



RAVI URBAN DEVELOPMENT AUTHORITY
GOVERNMENT OF THE PUNJAB



**ENVIRONMENTAL IMPACT ASSESSMENT (EIA)
OF THE RIVER TRAINING WORKS AND FLOOD
CONTROL INFRASTRUCTURE OF RIVER RAVI
FROM RAILWAY BRIDGE TO SL-04**

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List of Abbreviations

Aol	Area of Influence
BOD	Biochemical Oxygen Demand
CBOs	Community Based Organizations
Cd	Cadmium
CDFs	Confined Disposal Facilities
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
Cr	Chromium
DCO	District Coordination Officer
DD	Deputy Director
DG	Director General
DO	Dissolved Oxygen
DoA	Department of Archaeology
ECoPs	Environmental Code of Practices
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
ERP	Emergency Response Plan
ERT	Emergency Response Team
ESMP	Environment and Social Management Plan
GHG	Green House Gases
GPS	Global Positioning System
GRM	Grievance Redress Mechanism
HEC-RAS	Hydraulic Engineering Center – River Analysis System
Hg	Mercury
HH	House Hold
HIA	Health Impact Assessment
HSE	Health Safety and Environment
IEE	Initial Environmental Examination
ILO	International Labour Organization
IUCN	International Union for Conservation of Nature
LESCO	Lahore Electric Supply Company
LOR	Limit of Reporting
LWMC	Lahore Waste Management Company
MAES	Mirza Associates Engineering Services
MSDS	Display Material Safety Data Sheets
ND	Not Detected



NGOs	Non-Governmental Organizations
NOC	No Objection Certificate
NOx	Nitrogen Oxides
NTDC	National Transmission and Despatch Company
NTU	Nephelometric Turbidity Unit
OHS	Occupational Health and Safety
PAPs	Project Affected Persons
Pb	Lead
PEPA	Pakistan Environmental Protection Act
PEPC	Pakistan Environmental Protection Council
PEQS	Punjab Environmental Quality Standards
PEQS	Punjab Environmental Quality Standards
PLCs	Programmable Logic Controllers
PM	Particulate Matter
PMU	Project Management Unit
PPE	Personnel Protective Equipment
PPEs	Personal Protective Equipment
PRSP	Punjab Rural Support Program
PTCL	Pakistan Telecommunication Company Limited
RRUDP	Ravi Riverfront Urban Development Project
RTW	River Training Works
RUDA	Ravi Urban Development Authority
SC	Supervisory Consultant
SL	Southern Loop
SMP	Sedimentation Management Plan
SNGPL	Sui Northern Gas Pipelines Limited
SOx	Sulphur Oxides
SOP	Standard Operating Procedure
SSEMP	Site-Specific Environmental Management Plan
STDs	Sexually transmitted Diseases
TCs	Tehsil Councils
TDS	Total Dissolved Substance
ToR	Terms of Reference
TSS	Total Suspended Solids
UCs	Union Councils
UNESCO	United Nations Educational, Scientific, and Cultural Organization
USGS	United States Geological Survey
VOCs	Volatile Organic Compounds
WHO	World Health Organization



WWF Worldwide Fund for Nature

WWTPs Wastewater Treatment Plants

Executive Summary

Title and Location of the Project

The river training Works and Flood Control Infrastructure of River Ravi is a vital infrastructure project initiated by Ravi Urban Development Authority (RUDA) located along the River Ravi in Lahore, Punjab. This report covers the river area between Railway bridge and downstream Motorway M-2 till the end of the project including flood protection infrastructure of Phase-II and Phase- III of the project, which includes the construction of two proposed Rubber Dams/Weirs one near Saggian Bridge and the other adjacent to the M-2 Motorway in Phase- II. In addition to the Rubber Dams/Weirs, the project scope involves the channelization of the Ravi River over an approximate length of 32 kilometres. This project has been intended to regulate river flow, prevent erosion, and support the development of sustainable urban infrastructure within the Ravi River-front Urban Development Zone.

Name of the Project Proponent

Ravi Urban Development Authority (RUDA) Government of the Punjab is the proponent of the Proposed Project.

Name of the Organization Preparing the Report

RUDA has engaged M/s Mirza Associates Engineering Services (MAES) Pvt. Ltd. for the preparation of an Environmental Impact Assessment (EIA) of the proposed project.

Brief Introduction

River Training Works and Flood Control Infrastructure Project is the sub project of Ravi Riverfront Urban Development Project (RRUDP). The whole RRUDP covers the channelization of 46 km stretch of River Ravi starting from Syphon and ending at SL-4. It also includes construction of four Rubber Dams/Weirs; one near old Ravi Bridge, second near Saggian Bridge, third near M-2 crossing and fourth will be constructed near Mohlanwal at lower end of this channelization stretch of 46 km. The EIA report of the project "River Training Works and Flood Control Infrastructure from Railway Bridge to SL-4". The report identifies potential environmental and social impacts and proposes mitigation measures in compliance with the Pakistan Environmental Protection Act 1997 (PEPA) and relevant Punjab Environmental Quality Standards (PEQS).

Description of RTW & Flood Control Infrastructure

This report specifically covers the project from Railway Bridge on River Ravi to SL-4, which includes the construction of two proposed Rubber Dams/Weirs, one near Saggian Bridge with the coordinates of 31°34'37.96"N, 74°16'6.78"E and the other adjacent to the M-2 Motorway with the coordinates of 31°31'8.74"N, 74°12'19.21"E. In addition to the Rubber Dams/Weirs, the project scope involves the channelization of the Ravi River over an approximate length of 32 kilometres. The key activities under this phase comprise detailed topographic and geotechnical surveys,

excavation and earthworks for river training, embankment strengthening on both banks, and construction of hydraulic structures for flow regulation and flood control. Protective works such as stone pitching, gabion walls, and apron laying are planned to prevent erosion and ensure long-term stability of the riverbanks. Furthermore, access roads, service infrastructure, and temporary diversion channels will be developed to facilitate uninterrupted execution of works. All activities are designed to improve flood resilience, enhance water conveyance, and support integrated river management, in line with environmental compliance and sustainable development objectives.

and sustainable development objectives.

Institutional Responsibilities and Stakeholders

Institutional responsibilities play a critical role in conducting the environmental assessments and recommending mitigation measures. Stakeholders in the EIA process includes local communities, who may be impacted by the project through changes in land use, noise, or air quality. These communities will be engaged early in the process to address concerns and ensure that their rights and interests are considered. Engaging these institutions and stakeholders throughout the EIA process helps to create a transparent and accountable approach, ensuring the project aligns with both environmental and social sustainability goals.

Earthworks from RD 97 to RD 133 along the Ravi River

Comprehensive earthworks will be carried out along both the left and right banks of the Ravi River from RD 97 to RD 133. The scope of work includes clearing and grubbing of the existing terrain, excavation of unsuitable material, and embankment construction using approved borrow material. The riverbanks shall be strengthened and reshaped to enhance flood protection and channel stability. Compaction of filled sections will be performed to the specified density to ensure long-term structural integrity. The activity includes execution in accordance with environmental and safety standards, minimizing disruption to local habitats and maintaining natural flow patterns. Continuous monitoring and quality assurance procedures will be followed throughout the earthwork operations to meet the design specifications and project milestones.

Need of Environment Studies

River Training Works (RTW) involve multiple interventions such as construction of Rubber Dams/Weirs, earthworks, promenades development, stone pitching and other structural measures to control the flow of a river, prevent flooding, and protect surrounding infrastructure. While these activities provide significant engineering and socio-economic benefits, they also pose considerable risks to the environment and local communities if not managed carefully. Therefore, conducting an Environmental Impact Assessment (EIA) is essential before implementing RTW projects.

The key reasons for the need of an EIA in RTW & Flood Control Infrastructure Project are:

- **Environmental Protection:** The project may significantly affect the river's natural flow regime, leading to erosion, sedimentation, and further degradation of water quality. An EIA helps identify these risks early and provides effective mitigation strategies.

- **Preservation of Ecosystems:** An EIA ensures that river ecosystems are studied and protected from unnecessary disruption.
- **Public Health and Safety:** Installation and operational activities can generate dust, noise, and waste, affecting nearby populations. EIA outlines strategies to minimize health hazards and ensure community safety.
- **Regulatory Compliance:** In Pakistan, EIA is a legal requirement under the Pakistan Environmental Protection Act (PEPA) 1997 and the Punjab Environmental Protection Act 2012, especially for projects like RTW categorized under large-scale water management and infrastructure.
- **Informed Decision-Making:** EIA provides project developers, planners, and regulatory authorities with critical data for sustainable planning, ensuring that economic development does not come at the cost of environmental degradation.
- **Stakeholder Engagement:** EIA promotes consultation with local communities, ensuring transparency and incorporation of indigenous knowledge and concerns into project planning.
- **Long-Term Sustainability:** Through the EIA process, an Environmental Management Plan (EMP) is developed to monitor and manage impacts throughout the project lifecycle, ensuring that environmental standards are maintained over time.

The Ravi River, once a vital natural asset to the city of Lahore, has now become ecologically dead due to years of unchecked pollution. Untreated sewage, industrial effluents, and solid waste are continuously being discharged into the river, leading to dangerously high levels of Biochemical Oxygen Demand (BOD) and Total Dissolved Solids (TDS). As a result, aquatic life has drastically declined, and the river no longer supports a healthy ecosystem. In such a fragile environmental state, the implementation of River Training Works (RTW) such as embankments, revetments, spurs, and Rubber Dams/Weirs makes the need for a comprehensive Environmental Impact Assessment (EIA) even more critical.

The study assesses key environmental aspects such as air quality, water resources, meteorological data biodiversity, noise levels, river ecology, and land use patterns, providing a baseline for comparing the effects of the project. The goal of this baseline data analysis is to identify any significant environmental and social impacts, ensure compliance with national and international environmental standards, propose mitigation measures to minimize adverse effects on the environment and local communities and develop an Environmental Management Plan (EMP) to ensure the project sustainability.

Purpose for the Environmental Impact Assessment

Under the PEPA, 1997, as amended in 2012, it is a legal requirement to prepare and submit an Environmental Impact Assessment (EIA) report before starting any development project that could have a significant effect on the environment. According to Section 12 of the Act:

“No project can begin construction or operation unless the project proponent has submitted an Initial Environmental Examination (IEE) or, in cases where significant environmental impacts are expected, a full EIA, and received approval from the relevant provincial agency.”

The purpose of the EIA study is to identify the possible beneficial and adverse environmental impacts of the project as presently envisaged and propose the appropriate mitigation measures to be implemented during the construction and operational stages of the project in order to minimize the negative impacts and preparation of Environmental Management Plan (EMP).

This EIA report has been prepared keeping in view the following regulations and guidelines:

- PEPA, 2012.
- Pakistan Environmental Protection Agency Regulations, 2000 for review of IEE and EIA.
- Pakistan Environmental Impact Assessment procedures, 2000.

Project Categorization

According to Punjab Environmental Protection (Review of Initial Environmental Examination and Environmental Impact Assessment) Regulations 2022, The project (RTW & Flood Control Infrastructure) falls under SCHEDULE – II Category: E Water Management, Dams, Irrigation and Flood Protection Sub-category: 1 Medium and Large Dams and Reservoirs. Hence, this project i.e., RTW & Flood Control Infrastructure requires an EIA to be submitted to EPA Punjab. (Annex-1).

Environmental Scoping

Environmental Scoping of the project RTW & Flood Control Infrastructure involves identifying and defining the key environmental issues that could potentially be affected by the project. During the environmental examination, relevant environmental components such as air and water quality, meteorological data, noise, flora and fauna, land use, river ecology, and socio-economic conditions are reviewed in relation to the proposed project location and activities. Additionally, scoping includes consultations with stakeholders, including local communities, regulatory authorities, and environmental experts, to ensure that all potential concerns are identified and addressed. The outcome of this process is enabling the development of appropriate mitigation strategies, ensuring compliance with legal and regulatory requirements and developing EMP to make the project sustainable.

Physical Baseline

The project is located along the Ravi River in Lahore, primarily covering Shahdara, Saggian, and Mohlanwal areas. Understanding the physical environmental factors of the area is essential for effective planning and implementation. These include climate, geology, soil, air and water quality, hydrology, and noise levels—all of which influence the design, construction, and operational strategies for the project.

The project area experiences a hot semi-arid climate with extreme summer temperatures, a monsoon season, and mild winters. The geology is dominated by alluvial deposits, with soils that

are mostly loamy and susceptible to erosion during floods. Air quality is heavily impacted by vehicular and industrial emissions, particularly in Shahdara and Saggian, with PM_{2.5} and PM₁₀ levels exceeding standard limits. The Ravi River's hydrology is highly seasonal, highly affected by monsoon season, upstream water releases and urban pollution, resulting in degraded water quality and periodic flooding. Noise levels along major roads and bridges often exceed permissible limits, necessitating control measures during project execution.

Biological Baseline

The field surveys reveal that the Ravi River and surrounding regions support diverse ecological resources. Vegetation includes a mix of dry temperate, riverine, and subtropical thorn forests, with species such as *Acacia nilotica*, *Cassia fistula*, and *Quercus* spp., though many are under threat from deforestation and land-use change. The region harbors a variety of mammals, including Indian leopard, wild boar, golden jackal, and various rodents and bats. Bird diversity is high, with over 300 recorded species, including migratory waterfowl and resident forest birds. Herpetofauna includes over 40 documented species such as the Indian cobra, monitor lizard, and Indian bullfrog, with key habitats along riverbanks and wetlands. Fish surveys have recorded 50–68 species in the Ravi, but diversity is declining due to pollution, invasive species, and flow regulation. These ecological findings emphasize the need for conservation strategies to mitigate potential impacts from the proposed construction activities.

Socioeconomic Baseline

The proposed project area lies within Lahore District, where the socio-economic profile of Project Affected Persons (PAPs) mirrors that of nearby settlements such as Begum Kot, Abubakar Colony, Taragarh, Nonarian, and other smaller communities along the Ravi River. A detailed socio-economic assessment was conducted using both qualitative and quantitative methods, including a household-level survey of 140 randomly selected respondents. This survey revealed that the average household size in the project area is approximately 8 persons, higher than the district average of 6.5, indicating the prevalence of extended family systems. The population is predominantly in the 20–39 age group, reflecting a young and active workforce. The gender ratio stands at approx. 107 males per 100 females. These findings are critical for understanding community dynamics, informing resettlement planning, and designing appropriate social mitigation strategies under the Environmental Management Plan (EMP).

The project area's socio-cultural and economic landscape is shaped by traditional values and rural livelihoods. Marriage customs are predominantly arranged within close kinship, often among cousins, with parental involvement and a preference for intra-caste unions. Literacy rates remain low, particularly among women, due to socio-economic and cultural barriers, though awareness is gradually improving. Punjabi is the primary language, with Urdu and English used in formal or educated contexts. Housing varies from mud and brick structures to RCC constructions, often shared by extended families. The economy is largely agrarian, with farming, livestock rearing, and daily wage labour as primary income sources; a minority engage in small businesses or receive remittances. Agricultural practices rely on canal irrigation, with traditional methods still prevalent

despite some mechanization. Islam plays a central role in community life, guiding cultural norms and festivals, while family structures are typically joint and patriarchal. Conflict resolution is often handled by local elders or informal councils such as Panchayat¹, though these may lack inclusivity. Basic education and health services exist but are hampered by limited resources, prompting many residents to seek better facilities in nearby urban areas.

Stakeholders Consultation

The consultation process was conducted from April to May 2025. The feedback from the consultations was largely supportive of the project from both local communities and government agencies. However, there was a general request to maximize the project's benefits for local communities.

Key concerns raised during the consultations, such as wastewater and solid waste management, skill development, employment opportunities for unskilled labour from the project area, assistance with local mobility, pollution from construction machinery, community safety awareness campaigns, approval from Environmental Protection Agency (EPA), tree plantation, and sedimentation, etc. have been acknowledged and incorporated into the EIA.

Environmental Impacts

The anticipated impacts during the construction phase include localized increases in dust, noise, and emissions, as well as the potential for soil and water contamination. These impacts are temporary and can be mitigated with proper environmental management practices. Settlement issues related to the River Training Works & Rubber Dams/Weirs primarily involve the relocation of informal or vulnerable settlements located within the project's right-of-way (RoW) or flood-prone zones. To address this, RUDA will implement a compensation and resettlement framework in line with national regulations and international best practices. Affected persons will be compensated fairly for loss of land, structures, or livelihoods, and resettlement assistance will be provided where necessary to ensure minimal disruption to their socio-economic conditions. During the operational phase, waste management is identified as key concerns, both of which are manageable through the proposed mitigation measures.

Design Phase Impacts

To minimize risks of excessive inundation and potential damage to Kamran Baradari, the dam location and height will be optimized through hydraulic and inundation modelling, with adjustments to crest elevation, operating rules (e.g., partial deflation during high flows), and flow alignment to redirect hydraulic pressure. Sediment flushing gates will be incorporated to address siltation risks, and overflow or bypass structures will ensure unobstructed flood flows.

¹ Panchayat is a traditional village council, mainly found in rural Punjab and Sindh, where respected elders or local notables gather to resolve disputes and manage community matters through informal consensus. Though not legally recognized, Panchayats often settle issues like land conflicts, family disagreements, and local misconduct, especially in areas where access to formal courts is limited.

Pre-construction Phase Impacts

During the design and pre-construction phase, several critical environmental and social risks must be anticipated and addressed through engineering foresight and early-stage safeguards. Key among these is the potential for sediment accumulation in the proposed reservoirs, which, although physically manifested in the operational phase must be mitigated through the integration of sediment flushing infrastructure and sluicing gates into the Rubber Dam/Weir design. Similarly, the location of Kamran Baradari within the impoundment area necessitates hydrological and inundation modelling to ensure a safe buffer distance and tailored protective design measures to preserve the cultural heritage site. Wastewater issues will be resolved with proposed trunk infrastructure.

Construction Phase and Residual Impacts

To minimize dust emissions, contractors will regularly sprinkle water on exposed areas, cover stockpiles and trucks, phase and compact earthworks, impose speed limits, and maintain equipment. Air quality will be monitored weekly, with resident notifications and complaint handling. For noise, machinery will be maintained, operated only during approved hours, and preference given to low-noise equipment; weekly monitoring near receptors will be conducted.

Water pollution will be prevented by setting up designated fuelling zones, installing sediment controls, storing hazardous materials properly, and monitoring river water quality bi-weekly. Greywater and washing effluent will be treated before disposal. Waste management includes proper segregation, designated bins, no open dumping or burning, and regular site cleaning.

Occupational safety measures include PPE, training, fall protection, first aid stations, equipment checks, and a dedicated safety officer, with weekly audits. Public safety will be ensured through barricading, warning signage, and regular inspections. Given the historical and cultural significance of Kamran Baradari, special attention is being given to its protection. The river training works around this structure will be specifically engineered to withstand higher flow velocities and the erosive forces of floodwaters. These measures will ensure the long-term safety and preservation of Kamran Baradari during both regular flows and extreme flood events.

Operation Phase and Residual Impacts

To maintain water quality, RUDA and WASA will ensure WWTPs installation and its operations, with monitoring Rubber Dam/Weir through key parameters (DO, BOD₅, COD). Sediment management will include mandatory bi-annual flushing and dredging, supported by bathymetry surveys and safe disposal practices. Sludge must be disposed at the proper places away from river banks.

To prevent mosquito breeding, the reservoir need to be flushed periodically to avoid stagnant zones, and banks will be properly sloped and drained. The best way for prevention is to by decreasing the width and increasing the depth, so that we will cover the dam. This will protect the river from solid waste disposal and mosquito breeding. Vegetation and vector control measures, including fish and health department coordination, will be implemented quarterly.

Public safety measures include installing railings, warning signs, lifeguards, emergency rescue systems, and restricting access during winter and monsoon raining season, with monthly audits. The Kamran Baradari will be protected through regulated water levels, silt control, drainage, and quarterly structural monitoring in coordination with heritage authorities.

To ensure social acceptance, RUDA will operate a grievance redress mechanism (GRM), hold community consultations, and maintain transparency on project benefits, with quarterly reporting on engagement outcomes.

Preparation of Environmental Management Plan (EMP)

The Environmental Management Plan (EMP) outlines mitigation measures to address the environmental and social impacts associated with the construction of the grid station and transmission line. These measures include:

- Implementation of dust and noise control strategies to minimize air and noise pollution during excavation, foundation work, and equipment installation.
- Proper disposal and management of construction and operational waste, including hazardous materials such as transformer oil and insulating materials, to prevent environmental contamination.
- Strict safety protocols to protect workers and nearby communities from risks related to high-voltage equipment, heavy machinery, electrocution hazards, and working at heights.
- Establishment of buffer zones and safe clearance distances from settlements to minimize health and safety risks associated with electromagnetic fields (EMF) from transmission lines.
- Implementation of soil erosion and sediment control measures, particularly in areas where transmission towers are installed on slopes or near water bodies.
- Vegetation management, including controlled tree trimming and replantation programs, to mitigate deforestation and habitat disruption along the transmission line corridor.
- Continuous stakeholder engagement to ensure community concerns are addressed, particularly regarding compensation, and potential livelihood impacts.
- Establishment of a Grievance Redress Mechanism (GRM) to handle complaints related to construction activities, safety concerns, and environmental impacts throughout the project lifecycle.

Conclusion

The main objective of the project is to establish Ravi River as perennial fresh water body in order to provide a river front for development. The specific objectives are flood management, urban development, aesthetic and recreational enhancement, groundwater recharge, environmental and social sustainability and also ecological restoration. While construction activities may cause temporary impacts such as dust, noise, surface water pollution, and disruption to riverine habitats, these effects are considered manageable through the structured implementation of the EMP.

However, critical environmental risks, including long-term sedimentation in the river reservoir, untreated wastewater intrusion due to upstream discharges, erosion of embankments, and structural threats to Kamran Baradari, require proactive design and operational safeguards. These include incorporating sediment flushing infrastructure, ensuring upstream wastewater treatment plants (WWTPs) have been constructed and functional before dam commissioning, and establishing protective heritage measures. With these targeted interventions, the project's environmental and cultural risks can be effectively minimized, ensuring long-term social, ecological, and historical sustainability.

Recommendations

To ensure sustainable development, the project should adopt key environmental and cultural safeguards, including optimized hydraulic design to limit backwater near Kamran Baradari, effective sediment management through this dual approach i.e., engineered sediment capture and planned material mining, the project has been intended to reduce the sediment burden on the downstream low-head weir ponds, preserve the water quality, and enhance the operational life of all related river training works and infrastructure. and comprehensive upstream wastewater treatment to prevent pollution of the reservoir. Construction and commissioning of WWTPs upstream must be completed and verified before construction of Rubber Dams/Weirs. Protection of the heritage site requires the establishment of a 100-meter buffer zone, construction of engineered protective bunds, and continuous coordination with the Department of Archaeology. Additionally, ecological restoration, sustained water quality monitoring, emergency preparedness measures, and proactive community engagement through a functional grievance redressal mechanism are essential to ensure long-term environmental integrity and cultural preservation.

1 Introduction

River Training Works (RTW) and Barrages Phase-II Project is the sub project of Ravi River Training Works and Flood Control Infrastructure Project is the sub project of Ravi Riverfront Urban Development Project (RRUDP). The whole RRUDP covers the channelization of 46 km stretch of River Ravi starting from Syphon and ending at SL-4. It also includes construction of four Rubber Dams/Weirs; one near old Ravi Bridge, second near Saggian Bridge, third near M-2 crossing and fourth will be constructed near Mohlanwal at lower end of this channelization stretch of 46 km. The EIA report of the project “River Training Works and Flood Control Infrastructure from Railway Bridge to SL-4”. The report identifies potential environmental and social impacts and proposes mitigation measures in compliance with the Pakistan Environmental Protection Act 1997 (PEPA) and relevant Punjab Environmental Quality Standards (PEQS).

1.1 Description of the Project

The RTW is comprises from Ravi Syphon up to the SL-4 Mohalanwal (RD 00 to RD 152) over the 46 km stretch of the River Ravi. This EIA report specifically covers the project, which includes the channelization of the Ravi River over an approximate length of 32 kilometres (from RD 45 to RD 96). The key activities under this phase includes detailed topographic and geotechnical surveys, excavation and earthworks for river training, embankment strengthening on both banks, and construction of hydraulic structures for flow regulation and flood control. Protective works such as stone pitching, gabion walls, and apron laying are planned to prevent erosion and ensure long-term stability of the riverbanks. The scope of work in this project also involves the construction of two weirs or rubber dams, one near Saggian Bridge and the other adjacent to the M-2 Motorway. In addition to the weirs the project scope involves construction of, access roads, promenade and service infrastructure, temporary diversion channels will also be developed to facilitate uninterrupted execution of works. All activities are designed to improve flood resilience, enhance water conveyance, and support integrated river management, in line with environmental compliance and sustainable development objectives.

Furthermore, Comprehensive earthwork activities will also be carried out along both the left and right banks of the Ravi River, from RD 97 to RD 152. The riverbanks will be reshaped and reinforced to enhance flood protection and stabilize the channel.

All filled sections will be compacted to the specified density to ensure long-term structural integrity. These activities will be conducted in accordance with environmental and safety standards, with appropriate measures to minimize disturbance to local habitats and maintain the river’s natural flow regime. Continuous monitoring and quality assurance procedures will be implemented to ensure compliance with design requirements and project milestones.

1.2 Location of the Project

The proposed project falls under the administrative jurisdiction of District Lahore. The location of the project is shown in the Error! Reference source not found.. The aerial view of the project is shown in Error! Reference source not found..

1.3 Objectives of the Project

The primary objective of the project is to protect the Ravi River front from extreme flood events, specifically those associated with a 1000-year Average Recurrence Interval (ARI). The channelization is designed to safely convey such high-magnitude floodwaters, minimizing the risk of inundation, erosion, and damage to surrounding infrastructure, agricultural lands, and future urban development areas under the RUDA jurisdiction. In addition to flood protection, the project has been intended to maintain the ecological and hydrological character of the Ravi River by preserving its identity as a freshwater body. The channel will have the capacity and flow characteristics necessary to sustain aquatic life, support groundwater recharge, and enable year-round water retention in selected reaches through the construction of Rubber Dams/Weirs. These interventions will also contribute to environmental rehabilitation, recreational potential, and sustainable urban planning in the wider Ravi River front area.

1.4 Environmental Impact Assessment of the Project

Under the PEPA, 1997, as amended in 2012, it is a legal requirement to prepare and submit an Environmental Impact Assessment (EIA) report before starting any development project that could have a significant effect on the environment. According to Section 12 of the Act:

“No project can begin construction or operation unless the project proponent has submitted an Initial Environmental Examination (IEE) or, in cases where significant environmental impacts are expected, a full EIA, and received approval from the relevant provincial agency.”

The purpose of the EIA study is to identify the possible beneficial and adverse environmental impacts of the project as presently envisaged and propose the appropriate mitigation measures to be implemented during the construction and operational stages of the project in order to minimize the negative impacts and preparation of Environmental Management Plan (EMP).

This EIA report has been prepared keeping in view the following regulations and guidelines:

- PEPA, 2012.
- Pakistan Environmental Protection Agency Regulations, 2000 for review of IEE and EIA.
- Pakistan Environmental Impact Assessment procedures, 2000.

