Particular attention needs to be given after heavy rainfall, seismic events and after blasting activities. Risks needs to be minimized by appropriate bench and pit slope design, blast pattern design, rock scaling, protective berms and minimizing traffic. **Machine and Equipment Safety**: Use of contrast coloring on equipment / machinery, including the provision of reflective markings to enhance visibility; • Use of moving equipment / machinery equipped with improved operator sight lines; • Issuing workers high visibility clothing; • Use of reflective markings on structures, traffic junctions, and other areas with a potential for accidents (e.g., walls in static locations will be whitewashed for improved reflectance); • Use of appropriate illumination for the immediate operating areas of frequently turning and reversing equipment / machinery. **Air Quality Monitoring:** After every blast, tests need to be carried out before workers and staffs are allowed to re-enter the tunnel and powerhouse. The tunnel and powerhouse will be monitored throughout the work period in accordance with a suitable procedure. The workplace will be examined by suitably qualified people using detection and measuring equipment. The monitoring will include air testing for: • flammable fumes or gases; • oxygen deficiency and the presence of asphyxiant gases; • unsuitable temperature and humidity, and; • airborne contaminants like toxic gases, fumes or respirable dusts. No worker is to be exposed to a substance or mixture in an airborne concentration exceeding the exposure standard for the substance or mixture. Exposure standards are usually set for a standard 8 hour working day. Therefore, during periods of extended work, like shift work or overtime that requires working longer than 8 hours per			

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	day or more than 40 hours in a week, exposure standards will be determined by the contractor. **Ventilation:** The workplace must be ventilated to enable workers to carry out work without risk to health and safety. The consequences of poor ventilation include: • exposure to: excessive heat; • fumes, substances or mixtures which can lead to unconsciousness, acute or long-term health problems and even death; • oxygen depletion, and; • fatigue and impaired judgment. **Methane Detection:** The following minimum methane detection procedures are required: • Testing for methane to be carried out continuously during drilling or boring operations. • Continuous methane monitoring device(s) to be provided in ventilation columns with automatic alarm system. • Regular methane inspections of headings and tunnels whether discontinued or in use for access to the rearward of the advancing face are to be carried out. Acceptable Concentrations of Methane. **Respiratory PPE**: Where higher order control measures fail to eliminate or minimize, so far as is reasonably practicable, hazardous chemicals or respirable dust exposures the lower order control measure of PPE may have to be used. When respirators are supplied, they will be capable of preventing people inhaling hazardous dust or other airborne contaminants at the concentration and duration of the exposure. **Use of Respirators:** During Tunnel construction works all Contractor and Sub Contractors staff or whoever owes business inside tunnel will ensure proper use of Personal Protective Equipment. In this regard where, higher order control measures fail to eliminate or minimize, so far as is reasonably practicable, hazardous chemicals or respirable dust exposures the lower order control measure of PPE may have to be used. When respirators are supplied it will be ensured that they are capable of preventing			

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	workers inhaling hazardous dust or other airborne contaminants at the concentration and duration of the exposure **Heat Stress During tunnel work:** there is chance of heat stress due to; • Environmental conditions like air temperature, radiant heat, high humidity and air flow; • Physical work e.g., strenuous or light work; • Work organization e.g., exposure to heat and time of day, and; • PPE and clothing like heavy protective clothing, is worn by workers. Therefore, multiple factors may cause heat stress in the Contractor's staff. **Re-fueling in Tunnels:** In tunneling works at MHPP Project will be ensured that proper refueling procedures are adopted by the operators while working at site. **Fire at MHPP Project site:** fire and explosions hazards will be identified. Fire underground rapidly consumes oxygen and produces noxious fumes and gases. The fire will reduce and, in some cases, eliminate visibility. There is a significant risk the fire will block at least one tunnel exit forcing workers to seek an alternate exit or a place of safety. Therefore, combustible materials will be managed with good housekeeping measures as per HSE Program of MHPP. In addition, hot work procedures as per HSE program will be adopted in MHPP Tunnel and powerhouse work. Provision of firefighting facilities will be ensured along with training of firefighting to all tunnels staff including casual labors. Control measures will be implemented to eliminate or minimize, so far as is reasonably practicable, the risks associated with fire and plant and equipment. **Visibility and lighting:** the contractor at MHPP Project will ensure provision of adequate lighting arrangement inside the tunnel and powerhouse works. Lighting will be provided that: • Allows workers and others to move and work safely within the workplace; • Does not create excessive glare, and; • Allows safe entry and exit from the workplace including emergency exits. According to TRA, Control measures will be implemented to eliminate or minimize, so far as is reasonably practicable, the risks associated with poor visibility and lighting.			

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	• Illumination: The Contractor will install, operate and maintain a lighting system in the underground works until completion of the Works. All hazards will be clearly illuminated at all times. The first 50 m from the portal of each adit will be lit to double the above intensity. Suitable high intensity movable lamps will also be provided by the Contractor to illuminate any area in the underground works where the Engineer may wish to carry out testing or other inspection e.g., at a monitoring station or to inspect geological features. No person will work or travel in any underground working unless a light is carried. All safety helmets used underground will be equipped with suitable brackets for mounting the light. The light will be a sealed lamp of an approved type. **Electrical safety:** As per TRA (to be conducted by contractor), electrical hazards with residual risk may remain in tunnel and powerhouse construction works. Electrical equipment in tunneling and powerhouse work can be damaged from high temperature, pressure, humidity, dust, from hazardous and explosive chemicals and the effects of blasting. Electrical equipment will be protected from these exposures. Safety critical plant and equipment like firefighting equipment, pumps, ventilation, communications and atmospheric monitoring will remain operational even in an explosive atmosphere and where there is an explosion. Eye Injury: During Tunnel works, activities and process may give rise to particles such as flying particles which may pose threat of eye injuries to workers involved during construction works or engineers and visitors. Others; • Sensitive Receptors: Additional mitigation measures such as vibration barriers will be implemented at sensitive receptors (Kedam, Daroli, Ayeen, Ponkia and Gorejo villages), as required. • ITA guidelines: ITA guidelines will be implemented.			
Temporary accommodation related health risks	• The contractor will develop and implement a Camp Management Plan and/or follow ECP 16: Labor Influx Management and Construction Camp Management (Annex-I) • The construction camp will be built with all adequate facilities (safe drinking water and sanitation, kitchen and rest areas.) including entertainment facilities so that there will be minimal interaction between them and local communities			

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	• A medical clinic, with a medical doctor and attendants, will be established at the campsite. Regular health check-ups of the workers will be carried out. • The Contractor shall establish a mechanism to collect the complaints from the workers and address those complaints by the approved GRM plan.			
Air and Noise pollution from construction and traffic	• dust suppression techniques (e.g., wetting down, use of all-weather surfaces) for roads and work areas, optimization of traffic patterns, and reduction of travel speeds will be followed. • In case of blasting impacts on ambient air, blasting will be carried out at a time when workers are not expected to enter the affected area of the headrace tunnel and powerhouse for the next hour or so, this allows some dust to settle out and the rest to be carried away by the ventilation system. As more than 90% of the blasting would be carried out in confined environment; therefore; the impacts on aboveground ambient air minimal and is only anticipated during construction of headrace and powerhouse portal portions. • In case of drilling dust emissions from drilling activities needs to be controlled at the source by dust extractors, collectors, and filters, and wet drilling and processing will be adopted[80]. At this stage of the project, the contractor's type of drilling technology, plan and methodology of drilling is not available, therefore; different options for drill dust control are proposed for this ESIA and whichever is effective, efficient and feasible for contractor can be adopted; (i) the most common method of drill dust control is a **dry dust drill collector** with the intake at the tip of the drill bit. This arrangement provides excellent dust control if the collector is maintained properly. (ii) in hard-rock mines and tunnels, **water injection through the drill steel** has been effectively used to control dust for many years. (iii) **foam injection** through the drill steel also can be used in those applications where excessive water can create a problem[81]. (iv) **wet drilling systems** pump water into the bailing air from a water tank mounted on the drill. The water droplets in the bailing air trap dust particles as they travel up the annular space of the drilled hole, thus controlling dust as the air bails the cuttings from the hole. The drill operator controls the flow using	Implement measures in the following ECP: ECP 10 ECP 11 and prepare and implement vibration monitoring plan (Annex-II).	Contractor	PIC, PMO

[80] IFC Environmental, Health, and Safety Guidelines for Construction Materials Extraction available on https://www.ifc.org/wps/wcm/connect/dad17995-66be-4280-86da-b438cf9fbefc/Final%2B-%2BConstruction%2BMaterials%2BExtraction.pdf?MOD=AJPERES&CVID=nPtfjTM&id=1323162191491

[81] Source: NIOSH Handbook on Dust Control in Mining. Can be accessed on https://www.cdc.gov/niosh/mining/userfiles/works/pdfs/2003-147.pdf

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	a control valve located in the cab. Some drills are equipped with a flow meter to give the operator a visual sign of the flow rate. Raising the water flow will improve dust capture, but too much water causes operational problems. Because of this, the drill operator must exercise care in finding the best water flow rate. (v) **Dry Collection** systems require an enclosure around the area where the drill stem enters the ground. This enclosure is constructed by hanging a rubber or cloth shroud from the underside of the drill deck. The enclosure is then ducted to a dust collector, the clean side of which has a fan. The fan creates a negative pressure inside the enclosure, capturing dust as it exits the hole during drilling. The dust is removed in the collector, and clean air is exhausted through the fan. • In addition, for storage for dusty materials, the materials will be enclosed or operated with efficient dust suppressing measures; loading, transfer, and discharge of materials will take place with a minimum height of fall, and be shielded against the wind, and consider use of dust suppression spray systems and the contractor will monitor the ambient air levels regularly at the nearby villages and other sensitive receptors to ensure that these do not exceed NEQS and World Health Organization (WHO) standards. • Construction sites where Sensitive receptors (Kedam, Daroli, Ayeen, Ponkia and Gorejo villages) are located within 500 m will water sprinkled regularly by the Contractor • Water all access roads used for any vehicular traffic (close to sensitive receptors) at least twice per day during active operations and restrict vehicle speed to 20 km/hour; • Crushing and batching will be located a minimum 500 m away from sensitive receptors (Mosque, Schools, residential houses) and will have appropriate dust/emission suppression mechanisms such as wet scrubbers; • Ensure that all vehicles and machinery are fitted with appropriate emission control equipment, maintained properly, and serviced according to the manufacturer's specifications; • Smoke from internal combustion engines will not be visible for more than ten seconds; • Fit and maintain appropriate mufflers on earth-moving and other vehicles on the site;			

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	• During windy conditions, stockpiles of fine material will be wetted or covered with plastic; • Take dust suppression measures, such as promptly watering exposed areas when visible dust is observed; • Implement a program for sprinkling water on the roads under use for movement of construction machinery/equipment/labor; • Personal Protective Equipment (PPE) such as dust masks will be made available to the construction workers at the site to avoid potential health hazards; • Schedule deliveries to the site in day-time so that disruption to local community and traffic are minimized; • Idling of delivery trucks or other equipment will not be permitted during periods of unloading or when they are not in active use; • In no case, loose earth will be allowed to pile up along the approach roads; • All vehicles and other equipment used during construction will be properly and regularly tuned and maintained; • All permanently deployed vehicle exhausts will be monitored against NEQS/WHO guidelines; • Regular monitoring of air quality to ensure compliance with NEQS on ambient air quality • Possibility of excessive dust generation may be reduced by adopting the best construction practices, and precautions such as periodic watering, covering of construction material and usage of low emission equipment during construction; and • Adhere to the following project-specific construction stage mitigation actions: ○ The works along the sensitive receptors (nearby settlements) shall not be carried out during night. If the works require more time, the sound/noise barriers shall be installed by the Contractor to avoid any disturbance to students and residents. ○ Generators will only be operated on a standby basis for short periods. Electricity will be used where a connection from National grid is available. • To mitigate the anticipated impacts on ambient noise level, reduction of noise from drilling rigs by using downhole drilling or hydraulic drilling may be adopted.			

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	• Stationary noise sources such as batching plants will be kept at least 300 meters away from the nearest community; • Noise levels will be monitored on a regular basis at the key receptors (Kedam, Daroli, Ayeen, Ponkia and Gorejo villages, houses, mosque, school)- in the project area in order to take timely corrective measures, if needed; • Additional mitigation measures such as noise barriers will be implemented at sensitive receptors (Kedam, Daroli, Ayeen, Ponkia and Gorejo villages), as required. • Impose speed limits on construction vehicles to minimize noise emission along areas where sensitive receptors are located (Houses, Mosque, schools); • The contractor shall provide equipment only of the size/power required to complete each task; • The contractor shall plan his operations to be completed preferably based on a six-day working week from 6:00 am to 6:00 pm. Will the contractor require additional working hours, or weekend work, he shall submit a request to the Engineer and Environmentalist for permission to work extended hours, giving full reasons for the requests. Approval to such requests will not be granted for works close to the populated areas; • The contractor will monitor the noise levels regularly at the nearby villages and other sensitive receptors to ensure that these do not exceed NEQS and WHO standards. Contractors will adopt appropriate noise attenuation measures to reduce the noise generated from construction activities; • Construction activities that are close to settlements will be stopped during night times if high noise values are observed. • All vehicles used in the construction activities will comply with NEQS and WHO standards exhaust and noise standards (85 dBA at 7.5m from the source); • Construction activities close to nearby schools and hospitals will be timed to coincide with school vacations or long holidays. Noise barriers (or other appropriate arrangements) will be used where required. • High noise emitting equipment, if any, will be fitted with noise reduction devices such as mufflers and silencers wherever possible; • For protection of construction workers, earplugs would be provided to those working very close to the noise-generating machinery;			

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	• High noise emitting equipment, if any, will be used during regular working hours so as to reduce the potential of creating a noise nuisance during the night; • Regular inspection and maintenance of the construction vehicles and equipment will be carried out; • Replacement of worn out and noise-producing parts of construction machinery will be carried out in a timely manner; • The Community Liaison Officer shall notify affected people and communities prior to undertaking especially noisy work activities; • Implement the additional mitigation measures provided in ECPs to address air and noise quality impacts (see ECPs 10 and 11 in **Annex-I** for air and noise quality management).			

Vibration impact of tunnel construction	• The vibrations created by blasting for headrace tunnels may damage walls of residential houses of nearby communities and sensitive receptors (school, Mosque) that will be mitigated by adopting following measures;
	  • Conduct a pre-construction survey of structures at risk of vibration impacts on houses and other structures. If they are located close to the blasting area (100 m) then they need to be relocated, if the distance is more than 100 m, awareness will be created and residents must be notified in advance prior to every blast. Following completion of the blasting, the survey will be repeated to determine the condition of the buildings and verify that they are safe for re-occupation. Contractor will prepare Blasting Management Plan (Annex-II) prior to construction and obtain approval. The survey will cover the following aspects:
	    – Overall condition of the structures, both exterior and interior.
	    – Documentation of defects observed in the structure using digital imagery along with notes, measurements, and sketches.
	    – Documentation of pre-existing cracks using digital imagery along with notes, measurements, and sketches.
	  • Following completion of the blasting, the survey will be repeated to determine the condition of the buildings and verify that they are safe for re-occupation. If the buildings are safe, the residents will be allowed to return to their houses following any necessary damage repairs. If the buildings are damaged beyond repair, compensation will be managed under ESMP.
		Implement measures in the following ECPs:
		ECP 11
		ECP 18
		ECP 19
		
		Prepare and implement vibration monitoring plan (Annex-II).
			Contractor	PIC, PMO

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	• Following are key mitigation measures for the management of blasting: – Blasting will be scheduled during the day only. – Local communities will be informed of blasting timetable in advance and will be provided adequate notice of when blasts are required outside of the planned schedule. – A Blasting Management Plan (Annex-II) will be developed by the Construction Contractor. The Plan will be reviewed and approved by the Supervision Contractor before the initiation of the blasting work. – Throughout the blasting activity, vibration sensors will be installed at strategic locations to monitor the impact of blasting and to ensure that the vibration levels are within the adopted criteria. The monitoring plan will be part of the Blasting Management Plan (Annex-II). – Unscheduled blasting will be strictly prohibited in any case. • Meaningful contact with the community shall be maintained and their grievance shall be attended to in a timely manner. In this regard: – A meaningful consultation plan will be developed to address how consultation will take place during implementation[82]. The plan will cover identifying the affected community; the key contact persons; frequency of engagement; the information to be shared; the responsibilities to manage the plan; and the notice period to be given to the community for various blasting-related generating activities. – The Grievance Redress Mechanism will be used to record, investigate, and respond to any complaints. Investigation of the complaints will be undertaken by the Supervision Consultant. • Develop a Vibration Monitoring Plan (Annex-II) that will include monitoring of vibration levels and frequency around the blasting sites. The objectives of the monitoring will be to: – Ensure that vibration levels in the communities are within the adopted criteria levels; – Maintain a record of vibration to settle any potential conflicts; and			

[82] World Bank Stakeholder Consultations in Investment Operations Guidance Note available on https://documents1.worldbank.org/curated/en/830941468323985308/pdf/671210WP00PUBL0ultations0Note0web20.pdf

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	• Monitor changes in the vibration levels due to possible changes in the rock formation and take appropriate corrective actions. • In addition, commensurate to the Khyber Pakhtunkhwa Explosive Substances Act, 2013, therefore the legal procedure and approval from the KP Government entity will be obtained by PEDO/Contractor for the use of explosive substance[83] handling and transportation will be followed.			
Fly Rock from Blasting	• A minimum buffer of 500 m will be provided between the settlements and point of blasting.	Implement measures in the following ECPs: ECP 19	Contractor	PIC, PMO
Impacts from Quarry Activities – Sourcing of aggregates for concrete works	• Reuse of excavated material to the extent feasible. Use of licensed quarry sites. Source the material from the boulders from the eroded riverbanks in the proposed reservoir area (which are found to be suitable for aggregates). • Use only quarry and borrow sites that are licensed by the provincial government and approved by the project management unit/Implementation Consultants • Identify new borrow and quarry areas in consultation with Project Director, if required. • The use of explosives will be used in as much minimum quantity as possible to reduce noise, vibration and dust. • Although the material is widely available, the quarrying/mining activities will be limited to fewer areas to reduce the area of extent affected by quarrying activities. If any mining activities are to be carried out outside the project area, they will not be located in any sensitive areas. A survey of the area to identify sensitive receptors and permission from the PMO must be obtained before mining in any unplanned locations. • Maintain a buffer zone of 5 to 10m between the low flow channel and the mining operations to minimize the downstream impacts and limit the excavation activities to the low flow season. • Implement the generic measures and best practices on quarry areas development and operation that are given in ECP 9 (**Annex-I**) and World Bank Group EHS Guidelines for Construction Materials Extraction.	Implement measures in the following ECPs: ECP 9	Contractor	PIC, PMO

[83] Under this act, an explosive substance" means and includes any material for making any explosive substance, also any apparatus, machine, implement or material used, or intended to be used, or adapted for causing, or aiding in causing, any explosion in or any explosive substance; also, any part of any such apparatus, machine or implement

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
Impacts on flora and fauna from construction activities	• Limit the siting of any temporary facilities within the boundaries of the worksites. Use of non-wood fuel for cooking and heating. Code of conduct for workers and employees on protection of flora and fauna and a ban on tree cutting and hunting. Any violation to code of conduct leads to strict punishment including termination of employment. Awareness-raising to workers about the importance of biodiversity and their habitats. A tree plantation plan will be developed and implemented in consultation with the Forest Department Government of KP. • The Project is being developed by PEDO; therefore, the Project-related activities will only be undertaken on land acquired for the Project. They {PEDO} will not clear trees or brushwood outside the acquired area.	Implement measures in the following ECPs: ECP 12 ECP 13	Contractor	PIC, PMO
Impact on tourism	• Construction activities will affect tourist activities in Swat valley. However, hotel managers do not expect severe negative impacts on the number of tourists. There is the hope that projects like MHPP will bring more stability to the region. Mitigation measures include efforts not to increase the traffic in Bahrain town more than absolutely necessary. Furthermore, it is important to maintain spoil piles and properly dispose of wastes to ensure the visual environment is not negatively affected.	Implement measures given in ECP-1 to ECP-17:	Contractor	PIC, PMO
Safety hazards due to increased traffic on local roads especially for children and elderly people	• Development and implementation of occupational health and safety plan, Basting management plan, spoils management plan, vibration management plan, and labor influx management plan (Annex-III). • Regular site inspections and safety audits (OSHA) • Regular training program for workers on occupational health safety (monthly training and daily toolbox talks) • Incident investigation and reporting • Conduct a 'job hazard analyses at the new construction site to identify potential hazards and implement necessary control measures. • Use of relevant personal protection equipment at all times. • Barricade the work areas with hard fencing to prevent the entry of the community into the construction areas. • Placing of adequate signboards and flagmen to divert the community away from the construction works. • Implementation of Traffic Management Plan near the blasting sites	Implement measures in the following ECPs: ECP 15 and prepare and implement traffic management plan (Annex-II).	Contractor	PIC, PMO

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	• Community awareness programs on construction-related hazards, including awareness programs in school. Construction activities such as blasting and excavation, may pose safety risks to the nearby population. • Ambulance and first aid medical facilities will be made available at the worksite. • Community liaison will be maintained. • Also consider the **following mitigation measures devised for Community exposure to work hazards section.**			
Community exposure to work hazards	• Along with the implementation of the above mitigation measures, barricade the work areas (near the settlements) with hard fencing to prevent the entry of community in the construction areas. • Placing adequate signboards and flagmen to divert the community away from the construction works. • Construct access roads for the communities to avoid exposure of construction hazards. • Community awareness programs on construction-related hazards, including awareness programs for community leaders, Imams, and in schools for both teachers and students. • Ambulance and first aid medical facilities will be made available at the worksite. • Community liaison will be maintained.	Implement measures in the following ECPs: ECP 15 ECP 16 ECP 17	Contractor	PIC, PMO
Impacts from the influx of labor from the outside areas	• an awareness campaign will be implemented at the beginning of the construction phase. The Contractors will be aware of the possibility and risks of miscommunications between local residents and workers, which could easily lead to conflicts. This will be prevented by raising awareness and implementing a Code of Conduct for the workers. The Contractor shall develop a Worker Code of Conduct to govern the behavior of workers on-site, in camps, and in local communities. • The awareness campaign will also be aimed at the risk of interaction between the resident population and the construction workforce, including the spreading of sexually transmitted diseases such as HIV/AIDS. • The contractor will prepare a Labor Influx Management Plan prior to construction works for approval of PEDO. • The Contractor's Code of Conduct shall cover the program to promote awareness among the construction workers on respecting the local community.	Implement measures in the following ECPs: Implement measures in the following ECPs: ECP 16 ECP 17	Contractor	PIC, PMO

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	• Construction camps will be built in the designated areas, located away from the local settlements • The contractor will ensure local water usage will not be affected by water usage by project or compete with water requirements of the local community. The Contractor will reuse water wherever safe to do so to reduce water usage. • The Contractor's monthly training program will cover topics related to respectful attitude while interacting with the local community • Gender Action Plan (Annex-II) will be implemented in the project area.			
Risk of sexual exploitation and abuse (SEA), and sexual harassment (SH) by 200 migrant workers (60 foreigners and another 140 will be from Pakistan but outside the project area)	• Inclusion of clause on GBV/SEA/SH behavior obligations in the employment contracts of all employees and construction workers aimed at strengthening measures to address and prevent GBV/SEA/SH in the workplace and construction areas. • The Contractor will develop code of conduct (CoC) for locals and in-migrant workers (for instance, respect to local values and cultures). Workers strictly forbidden to establish contacts and relationship with local women. The contractor's code of conduct shall cover clauses related to avoiding gender-based violence, sexual exploitation and abuse, and sexual harassment. The CoC will be translated into Urdu and disseminated among the workers. The code of conduct will be included in the worker's contract agreement, and any violation of the code of conduct will lead to termination of employment. The contractor's CoC shall cover a program to promote awareness to the construction workers on avoiding SEA, SH and the risk of spreading sexually transmitted diseases. The Contractor's monthly training program will cover topics related to CoC such as sexual harassment particularly towards women and children, violence, including sexual and/or gender-based violence. • Posting of CoC standards in public spaces at contractor's work camps and living areas, and village information centers and public places of adjoining/neighboring communities in the Urdu language • Raising awareness that GBV SEA/SH is prohibited. • Provide information on the use of GRM to report cases of GBV/SEA/SH, Code of Conduct breaches, and assist victims of SEA/SH, if signs of SEA/SH are identified/a victim approaches them to complain about SEA/SH. • Awareness to communities, particularly women, and male and female children to understand the risks of SEA and SH and the roles and responsibilities of parties involved in project implementation on SEA and SH prevention, processes for reporting incidents of project-related SEA/SH, and the corresponding accountability structures.	Implement measures in the following ECPs: ECP 16 ECP 17 ECP 18 and implement the gender action plan (GAP) (Annex-II)	Contractor	PIC, PMO

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	• Strengthen the Contractors' obligations and capacity to public health and safety risks and ensure contractor supervision capacity to monitor the mitigation of these risks. • Preparing code of conduct for PEDO, PMO, Contractors, Sub-contractors, and service providers (such as security agencies, catering, transport, or any other services) on GBV/SEA/SH prevention and by integrating these measures/clauses in bidding documents. • Proactive GBV/SEA/SH prevention measures will be put in place, such as GBV/SEA/SH related training to sensitize workers and the local population along the project implementation area and ensuring that GRM for the project will also address the GBV related issues if any. • The workers will still be given awareness training to prevent any conflict. The training will focus on the appreciate behaviors near local women to prevent any unintentional disrespectful conduct in the event of any interaction. • The Contractor will employ their skilled staff and apply unskilled construction labor from the local population as far as possible to minimize an influx of outsiders into the communities. • The PMO will ensure compliance with the GoKP Act and policy and WB requirements related to GBV/SEA/SH. • The third-party monitoring agency of the project will also cover the monitoring of GBV/SEA/SH prevention measures. • Measures for receiving, reviewing, and acting as appropriate on GBV/SEA/SH concerns at the project management level. • Documentation and reporting of prevention and response in the progress reports of the project. • In all instances, the priority will be to protect the victims and keep the identity of the victim anonymous to prevent any backlash on the victim. • Gender Action Plan (Annex-II) will be implemented in the project area. • Certain gender-based restrictions are in place where women are prohibited from working in construction as well as on or near heavy machinery. Other national legislations in effect reduces women's working hours as well as restricts them from working night shifts. Although there are certain laws to ensure equal opportunities, women's participation rate remains one of the lowest in the world which makes it crucial to implement strict gender-based policies in the workplace. In addition, labor influx in the project sites, particularly in impoverished communities, may increase the			

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	likelihood of exploitive and coercive sexual relations with community members, particularly minors in exchange for goods or money. • As the project is Labor Intensive Public Works Project; therefore; in compliance to the KP Bonded Labor System (Abolition) Act, 1995, it is integral part of the ESMP, that the use of all forms of forced labor and child labors for MHPP project construction activities shall strictly be prevented by contractors. • In addition, compliance to the Khyber Pakhtunkhwa Prohibition of Employment of Children Act, 2015. the child labor will be disallowed on the project. The Project will not employ children or adolescents[84] for any Project-related activities. The Project will not employ children or adolescents for any Project-related activities.			
Environmental, Social and Occupational Health and Safety Risks during Operation				
Impact on aquatic habitat of the Swat River and its tributaries through the creation of reservoir/pondage	• A Fish ladder is designed (Figure 3.13) based on the requirements of snow trout, catfish, and other indigenous species. • Water will be released continuously through the fish ladder at all times. • After the construction of the weir and with an ecological flow of 3.5 cumecs, the water depth in the mainstream/river will be 0.8m. The sanctioned eflow 3.5m3/s will be bifurcated at the Weir site as 0.7m3/s flow will be released through fish pass and remaining 2.8m3/s will be released through mini-turbine. • Sensors and underwater video cameras will be placed on the ladder and monitored to count the fish and assess the effectiveness of the ladder. • to assess the effectiveness of the fish pass, monitoring mechanism will be implemented. • Installation of trash rack at the intake to prevent the fish from entering water intakes and protect the fish against entrapment. • Regular removal of deposited sediments from the ladder. • Monitor the effectiveness of the fish ladder and take adaptive measures to improve the performance of the fish ladder. • Supporting the fisheries department for upgrading their snow trout hatchery at Nagoha Shamozai, and annually releasing the fish both upstream and downstream of the weir.	ECP 13	Contractor	PIC, PMO

[84] Per this act, an "adolescent" means a person who has completed fourteenth but has not completed his eighteenth year of age.

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	• A Fish Management Plan (Annex-II) will be prepared and implementation will be ensured. • Sufficient budget will be allocated in the project budget for the above measures. Details of activities to be implemented under this budget will be worked out during the project implementation by the ESU staff of the PEDO in consultation with the fisheries departments, and the final list of activities will be shared with the World Bank prior to their implementation. • The Fisheries department will create an observation office near the entrance to the fish ladder to prevent illegal fishing and monitor licensed fishing activities (the recently passed Fisheries Act, 2022 allows the KP fisheries department to develop fisheries parks and issue fishing licenses. Officials suggested that they will utilize the newly established water reservoir / lake as fishing point for tourists). • A monitoring point / guard room will be constructed near the ladder entrance to intercept the hunters (fishers), especially during night time. • An office / information center will be constructed around the newly established reservoir/pond. • Fisheries Act, 2022 has been approved by KP government, which allows the department to develop fisheries parks and issue fishing licenses. Officials suggested that they will utilize the newly established water reservoir / pond as fishing point for tourists.			
Reduced water flow between the weir and the tailrace during low flow season	• Environmental flows have been estimated on hydrological analysis for the project, which is 3.5 m3/s. Hydrological modeling confirmed that the minimum flow to be maintained in Swat River will be 3.5 m3/s. • A Fish Management Plan (Annex-II) will be created to address the issues and provide tailored mitigation measures.	Follow ECP 13. Prepare and implement fish management plan (Annex-II).	Contractor	PIC, PMO
Risk of bird collision and electrocution from the transmission line	• Maintaining 1.5 meter (60-inch) spacing between energized components and grounded hardware or, where spacing is not feasible, covering energized parts and hardware; • installing elevated perches or insulating jumper loops; • placing obstructive perch deterrents (e.g., insulated" V's"), changing the location of conductors, and / or using raptor hoods; • Installing visibility enhancement objects such as marker balls, bird deterrents, or diverters after regular intervals	ECP 13	Contractor	PIC, PMO

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	• Construction of cage box on conductors to prevent the reported eagles and other low altitude flying birds from sitting or making nest on the towers; • Placing colorful/fluorescent tape on the towers to make them conspicuous; ensuring sufficient phase-to-phase and phase-to ground wire spacing.			
Reduction of sediment load in the downstream water flows from the reservoir	• Release of environmental flows and excess flows through sluices to release the sediments in the high flow season. • Schedule the flushing of sediments during high flow season from the desanders. Synchronize the flushing of sediments with other hydropower plants up and downstream so that cumulative impacts are minimal. • Avoid flushing at the same time. • Sediments will be flushed from the reservoir through under sluices during high flow season • Sediments from sand traps will be flushed regularly during high flow season • Environmental flows will be released through under sluices to allow some sediment flows during low flow season as well.	ECP 6	Contractor	PIC, PMO
Waste generation from the plant and staff colony	• Implement a waste management plan	ECP 1	Contractor	PIC, PMO
Improved livelihood opportunities from the development of tourist attractions	• PEDO will provide preference to affected persons in establishing small businesses in designated tourist areas established at the Project sites to improve their livelihood.	LRIP	Contractor	PIC, PMO
Exposure of toxic SF6 or arc products during maintenance of Circuit breakers and transformers	• Faulted SF6 will be handled carefully ensuring standard industry practices. World Bank Group's General EHS Guidelines will also be followed to handle SF6. Maintenance staff will observe the following guidelines: • Among other mitigation strategies, these include upgrading equipment to SF6-free circuit breakers to reduce SF6 use and leaks, establishing lifecycle approach for SF6 management, ensuring good management of SF6 acquisitions and gas inventory, training employees annually in SF6 handling and in using the necessary equipment, recycling SF6 gas at equipment servicing or disposal, implementing leak detection and repair strategies, and decommissioning equipment properly. • Do not breathe the vapors remaining in a circuit breaker where arcing or corona discharges have occurred in the gas.	ECP 2	PIC, PMO	Contractor

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	• Evacuate the faulted SF6 gas from the circuit breaker and flush with fresh air before working on the circuit breaker. • Arc products which do not recombine, or which combine with any oxygen or moisture present, are normally removed by the molecular sieve filter material within the circuit breaker. An Occupational Health and Safety Plan (Annex-III) will be created and include the above-mentioned mitigation measures, along with more detailed guidelines.			
Workers' health and safety during routine operation and maintenance	• Identify potential exposure levels in the workplace, including surveys of exposure levels in new projects and the use of personal monitors during working activities. • Train workers in the identification of occupational EMF levels and hazards • Establish and identify safety zones to differentiate between work areas with expected elevated EMF levels compared to those acceptable for public exposure and limiting access to properly trained workers. • Implement action plans to address potential or confirmed exposure levels that exceed reference occupational exposure levels developed by international organizations such as the International Commission on Non-Ionizing Radiation Protection (ICNIRP). The recommended EMF exposure levels by ICNIRP (also referred in WB EHSGs) are 10 kV/m for electrical field and 1000 µT for magnetic field • Personal exposure monitoring equipment will be set to warn of exposure levels that are below occupational exposure reference levels (for example, 50 percent). • Implement actions to minimize occupational exposure, which include limiting exposure time through work rotation, increasing the distance between the source and the worker, when feasible, or using shielding materials • Workers always use personal noise protective gear when working in high noise areas (typically areas with noise levels greater than 85 dBA). • Transmission line workers will be provided with adequate PPE and training on the safe use of equipment. • An Occupational Health and Safety Plan will be created and include the above-mentioned mitigation measures, along with more detailed guidelines.	Implement measures in the following ECPs: ECP 16 ECP 18 ECP 19	Contractor	PIC, PMO
Electrocution from overhead power lines, damaged tools and equipment, inadequate	• Only allowing trained and certified workers to install, maintain, or repair electrical equipment; • Deactivating and properly grounding live power distribution lines before work is performed on, or in close proximity, to the lines;	ECP 18 ECP 19	Contractor	PIC, PMO

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
wiring and overloaded circuits, exposed electrical parts, improper grounding, damaged insulation, and wet conditions.	• Ensuring that live-wire work is conducted by trained workers with strict adherence to specific safety and insulation standards. Qualified or trained employees working on transmission or distribution systems will be able to achieve the following: ○ Distinguish live parts from other parts of the electrical system; ○ Determine the voltage of live parts; ○ Understand the minimum approach distances outlined for specific live line voltages; ○ Ensure proper use of special safety equipment and procedures when working near or on exposed energized parts of an electrical system ○ Workers will not approach an exposed energized or conductive part even if properly trained unless: ○ The worker is properly insulated from the energized part with gloves or other approved insulation; or, ○ The energized part is properly insulated from the worker and any other conductive object; or, ○ The worker is properly isolated and insulated from any other conductive object (live-line work). ○ Where maintenance and operation are required within minimum setback distances (7.25 m for 765 kV connection), specific training, safety measures, personal safety devices, and other precautions will be defined in a health and safety plan; ○ Workers not directly associated with power transmission and distribution activities who are operating around power lines or power substations will adhere to local legislation, standards, and guidelines relating to minimum approach distances for excavations, tools, vehicles, pruning, and other activities; ○ Minimum hot stick distances may only be reduced provided that the distance remaining is greater than the distance between the energized part and a grounded surface. ○ PEDO will prepare an SOP based on the guidelines above for all maintenance work.			
Temporary accommodation related health risks	The contractor will develop and implement a Camp Management Plan	Implement measures in the following ECP:	Contractor	PIC, PMO

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
		ECP 16		
Additional Provision				
Chance finds during construction	Commensurate to Antiquity Act (1975) (amended in 1992), as for now, no known protected or unprotected antiquities are reported in the project area. However, keeping in view the excavation works for project, if buried/underground archaeological discoveries like elements of artistic value, inscriptions, coins, currency notes and engraved seals; objects of ethnological interests, pictures, paintings and drawings discovered, the PEDO will discontinue the construction works and shall report it to the Director Directorate of Archaeology and Museum, Khyber Pakhtunkhwa in wiring. Chance Finds Procedures which will be used during this Project are as follows: • Stop the construction activities in the area of the chance find; • Delineate the discovered site or area; • Secure the site to prevent any damage or loss of removable objects. In cases of removable antiquities or sensitive remains, a nightguard shall be present until the responsible local authorities and relevant Department of Archaeology take over; • Notify the supervisory Engineer who in turn will notify the responsible local authorities and relevant Department of Archaeology immediately (within 24 hours or less); • Responsible local authorities and relevant Department of Archaeology would be in charge of protecting and preserving the site before deciding on subsequent appropriate procedures. This would require a preliminary evaluation of the findings to be performed by the archeologists (within 72 hours). The significance and importance of the findings will be assessed according to the various criteria relevant to cultural heritage; those include the aesthetic, historical, scientific or research, social and economic values; • Decisions on how to handle the finding shall be taken by the local authorities and the relevant Department of Archaeology. This could include changes in the layout (such as when finding an irremovable remain of cultural or archeological importance) conservation, preservation, restoration, and salvage; • Implementation for the authority decision concerning the management of the finding shall be communicated in writing by the relevant Department of Archaeology; and	ECP 17	Contractor	PIC, PMO

Impact	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility	
			Implementation	Supervision
	• Construction work could resume only after permission is given from the local authorities and relevant Department of Archaeology concerning the safeguard of the heritage.			
River Protection	Compliance to KP Rivers Protection Ordinance, 2002, to provide for the protection of **aquatic ecology, water quality, economic and environmental value of rivers** and their tributaries in KP, the ordinance prohibits (i) construct, or undertake any related physical works of any commercial building or non-commercial building, or undertake any other developmental work, within **two hundred feet** on either side of the rivers or their tributaries or on a space within the limits between the banks of a river; (ii) **place or deposit or release, directly or indirectly, any substance into the river or their tributaries, in excess of the National Environmental Quality Standards (NEQS)** notified by Government from time to time; and; (iii) **dispose, directly or indirectly, any solid waste or hazardous waste or other additional substances** specified and notified by Government into rivers or their tributaries. **The Project is a hydropower project being developed on the main Swat River and the rules laid out in the ordinance relate mainly to encroachment onto the river and pollution of the river and in compliance, the contractor facilities like camp and batching plant shall be located away from the river and it is important that Project-related activities do not pollute the river and that all construction activities along the river banks be carried out within the area designated for the project as per proposed ESMP of this report.**	Implement the ECP-1, ECP-2, ECP-3, ECP-4, ECP-6, ECP-14 (Annex-I) and waste management plan (Annex-II).	Contractor	PIC, PMO

9.9.3 Construction Stage Monitoring Plans

The proposed monitoring plan to be carried out during the construction stage of the Project to ensure contractors are complying with the mitigation measures is given in **Table** 9-5**,** along with the monitoring indicators and frequency. PIC will be responsible for the supervision of the implementation of the plan.