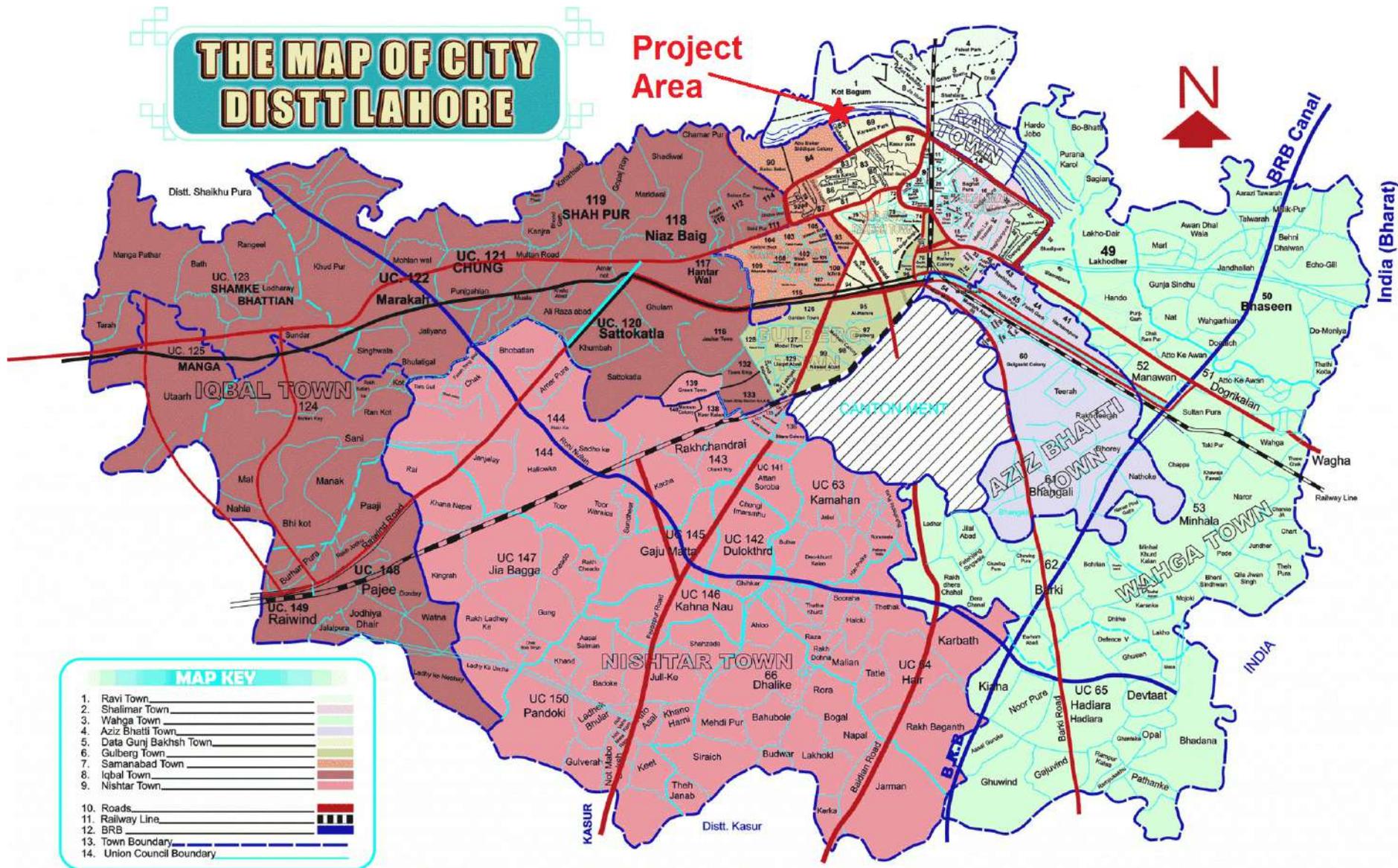


Figure 1-1 Location Map of the Project

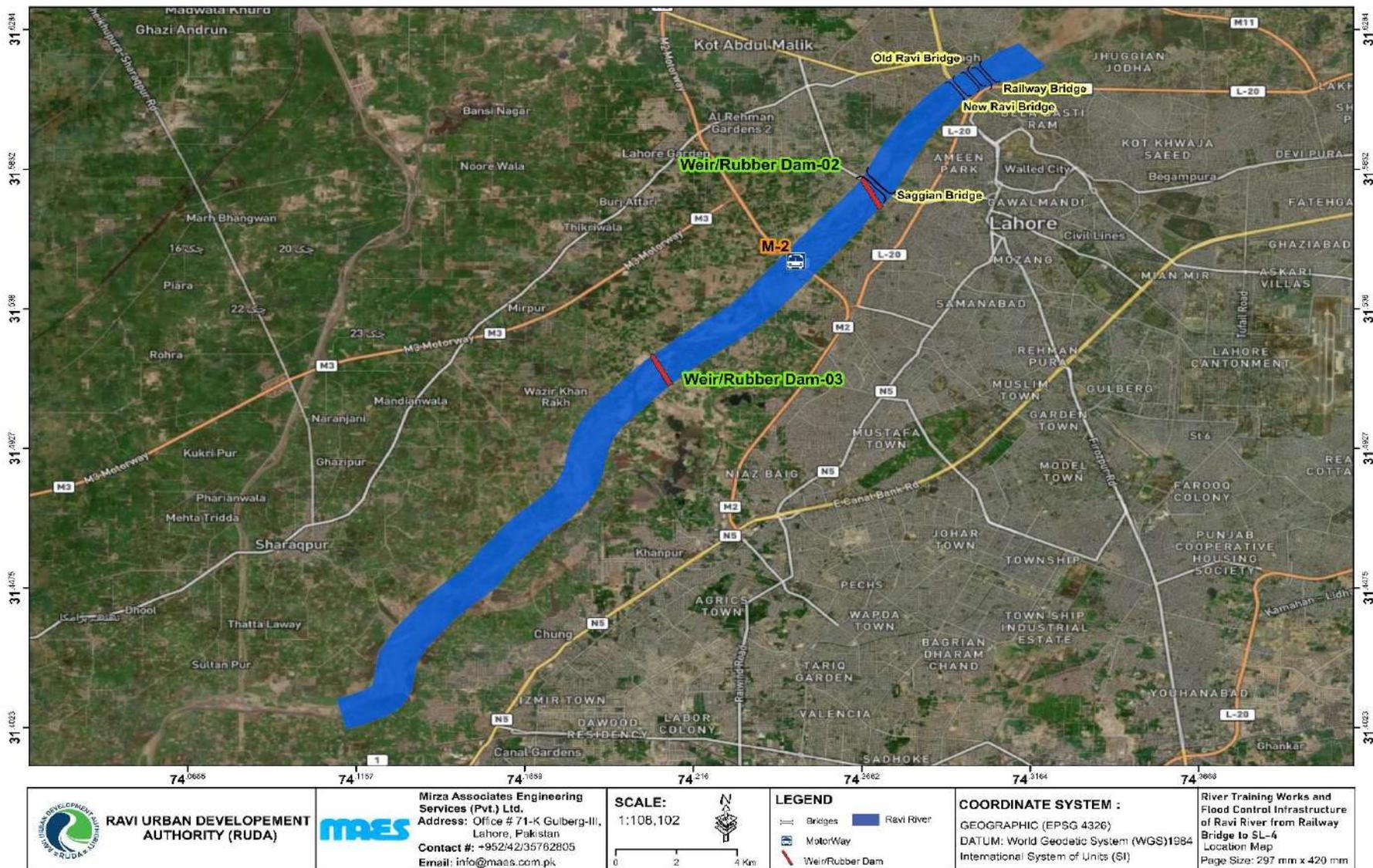


Figure 1-2 Aerial View of the Project

1.5 Objectives of the Environmental Impact Assessment (EIA)

The objectives of an EIA are to provide a preliminary assessment of the potential environmental impacts of the project, ensuring that environmental concerns are identified and addressed early in the project planning process. Specifically, the key objectives of an EIA include:

Identification of Environmental Impacts: To assess and identify potential environmental effects both positive and negative that could result from the project, including impacts on air, water, soil, biodiversity, river ecology, and local communities.

Baseline Data Collection: To gather and document baseline environmental data that provides a snapshot of the existing environmental conditions in the project area, which will be used to compare potential changes post-project implementation.

Compliance with Regulations: To ensure the project complies with local, national, environmental laws, standards, and regulations especially PEPA 1997 and PEQS and relevant international environmental guidelines by evaluating the environmental implications of the proposed activities.

Public and Stakeholder Engagement: To engage relevant stakeholders, including local communities, governmental agencies, and environmental organizations, ensuring that their concerns are considered in the decision-making process.

Recommendations for Mitigation: To propose feasible mitigation measures to minimize, avoid, or offset any identified negative environmental impacts, and ensure sustainable project implementation.

Ultimately, the EIA helps inform decision-makers, ensuring that environmental factors are integrated into the planning and design stages of the project.

1.6 Methodology and Approach

The methodology and approach for conducting an Environmental Impact Assessment (EIA) for RTW & Flood Control Infrastructure followed a systematic process as structured below:

1.6.1 Scoping and Identification of Key Environmental Issues

Initial Consultation: The process began with consultations with key stakeholders, including local authorities, environmental experts, and the community, to understand potential concerns related to the project site.

Scoping: Identified the significant environmental issues relevant to the project, such as air quality, water resources, noise, biodiversity, land use, river ecology, and socio-economic factors. This helped to prioritize the areas that need detailed evaluation.

Regulatory Review: Reviewed relevant environmental regulations, including national laws (Pakistan Environmental Protection Act, 1997), provincial regulations (Punjab Environmental Protection Act, 2012), and international environmental standards (if applicable).

1.6.2 Baseline Environmental Data Collection

Site Survey: Conducted a detailed site survey to collect baseline data on existing environmental conditions. This included 10 years Meteorological data (temperature, humidity, wind speed, etc.), Ambient air quality (concentrations of pollutants like SO₂, NO_x, CO, particulate matter, etc.), Water quality (surface and groundwater sources, chemical composition, pH, turbidity), Soil quality and land use patterns, Biodiversity assessment (flora, fauna, and any protected or endangered species), River Ecology (interactions between aquatic organisms, riparian vegetation, water quality, flow dynamics, and their surrounding physical environment), Stakeholder Consultations: (residents, farmers, local government officials and others validated and enrich baseline data with ground realities, such as land use patterns, socio-economic conditions, or cultural sensitivities), socio economy survey proformas.

Environmental Mapping: Prepared detailed maps showing the project location, surrounding land uses, proximity to settlements, water bodies, forests, protected areas, and any environmentally sensitive zones.

Community and Stakeholder Input: Gathered input from local communities to identify social concerns, such as land acquisition, resettlement, or impacts on local livelihoods.

1.6.3 Impact Assessment

The impact assessment aimed to establish a clear understanding of the existing environmental and social conditions within the project area and to evaluate how proposed activities could alter these conditions. A comprehensive baseline was developed through detailed field investigations, laboratory analyses, and stakeholder consultations. Sampling locations were carefully selected to ensure representative coverage of both terrestrial and aquatic zones that might experience direct or indirect influence from project interventions.

The assessment methodology was guided by the Pakistan Environmental Protection Act (1997), Punjab Environmental Quality Standards (PEQS). The process involved identifying environmental and social receptors, predicting potential impacts from each phase of the project, and evaluating their magnitude, duration, and significance. Both beneficial and adverse impacts were examined, and appropriate mitigation and enhancement measures were recommended to minimize negative effects and strengthen positive outcomes.

Air Quality: The construction phase of the project is expected to temporarily influence local air quality, primarily due to emissions from construction machinery, vehicular movement, material handling, and earthworks. During the baseline period, ambient air quality was monitored through a Punjab EPA-certified laboratory at four representative points along the project corridor. Parameters such as PM_{2.5}, PM₁₀, SO₂, NO₂, and CO were analyzed to understand prevailing conditions. The results indicated that air quality was generally within acceptable limits, though localized dust generation, vehicular pollution is anticipated once construction activities commence. Water sprinkling on haul roads, maintenance of construction equipment, and covering of transported materials will help mitigate dust and emissions, ensuring that air quality remains within permissible limits.

Noise Levels: Noise levels within the project corridor were also measured at four locations by a Punjab EPA-certified laboratory during baseline monitoring. Recorded levels were within acceptable ranges, although vehicular movement and occasional construction activities in adjacent areas contributed to ambient noise. The construction phase will temporarily elevate noise levels due to the use of heavy machinery, concrete mixers, and vehicular traffic. These effects, however, will be short-lived and confined to active work zones. The adoption of noise-reduction measures, such as acoustic enclosures, well-maintained equipment, and restricted working hours near sensitive receptors, will significantly reduce disturbance to local communities.

Water Quality: Water quality sampling was conducted at four representative sites along the Ravi River within the project influence area. Laboratory analysis focused on parameters such as pH, DO, BOD₅, COD, TDS, and heavy metals to determine the river's baseline condition. Results indicated that water quality is moderately influenced by upstream urban and industrial discharges. During construction, activities such as excavation, material washing, and accidental fuel spills could potentially increase turbidity and contaminate surface water. To mitigate these risks, construction camps and material yards will be located away from the riverbanks, and sediment control measures such as silt fences and settling ponds will be implemented to prevent direct discharge into water bodies.

Soil and Land Resources: The project will involve excavation, material storage, and heavy equipment movement, which may lead to soil compaction, erosion, and localized contamination from fuel or lubricant leaks. These effects will be limited to construction zones and are reversible through proper management. Rehabilitation of disturbed areas, soil stabilization, and controlled disposal of waste material will be implemented to restore soil productivity after construction.

Ecological Assessment: The study area covered the Ravi River, beginning downstream of the Railway Bridge and extending to downstream of the M-2 Motorway. This reach of the river was surveyed to establish a baseline of ecological conditions and biodiversity in anticipation of project-induced changes. The assessment focused on both aquatic and riparian ecosystems, examining fish diversity, plankton composition, bird populations, and vegetation cover. Field surveys indicated that the area supports common fish species adapted to the disturbed urban environment and moderately degraded riparian vegetation. During the construction phase, temporary habitat disturbances, noise, and human presence may affect local fauna and flora, though these impacts are not expected to be significant or permanent. Replantation with native species and controlled access to riparian zones will aid in ecological restoration and habitat improvement.

Social Impacts: From a social perspective, the project area includes scattered settlements and small commercial establishments along access routes. During construction, communities may experience temporary inconvenience due to increased noise, dust, and traffic congestion. Access to local roads and markets might be intermittently affected. However, the project will also create short-term employment opportunities for local labor and stimulate the local economy through demand for goods and services. A grievance redress mechanism will be established to address community concerns promptly, while continuous engagement with local stakeholders will ensure transparency and minimize social disruption.

Occupational Health and Safety: Construction activities inherently involve risks such as exposure to dust and noise, accidental injuries, and machinery-related hazards. A comprehensive Health, Safety, and Environment (HSE) Plan will be implemented, emphasizing the use of personal protective equipment (PPE), worker training, and emergency preparedness. Regular monitoring and supervision will ensure compliance with safety standards and protect the well-being of workers and nearby residents.

Community Health and Safety: The influx of workers and movement of heavy vehicles may temporarily increase the risk of traffic accidents and minor health issues in nearby communities. These risks will be minimized through traffic management plans, installation of warning signs, and awareness sessions for drivers and local residents. Medical aid and emergency response facilities will also be maintained at the construction site.

Cumulative and Long-Term Impacts: In the long term, the project is expected to bring positive outcomes, including improved infrastructure, enhanced connectivity, and economic growth in the region. However, cumulative effects from nearby infrastructure projects may place additional pressure on air quality, water resources, and biodiversity. Continuous monitoring and adaptive management will be essential to ensure environmental sustainability beyond the construction phase.

1.6.4 Mitigation Measures

The purpose of mitigation is to prevent, minimize, or offset adverse environmental and social impacts arising from project activities throughout its life cycle from construction through operation and decommissioning. Based on the findings of the impact assessment, a series of targeted mitigation and compensatory measures have been proposed to ensure that environmental quality, ecological integrity, and community well-being are maintained or improved as a result of project implementation.

Mitigation strategies have been developed in accordance with the mitigation hierarchy i.e., avoid, minimize, restore, and compensate. During the design phase, efforts were made to avoid sensitive ecological areas and minimize land disturbance through careful project alignment and selection of low-impact construction techniques.

During the construction phase, the emphasis will be on minimizing the generation of dust, noise, and waste, as well as preventing contamination of soil and water resources. Specific measures include:

- **Air Quality Control:** Regular water sprinkling on unpaved roads and construction sites, covering of material stockpiles and trucks, proper maintenance of vehicles and machinery, and scheduling of construction activities to avoid high wind periods.
- **Noise Management:** Limiting noisy operations to daylight hours, using well-maintained equipment with silencers, installation of temporary noise barriers near sensitive receptors, and routine noise monitoring.

- **Water Protection:** Establishment of sedimentation ponds and silt traps to control runoff, containment of fuel and lubricant storage areas, and prohibition of direct discharge of wastewater into the river or natural drains.
- **Soil and Land Management:** Controlled excavation to prevent erosion, temporary stabilization of exposed soils, proper disposal of spoil material in designated locations, and topsoil preservation for later re-use in site restoration.
- **Waste Management:** Implementation of a Waste Management Plan covering segregation, collection, transportation, and disposal of construction and domestic waste. Hazardous materials will be handled following national regulations and international safety practices.
- **Biodiversity Conservation:** Restriction of construction activities near riparian vegetation, replantation of native species, and avoidance of in-river works during breeding and migratory seasons. Wildlife disturbance will be minimized by limiting night-time operations and controlling site lighting.
- **Occupational Health and Safety:** Enforcement of a site-specific HSE Plan that includes mandatory use of PPE, worker training, first-aid availability, emergency response procedures, and regular safety inspections.
- **Community Health and Safety:** Implementation of traffic management measures, use of signage and speed controls near settlements, and awareness sessions for both workers and local residents to minimize risks of accidents.
- **Socio-Economic Measures:** Prioritization of local labor during construction, transparent recruitment practices, and establishment of a Grievance Redress Mechanism (GRM) to address community concerns promptly and fairly.

During the operation phase, impacts are expected to be significantly lower; however, continued environmental monitoring, maintenance of equipment, and periodic training for staff will ensure that mitigation measures remain effective. Routine inspections of drainage systems, vegetation cover, and waste handling practices will be carried out to sustain long-term environmental performance.

1.6.5 Environmental Management Plan (EMP)

The Environmental Management Plan (EMP) is prepared as a part of this EIA to serve as the key framework to ensure that all identified mitigation and monitoring measures are effectively implemented during the design, construction, operation, and decommissioning phases of the project. It provides a systematic approach to managing environmental and social aspects, defining clear responsibilities, monitoring mechanisms, and corrective actions to prevent or minimize adverse impacts. The EMP ensures that environmental protection and sustainable practices are fully integrated into project planning, design, and day-to-day execution.

1.6.6 Environmental Monitoring and Compliance

Monitoring Plan: Developed a monitoring plan that outlines how environmental parameters will be monitored during the construction, operation, and decommissioning phases. This includes air and water quality monitoring, noise level checks and waste management and disposal practices.

Compliance Checks: Ensured compliance with environmental standards and regulations, including regular inspections by environmental authorities and third-party auditors.

Adaptive Management: Established mechanisms for adaptive management to respond to unforeseen environmental challenges during the project lifecycle.

1.6.7 Stakeholder Consultation and Public Disclosure

1.6.7.1 Public Consultations

Public consultations are an essential part of the EIA process, aimed at engaging local communities, government representatives, and other stakeholders to ensure their views and concerns are incorporated into project planning. Consultations were carried out through public meetings, focus group discussions, and key informant interviews within the project area.

Stakeholders were informed about the project's objectives, potential environmental and social impacts, and proposed mitigation measures. Feedback gathered during these sessions such as concerns about dust, noise, traffic safety, water quality, and employment opportunities was integrated into the impact assessment and Environmental Management Plan (EMP).

1.6.7.2 Continued Engagement

Public consultations will not be limited to the EIA preparation phase. They will continue throughout project implementation and operation, ensuring that affected communities remain informed and involved.

1.6.7.3 Public Disclosure

In line with the Pakistan Environmental Protection Act (1997) and EPA (Review of IEE and EIA) Regulations (2000), the final EIA report including findings, mitigation measures, and the EMP will be disclosed to the public.

A public notice will be published in newspapers inviting feedback within the specified period. All comments received will be reviewed and, where applicable, incorporated into the final EIA. This process ensures transparency, accountability, and stakeholder participation in environmental decision-making.

1.6.7.4 Commitment to Transparency

Through structured consultations and public disclosure, the project proponent reaffirms its commitment to transparent, participatory, and accountable environmental management. The continuous involvement of stakeholders not only enhances project sustainability but also strengthens community trust and support throughout the project lifecycle.

1.6.8 Final Reporting and Approval

EIA Report Compilation: Will be compiled all findings, analyses, and mitigation plans into a comprehensive EIA report. The report should include:

- Executive summary.
- Introduction
- Legal and Administrative Framework

- Description of the project.
- Baseline Study.
- Impact assessment and mitigation measures.
- Environmental Management Plan.
- Stakeholder Consultation
- Conclusions and Recommendation

Submission to Authorities: Submit the final EIA report to the Environmental Protection Agency (EPA) for review, approval and issuance of NOC by paying review fee, filling Schedule IV (Application Form), Schedule VIII (Undertaking) according to Punjab Environmental Protection (Review of Initial Environmental Examination and Environmental Impact Assessment) Regulations 2022.

Follow-Up Actions: Depending on the review, the authorities will request additional studies, modifications to the project design, or further mitigation measures.

1.7 Approval Procedures

The approval procedure for a project from the Environmental Protection Agency (EPA) in Pakistan involves submitting a series of essential documents to ensure compliance with environmental regulations. We will submit the following to get approval from EPA:

- Formal application.
- Detailed EIA Report including EMP.
- Documentation of public consultations held with stakeholders
- Application Form and Undertaking
- Proof of payment for any required environmental clearance fees

Once all documents are submitted, the EPA will review the report for approval, after which an environmental clearance certificate (NOC) is issued, allowing the project to proceed under specified conditions.

1.8 Contents of the EIA Report

Chapter 1: Introduction: This first chapter of the Environmental Impact Assessment (EIA) serves as an introduction to the overall study, providing the foundational context for the project and its assessment process.

Chapter 2: Review of Relevant Policies and Regulatory Framework: This chapter provides a comprehensive review of the prevailing national and provincial regulatory frameworks, including Pakistan's Environmental Protection Act, Punjab Environmental Quality Standards (PEQS), and other applicable laws and guidelines. The chapter identifies compliance requirements, approval procedures, and key provisions necessary for aligning the project with both international and

national regulations. This ensures that the project adheres to best practices for environmental and social sustainability.

Chapter 3: Project Description: This chapter offers a detailed description of the project, including its objectives, scope, and technical components. It highlights the geographical location, design features, construction requirements, and operational aspects relevant to environmental assessment. The chapter also identifies associated activities such as land preparation, resource utilization, and potential ancillary developments. By providing this foundational understanding, the chapter establishes the context for assessing the environmental and social impacts of the project.

Chapters 4: Baseline Environmental Conditions: These chapters present a detailed analysis of the existing baseline conditions in the project area, categorized into physical, biological, and socioeconomic aspects:

Chapter 5: Environmental Impact Assessment and Mitigations: This chapter evaluates the potential environmental and social impacts of the project during construction, operation, and decommissioning phases. It identifies both positive and negative impacts and provides a detailed analysis of their significance. Appropriate mitigation measures to address adverse impacts, such as pollution control, habitat restoration, and community support programs, are discussed comprehensively. The chapter emphasizes the need for proactive management to minimize risks and ensure sustainable project implementation.

Chapter 6: Environmental Management Plan (EMP): This chapter presents summary of the Environmental Management Plan (EMP), prepared as a standalone volume. The EMP outlines detailed mitigation measures, monitoring frameworks, and institutional responsibilities for managing environmental and social impacts. It includes cost estimates, timelines, and capacity-building initiatives to ensure effective implementation of the proposed measures. The EMP serves as a practical tool to guide the project team in achieving environmental and social compliance.

Chapter 7: Stakeholder Consultations and Disclosure: This chapter details the consultations conducted with various stakeholders, including local communities, government authorities, and other relevant entities. It highlights the process followed, the concerns raised, and how these have been incorporated into the environmental and social assessment. Additionally, the chapter outlines the disclosure mechanisms used to share project-related information with stakeholders, ensuring transparency and fostering community engagement.

Chapter 8: Conclusions and Recommendations: The final chapter summarizes the key findings of the Environmental Impact Assessment (EIA) and provides recommendations for project implementation. It highlights the importance of adhering to the mitigation measures outlined in the EMP and emphasizes the need for continuous stakeholder engagement, monitoring, and adaptive management. The chapter concludes by affirming the project's feasibility from an environmental and social perspective, provided that the recommended measures are effectively implemented.

2 Legal and Administrative Framework

This chapter provides an overview of the policy framework and legislation that applies to manage/control the environmental consequences as a result of a project implementation and operation. The project needs to comply with all the applicable environmental policies, laws, regulations, guidelines of Government of Pakistan and Government of the Punjab. According to Punjab Environmental Protection Act, 2012, an environmental and social assessment study is required prior to commencement of any development project. The present document complies with this requirement.

2.1 Constitutional Context

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

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

The Ministry of Environment at the federal level was abolished. Its functions related to the national environmental management were transferred to the provinces. To manage the international obligations in the context of the environment, a new ministry, the Ministry of Climate Change—was created at the federal level.

The PEPA 1997 ceased to apply directly to the provinces. The provinces were required to enact their own legislation for environmental protection. However, to ensure legal continuity PEPA 1997 continued to be the legal instrument for environmental protection in the provinces till the enactment of the provincial law.

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

2.1.1 Punjab Environmental Protection Act 2012

The Punjab Environmental Protection Act of 2012 is the provincial version of the Pakistan Environmental Protection Act, 1997 (PEPA) relevant to the Project. Responsibility for administration and implementation of the PEPA was transferred from the Ministry of Environment to the provincial governments by an amendment to the PEPA in 2012. The provincial versions continue to remain materially the same as the PEPA except when it comes to the designation of the responsible governmental bodies.

The following key features of the provincial Acts have a direct bearing on the Project:

- 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”.
- Section 12 (Initial Environmental Examination and Environmental Impact Assessment) “No project can begin construction or operation unless the project proponent has submitted an Initial Environmental Examination (IEE) or, in cases where significant environmental impacts are expected, a full EIA, and received approval from the relevant provincial agency.”
- Section 13-1 (Initial Environmental Examination and Environmental Impact Assessment) requires that “No proponent of a project shall commence construction or operation unless he has filed with the Federal Agency an IEE or, where the project is likely to cause an adverse environmental effect, an EIA, and has obtained from the Federal Agency approval in respect thereof.”
- Section 13-2b (Review of IEE and EIA): “The 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”.
- 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 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.'

- Section 16 (Regulation of Motor Vehicles): "Subject to provision of this clause of the Act and the rules and regulations made there under, 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 PEQS, or where the applicable standards established under clause (g) of subsection (1) of Section-6 of the Act".
- 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 offence 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 officer of the body corporate, such director, partner, manager, secretary or other officer of the body corporate, shall be deemed guilty of such contravention along with the body corporate and shall be punished accordingly".

2.1.2 Pakistan Environmental Protection Agency (Review of IEE & EIA) Regulations, 2022

The IEE/EIA Regulations of 2022 establish the framework for the preparation, submission, and review of the IEE and the EIA. The regulations categorize development projects for IEE and EIA into two schedules (Schedules I and II). Schedule I include projects where the range of environmental issues is comparatively narrow and the issues can be understood and managed through less extensive analysis. Schedule II covers major projects that have the potential to affect a large number of people in addition to generating potentially significant adverse environmental impacts. It was determined that the proposed Project will fall under Schedule II requiring EIA.

2.1.3 Environmental Regulatory Authorities

Since the project area falls in Punjab Province, the Punjab Environmental Protection Agency (EPA) is the relevant environmental regulatory authority. The provincial EPAs are responsible for environmental regulation and implementing Government of Pakistan (GoP) environmental policies in their respective provinces. As part of their roles, provincial EPAs are responsible for reviewing EIA documentation for compliance with provincial EIA requirements and procedures and, using their district-based staff, monitoring the implementation of EMPs. The Statutory functions of the provincial EPAs are to:

- Administering and implementing the Environmental Protection Act, its rules and regulations.

- Reviewing IEE/EIA, preparation of procedures and guidelines.
- Prepare, revise and enforce Environmental Quality Standards (EQS) for industries, municipalities, vehicular emissions.
- Establishing and maintaining laboratories, certification of laboratories for conducting tests and analyses;
- Assisting local Councils, Authorities and/or Government Agencies in execution of projects.
- Establishing a system of surveys, monitoring, examination and inspection to combat pollution.
- Conducting training for government staff and industrial company staff.
- Provide information and education to the public on environmental issues.
- Publishing annual “State of the Environment” reports.
- Undertaking surveys and qualitative and quantitative analysis of data on air, soil and water quality, and industrial, municipal and traffic emissions.

2.1.4 RUDA HSE Manual and Construction Regulations

Ravi Urban Development Authority (RUDA) has implemented a structured framework for health, safety, and sustainable construction under its HSE Manual and Construction & Development Regulations. These Regulations are designed to ensure responsible urban growth, worker protection, and environmental stewardship.

RUDA Health, Safety, and Environment (HSE) Manual Highlights

Objective: To prevent workplace accidents, ensure worker health, and minimize environmental impacts during project execution.

Scope: Applies to RUDA headquarters, project sites, and jurisdictional areas.

Key Measures:

- Risk assessments and mitigation plans for construction activities.
- Provision of Personal Protective Equipment (PPE).
- Emergency response planning and first aid arrangements.
- Environmental controls for dust, emissions, and noise pollution.
- HSE training and awareness programs for all personnel.
- Regular HSE inspections and audits.
- Construction & Development Regulations (2021)
- Design & Safety Standards:
 - Mandatory inclusion of fire safety systems: alarms, hydrants, extinguishers, and emergency exits.
 - Minimum building standards for ventilation, access, and disabled-friendly design.
- Industrial Zone Specifics:

- Regulated disposal of solid and liquid waste.
- Buffer zones and green belts for pollution control.
- Enforcement:
- Non-compliance may lead to penalties, suspension of activity, or demolition of unauthorized structures.
- Compliance with RUDA's HSE Manual and Construction Regulations is essential for ensuring safe construction practices, protecting workers and nearby communities, and maintaining environmental integrity throughout the project lifecycle.

2.1.5 Other Important Environmental Legislations in Pakistan

This EIA report will be submitted to Punjab-EPA whom, according to the Regulations, shall complete its review process within 45 days of submission.

2.1.6 Applicable Legislation and Regulatory Framework

The national and provincial legislation applicable to the project are given in the Table 2-1.