Table 9-5: Effects Monitoring Plan during Construction

Parameter	Means of Monitoring	Location	Frequency	Responsibility	
				Implementation	Supervision
Topsoil storage	Visual inspection of stripping, storage and reuse of topsoil	Excavations	Monthly & Weekly in rainy season	Contractor	PIC, PMO
Erosion	Visual inspection of erosion prevention measures and the occurrence of erosion	All sites	Monthly & Weekly in rainy season	Contractor	PIC, PMO

Parameter	Means of Monitoring	Location	Frequency	Responsibility	
				Implementation	Supervision
Wastewater discharges from tunnels and batching plants, and campsites	Spot measurement for pH Visual inspection to ensure clear water leaving the site	Tunnel and batching plant discharges	Weekly	Contractor	PIC, PMO
	Sampling and analysis of wastewater discharges for the parameters given in NEQS	5 sites (including tunnel, batching, camp discharges)	Monthly	Contractor	PIC, PMO
Surface water quality	Sampling and analysis of river water quality parameters like color, taste, odor, temperature, turbidity, BOD, COD, DO, TDS, EC, pH by comparing with the Pak NEQS threshold levels.	5 sites in the river	Monthly	Contractor	PIC, PMO
	Visual inspection of the presence of petroleum products.	All sites	Monthly	Contractor	PIC, PMO
Air Quality (dust)	Visual inspection to ensure good standard equipment is in use and dust suppression measures (spraying of waters) are in place.	All sites	Daily	Contractor	PIC, PMO
	Visual inspection to ensure dust suppression work plan is being implemented	All sites	Daily	Contractor	PIC, PMO
Atmospheric monitoring in tunnels	Spot and 8-hour measurements for O_2, CO, H_2S, CH_4, and CO_2	In the tunnel	Each shift	EU-PIC	PMO
Ambient Air Quality	Air quality monitoring for 24 hours for the parameters specified in NEQS	At 5 sites	Monthly	Contractor	PIC, PMO
Noise and vibration	24-hour noise monitoring (at/near construction sites, campsites, offices, colony, communities, quarry area, transportation routes)	At 5 sites	Monthly & daily in case of major construction works	Contractor	PIC, PMO
Emissions from plant and equipment	Visual Inspection	All vehicles	Monthly	Contractor	PIC, PMO
Waste Management	Visual inspection of spoil disposal	At disposal sites	Monthly	Contractor	PIC, PMO
	Availability of dust bins at worksites and camp	At camp and work sites	Monthly	Contractor	PIC, PMO
	Collection and treatment of organic waste	At campsite	Monthly	Contractor	PIC, PMO

Parameter	Means of Monitoring	Location	Frequency	Responsibility	
				Implementation	Supervision
	Collection and treatment of recyclable and hazardous waste by the waste management contractor	At camp and work sites	Monthly	Contractor	PIC, PMO
Operation of quarry sites	Visual inspection of quarry sites	At quarry sites	Monthly	Contractor	PIC, PMO
Spills from hydrocarbon and chemical storage	Fuels are stored in contained facilities Availability of spill kits at the site Visual Inspection for leaks and spills	At fuel storage sites	Monthly	Contractor	PIC, PMO
Traffic Safety	Placement of traffic signs and traffic control personnel	Near the construction sites	Monthly	Contractor	PIC, PMO,
CHS risks	Preparation and implementation of the OCHSMP Plan in line with the **Annex-III.**	Construction sites	Monthly	Contractor	PIC, PMO,
Local Roads	Visual inspection to ensure local roads are not damaged	Kalam-Gabral Road	Monthly	Contractor	PIC, PMO,
Cultural and Sites	Visual observation for cultural sites	Along the local roads	Monthly	Contractor	PIC, PMO,
Drinking water and sanitation	Water quality analysis for drinking water parameters specified in NEQS	At the campsite	Monthly	Contractor	PIC, PMO,
Safety of workers	Usage of Personal Protective Equipment	All worksites	Daily	Contractor	PIC, PMO,
Labor engagement and GBV risks (including SEA/SH risks)	Interaction with labors and review of GRM	All work sites	Monthly	Contractor	PIC, PMO
Reinstatement of Work Sites	Visual Inspection	All worksites	After completion of all works	Contractor	PIC, PMO,
Grievances	GRM entry points are establish at different locations of the project site and Project Office. Staff are recruited at the PMO and Supervision Consultant as well as by Contractor.	All worksites	Before commencement of physical works	PMO, PIC and Contractor	PIC, PMO,

9.9.4 Reporting on ESMP Compliance

PMO and its Contractors will prepare periodic monitoring reports on the status of implementation of ESMP and will be submitted to World Bank for their review and feedback. Details of these reports and their content are given in Table 9-6.

Table 9-6: ESMP Monitoring and Compliance Reports

Sr. No.	Title of the Report	Contents of the Report	Frequency of Report Preparation	Report to be prepared by
1	OHS and ESMP Monitoring Report	The compliance status of the Project with environmental and social mitigation and monitoring measures. Besides, the report also covers: • ESMP implementation progress report • Environmental incidents; • Leading indicators (inspections, walk-through by supervisors, OHS Officer and management, work observation, training, tool-box talk, meetings, reward and recognition.) • Lagging indicators (fatalities, lost-time injuries, medical treatment cases, first-aid cases and near-misses); • Health and safety supervision: • Usage of PPE by workers • Worker accommodations • Worker's grievances • Community grievances • Chance Finds (if any)	Monthly	Contractor
2	ESMP & OHS/CHS Monitoring Report	The compliance status of overall Project with ESMP & OHS/CHS requirements	Monthly	PIC/PMO
3	ESMP & OHS Monitoring Report	The ESMP & OHS/CHS implementation progress reports	Quarterly	PIC/PMO
4	Incident Reports	Incident flash report, Incident investigation reports for all major incidents covering details of the incident, root cause analysis, and actions taken to address the future recurrence of this event	Initial investigation report within 24 hours Detailed Investigation Report within seven days	Contractor
5	Ecological monitoring	Quarterly Ecological monitoring will be carried out in the area to ensure that the ruderal habitats are being populated by native vegetation and not being taken over by invasive species.	Quarterly	PIC/PMO
6	Project Completion Environmental, Health and Safety Monitoring Report	One year after completion of construction, the ESU PEDO with the support of PIC will submit a Project Completion Environmental Monitoring Report which will summarize the overall environmental and social impacts and risks from the project.	After physical works completion	PIC/PMO

Contractor will prepare two separate monthly reports, one for Environmental and Social Management and the second one for OCHS Management. The ESU with assistance from PIC and contractors will also produce monthly reports based on site inspections and review of contractor's monthly ESMP and OCHS reports.

Contractor and PIC Monthly Report: Implementation schedule of the mitigation plans and safety inspections and preventive controls suggested in the ESMP will be reported in all monthly reports. The outcome of the field inspections and audits will be reported in all monthly report. Contractors will present the implementation schedule of mitigation measures and preventive actions in all monthly report along with monitoring and auditing and PIC will confirm the status of mitigation and preventive measures claimed by the Contractor.

Quarterly Progress Reports on Environment, Health and Safety: The environmental, Social, Health and Safety monitoring reports will include environmental and social mitigation measures and preventive actions undertaken, environmental and social monitoring activities conducted, details of monitoring data collected, analysis of monitoring results particularly the non-compliances, recommended mitigation and corrective measures, GRM data, ESHS training conducted, and environmental and OHS regulatory violations observed. The monitoring reports will be submitted quarterly during the construction period and annually for three years after completion of construction to EPA.

Project Completion Environmental, Health and Safety Monitoring Report: One year after completion of construction, the ESU will submit a Project Completion Environmental Monitoring Report which will summarize the overall environmental and social impacts and risks from the project.

9.10 Environmental and Social Management during Operation

9.10.1 O&M Stage Mitigation Plans

Detailed mitigation plans for operation and maintenance (O&M) stage impacts have been prepared on the basis of the detailed impact assessment covered under Chapter 7 and presented in **Table** 9-7. PMO's ESU staff will be responsible for implementing these measures.

The plans applicable to the O&M stage of the project will be prepared in perspective to cover the O&M stage aspects as well.

Table 9-7: ESHS Impacts and Risks in O&M and Mitigation Measures

	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility for implementation
Impact on aquatic Habitat of the Indus and its Tributaries through the Creation of Reservoir	• A Fish Management Plan (Annex-II) will be prepared and implemented to manage any potential risks on and related to the fishes. The fish management plan will be applicable for the O&M stage of the project. • eFlow OF 3.5 m^3/s is determined in the ESIA to maintain fish up and downward migration and river connectivity. This flow will be ensured throughout the year.	Implement measures in the following ECPs: ECP 3 ECP 14 and fish management plan (Annex-II)	PEDO O&M Staff PEDO ESU staff
Barrier effect on fish migration	• A fish ladder is considered in the design (Figure 3.13) with the weir to allow the movement/migration of fish on both up and downstream. The width of the proposed fish ladder is 1.2m, gradient of fish ladder is considered 1:14, drops/pool is 0.2 m, rest pool is provided after four drops, velocity in fish ladder is considered 0.42m/sec, cross-section of the entrance is (1.2 m x 0.5m) 0.6 m2, and the length is 116.5m. During the plant operation, a comprehensive monitoring regime will be implemented for the performance of fish ladder. • With the eflow of 3.5m3/s, the water depth in the river channel will be 0.8m. The eFlow of 3.5m3/s will be divided between mini-turbine (2.8 m3/s) and fish pass (0.7 to 0.76 m3/s), ensuring 0.5m to 1m water depth in the fish pass. A trash rack is integrated in the mini-turbine to avoid entrapment of the fish into the mini-turbine. • Sensors and underwater video cameras[85] will be placed on the ladder and monitored to count the fish and assess the effectiveness of the ladder[86]. • For monitoring performance of the fishway/fish pass, multifaceted monitoring program has been. During the consultation with the officials of the fisheries department, the following were suggested: • A monitoring point / guard room will be constructed near the ladder entrance to intercept the hunters, especially during night time. • An office / information center will be constructed around the newly established reservoir/pond. • Fisheries Act, 2022 has been approved by KP government, which allows the department to develop fisheries parks and issue fishing licenses. Officials	Implement measures in the following ECPs: ECP 14 and fish management plan (Annex-II)	PEDO O&M Staff Impact PEDO ESU staff

[85] Also proposed for Gabral Kalam HPP.

[86] ESIA Gabral Hydropower Project https://documents1.worldbank.org/curated/en/828001577945660144/pdf/Environmental-and-Social-Impact-Assessment.pdf.

	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility for implementation
	suggested that they will utilize the newly established water reservoir / pond as fishing point for tourists.		
Reduced water flow between weir and tailrace during low flow season	• Hydrological modelling conducted by PIC confirmed that the minimum flow to be maintained in Swat River will be 3.5 m^3/s. PIC also conducted various literature review for snow trout requirements and concluded that the minimum flow requirements for snow trout is 2.5-3.5 m^3/s during the migratory season (March-April and September-October). A Fish Management Plan will be created to address the issues and provide tailored mitigation measures.	Implement measures in the ECP 3 ECP 14 ECP 20 and fish management plan (Annex-II)	PEDO O&M Staff PEDO ESU staff
Microclimate and Emission of Greenhouse Gases	• Most of the few organic materials as trees and shrubs. will be removed before filling the reservoir. This reduces the generation of greenhouse gases to a minimum. Compared with oil or coal-fired power plants, the emission of CO2 can be neglected.	Implement measures in the following ECPs: ECP 10	PEDO O&M Staff PEDO ESU staff
Risk of bird collision and electrocution from the transmission line	• There is no known bird migration route in the Project area. Insulation of exposed parts of the tower structure. Installation of bird markers to divert migratory birds to prevent collision and electrocution can be considered in the design. • During detail design and construction, avian risk mitigation design solution will be integrated in line with the international best practices keeping in view the key birds reported in the baseline study as well as a review of the alignment of proposed transmission lines.	Implement measures in the ECP 13	PEDO O&M Staff PEDO ESU staff
Reduction of sediment load in the downstream water flows from the reservoir	• Release of environmental flows and excess flows through sluices to release the sediments in the high flow season. • Schedule the flushing of sediments during high flow season from the desanders. Synchronize the flushing of sediments with other hydropower plants up and downstream so that cumulative impacts are minimal. Avoid flushing at the same time.	Implement measures in the following ECPs: ECP 3 ECP 5 ECP 6	PEDO O&M Staff PEDO ESU staff
Occupational Health and Safety Risks during Operation			
Worker's health and safety during routine operation and maintenance	• Implementation of Standard Operating Procedures.	Implement measures in the ECP 16 ECP 18 and occupation al health and safety	PEDO O&M Staff

	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility for implementation
		management plan (Annex-III)	
Exposure of toxic SF6 or arc products during maintenance of Circuit breakers and transformers	• Faulted SF6 will be handled carefully ensuring standard industry practices. World Bank Group's General EHS Guidelines will also be followed to handle SF6. Maintenance staff will observe the following guidelines: • Among other mitigation strategies, these include upgrading equipment to SF6-free circuit breakers to reduce SF6 use and leaks, establishing lifecycle approach for SF6 management, ensuring good management of SF6 acquisitions and gas inventory, training employees annually in SF6 handling and in using the necessary equipment, recycling SF6 gas at equipment servicing or disposal, implementing leak detection and repair strategies, and decommissioning equipment properly. • Do not breathe the vapors remaining in a circuit breaker where arcing or corona discharges have occurred in the gas. • Evacuate the faulted SF6 gas from the circuit breaker and flush with fresh air before working on the circuit breaker. • Arc products which do not recombine, or which combine with any oxygen or moisture present, are normally removed by the molecular sieve filter material within the circuit breaker. • An Occupational Health and Safety Plan (Annex-III) will be created and include the above-mentioned mitigation measures, along with more detailed guidelines.	Implement measures in the following ECPs: ECP 18	PEDO O&M Staff
Electrocution from overhead power lines, damaged tools and equipment, inadequate wiring and overloaded circuits, exposed electrical parts, improper grounding, damaged insulation, and wet conditions.	• Conduct a job hazard analysis to identify the hazards. Follow PEDO's standard operating procedure for repair and maintenance. Only, qualified persons using proper test equipment and personal protective equipment must adhere to limited approach boundary with a distance of 7.25 m for 220 kV voltage. Must comply with the working space requirement for the equipment. Receptacles and cord connectors used in damp or wet locations must be designed for use in wet or damp locations and, unless approved for submersion, must not be allowed to lie in water. •	Implement measures in the ECP 18	PEDO O&M Staff
Social Impacts during Operation Stage			
Waste generation from the plant and staff colony	• Implement a waste management plan	Implement measures in the ECP 1	PEDO O&M Staff

	Mitigation/Enhancement Measures	Generic Mitigation Measures	Responsibility for implementation
		ECP 16 and waste management plan (Annex-II)	
Community health and safety from exposure to EMF of transmission lines and risk of weir failure	• Complied with World Bank recognized standards on EMF through design considerations. • Review of weir designs by an independent panel of experts	Implement measures in the ECP-18 (Annex-I) and occupational health and safety management plan (Annex-III):	PEDO O&M Staff
(Beneficial Impact) Improved livelihood opportunities from the development of tourist attractions	• PEDO will provide preference to affected persons in establishing small businesses in designated tourist areas established at the Project sites to improve their livelihood.		PEDO O&M Staff
Adverse impacts on community due to tourism from waste generated by the tourists	• The tourist facilities include waste collection bins and public toilets (separately for men and women), which will be maintained regularly by PEDO/NHA. The solid waste management system adopted for the PEDO colony and offices will be used for the collection, storage, transportation and disposal of solid waste from the tourist facilities. • Information posters could be hung around the Project-related tourist facilities about the proper etiquette to follow when encountering locals, especially women.	Implement measures in the ECP 1 (Annex-I) and waste management plan (Annex-II)	PEDO O&M Staff TCKP
Water-related Vector Diseases	• within the construction sites to prevent workers from excreting into the river • PEDO must create and maintain sanitation facilities near tourist areas created because of the MHPP • During construction and operation, minimize the presence of stagnant water and puddles by improving the drainage facilities. • • Ensure water flow of the river is not distrusted in order to prevent water sitting in the reservoir for too long	Implement measures in the following ECPs: ECP 1 ECP 3 ECP 15 ECP 18	PEDO O&M Staff

9.10.2 O&M Stage Monitoring Plans

The proposed monitoring plan to be carried during the O&M stages of the Project is given in Table 9-8 along with the monitoring indicators and frequency. PMO's ESU staff will be responsible for the implementation of the plan.

Table 9-8: Effects Monitoring Plan during O&M

Parameter	Means of Monitoring	Frequency	Responsibility	
			Implementation	Supervision
Downstream river flows	Measurements of discharges to the downstream	Monthly	PEDO O&M Staff	ESU
Fish counts	Data collection from sensors and monthly compilation of data	Monthly	PEDO O&M Staff	ESU
Fish catch surveys	Fish catch surveys to assess the use of ladder by the snow trout and brown trout	Monthly	PEDO O&M Staff	ESU
Waste	Collection and disposal of waste including hazardous waste	Monthly	PEDO O&M Staff	ESU
Weir Safety	Monitoring of data from weir safety equipment	Quarterly	PEDO O&M Staff	PEDO
EMF Exposure	Monitor EMF Levels in the powerhouse and switchyard	Continuous monitoring	PEDO O&M Staff	ESU
Water quality	Monitor water quality from the reservoir and on the fish ladders	Six-monthly	PEDO O&M Staff	ESU
Waste Management	Visual inspections to ensure the availability of waste collection bins at the tourist sites and regular waste collection and management	Continuous monitoring	PEDO O&M Staff	ESU

9.11 Capacity Building and Training

The environmental and social training will help to ensure that the requirements of the ESMP are clearly understood and followed by all project personnel. The competencies of the Consultant to be selected for capacity-building training will include a thorough knowledge and experience of WB Operational Policies and ESHGS guidelines. The trainings will be provided to different professional groups separately, such as managers, skilled personnel, unskilled labors, and camp staff. Capacity building will be aimed at strengthening the PMO staff in the field of environmental management and social development. Safeguard staff of PMO responsible for the supervision of environmental and social mitigation measures would be trained in environmental management, environmental quality control, ecology, environmental awareness, labor and working conditions, and social development. The contractor will also be required to provide environmental and social trainings to its staff to ensure the effective implementation of the ESMP. The training plan shall include a program for the delivery of intermittent training to cover the subjects included in **Table** 9-9**.** Training will be carried out initially at the induction of staff and repeated throughout the project.

Table 9-9: Environmental and Social Training Programs

Contents	Participants	Trainer	Schedule
Environmental and social impacts of the Project and ESMP requirements of the Contractor; World Bank Group Environmental Health and Safety Guidelines. The contents for the second and subsequent training programs will cover topics related to the issues associated with on-going construction activities.	All the technical Staff of PMO/ ESU, and relevant technical staff of PEDO who are involved in the management of environmental, social, health and safety issues associated with routine operation and maintenance of the powerplant. Site Engineers and EHS staffs of the Engineer/ PIC.	ESHS staff of the PIC; and an external training agency who has a thorough knowledge of the WB safeguard policies and guidelines	During the initial stages of the Project implementation. The training will be repeated every six months.
Occupational Health and Safety Job Hazard Analysis Incorporation of EHS in Method Statement	Site Engineers of the Contractor, PMO, and the PIC	E&S staff of the PIC, PMO	Prior to the start of the construction activities and during the construction activities (To be repeated as needed.)
Code of Conduct	Construction Staffs	Contractors ESHS Staff	
Road safety; Defensive driving/; Waste disposal; Cultural values and social sensitivity.	Drivers;	Contractors	Before and during the field operations. (To be repeated as needed.)
Importance and use of PPE and emergency communication Excavation, Cranes and Rigging, Working at heights, scaffolding,	Workers	Contractors	Before and during the field operations. (To be repeated as needed.)
Application of Contractual Instruments during OHS violations Excavation and trenching Blasting Methods in Road construction and related OHS	Contractor, PIC, ESU	PIC	During construction.

Contents	Participants	Trainer	Schedule
OHS in handling and transportation of mechanical equipment			
International Standard Training on EHS for ESU Staffs in WAPDA Administrative Staff College	ESU Staffs	Asian Institute of Technology	During Construction

9.12 Audits and Annual Review of ESMP

Internal environmental safety audits will be held on a monthly basis with an objective to review the effectiveness of environmental and social management of the project. PIC, under the supervision of PMO, will carry out an annual review of the appropriateness and adequacy ESMP in the light of its own monitoring and supervision as well as on the basis of the third-party monitoring and audits discussed earlier. PIC will revise the ESMP in case substantial gaps and shortcomings are identified in these plans.

External third-party environmental audits will be held with an objective to review the effectiveness of environmental and social management of the project. It is proposed that third party will carry out these audits on a yearly basis. These audits would be used to re-examine the continued appropriateness of the ESMP and to provide advice on any updates required.

9.13 Grievance Redress Mechanism

9.13.1 PEDO's Existing GRM

PEDO has a provision for receiving written complaints manually and their redressal but does not have standard operating procedures to receive and redress complaints and there is no practice of redressing anonymous complaints. The PEDO has been receiving and redressing complaints under the "Pakistan Citizen Portal," a government-owned Mobile Application established by Prime Minister's Performance Delivery Unit since, 2019 and is being used as a tool to promote citizen-centric and participatory governance. It is an integrated citizens' grievance redressal system connecting all government organizations both at the federal and provincial levels.

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A Project-specific grievance redress mechanism (GRM) for Gabral Kalam Hydropower Project (GKHPP) under KHRE is already established and functional. Based on the same model a project specific grievances redressal mechanism for MHPP will be established to receive, evaluate, and facilitate the resolution of affected parties concern, complaints, and grievances about the environmental and social performance of the Project.

A three-tier GRM has been designed to provide a time-bound, early, transparent and fair resolution for PAPs and other stakeholder grievances regarding E&S management of each project. All complaints received verbally or in writing will be properly documented and recorded in the Complaint Management Register(s). All possible efforts will be made to redress complaints through project-specific GRM and the complainants will also be encouraged to seek redressal of their complaints through this mechanism. Despite all efforts, if the complainant will not be satisfied with the resolution, s/he will have a right to lodge his/her complaint at the higher government administration or at the related court. If the complaint cannot be resolved at these three tiers, the complaint will have a choice to lodge his/her complaint at the related court of law. The GRM for the Program is outlined below and consists of three levels with time-bound schedules for addressing grievances and a detailed description of the GRM plan is given in the RAP.

The GRM have the ability to handle anonymous complaints. All complaints will be treated as confidential. The GRM will not disclose any personal data that may reveal the identity of complainants without his or her consent. If the complainant does not wish to stay anonymous, the name, address, telephone number, email, and/or other contact information of a contact representing the complainant should be provided.

The contractor will be required to establish worker GRM on the site as per their HR policy. This requirement will be ensured in the contractor's bidding documents.

First Tier of GRM. The PMO's project site office will be the first tier of GRM, which will offer the fastest and most accessible mechanism for the resolution of grievances at the local level. A local level Grievance Redressal Committee (GRC) will be formed for this purpose headed by the Project Director with the membership of Director-ESU, Land Acquisition Collector and other relevant staff of Revenue Department, contractors' representatives, consultants' representatives, representatives of other relevant departments, and two members from each PAP Committee. At this tier, the designated E&S staff of the PMO site office will try to resolve the complaints within two to 10 working days, depending on the nature of the grievance. The PD will convene the meetings of local GRC and conduct proceedings informally to reach an amicable settlement between the parties within 10 days of receiving a complaint (verbally or in writing) from an affected person or their representative. The report of the GRM meetings will be recorded in writing, and copies will be provided to the parties involved. Grievances will be documented with personal details (name, address, date of the complaint, and nature of the complaint) unless anonymity is requested. A tracking number shall be assigned to each complaint/grievance. Will the grievance remain unresolved or the AP not be satisfied with the decision, the grievance can be lodged with the Program level grievance redress committee, led by the head of PMO.

Second Tier of GRM. The E&S staff in PMO will refer to the unresolved issues or grievances (with written documentation) to the second tier of GRM, the PMO central level Grievance Redress Committee (GRC). The central level GRC shall be established by PEDO and will consist of the following persons: (i) a PEDO representative from senior management; (ii) the head of PMO will act as secretary of the GRC; (iii) Project Director of respective project; (iv) representative of DC office; (v) representative of PIC; (vi) Chief Resident Engineer of the Consultants (on-call); (vii) representative of relevant government offices (on-call); (viii) two to three representatives of respective PAPs (on-call). A hearing can be called with the GRC, if necessary, where the PAPs can present details of his/her/their concern/grievance. The GRC will meet as necessary when there are grievances to be addressed. The GRC will suggest corrective measures at the field level and assign clear responsibilities for implementing its decision within 15 working days, depending on the nature of the grievance. All possible efforts will be made to redress complaints through project-specific GRM and the complainants will also be encouraged to seek redressal of their complaints through this mechanism. Despite all efforts of complaint redressal, if the complainant is unsatisfied with the decision, the existence of the GRC shall not impede the complainant's access to the government's administrative or judicial remedies.

Third Tier of GRM: In the event that a grievance cannot be resolved directly by the second tier GRC or If a complainant is dissatisfied with the decision of GRC, the affected people can seek alternative redress through the Chief Executive Officer (CEO) or Board of Directors of PEDO, district administration, the Secretary Energy and Power Department or higher-level administrative authorities, the Pakistan Citizen Portal or the court of law, as appropriate.

Grievance Redressal Committee: The central level Grievance Redress Committee (GRC) will be formed by PEDO and as a continuing and functional structure, engaging personnel of PMO and other parties. The PEDO will specify that representatives of local/community authorities, elders, auditors, displaced persons and any other persons or entities can be included in the Committee as members. The details of central GRC and field-level/project site level GRC are provided in the RAP of MHPP including their composition and functions.

Monitoring and reporting. The monitoring reports of RAP and ESMP implementation will include the following aspects pertaining to progress on grievances: (i) number of cases registered, level of jurisdiction (first, second, third tiers), number of hearings held, decisions made, status of pending cases; and (ii) lists of cases in process and already decided upon, may be prepared with details such as name with copy of NIC, complaint number, date of application, date of hearing, decisions, remarks, actions taken to resolve issue(s), and status of grievance (i.e., open, pending, closed).

10 Stakeholder Consultations and Disclosure

10.1 Introduction

Stakeholder consultation is an inclusive process that involves relevant stakeholders throughout the project life cycle. This requires an open and transparent engagement, coordination, and consultations with all the stakeholders to get their inputs and feedbacks in project planning, design, and implementation. The Project proponent, PEDO also places great importance to stakeholders' consultations at every step of the Project. This Chapter describes the procedure of consultations, methodology used and the outcome of the consultations held with different stakeholders, including institutions, experts, project proponent and the communities affected by the project, and institutions and experts at the level of draft ESIA report.

10.2 Objectives of the Consultation and Participation

Objectives of stakeholder consultations are, (a) to inform the stakeholders about the projects and its potential environmental and social impacts/risks and obtain community feedback on project impacts and perceived benefits. For project-affected people, this provides an opportunity to obtain project information, to raise issues and concerns, and ask questions and/or provide suggestions that can potentially help shape the Project and (b) to enhance the quality of decisions making ultimately leading towards sustainable development. Therefore, the primary purpose of consultation in this project was to develop a more acceptable project design on a consultative basis and address the concerns raised in the process to share the benefits of the project, particularly by those immediately affected by the Project construction. The national/provincial legislations and WB safeguard policies require consultations to be carried out particularly with the affected communities as part of the environmental and social assessment process.

The specific objectives of the consultation were: (i) provide project information to the stakeholders and obtaining local and indigenous knowledge about the environment and people living in the nearby areas of project alignment; (ii) interaction with the project affected population and other stakeholders for the collection of primary and secondary data on environment and people; and (iii) engaging stakeholders for maximization of the project benefits. The consultations carried out during the present ESIA and reported in this Chapter meet these requirements.

10.3 Stakeholder Identification

Stakeholders are considered to be individuals or organizations which have an interest in the proposed project or knowledge that would provide insight into issues or affect decision making related to the proposed project. On the basis of interest and role criteria, there are two types of stakeholders for the proposed project, which are presented in the following sections.

10.3.1 Primary Stakeholders

The primary stakeholders are primarily the project affected persons and general public including women residing in the project area - for example, people living in the project area particularly those affected by the footprint of the Project components (weir, powerhouse, colony, spoil disposal, access road, tunnel and adit portals). These are the people who are directly exposed to the project's impacts though in most cases they may not be receiving any direct benefit from the project.

10.3.2 Secondary Stakeholders

The secondary stakeholders are typically institutional stakeholders – for instance, related government department/agencies, local government, and organizations that may not be directly affected by the project; however, they may influence the project and its design. They include project proponent PEDO, local administration, local electives, other concerned departments such as forest, fisheries, wildlife, NHA, and tourism that may have a role during various phases of the project, regulatory agencies such as KP EPA, non-governmental organizations (NGOs), the broader interested communities including academia and journalists, and general public.

10.4 Consultation Framework

Consultation is necessary to ascertain the stakeholders and public's views and providing an opportunity for the people and stakeholders to participate in the project design and development. The consultation involves actively seeking the opinions of those interested or affected by the project. It is a two-way flow of information, which may occur at any stage of development from project identification through planning, design, construction and operation. It may be a process or a continuing dialogue between project implementation authority and the affectees. Consultation is increasingly concerned with the objective of gathering information and finds the acceptable solutions.

The guiding principle underlying consultations was that the environmental and social safeguards planning and implementation must follow a consultative and participatory process to ensure success of the project. This was further reinforced by the requirements of the World Bank OP 4.12 and Bank's Access to Information Policy (2010), which give high priority to public consultation and participation in designing and implementation of a socially and environmentally compliant project in addition, compliance to KP EPA Act, 2014, public hearing will also be carried out for the project.

10.5 Consultation Process

As part of the present ESIA, detailed consultations were carried out through village-wise meetings, individual meetings, and focus group discussions (FGDs) with the communities, including women in the project area. PEDO has officially communicated with Deputy Commissioner/Collector District Swat to depute concerned officials of Moza Kadam, Kalgay and Ayeen, of Tehsil Bahrain to provide Khasrah numbers. of the land falling in the footprint of Madyan HPP so that further requirements of land acquisition be fulfilled timely. This letter has been marked to Assistant Commissioner and now is with Tehsildar of the Revenue Department In aligned to this letter, Deputy Director (Purchase of Land), PEDO and Social team have made consultations with the local community whose land is expected to be acquired for Madyan HPP. After receiving this data from the revenue department, draft Notification under Section 4 of Land Acquisition Act, 1894 will be shared with DC, so that PEDO could negotiate rates of land with land owners.

To facilitate the consultation process, PEDO has provided a letter for community and institutional stakeholder consultations to PIC notifying that PIC is working in the Madyan HPP and will consult local community on behalf of PEDO. PIC used this letter to introduce the local community leaders, brief them about the project scope and objectives, note their suggestions/concerns. After this, with the support from these community leaders, public consultation meetings were organized, that helped obtaining community support. Consultations have been done in an open environment, in which the community expressed their view freely without any coercion. In addition, drat ESIA was presented in a public hearing as per the requirements of KP EPA. Details of this consultations are described below.

10.5.1 Consultation Meetings with Communities

Extensive consultations were carried out with the various stakeholders of the Project. Consultations involved multiple methods such as household-level interviews, village-wise meetings, focus group discussions, individual meetings with government departments, and workshops. The 2022 consultation activities conducted by PIC included 12 FGDs with 176 males and 51 females in 6 villages, 23 meetings with government officials and academicians with 33 individuals, were done to share key findings of Environmental & Social Impact Assessment and mitigation measures and obtain feedback on the E&S issues and cumulative effects of hydropower project implementation in Swat River System. In addition, during 2009 FS, consultations were also conducted with the government officials, NGO, affected communities and local businesses. Locations of all consultation meetings are presented in **Figure 10.1**. Details of stakeholders consulted are given in Table 10-1 Photographs of the consultations with all communities are presented in Annex-VI.

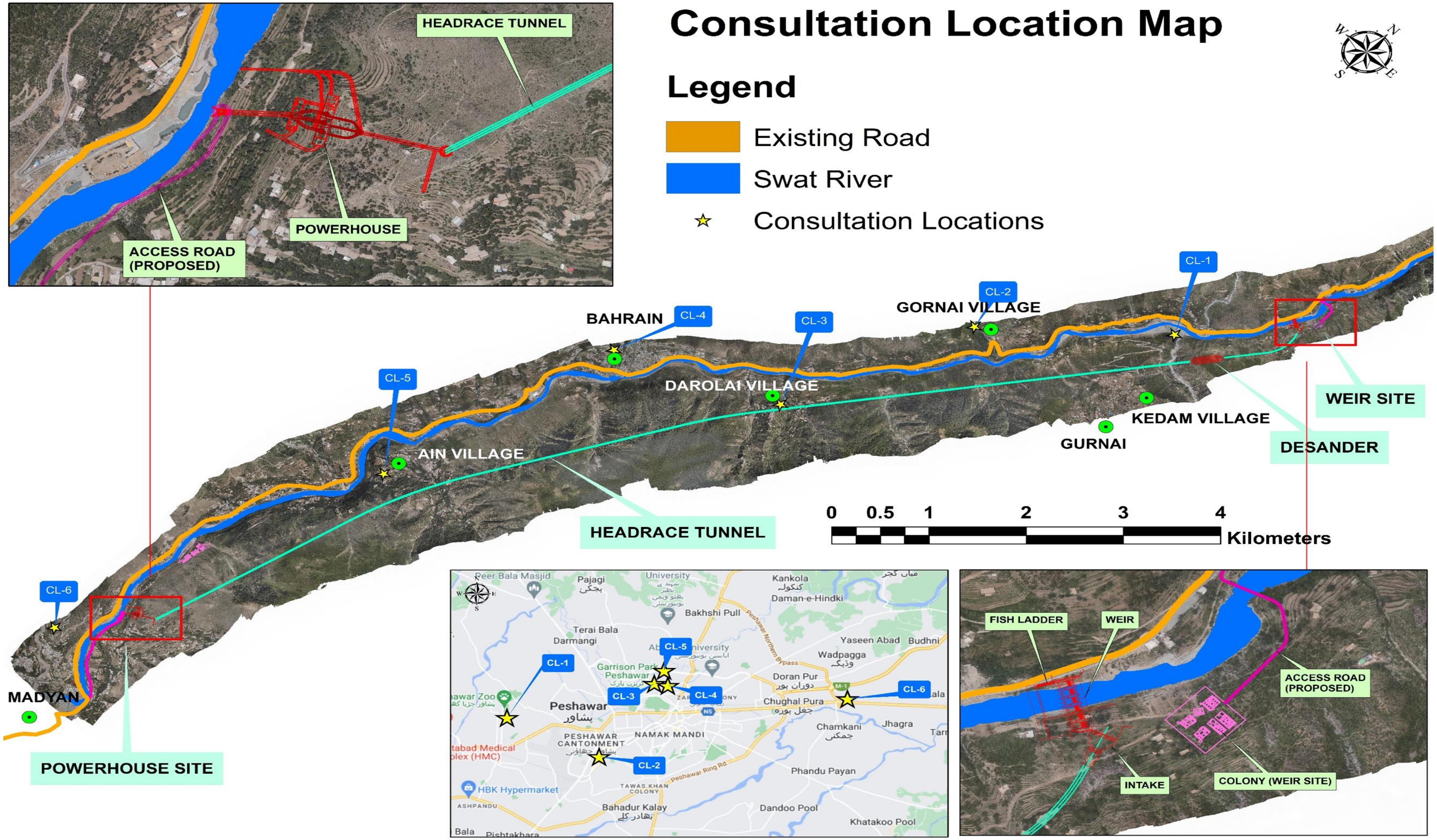


Figure 10-1: Location of Consultation Meetings

Table 10-1: Details of Stakeholders Consulted

Type of Stakeholders	Stakeholders Consulted
The general population in Project Area	Local community including affected people, Female, local community leaders of Ayeen, Kalgay, Kedam, Ponkia, Darolai, and Gharijo villages
Local and district governments	District Administration, Revenue Department, Agricultural department, Fisheries Department Madyan, Wildlife Department Range Officer Bahrain, Forest Department Kalam Forest Division Madyan, Irrigation Department Upper Swat, Upper Swat Tourism Authority, Archelogy Department Saidu Sharif Swat, Minerals Development Department Mingora Swat, Tehsil Municipal Administration (TMA) Bahrain, KP Emergency Rescue Office Swat, Public Health Department Matta Swat, Education Department Swat, Communication and Works Department Matta Swat, Social welfare special Education and Women Empowerment, Technical and Vocational Center (Boys) Mingora Swat, On-Farm Water Management Department Swat
Provincial government	Environmental Protection Agency, Forest Department, Forestry Department, National Highway Authority, Tourism, Archaeology,
Academic institute	Professors and researchers from Peshawar University
Non-government organizations/Non-profit organization	Sky-Aid (NGO) Lasoona Organization Saidu Sharif Swat

10.5.2 Approach followed for Consultations with Women and Vulnerable Groups

In general, the women of the project area of influence have a restricted cultural environment. Due to the limitations of women to participate in public meetings, women-specific consultations were conducted to get women’s feedback, their perspectives, aspirations, needs and priorities. The consultations were conducted at locations that were socially acceptable for women and in their own language by female field staff only. In total 156 men and 51 women participated in consultations. The qualitative tools were used to conduct the consultations such as focus group discussions and in depth and key informant interviews. These included perception analysis of women on:

- Nature and extent of positive and adverse impacts and risks of the project on women and children that can enhance or reduce their wellbeing and vulnerability;
- Coping strategies to recover from economic shocks such as loss of land, properties and income and livelihoods;
- The mitigation measures to avoid or mitigate impacts on their daily and seasonal activities, mobility and privacy due to their roles of water and wood collection, work on their family farms, livestock rearing, socialization within communities and tribes;
- All resettlement aspects especially eligibility, entitlements and compensation, resettlement and rehabilitation assistance;
- Strategies for rebuilding capacities of women and their household members to enable them to bear shocks of displacement and social and economic losses, and the time period for revival.