Table 2-1 Relevant Legislation for EIA

Legislation/ Regulation/ Conventions/ Standards	Theme and General Objective	Relevance with the Proposed Project
Review of IEE and EIA Regulations, 2000	Pakistan Environmental Protection Agency Review of IEE and EIA Regulations, 2000 sets procedures for preparing and reviewing Initial Environmental Examinations (IEEs) and Environmental Impact Assessments (EIAs). Projects are classified by impact, Schedule-I needing IEEs and Schedule-II requiring full EIAs with clear guidelines on responsibilities, approvals, and environmental screening across federal and provincial authorities.	The provisions of these regulations are applicable for environmental screening of project, which implies that the proposed project falls under Schedule (II) thus requires an EIA. An EIA has been prepared by following the regulations. The process described in the regulations will be useful for RUDA to follow the procedures to file an EIA with EPA-Punjab and to understand its review process along with timelines to be followed.

<p>Punjab Environmental Quality Standards (PEQS), 2016</p>	<p>PEQS promulgated in 2016. Specified standards under PEQS are for: Drinking Water; Ambient Air; Noise; Industrial Gaseous Emissions; Municipal and Liquid Industrial Effluents; Motor vehicle exhaust and noise; and Treatment of Liquid and Bio-Medical Waste.</p>	<p>The project to be commenced in Punjab must conform to PEQS during all phases i.e., construction and operation.</p>
<p>The Ravi Urban Development Authority Act, 2020</p>	<p>The Ravi Urban Development Authority Act 2020 establishes the Authority to oversee comprehensive planning and development within the designated project area. Its goal is to improve quality of life by promoting modern, integrated urban development, rehabilitating the Ravi River into a fresh perennial water body, and creating a healthy, prosperous community with high environmental and infrastructural standards.</p>	<p>As RUDA is the proponent of this project, which is established under this Act, and RUDA has to fulfill all its responsibilities for implementing this project as laid down in this Act.</p>
<p>The Parks and Horticulture Authority Act, 2012 (Act XLVII of 2012)</p>	<p>The Parks and Horticulture Authority Act 2012 (the "Act 2012") was promulgated to establish the Parks and Horticulture Authority (the "PHA") in the Punjab for the regulation,</p>	<p>PHA established under this Act</p>

	<p>development and maintenance of public parks, green belts and green areas in the Punjab; regulation of billboards, sky signs and outdoor advertisements; to promote open and unrestricted views of the Punjab; and, to provide for the connected matters.</p>	
<p>Pakistan Penal Code, 1860</p>	<p>The Pakistan Penal Code deals with offences where public or private property and/or human lives are affected due to the intentional or accidental misconduct of an individual or body of people. In the context of the environment, the Penal Code empowers local authorities to control noise, toxic emissions and disposal of effluents</p>	<p>Penal Code empower tehsil/district administration to check measures to control noise, toxic emissions and disposal of effluents.</p>
<p>The Punjab Firewood and Charcoal (Restriction) Act 1964</p>	<p>This act is to prohibit and regulate the burning of firewood and charcoal in West Pakistan. This Act extends to the whole of Pakistan, except the tribal areas. Use of firewood is still very common in the area and for this reason the Act is applicable for the entire project area.</p>	<p>Use of firewood is very common in the project area and for this reason, the Act is applicable to the contractor for the entire project area.</p>
<p>The Provincial Motor Vehicles Ordinance,</p>	<p>The law and rules deal with the licensing requirement for driving;</p>	<p>All vehicles used for project by construction supervisor consultants</p>

<p>1965 and Rules, 1969, GoPb</p>	<p>powers of licensing authority, Regional Transport Authority and those of Court vis-à-vis disqualification for license and registration requirements to control road transport; compensations for the death of or injury to a passenger of public carrier; traffic rules, power to limit speed, weight, use of vehicles; power to erect traffic signs; specific duties of drivers in case of accident and powers of police officers to check and penalize traffic offenders.</p>	<p>and the contractors will be subject to this Motor Vehicle Ordinance 1965 and rules 1969.</p>
<p>Pakistan Antiquities Act 1975 & Punjab Antiquities Amendment 2012 Act</p>	<p>The Punjab Antiquities Amendment Act, 2012, adapted from the Pakistan Antiquities Act of 1975, defines "ancient" as objects over 75 years old and mandates reporting accidental discoveries to the Federal Department of Archaeology. It establishes government ownership of all buried antiquities, prohibits construction within 200 feet of protected sites, and requires official approval for any changes to protected monuments, ensuring uniform</p>	<p>The law will be applicable to the project mainly due to its provision: The provisions of this act would be applicable, if any accidental archaeological discoveries may occur during the excavation works during the construction. In case of archaeological discoveries, the construction activity within 61 m or 200 ft. of protected antiquities, would be prohibited.</p>

	protection of cultural heritage across Pakistan.	
Highway Safety Ordinance, 2000	This Ordinance includes provisions for licensing and registration of vehicles and construction equipment; maintenance of road vehicles; traffic control offences, penalties and procedures; and the establishment of a police force for motorways and national highways to regulate and control the traffic as well as keep the highways clear of encroachments.	This Ordinance will have an impact on the road network leading to the Project area during the construction phase of the project.
Punjab Plantation and Maintenance of Trees Act, 1974	The Punjab Plantation and Maintenance of Trees Act, (1974) regulates tree plantations and enforces measures for their protection.	The forests in the project belong to Punjab Forest Department so could not be cut/uprooted without approval of provincial Forest Department and compensatory tree plantation.
Punjab Forest Act 1927 and Punjab Forests (Amendment) Ordinance 2016	The Forest Act, 1927 prohibits activities like setting fires, quarrying, removing forest produce, or damaging forests by cutting trees or clearing land. Originally based on British Indian laws, it aimed to conserve forest areas and regulate timber trade. After forestry became a provincial matter under Pakistan's	This Act will be relevant in case any part of the proposed intervention is located on a land previously prescribed as forest land by the Government of Punjab. In such cases, land acquisition will be governed under this Act, and the provincial department responsible for execution of the

	<p>18th Amendment, Punjab amended the Act in 2010 to allow limited use of protected forest land for national projects of strategic importance, while maintaining core conservation provisions.</p>	<p>project, will need to negotiate with the provincial Forest Department.</p>
<p>Punjab fisheries ordinance 1961</p>	<p>The Punjab Fisheries Department is responsible for the conservation, management, and development of natural fisheries resources in the province through the enforcement of the Punjab Fisheries Ordinance and Rules. It also promotes aquaculture in the private sector to help reduce protein deficiency and contribute to the national economy. Key provisions of the Ordinance include a ban on using explosives (Section 6) or poisonous substances (Section 7) in water to catch or destroy fish. Section 8 prohibits the capture or possession of undersized fish as specified in the Schedule. Additionally, Section 9A requires that fish sold or transferred commercially must meet prescribed quality standards set by the government.</p>	<p>This Act will be equally applicable to project stakeholders as well as to the Contractor's personnel.</p>

<p>Punjab Wildlife Act 2015</p>	<p>Government of Punjab has certain rules and regulations for the conservation and protection of wildlife under the Punjab Wildlife Act (amended 2015). Under the amended wildlife act, private parties could also set up wildlife breeding farms, wildlife parks and zoological gardens. The amended act says in any of the wildlife breeding farm owned by the government, no shooting, hunting, trapping, killing and capturing of animals would be allowed. In a government owned game reserve, hunting and shooting would not be allowed except under special permission that would specify the quantity of animals which could be killed.</p>	<p>The winter migrants waterfowls particularly ducks (including endangered white head duck) and geese etc from Siberia while flying over the Indus Flyway also diverge to project area. The Punjab Wildlife Act prohibits shooting of migratory birds more than a specified number. This Act will be applicable to the Contractor's personnel during project execution.</p>
<p>Land Acquisition Act 1894 and Punjab Land Acquisition Rules, 1983 (1983 Rules)</p>	<p>The Land Acquisition Act, 1894 is the primary law for acquiring private land for public purposes in Punjab. It covers compensation for titleholders and registered tenants but does not mandate resettlement or livelihood support for non-titleholders or vulnerable groups. The Act is</p>	<p>This Act is triggered where land is acquired through this Act</p>

	implemented alongside the Punjab Land Acquisition Rules, 1983.	
Provision in the Constitution of Pakistan on Labour Laws	The Constitution of Pakistan ensures labour rights through provisions such as Article 11 (ban on slavery, forced and child labour), Article 17 (freedom of association), Article 25 (equality before law), and Article 37(e) (humane work conditions and maternity benefits). These articles collectively protect workers, especially women and children, from exploitation and discrimination.	Applicable to the project as it would deal with labour rights under the constitution of Pakistan.
Labour Laws of GOPb	The labour laws deal with the following aspects: Contract of Employment; Termination of Contract; Working Time and Rest Time; Working Hours; Paid Leave; Maternity Leave and Maternity Protection; Other Leave Entitlements; Minimum Age and Protection of Young Workers; Equality Pay Issues; Workers' Representation in the Enterprise; Trade Union and Employers Association Regulation; and other Laws.	All labour laws will be applicable to the project as it would deal with employment of labour for the construction works.
Punjab Restriction on Employment of Children Act 2016	This act deals with child labour in the commercial and industrial sectors of	The relevance of this Act to the project will be to prohibit child employment

	Punjab. The Act prohibits the employment of children and to restrict the employment of adolescents in certain occupations and processes; and, to deal with ancillary matter.	for construction of the proposed project.
Protection Against Harassment of Women at the workplace Act, 2010 and Rules 2013	The Protection Against Harassment of Women at the Workplace Act (2010) refers to sexual harassment at the workplace. It extends to whole of the Punjab.	This Act will be applicable to all females working in the client office, CSC and contractor's staff of the project.
Punjab Occupational Health and Safety Act 2019	This act deals with occupational safety and health of the persons at workplace and to protect them against risks arising out of the occupational hazards; to promote safe and healthy working environment catering to the physiological and psychological needs of the employees at workplace and to provide for matters connected therewith or ancillary thereto.	The provisions of this Act will be applicable to personnel of all project entities including the construction contractor to protect all workers and employees against occupational health and safety risks of the project related activities.

2.2 National Policies

The proposed project will be planned, executed, and monitored in compliance with applicable environmental, social, health, and safety legislation at the federal and provincial levels. The following laws and regulations are particularly relevant to the project are given below in Table 2-2.

Table 2-2 National Policies

Legislation/ Regulation/ Conventions/ Standards	Theme and General Objective	Relevance with the Proposed Project
National Conservation Strategy, 1992	Pakistan National Conservation Strategy (NCS), which was approved by the federal cabinet in March 1992, is the principal policy document on environmental issues in the Country. The NCS outlines the Country's primary approach towards encouraging sustainable development, conserving natural resources and improving efficiency in the use and management of resources. The NCS has 68 specific programs in 14 core areas in which policy intervention is considered crucial for the preservation of Pakistan's natural and physical environment.	The core areas that are relevant in the context of the proposed project are pollution prevention during construction, increasing irrigation water availability, conserving biodiversity and supporting forestry and plantation.
National Environment Policy 2005	Government of Pakistan has notified National Environment Policy 2005, for different projects/aspects in which guidelines/priorities have been given to undertake/commence the projects having significant environmental impacts. The Policy provides a framework for addressing the environmental issues (particularly pollution of fresh water bodies and	Clause (b) of sub-section 5.1 will also apply, which states that EIA related provisions in Environmental Protection Act, 1997, will be diligently enforced for all developmental projects.

	<p>coastal waters, air pollution, lack of proper waste management, deforestation, loss of biodiversity, desertification etc.) confronting Pakistan. It recognizes the goals and objectives of the Pakistan National Conservation Strategy (PNCS, 1992), National Environmental Action Plans, and other existing environment related national policies, strategies, and action plans. It also provides broad guidelines to the Federal Government, Provincial Governments, federally administrated territories and local governments to address their environmental concerns and to ensure effective management of their environmental resources.</p>	
<p>National Water Policy 2018</p>	<p>The objective of the National Water Policy is to take cognizance of the emerging water crisis and provide an overall policy framework and guidelines for a comprehensive plan of action. Pakistan has a federal system of government and the provinces enjoy a considerable degree of autonomy. Thus, this policy is a national framework within which the provinces can develop their master</p>	<p>The project is in line with the policy objective No. 2.3 aiming at improving availability, reliability and quality of fresh water resources to meet critical municipal, agriculture, and environmental needs.</p>

	<p>plans for sustainable development and management of water resources. The water resource is a national responsibility but irrigation and agriculture, as well as rural and urban water supply, environment and other water related sub-sectors are provincial subjects.</p>	
<p>National Biodiversity Strategy and Action Plan 2017 – 2030</p>	<p>Pakistan ratified Convention on Biological Diversity (CBD) in 1994. The Convention requires countries to prepare a national biodiversity strategy and action plan for achieving Aichi Biodiversity Targets and Sustainable Development Goals. It focuses on causes and consequences of biodiversity loss such as deforestation, grazing, fishing, pollution etc. It also provides legal and institutional framework. The strategies have been drafted for biodiversity awareness, terrestrial ecosystem, forest ecosystem, wetlands, coastal and marine ecosystem, and agrobiodiversity.</p>	<p>The strategies and plan would be applicable to the project to conserve biodiversity in the project area.</p>
<p>Water Apportionment Accord (1991)</p>	<p>In 1991, the Water Apportionment Accord was signed between the representatives of all the</p>	<p>The project is being designed in accordance with Water</p>

	<p>four provinces of Pakistan to allocate supplies to the existing projects and future developments of the Indus River System. The need for storage wherever feasible on the Indus and other rivers was also recognized for planning future agricultural developments. The Water Apportionment Accord also included the following provision for Indus Delta: "The need for certain minimum water escape to the sea below Kotri Barrage to check sea intrusion was recognized. An optimum level of 12335m³ (10 Million Acre Feet) was discussed. It was decided that further studies would be undertaken to establish the minimal escape needs downstream of Kotri Barrage." Indus River System Authority (IRSA) was established to implement the Water Apportionment Accord with representation from all four provinces and the Federal Government. The system-wise allocations would also be worked out on a 10-day basis with actual average system uses for the post Tarbela period 1977-82 providing guidelines for developing future regulation pattern.</p>	<p>apportionment accord by IRSA.</p>
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<p>Pakistan Labour Policy, 2010</p>	<p>The main objective of the Labour Policy, 2010 is the social and economic well-being of the labour of Pakistan. The Labour Policy, 2010 has following 4 parts:</p> <p>Legal Framework;</p> <p>Advocacy: rights of workers and employers;</p> <p>Skill development and employment; and</p> <p>Manpower export.</p>	<p>The labour will be employed for construction activities of the project. The provision of policy will apply to all the labour employed.</p>
<p>Punjab Labour Policy 2018</p>	<p>The Labour policy identifies policies concerned with relations between employers and workers and those concerned with the employment, training and distribution of workers in the labour market and resolution of their disputes preferably through tripartite forums, so it may easily be deduced that maintenance of industrial peace and harmony is directly related to the effective implementation of a well-thought-out policy document on the subject. This Policy covers the key thematic areas in a redefined format with primary focus and emphasis on effective implementation of labour standards, social dialogue, improvements in workplace safety, living wages, child/ bonded</p>	<p>The labour will be employed for construction activities. The provision of policy will apply to all the labour employed.</p>

	labour, awareness raising, excellence in labour inspections regime, imparting quality technical trainings through well-improved Training Centres, simplification of labour laws, medical facilities for secured workers even after retirement, establishment of labour colonies and schools for workers' children, efficient disbursement of welfare grants and gradual extension of labour protection framework. It is expected that the Labour Policy in hand would augur well with the objectives conceived by the GoP.	
Guidelines for Sensitive and Critical Areas, 1997	Specifying the sensitive and critical areas in Pakistan, these guidelines apply to both the natural environment and cultural aspects of Pakistan.	The issue of natural and cultural aspects of the project areas would be dealt by these guidelines.

2.3 International Treaties and Conventions Signed by Pakistan

Pakistan is a signatory to a number of international environment-related treaties, conventions, declarations, and protocols. The International treaties and conventions relevant to the project are described in the Table 2-3.

Table 2-3 Applicable International Treaties, Conventions, Declaration and Protocols

Treaty/ Convention	Description	Relevance with the proposed Project
Indus Water Treaty, 1960	The Indus Waters Treaty is a water sharing treaty between Pakistan and India, mediated by the World Bank (then the International Bank for	As per Indus Water Treaty, the water of Ravi River had been allocated to India. According to this Treaty India is bound to inform Pakistan about any extra

	<p>Reconstruction and Development). The treaty, under Article 5.1, envisages the sharing of waters of the rivers Ravi, Beas, Sutlej, Jhelum and Chenab which join the Indus River on its left bank (eastern side) in Pakistan. According to this treaty, Ravi, Beas and Sutlej, which constitute the eastern rivers, are allocated for exclusive use by India before they enter Pakistan. However, a transition period of 10 years was permitted in which India was bound to supply water to Pakistan from these rivers until Pakistan was able to build the canal system for utilization of waters of Jhelum, Chenab and the Indus itself, allocated to it under the treaty. Similarly, Pakistan has exclusive use of the western rivers Jhelum, Chenab and Indus but with some stipulations for development of projects on these rivers in India. Pakistan also received one-time financial compensation for the loss of water from the eastern rivers. Since March 31, 1970, after the 10-year moratorium, India has</p>	<p>ordinary water releases in the Ravi River so that precautionary measures against flood during project execution be taken well in advance.</p>
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	<p>secured full rights for use of the waters of the three rivers allocated to it. The treaty resulted in partitioning of the rivers rather than sharing of their waters.</p>	
<p>United National Convention on Biological Diversity CBD 1992</p>	<p>Pakistan signed this treaty in 1992 and it was ratified by cabinet in 1994. Convention on Biological Diversity, known informally as the Biodiversity Convention covers ecosystems, species, and genetic resources and the field of biotechnology. The Convention has three main goals: Conservation of biological diversity; Sustainable use of its components; Fair and equitable sharing of benefits arising from genetic resources. The objective of the convention is to conserve biological diversity, promote the sustainable use of its components, and encourage equitable sharing of the benefits arising out of the utilization of genetic resources. Such equitable sharing includes appropriate access to genetic resources, as well as appropriate transfer of technology, taking into</p>	<p>The law is relevant as the project is proposed intervention on natural resource management and it surrounds natural habitats. The project is planned to minimize the negative impacts of the project on the biological resources. The EMP under the EIA provided a set of mitigation measures to mitigate impacts on the biological resources.</p>

	<p>account existing rights over such resources and such technology. In other words, its objective is to develop national strategies for the conservation and sustainable use of biological diversity.</p>	
<p>The Rio Declaration, 1992</p>	<p>Pakistan signed the treaty on 13 Jun 1992 and ratified on 1 June 1994. The Rio Declaration comprises 27 principles which address important issues such as; sustainable development to integrate environmental protection into the development process; common but differentiated responsibilities to conserve, protect and restore the earth's ecosystems; public participation and information access at the national level, reduce and eliminate unsustainable patterns of production and consumption.</p>	<p>The principles of Rio Declaration are applicable to the project with a focus on protection of natural environment.</p>
<p>Kyoto Protocol, 1992 to the Convention United Nations Framework on Climate Change</p>	<p>Pakistan has ratified Kyoto Protocol in 2005. The Kyoto Protocol is a protocol to reduce Greenhouse gasses (GHGs) that cause climate change. It was agreed on 11th December, 1997 at the</p>	<p>Pakistan has no obligation beyond monitoring and reporting emissions. Under the project, the monitoring and reporting will be done on emission of gasses.</p>

	<p>3rd Conference of the countries to the treaty when they met in Kyoto, and entered into force on 16th February, 2005. As of November 2007, 175 countries have ratified the protocol.</p>	
<p>UNESCO Convention on the Protection of the World's Cultural and Natural Heritage, 1972</p>	<p>Pakistan ratified this Convention on 23rd July 1976. Convention concerning the Protection of the World Cultural and Natural Heritage - requires parties to adopt a general policy on the protection of the natural and cultural heritage, to set up services for such protection, to develop scientific and technical studies, to take appropriate legal, technical, scientific and administrative measures and to foster training and education for such protection.</p>	<p>The ESU of the Project Director office and ES of CSC and Contractor will pay due attention to cultural and national heritage during implementation of the project.</p>
<p>Bonn Convention on the Conservation of Migratory Species of Wild Animals, 1979</p>	<p>Pakistan ratified this Convention in 1987. It aims to conserve terrestrial, marine and avian migratory species throughout their range. It is concerned with the conservation of wildlife and habitats on a global scale.</p>	<p>Owing to abundance of Sambar (wild deer) and Nilgai (blue bull) in areas that border Pakistan and the Occupied Kashmir, together with the growing trend of hunting, the animals instinctively run away from places where they feel threatened. As a result, they enter Kasur, Lahore and Sialkot to save their lives. As per Bonn convention,</p>

		<p>they are protected in Pakistan. The injured animals are given proper food and care. Their wounds are treated and a balanced diet is provided to them to help them get healthy⁴. The same practice will be adopted if any such animal form India enters in the project area.</p>
<p>International Plant Protection Convention, 1951/52</p>	<p>Pakistan ratified this Convention in 1954. This Convention (1997 Revised Text) is to prevent the international spread of pests and plant diseases. It requires maintenance of lists of plant pests, tracking of pest outbreaks, and coordination of technical assistance between member nations.</p>	<p>The provisions of this Convention will be applicable if locust attacks the project area</p>
<p>International Labour Organization's (ILO) Core Labour Standards</p>	<p>The core labour standards are the elimination of all forms of forced or compulsory labour; the abolition of child labour; elimination of discrimination in respect of employment and occupation; and freedom of association and the effective recognition of the right to collective bargaining, as per the relevant conventions of the</p>	<p>The labour will be employed for construction activities of the project. The Contractor and other project implementing parties will comply with Core Labour Standards.</p>

	International Labour Organization.	
Forced Labour Convention (29), 1930 and Abolition of Forced Labour Conventions (105) and occupation (conventions 100 & 111)	These Conventions ensure that a work relationship should be freely chosen and free from threats aimed at eliminating all forms of discrimination in respect of employment and occupation. The scope covers access to vocational training, access to employment and to particular occupations and terms and conditions of employment.	The Contractor and all other employers will strictly prohibit forced labour and conventions.
Abolition of child labour (conventions 138 and 182)	The obligations under these conventions are to respect, promote and realize the abolition of child labour and prohibit the worst forms of child labour to be eliminated as a matter of priority.	No child shall be employed or permitted to work in any project related activities.
United Nations Convention on the Rights of the Child	This Convention set out children's rights and how governments should work together to make them available to all children. Under the terms of the convention, governments are required to meet children's basic needs and help them reach their full potential. Central to this is the acknowledgment that every child has basic	RUDA will ensure that none of the children from the affected families will deprive of their rights as a result of adverse impacts of land acquisition and resettlement by ensuring timely disbursement of compensation.

	<p>fundamental rights. These include the right to: Life, survival and development; Protection from violence, abuse or Neglect. An education that enables children to fulfil their potential; Be raised by, or have a relationship with, their parents; Express their opinions and be listened to.</p>	
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These treaties ensure that the project adheres to both local and international standards for environmental protection, social inclusion, and sustainable development. The EIA incorporates these laws to mitigate potential negative impacts on both the environment and local communities while promoting the project's long-term benefits.

2.3.1 Environmental Standards and Guidelines

PEQS (Punjab Environmental Quality Standards) are part of the broader framework established by the Pakistan Environmental Protection Act, 1997 (PEPA) at the provincial level. While the National Environmental Quality Standards (NEQS) provide a general framework for pollution control across Pakistan, PEQS are tailored to address the unique environmental concerns of Punjab. Some PEQS are mentioned in Table 2-4.

Table 2-4 Relevant PEQS for EIA

Legislation	Description
Air Quality Standards	PEQS establish limits for concentrations of air pollutants like sulfur dioxide (SO ₂), nitrogen oxides (NO _x), carbon monoxide (CO), particulate matter (PM), and ozone, among others. These standards aim to control emissions from industrial, vehicular, and other sources to ensure air quality remains within acceptable levels, thus protecting public health and the environment.
Water Quality Standards	These standards set permissible limits for pollutants in surface water, groundwater, and wastewater, including parameters like pH, biochemical oxygen demand (BOD), total dissolved solids (TDS), heavy metals, and pathogens. Ensuring that water bodies meet PEQS is critical for the protection of aquatic ecosystems and human health.

Noise Pollution Standards	PEQS also define acceptable noise levels for different areas (residential, industrial, commercial, and recreational). These standards help to mitigate noise pollution, which can negatively affect human health, wildlife, and the overall quality of life.
Industrial Effluent Standards	For industries in Punjab, PEQS provide limits on the discharge of effluents to prevent contamination of land, water, and air. These regulations ensure that industrial activities do not degrade environmental quality or endanger public health.
Solid Waste Management	PEQS address standards for the disposal and management of solid waste, including waste segregation, treatment, and disposal practices to minimize environmental impacts.

These legal national requirements ensure that the project adhere environmental protection, social inclusion, and sustainable development. The EIA incorporates these laws to mitigate potential negative impacts on both the environment and local communities while promoting the project's sustainability and long-term benefits.

2.4 Specific Legal and Regulatory Requirements for Project Design

In accordance with national environmental laws and international best practices, the following legal obligations are applicable and must be fulfilled prior to the commissioning of the proposed Rubber Dams/Weirs on the Ravi River:

2.4.1 Wastewater Treatment Compliance

As per the Pakistan Environmental Protection Act, 1997 and its subsidiary NEQS (National Environmental Quality Standards), untreated municipal and industrial effluent must not be discharged into natural water bodies without treatment. Water availability will be ensured through designed mechanism.

Legal Reference: NEQS for municipal and industrial effluents (SRO 549(1)/2000 and amendments).

Implication: Construction or operation of any hydraulic structure leading to water stagnation without upstream effluent control will arrange aquatic habitat activity and stagnation will be dealt by design.

Requirement: Operational WWTPs treating a minimum of 80% of the dry weather flow from upstream urban drains (e.g., Cantt drain, Shadbagh drain, Shahdara drain).

2.4.2 Sediment Management Compliance

Under Pakistan Environmental Protection Agency (Review of IEE/EIA) Regulations, 2000, the project must include a sediment management plan to ensure river morphology, downstream ecosystem integrity, and dam operational safety are not compromised.

Legal Reference: Regulation 12(2) (Mitigation Measures) and Regulation 18 (Monitoring).

Requirement:

- Design and provision of sediment sluicing infrastructure within the Barrage structure.
- Flushing operations protocol, to be conducted at ecologically appropriate intervals.
- Secure sediment disposal plan, in line with hazardous and non-hazardous waste regulations.

2.4.3 Conditionality for Environmental Approval

In line with Section 17 of PEPA 1997, which gives powers to the Provincial EPA to refuse project approval based on high environmental risk, the environmental approval (NOC) for this project is conditional upon:

- Verified completion and trial operation of upstream wastewater treatment systems.
- Submission and approval of a Sediment Flushing and Disposal Strategy, duly integrated into the dam design and O & M manual.

Regulatory Warning: Any deviation from these conditions will result in the suspension of environmental clearance and legal liability for environmental degradation under PEPA, 1997 and related provincial regulations.

2.4.4 Solid Waste and Floating Debris Control

Issue: Uncollected solid waste and floating debris contribute to pollution and operational hazards for hydraulic infrastructure.

Legal Reference:

- PEPA 1997 – Sections 11 & 15.
- Punjab Solid Waste Management Act, 2014.
- NEQS for solid waste incineration and landfill leachate.

Requirement:

- Design inclusion of trash booms, waste interceptors, and floating barriers upstream.
- Allocation of designated waste collection and removal zones.
- Coordination with LWMC or local municipal authorities for integration into solid waste logistics.

2.4.5 Public Health and Mosquito Breeding

Issue: Water stagnation from damming may create ideal mosquito breeding conditions, leading to malaria, dengue, and other vector-borne diseases.

Legal Reference:

- Punjab Communicable Diseases Control Act.
- PEPA 1997 – Section 11 (preventing environmental conditions injurious to health).
- WHO guidelines on stagnant water bodies in urban settings.

Requirement:

- Design must ensure water circulation zones, aeration, or floating wetland vegetation to prevent stagnation. As it's a river body, will maintain circulation by design.
- Coordination with Punjab Health Department and vector control units to pre-empt health emergencies.
- Monitoring wells and biological indicators should be part of health & safety compliance.

2.4.6 Flood Risk and Drainage Backflow

Issue: A 9-meter-high impoundment height increases the risk of reverse flow into city drains during storm events.

Legal Reference:

- National Disaster Management Act, 2010.
- Punjab Drainage & Irrigation Act.2023
- PEPA 1997 – Section 11 (preventing man-made disasters).

Requirement:

- Installation of non-return valves, pumping systems, and overflow culverts in all major stormwater and wastewater outfalls.
- Integration of early warning systems and urban flood response plans.
- Emergency drawdown infrastructure for dam dewatering during extreme events.

2.4.7 Heritage Site Protection (Kamran Baradari and Others)

Issue: The Kamran Baradari monument lies in close proximity to the proposed impoundment and may face water damage or erosion.

Legal Reference:

- Antiquities Act, 1975 – Section 22 & 23 (preservation of listed sites).
- UNESCO guidelines on managing cultural heritage near hydraulic infrastructure.

Requirement:

- Buffer zone delineation around the Baradari with no intrusive construction or wave action near the foundation.

- Conduct a Heritage Impact Assessment (HIA) and coordinate with DOAM and UNESCO Pakistan.
- Regular geotechnical monitoring and bank protection works near the heritage asset.