Vulnerable groups (the affected families below the poverty line and those without formal titles), especially woman-headed households who required special assistance during the relocation and resettlement process were identified and consulted through focus groups discussions and in-depth interviews.

10.6 Feedback Received from Consultation Meetings

Feedback from the stakeholders was overall supportive of the project from both local communities, academics, and the government agencies, but requests have been made to enhance the benefits of the project to the local population through the provision of social services, in addition to compensation, resettlement and rehabilitation assistance.

Participants appreciated PEDO’s efforts in bringing them together from a variety of professional groups and representatives of affected people for formal consultations. All participants appreciated to learn about the environmental social aspects including the entitlement for resettlement and rehabilitation assistance. Efforts were made to maintain a steady consultation process with the PAPs and other relevant stakeholders in accordance with WB Policy. Extensive consultations were conducted for the preparation of MHPP with primary and secondary stakeholders by consultants in collaboration with PEDO in Peshawar (KP provincial capital) and the project areas with APs, officials of relevant government departments, general public, experts from academia, NGOs, public representatives, community leaders, and local journalists including women and vulnerable PAPs.

A series of public consultations were conducted to get the feedback/concerns of the different segments of stakeholders including provincial departments, district level departments, potential PAPs, local community and other general public residing in the Project Area. During the consultation process, the stakeholders were briefed about the project objectives and scope. Their concerns and suggestions were recorded.

The information dissemination and consultation activities were conducted from 14, June 2022 up till 30 July 2022. The purpose of these consultation meetings was to provide orientation on MHPP, the proposed technical design, share outcome of detailed social assessment and mitigation measures with the stakeholders and know their concerns and expectations.

The consultation activities included 12 FGDs with 176 males and 51 females in 6 villages, 12 meetings with government officials with 17 individuals, after preparation of RAP to present key finding of Environmental & Social Impact Assessment and mitigation measures. Table 10-2 presents the locations, dates and number of participants attended from the affected communities. Feedback received from the communities are summarized in Table 10-3, and feedback from the women are also reflected in this chapter.

Table 10-2: Details of Public Consultation Meetings with Locals

Sl.	Location/Village	Date	Number of Participants		Remarks
			Male	Female	
1	Ayeen (Adit 3)	14 June, 2022	10	8	10 male and 6 female consultations meeting held in the first round of consultation with community level
2	Kalgay (Powerhouse)	15 June, 2022	12	7	
3	Kedam (Weir Site)	29 June, 2022	24	15	
4	Gharijo (Mouza Rammit) Weir Site	29 June, 2022	8	6	
5	Ponkia (Mouza Gornai) (Adit 1)	30 June, 2022	8	7	
6	Darolai (Adit 2)	30 June, 2022	7	8	
7	Kedam	11 July, 2022	9	-	
8	Gharijo (Mouza Rammit) Weir Site	12 July, 2022	10	-	
9	Ponkia (Mouza Gornai) (Adit 1)	13 July, 2022	13	-	
10	Ayeen (Adit 3)	17 July, 2022	12	-	
11	Kedam (Weir Site)	19 July, 2022	34	-	2 consultation meeting organized for WB Social Safeguard Consultant and PEDO Independent Environment and Social Consultants.
12	Darolai (Adit 2)	19 July, 2022	9	-	2 consultation meeting organized for WB Social Safeguard Consultant and PEDO Independent Environment and Social Consultants.
13	Kalgay (Powerhouse)	19 July, 2022	20	- 2 consultation meetings organized for WB Social Safeguard Consultant and PEDO Independent Environment and Social Consultants.	
14	Kedam (Weir); Ayeen; Madyan Town; Marina Hotel, Bahrain Town	8-12 April, 2008	42	5 consultation meetings with the affected communities (Kedam and Ayeen villages) and local businesses (Madyan and Bahrain towns)	

Table 10-3: Key Concerns of Project Affected Persons (APs) and their Addressal

Key Concerns	Response/Actions/How they are addressed
Dam construction would increase water levels and block the river's downstream flow of driftwood that is primarily used as fuel wood by locals. Locals will then cut forest trees, resulting in deforestation.	Based on surveys, a very small number of people in the Study Area use driftwood, therefore, this may not be a major impact. In addition, at the detailed design phase, potential driftwood retention structure can be considered, where the driftwood can be retained in a bypass channel located at the outer river bend and release them in downstream.
Disturbances due to construction activities	
Land sliding will increase due to tunnels construction and walls of houses will be damaged due to vibrations from drilling and blasting operation	Contractor will develop a Blasting and Explosives Management Plan and Vibration Monitoring Plan. A pre-construction survey of structures at risk of vibration impacts will be conducted and accordingly management plan will be developed in Contractor's ESMP (C-ESMP) prior to commence the work.
Environmental issues will increase due to excavation, vehicles, and operation of other heavy machinery	The issues will be addressed through the site-specific traffic management plan and the care will be taken while moving heavy machinery to avoid traffic congestion on public road, damage or blockage of natural waterways and channels
The dust generated during drilling and blasting operation may cause respiratory diseases due to over exposures.	Sprinkling of water will be carried out on all exposed surfaces, particularly those close and up-wind directions of settlements.
Traffic increase due to project activity would result in congestion on local roads.	Access roads will be constructed to accommodate the additional construction traffic load, in addition, Contractor will develop a traffic management plan to reduce impacts on the local communities.
Machinery and vehicles used in project activities would cause environmental problems (air, noise, and oil spill).	Impacts on physical environment will be mitigated by the C-ESMP. ESMP and ECP will present the mitigation measures for air pollution, noise, and accidental spills.
Project construction activities would deteriorate the natural beauty of the village.	Mitigation measures will be proposed in the ESMP.
Inundation of the Madyan-Kalam Road at the weir will cause huge problem for mobility of local people and general traffic and eventually affect tourist's movement.	Relocation and construction of the Madyan-Kalam Road at higher elevation for 1.5km will be carried out on priority basis prior to the construction of cofferdam and weir.
Damaged lands will be rehabilitated/ restored after the construction work is completed.	The contractor will rehabilitate/ restore the lands damaged by the construction activities.
The access roads to the villages may be disturbed during the construction phase and there may be road safety concerns due to increased traffic volume.	A traffic management plan will be prepared and implemented by the Contractor under the supervision of Project Implementation Consultant.
Loss of agricultural land	
Main Agricultural land of Kalgay will be affected due to construction of proposed staff colony and spoil disposal site near Powerhouse	The 2009 FS proposed Feasibility site for staff colony will be changed to a nearby barren land, for which area assessment is underway.
Compensation for locals	
We need high priority in employment opportunities in the project activities. Employment opportunities will be provided to local skilled and unskilled labor in the project to improve the livelihood of the locals. At least one-third of the local community, especially PAPs, will be engaged in the project-related jobs.	Priority in jobs and labor will be given to the affected communities.

Key Concerns	Response/Actions/How they are addressed
Government will provide free electricity to local communities in exchange for their support and cooperation.	Power generated from Madyan Hydropower will be evacuated to the national grid. Local communities will have access to the power from the national grid. There is policy in the country to supply power directly from the hydropower plant to the local community.
Appropriate negotiation is required between affected people and government to resettle the affectees of the project.	The resettlement process will be undertaken with full participation of the affected community.
Minimize land acquisition to the extent feasible since the availability of suitable agricultural land is scarce in the project area.	While carrying out the feasibility studies for the Project, PEDO ensured the minimum acquisition of private land.
Adequate compensation for the loss of land. Payments to be made only to the legitimate owners at the prevailing market rates.	The principles and procedures for the valuation of assets at market rate have been laid down in RPF and RAP, in detail in compliant with national, provincial and World Bank policies.
Compensation for land and structures to be paid prior to the construction.	Construction activities will start only after the payment of compensation is made to the affected communities of their lost land and other assets, including resettlement and rehabilitation assistance.
Development schemes such as schools, health centers, mother and child health care centers, vocational training centers separately for men and women will be implemented in the affected villages.	Social Development Plan (SDP) will be implemented as a part of the Project. The plan will include several interventions to address the priority needs of the local communities particularly the affected population. In addition, a livelihood restoration and improvement plan will be implemented to support the improvement of existing means of livelihoods and alternative off-farm income-earning opportunities including women-specific interventions.
Social issues due to movement of labor	
Non–village residents with different cultures will come to the area because of the project and damage the community's culture.	Preference will be given to employ affected people in the Project. In addition, a clause will be added in the contractor's contract documents that they will be confined to their camps and will not breach privacy of local communities.
As we came to know that labor camp is proposed to construct nearby Kalgay Village, we don't allow to construct labor camp because it will create social issues due to increase of in–migration of labor for project construction. Labor camp will be outside from community settlement.	Design of the project is also being reviewed and if it is found possible, design will be changed to avoid resettlement and other social issues. Affected people will be given higher priority in employment and hence, reduce the need for a larger camp. Alternative site for labor camp is being investigated for selection.
Social security risk will increase due to increase of in–migration of labor for project construction.	Mitigation measures are proposed in the ESMP.
Pollution Related Issues	
During construction of the tunnel, water discharges from the tunnel may pollute the river water. River water pollution will be avoided from construction activities	Wastewater discharges from tunnels and project facilities will be transported to a settling basin for sedimentation prior to releasing to the river in compliance with NEQS.
What would be the mechanism for noise control during the construction phase due to the operation of heavy machinery?	Noise emissions from vehicles and machinery will comply with national standards, and high noise generating equipment will be provided with mufflers. Noise generating activities will not be carried out during night time near the residential and sensitive areas.
Grievance Redress	
What will be the procedure to raise complaints and will there be separate	Grievance Redress Mechanism will be established under the project and Grievance Redress Committee will be formed who will

Key Concerns	Response/Actions/How they are addressed
arrangements for women to raise their concern?	be responsible for receiving grievances from the communities including women.
Minimize land acquisition to the extent feasible since the availability of suitable agricultural land is scarce in the project area.	While carrying out the feasibility studies for the MHPP, PIC/PEDO ensured the minimum acquisition of private land by considering different design and weir location alternatives.
Adequate compensation for the loss of land. Payments to be made only to the legitimate owners at the prevailing market rates.	The principles and procedures for the valuation of assets at market rate have been laid down in RAP, in detail.
Compensation for land and structures to be paid prior to the construction.	Construction activities will start only after the payment of compensation to the affected communities of their lost land and other assets including resettlement and rehabilitation assistance. Compensation for loss of land, crops, trees, and structures will be paid in accordance with the Entitlement matrix presented in this RAP including compensation based on the market rate as well as replacement cost. Vulnerable APs have been identified and assistance will be provided to them in addition to entitled compensation.
Development schemes such as schools, drinking water supply schemes, health centers, mother and child health care centers, vocational training centers separately for men and women will be implemented in the affected villages. Access road from Darolai to Bahrain will be rehabilitated and bridge on swat river.	A Social Development Plan will be implemented as a part of the MHPP having several interventions to address priority needs of the local communities particularly the affected population. In addition, a LRIP will be implemented to support the improvement of existing means of livelihoods and alternative off-farm income earning opportunities including women specific interventions.
Employment opportunities will be provided to local skilled and unskilled labor in the project, as to improve the livelihood of the locals. At least one third of the local community, especially APs, will be engaged in the project related jobs.	Contractors will give preference to the local skilled and unskilled labor. Preference will also be given to the APs. PEDO will also support the local communities to improve their skills in construction activities.
Clearance of land will be minimized to the best possible extent.	Cultivated fields have been avoided to the extent possible while selecting the area for MHPP. Where unavoidable, compensation will be paid as detailed in the present RAP/entitlement matrix.

Key Concerns	Response/Actions/How they are addressed
Compensation will be fair and will be delivered before start of work. Payment of compensation for project APs especially vulnerable APs will be ensured.	Compensation for any loss to crops, trees, and structures will be paid in accordance with the rates given in the present RAP. These rates have been established based upon the official rates. APC will be established to ensure that compensation is fair and paid in a timely manner. Vulnerable Aps have been identified and assistance will be provided to them in addition to the station.
While selecting the place for weir and powerhouse, impacts on the structures will be avoided and relocation of settlements will minimize by changing the design, where possible.	Settlements, houses, and other structures would be avoided to the extent possible until and unless impacts cannot be mitigated and the settlement falls under the proposed site. In such situation compensation will be paid as per the RAP.
Transport for relocation of assets and timely compensation to all APs will be provided.	Transition/ shifting assistance will be provided to the eligible/ entitled persons in addition to the compensation for the lost assets.
Policy framework will be made for compensation of land at market rate.	Compensation against losses of land, crops, trees, structures and other assets will be paid to the APs in accordance with the present RAP.
Spoiled/damaged lands will be rehabilitated/ restored after the construction work is completed.	Contractor will rehabilitate/ restore the lands damaged by the construction activities.
Local norms will be honored; and construction work will be completed in time.	Liaison with the community will be maintained during construction activities. The construction staff will be provided trainings regarding local norms. The construction staff will comply with the code of conduct. Construction activities will be completed in the shortest possible time.
Wall along the river side will be built as to ensure waste in not dumped. Bridge over the river will be constructed.	Proper mitigation measures have been proposed to minimize waste generation and to facilitate efficient waste dumping. SDP will be implemented and assistance will be provided to the communities to address the community needs.
Existing roads will not be damaged and new access road will be provided. Livelihood losses will be as minimized as possible.	Contractor will take care during construction not to damage any roads. If roads will be damaged, Contractor will repair them. LRIP will be implemented and assistance will be provided to the communities to address the community needs.

Key Concerns	Response/Actions/How they are addressed
Respondents showed that they had no issue with the completion of this project. Barren land of some respondents will come under proposed muck disposal sites.	The compensation issue for such land has been addressed in the RAP for MHPP.
Land compensation for all types of affected land will be provided.	The compensation provisions have been included in the RAP.
The APs took the plea that as compared to others in the nearby vicinity the only available land for agriculture and residential purposes is Cheaper. The respondents elaborated that likely it is difficult to find suitable land both for agriculture and residential purposes in the nearby vicinity/area.	APs will be compensated as per prevailing market rate based on private negotiations so that they can purchase land and construct their houses in the new location.
Main concern is that they want their land back after restoration which will be used for muck disposal, after completion of construction activity.	The contractor will restore and return the land to owners in its original condition. The conditions will be made in the bidding document.

The details of women concerns and secondary stakeholders is shown in **Table 10-4.**

Table 10-4: Key Concerns of Women and their Addressal

Key Concerns	Addressal
Women participation in the activities outside the home is limited. However, in case of loss of any property/assets, crops/trees, compensation will be provided.	Compensation will be provided to the eligible and entitled Aps including women and vulnerable people. In accordance with the entitlement matrix of compensation given in the present RAP/entitlement matrix covering the current market rates and replacement cost. Entitlements and compensation issues were also discussed with women. Women will be entitled for the compensation.
In some cases, local women are working in agricultural fields, so their routine activities will not be disturbed due to the construction activities.	• Liaison with the community will be maintained during construction activities. • The construction staff will be provided trainings regarding local norms. • The construction staff will comply with code of conduct. • A GRM will also be established to address community complaints.
Females of the community were eager to know if there will be any provisions in the project for area development.	• A gender inclusive SDP has been designed and will be implemented as provided in the RAP to cater to the priority development needs of the area.
The local community will be allowed to collect the wood material from the trees cut.	• Compensation for any tree to be chopped will be paid to the owner.

Key Concerns	Addressal
	• The owner will be allowed to take the fallen trees.
Resettlement issues will be discussed in the presence of whole local community/local population including female.	• Extensive consultations with women have been carried out while preparing the present RAP • Finalized summary of RAP will be disclosed and an Urdu translation will also be shared with the communities and women. • RAP implementation will be carried out in a participatory manner as explained in the present RAP. • APs both for men and women will be established to ensure Aps participation in the process.
Women of the project area will be employed during project implementation stage for undertaking some office work/file management.	Contractor will maximize employment of the locals and preference will be given to the Aps including women.
Family male members will be employed in the project related jobs so that they can get the jobs in their own city/village instead of moving towards other cities for jobs. In this way their social safety could be enhanced.	Contractor will maximize employing the locals and preference will be given to the Aps.

Details summary of consultation meetings with secondary stakeholders is given in **Table 10-5.**

Table 10-5: Details of Public Consultation Meetings with Secondary stakeholders

Sr. No.	Date and Time	Venue	Stakeholder Category
1	2-6-2022 12:20 pm	Bahrain (Swat)	SDEO Education Department
2	2-6-2022 1:15 pm	Bahrain (Swat)	ADO/ASDEO (Girl), Education department
3	3-6-2022 2:00 pm	Matta (Swat)	SDO, Bahrain
4	3-6-2022 4:25	Mingora (Swat)	Public Health Coordinator
5	3-6-2022 12:30pm	Matta (Swat)	SDO C&W- Highway Division
6	17-6-2022 1:30pm	Saidu Sharif (Swat)	District officer, social welfare special Education and women empowerment department
7	17-6-22 3:00pm	Madyan (Swat)	Divisional Forest Officer
8	17-6-22	Saidu Sharif (Swat)	Tourism Department
9	17-6-22	Mangora (Swat)	Lasoona Organization (NGO)

Sr. No.	Date and Time	Venue	Stakeholder Category
10	24-6-22	Mangora (Swat)	Principal Government Technical and Vocational center (boys) Mingora Swat
11	24-6-22	Mangora (Swat)	Agriculture specialist Department of Agriculture (Extension) Swat
12	24-6-22	Mangora (Swat)	District Director on Farm Water Management.

10.7 Feedback Received from Institutions and Experts

This session encompasses the comparative assessment of feedbacks received from institutional consultations conducted during April 2008 as part 2009 FS conducted by FICHTNER Consultant and revised ESIA conducted during the period of July 2022, respectively. Major issues discussed during these consultations are public health and disease prevalence, anglers' license for tourists, flood and associated risks in major infrastructures, protection of aquatic flora and fauna, requirement of environmental flows for the sustainability of downstream aquatic species and habitats, compensatory replantation is recommended for loss of trees, feasibility of fish ladders for the movement of fish, health and safety of construction workers and host community, and appropriate assessment of property and asset losses and compensation arrangements.

Tables 10-6 and **Table 10-7** present the feedback received from government departments and institutional stakeholders respectively.

Table 10-6: Feedback received from government departments during April 2008

Date	Organization/Person Consulted and Position	Reason for Visit / Topics Discussed
7 April, 2008	Health Department -Medical Officer	• Public health situation including water supply and sanitation conditions in the project area is poor. Project will consider to make some improvement on them. • Conduct survey to identify the prevalent diseases • Health Department can play important role in disease prevention and control.
8 April, 2008	Revenue Department -Tehsildar (Revenue Officer)	• LAA – 1894 • Role of District Revenue Officer in land acquisition and payment of compensation • Grievance Redress procedures
9 April, 2008	Forest Department -Sub-Divisional Officer	• Forest types / trees • Location of forests / pastures • Sustainable use of forests by community
9 April, 2008	Trout Hatchery Madyan -Assistant Director -Assistant Research Officer	• Fish catch and consumption by local population • Timing and extent of release of fingerlings in Swat River • Steps to control fish catch
10 April, 2008	Fisheries Department -District Fisheries Officer	• Fisheries development in Swat River • Procedure for issuance of anglers' license particularly to tourists
10 April, 2008	Agriculture Department -Agriculture Officer -Field Assistant	• Crop calendar • Crop yield • Irrigation water • Farmland ownership
10 April, 2008	Wildlife Department	• Wildlife in project area • Wildlife protection measures
10 April, 2008	Pakistan Tourism Development Corporation (PTDC Centre)	• National and international tourists • Popular tourists attractions including angling in Swat River
11 April, 2008	NGO Sky-Aid	• Community awareness about development projects • Possible role of Sky-Aid in Madyan HPP

Table 10-7: Key Concerns of Institutional Stakeholders and their Addressal, July 2022

Sl.	Name and Address of Institute	Details of Interviewer	Key Concerns	Response/Actions
1	Upper Swat Tourism Authority	Deputy Director	• Floods from GLOFs will be a serious risk to the project. Early warning system for flood forecasting is necessary for the safe operation of the project. • Noise and air pollution will be generated during construction phase from which tourist will be affect. • The impacts on tourism are expected to be positive because of the development of a pondage in the upstream of weir. In the Khanpur Dam, for example, activities for children are organized.	• As per MHPP feasibility study, there is no risk of GLOF in the project catchment. Design flood (Probable Maximum Flood) of the project considered extreme flood events. • ESMP is prepared to monitor Air, Noise, and Water pollution. • The pondage is likely to be off-limits to the public, however, a section of it may be open for tourism. Look-out or selfie points can be established in realigned N95 in higher elevation for the tourists.
2	District Director Agriculture Extension SWAT	Assistant Director	Development of an agricultural terrace in the hilly areas normally takes several years of effort and hard work. Therefore, agricultural terraces can be considered for the affected community.	RAP has been prepared covering compensation of agriculture land and crops.
3	Irrigation Department Upper Swat	Executive Engineer	Protection of aquatic flora and fauna will be considered in project design. Requirement of environmental flows for the sustainability of downstream habitat is to be assessed.	Environmental flows have been estimated using Hydrological modelling conducted by PIC confirmed that the minimum flow to be maintained in Swat River will be 3.5 m^3/s. PIC also conducted various literature review for Snow Trout requirements and come to the conclusion that the minimum flow requirements for snow Trout is 2.5-3.5 m^3/s during the migratory season (March-April and September-October).
4	Wildlife Department of Bahrain	Range Officer	• Impact on migratory birds and important bird areas to be assessed. • From Blasting activities wildlife may be affected. • Watching huts may be constructed in the project area to facilitate wildlife watcher. • There is a risk of hunting and poaching of animals by the workers	• The MHHP pondage (1.46 km upstream from the weir) may have a positive impact as it will provide staging area for the migratory birds. • Controlled blasting will be carried out, and blasting management plan (Annex-II) will be developed. Most of the blasting will be underground and hence impacts on wildlife will be minimal. • Workers' code of conduct will include a ban on illegal cutting of trees and hunting and poaching of wildlife. The Contractor will carry out regular awareness

Sl.	Name and Address of Institute	Details of Interviewer	Key Concerns	Response/Actions
				sessions to the workers on the protection of flora and fauna.
5	Forest Department Kalam Forest Division Madyan	Divisional Forest Officer (DFO)	• Community based forest conservation will be promoted. • Using/cutting of forest trees for fuel wood must be avoided during construction phase. • Tree plantation will be considered during and after construction of the project. The Forest Department, KP is of the opinion that as per initial discussion with design consultants, it appears that the Project footprint does not include large forested areas, therefore, it is not expected to degrade significant forest habitat. In particular, there is no concern with respect to Reserved Forests as the nearest ones are not located within or adjacent to the Project infrastructure. • The habitat is already fragmented due to human activity. The locals have modified the habitat. • The Forest Department is in favor of the Project as it will generate much needed electricity with limited damage to forested areas. • Compensatory replantation is recommended for loss of any trees due to Project-related activities. • The Forest Department has not decided on the ratio of replantation yet.	Camp management and tree plantation plan will be developed under the ESMP (Annex-II). Noted. The information regarding Reserved Forests is especially useful for the ESIA. The fragmented habitat was observed by the field team carrying out terrestrial ecology surveys. The terrestrial habitat has, therefore, been designated as Modified Habitat under IFC PS6. Noted. Compensatory re-plantation has been included as a requirement in the ESMP in a ratio of 1:10.
6	Archaeology Department Saidu Sharif Swat	In-charge Regional Office Malakand	Historical and archaeological sites are to be protected. PEDPO/PIC will support the Archaeology Department for protection of any archaeological site identified in the project area.	ESMP has proposed a chance find procedure for the Contractor to be followed during the construction.
7	Minerals Development Department Mingora Swat	Deputy Director	For construction purpose aggregate will not be excavated from River Swat.	Proper approval will be taken for all quarry sites.
8	National Highways Authority Regional Office Township Swat	Deputy Director	N-95 Road is the lifeline of tourism as it is the only road for locals' community connecting Kalam with Madyan.	A Traffic Management Plan is prepared to address the traffic related issues along N-95 and along the access roads to the project sites.
9	Tehsil Municipal Administration (TMA) Bahrain	Tehsil Municipal Officer (TMO)	During construction solid waste will be generated in camps and site.	Solid waste management plan will be developed based on 3R

Sl.	Name and Address of Institute	Details of Interviewer	Key Concerns	Response/Actions
				strategy (reduce, reuse, and recycle).
10	Fisheries Department Chail Road Madyan	Assistant Director Fisheries	Swat River ecology will be protected. Feasibility of fish ladders will be studied and must be constructed.	Detailed studies on terrestrial and aquatic ecology are under taken as part of environmental assessment of the project. And fish ladder has been planned in the design and will be constructed.
11	KP Emergency Rescue Office Swat	District Emergency Officer (DEO)	There are no proper health facilities in Tehsil Bahrain. Health and safety of construction workers and host community need to be planned.	Occupational health and safety plan will be prepared by the contractor and reviewed and approved by PIC.
12	Education Department Swat	SDEO Bahrain	• Communications and Works (C&W) Department, National Highway Authority (NHA) and other stakeholders will be kept in loop as other road project passes in same vicinity. • Engineering team and Revenue team will be involved for land and structure assessment and compensation. • The key informants/ representatives of Revenue Department were aware about the MHPP project and its location. • The rates will be properly negotiated with the Aps. • Government will impose section 4 as soon as possible. • Evidences available for the minimum and maximum range of rates with the office of Tehsildar Madyan. • The respondent enumerated this project as beneficial for the people of area and overall, for Pakistan. • The owners will agree for the project provided they will be compensated for their property as per market rates. • The project requires meticulous planning and careful implementation including complete and accurate information of all land holders. • Compensation to the Aps will be based on their lost property and payment will be made at the existing market rate, so that they are able to reconstruct their houses and purchase agriculture land in the nearby vicinity to regenerate their livelihood.	• Institutional arrangement for the implementation of RAP covering all relevant departments/ agencies has already been included. The line Department will be consulted and involved during RAP and traffic management plan (TMP) implementation. • Need based liaison will be maintained with these departments during RAP and TMP implementation. • The comments from revenue department have been taken care of while developing the entitlement matrix and RAP.
13	Education Department Swat	ADO/ASDEO (Girls)		
14	Public Health Department Matta Swat	Sub Divisional Officer		
15	Communication and Works Department Matta Swat	SDO Highway Division		
16	Communication and Works Department Matta Swat	SDO Building		
17	Social welfare special Education and Women Empowerment Department Saidu Sharif Swat	District Officer		
18	Lasoona Organization Saidu Sharif Swat	Program Manager		
19	Principal Government Technical and Vocational Center (Boys) Mingora Swat	Zaman Principal		
20	Department of Agriculture (Extension) Swat	Agriculture Specialist		
21	On-Farm Water Management Department Swat	Director		

In addition, as part of the cumulative impact assessment, government departments, academicians and researchers of University of Peshawar were consulted during October 2022. **Table** 10- presents the details of these consultations. Important feedbacks obtained from these consultations are the consideration of environmental flow, impacts on snow trout, impact on tourism and landscape especially for the low temperature, greenery and water, fragmentation of fish habitats, coordination with fisheries department and renown experts, direct/indirect impacts on the plant biodiversity due to water diversion and subsequent effects on water table, destruction of plant species due to the submergence by the upstream pondage and pool, consideration for the recent flood events for the design flood flow, development of tourists' facilities (look-out or locally popular selfie points, tuck-shop, parking area) in the realigned N95, accumulated alluvial deposits in the desanders will be flushed in a coordinated way from all 24 powerplants in Swat River, and cumulative impacts of the transportation of construction materials and machinery of all projects on N95.

Table 10-8: Institutional/Expert Consultation Records as part of CIA Study, July and October 2022

Date	Person Consulted/Position/ Organization	Issues Discussed / Suggestions / Concerns /	Responses
October 5, 2022	Director Environment PMO, KHRE-PEDO Deputy Director PMO, KHRE-PEDO	• PIC E&S team made a presentation on the following and discussed in length: • Progress of ESIA • Data quality and presentation of information in the draft ESIA report, e.g., comparing with NEQS and converting ambient air quality monitoring data to correct averaging time. • Definition of area of influence (lateral boundary) • Identify correct VECs for the CIA Study and their rationale • Current institutional setup of ESU/PMO and status of the vacant positions • Support in expert consultations.	
October 5, 2022	Chairman, Department of Environmental Science, University of Peshawar	• It is suggested to consider appropriate environmental flow (eFlow). • Impacts of recent floods will be considered during redesigning of the MHPP. • Snow Trout might have negative impacts due to the implementation of all hydropower projects in the Swat River System. • Project Impact on tourism and landscape will be assessed, as low temperature, greenery and water the Project area are main attractions for tourists which may be affected both negatively and positively due to the project execution.	eFlow of 3.5 m^3/s is considered during the design stage to minimize the impacts on Aquatic Ecology. All possible mitigation will be adopted to avoid disturbance to the tourism.

Date	Person Consulted/Position/ Organization	Issues Discussed / Suggestions / Concerns /	Responses
October 5, 2022	Professor, Department of Environmental Sciences, University of Peshawar	• Mining (marble), municipal (plastic), and industrial wastes will not be disposed-off in River Swat. • Direct discharge of sewage /solid waste will be avoided during the construction phase. • Her research conducted on Swat River (Mingora) revealed that river water contains high quantity of dissolved plastics, which is a major concern for aquatic ecology. • Consider aquatic habitat protection during the planning and design stage of the project. • Footprint of the Project will avoid environmentally sensitive areas. • Construction of dams / weirs will make isolation barriers for fish fauna. • Brown trout and their spawning grounds will be affected since this species is dominant in Swat River system due to 24 dams in a row. • Water quality of the river will be monitored at regular intervals during project implementation. • PEDO will be in close liaison with fisheries department or fisheries experts (having research experience of Swat River Fisheries) during planning and implementation phase to avoid/minimize impacts on River Swat fish	Waste generated during the construction or operational stage will be properly collected, segregated and disposed-off to the designated sites. For aquatic habitat protection BAP study is also underway to find native species and their protection measures. Fish ladders and hatcheries are proposed to be design in every single project to avoid isolation barriers for fish fauna.

Date	Person Consulted/Position/ Organization	Issues Discussed / Suggestions / Concerns /	Responses
October 5, 2022	Professor, Department of Plant Biodiversity, University of Peshawar.	• Water table of the area will be disturbed by diverting water to the tunnel which will directly/indirectly affect the plant biodiversity (algae and herbs.) of the area and can affect the fish nutrients. • Due to the construction of weir and upstream pondage and pool, some plants species will be submerged and can disappear because they cannot survive in deep water. • Soil erosion may also occur in the weir site because the soil/geology is much lose as compared to other mountain ranges. • Submerging of many plant species will have negative impacts on herbivore animals including wild animals. • If project is launched sustainably than it may lead to increase in tourist activities of the project area • Blasting for tunnel will be managed carefully as due to lose soil structure of the area it may cause leakage of underground water table that is the source of springs. • Similarly, water seepage may occur if reservoir or tunnel walls not constructed according to standard engineering practices, that water may easily penetrate into surrounding loose soil and may lead to land slide and damage to project structures.	Biodiversity related mitigation measures devised in the ESIA/ESMP will be implemented to mitigate the impacts on plant biodiversity. Control blasting will be carried out to avoid disturbance/destruction in the project area, and also, a blasting management plan (Annex-II) will be prepared and implemented.
October 6, 2022	Project Director, Pakhtunkhwa Culture and Tourism Authority, Govt. of Khyber Pakhtunkhwa	• Impacts of recent flood will be considered in the design of the MHPP. • The Project implementation body will promote eco-tourism in the area. • Tourists' facilities (look-out or locally popular selfie points, tuck-shop, parking area) will be developed in the realigned N95 from the weir location to upstream to watch birds in the pondage area. • Air, water, noise, and soil pollution will be controlled during construction and operational phases of the project.	Hydrological study will be revised and the design of the project will be designed as per new outcomes of the study. Environmental monitoring will be carried out regularly throughout the project construction phase. Also, all other mitigation measures will be adopted to minimize environmental pollution.

Date	Person Consulted/Position/ Organization	Issues Discussed / Suggestions / Concerns /	Responses
October 6, 2022	Director General & Manager PPP Khyber Pakhtunkhwa Culture and Tourism Authority, Govt. of Khyber Pakhtunkhwa	• Provide electricity for the operational phase of the KITE project which will be constructed in the area of Mankiyal, Swat district. • PEDO will sign an MOU with the Tourism Department for the promotion of Water Sports in the pond location. • Realigned road of the N-95 highway will be constructed on priority basis to facilitate the smooth movement of tourists. • Traffic Management Plan will also be implemented during the construction phase.	Tourism department may sign MOU with PEDO for electricity supply and tourism promotion in the project area. Due to change in weir location, realignment of N-95is no more in the scope.
October 6, 2022	Deputy Chief Conservator, Forest Department, Govt. of Khyber Pakhtunkhwa. & Conservator Range Management, Forest Department Govt. of Khyber Pakhtunkhwa.	• Coordinates/maps of the project area will be shared for better understanding and coordination. • Design of the project must be redesigned considering the recent floods. • To be in touch with forest department for timely action related to the project. • Also, share additional data of the project for information.	As it is necessary to obtain NOCs from all line departments, so through EPA the EIA report will be shared for better understanding of the project activities, impacts and mitigation. PEDO will actively coordinate the forest department throughout the project construction phase.

Date	Person Consulted/Position/ Organization	Issues Discussed / Suggestions / Concerns /	Responses
October 6, 2022	Chief Conservator, Forests Malakand Division, & Director Forest Department Govt. of Khyber Pakhtunkhwa	• Structure shall be constructed far away from the protected/conserved forests. • The relocated area of the N-95 highway must be marked before the commencement of works so that forest department can confirm whether the realigned road right-of-way falls within any protected area or not. • Plantation will be promoted through the project. • Separate funds must be allocated for the forest department for Forest Development Fund. • Spoil disposal area must be identified before the commencement of works considering the sensitivity of the forest areas. • What procedure will be followed for the alluvial deposits at the weir site? The accumulated alluvial deposits in the desanders will be flushed in a coordinated way from all 24 powerplants, as they carry important nutrients for the aquatic species. • Weir and Powerhouse of the project must be constructed in consideration of recent flood as some of the MHPs are washed away by the 2022 flood. • Each project must be contributed to watershed management.	As per site surveys, and consultation with the department there is no protected/reserve forest in the project footprints. The ROW of the proposed realigned N-95 is not in the premises of the protected area. Tree plantation plan will be developed (Annex-II) and implemented with the support of the forest department. During peak flow in summer season radial gates will be fully operated to wash away delta formed at upstream of diversion weir.
October 7, 2022	Deputy Director, Fisheries, KP Fisheries Department. Govt. of Khyber Pakhtunkhwa	• It is suggested to maintain appropriate eFlow, especially in the winter season. • Get data from previous studies to minimize the impacts on fish. • Construction of 24 dams in a row, will affect the upstream movement of Snow Trout especially during breeding season. • Existing trout hatcheries were damaged / washed away with recent floods and construction of hatcheries must be considered in the design stage to minimize the impacts on fish. • Fish ladder will be designed by considering the migration pattern and fish characteristics (e.g., depth, flow and temperature of water to migrate.) so that effective migration using the fish ladder can take place. • Handsome money must be allocated for the stocking purpose during construction. • A private developer, KOAK suggested 20-22 % eFlow for Asrit-Kedam HPP, MHPP can also consider the same design for eFlow.	eFlow will be maintained as per requirements. Fish ladders and hatcheries are proposed to be design in every single project to protect aquatic life, boost tourism and economy.

Date	Person Consulted/Position/ Organization	Issues Discussed / Suggestions / Concerns /	Responses
October 7, 2022	Director, NHA, North, KP, Peshawar.	• Provide detailed studies of all the projects. • Construction of Structures near the Riverbed must be avoided. • Weir will be constructed in a wide area to minimize impact on the weir and N-95 road infrastructure. • Overloading must be avoided by all the contractors/sub-contractors. • Cumulative impacts must consider the construction material transport from all 24 powerplants and other planned projects in the region on the existing road and the impact on the N-95 infrastructures and associated traffic management. • Alternate road will be provided for tourists during the construction work.	As it is necessary to obtain NOCs from all line departments, so through EPA the EIA report will be shared for better understanding of the project activities, impacts and mitigation. due to change in weir location, realignment is no more in the scope.
November 23, 2022	Deputy Director, Headquarters & Deputy Director, Madyan	• Fisheries Department officials were satisfied with the design and specifications of the fish ladder • Officials suggested that a monitoring point / guard room will be constructed near the ladder because the ladder will be the point from where fish will move upstream or downstream and will be vulnerable due to easy access of the hunters especially during night time. • An office / information centre will be constructed anywhere around the newly established lake. • Recently, Fisheries Act, 2022 has been approved by KP government which allows the department to develop fisheries parks and issue fishing licenses. Officials suggested that they will utilize the newly established water reservoir / pond as fishing point for tourists. • Officials asked about the Environmental Flow data throughout the year especially during winter season.	Eco-tourism will be considered during the design stage of the project.

Date	Person Consulted/Position/ Organization	Issues Discussed / Suggestions / Concerns /	Responses
July 19, 2022	Range Officer, Madyan, Swat officer, Wildlife Department, Lower Swat, KP	• Protection of conservancy must be considered during the planning and designing stage of the project. • Appropriate eFlow must be designed to avoid disturbance of the aquatic life. • Hunting and shooting must be banned during the construction phase. • If there are 24 proposed hydropower projects on the river Swat, there will be some negative impact on the aquatic fauna like fish. • Construction of 24 weirs will have isolation effects on aquatic life especially the fish. • Construction of 24 small pools or ponds will attract migratory birds which ultimately pose food competition for resident birds and also damage the crops of local farmers. • Distance between the outlet of one weir and the inlet of next plant weir in downstream may become too short which will also have impacts on flow of water and hence on the biodiversity at the downstream. • In-terms of power shortage these projects may be necessary however, in-terms of the environment of the area, these projects will have significant negative impacts. • Consider the length of the tunnel to be minimal to minimize the negative impacts. • Construction of concreting structures in/on Swat River will lower the seepage of water and hence can impact on the water table.	As per site surveys, and consultation with the department there is no protected/reserve forest in the project footprints. As per SSMPs, hunting and shooting will be strictly monitor during the construction phase.

10.8 Disclosure of Updated ESIA

This ESIA and Executive Summary of ESIA will be disclosed on the PEDO website and will be sent to the World Bank for disclosure on its external website. The ESIA summary in Urdu will also be uploaded into the PEDO's website, and hard copies of these documents will be made available at local union council offices for public access and also at project site office.

10.9 Communications and Consultation during Implementation

10.9.1 Communication Plan

A Communication Plan (CP) will be prepared and a communication specialist will be recruited during the implementation phase of the project. The CP shall provide detailed roadmap that will guide all communications on the Project with internal and external stakeholders. This, in turn, will contribute to increased support from the stakeholders and ultimately, smoother implementation of the project. A CP will strengthen project internal communication flow, enhance teamwork, and increase support for the Project. It will also manage relationships with key stakeholders and increase the public visibility of all project activities, benefits, impacts, and progress and lessons learned. Finally, CP will promote accountability, transparency, participation and dialogue in project implementation.

10.9.2 Consultation and Stakeholders Participation

A comprehensive plan with a step-by-step guide is outlined in
Table 10-**9**, demonstrating the involvement of various stakeholders throughout the different stages of the MHPP implementation process.

Table 10-9: Consultation and Participation

Description	Target Stakeholders	Timing	Responsibility
- ESMP implementation	- PMO staff, consultants, relevant line departments, and APs (as needed).	- Implementation Stage	PMO & PIC
- Establishment of GRM and GRCs in the project area	- APs/ Communities within the Project affected area.	- Before commencement and quarterly during implementation of the project.	PMO and RAP Consultants
- Grievance redress	- PMO staff, consultants, relevant line departments, and APs (as needed).	- Implementation Stage	PMO and RAP Consultants
- Consultations with the APs/ communities during internal monitoring	- APs/ Communities within the Project affected area.	- Construction Stage	PMO and RAP Consultants
- Fortnightly meetings at project sites at site office	- PMO staff, consultants, and APs (as needed).	- Construction Stage	PMO and RAP Consultants
- Consultations with the APs/ Communities during the Independent Monitoring	- APs/ Communities within the Project affected area.	- Construction Stage	M & E Consultants
- Consultation workshops to review RAP implementation, any outstanding issues and grievances, views and concerns of APs; and actions needed to address them.	- APs/ Communities within the Project affected area., relevant line department, relevant NGOs.	- Six-monthly during implementation phase	PMO and RAP Consultants
- Consultations with the APs/ Communities during the site visits by the World Bank Review Missions.	- PMO, project consultants, APs	- Construction/ Operation Stage	PMO, WB Mission

ANNEXES

ANNEXURE I: ENVIRONMENTAL CODE OF PRACTICES

The objective of the Environmental Code of Practices (ECPs) is to address all potential and general construction-related impacts during the implementation of the Project. The ECPs will provide guidelines for best-operating practices and environmental management guidelines to be followed by the contractors for sustainable management of all environmental issues. These ECPs shall be annexed to the general conditions of all the contracts, including subcontracts, carried out under the Project.

The list of ECPs prepared for the Project is given below.

- ECP 1: Waste Management
- ECP 2: Fuels and Hazardous Goods Management
- ECP 3: Water Resources Management
- ECP 4: Drainage Management
- ECP 5: Soil Quality Management
- ECP 6: Erosion and Sediment Control
- ECP 7: Topsoil Management
- ECP 8: Topography and Landscaping
- ECP 9: Quarry Areas Development and Operation
- ECP 10: Air Quality Management
- ECP 11: Noise and Vibration Management
- ECP 12: Protection of Flora
- ECP 13: Protection of Fauna
- ECP 14: Protection of Fish
- ECP 15: Road Transport and Road Traffic Management
- ECP 16: Labour Influx Management and Construction Camp Management
- ECP 17: Cultural and Religious Issues
- ECP 18: Workers Health and Safety
- ECP 19: Tunneling and Underground Construction Works
- ECP 20: Instream Construction Works (Diversion, Coffer Dam and Dam Construction)

ECP 1: Waste Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
General Waste	Soil and water pollution from the improper management of wastes and excess materials from the construction sites.	The Contractor shall • Develop a waste management plan for various specific waste streams (e.g., reusable waste, flammable waste, construction debris and food waste.) prior to commencing of construction and submit to CSC for approval. • Organize disposal of all wastes generated during construction in an environmentally acceptable manner. This will include consideration of the nature and location of the disposal site, so as to cause less environmental impact. • Minimize the production of waste materials by 3R (Reduce, Recycle and Reuse) approach. • Segregate and reuse or recycle all the wastes, wherever practical. • Prohibit burning of solid waste • Collect and transport non-hazardous wastes to all the approved disposal sites. Vehicles transporting solid waste shall be covered with tarps or nets to prevent spilling waste along the route • Train and instruct all personnel in waste management practices and procedures as a component of the environmental induction process.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Provide refuse containers at each worksite. • Request suppliers to minimize packaging where practicable. • Place a high emphasis on good housekeeping practices. • Maintain all construction sites in a cleaner, tidy and safe condition and provide and maintain appropriate facilities as temporary storage of all wastes before transportation and final disposal.
Hazardous Waste	Health hazards and environmental impacts due to improper waste management practices	The Contractor shall • Collect chemical wastes in 200-litre drums (or similar sealed containers), appropriately labelled for safe transport to an approved chemical waste depot. • Store, transport and handle all chemicals avoiding potential environmental pollution. • Store all hazardous wastes appropriately in bunded areas away from watercourses. • Make available Material Safety Data Sheets (MSDS) for hazardous materials on-site during construction. • Collect hydrocarbon wastes, including lube oils, for safe transport off-site for reuse, recycling, treatment or disposal at approved locations. • Construct concrete or impermeable flooring to prevent seepage in case of spills

ECP 2: Fuels and Hazardous Goods Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Fuels and hazardous goods.	Materials used in construction have the potential to be a source of contamination. Improper storage and handling of fuels, lubricants, chemicals and hazardous goods/materials on-site, and potential spills from these goods may harm the environment or health of construction workers.	The Contractor shall • Prepare spill control procedures and submit the plan for CSC approval. • Train the relevant construction personnel in the handling of fuels and spill control procedures. • Store dangerous goods in bunded areas on a top of a sealed plastic sheet away from watercourses; and also, under rainwater shed (to prevent contact with rainwater). • Refueling shall occur only within bunded areas. • Make available MSDS for chemicals and dangerous goods on-site. • Transport waste of dangerous goods, which cannot be recycled, to a designated disposal site approved by EPA or sold to EPA registered vendors. • Provide absorbent and containment material (e.g., absorbent matting) where hazardous material is used and stored, and personnel trained in the correct use. • Provide protective clothing, safety boots, helmets, masks, gloves, goggles, to the construction personnel, appropriate to materials in use.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Make sure all containers, drums, and tanks that are used for storage are in good condition and are labeled with the expiry date. Any container, drum, or tank that is dented, cracked, or rusted might eventually leak. Check for leakage regularly to identify potential problems before they occur. • Put containers and drums in temporary storage in clearly marked areas, where they will not be run over by vehicles or heavy machinery. The area shall preferably slope or drain to a safe collection area in the event of a spill. • Put containers and drums in permanent storage areas on an impermeable floor that slopes to a safe collection area in the event of a spill or leak. • Take all precautionary measures when handling and storing fuels and lubricants, avoiding environmental pollution. • Avoid the use of material with greater potential for contamination by substituting them with more environmentally friendly materials. • Return the gas cylinders to the supplier. However, if they are not empty prior to their return, they must be labeled with the name of the material they contained or contain, information on the supplier, cylinder serial number, pressure, their last hydrostatic test date, and any additional identification marking that may be considered necessary.

ECP 3: Water Resources Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Hazardous Material and Waste	Water pollution from the storage, handling and disposal of hazardous materials and general construction waste, and accidental spillage	The Contractor shall • Follow the management guidelines proposed in ECPs 1 and 2. • Minimize the generation of sediment, oil and grease, excess nutrients, organic matter, litter, debris and any form of waste (particularly petroleum and chemical wastes). These substances must not enter waterways, stormwater systems or underground water tables
Discharge from construction sites	Wastewaters from construction sites and work camps. The construction works will modify groundcover and topography changing the surface water drainage patterns of the area including infiltration and storage of stormwater.	The Contractor shall • Minimize the amount of exposed soil at any one time (only clear vegetation immediately before construction is about to begin) • Install temporary drainage works (channels and bunds) in areas required for sediment and erosion control and around storage areas for construction materials • Install temporary sediment basins, where appropriate, to capture sediment-laden run-off from the site • Divert runoff from undisturbed areas around the construction site • Stockpile materials away from drainage lines

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Prevent all solid entering waterways by collecting solid waste, oils, chemicals, bitumen spray waste and wastewaters from brick, concrete and asphalt cutting and transport to an approved waste disposal site or recycling depot • Collect, transport and discharge the septic tank waste from the construction camps in the nearby municipal wastewater treatment plants • Ensure that tires of construction vehicles are cleaned in the washing bay (constructed at the entrance of the construction site) to remove the mud from the wheels. This shall be done in every exit of each construction vehicle to ensure the local roads are kept clean.
Soil Erosion and siltation	Soil erosion and dust from the material stockpiles will increase the sediment and contaminant loading of surface water bodies.	The Contractor shall • Ensure that sealed roads used by construction vehicles are swept regularly to remove sediment. • Water the material stockpiles, access roads and bare soils on an as-required basis to minimize dust. Increase the watering frequency during periods of high risk (e.g., high winds)

ECP 4: Drainage Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Excavation and earthworks, and construction yards	Lack of proper drainage for rainwater/liquid waste or wastewater owing to the construction activities harms the environment in terms of water and soil contamination, and mosquito growth.	The Contractor shall • Prepare a program for preventing/avoid standing waters, which CSC will verify in advance and confirm during implementation • Provide alternative drainage for rainwater if the construction works/earth-fillings cut the established drainage line • Establish local drainage line with appropriate silt collector and silt screen for rainwater or wastewater connecting to the existing established drainage lines already there • Rehabilitate road drainage structures immediately if damaged by contractors' road transports. • Build new drainage lines as appropriate and required for wastewater from construction yards connecting to the available nearby recipient water bodies. Ensure wastewater quality conforms to the relevant standards provided by NEQS, before it being discharged into the recipient water bodies. • Ensure the internal roads/hard surfaces in the construction yards/construction camps that generate has stormwater drainage to accommodate high runoff during a downpour and that there is no stagnant water in the area at the end of the downpour.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Construct wide drains instead of deep drains to avoid sand deposition in the drains that require frequent cleaning. • Provide appropriate silt collector and silt screen at the inlet and manholes and periodically clean the drainage system to avoid drainage congestion • Protect natural slopes of drainage channels to ensure adequate stormwater drains. • Regularly inspect and maintain all drainage channels to assess and alleviate any drainage congestion problem. • Reduce infiltration of contaminated drainage through stormwater management design
Ponding of water	Health hazards due to mosquito breeding	• Do not allow ponding of water especially near the waste storage areas and construction camps • Discard all the storage containers that are capable of storing water, after use or store them in the inverted position

ECP 5: Soil Quality Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Storage of hazardous and toxic chemicals	Spillage of hazardous and toxic chemicals will contaminate the soils	The Contractor shall • Strictly manage the wastes management plans proposed in ECP1 and storage of materials in ECP2 • Construct appropriate spill contaminant facilities for all fuel storage areas • Establish and maintain a hazardous material register detailing the location and quantities of hazardous substances including the storage, use of disposals • Train personnel and implement safe work practices for minimizing the risk of spillage • Identify the cause of contamination, if it is reported, and contain the area of contamination. The impact may be contained by isolating the source or implementing controls around the affected site • Remediate the contaminated land using the most appropriate available method to achieve required commercial/industrial guideline validation results
Construction material stockpiles	Erosion from construction material stockpiles may contaminate the soils	The Contractor shall • Protect the toe of all stockpiles, where erosion is likely to occur, with silt fences, straw bales or bunds

ECP 6: Erosion and Sediment Control

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction activities and material stockpiles	The impact of soil erosion is (i) Increased runoff and sedimentation causing a greater flood hazard to the downstream, (ii) destruction of aquatic environment in nearby lakes, streams, and reservoirs caused by erosion and/or deposition of sediment damaging the spawning grounds of fish, and (iii) destruction of vegetation by burying or gullying.	The Contractor shall • Locate stockpiles away from drainage lines • Protect the toe of all stockpiles, where erosion is likely to occur, with silt fences, straw bales or bunds • Remove debris from drainage paths and sediment control structures • Cover the loose sediments and water them if required • Divert natural runoff around construction areas prior to any site disturbance • Install protective measures on-site prior to construction, for example, sediment traps • Observe the performance of drainage structures and erosion controls during rain and modify them as required.

ECP 7: Topsoil Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Land clearing and earthworks	Earthworks will impact the fertile topsoil that is enriched with nutrients required for plant growth or agricultural development.	• The Contractor shall • Strip the topsoil to a depth of 15 cm and store in stockpiles of height not exceeding 2m. • Remove unwanted materials from topsoil like grass, roots of trees and similar others. • The stockpiles will be carried out in slopes of 2:1 to reduce surface runoff and enhance percolation through the mass of stored soil. • Locate topsoil stockpiles in areas outside drainage lines and protect them from erosion. • Construct diversion channels and silt fences around the topsoil stockpiles to prevent erosion and loss of topsoil. • Spread the topsoil to maintain the physio-chemical and biological activity of the soil. The stored topsoil will be utilized for covering all disturbed areas and along with the proposed plantation sites • Before the re-spreading of topsoil, the ground surface will be ripped to assist in the bunding of the soil layers, water penetration, and revegetation
Transport	Vehicular movement outside right of way of existing roads or temporary access roads will affect the soil fertility of the agricultural lands	• Limit equipment and vehicular movements within the approved construction zone • Construct temporary access tracks to cross concentrated water flow lines at right angles • Plan construction access to make use, if possible, of the final road alignment • Use vehicle-cleaning devices, for example, ramps or wash-down areas

ECP 8: Topography and Landscaping

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Land clearing and earthworks	Construction activities especially earthworks will change topography and disturb the natural rainwater/floodwater drainage as well as will change the local landscape.	The Contractor shall • Ensure the topography of the final surface of all raised lands (construction yards, approach roads and access roads.) are conducive to enhance natural draining of rainwater/flood water; • Keep the final or finished surface of all the raised lands free from any kind of depression that insists waterlogging. • Undertake mitigation measures for erosion control/prevention by grass-turfing and tree plantation, where there is a possibility of rain-cut that will change the shape of topography. • Cover immediately the uncovered open surface that has no use for construction activities with grass-cover and tree plantation to prevent soil erosion and bring improved landscaping.

ECP 9: Quarry and Borrow Areas Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Development and operation of Quarry and borrow areas. The project will use approved quarry sites available near the project site. This ECP will be used only when a new quarry or borrow area is to be developed.	Quarry areas will have impacts on local topography, landscaping and natural drainage.	The Contractor shall • Use only quarry and borrow sites that are licensed by the provincial government and approved by the project management unit/Implementation Consultants • Identify new borrow and quarry areas in consultation with Project Director, if required. • Reuse excavated or disposed of material available in the project to the maximum extent possible. • Store topsoil for reinstatement and landscaping. • Develop surface water collection and drainage systems, anti-erosion measures (berms and re-vegetation.) and retaining walls and gabions where required. Implement mitigation measures in ECP 3: Water Resources Management, ECP 6: Erosion and Sediment Control • The use of explosives will be used in as much minimum quantity as possible to reduce noise, vibration and dust. • Control dust and air quality deterioration by application of watering and implementing mitigation measures proposed in ECP 10: Air Quality Management • Noise and vibration control by ECP 11: Noise and Vibration Management. • In compliance to KP Bonded Labor System (Abolition) Act, 1995 and The Khyber Pakhtunkhwa Prohibition of Employment of Children Act, 2015, use of all forms of forced labor and child labors for quarry sites shall strictly be prevented.

ECP 10: Air Quality Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction vehicular traffic	Air quality can be adversely affected by vehicle exhaust emissions and combustion of fuels.	The Contractor shall • Fit vehicles with appropriate exhaust systems and emission control devices. Maintain these devices in good working condition. • Operate the vehicles in a fuel-efficient manner • Cover haul vehicles carrying dusty materials moving outside the construction site • Impose speed limits on all vehicle movement at the worksite to reduce dust emissions • Control the movement of construction traffic • Water construction materials prior to loading and transport • Service all vehicles regularly to minimize emissions • Limit the idling time of vehicles to not more than 2 minutes
Construction machinery	Air quality can be adversely affected by emissions from machinery and the combustion of fuels.	The Contractor shall • Fit machinery with appropriate exhaust systems and emission control devices. Maintain these devices in good working condition in accordance with the specifications defined by their manufacturers to maximize combustion efficiency and minimize contaminant emissions. Proof of maintenance register shall be required by the equipment suppliers and contractors/subcontractors • Focus special attention on containing the emissions from generators • Machinery causing excess pollution (e.g., visible smoke) will be banned from construction sites • Service all equipment regularly to minimize emissions • Provide filtering systems, duct collectors or humidification or other techniques (as applicable) to the concrete batching and mixing plant to control the particle emissions in all its stages, including unloading, collection, aggregate handling, cement dumping, circulation of trucks and machinery inside the installations
Construction activities	Dust generation from construction sites, material stockpiles and access roads are a nuisance in the environment and can be a health hazard.	• Water the material stockpiles, access roads and bare soils on an as-required basis to minimize the potential for environmental nuisance due to dust. Increase the watering frequency during periods of high risk (e.g., high winds). Stored materials such as gravel and sand shall be covered and confined to avoid their being wind-drifted • Minimize the extent and period of exposure of the bare surfaces Reschedule earthwork activities or vegetation clearing activities, where practical, if necessary, to avoid periods of high wind and if visible dust is blowing off-site • Store the cement in silos and minimize the emissions from silos by equipping them with filters. • Establish adequate locations for storage, mixing and loading of construction materials, in a way that dust dispersion is prevented because of such operations

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Crushing of rocky and aggregate materials shall be wet-crushed or performed with particle emission control systems

ECP 11: Noise and Vibration Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction vehicular traffic	Noise quality will be deteriorated due to vehicular traffic	The Contractor shall • Maintain all vehicles in order to keep them in good working order in accordance with manufactures maintenance procedures • Make sure all drivers will comply with the traffic codes concerning the maximum speed limit and driving hours. • Organize the loading and unloading of trucks, and handling operations for the purpose of minimizing construction noise on the worksite
Construction machinery	Noise and vibration may have an impact on people, property, fauna, livestock and the natural environment.	The Contractor shall • Appropriately site all noise-generating activities to avoid noise pollution for local residents. • Use the quietest available plant and equipment • Modify equipment to reduce noise (for example, noise control kits, the lining of truck trays or pipelines) • Maintain all equipment in order to keep it in good working order in accordance with manufactures maintenance procedures. Equipment suppliers and contractors shall present proof of the maintenance register of their equipment. • Install acoustic enclosures around generators to reduce noise levels. • Fit high-efficiency mufflers to appropriate construction equipment • Avoid the unnecessary use of alarms, horns and sirens
Construction activity	Noise and vibration may have an impact on people, property, fauna, livestock and the natural environment.	The Contractor shall • Notify adjacent landholders prior to any typical noise events outside of daylight hours (6 pm to 7 am) if the construction works are being carried out near residential areas • Educate the operators of construction equipment on potential noise problems and the techniques to minimize noise emissions • Employ the best available work practices on-site to minimize occupational noise levels • Install temporary noise control barriers where appropriate • Notify affected people if major noisy activities are undertaken, e.g., pile driving • Plan activities on-site and deliveries to and from site to minimize the impact

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Monitor and analyze noise and vibration results and adjust construction practices as required. • Avoid undertaking the noisiest activities, where possible, when working at night (6 pm to 7 am) near the residential areas.

ECP 12: Protection of Flora

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Vegetation clearance	Local flora is important to provide shelters for the birds, offer fruits and/or timber/firewood, protect soil erosion and overall keep the environment very friendly to human-living. As such damage to flora has a wide range of adverse environmental impacts.	The Contractor shall • Reduce disturbance to surrounding vegetation • Use appropriate type and minimum size of machine to avoid disturbance to adjacent vegetation. • Get approval from the supervision consultant for the clearance of vegetation. • Make selective and careful pruning of trees where possible to reduce the need for tree removal. • Control noxious weeds by disposing of them at a designated dump site or burn on site. • Plant only native species that are approved by the local forest department (to confirm that they are not invasive) for plantation in the construction yards and project sites. • Clear only the vegetation that needs to be cleared in accordance with the plans. These measures are applicable to both the construction areas as well as to any associated activities such as sites for stockpiles, disposal of fill and construction of diversion roads. • Before excavation, mark the trees that must remain on the site and cannot be removed. • Do not burn off cleared vegetation – where feasible, chip or mulch and reuse it for the rehabilitation of affected areas, temporary access tracks or landscaping. Mulch provides a seed source, can limit embankment erosion, retains soil moisture and nutrients, and encourages re-growth and protection from weeds. • Return topsoil and mulched vegetation (in areas of native vegetation) to approximately the same area of the roadside it came from. • Avoid work within the dripline of trees to prevent damage to the tree roots and compacting the soil. • Minimize the length of time the ground is exposed, or excavation left open by clearing and re-vegetate the area at the earliest practically possible. • Ensure excavation works occur progressively and re-vegetation is done at the earliest • Provide adequate knowledge to the workers regarding nature protection and the need to avoid felling trees during construction

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Supply appropriate fuel in the work caps to prevent fuelwood collection

ECP 13: Protection of Fauna

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Vegetation clearance	Clearance of vegetation may impact shelter, feeding and/or breeding of animals	The Contractor shall • Restrict the tree removal to the minimum required. • Retain tree hollows on-site, or relocate hollows, where appropriate • Leave dead trees where possible as habitat for fauna • Identify the trees that require specific attention (e.g., the hollow-bearing trees) and fall them in a manner that reduces the potential for fauna mortality. Felled trees will be inspected after felling for fauna and if identified and readily accessible will be removed and relocated or rendered assistance if injured. After felling, hollow-bearing trees will remain unmoved overnight to allow animals to move of their own volition.
Construction camps	Illegal poaching	• Provide adequate knowledge to the workers regarding the protection of flora and fauna, and relevant government regulations and punishments for illegal poaching. • The contractor's code of conduct shall include on the protection of flora and fauna, and a ban on tree cutting and hunting of animals. Employees found violating would be subject to strict actions including fines and termination of employment.

ECP 14: Protection of Fish

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction activities in River	The main potential impacts to fisheries are hydrocarbon spills and leaks from riverine transport and disposal of wastes into the river	The Contractor shall • Prepare procedures for the protection of fish and submit them for supervision consultant approval. • Ensure the construction equipment used in the river are well maintained and does not have oil leakage to contaminate river water. • Contain oil immediately on the river in case of accidental spillage from equipment; make an emergency oil spill containment plan (under the Fuels and Hazardous Substances Management Plan) to be supported with enough equipment, materials and human resources.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Do not dump wastes, be they hazardous or non-hazardous into the nearby water bodies or in the river.
Construction activities on the land	The main potential impacts on aquatic flora and fauna River have increased suspended solids from earthworks erosion, sanitary discharge from work camps, and hydrocarbon spills	The Contractor shall • follow mitigation measures proposed in ECP 3: Water Resources Management and EC4: Drainage Management.

ECP 15: Road Transport and Road Traffic Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction vehicular traffic	Increased traffic use of the road by construction vehicles will affect the movement of normal road traffics and the safety of the road-users.	The Contractor shall • Prepare and submit a traffic management plan to the CSC for their approval before the commencement of construction. • Include in the traffic management plan to ensure uninterrupted traffic movement during construction: detailed drawings of traffic arrangements showing all detours, temporary road, temporary bridges temporary diversions, necessary barricades, warning signs/lights, and road signs. • Provide signs at strategic locations of the roads complying with the schedules of signs contained in the Pakistan Traffic Regulations. • Install and maintain a display board at each important road intersection on the roads to be used during construction, which shall clearly show the following information in the local language: • Location: chainage and village name • Duration of the construction period • Period of proposed detour / alternative route • Suggested detour route map • Name and contact address/telephone number of the concerned personnel • Name and contact address/telephone number of the Contractor • Inconvenience is sincerely regretted.
	Accidents and spillage of fuels and chemicals	• Restrict truck deliveries, where practicable, to daytime working hours (7 am to 6 pm). • Restrict the transport of oversize loads. • Operate road traffics/transport vehicles, if possible, during non-peak periods to minimize traffic disruptions. • Enforce on-site speed limit

ECP 16: Labor Influx Management and Construction Camp Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Siting and Location of construction camps	Campsites for construction workers are important locations that have significant impacts such as health and safety hazards on local resources and infrastructure of nearby communities.	The Contractor shall • Prepare a management plan for construction of workers camp in accordance with IFC Guidance on Workers Accommodation and submit the plan for supervision consultant's approval. • Locate the construction camps within the designed sites or at areas that are acceptable from the environmental, cultural or social point of view; and approved by the supervision consultant. • Consider the location of construction camps away from communities in order to avoid social conflict in using natural resources such as water or to avoid the possible adverse impacts of the construction camps on the surrounding communities. • Submit to the supervision consultant for approval a detailed layout plan for the development of the construction camp showing the relative locations of all temporary buildings and facilities that are to be constructed together with the location of site roads, fuel storage areas (for use in power supply generators), solid waste management and dumping locations, and drainage facilities, prior to the development of the construction camps. • Local authorities responsible for health, religion and security shall be duly informed on the set up of camp facilities so as to maintain effective surveillance over public health, social and security matters.
Construction Camp Facilities	Lack of proper infrastructure facilities, such as housing, water supply and sanitation facilities will increase pressure on the local services and generate substandard living standards and health hazards.	The contractor shall provide the following facilities in the campsites • Adequate accommodation, transportation, and basic services including water, sanitation, and medical care for the workers working on that project Safe and reliable water supply, which will meet NEQS. Drinking water to be chlorinated at the source and ensure the presence of residual chlorine 0.1 ~ 0.25 ppm as a minimum after 30 minutes of chlorine contact time (WHO guideline). • Hygienic sanitary facilities and sewerage systems. The toilets and domestic wastewater will be collected through common sewerage. Provide separate latrines and bathing places for males and females with total isolation by location. The minimum number of toilet facilities required is one toilet for every ten persons. • Treatment facilities for sewerage of toilets and domestic wastes. • Stormwater drainage facilities. • Paved internal roads.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Provide child crèches for women working on construction sites. The crèche will have facilities for a dormitory, kitchen, and indoor and outdoor play area. Schools will be attached to these crèches so that children are not deprived of education whose mothers are construction workers. • Provide in-house community/common entertainment facilities. Dependence of local entertainment outlets by the construction camps to be discouraged/prohibited to the extent possible.
Workers Accommodation	All workers in the camp will have adequate accommodation facilities	The Contractor shall provide the following: • The labor will be provided with accommodation on twin sharing basis made of insulating material and locally available building material.; • The migrant workers with families shall be provided with individual accommodation comprising a bedroom, sanitary and cooking facilities; • The units will be supported by common latrines and bathing facilities duly segregated for male and female labor; • An adequate number of toilets shall be provided in the accommodation facilities. A minimum of 1 unit for 15 males and 1 unit for 10 females shall be provided; • The contractor shall provide a kitchen facility for the construction workers and the food will be of appropriate nutritional value and will consider religious/cultural backgrounds; • All doors and windows shall be lockable and mobile partitions/curtains shall be provided for privacy; • Facilities for the storage of personal belongings for workers shall be provided within the campsite only; • Dustbins shall be provided for collection of garbage and will be removed on a daily basis; • It is also required to provide first aid boxes in adequate numbers; and • Ventilation will be appropriate for the climatic conditions and provide workers with a comfortable and healthy environment to rest and spend their spare time.
Disposal of waste	Management of wastes is crucial to minimize impacts on the environment	The Contractor shall • Ensure proper collection and disposal of solid wastes within the construction camps • Insist waste separation by source; organic wastes in one pot and inorganic wastes in another pot at the household level. • Store inorganic wastes in a safe place within the household and clear organic wastes on a daily basis to waste collectors. Establish waste collection, transportation and disposal systems with the manpower and equipment/vehicles needed.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Dispose of organic wastes in a designated safe place on a daily basis. At the end of the day cover the organic wastes with a thin layer of sand so that flies, mosquitoes, dogs, cats, and rats are not attracted. One may dig a large hole to put organic wastes in it; take care to protect groundwater from contamination by leachate formed due to the decomposition of wastes. Cover the bed of the pit with an impervious layer of materials (clayey or thin concrete) to protect groundwater from contamination. • Locate the garbage pit/waste disposal site min 500 m away from the residence so that people are not disturbed by the odor likely to be produced from the anaerobic decomposition of wastes at the waste dumping places. Encompass the waste dumping place with fencing and tree plantation to prevent children from entering and playing with it. • Do not establish site-specific landfill sites. All solid waste will be collected and removed from the work camps and treated by composting.
Fuel supplies for cooking purposes	Illegal sourcing of fuelwood by construction workers will impact the natural flora and fauna	The Contractor shall • Provide fuel to the construction camps for their domestic purpose, in order to discourage them from using fuelwood or any other biomass. • Made available alternative fuels like natural gas or kerosene on ration to the workforce to prevent them from using biomass for cooking. • Conduct awareness campaigns to educate workers on preserving the protecting biodiversity and wildlife of the project area, and relevant government regulations and punishments on wildlife protection.
Health and Hygiene	There will be a potential for diseases to be transmitted including malaria, exacerbated by inadequate health and safety practices. There will be an increased risk of work crews spreading sexually transmitted infections and HIV/AIDS.	The Contractor shall • Provide adequate health care facilities within construction sites. • Provide first aid facility round the clock. Maintain stock of medicines in the facility and appoint full-time designated first aider or nurse. • Provide ambulance facilities for the laborer's during an emergency to be transported to the nearest hospitals. • Initial health screening of the laborer coming from outside areas • Inspect all camp facilities regularly to ensure ○ Daily sweeping of rooms and houses shall be undertaken; ○ Regular cleaning of sanitary facilities shall be undertaken; ○ The kitchen and canteen premises shall be established under good hygiene conditions;

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		○ Daily mealtimes shall be fixed for the labor; ○ Smoking and alcohol consumption shall be prohibited in the workplace; ○ Waterlogging shall be prevented at areas near the accommodation facilities and adequate drainage is to be provided; and ○ Checklists pertaining to the daily housekeeping schedule shall be maintained and displayed at houses, toilets, and kitchens. • Train all construction workers in basic sanitation and health care issues and safety matters, and on the specific hazards of their work • Provide HIV awareness programming, including STI (sexually transmitted infections) and HIV information, education and communication for all workers on a regular basis • Complement educational interventions with easy access to condoms at campsites as well as voluntary counselling and testing. • Provide adequate drainage facilities throughout the camps to ensure that disease vectors such as stagnant water bodies and puddles do not form. Regular mosquito repellent sprays during monsoon. • Carry out short training sessions on best hygiene practices to be mandatorily participated by all workers. Place display boards at strategic locations within the camps containing messages on best hygienic practices.
Safety	Inadequate safety facilities to the construction camps may create security problems and fire hazards	The Contractor shall • Provide appropriate security personnel (police/home guard or private security guards) and enclosures to prevent unauthorized entry into the camp area. • Maintain a register to keep track of the headcount of persons present in the camp at any given time. • Encourage the use of flameproof material for the construction of labor housing/site office. Also, ensure that these houses/rooms are of sound construction and capable of withstanding windstorms/cyclones. • Provide the appropriate type of firefighting equipment suitable for the construction camps • Display emergency contact numbers clearly and prominently at strategic places in camps. • Communicate the roles and responsibilities of labourers in case of an emergency in the monthly meetings with contractors.
Site Restoration	Restoration of the construction camps to their original condition	The Contractor shall

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
	requires demolition of construction camps.	• Dismantle and remove from the site all facilities established within the construction camp including the perimeter fence and lockable gates at the completion of the construction work. • Dismantle camps in phases and as the work gets decreased and not wait for the entire work to be completed • Give prior notice to the labourers before demolishing their camps/units • Reuse the demolition debris to a maximum extent. Dispose of remaining debris at the designated waste disposal site. • Hand over the construction camps with all built facilities as it is if an agreement between both parties (contractor and landowner) has been made so. • Restore the site to its condition prior to commencement of the works or to an agreed condition with the landowner. • Not make false promises to the labourers for future employment in O&M of the project.