2.4.8 Environmental Flow and Ecosystem Preservation

Issue: The dam may reduce flow variability critical for downstream habitats and aquatic biodiversity.

Legal Reference:

- PEPA 1997 – Section 11.
- Pakistan Water Policy, 2018 – Clause on Environmental Flows.
- IUCN guidelines on minimum flow requirements for river health.

Requirement:

- Maintain minimum environmental flow (e-flow) release as part of dam operation strategy.
- Consider seasonal flow fluctuation simulation in the dam's hydraulic design.
- Establish an ecosystem flow monitoring system with adaptive management triggers.

2.4.9 Institutional Responsibilities and Stakeholders

Institutional responsibilities play a critical role in conducting the environmental assessments and recommending mitigation measures. Stakeholders in the EIA process include local communities, who may be impacted by the project through changes in land use, noise, or air quality. These communities will be engaged early in the process to address concerns and ensure that their rights and interests are considered. Engaging these institutions and stakeholders throughout the EIA process helps create a transparent and accountable approach, ensuring the project aligns with both environmental and social sustainability goals.

2.5 Environmental Screening of the Project

The IEE/EIA Regulations, 2022 established the framework for the preparation, submission, and review of the IEE and the EIA. The regulations categorise development projects for IEE and EIA into two schedules (Schedules I and II). Schedule I include projects where the range of environmental issues is comparatively narrow and the issues can be understood and managed through less extensive analysis. Schedule II covers major projects that have the potential to affect a large number of people in addition to generating potentially significant adverse environmental impacts.

In accordance with the Punjab Environmental Protection (Review of Initial Environmental Examination and Environmental Impact Assessment) Regulations, 2022, the project falls under Schedule II, which mandates the preparation of a full Environmental Impact Assessment (EIA). Specifically, under Category E: Water Management, Dams, Irrigation and Flood Protection, and Sub-category 1: Medium and Large Dams and Reservoirs, the proposed Rubber Dams/Weirs and River Training Works qualify as a Schedule II undertaking. Therefore, the EIA must be

submitted to the Punjab Environmental Protection Agency (EPA) for review and approval prior to the commencement of any physical works. See Annex-1.

3 Project Description

3.1 Location and Site Layout of the Project

The proposed project falls under administrative jurisdiction of the District Lahore and District Sheikhupura of Punjab Province. The primary objective of the River Training and Channelization and Flood Control Infrastructure from SL-4 to Railway bridge is to protect the Ravi River front from extreme flood events, specifically those associated with a 1,000-year ARI and to improve the quality of river. The channelization is designed to safely convey such high-magnitude floodwaters, minimizing the risk of inundation, erosion, and damage to surrounding infrastructure, agricultural lands, and future urban development areas under the RUDA jurisdiction. In addition to flood protection, the project has been intendeds to maintain the ecological and hydrological character of the Ravi River by preserving its identity as a freshwater body. The channel will have the capacity and flow characteristics necessary to sustain aquatic life, support groundwater recharge, and enable year-round water retention in selected reaches through the construction of Rubber Dams/Weirs. These interventions will also contribute to environmental rehabilitation, recreational potential, and sustainable urban planning in the wider Ravi Riverfront area. This project includes two Rubber Dams/Weirs from Railway Bridge to M-2 Motorway. An overview of project area is shown in **Error! Reference source not found..**

3.2 Project Components

The proposed project components include large-scale Earthworks for flood mitigation and River Channelization with bed width upto 1 km, Retaining wall along the banks of river, River promenade, and 2 water reservoirs structures i-e Rubber Dam/Weir.

3.3 Road Accessibility

The proposed Weir/Rubber Dam 02, located just downstream of Saggian Bridge, enjoys convenient access via Saggian Interchange from the M-2 Motorway and adjacent northern Lahore avenues such as Shahdara, facilitating efficient mobilization of construction crews and heavy machinery. Meanwhile, Weir/Rubber Dam 03 can be reached by exiting the M-2 Motorway at the Babu Sabu Toll Plaza, then following Take Heavens Road towards the river site.

3.4 Construction and Operation Activities

The construction phase of river training works and Rubber Dams/Weir will involve intensive physical activities such as excavation, embankment construction, concreting, diversion of river flow, and installation of hydraulic structures, which can lead to habitat disruption, increased sedimentation, noise, water pollution, and temporary disturbance to local wildlife and communities.

The operational phase begins once the structures are functional, aiming to regulate river flow, water recharge, control flooding, and support irrigation or navigation; however, it can cause changes in habitats and these habitats will be new developments which will act as ecological habitats and enhanced ecological interactions.

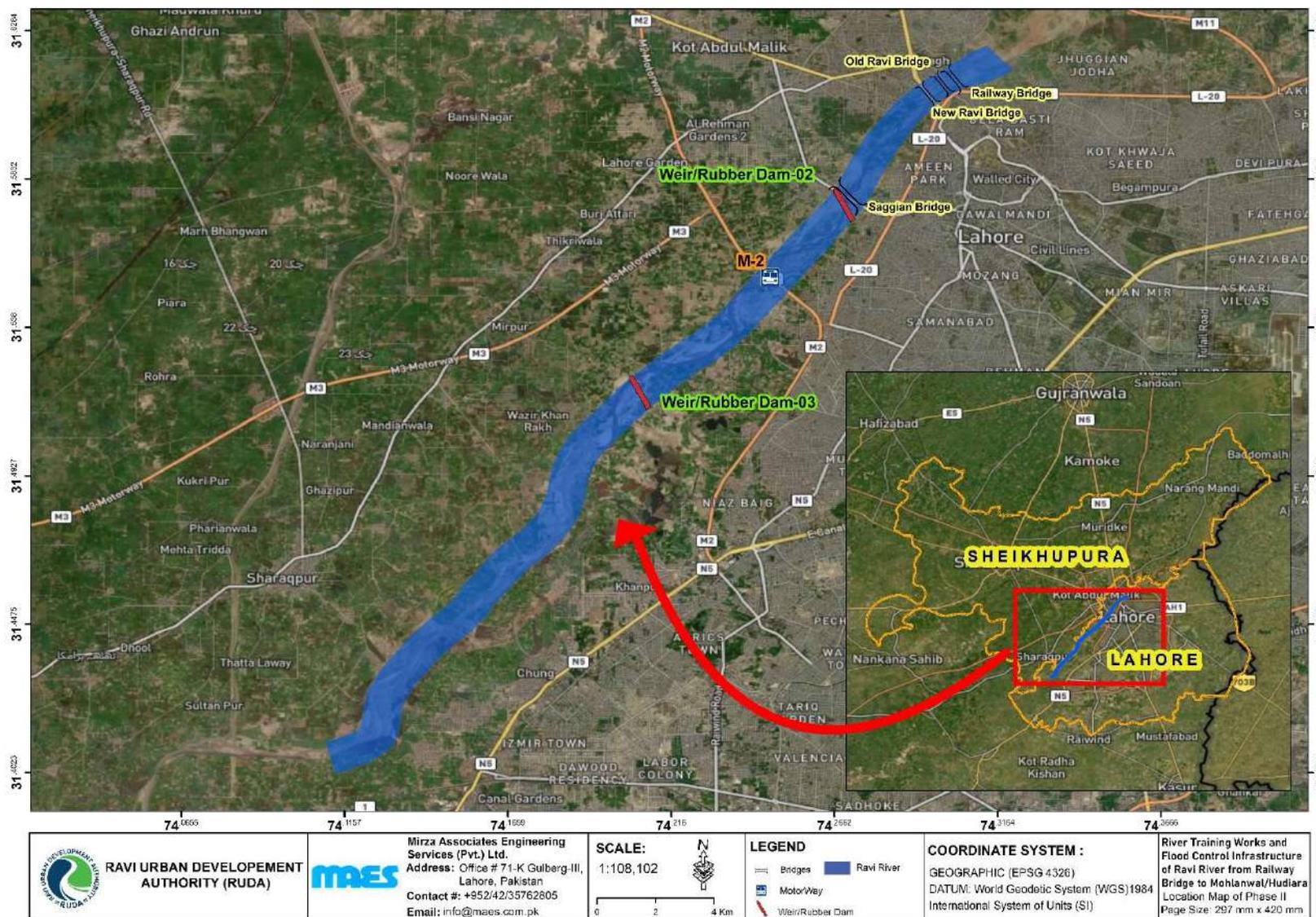


Figure 3-1 Overview of the Project Site

3.5 Construction of Rubber Dams/Weirs

The Rubber Dams/Weirs are proposed from the New Ravi Bridge to downstream of the M-2 Motorway Bridge and are intended to create controlled water reservoirs for aesthetic, recreational, and groundwater recharge purposes. Riverbank protection and stabilization works to prevent erosion, flooding, and damage to nearby infrastructure. Measures are adopted to reduce chances for back flow of water in river from Rubber Dams/Weirs in high flood period.

Furthermore, the design must incorporate a robust sediment flushing mechanism, as the Ravi River carries a significant sediment load coming from sewerage drains during monsoon seasons. Lack of sediment management would result in silt accumulation behind the Rubber Dams/Weirs, reducing storage capacity and impacting dam performance over time.

Special attention must also be given to the protection and conservation of Kamran Baradari, culturally significant site located within the alignment of the riverbank due to natural meandering of river and scouring which takes away the land and damages the land and structures. The hydraulic design and inundation modelling will ensure that Kamran Baradari remains structurally safe.

Analysis of Alternatives

3.5.1 Site Selection Criteria

The analysis of alternatives is a critical part of the EIA process. It ensures that project planning considers various viable options and selects the most environmentally sustainable, socially acceptable, and technically feasible alternative. This approach supports environmental conservation, minimizes socio-economic disruption, and promotes informed, sustainable development.

For the proposed River Training Works and Rubber Dams/Weirs, the selection of project sites and alignment was based on a detailed assessment of alternative locations and engineering layouts. The evaluation combined strategic-level screening with site-specific feasibility studies, aiming to reduce environmental degradation and social conflict while ensuring engineering viability and cost-effectiveness.

3.5.2 Location Alternatives

The identification of suitable locations for river training and flood control infrastructure involved a multi-disciplinary committee comprising experts from hydrology, civil engineering, environmental scientist, and social planning. The committee assessed multiple options using the following criteria:

Land Ownership and Legal Status

- Preference was given to government-owned or non-encroached lands to avoid delays, legal disputes, or increased compensation costs.
- The selected locations are primarily on government-controlled riverine and riparian zones, avoiding displacement of private landowners.

Environmental and Ecological Sensitivity

- Alternatives were evaluated for the presence of sensitive ecosystems such as wetlands, aquatic habitats, migratory bird zones, and protected areas.
- The selected alignments avoid ecologically sensitive areas and are located in regions with disturbed habitats or modified landscapes, reducing ecological risk.

Proximity to Human Settlements

- Locations close to densely populated communities were excluded to minimize health risks, noise, and disruption from construction and flood diversion operations.
- The final design ensures buffer distances from residential clusters, reducing social impacts and enhancing safety. The river bed is encroached and flooded as the settlements are in the route and are posed to face floods particularly in the monsoon season.

Social Impacts and Displacement

- A key criterion was avoiding physical or economic displacement of local populations.
- The proposed sites do not require relocation of households or loss of livelihoods, significantly reducing the project's social footprint.

Hydrological and Engineering Feasibility

- River morphology, sedimentation patterns, topography, and hydrological dynamics were analyzed to ensure long-term structural stability and flood management efficiency.
- The selected sites offer optimal flow regulation potential with minimal need for major channel realignments or embankment reinforcements.

Integration with Existing Infrastructure

- The alignment considers existing roads, irrigation systems, and drainage networks to minimize infrastructure conflicts.
- Locations were chosen to complement existing flood protection structures and improve connectivity to surrounding communities.

Cost Considerations

- Financial feasibility was evaluated by comparing construction costs, land needs, material transport distances, and potential compensation or mitigation expenses.
- The selected option presents the most cost-effective and operationally viable solution.

3.5.3 Technology Alternatives

River training works and Rubber Dams/Weirs, multiple engineering approaches were considered, including:

- Conventional Earthen Embankments

- Concrete-lined Floodwalls
- Rock Riprap Revetments
- Gabion Structures
- Spur Dikes and Guide Banks

After technical and environmental evaluation, a hybrid approach was selected. This combines concrete and earthen embankments, riprap protection in high-velocity zones, and energy dissipation structures at the Rubber Dams/Weirs to improve hydraulic performance while minimizing environmental impact.

This approach balances structural integrity, cost-efficiency, and ecological safety. Advanced sediment control and flow regulation features will also be incorporated to ensure long-term resilience against climate variability and extreme flood events.

3.5.4 Conclusion of Alternatives Analysis

The alternatives analysis concluded that the selected sites and engineering design for the river training works and Rubber Dams/Weirs represent the optimal balance of environmental sustainability, social responsibility, technical soundness, and economic feasibility. The project avoids resettlement, minimizes ecological disruption, and aligns with the broader objectives of integrated river basin management and flood resilience.

Future enhancements or extensions will continue to apply these principles, ensuring adaptive management in response to evolving environmental and social contexts.

3.6 Discussion on Ravi River Cross Sections

The cross section of the Ravi River illustrates the natural and engineered profile of the river channel, including the width, depth, and side slopes, as well as the positioning of Rubber Dams/Weirs and associated infrastructure. It typically features a trapezoidal or compound shape, with variations in bed levels and embankment heights on both banks to manage flood flows and sediment transport. The design accommodates seasonal flow fluctuations and integrates flood protection measures such as levees, retaining walls, and side drains. Additionally, the cross-section accounts for hydraulic requirements, safe flow conveyance, and accessibility for maintenance and monitoring.

3.6.1 Embankment Design and Symmetry

All three cross sections exhibit a symmetrical layout with reinforced earthen embankments on both riverbanks See Figure 3-7. The embankments have a typical width of approximately 32 meters on each side, with mild side slopes for slope stability. These structures are essential for controlling floodwaters, defining the flow corridor, and supporting the adjacent promenade and access roads.

3.6.2 Structural Features

At RD 51+000, the section includes a central river channel flanked by retaining walls and stone pitching. The channel appears to be relatively narrow, with structural protection provided on both banks to prevent scouring and erosion.

At RD 54+000, the section introduces a more complex geometry, incorporating twin box culverts or structural channels in the middle, supported by embankments on both sides. This configuration likely reflects an area of greater hydraulic load or critical flow transition where energy dissipation or sediment flushing might be required.

At RD 57+000, the cross section includes multiple embedded box channels, perhaps for sediment management or to regulate discharge volumes across different flow conditions. The extended width and number of structures indicate a high-capacity reach or potential location of Rubber Dam/Weir.

Figure 3-8 illustrates the river profile and engineered embankments at RD 60+000 to RD 89+000. These sections form part of the broader river training works and Rubber Dams/Weirs installation strategy aimed at regulating water flow, preventing erosion, and transforming the Ravi corridor into a sustainable and aesthetically improved urban water body.

Each of the three cross sections reflects a consistent and standardized profile, suggesting a stable reach of the river within these chainages. The river channel width is maintained at approximately 100 meters, flanked on both sides by 32-meter-wide embankments, with retaining walls, revetments, and stone pitching for slope protection.

The cross-sectional designs from RD 69+000 to RD 75+000 shown in Figure 3-9 reflect a standardized and engineered river profile with consistent channel geometry and protective embankments. Each section shows a 300-foot-wide river channel, flanked symmetrically by 32-meter-wide earthen embankments on both sides. These embankments are reinforced with retaining walls, stone revetments, and paved shoulders, indicating attention to slope stability and erosion control. The uniformity of design supports controlled water flow, facilitates sediment transport, and ensures compatibility with landscaping and riverfront urban development objectives, while also offering pathways for access and maintenance.