ECP 17: Socio-cultural and Religious Issues

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction activities near residential areas	Disturbance from construction activities (dust, noise, traffic, conflicts with contractor's workforce.)	The Contractor shall • Establish a system for receiving complaints from the community and address them (the community can also make complaints to the GRM established under the project) • Shall ensure all the construction workers follows the following code of conduct: • All workers are strictly forbidden to establish any kind of relationship with local women and bring any unrelated women to the project site. • All workers will avoid sexual harassment and child abuse. • All workers must not leave the camps or work sites unless written authorization is issued by the respective supervisor • The contractors will advise and prohibit the local population and its authorities or representatives not to enter the project operation areas (campsites and colonies.) in order to minimize the potential risk of incidents related to the operations.
Construction activities near-religious and cultural sites	Disturbance from construction works to the cultural and religious sites, and contractors' lack of knowledge on cultural issues cause social disturbances.	The Contractor shall • Communicate to the public through community consultation and newspaper announcements regarding the scope and schedule of construction, as well as certain construction activities causing disruptions or access restrictions. • Do not block access to cultural and religious sites, wherever possible

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Restrict all construction activities within the footprints of the construction sites. • Stop construction works that produce noise (particularly during prayer time) shall there be any mosque/religious/educational institutions close to the construction sites, and users make objections. • Take special care and use appropriate equipment when working next to a cultural/religious institution. • Stop work immediately and notify the site manager if, during construction, an archaeological or burial site is discovered. It is an offence to recommence work in the vicinity of the site until approval to continue is given by the CSC/PMU. • Provide separate prayer facilities to the construction workers. • Show appropriate behavior with all construction workers especially women and elderly people • Allow the workers to participate in praying during construction time • Resolve cultural issues in consultation with local leaders and supervision consultants • Establish a mechanism that allows local people to raise grievances arising from the construction process. • Inform the local authorities responsible for health, religion and security duly informed before commencement of civil works so as to maintain effective surveillance over public health, social and security matters.

ECP 18: Worker Health and Safety

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Best practices	Construction works may pose health and safety risks to the construction workers and site visitors leading to severe injuries and deaths. The population in the proximity of the construction site and the construction workers will be exposed to a number of (i) biophysical health risk factors, (e.g., noise, dust, chemicals, construction material, solid waste, wastewater and vector transmitted diseases.), (ii) risk factors	The Contractor shall • Implement suitable safety standards for all workers and site visitors which shall not be less than those laid down on the international standards (e.g., International Labor Office guideline on 'Safety and Health in Construction; World Bank Group's 'Environmental Health and Safety Guidelines') and standards applicable in US/UK/Australia/or any other developed country can also be used. • Provide the workers with a safe and healthy work environment, taking into account inherent risks in its particular construction activity and specific classes of hazards in the work areas, • Provide personal protection equipment (PPE) for workers, such as safety boots, helmets, masks, gloves, protective clothing, goggles, full-face eye shields, and ear protection. Maintain the PPE properly by cleaning dirty ones and replacing them with damaged ones.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
	resulting from human behavior (e.g., STD and HIV.) and (iii) road accidents from construction traffic.	• Safety procedures include the provision of information, training and protective clothing to workers involved in hazardous operations and proper performance of their job • Appoint an environment, health and safety manager to look after the health and safety of the workers • Inform the local authorities responsible for health, religion and security duly informed before commencement of civil works and establishment of construction camps so as to maintain effective surveillance over public health, social and security matters
	Child and pregnant labor	The Contractor shall • not hire children of less than 18 years of age and pregnant women or women who delivered a child within 8 preceding weeks, in accordance with the National Labor Laws
Accidents	Lack of first aid facilities and health care facilities in the immediate vicinity will aggravate the health conditions of the victims	• Provide health care facilities and first aid facilities are readily available. Appropriately equipped first-aid stations shall be easily accessible throughout the place of work • Document and report occupational accidents, diseases, and incidents. • Prevent accidents, injury, and disease arising from, associated with, or occurring in the course of work by minimizing, so far as reasonably practicable, the causes of hazards. In a manner consistent with good international industry practice. • Identify potential hazards to workers, particularly those that may be life-threatening and provide necessary preventive and protective measures. • Provide awareness to the construction drivers to strictly follow the driving rules • Provide adequate lighting in the construction area and along the roads
Construction Camps	Lack of proper infrastructure facilities, such as housing, water supply and sanitation facilities will increase pressure on the local services and generate substandard living standards and health hazards.	The Contractor shall provide the following facilities in the campsites to improve health and hygienic conditions as mentioned in ECP 15 • Adequate ventilation facilities • Safe and reliable water supply. • Hygienic sanitary facilities and sewerage systems. The toilets and domestic wastewater will be collected through common sewerage. • Treatment facilities for sewerage of toilet and domestic wastes • Stormwater drainage facilities. • Recreational and social facilities • Safe storage facilities for petroleum and other chemicals in accordance with ECP 2 • Solid waste collection and disposal system in accordance with ECP1. • Arrangement for training

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Paved internal roads. • Security fence at least 2 m in height. • Sickbay and first aid facilities
Water and sanitation facilities at the construction sites	The lack of water sanitation facilities at construction sites causes inconvenience to the construction workers and affects their personal hygiene.	• The contractor shall provide portable toilets at the construction sites if about 25 people are working the whole day for a month. The location of portable facilities shall be at least 6 m away from the storm drain system and surface waters. These portable toilets shall be cleaned once a day and all the sewerage shall be pumped from the collection tank once a day and shall be brought to the common septic tank for further treatment. • The contractor shall provide bottled drinking water facilities to the construction workers at all the construction sites.
Other ECPs	Potential risks to the health and hygiene of construction workers and the general public	The Contractor shall follow the following ECPs to reduce health risks to the construction workers and the nearby community • ECP 2: Fuels and Hazardous Goods Management • ECP 4: Drainage Management • ECP 10: Air Quality Management • ECP 11: Noise and Vibration Management • ECP 14: Road Transport and Road Traffic Management
Training	Lack of awareness and basic knowledge in health care among the construction workforce makes them susceptible to potential diseases.	The Contractor shall • Train all construction workers in basic sanitation and health care issues (e.g., how to avoid malaria and transmission of sexually transmitted infections (STI) and HIV/AIDS. • Train all construction workers in general health and safety matters, and on the specific hazards of their work. Training shall consist of basic hazard awareness, site-specific hazards, safe work practices, and emergency procedures for fire, evacuation, and natural disaster, as appropriate. • Commence malaria, HIV/AIDS and STI education campaign before the start of the construction phase and complement it with strong condom marketing, increased access to condoms in the area as well as voluntary counselling and testing. • Implement malaria, HIV/AIDS and STI education campaigns targeting all workers hired, international and national, female and male, skilled, semi- and unskilled occupations, at the time of recruitment and thereafter pursued throughout the construction phase on an ongoing and regular basis. This shall be complemented by easy access to condoms at the workplace as well as to voluntary counselling and testing.

ECP 19: Tunneling and Underground Construction Works

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Ventilation	Poor ventilation results in oxygen depletion and exposure to excessive heat and fumes, which can lead to acute or long-term health problems;	The Contractor shall • follow Specifications on Ventilation and Lighting for Underground Works of the International tunneling association.
Atmospheric pollution	Release of toxic gases, fumes and vapors	• The Contractor shall follow Technical Specifications on Ventilation and Lighting for Underground Works
	Release of dust and silica. Long-term exposure to respirable dust can lead to diseases ranging from bronchitis to cancer. Even if the dust is not at harmful levels, it can cause irritation to the eyes and throat and increase the risk of physical injury due to poor visibility	The Contractor shall • Identify possible sources of the generation of dust in a tunnel and control measures implemented to eliminate or minimize, so far as is reasonably practicable, the generation of the dust at the source. • Maintain extraction at or close to the point of • Use extractors or dust collection devices in-line near the face • Increase ventilation capacity by increasing the extraction rate when and where needed • Use wet spraying to suppress dust at the point of generation e.g., conveyors, spoil heaps after blasting, while loading and on roadways • providing PPE-like respirators rated for the concentration and duration of exposure
Work Place Facilities	All underground workers will have access to adequate water and sanitation facilities	The Contractor shall • Provide adequate facilities for workers including toilets, drinking water, washing facilities and eating facilities • Ensure the facilities are maintained in good working order, clean, safe and accessible • Ensure the eating facilities (crib rooms) will be away from dusty environments • Ensure regular collection and disposal of solid waste and other construction waste from underground areas.
Heat Stress	Heat stress causes tiredness, irritability, light-headedness, and muscular cramps.	The Contractor shall • Regulate the airflow or modify ventilation to ensure cooling • Reduce items of heat-producing equipment in the tunnel • Provide extra ventilation fans to create air flows in low-flow areas • Provide cool drinking water
	Fire and explosion	The Contractor shall • Conduct fueling in designated fueling bays • Eliminate ignition sources underground where practicable • Isolate fuel sources from remaining ignition sources • Remove potential fuel sources from the work area • Store only necessary fuel underground • Implement firefighting training and procedures

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Ensure the availability of firefighting resources • Restrict smoking to designated areas
	Collisions with moving plant (vehicle and equipment)	The contractor shall • plan pedestrian movements are separated from vehicle movements • providing lighting for safe movement • provide a system to warn workers when the plant is reversing or special loads like explosives are being moved
Emergency Response	Emergency Plan	• The Contractor shall prepare an emergency response plan with emergency procedures including an effective response to an emergency evacuation procedure notifying emergency service organizations at the earliest opportunity • effective communication between the person authorized by the person conducting the business or undertaking to coordinate the emergency response and people at the workplace • testing emergency procedures including the frequency of testing, and • Information, training and instruction to relevant workers about implementing the emergency procedures
	Check-in/check-out procedures	The Control shall • Maintain a check-in/check-out procedure to ensure that the above-ground personnel maintain an accurate accounting of the number of persons underground and to prevent unauthorized persons from gaining access to the site. This is especially important in the event of an emergency but is a common-sense requirement at all times. • Any time an employee is working underground, at least one designated person must be on duty above ground. This person is responsible for calling for immediate assistance and keeping an accurate count of employees who remain underground in the event of an emergency.
	Communication system	• The contractor shall establish a communication system throughout the construction site to pass the information and instructions, monitoring of systems and control of operations such as lifting; transporting persons, materials and plants; coordinating maintenance and managing emergencies.

ECP 20: Instream Construction Works (Diversion, Coffer Dam and Dam Construction)

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
General Construction Works	River water quality and aquatic habitat due to risk of release of deleterious substances into the river	The Contractor shall • Prevent the release of silt, sediment, sediment-laden water, raw concrete, concrete leachate, or any other deleterious substances into the river. • Ensure equipment and machinery are in good operating condition (power washed), and free of leaks, excess oil and lubricants, and grease. • Machinery leaking fuel, lubricants, hydraulic fluids or solvents shall not work within the river. • Keep a spill containment kit readily accessible onsite in the event of a release of a deleterious substance to the environment. Train onsite staff in its use.
	Stranding of fish in the dewatered area	The Contractor shall • Complete fish salvage before the start of works from the dewatered portion of the river using appropriate techniques.
	Risk of safety relative to river work	The Contractor shall • Devise an evacuation plan, including the installation of warning signals and emergency exits, to safely evacuate employees and equipment from the work area. • Ensure risk management procedures are in place on all work sites to minimize the potential for damage arising from inclement weather and/or/elevated river levels during the course of work.
Excavation Works	.	The Contractor shall • Remove excavated material and dispose of it in the designated disposal areas, not dumping these materials into the river. Use mitigating measures to protect excavated material from being eroded and reintroduced into the river
Concrete Works	Concrete leachate is alkaline and highly toxic to fish and other aquatic life.	The Contractor shall • Provide appropriate devices and measures against the discharge of toxic materials and fluids originating from concreting work into the rivers, • Ensure that any materials or liquids produced by works involving the use of concrete, cement and cementitious materials shall not be deposited at non-designated places, and not be discharged into or about any watercourse without treatment. • Provide containment facilities for the wash-down water from concrete delivery trucks, concrete pumping equipment, and other tools and equipment.

ANNEXURE II: ENVIRONMENTAL & SOCIAL MANAGEMENT PLANS

1. Spoil Management Plan

As Madyan HPP has a run-of-river design with a long headrace tunnel, huge quantity of material to be excavated are estimated at the feasibility stage of the MHPP Project is about 2.75 million cubic meters of rock material from excavation. The major portion of excavated material are anticipated to be generated (see figure) due to excavation for Weir that will generate about 0.99 m3 (35.88%), headrace tunnel 0.92million m^3 (33.3%), desander is 513,267 m^3 (18.53%), tailrace tunnel is 0.53 million m^3, approach tunnel is 86,893m3, and powerhouse 79,813 m3. Depending upon the quality of the excavated material, some quantity about 18% (0.9 million m^3) of the total volume of excavated material will be reused to meet the requirement of aggregate rock fill for the construction of project structural elements like weir, cofferdam, tunnel and tailrace. Dumping of this large amount of excavated material is one of the biggest challenges of the project from an environmental point of view. The amount of excavated material is reasonable based on the design concept of a run-of-river hydropower project with a low weir structure and a long headrace tunnel.

The area for disposal of surplus excavated material is mostly constituted of high hills that are generally occupied by community forests, limited area of nearly flat benches that are occupied partly by settlements and partly used for cultivation, and narrow river and tributaries. The topography of the land in vicinity of the project structures and in the surroundings is such that limited area is available for disposal for the surplus excavated material. Disposal of such a huge amount of excavated material has impacts on many issues such as air quality, noise aspects, traffic, landscape, flora and fauna and tourist activities.

This issue will significantly affect different aspects such as land acquisition, use of terrestrial habitats, traffic, noise, air quality and tourist activities. The impact of dumping excavated material has to be evaluated as being Major.

- The area for disposal of surplus excavated material has been identified and will be acquired in line with the Project RAP.
- Disposal of such a huge amount of excavated material has impacts on many issues such as air quality, noise aspects, traffic, landscape, flora and fauna and tourist activities.
- To mitigate these impacts, some of the material will be reused as concrete aggregates, for the aforementioned structures as well as gabions and slope protection.
- As a mitigation measure, disposal sites are selected close to the adits on the left river bank helping to reduce transportation routes. Transport of excavated material through the City of Bahrain to be avoided.
- Transport of excavated material through the City of Bahrain to be avoided. The spoil disposal area will be fenced on the riverside so that there will be no rock or sediment laden flows into the river. The spoil disposal sites must be regularly visually inspected.
- Following the completion of construction works and removal of the spoil, landscaping of the spoil sites that will be in the permanently acquired lands will be carried out.

2. Tree Plantation Plan

Background

Trees will need to be removed from the work sites (reservoir impounding, weir site, dumping areas and adits, powerhouse.) to allow the construction of project and later for maintenance operations. There will be a permanent loss of 4,391 trees, (detailed breakdown provided in Table 2.1). The loss of trees will be compensated by successful plantation of native species. The lost trees will be replaced at a minimum ratio of 10:1. Therefore, a minimum of 44,000 trees will need to be planted. For plantation, the areas have been identified for development of plantation, with space availability and type of trees to be planted as given in Table 2.2. The losses of the community caused by on the felling of trees will be compensated by allowing the community to cut and use the wood in addition to the monetary compensation (breakdown and total compensation provided in **Annex VI**). The communities will also play a key role in planting and watering the plantations.

Table: Privately Owned Fruit and Timber Tree to be removed on Permanent Basis

Type of Tree/ Component	Number of Trees						Total
	Weir Site	Adit-1 & Dumping site	Adit-2 & Dumping site	Adit-3 & Dumping site	Staff Colony	Powerhouse	
A. Fruit Trees							
(1) Apple	60		39	28	20	-	147
(2) Apricot	41		18		35	10	104
(3) Black Persimmon	187	15	16	24	-	116	358
(4) Cherry	72		2		-	-	74
(5) Figs	56				20	6	82
(6) Peaches	153		416		10	-	579
(7) Pear	46		41	2	10	3	102
(8) Red Persimmon	141		37	33	-	173	384
(9) Walnut	356	12	1	24	18	80	491
Sub-Total (A)	1,112	27	570	111	113	388	2,321
B. Wood/Timber Trees							
Bakain	213	32		26	175	44	490
Bhanj	470	30	17	30	157	102	806
Diyar	6	-			-	-	6
Kikar	642	-			-	81	723
Shandai		-			-	4	4
Shatoot	22	-			-	-	22
Sufaida	11	0			-	-	11
Shesham	8	-			-	-	8
Sub-Total (B)	1,372	62	17	56	332	231	2,070
Grand Total	**2,484**	**89**	**587**	**167**	**445**	**619**	**4,391**
AHHs. No.	**39**	**1**	**16**	**17**	**6**	**24**	**103**

Table: Details of suitable Locations for Proposed Plantation in the Project Sites

Sl.	Location	Space Available	Fruit Trees	Timber/Wood Trees
1)	Weir Abutment	Limited	√	
2)	Intake	Sufficient	√	√
3)	Desander	Sufficient	√	√
4)	Powerhouse	Limited	√	
5)	Colony	Sufficient	√	√
6)	Disposal Areas	Sufficient	√	√
7)	Access Road	Limited	√	√
8)	Weir Upstream- From Weir to Proposed bridge at both sides	Sufficient (Most Suitable)	√	√
9)	On Head Race Tunnel	Sufficient (Ideal for landscaping)	√	√

Selection of Suitable Plant Species

The species for the proposed plantation is selected based on the statistics of the lost vegetation and in consultation with the officials of district, Khyber Pakhtunkhwa Forest Department. The list of species to be used for the plantation is given below:

- Fruit Trees: Apple (*Pyrus malus*), Walnut (*Fuglans regia*), Pear (*Pyrus communis*), Black Persimmon (*Diaspyros lotus*), Apricot (*Prunus armenica*), Peach (*Prunus persica*), Fig (*Ficus carica*), Cherry (*Prunus avium*), Persimmon (*Diospyros kaki*)
- Wood/Timber Trees: Bakain (*Melia azodracle*), Bhanj (*Quner cus*), Diyar (*Cedrus deodara*), Chir (*Pinus roxbur ghii*), Mulberry (*Morus alba*), Kikar (*Accacia nilotica*), and Sufaida (*Eucalyptus*).

Suitable Seasons

In Pakistan, specifically in the Project Area, tree plantation activity will be suitable in following two seasonal months:

i. Mid-February to mid-April
ii. Mid-July to mid-September

These seasons are good for overall plant growth and nourishment.

Institutional Arrangement

Plantation activity is to be implemented by Pakhtunkhwa Energy Development Organization (PEDO) through Forest Department of Khyber Pakhtunkhwa with two (02) years of maintenance of the plantation.

Pakhtunkhwa Energy Development Organization (PEDO) will execute Tree Plantation work through Forest Department, as deposit work. Hence, the main responsibility for the tree plantation will rest upon Forest Department while monitoring of the plantation activity will be carried out by ESU of PMO and field staff of the PEDO.

The Forest Department will be asked to submit the quotation and cost breakup (Replenishment Cost Plan) for the works to be done.

The plantation activity will be carried out as per the approved Tree Plantation Plan, developed and submitted to PEDO/PMO by the Forest Department.

Budget

The budget for proposed plantation development plan is given in below table. The budget also includes maintenance for first 2 years of plantation to ensure that all planted saplings will survive and provision for an additional plantation. The plantation in the colony area and weir site will be taken up during pre-construction stage or initial stages of construction, while plantation in other project areas (dumping sites and over headrace tunnel.) will be taken up immediately after completion of the construction activities. The budget also includes measures required for maintenance of plantation, such as watering, weeding and fertilizer application.

3. Fisheries Management Plan

Background

Based on the biodiversity baseline survey conducted by PIC, it was identified that three species of fish belonging to three orders and three families exist in the Project area. Two of the recorded species (indigenous species of Snow trout and introduced species Brown trout) have been categorized as "Least Concern" while one species catfish (Nangra robusta) has been categorized as Endangered with decreasing population trend according to IUCN Red List of Threatened Species 2022. Catfish is an Endemic species of Pakistan. The weir will become a barrier for fish migration and river habitat will be fragmented due to the construction of the weir and diversion of water for power generation in MHPP. In order to mitigate the impacts on aquatic species and habitats, a Fisheries Management Plan has been development to compensate the impacts on local fisheries.

Fisheries department, Swat has been successfully running Madyan Trout hatchery in the vicinity of the project area containing large stock of trout, which has been supplied to various parts of the country including Kalam, Dir, Kohistan, Punjab and Peshawar. The department also has a Trout Culture and Training Centre located in Madyan, Swat. During 2022 Flood, the hatchery has been completely destroyed and some of the buildings of the training center. Hundreds of thousands of fish were washed away. More than 20 privately-built trout fish farms had also vanished. There is an urgent need of the re-development of the hatchery in Madyan. The long experience of Fisheries department, must be utilized and the MHPP reservoir/pondage can be used for fishery development. Fishery will help to become a very important factor of employment in the project area. In addition, the fish would significantly improve food proteins of the local community and other places of the country.

Components of the Fisheries Management Plan

The Plan has the following main components:

- Redevelopment of the hatchery of the fisheries department in the vicinity of the Project area under the guidance of fisheries department.
- Construction of a Fish Ladder within the weir.
- Maintaining suitable eFlow for the sustainability of the fish and their migration and maintain an aquatic habitat for all species.

Redevelopment of the Hatchery

A proposal has been made to redevelop the hatchery of the Fisheries Department to meet the fingerling requirement. This hatchery may be located in the fringe of reservoir of MHPP or in other suitable locations identified by the Fisheries Department (e.g., snow trout hatchery located at Nagoha Shamozai). The land will be supplied by the Fisheries Department. The following activities would be involved in establishment of this hatchery:

- Construction of infrastructure for administration, breeding and laboratory in the premise of Fisheries Department.
- Establishment of water ponds including related water supply and exchange system.
- Establishment of breeding facilities including modern laboratory (with the Fisheries Department own resources).
- Suitable accommodation including offices and modern office equipment (vessels, nets, other devices).
- Utilize Fisheries Department human resources to construct and operate the hatchery.

Fish Ladder

A Fish ladder is designed based on the requirements of snow trout, catfish, and other indigenous species of Swat River. This will be built in the MHPP weir to allow the movement/migration of fish on both upstream and downstream. The PIC design of the fish ladder is based on the requirements of local fish species (depth of water, flow velocity, and slope) and presented in Table 3.1.

Table 3.1: Fish ladder specifications

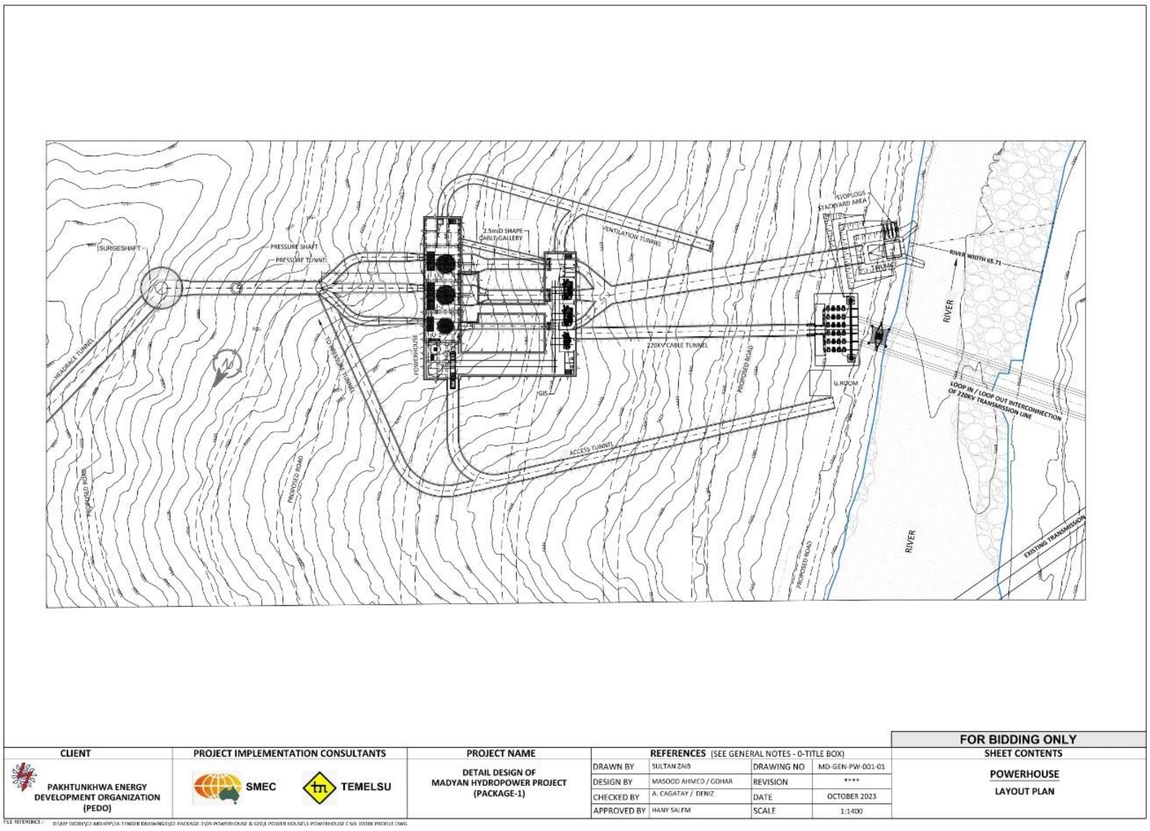
Sl.	Items	Unit	Value

1.	Type	Slot pass type	
2.	Design Discharge	m^3/s	0.25
3.	Elevation	amsl	1,501.05
4.	Ladder Width	m	1.2
5.	Ladder Height	m	0.5
6.	Drops/Pool	m	0.2
7.	Pool Wall Width	m	0.3
8.	Velocity of Water	m/s	0.42
9.	Total Length of Fish Ladder	m	116.5m
10.	Slope	V:H	1:14

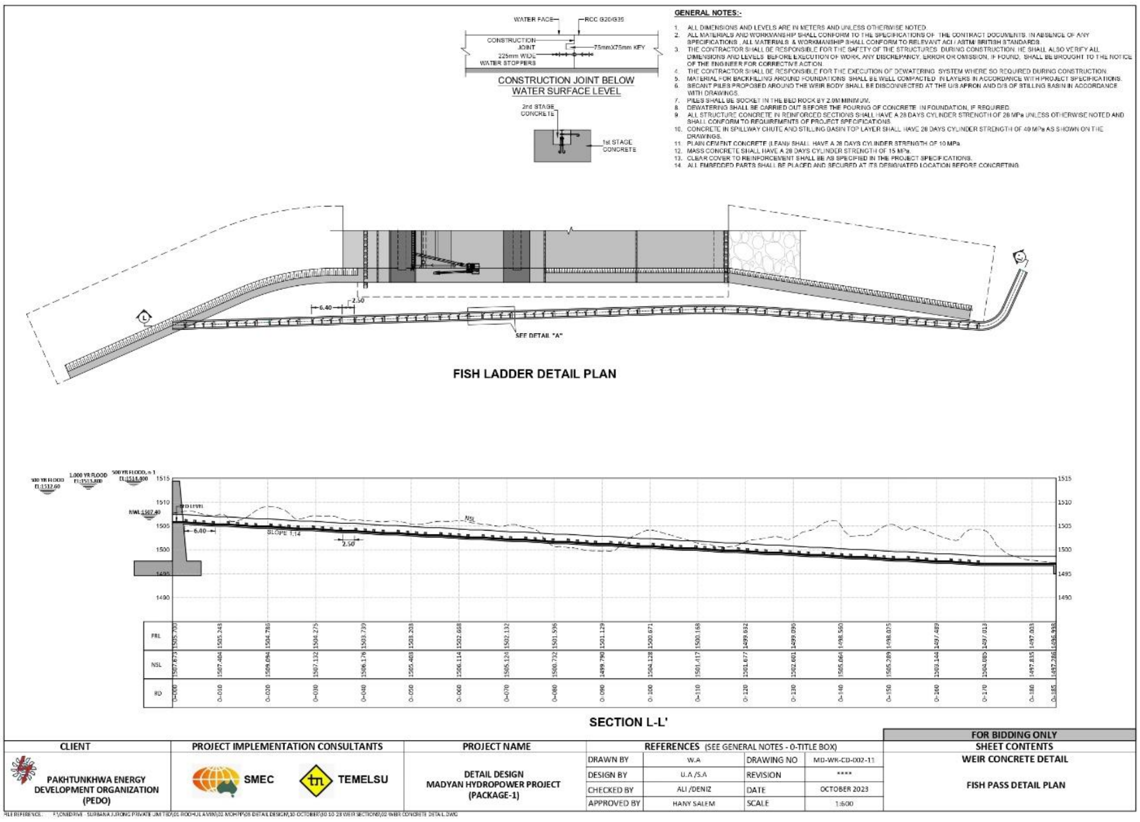
The Schematic Profile of the Fish Ladder is presented in Annex-II

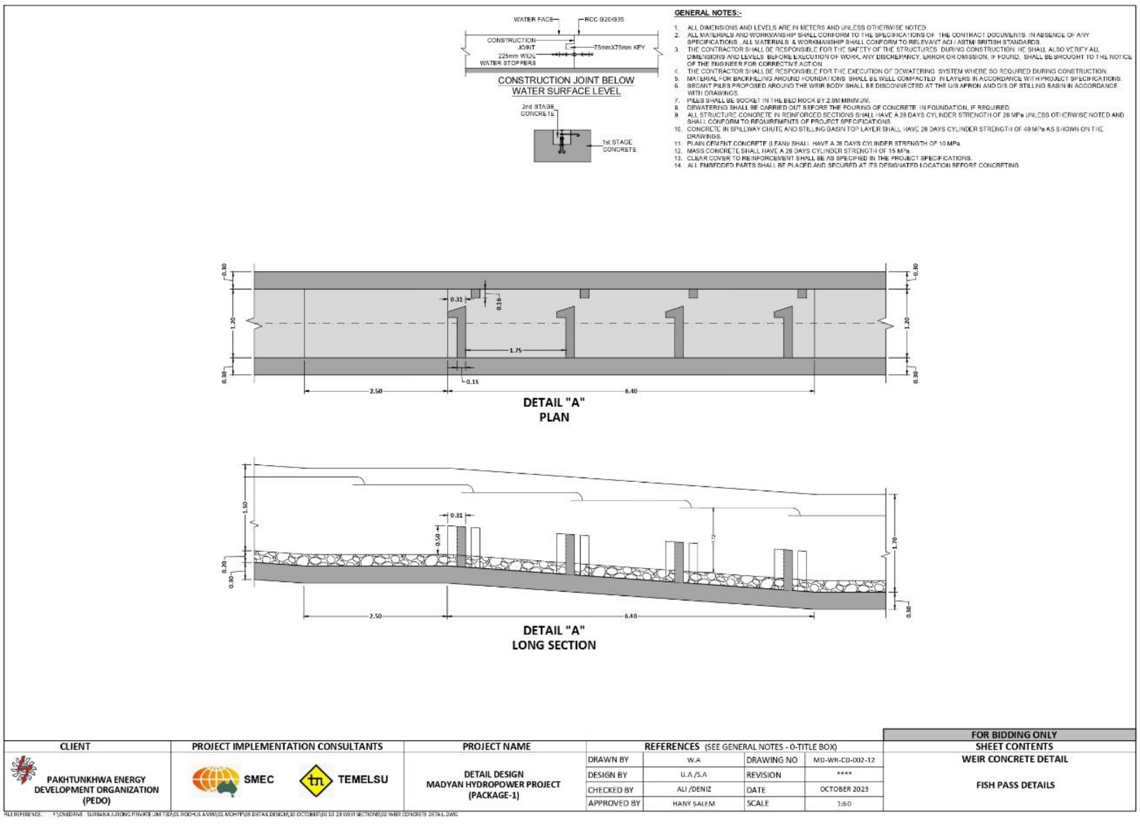
A fish ladder will be built in the weir to allow the movement/migration of fish on both up and downstream. The gradient of fish ladder is considered 1 in 14, drops/pool is 0.5 m, rest pool is provided after four drops, velocity in fish ladder is 0.42 m/sec, cross-section of the entrance is (1.2 m x 0.5 m) 0.6 m^2, and the length is 116.5 m. Discharge through fish ladder is 0.25 m^3/s. Fish ladder is proposed at low turbulence area, which is more suitable at right-side of the weir. Initial consultation has been completed with fisheries department by PIC and research has been undertaken to assess the requirements of eFlow for the snow trout. Additional consultation has been conducted on November 23, 2022 with fisheries department to share the design details of the fish ladder. They are satisfied with the proposed design specifications applicable for the indigenous species which require migration up and downstream.

The river width at tailrace is sufficiently wide and tailrace is designed to prevent backwater effects, ensuring unobstructed fish passage. Tailrace can be seen in the following Figure.



Annex-II.1: Tailrace Layout Plan.





Annex-II.2: Schematic profile of fish ladder.

The specification for the fish ladders in the updated feasibility study are;

- 1 in 14, drops/pool is 0.2 m, rest pool is provided after four drops;
- Velocity in fish ladder is 0.42 m/sec,
- Cross-section of the entrance is (1.2 m x 0.5 m) 0.6 m2, and the length is 116.5 m.
- Discharge through fish ladder is 0.25 m3/s.
- Fish ladder is proposed at low turbulence area, which is more suitable at right-side of the weir.

The following management measures are recommended for the Fish ladder:

- Water will be released continuously through the fish ladder at all times.
- Sensors and underwater video cameras will be placed on the ladder and monitored to count the fish and assess the effectiveness of the ladder.
- Deposited sediments will be regularly removed from the ladder.
- Effectiveness of the fish ladder will be monitored and adaptive measures will be taken to improve the performance of the fish ladder.
- A monitoring point / guard room will be constructed near the ladder entrance to intercept the hunters, especially during night time.
- An office / information center will be constructed around the newly established reservoir/pond.
- Fisheries Act, 2022 has been approved by KP government, which allows the fisheries department to develop fisheries parks and issue fishing licenses.
- Provision to utilize the newly established water reservoir / pond as fishing point for the tourists is proposed in the ESIA.

Design Consideration for Environmental Flow Assessment

Assessment for the required environmental flow (eFlow) were done under the ESIA by considering site investigation of aquatic flora and fauna, their habitats and the interventions to be made in Swat River.

An eFlow of 3.5 m^3/s has been estimated based on PIC's Hydrological and basic hydraulic parameters, the minimum flow to be maintained in Swat River will be 3.5 m^3/s, which is considered to be sufficient for snow trout (2.5-3.5 m^3/s) during the migratory season (March-April and September-October) and minimum flow (2 m^3/s is required) during extreme low flow season (November to February) when the snow trout do not migrate and live in pools. With recommended eFlow, the losses in fish populations cannot be completely eliminated in the section of Swat River. These losses will be offset by gains in other section of the river. Establishment of proposed fish hatchery will help for compensating the impacts.

4. Gender Action Plan

The Gender Action Plan (GAP) for the Project is given in Table[87]. The internal monitoring of GAP implementation will be carried out by the social and gender staff of the PIC. A third-party monitoring agency (TPMA) hired under RAP/ESIA implementation will be responsible for the external monitoring of the GAP.

The Gender Action Plan (GAP) for the Project is given in the following table will be updated within 6 months of start of project implementation. The internal monitoring of GAP implementation will be carried out by the social and gender staff of the Construction Supervision Consultant (CSC). A Third-Party Monitoring Agency (TPMA) hired under RAP/ESIA implementation will be responsible for the external monitoring of the GAP.

It is essential that due attention be paid to women and gender issues. The gender actions developed are an important step towards developing a comprehensive gender strategy and taking effective institutional measures. This and other policy actions and instruments could serve as suggestions to create a gender-balanced framework for a sound management of Environment and Social Impacts of the Project.

Targets/Objectives

- To increase the access of women to different available opportunities and project's resources
- To develop a favorable environment that educates the local people to support women's participation in project's activities
- To ensure women's active role in planning, design and implementation of the project
- To change the decision-making patterns by involving women in different management committees of the project
- To increase women's financial security through providing them more livelihood opportunities
- To make a positive change in women's social and political status

Table: Gender Action Plan of the Project

Sr#	Activities	Targets & Tasks	Steps/Sub-Tasks
1	Conduct public awareness campaigns on project benefits and encourage women to equally access development opportunities provided under the Project.	1.1 Project brochure in Urdu disseminated in villages of the project area of influence and within one month of the start of the Project and orientation to women in face-to-face meetings.	1.1.1 Preparation and Printing of Project brochure. 1.1.2 Distribution of project brochure in villages of project area 1.1.3 Organize a face-o-face meeting with women for Project orientation to women by gender Specialist (Female)
		1.2 A documentary on the Project mitigation measures and benefits prepared in Pashto and Kohistani and shown to affected and beneficiary population in meetings and on electronic media, among them 30% will be women.	

[87] After development of implementation plan of Social Development Plan and detailed soc Plan, this Gender Action Plan will be updated within 6 months of start of project implementation

Sr#	Activities	Targets & Tasks	Steps/Sub-Tasks
		1.3 Dissemination campaign to introduce project via local FM radio and local print media, minimum weekly basis for one month of the Project start.	1.3.1 Contact and liaison must be established with the local print media (newspaper) and local FM radio. The name of the local newspaper and local radio station (if any) must be acquired.
		1.4 Gender Sensitization Session	
2	Socially and gender-inclusive consultations	2.1 Two broad-based socially and gender-inclusive participatory consultation workshops for relevant stakeholders on GAP objectives, one for male and one for female.	2.1.1 Broad-based socially and gender inclusive participatory consultation workshops for relevant stakeholders on objectives of Gender Action Plan will require considerable support and coordination with local key persons and administrative authorities. Therefore, liaison must be established.
			2.1.2 Preparation of workshop material (consisting of handouts/printouts and stationery) that would be distributed to the participants. A suitable venue will be required for conducting the said workshop.
		2.2 At least 25% of participants of stakeholder consultation activities are women.	2.2.1. Selection of a vocational training institute, preferably, if possible, local and conveniently accessible for the participants, especially women participants. Given the fact that women's mobility, the easy accessibility of the said firm or organization is highly crucial. Another equally significant consideration would be the sensitization of the local men which would provide quite challenging. Vocational training will not be achieving any sustainable result with a sensitization training. For this purpose, strong, persistent support

Sr#	Activities	Targets & Tasks	Steps/Sub-Tasks
			from authorities is indispensable.
		2.3 Representation of women in consultation, participation and decision-making forums such as women-specific Affected Person Committee and Social Development Implementation Committee to voice their opinions, needs and preferences at a location and time that increases the possibility of women's participation, 20% of participants are to be women's representatives.	
3	Women and men benefit equitably from the Livelihood Restoration Plan.	3.1 Minimum 80% vulnerable AHs provided training in improving existing skills or developing new income-generating skills either in on-farm or off-farm income-generating activities, among them 30% women trained in formal/informal skills (sewing, art and craft, veterinary and Agri-processing as relevant) with microenterprise development training and financial support including marketing.	3.1.1. Selection of a vocational training institute, preferably, if possible, local and conveniently accessible for the participants, especially women participants. Given the fact that women's mobility, the easy accessibility of the said firm or organization is highly crucial. Another equally significant consideration would be the sensitization of the local men which would provide quite challenging. Vocational training will not be achieving any sustainable result with a sensitization training. For this purpose, strong, persistent support from authorities is indispensable.
		3.2 Give priority and facilitate vulnerable persons (especially vulnerable women) in resettlement and relocation.	
4	Social and gender-inclusive Social Development Plan (SDP)	4.1 Social Development Plan developed based on target population needs and priorities.	

Sr#	Activities	Targets & Tasks	Steps/Sub-Tasks
		4.2 Installed water points/rehabilitation of existing water systems in all villages in the project area of influence, within 30 minutes round-trip travel time [1], will release women and children burden of fetching water, save time and improve their health. Details of the activity will be prepared after coordination with the relevant line departments.	
		4.3 At least one safe water connection at visible and accessible locations in community facilities, e.g., mosques, market area;	
		4.4 Safe and accessible water facilities for all girls' and boys' schools.	
		4.5 Conducted literacy campaigns to increase awareness of women and men to enroll the boys and girls in newly built schools under SDP.	
		4.6 Appoint at least one woman for Grievance Redress Mechanism (GRM) at the project site to address 100% women related complaints.	
		4.7 Monitor and evaluate the results of the implementation of the SDP by documenting successes, challenges, and lessons learned.	
		4.8 Recorded gender-disaggregated data by ethnicity, income, marginalized and vulnerable group against a set of socially inclusive and gender-sensitive indicators, monitored against baseline conditions and reported annually, focusing on improvements to the quality-of-life parameters.	
5	Women and girls visit the weir site with their families for recreation	5.1 Recreational area developed for families with sitting arrangement, water sports, and eateries;	
		5.2 Separate restrooms for women and men with a minimum of 6 toilets for women with clean running water and other personal hygiene facilities.	

Sr#	Activities	Targets & Tasks	Steps/Sub-Tasks
		5.3 Institutional Strengthening, Project Management, and Monitoring and Evaluation	
6	Enhance the capacity of PEDO and PMO to include a gender perspective into program/project operations.	6.1 Evidence that equal employment opportunity policy and practices are implemented, at least 10% of female staff in PMO with equal salaries by following GoKP fixed minimum quota for women employment;	
		6.2 Evidence of the type of incentives designed to recruit women, increase their capacity, and provide career development;	
		6.3 Social and Gender Specialist and female staff deployed in PMO and PIC to assist in GAP implementation and monitoring;	
		6.4 PMO and PEDO staff trained in job-related skills of which 10% are women;	
		6.5 Gender awareness and social inclusion training provided to 100% PMO and 50% management staff of PEDO for clarity in gender mainstreaming and social inclusion concepts, orientation on GAP targets, roles, and responsibilities, better planning, communication, coordination, implementation, documentation, monitoring and evaluation;	
7	Monitor satisfaction level of target beneficiaries	7.1 Conduct yearly satisfaction surveys of men and women project affected persons and beneficiaries of SDP including accessibility, quality, quantity, reliability, affordability, operations and maintenance; and share results;	
8	Include gender-disaggregated data in monitoring and evaluation and project progress reports.	8.1 Develop a set of quantitative and qualitative sub-indicators of key indicators, and develop a system to consistently collect, retrieve and analyze the gender-disaggregated data of level of participation, immediate results of activities, benefits, and outcomes, of the project on women, men, boys, and girls (disaggregated by gender,	

Sr#	Activities	Targets & Tasks	Steps/Sub-Tasks
		income, marginalized and vulnerable groups)	
9	Assess impacts of services on women, men, girls and boys	9.1 Conduct an impact assessment survey as a part of project evaluation to collect gender-disaggregated data to identify differential impacts on women and men, boys and girls due to implementation of RAP, Livelihood Restoration and Improvement Plan and Social Development Plan.	

ANNEXURE III: OCCUPATIONAL AND COMMUNITY HEALTH AND SAFETY

Overview

This Chapter presents a plan for the occupational and community health and safety management system (OCHSMP) during construction and operation stages. In Chapter 7 occupational hazards and risks associated with the construction and operation are briefly covered. This chapter will enhance those discussions in detail. The OCHSMP comprises high-level corporate policies of the Contractors, Processes and Standard Operating Procedures (SOPs). Relevant list of Processes and SOPs are presented in this Chapter and they will be further developed by the Contractors during construction with site and operation specific information.

Purpose

The guidance provided in this chapter is a plan meant to help the Contractor prepare their own specific Occupational Health and Safety (OHS) Management Plan and Community Health and Safety (CHS) Plan. Its core purpose is to ensure that all activities are planned, carried out, controlled and directed with consistent, approved, health, safety, and security management practices, procedures or standards.

This document is a plan for the Contractor providing a practical approach to manage OHS and CHS risks as per World Bank Group Environmental Health and Safety Guidelines (EHSGs), and Provincial regulatory framework, and requirements (please refer to Chapter 2 for country's Acts and Regulations). In addition, few international guidelines are recommended to be followed by the Contractor

Scope

This plan is applicable on all construction and operational activities related to the MHPP. Some of the key high-risk activities may involve the following:

- Blasting;
- Working at height;
- Confined space;
- Working near water;
- Vehicles and driving;
- Operation of mobile equipment on site and on community roads including passenger vehicles, jumbo.;
- Material haulage;
- Manual handling;
- Lifting and cranage;
- Scaffolding;
- Hot work;
- Maintenance and operation of the site camp and other facilities like workshop;
- Use of security forces; and
- Electrical works.

- Site security: access, safety of visitors, separation of work and rest areas and signage.
- Over-exertion, and ergonomic injuries and illnesses (repetitive motion and manual handling.).
- Slips and falls (due to poor housekeeping, such as excessive waste debris, loose construction materials and liquid spills.).
- Struck by objects.
- Working in excavations and trenches.
- Handling of raw materials (earthwork, gravel, crushed rock and sand.), handling of other materials causing dust development (such as cement), handling of hydrated lime and other activators and additives, handling of asphalt.
- Handling of flammable materials.
- Management of hazardous materials.

- Maintenance of vehicles and machinery.

Objectives and Targets

This plan is developed on the following objectives:

Safe operation with Zero harm to community members and all site personnel including Contractor's Staff and visitors;
Maintain a healthy workforce and labor pool in the community; and
Contribute to the improved health, safety and wellbeing of the local community in the areas of influence; and
Meet or exceed the contractual safety obligations

Project specific measurable targets to achieve, along with the above objectives, will be established by the Contractor. The determination of these targets will be based upon Contractor's continual improvement philosophy, external peer group benchmarking and stakeholders' input. The Contractor will establish targets for each project site for every fiscal year. Some examples of these targets are listed below to guide the contractor:

- Total Recordable Injury Rate[88] of 1.5 or less (or based on the Contractor previous yearly trend)
- Lost Time Injury Frequency Rate[89] of 0.5 or less (or based on the Contractor previous yearly trend)

Community health indicators may include, but not be limited to:

- Rates of communicable disease in the Project workforce

Rates of communicable disease in the community
Project related safety and security incidents in the community
Number of grievances or claims of Project related impacts on the community.
Rates of Chikungunya and Dengue, and other vector-borne diseases
Community health aspects (i.e., rate of STI's, TB, HIV/AIDS).

Senior Leaderships of the Contractor (Project Manager, Construction Manager and Technical Director) will need to be fully committed to achieve the above-mentioned targets. Leading and lagging indicators will be established by the Contractor to drive performance to meet these targets. Following are some leading indicators showing senior management commitment. Complete details of all Key Performance Indicators (KPIs) will be presented in "PR12: Measurement" Process of Contractor's project specific OHS plan (the OHS processes are discussed later on in the Chapter).

- All Project Managers to complete 1 Walk-through Inspection per month.
- All Construction Managers to complete 2 Walk-through Inspections per month with their assigned Health and Safety and Community Relations Officers.
- All OHS supervisors complete 1 site inspection weekly.

The risks and potential project impacts to community health, safety, and security can emanate from both within and outside the so-called "project fence." For this reason, the scope of this plan focuses on the management of aspects associated with the interaction of construction activities, the workforce, and the community.

The central element of the plan is a set of control measures designed to avoid or control the hazards posed by project activities on the health, safety, and security of the community, while at the same time, enhancing the beneficial effects and capitalize on opportunities that may contribute to improving overall community well-being.

Working together for Success

The responsibility for safety cannot simply be "delegated" to "OCHSM Officers or HSE Managers". The Contractor will ensure that OHS staff will support line management by assisting in jobsite training, serving as trained and knowledgeable observers, providing administrative assistance, monitoring and evaluating the success of the safety program and acting to continuously improve OHS and CHS plans. While this role is

[88] A rate of injuries and illnesses computed from the following formula: (Number of injuries and illnesses X 200,000) / Employee hours worked.

[89] A rate of lost time computed by: ([Number of lost time injuries in the reporting period] x 1,000,000) / (Total hours worked in the reporting period).

important, commitment and active participation by everyone, every day, on every task, is necessary if the Contractor is to achieve the level of safety excellence that PEDO expects.

The Contractor will follow a hierarchy of control for OCHSMP implementation. Mandatory requirements are established by the HSE policy, followed by the agreed OCHSMP Management system standard, linked to other OCHSMP system controls such as; standards, codes of practices, safe job procedures, safe work practices and facility / site specific safety instructions and any other safe systems of work that fosters a safe environment at the work execution level (refer to diagram in Figure).

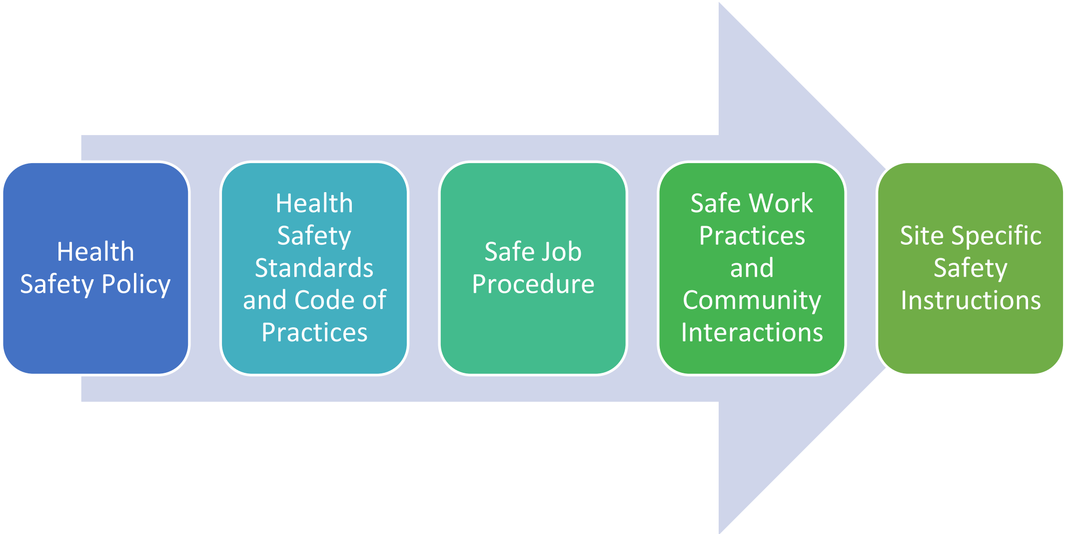


Figure Annex-III.1: OCHSM Management System

Requirements at any level must meet and support the requirements at higher levels. The Health and Safety policy and OCHSM management system standard apply to all activities covered in the scope of this plan.

All relevant OCHSM documents and tools are available and held by the Contractor's OHS and Community Relations Officers.

Review and Revision of Plans

OCHSMP Plan will be live documents and undergo routine review and updates when any of the following happens: There is a change in the scope of the project, or

- A yearly periodic review, or
- There is a change in construction methodology/technique based on site condition, or
- Following a significant OCHSM hazard or a major accident, and instructed by the Engineer, or
- Emerging social change and community health issues such as new communicable or non-communicable diseases, or
- At the end of the Project (to allow for improvements in subsequent projects).

The Contractor's OHS and Community Relations Officers are responsible for the review and update.

In addition, the Contractor can also prepare, submit and implement OCHSM sub plans and SOPs to address specific construction hazards either as a separate document or as part of the Method Statement.

Risk Assessment

Risk assessment is a process to identify hazards and risk factors that have the potential to cause harm (hazard identification), analyze and evaluate the risk associated with that hazard (risk analysis, and risk evaluation), and determine appropriate ways to eliminate the hazard, or control the risk when the hazard cannot be eliminated (risk control). Performing regular risks assessments can help construction and O/M stakeholders comply with regulations. Risk assessments can help health and safety and technical teams implement corrective measures to protect workers from health and safety threats during construction and operation stages.

Risks Assessment Codes

The principle behind the Risks Assessment System and the assignment of Risks Assessment Codes (RACs) is to identify and control workplace hazards. RACs are based on the hazard severity, probability of occurrence, and number of people exposed or potentially adversely affected in the event of an accident. While all hazards will be resolved as soon as possible, the Job Hazard Analysis is a health and safety risk ranking method to assist in making informed decisions concerning hazard control while providing decision makers with a consistent and defensible approach for prioritizing health and safety hazard abatement efforts based on available resources and with consideration towards competing demands and priorities.

Likelihood and Consequence of Hazards

RACs require assigning values for likelihood or probability of an outcome occurring, and the consequence or severity of a potential outcome. Based on these assigned values, a matrix format is used to place the specific hazard within a specific location of the matrix. This location can then be used to determine an RAC number for that hazard activity.

The Likelihood or probability Code is considered numerical (1 to 5). These are presented in below table.

Table: Likelihood ratings

Sl.	Likelihood	Definition
1	Remote (1)	Unlikely to occur but known in the sector; probability 0.1%-1%
2	Possible (2)	Likely to occur once or more during construction/ organization; probability 1%-10%
3	Occasional (3)	Likely to occur once every two years or more; probability 10%-50%
4	Likely (4)	Occurs more than once or twice per year, is continuous or certain to occur; probability 50%-80%
5	Frequent (5)	Multiple occurrences have happened frequently in the industry; probability >80% and above

Next is the Consequence or severity Code, varies from 1 to 5 and is presented in below table**.**

Table: Consequence ratings

Sl.	Consequence	Definition
1	Incidental (1)	No impact or minor First Aid injury
2	Minor (2)	First aid injury (e.g., minor cuts and bruises, eye irritation from dust) or very minor health effect
3	Moderate (3)	Lost Time/ Non-Lost Time injury (e.g., sprains, fracture, cut, lacerations, burns or bruises) or health effect (i.e., deafness or dermatitis)
4	Serious (4)	Major injuries: amputations, major fractures, multiple injuries, or health effects: severely life shortening disease, occupational illness, Single Fatality High potential incidents
5	Catastrophic (5)	Multiple fatalities or Multiple permanent disabilities

Risks Assessment Matrix

The risks assessment matrix is presented in Table. This matrix helps OCHSM team to prioritize workplace hazards by identifying them as high, substantial, moderate, and low. Those hazards identified as high will require the most stringent controls available as well as immediate attention. They may even demand that such activities be cancelled from the Project. Specific workplace controls can be applied so that the associated hazards are more effectively controlled and therefore, result in a revised assessment category to a more acceptable level. Note that the box at the bottom indicates that if we can eliminate the hazard (such as eliminating the task that subjects the worker to the hazard or allowing an outside specialized contractor to complete the task for the worker), the hazard no longer exists and therefore can be removed from a project's control process – this is the ultimate hazard control.

Table: Risk Matrix

Likelihood / Severity	Remote (1)	Possible (2)	Occasional (3)	Likely (4)	Frequent (5)
Incidental (1)	Low (1)	Low (2)	Low (3)	Low (4)	Low (5)
Minor (2)	Low (2)	Low (4)	Low (6)	Moderate (8)	Moderate (10)
Moderate (3)	Low (3)	Low (6)	Moderate (9)	Substantial (12)	Substantial (15)
Serious (4)	Low (4)	Moderate (8)	Substantial (12)	High (16)	High (20)
Catastrophic (5)	Low (5)	Moderate (10)	Substantial (15)	High (20)	High (25)

Summary of Assessed Risks

The project's potential risks and their significance have been assessed using the methodology described as per Risk matrix will be revisited by the Contractor once construction details are available.

Documents Structure

Contractor's OCHSMP will contain the following items (also presented in Figure):

- Policies, codes, organogram and responsibilities of individuals;
- OCHSMP Management Processes; and
- Standard Operating Procedures.

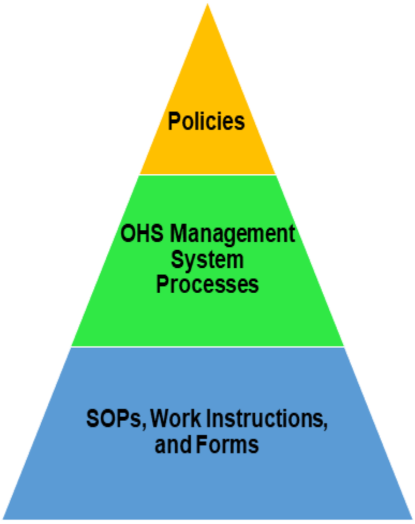


Figure Annex-III.2: Document hierarchy of the OCHSMP Plan

Policies

Contractor’s operating policies are the highest-level document. They provide with direction when the Contractor operates in different geographies of the world. These are based on the Contractor’s senior management commitments and they guide in day-to-day operations. Typical policies of the Contractor consist of the following:

- Human rights policy;
- Health and Safety Policy;
- Alcohol and Drug Policy; and
- Business Conduct and Ethics Code

Management System Processes

Management System Process forms a vital component of the Contractor OCHSM management (OCHSMP Plan) and these will be the Contractor’s second-tier documents after policies. The Contractor will need to develop the following health and safety Management System Processes based on the project and site requirements:

PR01: Induction Process
PR02: Risk Assessment (Job Hazard Analysis, Critical Risk Protocols, and Personal Risk Assessment)
PR03: Meetings
PR04: Personnel Competency and Training
PR05: Short Service Worker Program (with tools for assessment)
PR06: Reward and Recognition
PR07: Disciplinary Process
PR08: Permit to Work Process
PR09: Work Observation Process
PR10: Personal Protective Equipment (PPE)
PR11: Incident Investigation
PR12: Measurement - Leading and Lagging Indicators
PR13: Pandemic Action Plan (COVID-19)
PR14: OHS Compliance Audit
PR15: Inspections
PR16: Communications
PR17: Document Control
PR18: Risk Management
PR19: Management of Change
PR20: Document Control
PR21: Communication

Standard Operating Procedures (SOP), Work Instructions and Forms

Standard Operating Procedures and Work Instructions are mostly technical in nature and are third-tier documents in overall risk management approach. Forms and checklists provide support for implementing the controls mentioned in these SOPs. The following SOPs need to be developed by the Contractor based on project specific risk assessment and be part of the health and safety Plan (this is a non-exhaustive list and additional SOPs may need to be developed for the Project as appropriate/needed):

SOP 01: Explosives – Storage, Transport and use
SOP 02: Work at Height
SOP 03: Excavation
SOP 04: Mobile Equipment
SOP 05: Barricading and signs
SOP 06: Cell Phone Use
SOP 07: Safe Driving
SOP 08: Drilling and Blasting
SOP 09: Material Haulage
SOP 10: Traffic Interface Planning

SOP11: Severe Weather
SOP 12: Lifting and Hoisting
SOP 13: Scaffold Erection
SOP 14: Working Near or Over Water
SOP 15: Illumination
SOP 16: Ground Support
SOP 17: Water Management - Tunneling
SOP 18: Ventilation
SOP 19: Fire
SOP 20: Electrical Systems
SOP 21: Hazardous Material Management
SOP 22: Equipment Inspection and Maintenance
SOP 23: First Aid
SOP 24: Worker Welfare Facilities
SOP 25: Camp Management
SOP 26: Emergency Response Plan (ERP)
SOP 27: Tunneling Operation
SOP 28: Operation of Crushing and Batching Plants
SOP 29: Confined Space Entry
SOP 30: Contractor Security Management
SOP 31: Weir/Cofferdam Construction
SOP 32: Manual Handling
SOP 33: Stringing of Conductors
SOP 34: Working with Compressed Air
SOP 35: Community Health and Safety Awareness
SOP 36: Contractor's Code of Conduct for SEA/SH
SOP 37: Management of Communicable Disease

Others (if required) as pointed out earlier in "Scope" of this OHS/CHS.

Project Organization

In this section, the Contractor's Organogram and OCHSMP Organogram will be included. The company organogram will show the general structure of the company hierarchy. The OCHSMP organogram will clearly show the roles and hierarchy of the team responsible for upholding all project related HSE issues.

Contractor Organogram

A typical Contractor's organogram is presented in Figure**.** And efforts will be made to maintain an organogram like this, especially to make direct link between health and safety and Project Manager (Senior Leadership)

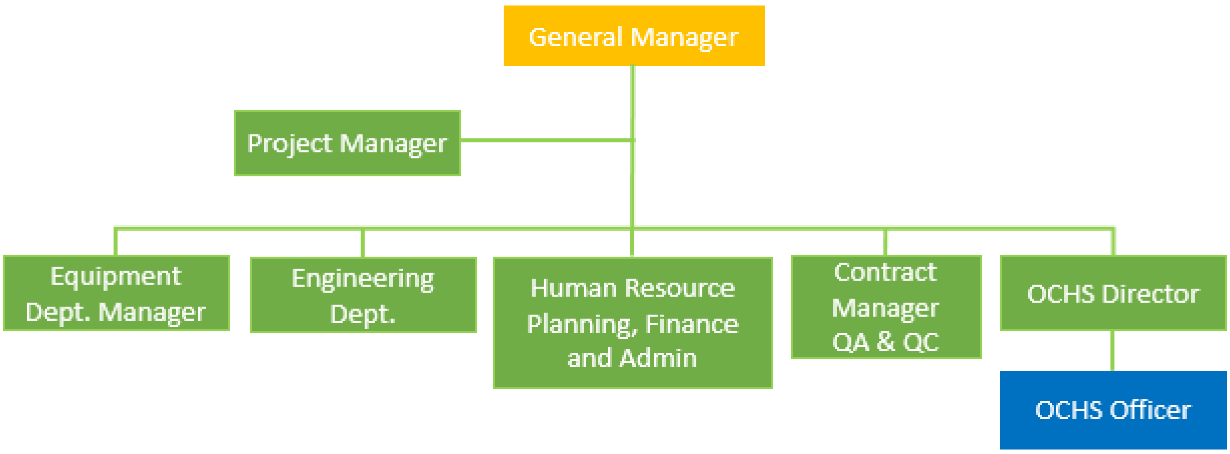


Figure Annex-III.3: Contractor Organogram

OHS Organogram

The Contractor's typical health and safety organization will look like as presented in Figure**.**

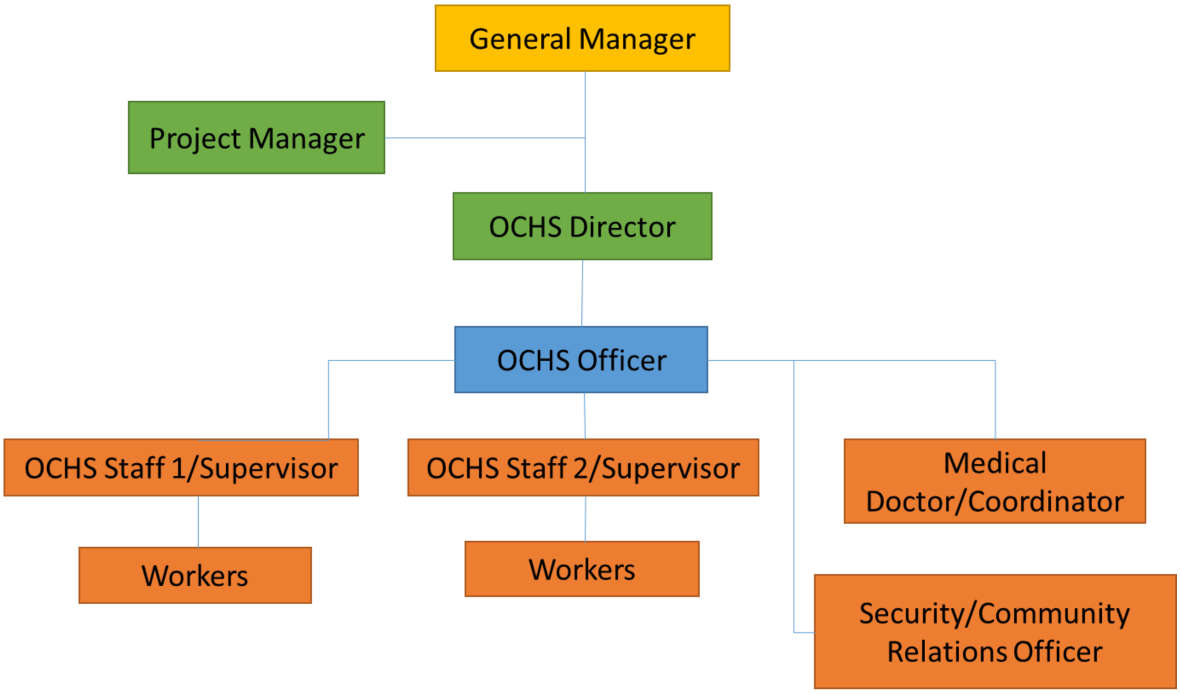


Figure Annex-III.4: Contractor's OCHSM Organogram

Roles and responsibilities

These typical roles and responsibilities give a holistic understanding pertaining to implementation of the OCHSMP Plan which comprises multiple processes and SOPs. However, each process and SOP may also have additional specific requirements pertaining to a specific role.

General Project Manager

- Overall accountability for the development, implementation and maintenance of the Health and Safety Plan.
- Accountable for allocation of sufficient resources for the execution of the plan.
- Ensure that empowered and competent personnel are available for the execution of the plan
- Make sure that senior leadership (all directors, Construction Managers and other line management personnel) are fully aware of their responsibilities as per the Processes and SOPs of the Health and Safety Plan.
- Discourage achievement of operational results at the cost of safety violations
- Develop a culture where it is safe to speak up and provide the time, people and resources to respond to OHS concerns identified by their workers
- Review Executive Summary of incidents, ensure that Root Causes are being identified and resources are provided for the closure of Preventive and Corrective Actions

Project Manager

- Overall accountability for the development, implementation and maintenance of the Health and Safety Plan.
- Accountable for allocation of sufficient resources for the execution of the plan.
- Ensure that empowered and competent personnel are available for the execution of this plan

- Make sure that Sr. Leadership (all directors, Construction Managers and other line management personnel) are fully aware of their responsibilities as per the Processes and SOPs of the Health and Safety Plan.
- Demonstrate visible leadership, walk to talk behavior to reinforce the implementation of the Health and Safety Plan
- Attend monthly Health and Safety Committee/Progress Review Meeting and monitor the performance through leading and lagging indicators.
- Discourage achievement of operational results at the cost of safety violations
- Develop a conducive culture where Personnel are authorized to *STOP unsafe work without fear of retribution
- Develop a culture where it is safe to speak up and provide the time, people and resources to respond to Health and Safety concerns identified by their workers.
- Ensure that Work Observation program is utilized, and all incidents are fully investigated
- Review Executive Summary of incidents, ensure that Root Causes are being identified and resources are provided for the closure of Preventive and Corrective Actions
- Encourage reward and recognition where personnel demonstrate safe behavior or identify hazards and fairly apply disciplinary process when personnel cut short.

**ILO COP 2.2.12. Where there is an imminent danger to the safety of workers, the employer will take immediate steps to stop the operation.*

OCHSMP Director

- Be a Subject Matter Expert of the Health and Safety Plan. Provide training and awareness regarding the implementation of the Health and Safety Plan that includes multiple Processes and SOPs.
- Convene monthly Health and Safety Committee/Progress Review meeting and share implementation progress, points of concern.
- Be familiar with all local, national, and international laws that are applicable to the operations.
- Establish and maintain a professional relationship with Company /Contractor and subcontractor representatives.
- Establish an audit system that measures the effectiveness of the Health and Safety Plan.

OCHSMP Officer

- Be a Subject Matter Expert of the Health and Safety Plan. Provide training and awareness regarding the implementation of the Health and Safety Plan that includes multiple Processes and SOPs
- To be familiar with all local, national, and international laws that are applicable to Operations.
- Raise concern in the monthly Health and Safety Committee/Progress Review meeting regarding implementation of controls stipulated in the Health and Safety Plan.
- Provide training to staffs on the Health and Safety Plan. Conduct regular sessions for all project team members to inculcate the requirements of the Health and Safety Plan.
- To report to the Contractor’s Management Team on implementation progress, monthly KPIs.
- To ensure that sufficient training and induction of all personnel is being provided and maintained.
- To ensure that visit induction is given to all visitors before they are allowed to visit the site.
- To develop the Health and Safety awareness of all personnel employed on the project and ensures their participation in all aspects of the health and Health and Safety program
- Provide guidance for the purchase of personal protective equipment
- Regular inspection of construction safety and security
- Provide guidance to employees regarding their emergency response responsibilities.

- Decide whether a potential rescue service or team is adequately trained and equipped to perform permit space rescues of the kind needed at the facility and whether such rescuers can respond in a timely manner, and organize drills
- Review of Health and Safety management plan annually.

OCHSMP Staff/ Supervisor

- Perform the assigned inspections and discuss the findings with OHS Officer
- Ensure communication procedure and system to communicate emergency events to site technical supervisor and emergency authorities (e.g., Incident Response Center (IRC) and/or Police, health centers)
- Communicate with construction site personnel to help them understand the hazards of the site and understand the demands of the operating personnel about Health and Safety matters.

Site Technical Supervisors (part of the technical team)

- They allocate tasks and check that the project workers are implementing Health and Safety requirements to standard. They provide feedback and guidance on Health and Safety implementation.
- Ensure that the controls stipulated in Permit to Work (if needed) are implemented and STOP the work when critical controls are missing or compromised
- Discuss Job Hazard Analysis (JHA) and conduct effective Tool Box Talk with all project workers. Ask questions to ensure that they have a good understanding.
- Ensure that all new employees receive training as per PR01: Induction Process and PR05: Short Service Worker Process
- Conduct worksite observations, discuss safety concerns with project workers
- Develop a culture where it is safe to speak up and provide the time, people and resources to respond to Health and Safety concerns identified by their workers. They are also responsible for escalating issues that can't be resolved by the project workers or at the supervision level to Health and Safety Team or senior management.
- Responsible for making an incident scene safe and secure and for ensuring that hazards, near misses and incidents are entered into the reporting system.
- Ensure all project workers use appropriate PPE and train them how to use PPE.

Workers Conduct Personal Risk Assessment Take 5 (Stop, Look, Assess, Control, and Monitor) and do not proceed to work if unsafe to do.

- Use authority to STOP work if observe an unsafe work by fellow worker or SSW.
- Report hazards and at-risk behavior as and help the Contractor management to develop a conducive safety culture.
- Use PPE as provided.
- Conduct a visual inspection of equipment in the beginning of the operation and ensure that equipment is de-energized before working on a piece of equipment.
- Ensuring that they wear appropriate PPE for the activity that they undertake.
- Be aware and mindful of hazards related to any work activity; do not undertake a job or task if physically or mentally not fit.
- Seek clarification for uncertainty relating to a task with the Supervisor.
- Do not undertake a job if not competent to do so.
- Raise improvement opportunities.
- Report near misses and actual incidents immediately to the supervisor.

Medical Doctor/Coordinator

- Responsible for health support coordination, delivery and implementation of health services to the workforces
- Ensure health specifications and programs/procedures meets Country health regulatory requirements
- Develops and coordinates the implementation of health inspection and audit programs to monitor compliance with health requirements
- Provides review of disease prevalence data and recommends changes to address disease prevalence and severity.

Security and Community Relations Officer

- In consultation with Medical Doctor/Coordinator, identifies and evaluates community health risks
- Identifies mitigation steps to address community health issues affected by project activities
- Conducts inspections and audits for effective implementation of community health programs
- Management and coordination of security guards employed by the Project
- Management of security incidents which occur both on the Project site and outside the site
- Collects, analyses data, reports on and provides recommendations on initiatives for continuous improvement in the community health program performance and compliance.

Subcontractor Integrity Program

The Contractor will be clear about its expectations of subcontractors during all phases. The Contractor will continually monitor and evaluate subcontracting companies' performance, including performing spot checks on-site, to ensure that the expected level of safety culture is being adhered to. The Contractor will be contractually responsible for the subcontractors' performance and legally liable to the employer for any non-compliances caused by the subcontractor. The subcontractor integrity program will be far reaching and include, but not be limited to the performance regarding the following:

- General traffic safety;
- Hazardous materials management;
- Community health and safety;
- Occupational health and safety; and
- Adherence to construction standards stated in the general and specific conditions of the main contract.

Audit

The Contractor will conduct bi-annual internal occupation and community health and safety audit to evaluate the ethical compliance, comprehensiveness and effectiveness of the Occupation and Community Health and Safety Plan. Periodically the plan may be audited by qualified external auditors to verify the internal auditing.