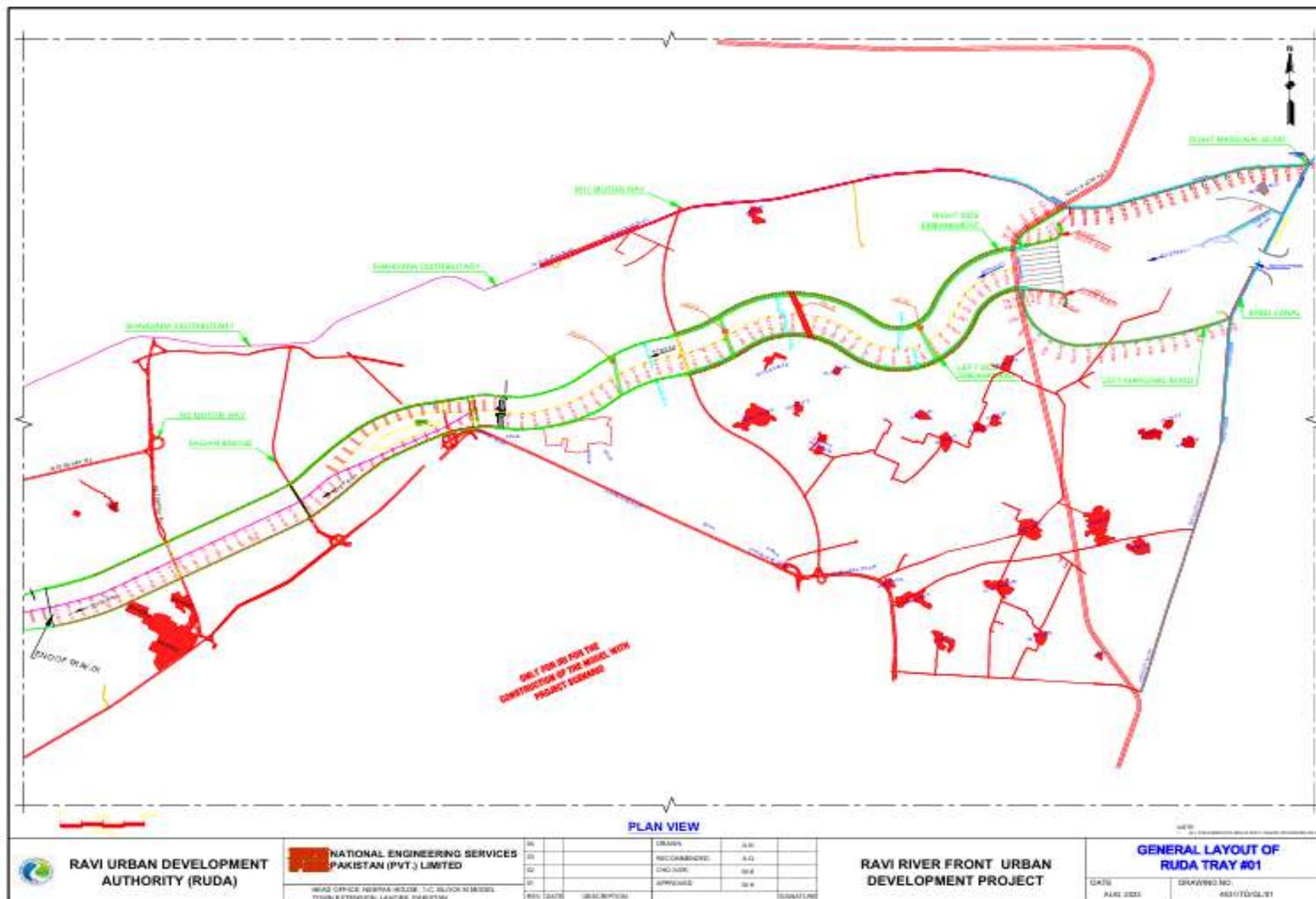


Figure 3-2 River Channel Profile for Phase-II

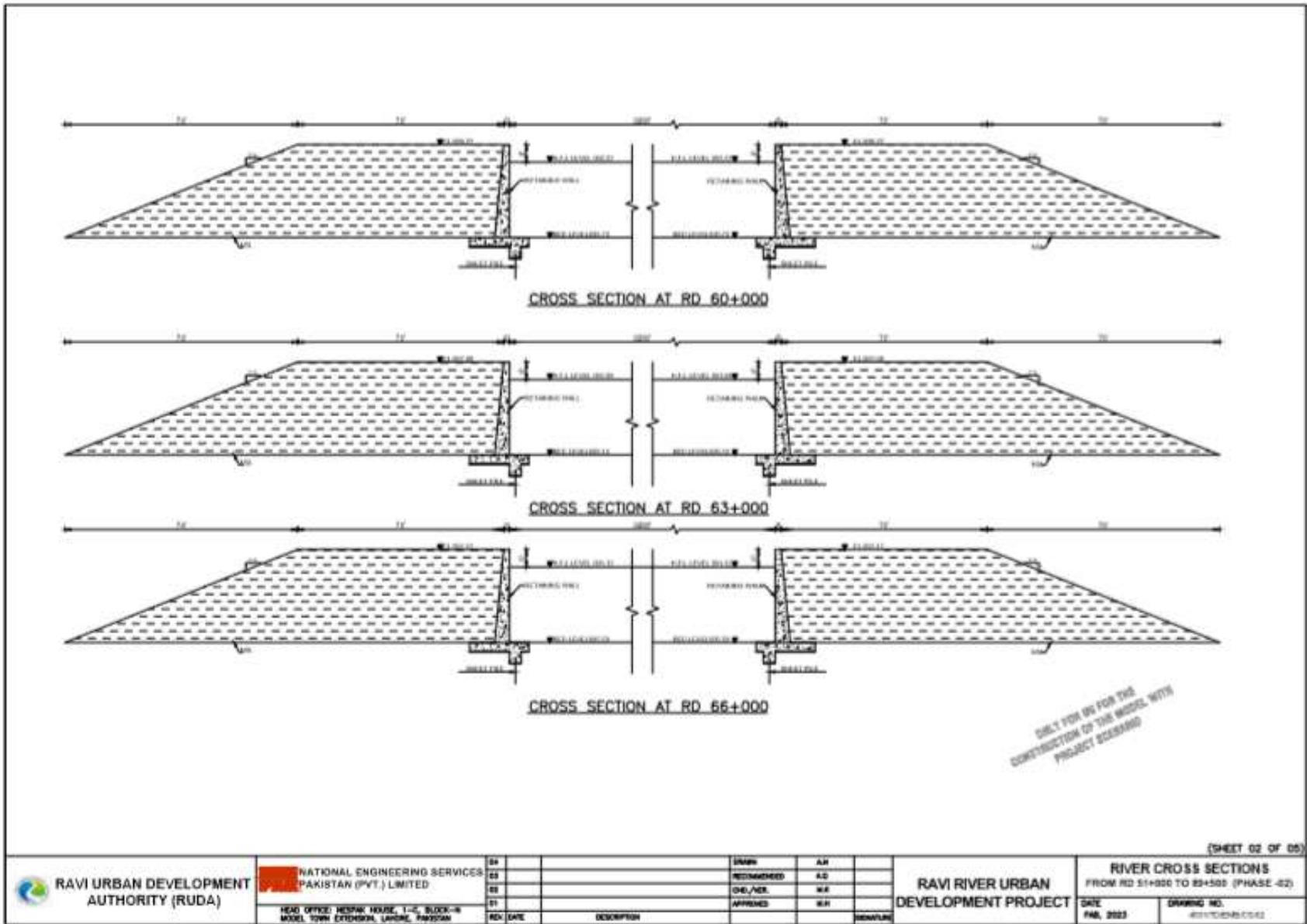


Figure 3-3 Embankment Design and Symmetry RD 60+000- 66+000

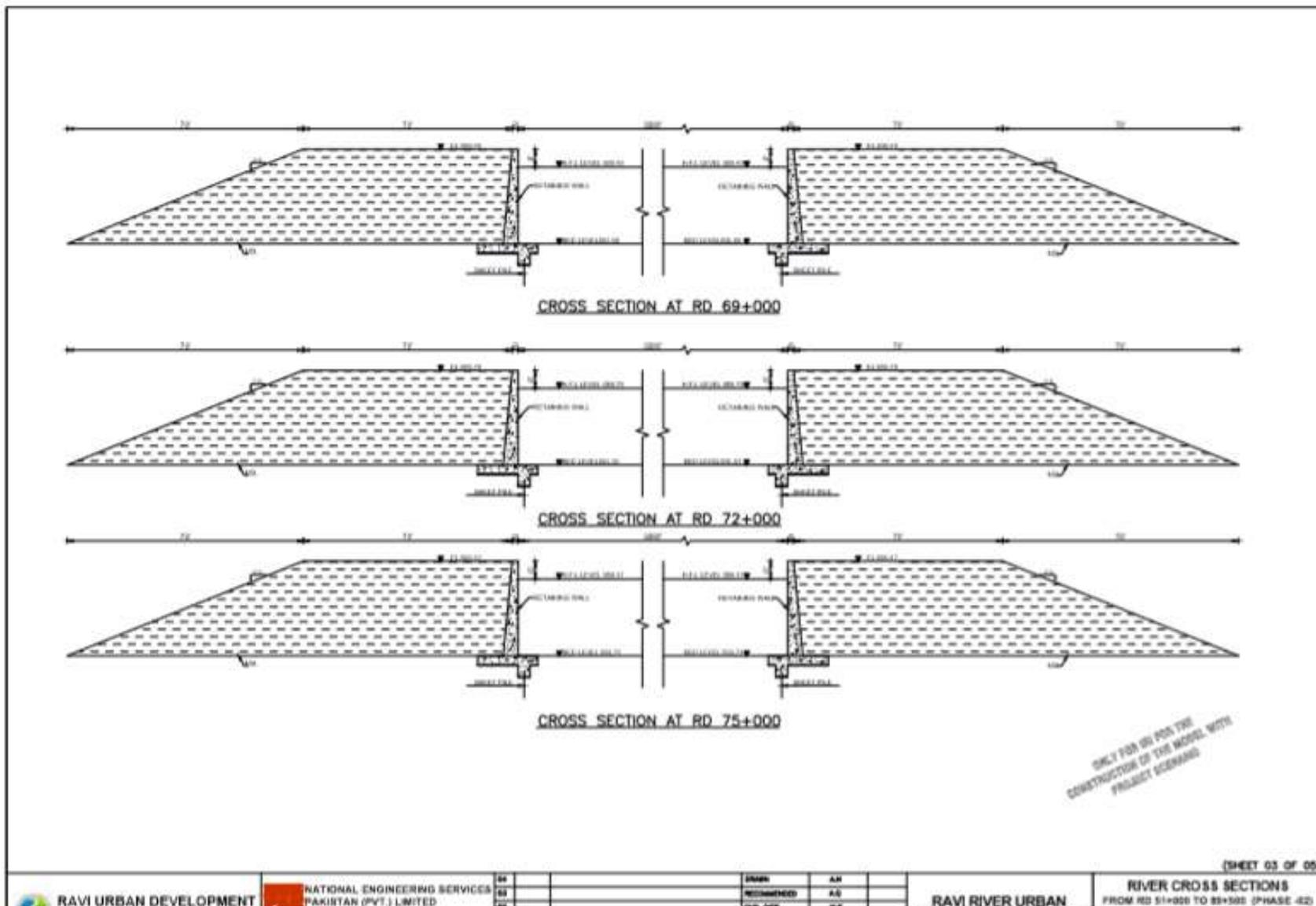


Figure 3-4 Embankment Design and Symmetry RD 69+000- 75+000

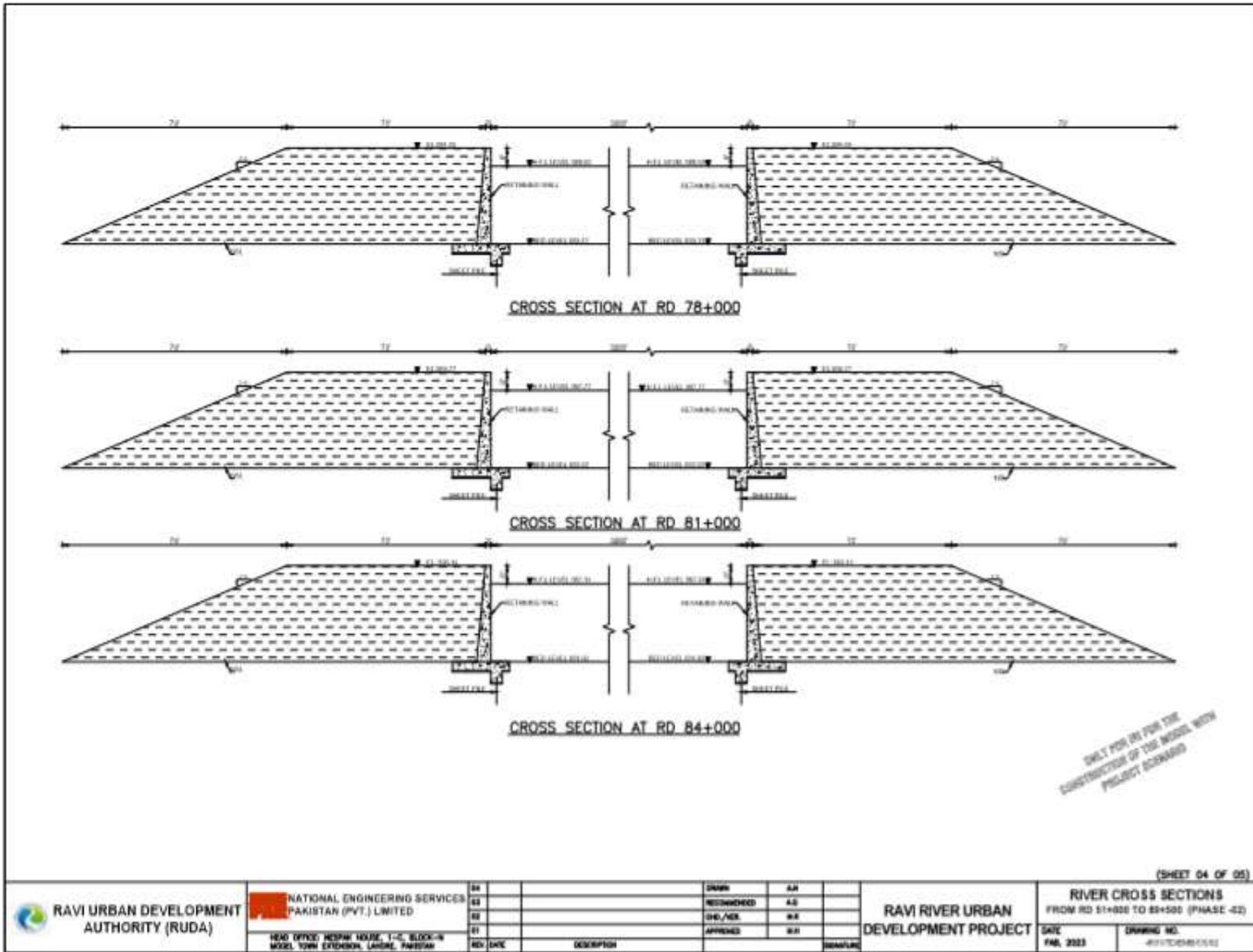


Figure 3-5 Embankment Design and Symmetry RD 78+000- 84+000

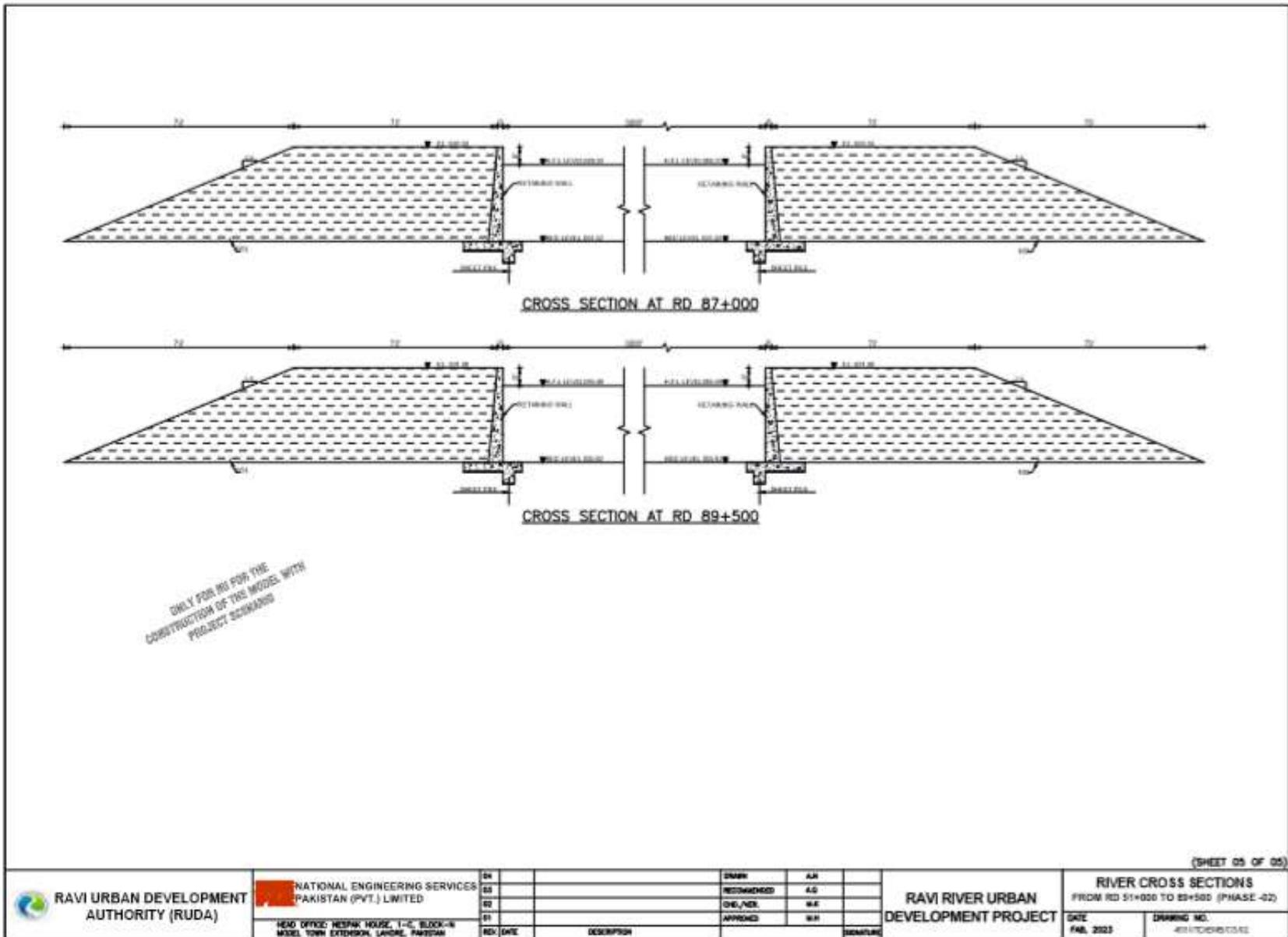


Figure 3-6 Embankment Design and Symmetry RD 87+000- 89+000

3.6.3 Slope Protection and Riverbed Treatment

The embankment slopes are protected using stone pitching, indicating consideration for erosion control during both low and high-flow events. This is particularly important in an alluvial river like the Ravi, where unprotected slopes could erode rapidly during monsoonal flooding.

3.6.4 Functional Integration

These cross sections reflect the integration of hydraulic functionality with urban development goals. The wide embankments and structured flow paths ensure hydraulic safety, while also accommodating future landscaping, pedestrian zones, or vehicular pathways as part of the riverfront transformation.

3.6.5 Considerations for Sediment and Flow Management

The inclusion of multiple channels and structural reinforcement suggests that sediment transport, energy dissipation, and water level regulation have been incorporated into the design. These are crucial to ensure long-term functionality of Rubber Dams/Weirs and to avoid siltation and backwater effects near sensitive areas such as Kamran Baradari.

3.7 Basic Criteria for Weir/ Rubber Dam/Weirs

The Rubber Dams/Weirs and appurtenant structures will be designed on the basis of standard design criteria established for other Rubber Dams/Weirs and allied structures, already constructed on the Ravi River. Basically, the design criteria given in the following sections in general will follow the design principles practiced for the design of existing Rubber Dams/Weirs founded on permeable bed of Ravi and other rivers.

3.8 Design Return Period

A return period of 100 years is generally adopted in the design of important and costly Rubber Dams/Weirs structures where possible consequences of failure are very serious. Accordingly, the estimation of design flood has been carried out for various return periods of 100 years, 200, 500 and 1000 years as desired by Client. However, the actual recorded peak flood discharge has been reviewed for design as it exceeds the discharge calculated for the concerned return period of 100 years. The discharge of 586,000 cusecs has been used as per HECRAS Model and historical discharge observed during past years which is very near to 1000 years return period.

3.9 Existing Bridges and Proposed Extensions

A detailed assessment of existing bridge structures along the project corridor has been carried out to evaluate their hydraulic, structural, and operational adequacy in relation to the proposed river training and flood management works. The study also covers six key bridges spanning the Ravi River and its associated channels, namely the Lahore–Sialkot Motorway Bridge, Railway Bridge, Old Ravi Bridge, New Ravi Bridge, Saggian Bridge, and M-2 Motorway Bridge. The salient features of these bridges and their proposed extensions are summarized below.

3.9.1 Existing Conditions

Each of the six bridges currently provides essential connectivity between major transport routes and urban centers across the Ravi River. The levels of these bridges range from 696.67 ft (M-2 Motorway Bridge) to 711.20 ft (Lahore–Sialkot Motorway Bridge), while the top deck slab elevations vary between 704.20 ft and 721.48 ft, ensuring sufficient hydraulic clearance under normal flow conditions.

The number of spans across these bridges ranges from 12 to 18, with clear span widths varying between 89.50 ft (Railway Bridge) and 138.00 ft (Lahore–Sialkot Motorway Bridge). The pier widths are relatively modest—ranging from 3.40 ft at the Old Ravi Bridge to 8.00 ft at the Railway Bridge—indicating differences in design approaches and load requirements depending on bridge type and traffic function.

Existing bridge lengths currently extend between 1,454.50 ft and 2,595.52 ft, reflecting differences in river width and channel morphology along each crossing. Despite their adequate design for existing conditions, hydraulic modeling and flood risk assessments indicate the need for additional capacity to accommodate higher design discharges and to improve flow efficiency during flood events.

3.9.2 Proposed Extensions

To enhance flood conveyance and structural resilience, bridge extensions are proposed for each crossing. The extensions are designed to maintain uniformity in total length across all bridges, achieving a total proposed length of approximately 3,280 ft per bridge. Current flood passed through Shahdara of 2,19,000 Cusecs capacity and did not damage any of these structures.

The proposed extensions will be achieved through the construction of additional bays at each bridge, with the number of added spans determined by site-specific hydraulic requirements and structural feasibility:

- Lahore–Sialkot Motorway Bridge: 6 additional bays
- Railway Bridge: 19 additional bays
- Old Ravi Bridge: 19 additional bays
- New Ravi Bridge: 13 additional bays
- Suggian Bridge: 9 additional bays
- M-2 Motorway Bridge: 8 additional bays

These extensions will significantly increase the total flow-carrying capacity of each bridge, reduce upstream water levels during flood peaks, and minimize pressure on bridge foundations. Structural design will conform to national and international standards, ensuring durability, seismic stability, and load-bearing capacity suitable for future traffic demands.

3.9.3 Engineering and Environmental Considerations

The proposed bridge extensions have been planned in conjunction with river training and channel improvement works to maintain hydraulic efficiency and ecological balance. During design, care has been taken to ensure that:

-
- Bridge soffit levels align with the proposed high flood levels;
 - Pier spacing minimizes flow obstruction and sediment deposition;
 - Foundation works do not adversely impact riverbank stability or aquatic habitats;
 - Construction activities incorporate best practices to control siltation, noise, and vibration.

Environmental management and monitoring measures will be integrated into the construction plan to mitigate temporary impacts on water quality, river ecology, and nearby settlements.

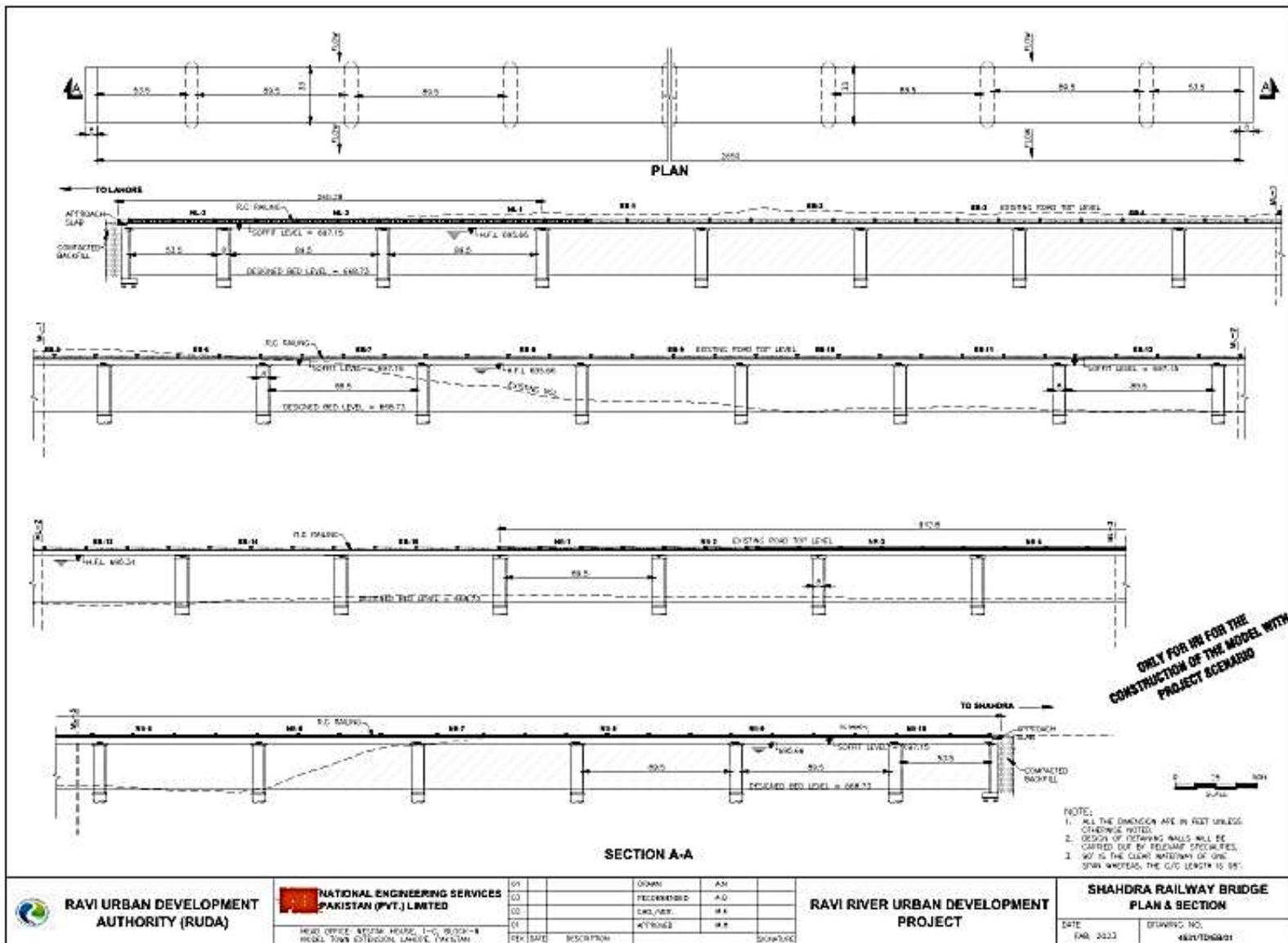


Figure 3-7 Railway Bridge Plan and Section

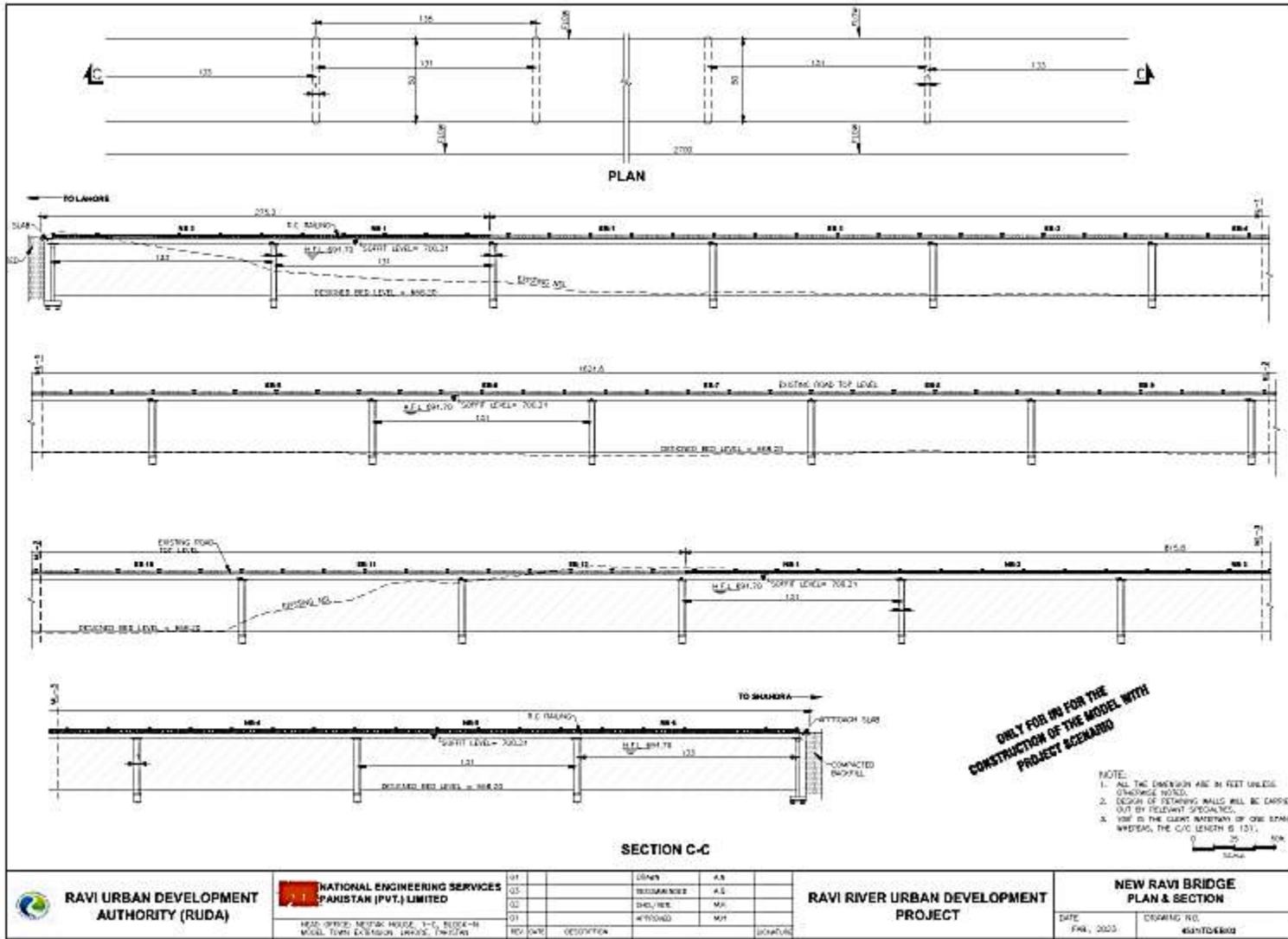


Figure 3-9 New Ravi Bridge Plan and Section

3.10 Ecological Water Flows

When sufficient water is naturally available in the Ravi River, there is no issue in fulfilling the freshening and ecological flow requirements of the proposed lake. However, during periods when the demand exceeds the available river flow, alternative options such as diverting water from other rivers or sources need to be explored. Raising the water level in the river through a gated or regulating structure will increase the flow depth and reduce flow velocity, which directly influences the freshening process. While such interventions improve flow conditions, they may also deteriorate water quality, especially during low-flow periods. Key concerns include the quality of incoming water—particularly its Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD)—as well as the biological load added along the river course and the in-stream processes that affect water health. As per USEPA (1985), a minimum DO concentration of 3–5 mg/l is essential to support aquatic life, whereas Pakistan’s National Conservation Strategy (NCS) recommends a DO level of at least 4 mg/l for ecological preservation. The minimum ecological flow needed to maintain the lake’s freshness depends on seasonal variation and operating water levels, with initial estimates suggesting around 300 cusecs, accounting for evaporation and seepage losses. These losses are illustrated in Figure 3.4 across different months. Flow analysis for the driest periods from October to May indicates that additional inflows ranging from 100 to 450 cusecs may be necessary during these months. However, a more conservative analysis based on the 90th percentile flow availability suggests that natural river flows should be adequate to meet ecological and operational demands throughout the year without requiring supplemental inputs.

The required ecological and freshening flow for the lake in Phase 2 can be provided through the upstream Rubber Dam/Weir constructed under Phase 1 and similarly the effect passes on to phase III. Flow Provision Mechanism via Upstream Rubber Dam/Weir (Phase 1) is described hereunder:

- **Controlled Releases:** The Rubber Dam/Weir in Phase 1 can regulate water levels and release controlled flows downstream to ensure a consistent supply of fresh water to the downstream lake area, especially during dry months (October to May).
- **Storage and Regulation:** The Rubber Dam/Weir acts as a regulating structure, storing water during high-flow periods (monsoon months) and gradually releasing it during low-flow seasons to maintain the minimum ecological flow (estimated 300–450 cusecs) required for lake freshness, dilution of pollutants, and sustaining aquatic life.
- **Operational Coordination:** A real-time operational plan can be developed that considers:
 - Seasonal flow variability in the Ravi River.
 - Forecasted demand and evaporation/seepage losses downstream.
 - Available storage upstream. This ensures efficient release scheduling from the Phase 1 Rubber Dam/Weir.
- **Monitoring and Adaptive Management:** Water quality and flow gauges downstream of the Rubber Dam/Weir will help in tracking flow adequacy and water quality parameters (DO, BOD). If flows fall below threshold levels, additional releases can be triggered promptly.

- Connectivity Channel: A properly designed conveyance channel or river reach between the Rubber Dams/Weirs and the lake must be maintained and periodically desilted to ensure uninterrupted flow delivery.

In summary, the upstream Rubber Dam/Weir in Phase 1 serves as a feasible and strategic source for ensuring continuous and controlled water supply to maintain the environmental health of the downstream lake system.

3.11 Upstream Flow Provision and Protection

The Phase 2 project area lies downstream of the Rubber Dam/Weir constructed under Phase-I. This upstream Rubber Dam/Weir serves as a critical control point for regulating flows into the Phase-II reach of the Ravi River and providing/regulating water downstream. To ensure consistent environmental and operational flows for the lakes and channelized sections—particularly during low-flow months, controlled releases from the Phase-I Rubber Dam/Weir will be utilized. These regulated flows will help maintain ecological balance, support aquatic life, and ensure water quality standards by meeting the freshening flow requirements. Furthermore, since the downstream channelization and development may alter hydraulic conditions, the presence of the Phase-I Rubber Dam/Weir upstream provides an opportunity for active flood management and upstream flow moderation. In case of high river discharge or flood events, coordinated operation of the upstream Rubber Dam/Weir will help mitigate risks by adjusting inflow rates downstream, thereby providing both flow security during dry periods and flood protection during peak flows.

3.12 Description of Works

3.12.1 Channelization & restructuring of Ravi River

The Ravi River will be channelized with the width of about 1 km (1000m) for a length of 14 km in first Phase. The bed will be raised about 9 meters. The path and specific length of channelization is shown in Master Plan **Error! Reference source not found.** while the cross-sectional view of the river is shown in

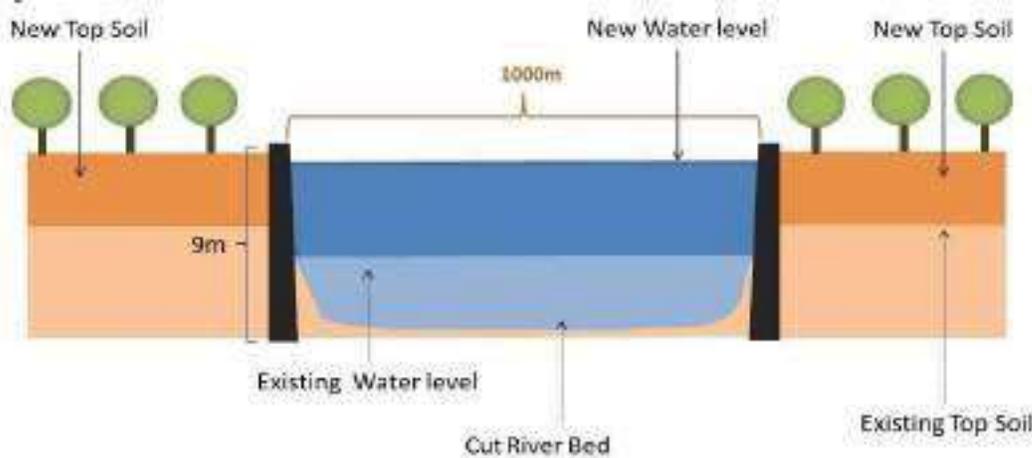


Figure 3-8.

Figure 3-10 Proposed New Cross section

3.12.1.1 Design Parameters for River Training & Channelization Works

The design flood used for river training work and estimation of Rubber Dam/Weir/control structures is considered as 5,86,000 cusecs as the flood above 500,000 cusecs was already witnessed twice in 89 years in 1988 and 1955. Detailed analysis for the Phase -I was carried out to determine the width and depth of the channel. The width of the channel is 3280.84 ft (1000 m) with wall height of 33 ft including free board.

3.12.1.2 Temporary Storage Water Requirement

The ultimate goal to carry out river channelization is to make a perennial water body with temporary storage /detention that will flow throughout the year. Once this temporary storage is filled, the outflows that would be kept equal to inflows. The maximum temporary storage is estimated to be about 0.22-million-acre feet (MAF) with 1000 m wide.

3.12.2 Civil and Hydraulic Structures

The proposed river training and Rubber Dam/Weir works will include:

- River embankments (earthen and concrete)
- Rubber Dam/Weir gates and piers
- Energy dissipation structures (stilling basins, baffle blocks)
- Diversion channels
- Protection works (riprap, gabions)
- Flood monitoring and early warning systems
- Access and service roads

3.12.3 Construction Requirements

Construction activities will involve:

Site Preparation and Earthworks: Clearing, grading, excavation, and backfilling along riverbanks and proposed alignment.

Structural Construction: Foundation laying, concrete works for Rubber Dam/Weir and floodwalls, and mechanical systems, MSE walls, promenades development with roads.

Material Handling: Transport and stockpiling of aggregates, boulders, concrete materials, and steel reinforcement.

Machinery and Equipment: Use of excavators, cranes, dumpers, batching plants, and dewatering systems.

Safety and Compliance: Adherence to occupational health, environmental regulations, and safety protocols.

Support Infrastructure: Construction of access roads, fencing, drainage systems, and site camps.

Water Requirement: For the River Training Works and construction of two Rubber Dams/Weirs, approximately 4 to 5 million gallons of groundwater are expected to be used during the construction phase. This includes water for concrete mixing, dust suppression, soil compaction, equipment washing, and sanitation facilities for workers. Efforts will be made to optimize water use through recycling where feasible (e.g., reusing concrete wash water) and by adopting efficient construction practices to minimize wastage. Groundwater abstraction will be monitored to avoid over-extraction and ensure compliance with relevant environmental and regulatory limits.

Electricity Requirement: Power will be supplied via generators and, where feasible, connection to the local LESCO grid.

3.12.4 Construction and Quarry Materials

Extensive quantities of construction materials will be required to support the development of the proposed project, particularly for civil works such as channelization, Rubber Dams/Weirs, embankments, roads, and associated infrastructure. The primary materials include coarse and fine aggregates for concrete works, sandy gravel or other free-draining materials for backfilling and embankment raising, cement for structural integrity, reinforcement steel for durability and strength, and bitumen for road surfacing. Additional items such as kerb stones, masonry blocks, geotextiles, and other construction components will also be utilized as per the design specifications. To minimize environmental impacts and comply with regulatory standards, no new quarries will be established for this project; instead, all required materials will be sourced from licensed and operational existing quarries and approved suppliers. This approach will help reduce the ecological footprint, avoid additional land degradation, and ensure responsible material procurement. The sourcing, transportation, and storage of these materials will be carefully managed to avoid dust emissions, traffic disruptions, and any adverse effects on local communities or habitats.

3.12.5 Manpower Requirements

The exact number of workers for the project at different phases including channelization, Rubber Dams/Weirs, embankments, roadworks, and associated infrastructure will be provided by the contractor on the basis of the scale, duration, and construction methodology. However, based on similar infrastructure projects, the following can serve as a general estimate:

- Skilled Labour (Engineers, Surveyors, Technicians, Supervisors, Safety Officers): Approx. 100–150 personnel over the course of the project.
- Unskilled/Semi-skilled Labour (Masons, Carpenters, Welders, Drivers, Helpers, Labourers): Approx. 400–600 workers, depending on construction intensity and work scheduling.
- Total Estimated Workers On-Site at Peak Construction: 500 to 750 workers

The number may vary seasonally and with the phasing of activities (e.g., civil works, mechanical installation, road construction). This estimate includes direct labour only and does not account for indirect employment (e.g., supply chain, transportation, food vendors).

A portion of the workforce may be locally hired, while the rest may come from outside the area, especially for skilled roles.

Table 3-1 List of Required Labours

Sr. #	Phase/Activity	Skilled Workers	Unskilled/Semi-skilled Workers
1.	Site Preparation & Mobilization (Surveying, fencing, utility relocation, temporary camps setup.)	20–30	50–70
2.	Earthworks & Excavation (Canal excavation, embankment cutting/filling, spoil disposal.)	15–20	100–150
3.	Concrete & Structural Works (Construction of Rubber Dams/Weirs, Rubber Dam/Weir components, retaining walls, etc.)	40–50	120–180
4.	Mechanical/Electromechanical Works (Installation of Rubber Dams/Weirs, control gates, instrumentation.)	30–40	20–30
5.	Road Works & Access Infrastructure (Base course laying, bitumen work, kerb stone fixing, etc.)	20–30	80–100
6.	Ancillary Works (Drainage, Landscaping, Safety Features, Outfall drains, access paths, fencing, signage, plantation, etc.)	15–20	40–60
7.	Demobilization and Site Restoration	10–15	20–30

3.12.5.1 Estimated Peak Workforce

During peak construction (overlapping civil, structural, and road works):

Approximately 500–600 workers will be present on-site. While on average 200-300 will be available at site at most of the times

Local Employment

At least 20-30% of the unskilled/semi-skilled labour is expected to be hired locally if labour come to work, promoting community benefit and social acceptance.