ANNEXURE IV: BIODIVERSITY STUDY DATA

Table Annex-IV-6-1: Vegetation Composition in the project area

Sr. No.	Vegetation Type	No. of Species	Percentage
1	Trees	35	18 %
2	Shrubs	18	9.2 %
3	Herbs	116	59.1 %
4	Grasses	18	9.2 %
5	Climbers	8	04 %
6	Sedges	1	0.5 %

Table Annex-IV-6-2: Tree (35 species) found in the project area

Sr. No.	Family	Botanical Name	KP Forest Ordinance 2002	IUCN Status
1	Caprifoliaceae	*Viburnum cotinifolium*	-	-
2	Caprifoliaceae	*Viburnum grandiflorum*	-	-
3	Cupressaceae	*Cupressus sempervirens*	-	Least Concern
4	Ebenaceae	*Diospyros lotus*	Protected	Least Concern
5	Ebenaceae	*Diospyros kaki*	-	Least Concern
6	Fagaceae	*Quercus incana*	Protected	Least Concern
7	Hamamelidaceae	*Parrotiopsis jacquemontiana*	-	Least Concern
8	Juglandaceae	*Juglans regia*	Protected	Least Concern
9	Meliaceae	*Melia azedarach*	Protected	Least Concern
10	Mimosaceae	*Acacia nilotica*	-	Least Concern
11	Mimosaceae	*Robinia pseudoacacia*	-	Least Concern
12	Moraceae	*Broussonetia papyrifera*	-	Least Concern
13	Moraceae	*Ficus carica*	-	Least Concern
14	Moraceae	*Morus alba*	Protected	Least Concern
15	Moraceae	*Morus nigra*	-	-
16	Myrtaceae	*Eucalyptus camaldulensis*	Protected	Near Threatened
17	Myrtaceae	*Olea ferruginea*	Protected	-
18	Myrtaceae	*Dalbergia sissoo*	Protected	Least Concern
19	Pinaceae	*Cedrus deodara*	-	Least Concern
20	Pinaceae	*Pinus gerardiana*	-	Near Threatened
21	Pinaceae	*Pinus wallichiana*	Protected	Least Concern
22	Platanaceae	*Platanus orientalis*	Protected	Data Deficient
23	Rhamnaceae	*Ziziphus nummularia*	-	-
24	Rhamnaceae	*Ziziphus oxyphylla*	-	Least Concern
25	Rhamnaceae	*Eriobotrya japonica*	-	-
26	Rhamnaceae	*Prunus armeniaca*	-	Data Deficient
27	Rhamnaceae	*Prunus cerasoides*	-	Least Concern
28	Rhamnaceae	*Prunus domestica*	-	Data Deficient
29	Rhamnaceae	*Prunus persica*	-	-
30	Rhamnaceae	*Pyrus communis*	-	Least Concern
31	Salicaceae	*Populus nigra*	-	Data Deficient
32	Rhamnaceae	*Salix babylonica*	-	Data Deficient
33	Rhamnaceae	*Salix tetrasperma*	Protected	Least Concern
34	Sapindaceae	*Acer cappocicum*	-	-
35	Simaroubaceae	*Ailanthus altissima*	-	-

Table Annex-IV-6-3: Shrubs (18 species) found in the project area

Sr. No.	Family	Botanical Name	Habit
1	Asclepiadaceae	*Calotropis procera*	Shrub
2	Berberidaceae	*Berberis lycium*	Shrub
3	Buddlejaceae	*Buddleja crispa*	Shrub
4	Cannabaceae	*Cannabis sativa*	Shrub
5	Caprifoliaceae	*Lonicera myrtillus*	Shrub
6	Celasteraceae	*Maytenus royleanus*	Shrub
7	Euphorbiaceae	*Andrachne cordifolia*	Shrub
8	Onagraceae	*Epilobium hirsutum*	Shrub
9	Onagraceae	*Astaragalus congestus*	Shrub
10	Onagraceae	*Crotalaria medicagineae*	Shrub
11	Onagraceae	*Desmodium elegans*	Shrub
12	Onagraceae	*Indigofera heterantha*	Shrub
13	Onagraceae	*Thalictrum cultratum*	Shrub
14	Rosaceae	*Cotoneaster affinis*	Shrub
15	Rosaceae	*Rosa brunoni*	Shrub
16	Rosaceae	*Rosa moschata*	Shrub
17	Rosaceae	*Rosa webbiana*	Shrub
18	Verbenaceae	*Lantana camara*	Shrub

Table Annex-IV-6-4: Herbs (116 species) found in the project area

Sr. No.	Family	Botanical Name	Habit
1	Acanthaceae	*Dicliptera bupleuroides*	Herb
2	Adiantaceae	*Adiantum capillus-veneris*	Herb
3	Adiantaceae	*Adiantum caudatum*	Herb
4	Adiantaceae	*Adiantum cuneatum*	Herb
5	Adiantaceae	*Adiantum venustum*	Herb
6	Adiantaceae	*Chelianthus acrostica*	Herb
7	Adiantaceae	*Cheilanthes argentea*	Herb
8	Adiantaceae	*Onychium japonicum*	Herb
9	Amaranthaceae	*Alternanthera pungens*	Herb
10	Amaranthaceae	*Amaranrhus spinosus*	Herb
11	Amaranthaceae	*Amaranthus graecizans*	Herb
12	Amaranthaceae	*Amaranthus viridis*	Herb
13	Apiaceae	*Aegopodium alpestre*	Herb
14	Aspleniaceae	*Asplenium adiantum-nigrum*	Herb
15	Aspleniaceae	*Asplenium trichomanes*	Herb
16	Aspleniaceae	*Ceterach dalhousiae*	Herb
17	Asteraceae	*Artemisia scoparia*	Herb
18	Asteraceae	*Artemisia vulgaris*	Herb
19	Asteraceae	*Bidens biternata*	Herb
20	Asteraceae	*Cnicus benedictus*	Herb

Sr. No.	Family	Botanical Name	Habit
21	Asteraceae	*Conyza bonariensis*	Herb
22	Asteraceae	*Conyza Canadensis*	Herb
23	Asteraceae	*Eclipta prostrata*	Herb
24	Asteraceae	*Gnaphalium luteo-album*	Herb
25	Asteraceae	*Lactuca serriola*	Herb
26	Asteraceae	*Launaea nudicaulis*	Herb
27	Asteraceae	*Onopordum acanthium*	Herb
28	Asteraceae	*Saussurea heteromala*	Herb
29	Asteraceae	*Silybum marianum*	Herb
30	Asteraceae	*Sonchus arvensis*	Herb
31	Asteraceae	*Sonchus asper*	Herb
32	Asteraceae	*Sonchus oleraceus*	Herb
33	Asteraceae	*Taraxacum officinale*	Herb
34	Boraginaceae	*Asperugo procumbens*	Herb
35	Boraginaceae	*Gastrocotyle hispida*	Herb
36	Boraginaceae	*Nonea edgworthea*	Herb
37	Brassicaceae	*Alliaria petiolata*	Herb
38	Brassicaceae	*Arabidopsis himalaica*	Herb
39	Brassicaceae	*Capsella burs-pastoris*	Herb
40	Brassicaceae	*Coronopus didymus*	Herb
41	Brassicaceae	*Lepidium apetalum*	Herb
42	Brassicaceae	*Malcolmia africana*	Herb
43	Brassicaceae	*Neslia apiculata*	Herb
44	Brassicaceae	*Sisymbrium irio*	Herb
45	Brassicaceae	*Thlaspi arvense*	Herb
46	Caryophyllaceae	*Arenaria serpyllifolia*	Herb
47	Caryophyllaceae	*Cerastium dhuricum*	Herb
48	Caryophyllaceae	*Silene conoides*	Herb
49	Caryophyllaceae	*Silene vulgaris*	Herb
50	Caryophyllaceae	*Spergularia marina*	Herb
51	Caryophyllaceae	*Stellaria media*	Herb
52	Chenopodiaceae	*Chenopidium ambrosioides*	Herb
53	Chenopodiaceae	*Chenopodium album*	Herb
54	Chenopodiaceae	*Chenopodium murale*	Herb
55	Convolvulaceae	*Convolvulus arvensis*	Herb
56	Dryopteridaceae	*Dryopteris filix-mas*	Herb
57	Dryopteridaceae	*Euphorbia helioscopia*	Herb
58	Dryopteridaceae	*Phyllanthus fraternus*	Herb
59	Fumariaceae	*Fumaria indica*	Herb
60	Funariaceae	*Funaria hygrometrica*	Herb
61	Geraniaceae	*Geranium nepalense*	Herb

Sr. No.	Family	Botanical Name	Habit
62	Geraniaceae	*Geranium lucidum*	Herb
63	Geraniaceae	*Geranium rotundifolium*	Herb
64	Lamiaceae	*Ajuga bracteosa*	Herb
65	Lamiaceae	*Isodon rugosus*	Herb
66	Lamiaceae	*Leucas cephalotes*	Herb
67	Lamiaceae	*Mentha longifolia*	Herb
68	Lamiaceae	*Salvia plebeian*	Herb
69	Lamiaceae	*Thymus linearis*	Herb
70	Malvaceae	*Malva neglecta*	Herb
71	Malvaceae	*Malva parviflora*	Herb
72	Malvaceae	*Oenothera rosea*	Herb
73	Oxalidaceae	*Oxalis corniculata*	Herb
74	Papilionaceae	*Argyrolobium roseum*	Herb
75	Papilionaceae	*Lathyrus aphaca*	Herb
76	Papilionaceae	*Lathyrus hirsutus*	Herb
77	Papilionaceae	*Lathyrus pratensis*	Herb
78	Papilionaceae	*Medicago denticulata*	Herb
79	Papilionaceae	*Medicago lupulina*	Herb
80	Papilionaceae	*Medicago polymorpha*	Herb
81	Papilionaceae	*Trifolium repens*	Herb
82	Papilionaceae	*Trigonella monantha ssp. incisa*	Herb
83	Papilionaceae	*Vicia sativa*	Herb
84	Plantaginacee	*Plantago lanceolata*	Herb
85	Plantaginacee	*Plantago major*	Herb
86	Plumbaginaceae	*Limonium cabulicum*	Herb
87	Polygonaceae	*Emex australis*	Herb
88	Polygonaceae	*Polygonum plebeium*	Herb
89	Polygonaceae	*Rumex dentatus*	Herb
90	Polygonaceae	*Rumex hastatus*	Herb
91	Primulaceae	*Anagallis arvensis*	Herb
92	Primulaceae	*Androsace foliosa*	Herb
93	Ranunculaceae	*Ranunculus arvensis*	Herb
94	Ranunculaceae	*Ranunculus muricatus*	Herb
95	Ranunculaceae	*Ranunculus sceleratus*	Herb
96	Ranunculaceae	*Ranunculusdiffusus*	Herb
97	Ranunculaceae	*Duchesnea indica*	Herb
98	Ranunculaceae	*Eriobotrya japonica*	Tree
99	Ranunculaceae	*Fragaria nubicola*	Herb
100	Ranunculaceae	*Geum elatum*	Herb
101	Ranunculaceae	*Potentilla argentea*	Herb
102	Scrophulariaceae	*Verbascum thapsus*	Herb

Sr. No.	Family	Botanical Name	Habit
103	Scrophulariaceae	*Veronica agrestis*	Herb
104	Scrophulariaceae	*Veronica anagallis-aquatica*	Herb
105	Scrophulariaceae	*Veronica laxa*	Herb
106	Scrophulariaceae	*Veronica polita*	Herb
107	Selaginellaceae	*Selaginella sp.*	Herb
108	Solanaceae	*Solanum nigrum*	Herb
109	Solanaceae	*Solanum pseudo-capsicum*	Herb
110	Solanaceae	*Solanum surattense*	Herb
111	Solanaceae	*Withania coagulens*	Herb
112	Solanaceae	*Withania somnifera*	Herb
113	Urticaceae	*Urtica dioica*	Herb
114	Urticaceae	*Phyla nodiflora*	Herb
115	Urticaceae	*Verbena officinalis*	Herb
116	Violaceae	*Viola canescens*	Herb

Table Annex-IV-6-5: Grasses (18 species) found in the project area

Sr. No.	Family	Botanical Name	Habit
1	Poaceae	*Apluda mutica*	Grass
2	Poaceae	*Aristida adscensionis*	Grass
3	Poaceae	*Avena fatua*	Grass
4	Poaceae	*Brachiaria reptans*	Grass
5	Poaceae	*Bromus pectinatus*	Grass
6	Poaceae	*Cenchrus ciliaris*	Grass
7	Poaceae	*Cynodon dactylon*	Grass
8	Poaceae	*Dactylis glomerata*	Grass
9	Poaceae	*Dichanthium annulatum*	Grass
10	Poaceae	*Elusine indica*	Grass
11	Poaceae	*Enneapogon persicus*	Grass
12	Poaceae	*Eragrostis atrovirens*	Grass
13	Poaceae	*Eragrostis barrelieri*	Grass
14	Poaceae	*Lolium temulentum*	Grass
15	Poaceae	*Phalaris minor*	Grass
16	Poaceae	*Poa annua*	Grass
17	Poaceae	*Polypogon monspeliensis*	Grass
18	Poaceae	*Themeda anathera*	Grass

Table Annex-IV-6-6: Climbers (8 - species) and Sedges (1- species) found in the project area

Sr. No.	Family	Botanical Name	Habit
1	Araliaceae	*Hedera nepalensis*	Climber
2	Asparagaceae	*Asparagus adscendens*	Climber
3	Asparagaceae	*Asparagus filicinus*	Climber
4	Oleaceae	*Jasminum humile*	Climber
5	Rubiaceae	*Galium aparine*	Climber
6	Rubiaceae	*Galium asperuloides*	Climber
7	Rubiaceae	*Rubia cordifolia*	Climber

Sr. No.	Family	Botanical Name	Habit
8	Rubiaceae	*Cardiospermum halicacabum*	Climber
9	Cyperaceae	*Cyperus rotundus*	Sedge

Table Annex-IV-6-7: Fish species recorded at Madyan HPP Area

Sr. No.	Zoological Name	Common Name	Local Name	Order	Family	IUCN Status (2023)
1	*Salmo trutta fario*	Brown trout	Trout	Salmoniformes	Salmonidae	Least Concern
2	*Schizothorax plagiostomus*	Snow trout / Snow carp	Swati	Cypriniformes	Cyprinidae	Vulnerable
3	*Nangra robusta*	Cat fish	Chakora	Siluriformes	Sisoridae	Endangered

Table Annex-IV-6-8: Amphibian species recorded at Madyan HPP Area

Sr. No.	Zoological Name	Common Name	Order	Family	IUCN Status (2023)
1	*Bufo stomaticus*	Indus valley toad	Anura	Bufonidae	Least Concern
2	*Bufo pseudoraddei*	Swat Green Toad	Anura	Bufonidae	Least Concern
3	*Euphlyctis cyanophlyctis*	Skittering frog	Anura	Ranidae	Least Concern

Table Annex-IV-6-9: Reptiles recorded at Madyan HPP Area

Sr. No.	Zoological Name	Common Name	Order	Family	IUCN Status (2023)
1	*Laudakia himalayana*	Himalayan Agama	Squamata	Agamidae	Least Concern
2	*Laudakia pakistanica*	North-Pakistan Agama	Squamata	Agamidae	Least Concern
3	*Laudakia tuberculata*	Blue Rock Agama	Squamata	Agamidae	Least Concern
4	*Ophisops jerdonii*	Rugose-spectacled	Squamata	Lacertidae	Least Concern
5	*Ablepharus pannonicus*	Snake-eyed skink	Squamata	Scincidae	Least Concern
6	*Scincella himalayana*	Himalayan skink	Squamata	Scincidae	Least Concern
7	*Python molurus*	Indian Rock Python	Squamata	Pythonidae	Near
8	*Platyceps rhodorachis*	Ladakh Cliff racer	Squamata	Colubridae	Least Concern
9	*Pseudocyclophis persicus*	Dark-head Dwarf racer	Squamata	Colubridae	Least Concern
10	*Ptyas mucosus*	Rope-snake	Squamata	Colubridae	Least Concern
11	*Spalerosophis diadema*	Blotched diadem snake	Squamata	Colubridae	Least Concern
12	*Naja oxiana*	Brown cobra	Squamata	Elapidae	Near Threatened

Table Annex-IV-6-10: Birds recorded at Madyan HPP Area

Sr. No.	English Names	Zoological Names	Category	IUCN Status (2023)
Order Galliformes				
1	Chukar Partridge	*Alectoris chukar*	Resident	Least Concern
2	Common Quail	*Coturnix coturnix*	Passage Migrant	Least Concern
3	Koklass Pheasant	*Pucrasiamacrolopha*	Resident	Least Concern
4	Himalayn Monal	*Lophophorus impejanus*	Resident	Least Concern
5	Gadwall	*Anas strepera*	Winter Visitor	Least Concern
6	Eurasian Wigeon	*Anas penelope*	Winter Visitor	Least Concern

Sr. No.	English Names	Zoological Names	Category	IUCN Status (2023)
7	Mallard	*Anas platyrhynchos*	Winter Visitor	Least Concern
8	Common Teal	*Anas crecca*	Winter Visitor	Least Concern
9	Northern Pintail	*Anas acuta*	Winter Visitor	Least Concern
10	Northern Shoveler	*Anas clypeata*	Winter Visitor	Least Concern
Order Piciformes				
11	Eurasian wryneck	*Jynx torquilla*	Summer Breeder	Least Concern
12	Himalayan Woodpecker	*Dendrocopos himalayensis*	Resident	Least Concern
Order Coraciiformes				
13	Common Hoopoe	*Upupa epops*	Summer Breeder	Least Concern
14	Indian Roller	*Coracias benghalensis*	Summer Breeder	Least Concern
15	Eurasian Roller	*Coracias garrulus*	Summer Breeder	Least Concern
16	White-throated Kingfisher	*Halcyon smyrnensis*	Resident	Least Concern
17	Common Kingfisher	*Alcedo atthis*	Resident	Least Concern
18	Green Bee-eater	*Merops orientalis*	Resident	Least Concern
Order Cuculiformes				
19	Eurasian Cuckoo	*Cuculus canorus*	Summer Breeder	Least Concern
Order Psittaciformes				
20	Rose-ringed Parakeet	*Psittacula krameri*	Resident	Least Concern
Order Apodiformes				
21	House Swift	*Apus affinis*	Summer Breeder	Least Concern
22	Common Swift	*Apus apus*	Summer Breeder	Least Concern
23	Alpine Swift	*Tachymarptis melba*	Summer Breeder	Least Concern
Order Strigiformes				
24	Collared Scops Owl	*Otus bakkamoena*	Summer Breeder	Least Concern
25	Spotted Owlet	*Athene brama*	Summer Breeder	Least Concern
26	Eurasian Eagle Owl	*Bubo bubo*	Resident	Least Concern
Order Caprimulgiformes				
27	Eurasian Nightjar	*Caprimulgus europaeus*	Summer Breeder	Least Concern
Order Columbiformes				
28	Rock Pigeon	*Columba livia*	Resident	Least Concern
29	Oriental Turtle Dove	*Streptopelia orientalis*	Resident	Least Concern
30	Eurasian Collared Dove	*Streptopelia decaocto*	Resident	Least Concern
31	Spotted Dove	*Streptopelia chinensis*	Resident	Least Concern
Order Gruiformes				
32	Common Moorhen	*Gallinula chloropus*	Resident	Least Concern
33	Common Coot	*Fulica atra*	Winter visitor	Least Concern
Order Charadriiformes				
34	Common Sandpiper	*Actitis hypoleucos*	Summer Breeder	Least Concern
35	Northern Lapwing	*Vanellus vanellus*	Winter visitor	Near Threatened
Order Accipitriformes				
36	Black Kite	*Milvus migrans*	Summer Breeder	Least Concern
37	Himalayan Griffon	*Gyps himalayensis*	Resident	Near Threatened
38	Eurasian Sparrow-hawk	*Accipiter nisus*	Summer Breeder	Least Concern
39	Long-legged Buzzard	*Buteo rufinus*	Winter visitor	Least Concern
40	Booted Eagle	*Hieraetus pennatus*	Resident	Least Concern
41	Common Kestrel	*Falco tinnunculus*	Resident	Least Concern
42	Peregrine Falcon	*Falco peregrinus*	Winter visitor	Least Concern

Sr. No.	English Names	Zoological Names	Category	IUCN Status (2023)
Order Ciconiiformes				
43	Cattle Egret	*Bubulcus ibis*	Resident	Least Concern
44	Night Heron	*Nycticorax nycticorax*	Summer breeder	Least Concern
Order Passeriformes				
45	*Rufous-tailed Shrike*	*Lanius isabellinus*	Winter visitor	Least Concern
46	*Long-tailed Shrike*	*Lanius schach*	Summer breeder	Least Concern
47	*Black-headed Jay*	*Garrulus lanceolatus*	Resident	Least Concern
48	*Large-billed Crow*	*Corvus macrorhynchos*	Resident	Least Concern
49	*Eurasian Golden Oriole*	*Oriolus oriolus*	Summer breeder	Least Concern
50	*Black Drongo*	*Dicrurus macrocercus*	Summer breeder	Least Concern
51	*Brown Dipper*	*Cinclus pallasii*	Resident	Least Concern
52	*Blue Rock Thrush*	*Monticola solitarius*	Summer breeder	Least Concern
53	*Blue Whistling Thrush*	*Myophonus caeruleus*	Summer breeder	Least Concern
54	*Eurasian Blackbird*	*Turdus merula*	Resident	Least Concern
55	*Black Redstart*	*Phoenicurus ochruros*	Winter visitor	Least Concern
56	*White-capped Water Redstart*	*Chaimarrornis leucocephalus*	Summer breeder	Least Concern
57	*Plumbeous Water Redstart*	*Rhyacornis fuliginosus*	Summer breeder	Least Concern
58	*Pied Bushchat*	*Saxicola caprata*	Summer breeder	Least Concern
59	*Common Stonechat*	*Saxicola torquata*	Summer breeder	Least Concern
60	*Pied Wheatear*	*Oenanthe pleschanka*	Passage Migrant	Least Concern
61	*Isabelline Wheatear*	*Oenanthe isabellina*	Passage Migrant	Least Concern
62	*Common Myna*	*Acridotheres tristis*	Summer breeder	Least Concern
63	*Wall Creeper*	*Tichodroma muraria*	Winter Visitor	Least Concern
64	*Bar-tailed Tree Creeper*	*Certhia familiaris*	Resident	Least Concern
65	*Rufous-naped tit*	*Parus rufonuchalis*	Resident	Least Concern
66	*Great tit*	*Parus major*	Resident	Least Concern
67	*Eurasian Crag Martin*	*Hirundo rupestris*	Summer breeder	Least Concern
68	*Asian House Martin*	*Delichon dasypus*	Summer Breeder	Least Concern
69	*Barn Swallow*	*Hirundo rustica*	Summer breeder	Least Concern
70	*Himalayan Bulbul*	*Pycnonotus leucogenys*	Resident	Least Concern
71	*Lesser Whitethroat*	*Sylvia curruca*	Summer breeder	Least Concern
72	*Common Chiffchaf*	*Phylloscopus collybita*	Winter visitor	Least Concern
73	*Greenish Warbler*	*Phylloscopus trochiloides*	Winter visitor	Least Concern
74	*Crested Lark*	*Galerida cristata*	Resident	Least Concern
75	*Eurasian Skylark*	*Alauda arvensis*	Winter visitor	Least Concern
76	*Oriental Skylark*	*Alauda gulgula*	Summer breeder	Least Concern
77	*House Sparrow*	*Passer domesticus*	Summer breeder	Least Concern
78	*Spanish Sparrow*	*Passer hispaniolensis*	Passage migrant	Least Concern
79	*Eurasian Tree Sparrow*	*Passer montanus*	Resident	Least Concern
80	*White Wagtail*	*Motacilla alba*	Summer breeder	Least Concern
81	*Yellow Wagtail*	*Motacilla flava*	Passage migrant	Least Concern
82	*Citrine Wagtail*	*Motacilla citreola*	Summer breeder	Least Concern
83	*Grey Wagtail*	*Motacilla cineria*	Summer breeder	Least Concern
84	*Long-billed Pipit*	*Anthus similis*	Resident	Least Concern
85	*Water Pipit*	*Anthus spinoletta*	Winter visitor	Least Concern
86	*Alpine Accentor*	*Prunella collaris*	Winter visitor	Least Concern
87	*Plain Mountain Finch*	*Leucosticte nemoricola*	Resident	Least Concern
88	*Eurasian Goldfinch*	*Carduelis carduelis*	Winter visitor	Least Concern

Sr. No.	English Names	Zoological Names	Category	IUCN Status (2023)
89	*Indian Silverbill*	*Lonchura malabarica*	Summer breeder	Least Concern
90	*Common Rosefinch*	*Carpodacus erythrinus*	Summer breeder	Least Concern
91	*Rock Bunting*	*Emberiza cia*	Winter visitor	Least Concern

Table Annex-IV-6-11: Mammals recorded at Madyan HPP Area

Sr. No.	Common Name	Zoological Name	Order	Family	IUCN Status (2023)
1	Himalayan White-toothed Shrew	*Crocidura suaveolens*	Insectivora	Soricidae	Least Concern
2	Greater Horse-shoe Bat	*Rhinolophus ferrumequinum*	Chiroptera	Rhinolophidae	Least Concern
3	Common Pipistrelle	*Pipistrellus pipistrellus*	Chiroptera	Vespertilionidae	Least Concern
4	Cape Hare	*Lepus capensis*	Lagomorpha	Leporidae	Least Concern
5	Himalayan Flying Squirrel	*Petaurista petaurista*	Rodentia	Sciuridae	Least Concern
6	Himalayan Wood Mouse	*Apodemus rusiges*	Rodentia	Muridae	Least Concern
7	House Rat	*Ratus ratus*	Rodentia	Muridae	Least Concern
8	House Mouse	*Mus musculus*	Rodentia	Muridae	Least Concern
9	Indian Wolf	*Canis lupus*	Carnivora	Canidae	Least Concern
10	Asiatic Jackal	*Canis aureus*	Carnivora	Canidae	Least Concern
11	Black Bear	*Ursus thibetanus*	Carnivora	Ursidae	Vulnerable
12	Rhesus monkey	*Macaca mulatta*	Primates	Cercopithecidae	Least Concern

The study team was comprised of different experts during different field visits to study fauna and flora. These included plant taxonomist, ichthyologist, herpetologist, ornithologist, mammologist, field assistant, photographer and local guide. A list of team members is given in the table below:

Table Annex-IV-6-12: Biodiversity Survey Team

Sr. No.	Name of Team Member	Qualification	Expertise/Affiliation
1	Dr. Waseem Ahmad Khan	PhD Zoology (Wildlife Ecology)	Biodiversity Specialist / Freelance Consultant
2	Dr. Muhammad Shafiq	PhD Zoology (Fish Biology)	Freelance Consultant
3	Dr. Saeed Ahmad	PhD Botany (Plant Taxonomy)	Assistant Professor, University of Sargodha
4	Dr. Muhammad Waris	PhD Botany (Plant Taxonomy)	Assistant Professor, University of Sargodha
5	Dr. Atif Yaqub	PhD Zoology (Mammologist)	Prof. of Zoology GCU, Lahore
6	Mr. Shahid Iqbal	DAE (Bird Watching)	Freelance Consultant

Sr. No.	Name of Team Member	Qualification	Expertise/Affiliation
7	Mr. Altaf Hussain	MS Environ. Sciences (Environmentalist)	Field Assistance
8	Mr. Ikram Ullah	M Phil Zoology (Field Biologist)	Field Assistance

During field visits, 23 different people including local residents, officials of wildlife, forest and fisheries departments, hunters, conservationists, teachers, farmers, shopkeepers, transporters and nature lovers were interviewed to have an idea about the existence and distribution of various wildlife species in the study area.

QUESTIONNAIRE FOR INVESTIGATING MARKHOR'S EXISTENCE IN MADYAN, SWAT, KP

QUESTIONNAIRE
Investigating Markhor's Existence in Madyan, Swat, KP
Interview Date: ……………………………

1. Name

2. Age (Years)

3. Education

Nil:	Primary:	Middle:	Metric:	Higher:

4. Occupation

Agriculture	Hunter	Teacher	Other

5. Resident of / Postal Address

Village/ Tehsil / District

6. Contact No.

7. Have you heard the presence of Markhor in your area from your forefathers?

Yes:	No.

8. If yes, approximately how many years before?

9. Location where the Markhor was found according to your forefathers?

10. Have you ever seen a Markhor?

Yes:	No.

11. If yes, (a) When?

A week ago:	A month ago:	A year ago:	Other:

12. What was the season when you observed Markhor?

Winter	Spring	Summer	Autumn

13. Which of the following Markhor did you see? Place a tick mark (✓) on the picture

14. Where did you see the Markhor?

On hill top	On hill slope	Close to river	Other

15. Can you tell us about its size?

16. At which time did you see the Markhor?

Morning:	noon:	after noon:	evening:	night:

17. What the Markhor was doing when you saw the animal?

Feeding:	Resting:	Walking:	Playing:	Grooming:

18. What was animal's behavior when he realized that he is being watched?

Ran away:	Stand still and looking at you:	Other:

19. Was it alone or in a group?

20. What was the group size?

A single animal:	A pair:	Other:

21. Can you show us any evidence of Markhor like its horns, trophy picture with you?

Yes:	No.

22. Have you ever hunted a Markhor?

Yes:	No.

23. Have you ever kept a Markhor?

Yes:	No.

24. Do you know someone who has kept or used to keep Markhor?

Yes:	No.

25. Can you tell us something about Markhor's behavior in captivity?

26. Do you know what do the Markhor eat?

27. Do you know about the preferred food of Markhor?

28. Why do the people hunt Markhor?

29. Have you ever seen a Markhor damaging the crops?

Yes:	No.

30. Do you know someone who use to hunt Markhor?

Yes:	No.

31. Do you know any outfitter or a person facilitating Markhor Hunting?

Yes: (Name and contact details)	No.

32. Do you know about the importance/ecological role of Markhor?

Yes:	No.

33. Can you tell us about the population trend of Markhor in your area?

Increasing:	Decreasing:	Stable:	Don't know:

34. Will we save Markhor or not?

Yes:	No.

35. If yes, why?

36. How the Markhor can be conserved in your area?

37. How can we control illegal hunting of Markhor?

38. How can we convince Markhor hunters for saving Markhor?

39. How can we increase the number of Markhor in this area?

40. How do the majority of people see the Markhor in this area? As haunt or else?

41. Any other information / story / remarks / picture about Markhor?

Signature: …………………………….……………….

Date: ……………………..………………….………….

BIODIVERSITY SURVEY-PHOTOGRAPHS

Blotched diadem snake (Spalerosophis diadema)

Brown cobra (Naja oxiana)

Cliff racer (Platyceps rhodorachis)

Bank myna

Common myna

Black bulbul


White wagtail


Carion crow


Blue rock thrush


Kashmir Roack Agama (Laudakia tuberculata)


Wild Rose (Rosa webbiana)


Rugose-spectacled lacerta (Ophisops jerdonii)

Pakistanni Rock Agama (Laudakia pakistanica)

Himalayan Rock Agama (Laudakia himalayana)

Lichens growing on a tree trunk. Lichens are two symbionts; one is algae while the other is a fungus. Both live together in a mutualistic association and both get benefited from this association. In this example, the mycobiont (fungus) is responsible for the maintenance of the lichen thallus, while the photobiont (algae) is responsible for producing food for both partners through photosynthesis.

ANNEXURE V: ENVIRONMENTAL FLOW ASSESSMENT

EFLow Assessment Methodology

In the common view of river science, a specific flow regime in a river, capable of sustaining a complex set of aquatic habitats and ecosystem processes, is referred to as an environmental flow (e-flow). The term "environmental flows" was originally referred to in the Brisbane Declaration (2007), endorsed at the 10th International River Symposium held in Brisbane, Australia, in 2007. In the declaration, "*the Environmental Flows90 (EFlows) are defined as the quantity, frequency, timing, and quality of water and sediment flows necessary to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems*"[91].

Critically Dewatered Stretch of MHPP

The dewatered stretch of the Swat River for the MHPP has been considered about 13km area from the Weir site to the tailrace. The critical dewatered stretch is the area from the Weir site to the Kedam tributary joining Swat River downstream of the Weir after 0.8km.

Determinants of Eflow

The quality, quantity, frequency, duration, timing and rate of change of river flow are essential for maintaining freshwater ecosystem functions, processes and services on which livelihoods and economic opportunities depend[92]. Together with the flow regime, the sediment regime and river morphology are also important determinants that ensure the desired services of freshwater ecosystems[93]. While determining the Eflow of MHPP, based on the reported fish species, their migration behavior was considered the key determinants for Eflow assessment;

- **Snow Carp or Snow Trout (*Schizothorax plagiostomus*) Migration Behavior:** It is a short distance migratory fish which enters tributaries for breeding. Spawning is thought to be linked to increases in temperature and can occur twice a year in clear gravelly or fine pebble beds 10-30 cm deep[94]. Thrive in snow fed river habitat of clear, shallow water of stony substratum with an average depth from 0.5 to 3 meters, and river flows with low to high velocities (0.5 to 1.5 m/s**)**[95]. Average temperature requirements are varying 4-20 °C and 10-25°C. Spawns in rivers and streams with swift water. Low water currents of 0.5- 1.5 m/sec, pH 7.5, dissolved oxygen concentration of 8-12 ppm and gravel sizes of 50-60 mm or less are the optimum conditions for spawning[96].

- **Brown trout (*Salmo trutta*) Migration Behavior:** This fish spawn in rivers and streams with swift water and is a full migrant. Eggs are covered with 3-30 cm of gravel[97]. The relationship between spawning brown trout and flow conditions is important factor. Generally low velocities (0.2–0.55 m/s) and low depths (0.15–0.45 m) are preferred. The critical flows for spawning brown trout and their biotic dependents are 0.18 m^3/s and 2 m^3/s. The minimum and maximum average temperature required for the Snow trout is 6.80 °C and 14.38 °C respectively[98]. The brown trout used gravel and sand for spawning but mostly pebbles with a median grain size of 20–30 mm therefore medium gravel is considered the preferable substrate[99].

- **Catfish (*Nangra robusta*):** The catfish is a carnivorous species and habitat is commonly in mountain rivers and streams over sandy or muddy bottoms[100]. In case of MHPP project area, catfish was reported in the tributaries of Swat River around Madyan and Bahrain town. The movement pattern of Catfish as well as spawning time is not reported/assessed by IUCN or other recognized entities.

[90] the term "e-flow" has other names or variants worldwide like environmental water, ecological reserve, ecological demand of water, environmental water allocation (or requirement), compensation flow, instream flow requirements, minimum flow and downstream flow.

[91] Amended from Brisbane Declaration (2007).

[92] Poff et al., 1997.

[93] Wohl et al., 2015.

[94] https://www.iucnredlist.org/species/128725859/139131270#habitat-ecology

[95] MHPP ESIA baseline.

[96] https://academic-accelerator.com/encyclopedia/schizothorax-plagiostomus

[97] https://www.iucnredlist.org/species/19861/9050312#habitat-ecology

[98] Witzel and Maccrimmon, 1983, Louhi et al., 2008 referred in Jennifer Garbe etal The interaction of low flow conditions and spawning brown trout (Salmo trutta) habitat availability. Available on https://www.sciencedirect.com/science/article/pii/S0925857415303219 .

[99] Crisp and Carling (1989)

[100] https://www.iucnredlist.org/species/128723659/128723664#habitat-ecology

Environmental Flow Determination Methods

There are various types of methods and frameworks used in different parts of the world to determine minimum environmental flow requirements. Some of the most widely used approaches include:

(a) **Historic stream flow method:** As the name implies this method relies solely on estimates of the historic flow regime of the river (Jowett, 1997).

(b) **Hydraulic rating method (desk top):** It involves properties of river cross sections or aspects of the physical structure of river channel, this represents improvement over hydrological methods but often lack ecological rigor (Gippel and Stewardson, 1998).

(c) **Functional analysis method:** This method takes a broad view and covers many aspects of the river ecosystem, use of hydrological analysis, hydraulic rating information and biological data (Arthington et.al., 1992, King et al. 2000).

(d) **Habitat modelling method:** This method is an extension of historic stream flow and hydraulic methods because they relate stream discharge and hydraulic properties of a river cross section to biological requirements for a particular aquatic species. These tend to be the costly and data hungry methods, but give the most quantitative and replicable results. (Bovee, 1982; jowett, 1989; Jorde, 1996; Killingtviet and Harby, 1994).

(e) **Hydrological method / Tennant method / Montana method:** This method is based on analysis of river flow data and on percentage of mean annual flow to the more complex indicators of hydrologic alteration and the range of variability approaches which involves different hydrologic statistics (Tennant 1976; Richter *et. al.,* 1996; 1997).

(f) **Holistic approaches:** Many early applications of environmental flow setting were focused on a single species or a single component of the flow regime. Environmental flow assessments should consider all aspects of the river ecosystem and flow regime and thus be 'holistic' in their application. In some ways, even purely hydrological methods (such as Range of Variability Approach (RVA) / Indicators of Hydrological alterations (IHA)) can be said to be holistic. The concept that if the flow regime is natural, all elements of the ecosystem will be supported is implicitly if not explicitly holistic.

More and more methods now take a holistic approach that includes assessment of the whole ecosystem, such as associated wetlands, groundwater and estuaries, as well as all species that are sensitive to flow (e.g. vertebrates, invertebrates, higher and lower plants and algae) and all aspects of the hydrologic regime; foods, droughts and water quality.

To manage the complex assessment of flow impacts at the ecosystem level, holistic approaches necessarily place greater emphasis on expert opinion than on modelling; they may involve participation of stakeholders, so that the procedure is holistic in terms of interested parties as well as of scientific issues. Where methods are holistic, they clearly have the advantage of covering the whole hydrological-ecological-stakeholder system. If such methods are to be based on actual data, the collection of the data could well be expensive and time consuming, hence the current reliance on experts. (Acreman and Dunbar, 2004).

A prescriptive approach has been adopted for the assessment of Eflow for MHPP.

Selected Method: To determine the required flow for maintaining river connectivity and migration of the reported fish species, a prescriptive approach was adopted which includes an assessment of the flow by both hydrological and hydraulic methods by analyzing the hydrological data coupled basic hydraulic parameters like average velocity, average and maximum depth and wetted perimeter. The mean annual flow and mean monthly flows were estimated along with the requirement of ecosystem and downstream riparian needs.

Water availability at dam site: The gauging station and the dam site is located along to the same river and located within relatively short distance. Therefore, it can be assumed that the catchment characteristics and flow pattern between Kalam gauging station and the dam site are similar. With these assumptions, it is reasonable to derive river flow at the dam site with area ratio method. The mean annual flow at the dam site is 107.35 m^3/sec. The estimated mean monthly flows are shown in the **Figure V-1 and Table V-1**.