Labour Camps

Temporary labour camps, material storage yards, and utility zones will be established within the project site boundary to avoid external land acquisition and reduce social impact.

3.12.6 Wastewater Generation:

For the proposed project, the total estimated wastewater generation during the construction phase includes both domestic and construction-related sources:

- Domestic wastewater from approximately 150 workers (assuming larger workforce due to the scale of works) is estimated at 337,500 liters per month, based on an average of 75 litres per person per day over 30 days.
- Construction process wastewater, including concrete washout, equipment and vehicle washing, and site drainage, is projected to range from 50,000 to 75,000 litre per month, considering increased scale and activity compared to a single Rubber Dam/Weir project.

Thus, the total monthly wastewater generation is projected to be in the range of approximately 387,500 to 412,500 litres during the peak construction phase of the RTW and Rubber Dams/Weirs components.

3.12.7 Solid Waste Generation:

For the proposed project, the estimated solid waste generation is expected to be approximately 150–200 kg/month, primarily comprising construction debris, packaging materials (e.g., cement bags, plastic wraps), and non-hazardous solid waste from labour camps and site activities. All waste will be segregated at source into recyclable, reusable, and non-recyclable categories and disposed of in accordance with approved waste management protocols, including transportation to licensed disposal or recycling facilities. Regular waste audits and site cleanliness inspections will be conducted to ensure compliance.

3.12.8 Cost and Magnitude of Operation

The total development cost of the river channelization project is estimated as PKR ----- billion.

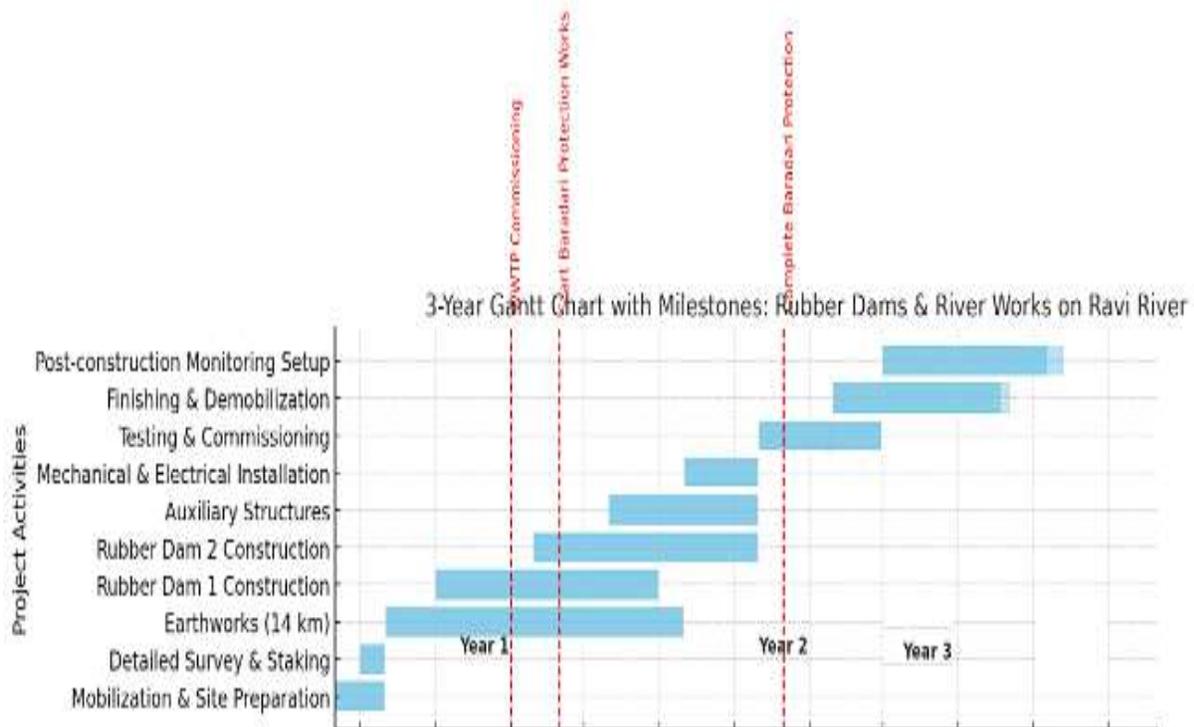
3.12.9 Schedule of Implementation

The total project completion time is estimated 3 years period. The first year focuses on preparatory and major civil works. Key activities include mobilization, detailed topographic surveys, and staking. Full-scale earthworks along the embankment corridor are initiated, involving excavation, filling, compaction, and stabilization. Rubber Dam/Weir 1 construction also begins this year, focusing on civil foundation works and primary structure erection. Coordination with utility service providers and initiation of environmental mitigation actions are part of this phase.

The second year represents peak construction activity. Rubber Dam/Weir 2 construction is also planned. Construction of auxiliary structures like guide bunds, spillways, and energy dissipation structures is underway. Simultaneously, mechanical and electrical installations such as control

systems, hydraulic actuators, and automation for dam inflation/deflation mechanisms are executed. Initial testing and commissioning procedures also begin in the later part of the year.

The third year emphasizes system testing, commissioning, and site rehabilitation. Remaining works such as landscaping, embankment finishing, and demobilization of construction equipment are completed. Post-construction monitoring systems for sedimentation, water quality, dam performance,



and heritage protection are established. Documentation, environmental audits, and stakeholder wrap-up meetings are conducted before handover.

Figure 3-11 Schedule of Implementation

4 Baseline Study

This chapter describes the environmental and social baseline studies intended to establish a data base against which potential impacts can be predicted and managed later. The existing environmental conditions around the proposed project have been considered with respect to physical, biological and socio-economic aspects. Information on these aspects has been derived from the desk study of available data, site visits (conducted to survey the field area and to collect environmental data on physical, biological and socioeconomic parameters) and through detailed consultations with the Government departments and other agencies. Further, interviews were held with the general public and stakeholders of the areas adjacent to the project area in order to seek the public opinion on the implementation of the proposed action. The Major environmental components are:

- Physical Environment
- Ecological Environment
- Socioeconomic Environment

The areas covered under physical resources are; climate, water resources, topography, seismology, geology and soil conditions

4.1 Physical Environment

Physical environmental factors are critical to understanding the context in which the facility operates. These factors include climate, topography, river ecology and surrounding infrastructure, all of which influence the design, construction, and functioning of the RTW & Rubber Dams/Weirs.

4.1.1 Land Use

The land use within a 500-meter buffer of the proposed project alignment reflects a complex mix of residential, institutional, agricultural, recreational, and historically significant zones and not of even use, somewhere is encroached for temporary occupations as the flood recurrence is considered less but the flood will take away all which is lying in the bed and will wash out as the river course is also on changes.

4.1.1.1 Settlements and Built-up Areas

Numerous built-up and semi-urbanized settlements lie within the 500 m buffer zone of the project corridor as shown Figure 4-1. These include:

- Shahdara Bagh and adjoining neighbourhoods (e.g., Karim Park, Islam Pura, and Misri Shah
- Farmhouses and agricultural estates, such as Choudhary Farmhouse, Mian Ayyan Farm, and several dairy farms
- Public and private institutions, including schools, packaging industries, warehouses, and hospitals (e.g., City Government Boys High School, Birdline Hospital, and various food and dairy factories)

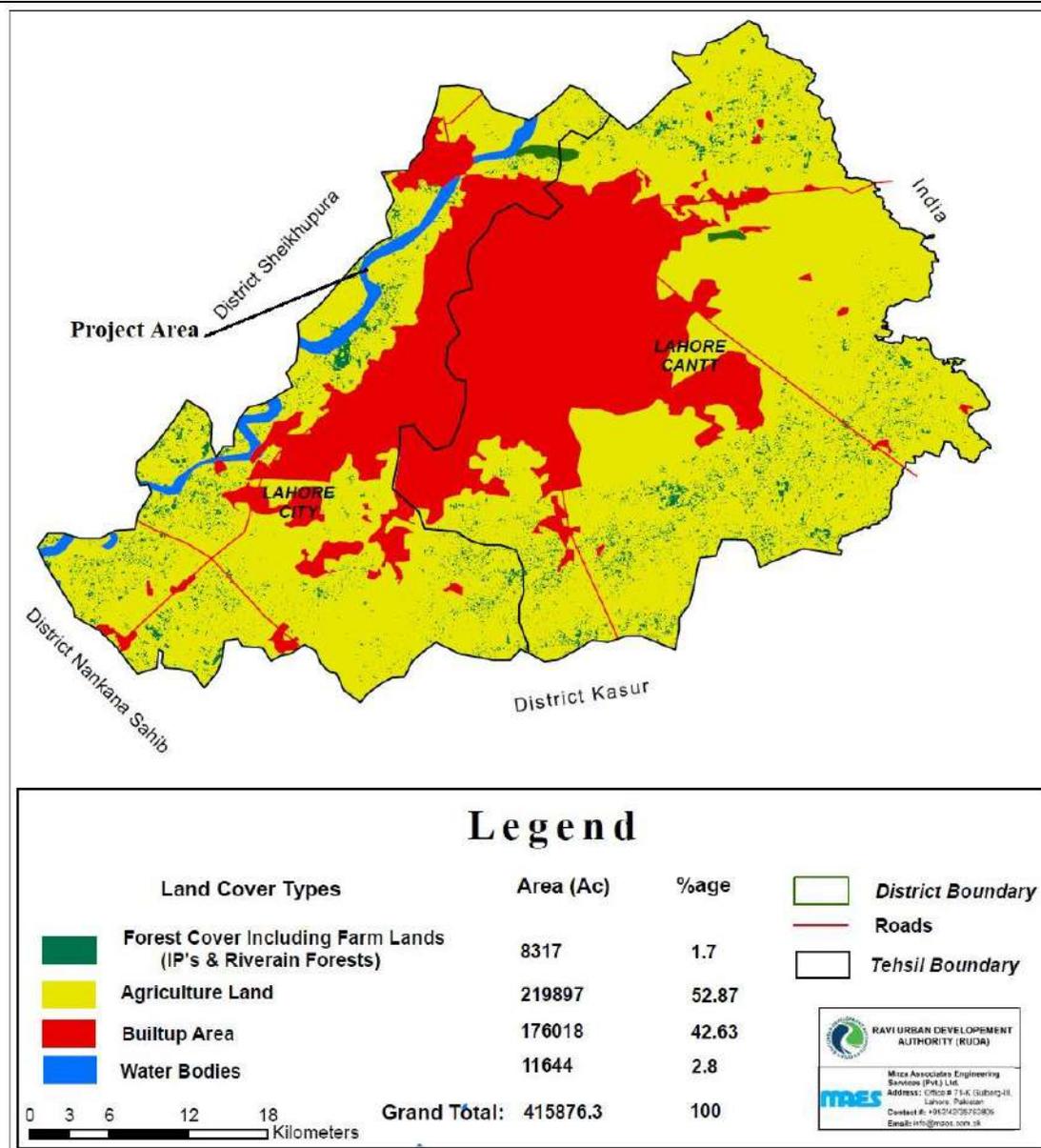


Figure 4-1 Land Use Map for District Lahore and Sheikhupura

The dense distribution of community and commercial establishments indicate a high level of human activity and interaction with the land, which could be sensitive to dust, noise, construction traffic, and land accessibility. Local livelihoods dependent on small industries, farming, and service sectors may experience temporary disruptions during project activities.

4.1.1.2 Agricultural and Open Land

The southern and western flanks of the project corridor are marked by vast agricultural lands, especially near Shahdanwali Forest and Mian Ayyan Farm. These lands support seasonal crop production and dairy operations, and some are used for grazing and informal recreation. The project design should aim to minimize acquisition or disturbance of these lands to preserve local agriculture-based economies.

4.1.1.3 Archaeological and Heritage Sites

The major historical and archaeological landmarks fall within the 500 m influence zone as shown in **Error! Reference source not found.** and are protected under national and provincial heritage laws:

- Kamran Baradari

These sites are of immense historical and architectural importance, attracting both domestic and international visitors. Their proximity to the proposed project infrastructure is considered in the study and design as well and recent floods did not affect them.

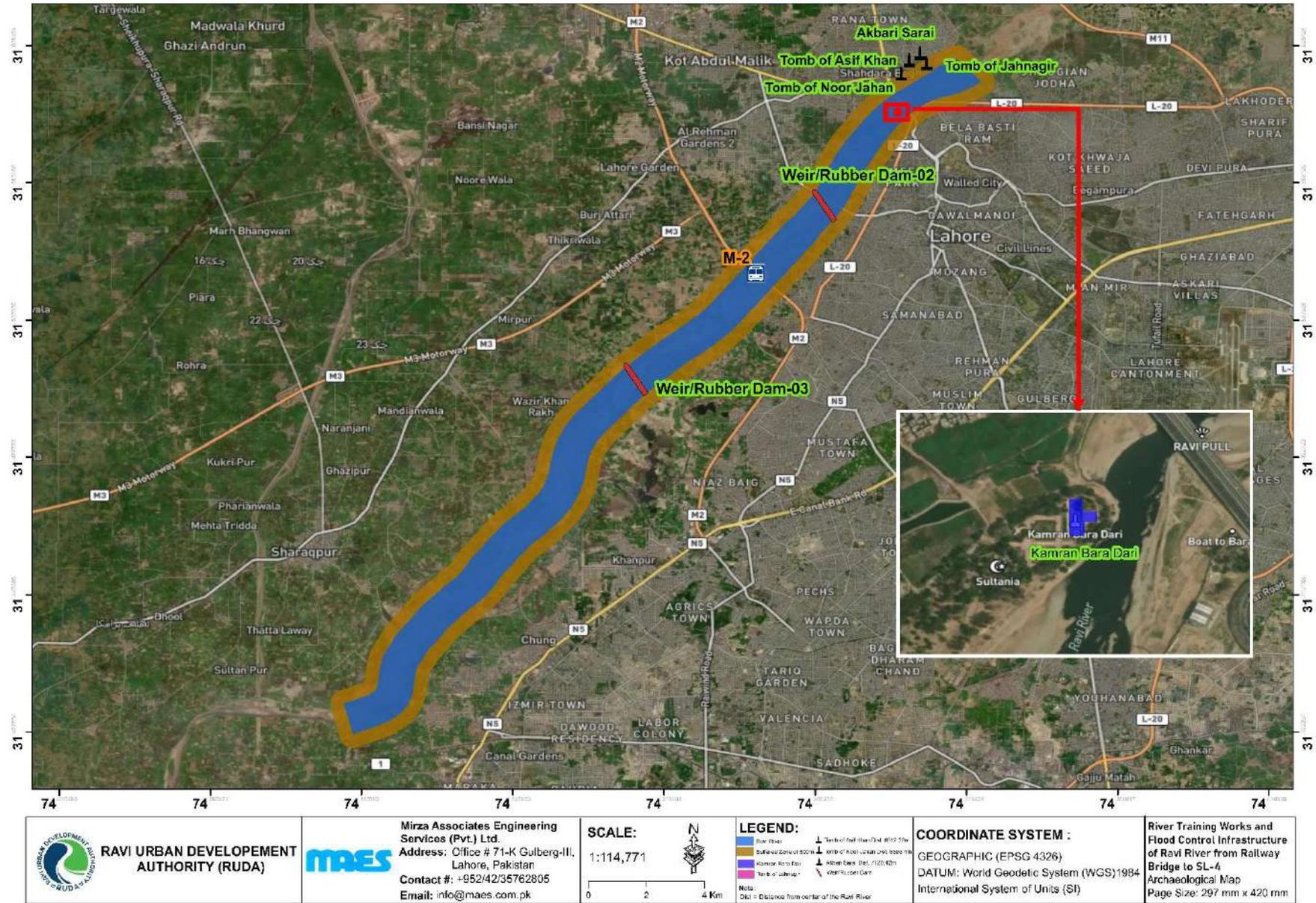


Figure 4-2 Map of Archaeological Sites

4.1.2 Climate

The climate of project site, is consistent with the general climate of Lahore, which is classified as a hot semi-arid climate. Lahore experiences distinct seasonal changes, including hot summers, mild winters, and a monsoon season.

- **Summer (April to June):** Summers in project area are typically extremely hot, with temperatures often soaring above 45°C in June. The city experiences intense heat during this period, with low humidity levels. Climate change effects and 50°
- **Monsoon (July to September):** The monsoon season brings relief from the extreme summer heat. Rainfall in Lahore generally begins in late June or early July and can last until September. The rains are critical for the region's agriculture and have an impact on the city's air quality and temperature levels. The average rainfall during this period is around 200-300 mm (7.8-11.8 inches).
- **Winter (December to February):** Winters are relatively mild, with temperatures dropping to around 5°C to 12°C (41°F to 54°F) at night, but the days are generally warm and pleasant. Fog can be a significant phenomenon during winter mornings, especially in December and January, impacting visibility and air quality.
- **Spring and Autumn:** Spring (March to April) and autumn (October to November) are pleasant with moderate temperatures, ranging from 15°C to 30°C (59°F to 86°F). These seasons are the most comfortable in terms of outdoor activities and environmental conditions.

The climate of Lahore, including the site area, is affected by urbanization, which leads to the urban heat island (UHI) effect, making temperatures in the city center higher than in surrounding rural areas. In recent years, Lahore has also faced intensifying climate-related challenges, notably smog and heat shocks.

- **SMOG:** It is primarily during late October to January, is caused by a combination of vehicular emissions, industrial pollutants, crop burning in neighbouring regions, and stagnant weather conditions. It severely reduces air quality, posing significant health risks such as respiratory and cardiovascular issues.
- **Heat shocks or heatwaves:** It have become more frequent and intense due to urban heat island effects, deforestation, and climate change. These events stress vulnerable populations, increase energy demand, and threaten public health, agriculture, and infrastructure. Climate adaptation and mitigation strategies are increasingly urgent to manage these escalating environmental risks in Lahore.



Figure 4-3 Climate at Saggian Bridge

4.1.3 Geology and Soil

The geology and soil at the project site along the Ravi River, would be understood in the context of the broader region's geological formation and soil types, influenced by the city's historical development, its proximity to the Ravi River, and urbanization.

4.1.3.1 Geology

The geology along the Ravi River, particularly in the areas of Shadbagh, Saggian, and Shahdara, is primarily shaped by the river's alluvial deposits and the underlying tectonic history of the region. The following are the key geological characteristics:

- **Alluvial Deposits:** The region consists predominantly of young alluvial soils, mainly comprising sand, silt, clay, and gravel deposited by the river over thousands of years. These deposits are part of the Indus alluvial plain, a result of long-term fluvial processes.
- **Stratigraphy:** The Quaternary sediments dominate the region's stratigraphy, with thick layers of unconsolidated sand, silt, and clay found near the riverbed. These layers are generally deposited during seasonal flooding events and river channel migration.
- **Lithology:** The lithological composition along the river is mainly unconsolidated sediments, with older Pleistocene deposits found in deeper layers. Surface deposits are constantly eroded and re-deposited by the river's shifting course.
- **Riverbed Composition:** The riverbed consists of gravel and sand, which undergoes periodic rearrangement due to river flow changes, sediment transport, and seasonal flooding. This sedimentation plays a significant role in replenishing the surrounding agricultural land with fertile soil.
- **Tectonic Setting:** The region lies in a relatively stable tectonic environment but is affected by seismic activity from the Himalayan orogenic belt to the north. While the region is not seismically active on a large scale, occasional minor tremors have been recorded due to regional tectonic movements.

- **Erosion and Sedimentation:** The erosion of riverbanks and sedimentation along the river is significant. During high-flow periods, the river erodes its banks, depositing sediments downstream, which contributes to the fertile soil but also leads to riverbank instability.
- **Groundwater Resources:** The region's alluvial aquifers are typically shallow and highly productive, supporting irrigation and groundwater extraction. These aquifers are replenished by the river and seasonal flooding, making the area important for both agricultural and domestic water supply.
- **Seismic Activity:** While the area does not experience frequent earthquakes, minor seismic events can occur due to the tectonic forces from the Himalayan region, which affects the structural integrity of the soil and may influence construction projects..

4.1.3.2 Soil

The soils in the site area of Lahore belong to the Alluvial Soil category, with certain variations in their texture and fertility. The soils in this region are influenced by periodic flooding and sedimentation by the Ravi River. Key characteristics include:

- **Soil Type:** Predominantly alluvial soils, formed by continuous deposition from the river.
- **Texture:** Loamy to sandy loam, with significant silt content, contributing to moderate drainage.
- **Fertility:** Decrease fertility, particularly in areas not yet urbanized.
- **pH Range:** Neutral to slightly alkaline, typically ranging between 7.0 and 8.5.
- **Drainage:** Soils are well-drained but susceptible to erosion and leaching, particularly in flood-prone areas.
- **Organic Matter:** Moderate organic content, with higher levels in vegetated and agricultural areas.
- **Load-Bearing Capacity:** Suitable for low to medium-load construction, though localized variations exist.
- **Contamination Risk:** Elevated risk of pollution from industrial and residential runoff, particularly in Saggian. (Sultana, 2020)
- **Flood Sensitivity:** High vulnerability to erosion and sediment displacement during seasonal floods, especially along riverbanks.
- **Construction Considerations:** Geotechnical investigations recommended to assess soil stability and suitability for major infrastructure.
- **Geology and Soil Characteristics:** Geology and Soil Characteristics of the project area determined through Punjab EPA certified Lab during baseline data collection.

4.1.4 Air Quality

The air quality along the Ravi River, especially in the project area is influenced by a combination of natural and anthropogenic factors. The region's air quality is impacted by urbanization,

industrial activities, and agricultural practices, with both seasonal fluctuations and localized pollution sources affecting the overall air quality.

Urban and Industrial Emissions: Air quality in urbanized areas such as Shadbagh and Shahdara is significantly influenced by vehicular emissions, industrial emissions, and construction activities. Type of traffic also determine the air quality and the fuel being used. These contribute to high levels of particulate matter (PM₁₀ and PM_{2.5}), nitrogen oxides (NO_x), and sulfur oxides (SO_x), particularly during the dry months when wind speeds are lower and pollutant dispersion is limited. This causes SMOG in this region.

Agricultural Practices: In more rural areas like Saggian, the burning of crop residues and open burning of waste contribute to increased levels of smoke, particulate matter, and carbon monoxide (CO), especially during the post-harvest seasons. These activities further degrade the air quality and contribute to seasonal smog formation.

Particulate Matter (PM): The levels of PM₁₀ and PM_{2.5} often exceed safe limits in both urban and rural areas. These fine particles pose significant health risks, particularly respiratory issues and cardiovascular problems (Khan, 2019). Higher PM levels are generally observed during the winter and early spring months, primarily due to vehicular emissions, industrial activity, and seasonal agricultural burning.

Pollutant Sources: Key pollutants in the region include carbon monoxide (CO), nitrogen dioxide (NO₂), ozone (O₃), and sulfur dioxide (SO₂), with elevated concentrations near major industrial zones in Saggian. These pollutants are linked to traffic congestion, industrial emissions, and waste burning.





Figure 4-4 Air Quality Monitoring

Air Quality Analysis

The ambient air quality monitoring conducted at Bara Dari, Saggian Bridge, New Ravi Bridge, and Ravi Toll Plaza M-2 in Lahore revealed significant air pollution issues, particularly concerning particulate matter. The levels of PM_{2.5} and PM₁₀ were found to be alarmingly high at all locations. PM_{2.5} concentrations ranged from 180.05 µg/m³ at Saggian Bridge to 267.35 µg/m³ at Bara Dari, far exceeding the Punjab Environmental Quality Standard (PEQS) of 35 µg/m³. Similarly, PM₁₀ levels were also well above the PEQS limits of 150 µg/m³, with values ranging from 243.45 µg/m³ to 279.87 µg/m³. Such elevated concentrations of fine particulate matter are a major health concern as they can penetrate deep into the lungs and even enter the bloodstream, increasing the risk of respiratory and cardiovascular diseases.

In contrast, the concentrations of gaseous pollutants such as Nitrogen Dioxide (NO₂), Nitric Oxide (NO), Nitrogen Oxides (NO_x), Sulphur Dioxide (SO₂), and Carbon Monoxide (CO) were found to be within the permissible limits set by the PEQS. For instance, NO₂ levels across all sites remained well below the limit of 80 µg/m³, with the highest observed value being 39.80 µg/m³ at Ravi Toll Plaza. Similarly, CO concentrations ranged between 1.90 mg/m³ and 3.98 mg/m³, staying within the 8-hour PEQS limit of 5.0 mg/m³. These findings suggest that, while particulate pollution is a critical issue, gaseous emissions from vehicles and other sources were relatively controlled during the monitoring period.

The levels of Ozone (O₃) were also assessed and found to be within safe limits at all locations. Ozone concentrations ranged from 17.64 µg/m³ to 35.00 µg/m³, well under the PEQS 1-hour limit of 130 µg/m³. Similarly, Lead airborne particles were detected in the range of 0.41 to 0.52 µg/m³, staying within the standard of 1.5 µg/m³, indicating minimal risk from heavy metal contamination in the air.

However, Suspended Particulate Matter (SPM) levels presented another concern. Except for Saggian Bridge, where the average SPM was slightly below the limit (458.50 µg/m³), the other three locations recorded SPM levels exceeding the PEQS threshold of 500 µg/m³. Bara Dari, in particular, recorded the highest SPM concentration at 582.22 µg/m³. These high SPM values are typically associated with dust, unpaved roads, ongoing construction work, and vehicular emissions, and they contribute significantly to urban SMOG and poor visibility.

In conclusion, while gaseous pollutant levels remain within regulatory limits, particulate matter pollution—both PM_{2.5} and PM₁₀—poses a serious environmental and public health threat in Lahore. Immediate attention is required to control dust, reduce vehicular emissions, and implement stricter construction site regulations to improve air quality in the affected areas.

Impact of Seasonal Winds: Seasonal wind patterns also influence air quality along the river. During the winter months, air tends to be stagnant, which traps pollutants near the surface, leading to higher concentrations of smog and particulate matter in the atmosphere. Conversely, the summer winds tend to disperse pollutants more effectively, although temperature inversions during certain times of the year can exacerbate pollution. The wind rose diagrams are shown below Figure 4-5.

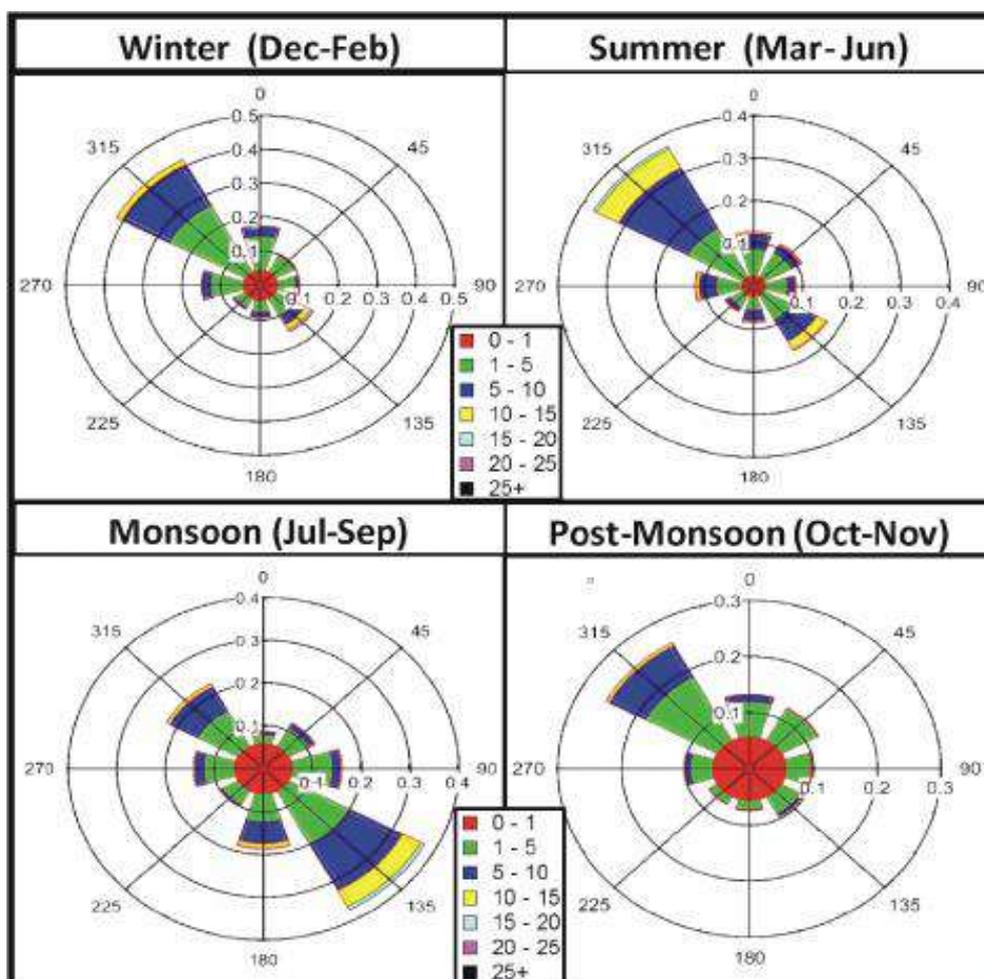


Figure 4-5 The wind rose diagrams

4.1.4.1 Ambient Air Quality Monitoring

Ambient air quality monitoring was conducted at four locations along the project corridor:

- Saggian Bridge
- New Ravi Bridge
- Bara Dari
- Motorway Ravi Toll Plaza (M-2)

Table 4-1 Ambient Air Monitoring Analysis

Sr.#	Parameter	Unit	Saggian Bridge	New Ravi Bridge	Bara Dari	Ravi Toll Plaza (M-2)	PEQs
1	Nitrogen Dioxide (NO ₂)	µg/m ³	15.10	35.36	35.36	39.80	80.0
2	Nitrogen Oxide (NO)	µg/m ³	16.18	24.35	24.35	24.80	40.0
3	NO _x	µg/m ³	39.99	59.71	59.71	64.60	120.0
4	Sulphur Dioxide (SO ₂)	µg/m ³	99.20	80.89	80.89	64.47	120.0
5	Carbon Monoxide (CO)	mg/m ³	2.58	2.81	2.81	3.98	5.0*
6	Ozone (O ₃)	µg/m ³	17.64	19.60	19.60	35.0	130.0**
7	Particulate Matter (PM _{2.5})	µg/m ³	180.05	243.83	243.83	223.42	35.0
8	Particulate Matter (PM ₁₀)	µg/m ³	243.45	253.01	279.87	265.09	150.0
9	Suspended Particulate Matter (SPM)	µg/m ³	458.50	253.01	253.01	265.09	500.0
10	Lead Airborne Particles	µg/m ³	0.41	531.84	531.84	523.51	1.5
*08 hour standard for CO							
**01 hour standard for O ₃							

4.1.4.2 Conclusion:

The monitoring covered key parameters including Nitrogen Dioxide (NO₂), Nitric Oxide (NO), Oxides of Nitrogen (NO_x), Sulphur Dioxide (SO₂), Carbon Monoxide (CO), Ozone (O₃), Lead, and Particulate Matter (PM₁₀ and PM_{2.5}). All gaseous pollutants (NO_x, SO₂, CO, O₃) and Lead levels were found to be within the permissible limits of PEQS at all monitoring sites. However, Particulate Matter (PM_{2.5} and PM₁₀) levels were found to be consistently above the PEQS limits at all four monitoring sites, indicating elevated dust and particulate concentrations in the project area. This

suggests a need for dust control measures during construction activities, especially near New Ravi Bridge and Bara Dari, where PM levels were notably higher.