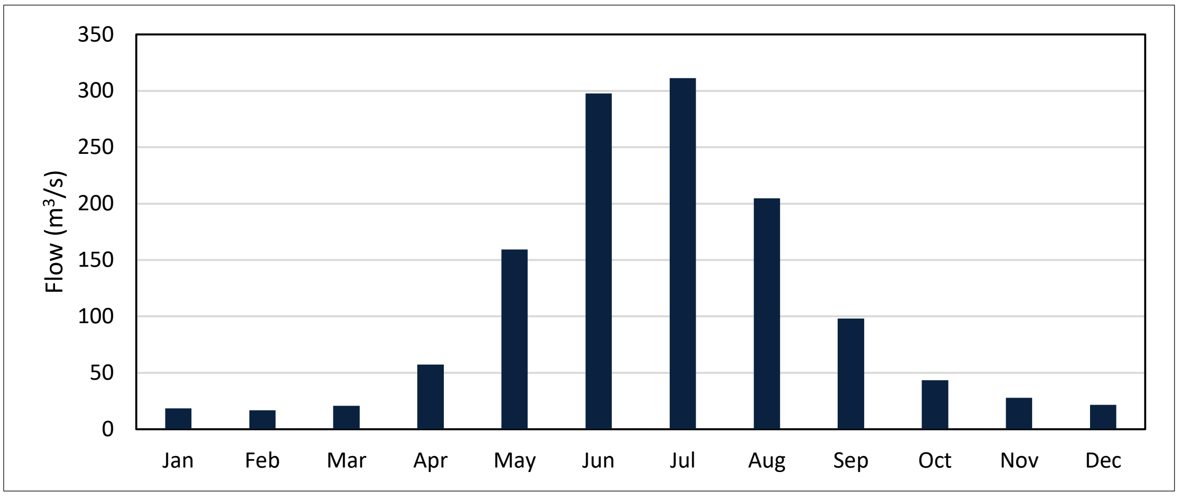


Figure V-1: Mean Monthly Flows at the Weir site

Table V-1: Mean Monthly Flows at the Weir site

It is very important that number of dry, wet and average years to be determined in the long-term data series.

	Mean Monthly flow at the Weir site											
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Discharge (m^3/s)	17.97	16.81	20.44	58.20	160.84	304.04	313.75	205.23	98.22	43.65	28.11	20.97

The 5-year moving average was estimated to determine the dry, wet and average year flows. The years above 5-year average year flows were categorized as wet year, less than 5-year average flows were considered as dry years and flows approximate to 5 years average was taken as average year flows. The 5-year moving average flows are shown in the **Figure V-2**. The results indicate that difference of flows for wet, dry and average year is for 50 to 100% of time, whereas the basin response is quite similar for the flows between 0 to 50% as shown in the **Figure V-2**.

The river width at tailrace is sufficiently wide and tailrace is designed to prevent backwater effects, ensuring unobstructed fish passage. Tailrace can be seen in the following Figure.

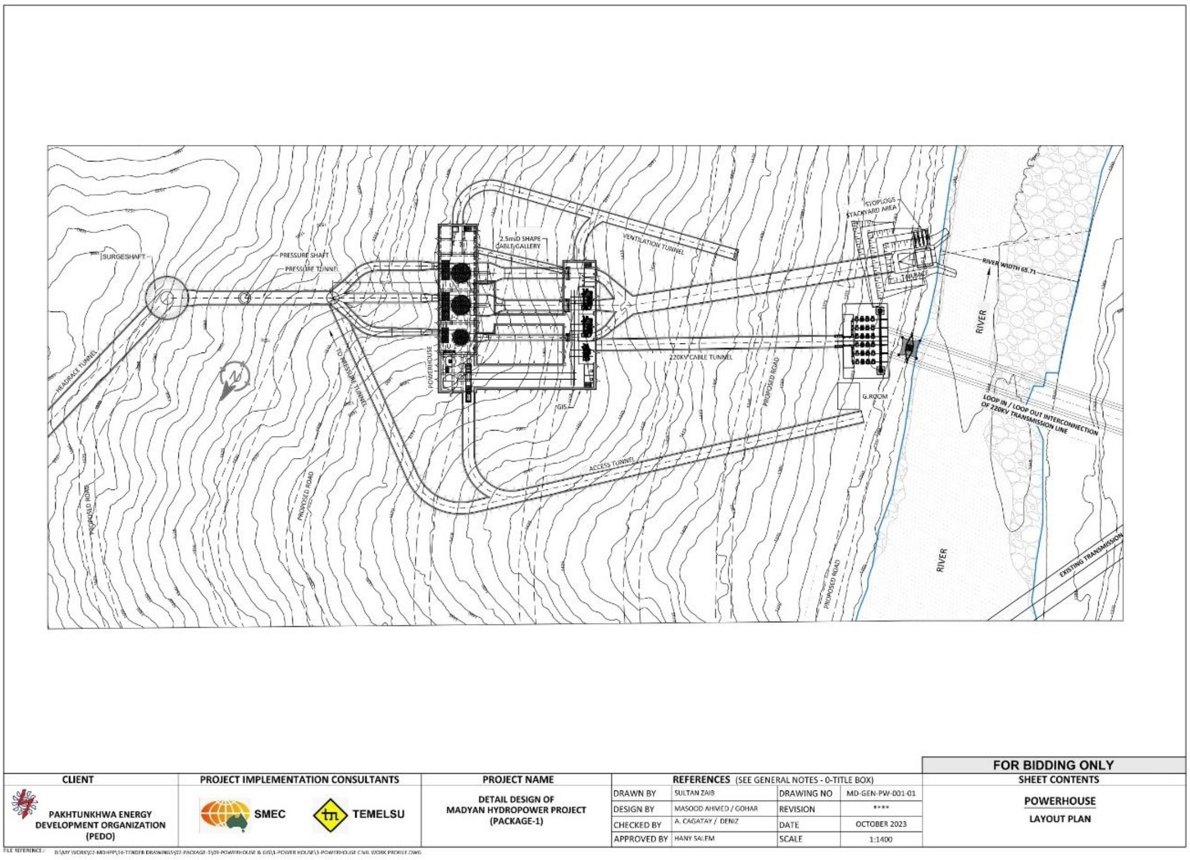


Figure V-2: Power House & Tailrace Layout Plan

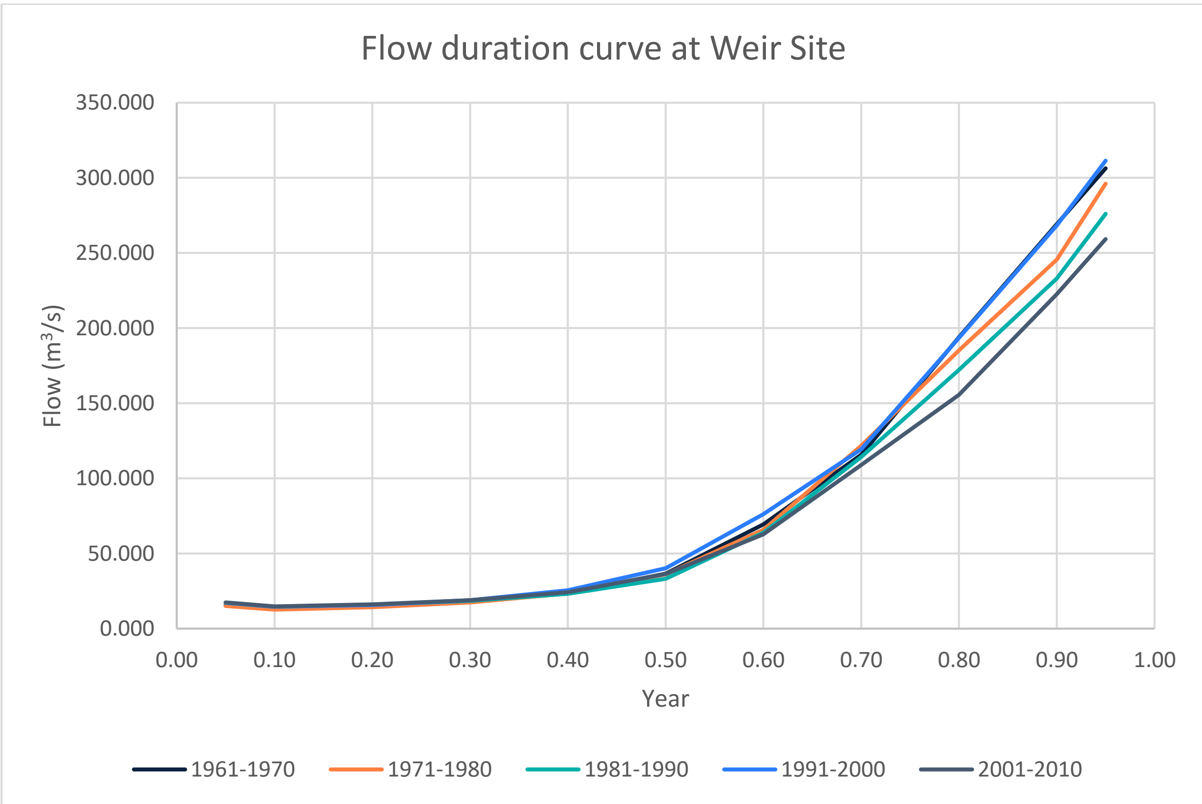


Figure V-3: Flow Duration Curve at the dam site

The analysis was also carried out for the minimum flow throughout the length of the data. The results indicate that minimum daily flow can go up to 6.82 m^3/s as shown in the **Figure V-4**.

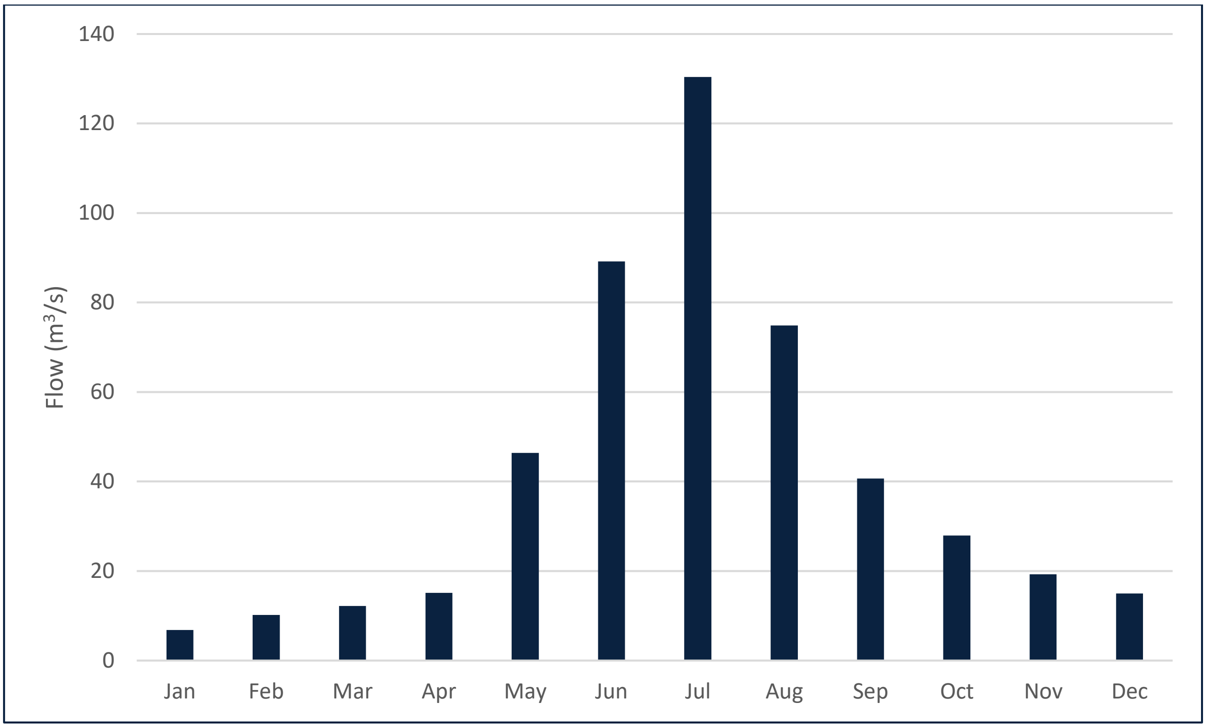


Figure V-4: 1-day minimum flow at the weir site in months

Downstream flow requirement

The flow requirement by each of these uses was determined to develop a water budget for the critical reach of the river.

a) Drinking water supply

There is no social reliance of the Swat River water. The source of potable water supply for all the villages situated along the critical reach is from the springs and there is no use of river water.

b) Irrigation water requirement

Irrigated agricultural land is the major land cover in the basin. The irrigated land is mostly found on flat plains and gentle slopes, forming terraces and comprising post flooding or irrigated croplands, rainfed crop land and mosaic crop land. During the detailed survey of the critical reach, it was found that no water is pumped from the river for irrigation purpose. Therefore, no allowance is taken for irrigation water

c) Aquatic Ecosystem

The freshwater biota of a river has evolved with and is intimately depend upon the natural patterns of hydrological variability. Naturally high and low water levels create habitat conditions essential to reproduction and growth of plants and animals and drive ecological processes required for ecosystem health. Specific patterns of freshwater flows also support a range of other services provided by river systems. For example, flood pulses move sediment that maintains the form and function of rivers. Seasonal inundation of floodplains and wetlands supports groundwater recharge and the flow of freshwater to estuaries prevents saline intrusion into coastal aquifers.

When a river has been dammed, one of the most obvious changes is the disruption to the amount and timing of its flow. Provision of Environmental flows provides a system for managing the quantity, timing, and quality of water flows below a dam, with the goal of sustaining freshwater and estuarine ecosystems and the human livelihoods that depend on them. The most ecologically important aspects of a river's flow are extreme low flows, low flows, high flow pulses, small floods, and large floods. Environmental flows supplied through releases from a reservoir can be manipulated to restore any of these, with the goal of improving water quality, restoring sediment deposition, addressing the life-cycle needs of Senior Economist and wildlife, and restoring the livelihoods of river-based communities.

Consultant team visited the project area in the low flow season to take account the biotic and abiotic parameters associated with the water channels developed in low season. The team concluded that the velocity at which the attracting current exits the fish pass should be within the range of 0.8 to 2.0 m /s. Except for special cases flow velocity should not exceed 2m/s. **S**hallow water of stony substratum with an average depth from 0.5 to 3 meters, and river flows with low to high velocities (0.5 to 1.5 m/s) is required for Snow Carp. For Brown trout (full migrant), generally low velocities (0.2–0.55 m/s) and low depths (0.15–0.45 m) are preferred. The critical flows for spawning brown trout and their biotic dependents are 0.18 m^3/s and 2 m^3/s.

Hydraulic analysis for the optimum flow and velocity

Hydraulic Model (HEC RAS) was used to determine the required depth in the critical river reach that will be affected by construction of Madyan HPP. As depicted from **Table V-2**, required minimum depth for fish survival is about 1.5 meters, and required flow was determined to maintain that flow depth. River cross sections were taken at an interval of 1000 m in 18 km reach from dam site to downstream (**Figure V-5 and Figure V-6**). The model results show that flow required maintaining the flow depth of 0.15 to 0.36 meters is 3.5 m^3/s. The distance of cross section from the dam axis, cross sectional area, discharge, depth of flow and velocity are presented in the **Table V-2**. There is a slight variation in the flow depth in the 18 Km stretch of the river as depth varies from 0.15 meters to 0.36 meters and average depth in this reach will be 0.15 to 0.45 meters depending upon the width of the river section at that particular reach.

Table V-10: River Swat Longitudinal Profile Data

Station	Discharge (cumecs)	River Bed El (m)	Water Surface El (m)	Flow Area (sq m)	Top Width (m)	Flow Depth (m)
1	3.5	1506.97	1507.12	3.27	27.61	0.15
2	3.5	1505.99	1506.35	4.31	13.45	0.36
3	3.5	1505.94	1506.28	4.29	14.88	0.34
4	3.5	1505.9	1506.09	3.38	30.78	0.19
5	3.5	1505.28	1505.61	2.03	11.7	0.33
6	3.5	1503.99	1504.16	1.3	8.63	0.17
7	3.5	1503.94	1504.17	2.65	14.81	0.23

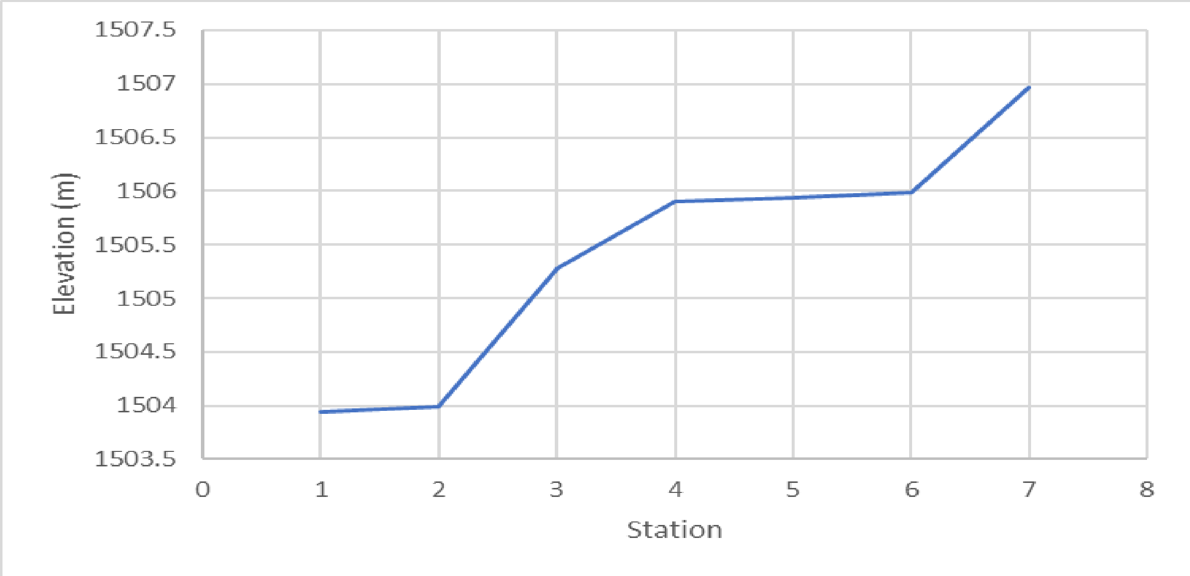


Figure V-5: Longitudinal Profile of River Swat Downstream Dam-site

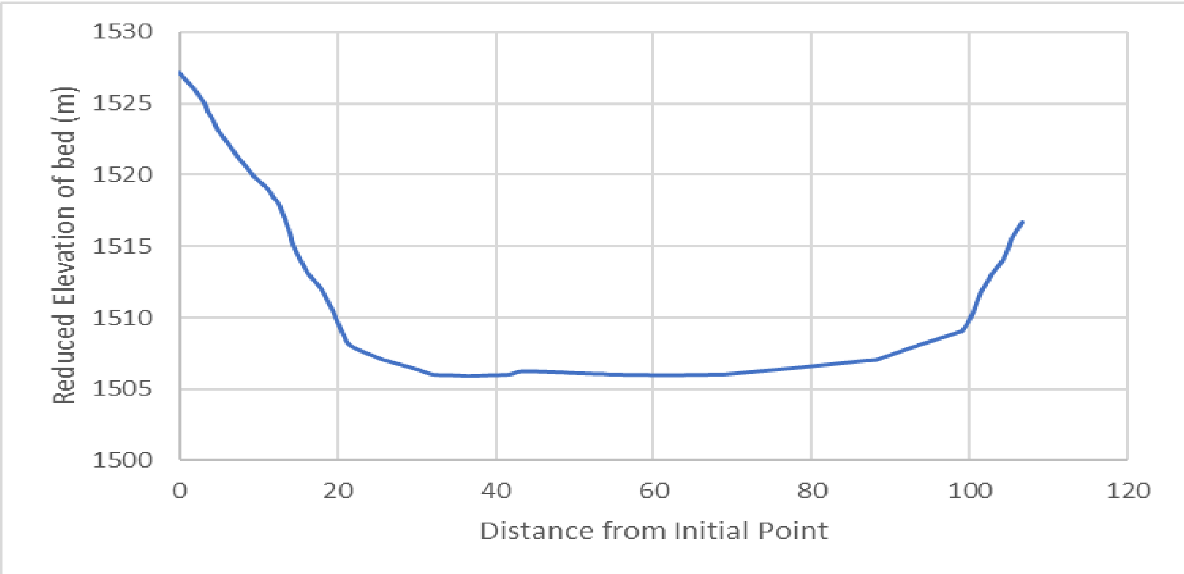


Figure V-6: Cross Section at Maximum Top Width

Conclusion and Recommendation

On the basis of analysis of historical hydrological data and basic hydraulic parameters, the current river water uses, the river morphological features and existing aquatic ecosystem, the downstream releasable should not be less than 3.5 m^3/s. The Kadam nullah that is located just 800 meters downstream of the weir will contribute the flow 1 m^3/s to 10 m^3/s therefore the critical reach is only 800 meters and minimum flow recommend is 3.5 m3/s for the critical reach. 2. For the 800 m reach up to the Kedam tributary, a minimum flow of 3.5 cumecs will be released throughout the year. The dewatered stretch is a narrow gully where the ecological flow will pass concentrated through a depressed section.

The reported two major tributaries, Kedam and Bara Dar River, in the dewatered stretch contributing, the average discharges during low flow season vary from 0.31 to 3.41 m3/s and 0.47 to 5.19 m3/s, respectively, during low flow season, which indicates that there will be minimal impact on the flows downstream of the weir. Detailed hydrological data is presented in the ESIA report Section 5.1.6 and 7.6.3. This flow can significantly improve the required ichthyological depth and velocity for the reported fish species. In addition, there are 13-15 perennial springs reported in the stretch also discharging into the river.

During the plant operation, a comprehensive monitoring regime will be implemented for the performance of fish ladder.

With the eflow of 3.5m^3/s, the water depth in the river channel will be 0.8m.The eFlow of 3.5m^3/s will be divided between mini-turbine (2.8 m^3/s) and fish pass (0.7 to 0.76 m^3/s), ensuring 0.5m to 1m water depth in the fish pass. A trash rack is integrated in the mini-turbine to avoid entrapment of the fish into the mini-turbine. The calculations are as follows.

Design Parameters:

-Top Free Width (m) =1.5

-Flow Depth (m) = 0.5 to 1

Channel Hydraulic Properties:

-Flow Quantity (m^3/s) =0.7 to 0.7596

-Channel Slope (No Unit) =0.0714

-Manning Roughness Coefficient (No Unit) =0.3

-Vetted Perimeter (m) =2.5 to 3.5

-Hydraulic Surface (m^2) =0.7 to 1.5

-Hydraulic Depth (m) =0.5 to 1

-Hydraulic Radius (m) =0.3 to 0.4286

-Flow Velocity (m/s) =0.5064 to 0.9

Rectangular Section Geometrical Properties for stream with discharge of 3.5 cumecs:

-Top Free Width (m) =2.477

-Flow Depth (m) =0.8

*Channel Hydraulic Properties:

-Flow Quantity (m^3/s) =3.5

-Channel Slope (No Unit) =0.01

-Manning Roughness Coefficient (No Unit) =0.035

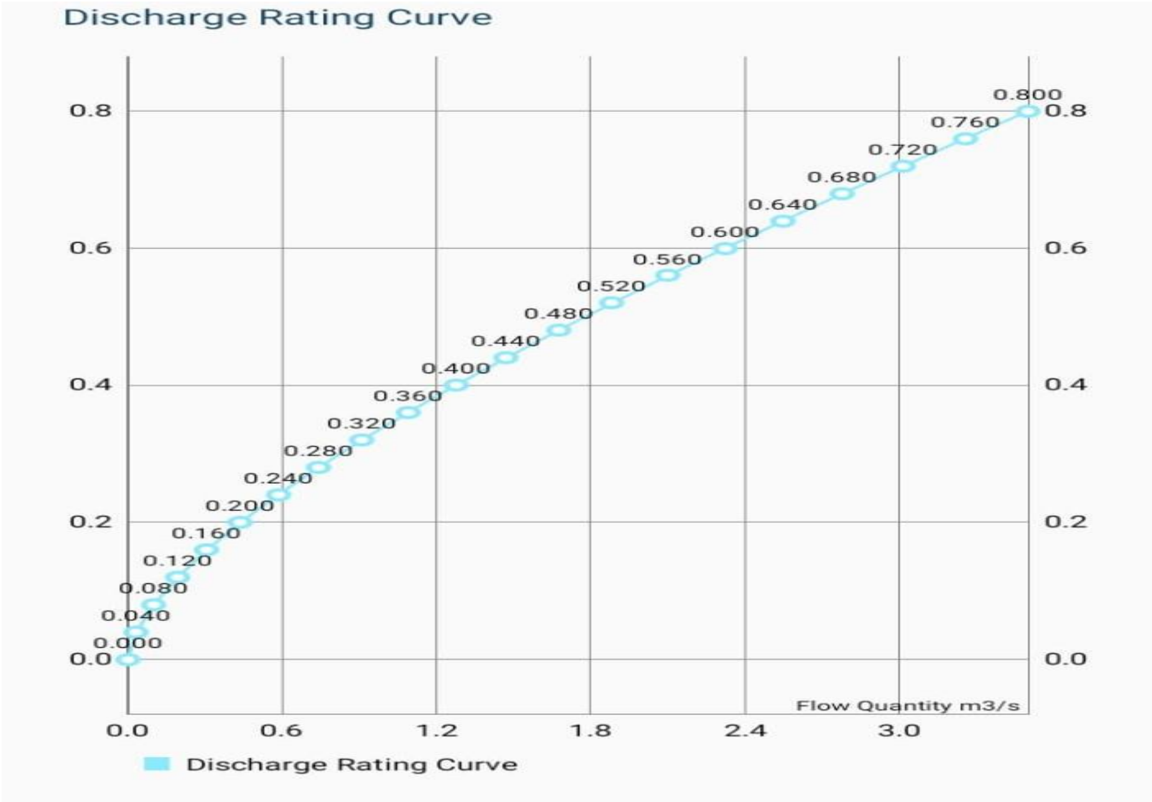
-Vetted Perimeter (m) =4.077

-Hydraulic Surface (m^2) =1.9816

-Hydraulic Depth (m) =0.8

-Hydraulic Radius (m) =0.486

-Flow Velocity (m/s) =1.7662


Discharge Rating Curve
0.8
0.6
0.4
0.2
0.0
0.000
0.040
0.080
0.120
0.160
0.200
0.240
0.280
0.320
0.360
0.400
0.440
0.480
0.520
0.560
0.600
0.640
0.680
0.720
0.760
0.800
Flow Quantity m3/s
0.0
0.6
1.2
1.8
2.4
3.0
Discharge Rating Curve

Guddu Barrage Fish Pass Pcitures

ANNEXURE VII: ENVIRONMENTAL MONITORING RESULTS

STEPS

Environmental Laboratory

STEPS ENVIRONMENTAL LABORATORY

(A Joint-Venture between IRSP & STEPS Pakistan)

Address: Jail Road, near GHSS, Mohabbat Abad, Mardan, KP, Pakistan

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E-mail: lab@stepspakistan.com

Website: www.stepspakistan.com

Registered from EPA

Certificate No:

PA/Lab-Cer/SEL/002

Surface Water Analysis Report

Report reference No: W-20194165 **Date: 15/08/2022**

Organization: JV of SMEC International Pty Ltd. & TEMELSU International Engineering Services Inc

Sample Location: Madyan Hydropower Project **Nature of sample:** Surface Water

Date of sample received: 08/08/2022 **Date of sample collection:** 08/08/2022

Sample collected sent by: STEPS **Date of completion of analysis:** 12/08/2022

S. No.	Parameters	NEQS Limits	Kadam Village Near Weir Site	Darolae Village	Kalagay Village Near Power House
01	**pH**	**6.5-8.5**	7.89	6.99	7.21
02	**Temp**	-	28 C	28 C	29 C
04	**COD**	**150 Mg/l**	26	29	46
05	**BOD**	**80Mg/l**	18	19	23
06	**Dissolve Oxygen**	-	0 ppm	0 ppm	0 ppm
07	**Turbidity**	**≤ 5NTU**	4.67	4.31	4.11
08	**E. Conductivity**	**NGVS**	1976	1775	1832
09	**TDS**	**1000 ppm**	987	853	816
10	**Color**	**< 15 TCU**	0.0	0.0	0.00
11	**Odor**	**Odorless**	Unobjectionable	Unobjectionable	Unobjectionable
12	**Taste**	**Tasteless**	objectionable	objectionable	objectionable
13	**Total Alkalinity**	**< 500 ppm**	169	143	157
14	**Total Hardness**	**< 500 ppm**	187	151	176
15	**Lead**	**Mg/l 0.5**	0.0226	0.0121	0.0042
16	**Chromium**	**Mg/l 1**	0.053	0.057	0.039
17	**Sodium**	**≤ 200 ppm**	29.1	39.8	33.4
18	**Total Suspended Solid**	**mg/l ,1**	<1.0	<1.0	<1.0
19	**Sulfate**	**≤ 250 ppm**	15.5	27.3	26.8
20	**Chloride**	**≤ 250 ppm**	17.2	31.6	29.5
21	**Silver**	**mg/l 1**	0.032	0.029	0.038
22	**Cadmium**	**mg/l 0.1**	0.071	0.069	0.073
23	**Fluoride**	**≤ 1.5 ppm**	0.01	0.021	0.19
24	**Arsenic**	**≤ 0.01 ppm**	0.017	0.000	0.004
25	**Iron**	**≤ 2 ppm**	0.04	0.07	0.006
26	**Copper**	**≤ 2 ppm**	0.07	0.003	0.13
27	**Mercury**	**mg/l 0.01**	BDL	BDL	BDL
28	**Nickle**	**mg/l 1**	0.017	0.019	0.018

(NEQS) National Environmental Quality Standards
NGVS (No Guideline Value Set)
BDL (Below Detection Limit)
TDS (Total Dissolved Solid)

1. Sample analyzed by: Sadat Hayat

STEPS ENVIRONMENTAL LABORATORY Sheikh Maltoon Town Mardan

2. Chief Analyst with seal: Tayyaba Akhtar

3. In charge STEPS Environmental Lab

4. **Countersigned by:**

"Note: This report state the result of the test performed for the sample received by the laboratory from the above stated ""Client/Organization"". Verification or acknowledgement of the origin on association of the sample being tested to particular site is beyond the responsibility of STEPS Environmental Laboratory."

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Website: www.stepspakistan.com

Registered from EPA
Certificate No:
PA/Lab-Cer/SEL/002

Drinking Water Analysis Report

Report reference No: W-20194165 **Date:** 15/08/2022
Organization: JV of SMEC International Pty Ltd. & TEMELSU International Engineering Services Inc.
Office Address: House No.69-C1 A, Sahibzada Abdul Qayyum Road, University Town, Peshawar KPK
Sample Location: Madyan Hydro Power Project.
Nature of sample: Spring (Drinking Water) **(Grab Composite):** Grab
Date of sample received: 08/08/2022 **Date of sample collection:** 08/08/2022
Sample collected sent by: STEPS **Date of completion of analysis:** 12/08/2022

S. No.	Parameters	NDWQS Limits	Kedam Village Near Weir Site	Darolae Village	Kalagay Village Near Power House
01	**pH**	**6.5-8.5**	7.64	6.94	7.41
02	**Temp**	-	26 C	26 C	26 C
03	**Dissolve Oxygen**	-	0 ppm	0 ppm	0 ppm
04	**Turbidity**	**≤ 5NTU**	2.22	2.01	3.66
05	**E.Conductivity**	**NGVS**	1441	1665	1554
06	**TDS**	**1000 ppm**	721	828	777
07	**Color**	**< 15 TCU**	0.0	0.0	0.00
08	**Odor**	**Odorless**	Unobjectionable	Unobjectionable	Unobjectionable
09	**Taste**	**Tasteless**	Unobjectionable	Unobjectionable	Unobjectionable
10	**Total Alkalinity**	**< 500 ppm**	98	101	95
11	**Total Hardness**	**< 500 ppm**	108	110	98
12	**Lead**	**Mg/l 0.5**	BDL	BDL	BDL
13	**Chromium**	**Mg/l 1**	BDL	BDL	BDL
14	**Sodium**	**≤ 200 ppm**	61.78	47.2	37.2
15	**Total Suspended Solid**	**mg/l ,1**	BDL	BDL	BDL
16	**Sulfate**	**≤ 250 ppm**	57.1	39.9	32.9
17	**Chloride**	**≤ 250 ppm**	51.6	37.2	30.1
18	**Silver**	**mg/l 1**	BDL	BDL	BDL
19	**Cadmium**	**mg/l 0.1**	BDL	BDL	BDL
20	**Fluoride**	**≤ 1.5 ppm**	0.19	0.17	0.18
21	**Arsenic**	**≤ 0.01 ppm**	0.001	0.009	0.008
22	**Iron**	**≤ 2 ppm**	0.06	0.05	0.006
23	**Copper**	**≤ 2 ppm**	0.8	0.07	0.1
24	**Mercury**	**mg/l 0.01**	BDL	BDL	BDL
25	**Nickle**	**mg/l 1**	BDL	BDL	BDL
26	**E.Coli**	**0 CFU/100 ml**	68	0.00	79
27	**Fecal Coliform**	**0 CFU/100 ml**	63	0.00	77

(NEQS) National Environmental Standards
NGVS (No Guideline Value Set)
BDL (Below Detection Limit)
TDS (Total Dissolved Solid)

1. Sample analyzed by:
Sadat Hayat

STEPS ENVIRONMENTAL LABORATORY
Sheikh Maltoon Town Mardan

2. Chief Analyst with seal:
Tayyaba Akhtar

3. In charge STEPS Environmental Lab

4. **Countersigned by:**

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Website: www.stepspakistan.com

Registered from EPA
Certificate No:
PA/Lab-Cer/SEL/002

Ambient Air Quality Report

Report reference No: A-201940111 **Date: 12/08/2022**
Name of Organization: JV of SMEC International Pty Ltd. & TEMELSU International Engineering Services Inc.
Office Address: House No.69-C1 A, Sahibzada Abdul Qayyum Road, University Town, Peshawar KPK
Sample Location: Madyan Hydropower Project **Sample collected sent by:** STEPS
Nature of sample: Air **Date of sample analysis:** 08- 11/08/2022
Date of completion of analysis: 11/08/2022

S.No.	Parameters	NEQS Limits	Weir site Kedam Point (A)	Torwal village Point B	Darolai village Point C	Ayeen Village Point D	Power House Point E	Method used	Remarks
A. Field Analysis.									
01	**PM 2.5**	**35 ug/m³**	19.8	21.2	17.7	22.4	18.1	**-β Ray Absorption method**	Satisfactory
02	**PM 10**	**150 ug/m³**	53.4	35.1	29.5	27.1	24.0	**-β Ray Absorption method**	Satisfactory
03	**CO2**	**400-600 mg/m³**	489	527	539	590	587	**40 CFR Part 50, App. D (US-EPA)**	Satisfactory
04	**CO**	**10 mg/m³**	1.34	1.03	1.05	0.68	0.00	**Non-Dispersive Infra-Red (NDIR) method**	Satisfactory
05	**NO2**	**80 ug/m³**	43.1	29.6	31.0	50.4	29.7	**Gas Phase Chemiluminescence**	Satisfactory
06	**SO2**	**120 ug/m³**	12.01	09.01	7.02	3.07	4.04	**UV fluorescence (UVF)**	Satisfactory
07	**NO**	**40 ug/m³**	26.19	22.12	17.11	15.10	19.17	**Gas Phase Chemiluminescence**	Satisfactory
08	**NOx**	**ug/m³**	113.49	108.23	103.9	65.57	107.2	**Addition**	Satisfactory
09	**O_3**	**180 ug/m³**	0.00	0.00	0.00	00	0.00	**Non-Dispersive UV Absorption method**	Satisfactory
	B. Lab Analysis.								

National Environmental Quality Standards (NEQS)

1 **Sample analyzed by:**
Sadat Hayat

STEPS ENVIRONMENTAL LABORATORY
Sheikh Maltoon Town Mardan

3. **Name & sign of Chief Analyst with seal:**
Tayyaba Akhtar

2. **In charge of STEPS Environmental Laboratory:**
Muhammad Idrees Zaman

4. **Countersigned by:**
Fazal Ullah
Director Admin & Finance

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website: www.stepspakistan.com

Registered from EPA
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PA/Lab-Cer/SEL/002

Noise Level

Report reference No: N-201940111 **Date: 12/08/2022**
Name of Organization: JV of SMEC International Pty Ltd. & TEMELSU International Engineering Services Inc.
Office Address: House No.69-C1 A, Sahibzada Abdul Qayyum Road, University Town, Peshawar KPK
Sample Location: Madyan Hydropower Project **Sample collected sent by:** STEPS
Nature of sample: Noise Level **Date of sample analysis:** 08,09,10,11/08/2022
Date of completion of analysis: 11/08/2021

S.No.	Param eters	NEQS Limits	Method used	Concentration at Weir site Kedam Point(A)	Concentration at Torwal village Point(B)	Concentration at Darolai village Point(C)	Concentration at Darolai village Point(C)	Concentration at Power House Point(E)	Remarks
A. Field Analysis.									
01	Noise level	dB (A)	BS 7445: 2003	53.1	51.7	49.1	53.2	50.9	Satisfactory
B. Lab Analysis.									
The noise quality in the project area are generally good and well below the national standards (NEQS). The following tests are performed during day time.									

S.No	Category of Area/Zone	Day Time dB(A)	Night Time dB(A)
1	Residential area	55	45
2	Commercial area	65	55
3	Industrial area	75	65
4	Silence Zone	50	45

National Environmental Quality Standards (NEQS)

1 **Sample analyzed by:**

Sadat Hayat

STEPS ENVIRONMENTAL LABORATORY
Sheikh Maltoon Town Mardan

3. **Name & sign of Chief Analyst with seal:**

Tayyaba Akhtar

Tayyaba

2. **In charge of STEPS Environmental Laboratory:**

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S