4.1.5 Water Resources

4.1.5.1 Surface water

Surface water sources in the Study Area of the Project are Ravi River and Saggian, Shalimar & Shahdara Drains. The most of discharge that falls in to the Ravi River is of sewage and industrial nature. Due to present conditions, there is high level of contamination in the form of organic, inorganic and heavy metals in Ravi River. The aquatic life is almost gone and the river now called as Dead River.



Figure 4-6 Surface Water

4.1.5.1.1 Surface water Quality Analysis

Surface water samples were collected from two locations:

- Near Ravi Toll Plaza
- Near Saggian Bridge

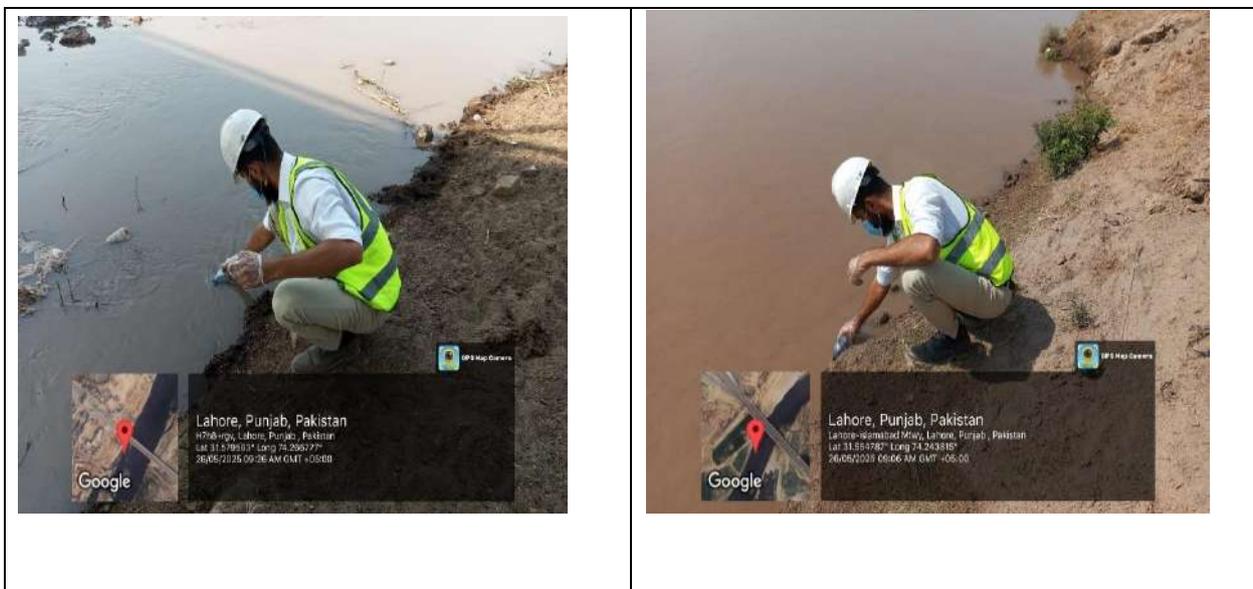


Figure 4-7 Water Sampling

The samples were analysed for physical and chemical characteristics including pH, TDS, TSS, COD, BOD, metals (e.g., Lead, Zinc, Copper, Nickel), and organic compounds. See Annex: 3.

Table 4-2 Surface water Analysis

Sr.#	Parameters	Analysis Method	Unit	LOR	Results	
					Toll Plaza	Saggian Bridge
PHYSICAL & CHEMICAL ANALYSIS						
1	Temperature	-	°C	-	28.5	28.6
2	pH	APHA-4500H ⁺ B	pH unit	0.01	7.70	7.37
3	Total Dissolved Solid (TDS)	APHA-2540 C	mg/l	1.0	97.0	124.0
4	Oil and Grease	USEPA-1664	mg/l	0.2	<0.2	<0.2
5	Biological Oxygen Demand (BOD)	APHA-5210 B	mg/l	1.0	5.0	7.0
6	Chemical Oxygen Demand (COD)	APHA-5220-D	mg/l	1.0	13.0	16.0
7	Total Suspended Solid	APHA-2540-D	mg/l	1.0	43.0	61.0
8	Phenolic Compound	APHA-5530 D	mg/l	0.01	<0.01	<0.01
9	Chloride (Cl)	APHA-4500Cl ⁻ B	mg/l	0.24	7.82	11.74
10	Fluoride (F)	APHA-4500F ⁻ C	mg/l	0.01	<0.01	<0.01
11	Cyanide (CN)	APHA-4500CN F	mg/l	0.01	<0.01	<0.01
12	Detergent	APHA-5540 B	mg/l	-	ND	ND

13	Sulphate	APHA-4500-SO ₄ C	mg/l	0.41	22.63	31.69
14	Sulphide	APHA-4500-S ₂ -E	mg/l	0.4	<0.4	<0.4
15	Ammonia	APHA-4500-NH ₃ -B	mg/l	0.002	<0.002	<0.002
16	Silver	APHA-3500Ag-B	mg/l	0.0032	<0.0032	<0.0032
17	Cadmium	APHA-3500Cd B	mg/l	0.0028	<0.0028	<0.0028
18	Chromium	APHA-3500Cr B	mg/l	0.0054	<0.0054	<0.0054
19	Copper	APHA-3500Cu B	mg/l	0.0045	0.0133	0.0221
20	Lead	APHA-3500-Pb B	mg/l	0.013	<0.013	<0.013
21	Mercury	APHA-3500-Hg B	mg/l	0.0008	<0.0008	<0.0008
22	Nickel	APHA-3500-Ni B	mg/l	0.008	<0.008	0.1927
23	Zinc	APHA-3500-Zn B	mg/l	0.0033	0.0408	<0.0033
24	Arsenic	APHA-3500As B	mg/l	0.01	<0.01	<0.01
25	Barium	APHA-3500Ba B	mg/l	0.031	<0.031	<0.031
26	Manganese	APHA-3500-Mn B	mg/l	0.0016	<0.0016	<0.0016
27	Iron	APHA-3500-Fe-B	mg/l	0.1	<0.1	<0.1
28	Boron	APHA-4500B-C	mg/l	0.1	<0.1	<0.1
29	Total Chlorine	APHA-4500Cl-B	mg/l	0.1	<0.1	<0.1
30	Selenium	APHA-3500Se C	mg/l	0.23	<0.23	<0.23
31	Total Toxic Metals	By Calculation	mg/l	-	0.0133	0.2148

Note:

*Uncertainty of all the parameters and laboratory conditions at the time of analysis will be provided as per client's requirement. The lab environmental conditions are maintained at 25±5C° and humidity at 50±20%. PEQs are not available for Surface Water.

Observations:

- Most parameters were within acceptable levels, with many substances (e.g., oil & grease, heavy metals like mercury, arsenic, cadmium) below detectable limits.
- Notably, Nickel concentration near Saggian Bridge was relatively higher (0.1927 mg/l), which may warrant further observation.
- There are no defined PEQS limits for surface water, thus compliance status cannot be formally concluded. However, results indicate no immediate signs of significant pollution at the sampled sites.

4.1.5.2 Ground water

Groundwater was encountered at around 7-11 m depth below the NSL as per Geotechnical Investigation Report. Given a margin for seasonal fluctuations, the groundwater may be considered to rise/fall beyond this depth by about 1 m.

4.1.5.2.1 Hydrology

The Ravi River is one of the five major rivers of the Indus River Basin, originating from the Chamba district of Himachal Pradesh, India, and flowing westward into Pakistan, where it passes through the Lahore District, including areas like Shahdara, Saggian, and Shadbagh. Hydrologically, the river exhibits seasonal flow variability, with peak discharge of 600,000 cubic feet per second (approximately 17,000 cubic meters per second) during the monsoon months (July to September) due to heavy rainfall and upstream glacier melt. In contrast, dry season flows (October to May) are significantly reduced from 0-471 cubic meters per second (cumecs) due to upstream diversions under the Indus Waters Treaty, primarily for irrigation in India. Within the Pakistani stretch, the Ravi is primarily ephemeral, often carrying minimal flow outside the monsoon period. The river's catchment area is prone to flash flooding, and its floodplains are susceptible to seasonal inundation, especially in low-lying zones near Saggian. Hydrologically, the river also plays a role in recharging shallow aquifers in the adjacent areas. However, in recent years, surface water quality and flow regimes have been heavily altered by urban encroachment, industrial discharges, and climate variability, impacting both groundwater-surface water interactions and the ecological health of the river system.

Over the past decade, the Ravi River has experienced several significant flood events, primarily influenced by monsoon rains and upstream water releases from India. Notably, in September 2025, due to heavy rains, 2,19,000 cusecs passed through Shahdara releasing through their dam reaching Jassar and Shahdara while damaging Madupur headworks gates but no structural damage in Lahore, in July 2023, India released approximately 1,85,000 cusecs of water from the Ujh Dam, leading to the inundation of 40 villages in Punjab and affecting around 48,000 residents. Similarly, in August 2022, a release of 171,797 cusecs caused medium to high flood levels at Jassar, prompting emergency responses and evacuations. These events underscore the recurring nature of flood risks in the region, often exacerbated by upstream water management and climatic factors.

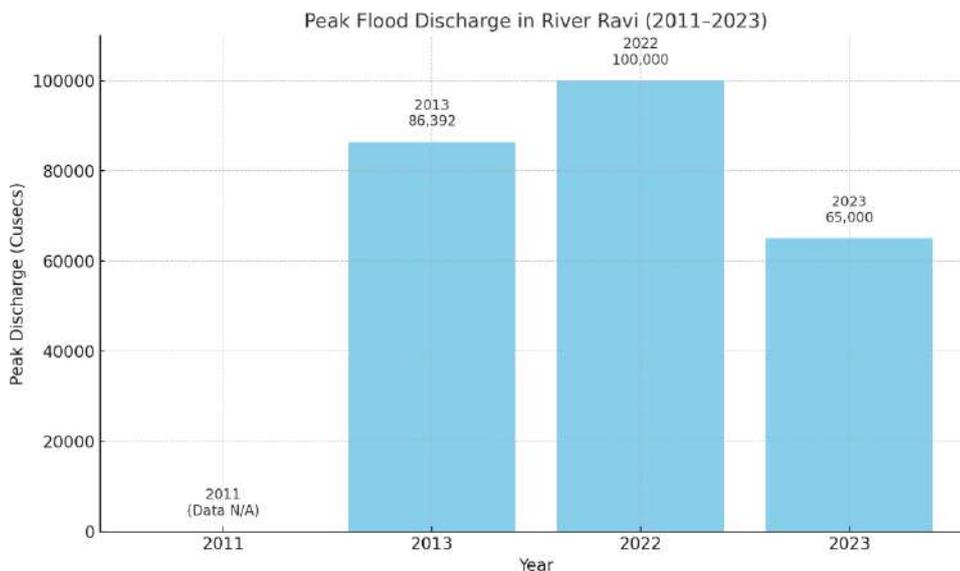


Figure 4-8 Floods during last ten years

4.1.6 Wastewater Drains

Several major wastewater drains discharge untreated domestic and industrial effluents into the River Ravi along its course through Lahore. These drains significantly affect the river’s hydrology and water quality. See Figure 4-9 for the location of major wastewater drains within the project area.

4.1.6.1 Shahdara Drain (35 MGD):

Located upstream of the project area, this drain receives municipal and small-scale industrial effluents from Shahdara and adjacent settlements. It carries about 35 MGD of wastewater and discharges into the Ravi River before entering the project stretch, contributing to the cumulative pollutant load reaching downstream weirs.

4.1.6.2 Upper Chota Ravi Drain (74 MGD):

This drain collects wastewater from the northern industrial and residential zones of Lahore. With a discharge of 74 MGD, it contributes a substantial portion of untreated effluent entering the Ravi River upstream of the study area.

4.1.6.3 Cantonment Drain (88 MGD):

The Cantonment Drain serves as one of the major conduits of wastewater generated from the Lahore Cantonment area and nearby residential and commercial localities. It conveys an estimated 88 million gallons per day (MGD) of domestic and industrial effluents into the Ravi River. Due to its proximity to the project site, the drain’s discharge has a considerable influence on the river’s water quality in the vicinity of the proposed weir structures.

4.1.6.4 Shalimar Escape Channel (78 MGD):

The Shalimar Escape Channel carries both stormwater and wastewater from the northern parts of Lahore, including Shalimar Town, Mughalpura, and adjacent industrial areas. With an

estimated flow of 78 MGD, it constitutes a significant pollution source within the project's study corridor and directly affects the river stretch near the Weir/Rubber Dam-02.

4.1.6.5 Sattu Katla Drain (11 MGD):

The Sattu Katla Drain originates in the southern parts of Lahore and mainly carries domestic sewage and minor industrial discharges. It has an approximate flow of 11 MGD and joins the Ravi River downstream of the Weir/Rubber Dam-03 location.

4.1.6.6 Hudiara Drain (544 MGD):

The Hudiara Drain is one of the largest transboundary drains between India and Pakistan, carrying a massive 544 MGD of wastewater. It receives untreated effluent from urban and industrial areas on both sides of the border and discharges into the Ravi River downstream of Lahore, making it the single largest pollution source affecting the lower reaches of the river.

4.1.6.7 Darins within study area

Among them, the Cantonment Drain and the Shalimar Escape Channel lie within the study area of the proposed project and are therefore of particular environmental concern. Both drains directly outfall into the section of the Ravi River between the Weir/Rubber Dam-02 and Weir/Rubber Dam-03, influencing the water quality and sediment characteristics within the project influence zone.

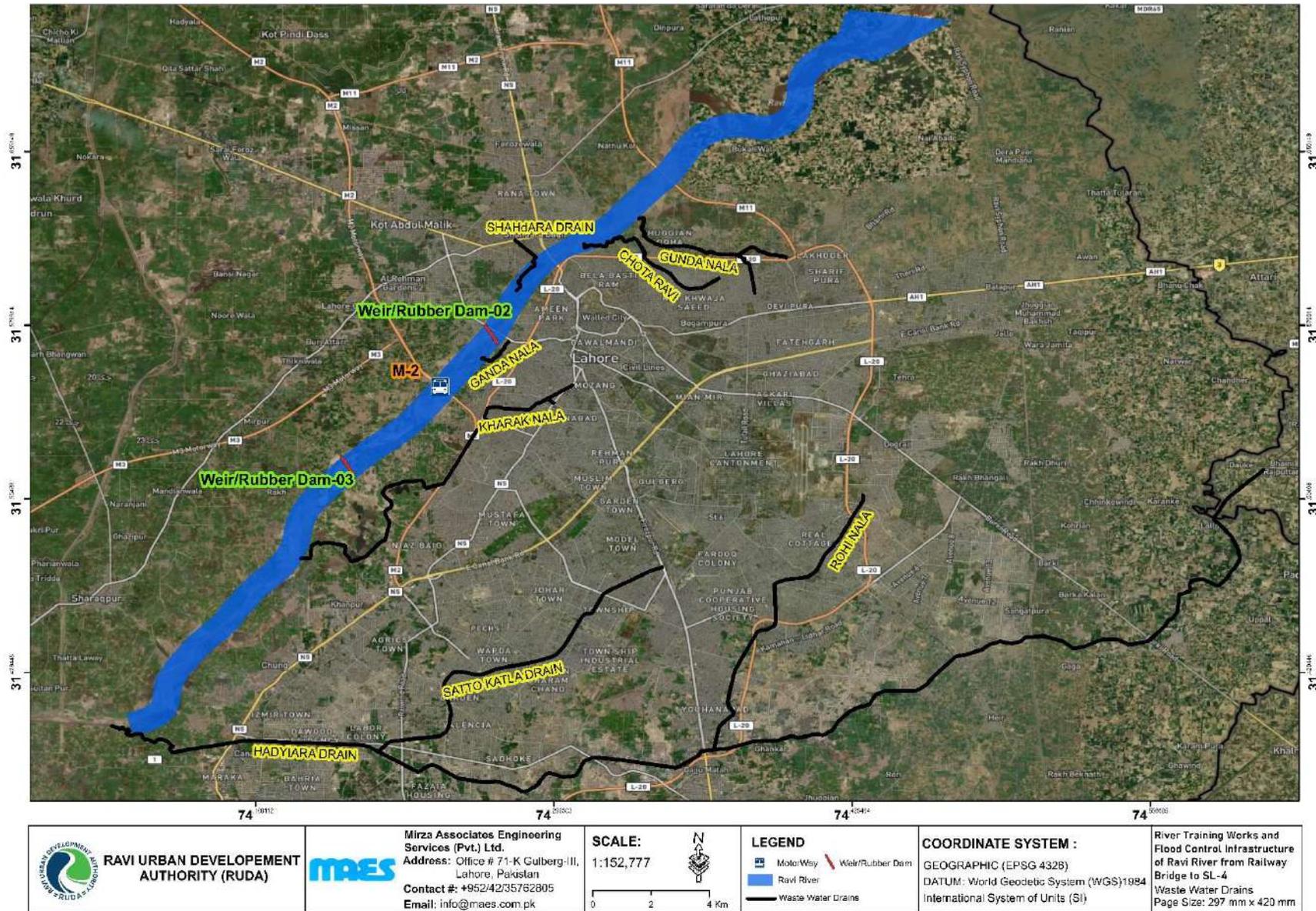


Figure 4-9 Wastewater Drains

4.1.7 Noise

The ambient noise levels along the Ravi River vary significantly depending on proximity to urban infrastructure, transportation corridors, and industrial zones. In areas such as Saggian and Shahdara, noise pollution is notably high due to heavy traffic on Saggian Interchange, Ravi Road, and nearby industrial activities. Average daytime noise levels in these zones often exceed the NEQS limits of 65 dB(A), especially during peak traffic hours, posing risks to both public health and local fauna. In contrast, quieter segments near agricultural or undeveloped land along the riverbanks exhibit lower noise levels, particularly during night time, ranging between 45–55 dB(A). Major sources of noise include vehicular traffic, industrial machinery, construction activities, and public gatherings near the river, especially during festivals or holidays. Persistent high noise levels not only impact human well-being causing stress, hearing fatigue, and sleep disturbances but may also disturb bird nesting and aquatic species behaviour, requiring noise mitigation strategies as part of riverfront development and environmental management plans.

4.1.7.1 Noise Level Monitoring

Noise monitoring was performed over 24-hour periods at the following locations:

- Saggian Bridge
- New Ravi Bridge
- Bara Dari
- Motorway Ravi Toll Plaza (M-2)

Table 4-3 Noise Level Analysis

Sr. #	Location	Average 24 hrs. Reading (dB)	PEQs Commercial
1	Saggian Bridge	67.66	65.0
2	New Ravi Bridge	80.75	65.0
3	Bara Dari	61.81	65.0
4	Ravi Toll Plaza (M2)	84.6	65.0

Noise levels were evaluated against the PEQS thresholds for commercial and residential areas:

- Daytime limit: 65 dB(A) (Commercial) / 55 dB(A) (Residential)
- Nighttime limit: 55 dB(A) (Commercial) / 45 dB(A) (Residential)



Figure 4-10 Noise Level Monitoring

Key Findings

- At Saggian Bridge, New Ravi Bridge, and Ravi Toll Plaza, both daytime and nighttime noise levels exceeded the applicable PEQS limits.
- The highest noise levels were observed at New Ravi Bridge and Ravi Toll Plaza, indicating substantial noise pollution likely due to traffic and ongoing urban activities.
- These results underline the importance of implementing noise mitigation strategies such as proper scheduling of noisy operations, use of noise barriers, and regular maintenance of construction machinery.

4.2 Ecological Environment

This ecological baseline report provides an overview of the existing ecological and biological conditions in the project area, serving as a reference point for future monitoring and impact assessments. The proposed alignment traverses diverse land uses, including agricultural fields, floodplains, settlements, forested areas, and riverine zones. Additionally, small-scale industries and commercial units are present near the project area.

4.2.1 Objectives of Ecological Baseline

The specific objectives of the report include the following:

- Establish an ecological baseline to inform future conservation and management efforts at the project sites.
- Conduct qualitative and quantitative assessments of terrestrial vegetation, including diversity and relative abundance at the project sites.
- Perform qualitative and quantitative assessments of mammal, avifauna, herpetofauna and fish fauna species, including their relative abundance and diversity at the project sites.
- Identify threatened, endemic, and restricted-range species at the project sites.
- Propose mitigation measures for the conservation of flora and fauna at the project sites.

4.2.2 Ecological Resources Samples and Study-Area

The samplings were conducted for the terrestrial and aquatic ecological resources to assess the status of the biodiversity within the Ecological Study Areas. The ecological resources sampled in the months of May and June 2025 and survey details are given below:

- Vegetation diversity and relative abundance
- Mammals diversity and relative abundance.
- Herpetofauna diversity and relative abundance
- Birds diversity and relative abundance
- Fish diversity and relative abundance

4.2.3 Study Area and Sampling Locations

The study area is located around Ravi River, starting from the Old Ravi Bridge and extending downstream to the Motorway Bridge to Mohlanwal Ring Road Southern loop (SL-04). The area comprises the following habitat types, where sampling was carried out accordingly.

A reconnaissance survey conducted in April 2025 identified five major habitat types along the Ravi River. The surveyed section lies within the administrative boundaries of Lahore and Sheikhpura Districts in Punjab Province and represents a key ecological corridor currently under assessment for a proposed urban development project. The identified habitat types are as follows:

4.2.3.1 Wetlands Ecosystems

This habitat includes shallow pools, backwaters, and seasonally inundated patches along the river margins. These wetlands support a variety of aquatic and semi-aquatic species and serve as crucial staging and feeding grounds for resident and migratory water birds, including ducks, herons, egrets, and waders. Their ecological function varies with seasonal flows, sediment load, and adjacent land use.

4.2.3.2 Belas (Islands) in Floodplains

The Ravi River floodplain features numerous belas islands and sandbars formed by river dynamics. These landforms may be temporary or semi-permanent depending on water flow and sediment deposition. Belas provides important nesting, resting, and foraging habitats for birds,

and also support small mammals and reptiles. Their condition was affected by human activities such as grazing, cultivation, and wood collection.

4.2.3.3 Forested Habitat

Patches of forest located along the riverbanks offer relatively undisturbed terrestrial habitats. These areas support various bird species and contribute to the river’s ecological diversity. Despite fragmentation, these forests are essential for breeding, roosting, and foraging, and serve as ecological buffers within the broader riverine landscape.

4.2.3.4 Agricultural Lands

Extensive agricultural areas adjacent to the river function as secondary habitats for a range of fauna, particularly insectivorous and ground-nesting birds. The biodiversity value of these lands depends on crop types, seasonal cycles, and field margin vegetation. Integrating wildlife-friendly practices into agricultural systems can enhance their ecological value.

4.2.3.5 River Channel and Marshy Habitat

The main river channel, side channels, and adjacent marshy banks represent key aquatic habitats within the study area. The silty-bottomed main channel supports fish and other aquatic organisms, while the marshy margins and belas provide habitat for reeds, grasses, sedges, and other wetland vegetation. These habitats are vital for maintaining ecological complexity and connectivity across the river corridor.



Figure 4-11 River Channel and Marshy Habitat

4.2.4 Review of Literature

Mammalian diversity along the Ravi River and similar riparian systems in Punjab has been relatively under-documented, though studies from nearby rivers offer useful insights. Altaf et al. (2014) recorded 15 mammalian species in the Chenab Riverine Forest, noting moderate diversity levels based on the Shannon-Wiener Index. Similar surveys along the Sutlej River reported 266 individuals across 12 species, with rodents being the most dominant group (Sial et al., 2024). These findings suggest that the Ravi River's riparian corridors may support comparable assemblages of small and medium-sized mammals, depending on habitat conditions and human disturbance.

Avifaunal diversity in wetland and riverine ecosystems of Punjab, including the Ravi River, is high. At Taunsa Barrage a Ramsar designated wetland downstream of the Ravi over 150 bird species have been documented, including 10 globally threatened species (Haider et al., 2022). In a similar setting at Rana Resort Forest (Kasur District, near Ravi), 655 birds from 36 species were recorded, highlighting the importance of such habitats for both migratory and resident bird species (Siddiqui et al., 2024).

Herpetofaunal diversity near the Ravi River is supported by a range of microhabitats including riverbanks, wetlands, and forest patches. Rais et al. (2012) recorded 35 species in North Punjab, including 30 reptiles and 5 amphibians. A more extensive survey by Ali (2020) documented 43 herpetofaunal species across Punjab, including frogs, turtles, lizards, and snakes. These species play crucial roles in ecosystem functioning and serve as bio indicators of environmental health.

Riparian vegetation along the Ravi River supports a mix of native trees, shrubs, and grasses, offering critical habitat and erosion control. Near the Ropar Wetland a riverine area upstream in India species like *Acacia nilotica*, *Dalbergia sissoo*, and *Ficus benghalensis* dominate the landscape. Although specific studies along the Ravi in Pakistan are limited, similar vegetation structures are expected, shaped by semi-arid climate and anthropogenic land use.

Ichthyofaunal surveys reveal high diversity but declining ecological health in the Ravi River. Rafique and Khan (2012) recorded 68 fish species from 14 families, noting the presence of invasive species like *Cyprinus carpio* and *Hypophthalmichthys molitrix*. Another study documented 50 species and observed seasonal variations in abundance, with lower diversity during dry flow periods (Ashraf et al., 2024). These shifts are linked to pollution, flow regulation, and habitat fragmentation.

4.2.5 Methodology

To establish a comprehensive baseline of ecological conditions and biodiversity within the project area, a combination of field surveys and standardized ecological assessment techniques were employed. Sampling locations were strategically selected to ensure representative coverage of various habitat types and anticipated zones of project influence. Sampling was conducted using multiple methods during May and June 2025 at selected sampling locations.

4.2.5.1 Equipment's and Field kit

The field kit and equipment were during the survey included;

1. Binoculars (Nikon 10 x 50)

2. Spotting Scope
3. GPS receiver (Garmin Map 76)
4. Digital camera (Nikon D3200) with 18-55 mm zoom lens for still photography
5. Cast Nets
6. Pug mark identification kit
7. Sampling Bottles/Bags
8. Pitfall traps
9. Sherman's traps
10. Measuring tape and Board
11. Field guide books for quick identification of species
12. Note book for taking field notes/data sheets

4.2.5.2 Vegetation

The vegetation in terrestrial habitats at the project sites were sampled using the quadrat method, with three quadrats of 5 m x 5 m to be taken at each sampling location. The first quadrat will be placed at the beginning of the transect, the second at 250 m, and the third at 500 m. Plants within each quadrat will be recorded and collected for species identification, if required. Additional plant species present in the area adjacent to the quadrats were also be noted. The collected plant specimens were identified using the nomenclature from the Flora of Pakistan (Nasir and Ali, 1972-1994;¹ Ali and Qaiser, 1995 to date).²

Data Analysis

The data collected from the field was analyzed to know the species richness and relative abundance. All these parameters for each species were calculated.

The relative abundance of the species in the area was calculated using the following formula:

$$\text{Relative abundance} = \frac{\text{Total number of individuals of a species in all quadrats} \times 100}{\text{Total number of individuals of all species in all quadrats}}$$

4.2.5.3 Mammals

Data Collection

The survey methodology for mammals at project site was combined both direct and indirect methods to gather comprehensive data on species abundance, distribution, and behavior. Direct methods include visual observations, allowing experts to document species sightings,

¹ S. I. and Nasir. 1972-1994. Flora of Pakistan Fascicles. Islamabad

² Ali, S. I. and Qaiser, M. 1995 to date. Flora of Pakistan Fascicles. Karachi

vocalizations, and photographic evidence of mammal activity at various times of day.^{3 4} These methods were providing immediate data on animal presence and behavior. Indirect methods, such as track and sign surveys, scat analysis, and habitat assessments, provide insights into species' presence and environmental associations by examining physical traces like pug marks, burrows, feces, and feeding signs.^{5 6} These indirect methods complement the direct observations, especially for elusive or nocturnal species. Data collected from both approaches were analyzed to estimate population size, detectability, and habitat preferences.^{7 8} By combining these techniques, the methodology creates a robust framework for monitoring mammal populations and understanding their ecological roles within the project site that are terrestrial ecosystems. The relative abundance and number of species were recorded and identified using a field guide to mammals of Pakistan.

Data Analysis

The data analysis was focused on evaluating species diversity using direct and indirect methods collected across the sampling locations.

4.2.5.4 Birds

Line transects measuring 500 m × 50 m were used to assess bird diversity and abundance at each sampling location. Transects were established to cover all major habitat types within the study area. Surveys were conducted during the early morning and late afternoon hours, when bird activity is typically highest. The start time and geographic coordinates of each transect was recorded. All bird species observed along the transects were identified using the most recent and reliable field guides and taxonomic keys available in the literature. Data collected were used to calculate bird species density and diversity at each site.

Data Analysis

The species richness (number of species observed) and abundance (number of individuals of each species observed) at the specified monitoring locations were calculated using data obtained from the line transect.

4.2.5.5 Herpetofauna

Line transects, 500 meters long and 20 meters wide, was systematically placed at each sampling location within the project site to survey reptiles and amphibians. Active searching was the primary method employed, particularly during daylight hours, to detect both diurnal and nocturnal species

³ Wilson, D. E., & Mittermeier, R. A. (2011). Handbook of the Mammals of the World. Volume 1: Carnivores. Lynx Edicions.

⁴ Bischof, Sutherland, W. J., et al. (2016). Methods for monitoring birds and mammals. Wiley Blackwell.

⁵ Ahmed, Harris, S., & Yalden, D. W. (2008). Mammals of the British Isles Handbook. The Mammal Society.

⁶ Clevenger, A. P., & Waltho, N. (2005). Use of fecal samples for studying carnivore ecology. *Wildlife Research*, 32(1), 61-67.

⁷ Buckland, S. T., et al. (2001). Introduction to Distance Sampling: Estimating Abundance of Wildlife Populations. Oxford University Press.

⁸ MacKenzie, D. I., et al. (2002). Estimating site occupancy, colonization, and local extinction rates when a species is detected imperfectly. *Ecology*, 83(8), 2248-2255.

in their resting or basking habitats. Survey efforts were focus on suitable microhabitats such as under rocks, logs, leaf litter, and near water bodies.

All reptile and amphibian species observed or collected along the transects were photographed using a digital camera, and relevant field data was recorded, including behaviour, microhabitat, and time of observation. Geographic coordinates and elevation were recorded using GPS, and associated habitat characteristics were also be documented. Indirect evidence such as body or tail impressions, footprints, faecal pellets, tracks, dens, or egg-laying sites were noted as indicators of species presence.

Specimens that cannot be reliably identified in the field were collected and preserved for later identification using standard taxonomic references. Hand collection either with bare hands or using long forceps or a snake clutch was employed as the most effective method for capturing different reptile species.

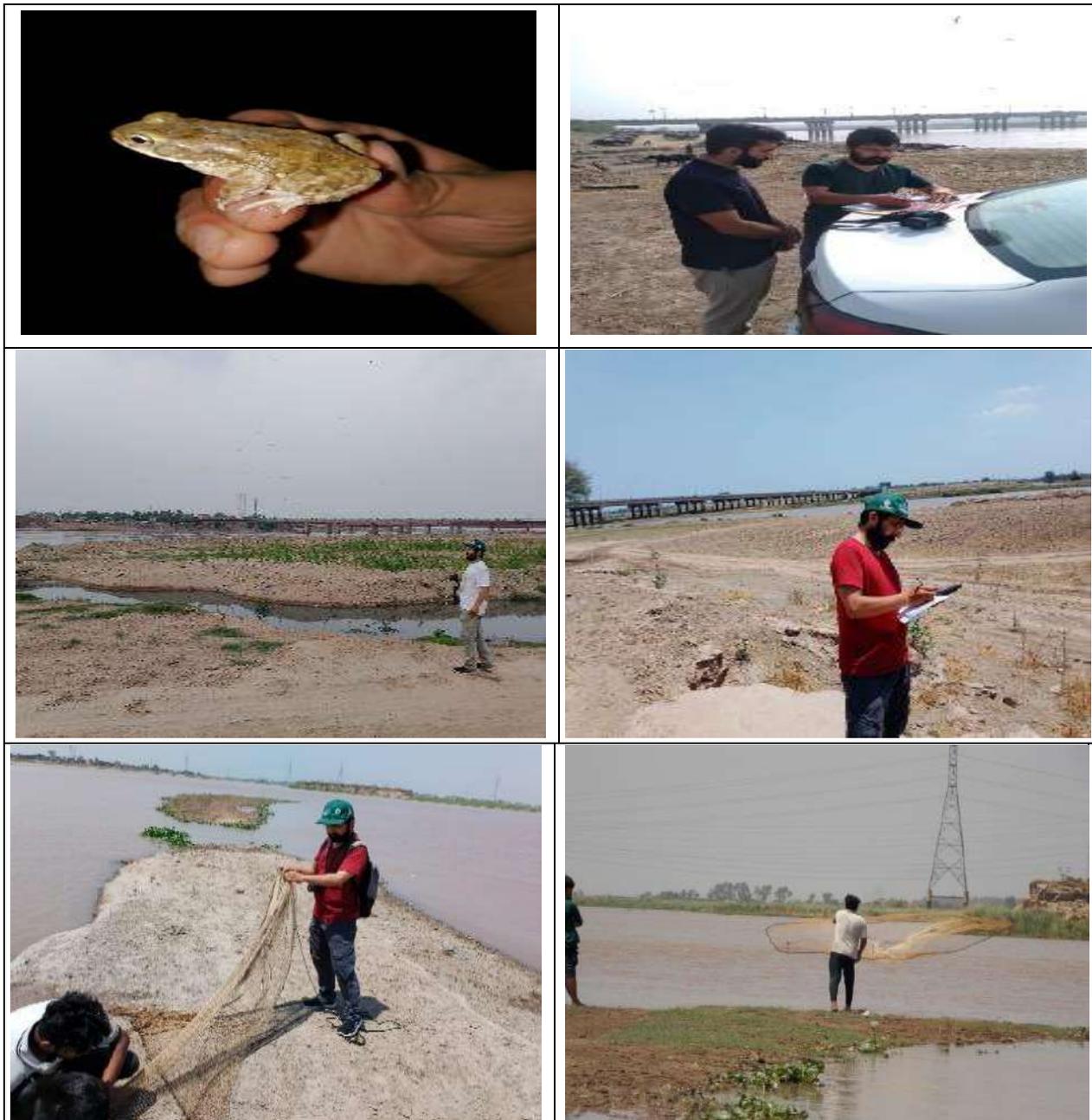




Figure 4-12 Data Collection at site

Data Analysis

The species richness (number of species observed) and abundance (number of individuals of each species observed) at the specified monitoring location was calculated using data obtained from the line transect.

4.2.5.6 Fish fauna

A fish fauna survey was conducted using the cast netting method, which is recognized for its efficiency and suitability in riverine environments. This method is particularly effective in shallow, moderately flowing sections of rivers and enables systematic sampling across various microhabitats such as pools, riffles, and near-shore areas. Cast netting facilitates the capture of a wide range of fish species, including juveniles and small-bodied taxa that may not be adequately sampled by other techniques. The primary objective is to generate qualitative and quantitative data on species composition and relative abundance to inform the assessment of potential environmental impacts. Sampling was standardized in terms of effort, location, and time to ensure data comparability and reliability. All specimens were identified using established taxonomic keys, and biodiversity metrics were applied to evaluate ecological health. This approach aligns with

ethical and legal standards for aquatic research and provides a non-destructive, cost-effective tool for monitoring fish communities in support of the broader environmental impact assessment process.^{9 10 11 12}

Data Analysis

Fish survey data was analyzed to assess species composition, diversity, and relative abundance across the sampling locations. Biodiversity indices such as species richness and the Shannon-Wiener index was used to evaluate ecological health. Comparisons across different microhabitats was help identify patterns and potential impact zones. The analysis was providing a baseline for understanding the status of fish communities and informs the environmental impact assessment.

4.2.6 Overview and survey results of Ecological Resources

A thorough review of existing literature on the biodiversity of the Ravi River Punjab province was conducted. This literature review was based on the previous studies, reports, and scientific articles related to the flora and fauna of the Ravi River Punjab province.

4.2.6.1 Vegetation

Punjab, is a home to a variety of forest ecosystems, including dry temperate forests, riverine forests, and subtropical thorn forests. The region's forests play a vital role in maintaining biodiversity, regulating climate, and providing resources for local communities. The dry temperate forests, found in the northern parts of Punjab, are dominated by species such as the deodar cedar (*Cedrus deodara*), blue pine (*Pinus wallichiana*), and oak (*Quercus* spp.), while subtropical thorn forests in the southern and central areas feature species like the babul (*Acacia arabica*), beri (*Ziziphus mauritiana*), and khejri (*Prosopis cineraria*). Riverine forests along the Indus River are rich in species like the tamarix (*Tamarix* spp.) and willows (*Salix* spp.), which thrive in the water-rich environment. In addition to these, various medicinal and economic plants such as aloe vera (*Aloe barbadensis*), Amaltas (*Cassia fistula*), and barley (*Hordeum vulgare*) are found across the region. However, these forests are under threat due to deforestation, overgrazing, and agricultural expansion, which has led to the loss of valuable plant species and ecosystems. Conservation¹³

⁹ American Fisheries Society. (2014). *Guidelines for the Use of Fishes in Research* (2nd ed.). American Fisheries Society. <https://fisheries.org/docs/wp/Guidelines-for-Use-of-Fishes.pdf>

¹⁰ Bonar, S. A., Hubert, W. A., & Willis, D. W. (Eds.). (2009). *Standard methods for sampling North American freshwater fishes*. American Fisheries Society.

¹¹ Magurran, A. E. (2004). *Measuring biological diversity*. Blackwell Publishing.

¹² Nelson, J. S., Grande, T. C., & Wilson, M. V. H. (2016). *Fishes of the World* (5th ed.). Wiley.

¹³ Qadir, M., et al. (2010). *Indus Basin: Ecology and Conservation of the Forests of Punjab*. Environmental Science and Technology, 44(3), 1112-1125.

efforts are needed to protect these forests and their plant species, which are crucial for maintaining ecological balance and supporting the livelihoods of local communities.¹⁴

The common trees of the Punjab are *Acacia catechu*, *Acacia nilotica*, *Acacia modesta*, *Cassia fistula*, *Ficus carica*, *Olea ferruginea*, *Pinus roxburghii* and *Quercus leucotrichophora*. The most common shrubs are *Dodonaea viscosa* and *Justicia adhatod*. *Allium jacquemontii*, *Arundo donax*, *Cannabis sativa*, *Centaurea iberica*, *Geranium ocellatum*, *Hibiscus caesius*, *Pennisetum orientale*, *Saccharum spontaneum*, *Tulipa stellata* and *Typha elephantine* are widespread herbs.

Survey Results

A total of 60 plant species were recorded during the ecological survey, distributed across five primary habitat types within the project area: wetland ecosystems, belas (islands) in floodplains, forested habitats, agricultural lands, and river channel and marshy habitats. The wetland ecosystems supported a variety of hydrophilic species, including herbs and grasses adapted to moist and waterlogged conditions. Belas or seasonal islands within the floodplain, hosted a diverse mix of grasses, herbs, and opportunistic shrubs, shaped by periodic flooding and nutrient-rich alluvial soils. In the forested habitats, a range of tree and shrub species were documented, both planted and naturally occurring, contributing to canopy cover and ecosystem stability. Agricultural lands featured not only cultivated crops but also numerous wild herbs and ruderal species growing along field edges and fallow areas. Finally, the river channel and marshy habitats contained semi-aquatic vegetation such as reeds and sedges, along with other moisture-loving herbs, which are vital for maintaining the ecological balance of riparian systems. The relative abundance of these species given in Table 4-4 below:

Table 4-4 Relative Abundance

Vegetation Type	No. of Species	Relative Composition (%)
Trees	28	34.09%
Shrubs	10	16.51%
Herbs	25	36.34%
Grasses	7	13.08%
Total	60	100%

A total of 757 individual plants comprising 60 different species were recorded during the ecological assessment. These species were classified into four major vegetation types: trees, shrubs, herbs, and grasses, each contributing differently to the overall floral composition and structure of the study area. The details given in Table No. 2.

¹⁴ Hussain, S. A., et al. (2005). *Forests of Pakistan: Distribution, Management, and Conservation*. Pakistan Forest Institute.

Trees accounted for 258 individuals, representing 34.09% of the total vegetation. A total of 28 tree species were identified, with notable dominance observed in *Neltuma juliflora* (Kikri) with a relative abundance of 3.82%, *Bauhinia variegata* (Kachnar) at 3.16%, and *Albizia lebbek* (Siris) and *Conocarpus erectus* (Button Mangrove) each at 2.50%. Other common trees included *Pongamia pinnata* (Shukh Chain Tree), *Cassia fistula* (Amaltas), and *Acacia nilotica* (Kikar). All tree species recorded were classified as Least Concern under the IUCN Red List, reflecting a stable conservation status. These trees play a vital ecological role in supporting biodiversity, offering shade, shelter, and foraging opportunities for numerous fauna species.

Shrubs were represented by 10 species, totaling 125 individuals and contributing 16.51% to the vegetation structure. The most abundant shrub was *Calotropis gigantea* (Aak), with a relative abundance of 3.69%, followed by *Lantana camara* (Panj Phuli) and *Ricinus communis* (Castor Oil Plant), at 2.37% and 2.11% respectively. While most shrub species were native and of ecological value, the presence of *Lantana camara*, a known invasive plant, is a concern due to its potential to suppress native plant growth and alter ecosystem dynamics.

Herbs emerged as the most dominant group, both in terms of number of individuals (275) and percentage composition (36.34%). This group included 25 species, with *Parthenium hysterophorus* standing out as the most abundant species overall at 5.01% relative abundance. Other common herbs included *Amaranthus viridis* (Chaolai) at 3.82%, *Chenopodium ambrosioides* (Worm Seed) at 3.16%, and *Trianthema portulacastrum* (Desert Horsepurslane) at 2.50%. A significant proportion of the herbaceous layer consisted of invasive or fast-growing ruderal species, which typically indicate disturbed or nutrient-rich habitats. The presence of *Parthenium*, a highly invasive species, warrants management attention due to its aggressive growth and harmful effects on native biodiversity and human health.

Grasses formed the smallest group in terms of total count, with 99 individuals and 13.08% representation, yet they play an essential role in soil stabilization and habitat support. Dominant grass species included *Dichanthium foveolatum* (Palwa Grass) and *Cenchrus setigerus* (Birdwood Grass), each at 2.37% relative abundance, followed by *Cynodon dactylon* (Couch Grass) at 2.11%. Grasses in the area provide critical ground cover and are vital for ecosystem resilience, particularly in supporting grazing fauna and reducing erosion.

The vegetation community in the study area is dominated by herbaceous species, comprising a mix of both native and invasive plants. The notable presence of aggressive invasive species such as *Parthenium hysterophorus* and *Lantana camara* suggests potential ecological stress or habitat disturbance. This underlines the need for regular monitoring and appropriate management interventions to conserve native biodiversity and maintain ecological balance. Table 4-5 A list of tree, shrub, herb, and grass species documented at the project site during the ecological survey

Table 4-5 List of tree, shrub, herb, and grass species

Sr. #	Name of Species	Scientific Name	Type	IUCN Status	Relative Abundance (%)
1	Pipal	<i>Ficus religiosa</i>	Tree	Least Concern	0.79
2	Phagwara	<i>Ficus virgate</i>	Tree	Least Concern	0.40
3	Paper mulberry	<i>Braussonetia papyrifera</i>	Tree	Least Concern	0.66
4	Wild Fig	<i>Ficus auriculata</i>	Tree	Least Concern	0.26
5	Bhor, Banyan	<i>Ficus benghalensis</i>	Tree	Least Concern	0.66
6	White Toot	<i>Morus alba</i>	Tree	Least Concern	1.05
7	Kikar	<i>Acacia nilotica</i>	Tree	Least Concern	1.58
8	Siris	<i>Albizia labbeck</i>	Tree	Least Concern	2.50
9	Kachnar	<i>Bauhinia variegata</i>	Tree	Least Concern	3.16
10	Amaltas	<i>Cacia fistula</i>	Tree	Least Concern	2.37
11	Tali, Sheesham	<i>Dalbergia sissoo</i>	Tree	Least Concern	1.58
12	Dhauldak	<i>Erythrina subrosa</i>	Tree	Least Concern	0.79
13	Chir pine	<i>Pinus roxburghii</i>	Tree	Least Concern	0.66
14	Kikri	<i>Neltuma juliflora</i>	Tree	Least Concern	3.82
15	Devil Tree	<i>Alstonia scholaris</i>	Tree	Least Concern	0.53
16	Asian Tropical Tree	<i>Bombax ceiba</i>	Tree	Least Concern	1.05
17	Athel Pine	<i>Tamarix aphylla</i>	Tree	Least Concern	1.98
18	Arjun Tree	<i>Terminalia arjuna</i>	Tree	Least Concern	0.66
19	Red Date	<i>Ziziphus jujuba</i>	Tree	Least Concern	1.05
20	Beri	<i>Ziziphus nummularia</i>	Tree	Least Concern	1.84
21	Shukh Chain Tree	<i>Pongamia pinnata</i>	Tree	Least Concern	2.37
22	Button Mangroove	<i>Conocarpus erectus</i>	Tree	Least Concern	2.50
23	Lemon Cented Gum	<i>Eucalyptus citriodora</i>	Tree	Least Concern	0.92
24	Mango	<i>Mangifera indica</i>	Tree	Least Concern	0.53
25	Date Palm	<i>Phoenix dactylifera</i>	Tree	Least Concern	0.40
26	Indian Willow	<i>Salix tetrasperma</i>	Tree	Least Concern	0.26

27	Bakain, Drek	Melia azedarach	Tree	Least Concern	1.05
28	Guava	Psidium guajava	Tree	Least Concern	0.13
29	Aak	Calotropis gigantea	Shrub	Least Concern	3.69
30	PeeliBooti	Abutilion indicum	Shrub	Least Concern	1.58
31	Karira	Capparis decidua	Shrub	Least Concern	1.19
32	Panj Phuli	Lantana camara	Shrub	Least Concern	2.37
33	Castor Oil Plant	Ricinus communis	Shrub	Least Concern	2.11
34	Ashwagandha	Withania somnifera	Shrub	Least Concern	1.05
35	Bush Morning Glory	Ipomoea carnea	Shrub	Least Concern	0.40
36	Salt Cedar	Tamarix dioca	Shrub	Least Concern	0.79
37	Yellow Fruit Night Shade	Solanum virginianum	Shrub	Least Concern	1.71
38	Bush Weed	Halothamnus hierochunticus	Shrub	Least Concern	1.58
39	Chaolai	Amaranthis viridis	Herbs	Least Concern	3.82
40	Desert horsepurslane	Trianthema portulacastrum	Herbs	Least Concern	2.50
41	Wild Spinch	Chenopodium album	Herbs	Least Concern	2.37
42	Tick Weed	Cleome viscosa	Herbs	Least Concern	1.19
43	Parthenium	Parthenium hysterophorus	Herbs	Least Concern	5.01
44	Marihuana	Cannabis sativa	Herbs	Least Concern	2.37
45	Asthma Weed	Euphorbia hirta	Herbs	Least Concern	1.58
46	Little Hogweed	Portulaca oleracea	Herbs	Least Concern	2.24
47	Spiny Milk Thistle	Sonchus asper	Herbs	Least Concern	2.37
48	Worm Seed	Chenopodium ambrosioides	Herbs	Least Concern	3.16
49	Red Spiderling	Boerhavia diffusa	Herbs	Least Concern	1.58
50	Horseweed	Conyza Canadensis	Herbs	Least Concern	2.11
51	Field Bindweed	Convolvulus arvensis	Herbs	Least Concern	2.50
52	False Mallow	Malvastrumcoromandelianum	Herbs	Least Concern	1.58
53	Turkey Tangle Frogfruit	Phyla nodiflora	Herbs	Least Concern	0.53
54	Jwarankush Grass	Cymbopogon iwarancusa	Grass	Least Concern	1.58

55	Couch Grass	<i>Cynodon dactylon</i>	Grass	Least Concern	2.11
56	Palwa Grass	<i>Dichanthium foveolatum</i>	Grass	Least Concern	2.37
57	Browntop Millet	<i>Brachiaria ramosa</i>	Grass	Least Concern	1.58
58	Birdwood Grass	<i>Cenchrus setigerus</i>	Grass	Least Concern	2.37
59	Tall Reed	<i>Phragmites karka</i>	Grass	Least Concern	1.32
60	Yellow Foxtail	<i>Setaria glauca</i>	Grass	Least Concern	1.71



Ricinus communis



Braussonetia papyrifera



Pinus roxburghii



Ficus benghalensis



Cacia fistula



Tamarix aphylla

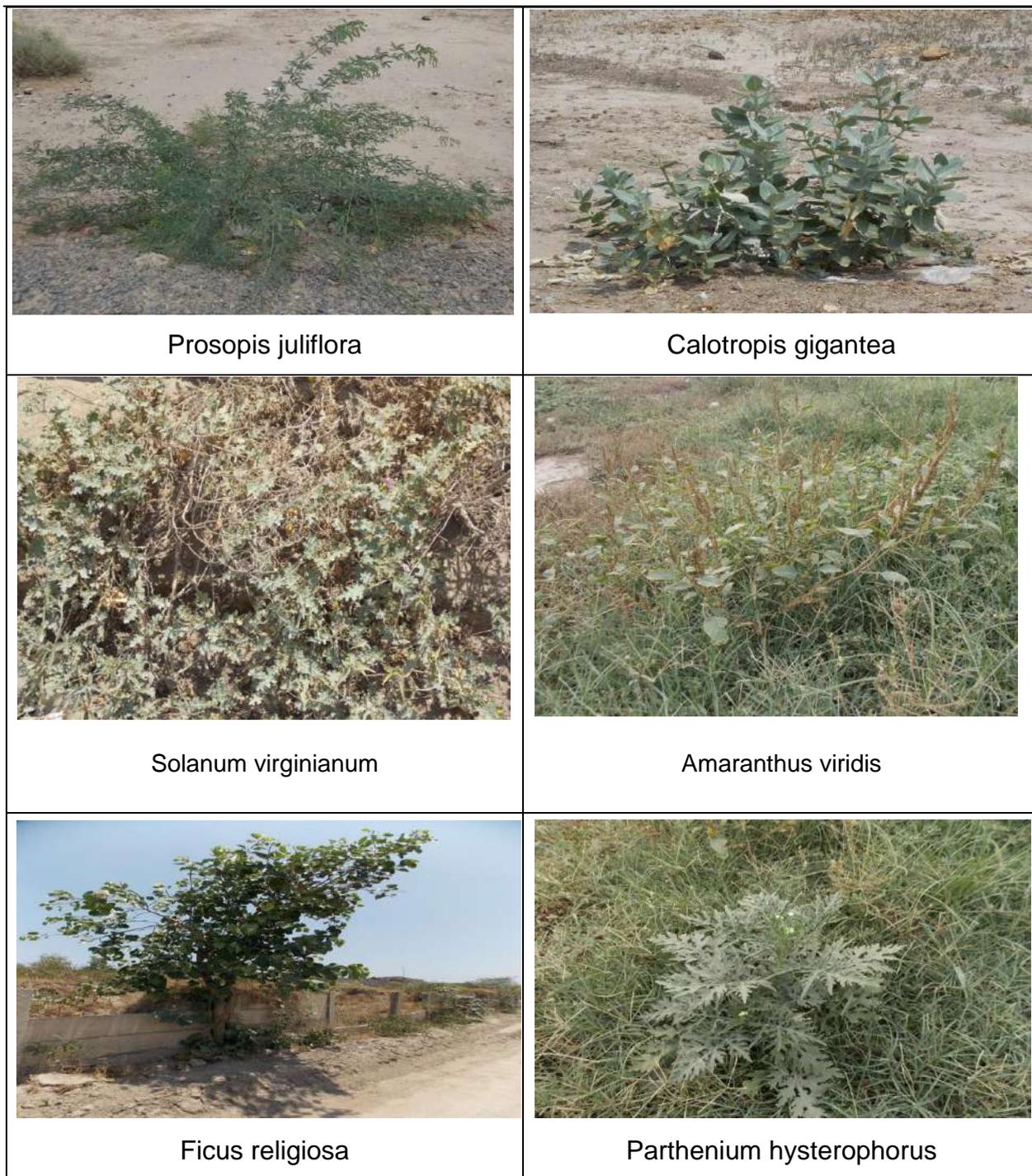


Figure 4-13 List of tree, shrub, herb, and grass species

IUCN Conservation Status

All plant species observed at the project site are classified as Least Concern (LC) under the IUCN Red List. No species of significant conservation concern were recorded during the survey. However, the habitat along both the right and left banks of the river is severely disturbed. While the area continues to support a plant community, deforestation by local communities residing along the river has significantly altered the natural vegetation composition. This disturbance threatens the ecological balance and reduces the habitat's capacity to support native flora and fauna. The forested habitats along the riverbanks are of particular ecological importance, as a large number of plant species were found in these areas. These forests also provide critical

shelter and foraging grounds for local wildlife. The forests normally contain Eucalyptus, and it is needed to plant indigenous plants.

Plantation by Parks and Horticulture Authority (PHA) at the site have included species such as Chir Pine (*Pinus roxburghii*), Kachnar (*Bauhinia variegata*), Amaltas (*Cassia fistula*), and Shukchain (*Pongamia pinnata*). While most of these species are suitable, Chir Pine is not naturally adapted to riverine or floodplain ecosystems. Its presence underscores the need to prioritize indigenous and ecologically appropriate species in future plantation activities to ensure compatibility with local environmental conditions. Furthermore, to enhance local biodiversity and promote ecological sustainability, the use of native plant species should be prioritized over exotic or non-native species. Such an approach will help restore the natural vegetation structure, support wildlife, and contribute to the long-term ecological resilience of the area. PHA must plan plantation modes keeping in view the proposed RUDA river alignment and the plantation near Saggian bridge drowned and site selection must be consulted to ensure plantation effectiveness.

4.2.6.2 Mammals

Punjab, located in northeastern Pakistan, is home to a diverse range of mammal species due to its varied landscapes, including plains, riverine forests, wetlands, and agricultural areas. The region supports both large and small mammals, including iconic species like the Indian leopard (*Panthera pardus*), wild boar (*Sus scrofa*), and Nilgai (*Boselaphus tragocamelus*), which are primarily found in forested and semi-arid regions. Medium-sized carnivores such as the Indian wolf (*Canis lupus*) and golden jackal (*Canis aureus*) also inhabit Punjab, where they contribute to maintaining ecological balance through their roles as predators and scavengers. Smaller mammals, including the Indian red fox (*Vulpes bengalensis*) and various rodent species, thrive in agricultural landscapes, while bats, like the Indian flying fox (*Pteropus giganteus*), are critical for pollination and insect control. However, these species face numerous challenges, including habitat fragmentation, poaching, and human-wildlife conflict, which threaten their populations. Conservation efforts are essential to protect these species, especially those that are endangered, such as the Indian wolf and the wild boar.^{15 16 17}

Punjab's mammalian fauna is diverse, with a mix of large, medium, and small species adapted to various habitats, including forests, grasslands, wetlands, and urban areas. However, many of these species face significant threats from habitat destruction, poaching, and human-wildlife conflict. Conservation efforts are crucial to protect the region's mammalian biodiversity, and ongoing monitoring is needed to assess population trends and ecological health.

Mammalian diversity along the Ravi River and similar riparian systems in Punjab has been relatively under-documented, though studies from nearby rivers offer useful insights. Altaf et al.

15 Gompper, M. E. (2010). The ecology of the Indian wolf in human-dominated landscapes. *Journal of Mammalogy*, 91(5), 1135-1145.

16 Javed, S., et al. (2015). Wildlife of Punjab: An Overview of Mammal Populations. *Pakistan Journal of Zoology*, 47(4), 1023-1030. Iqbal,

17 Roberts, T. J. (1997). *The Mammals of Pakistan*. Oxford University Press.

(2014) recorded 15 mammalian species in the Chenab Riverine Forest, noting moderate diversity levels based on the Shannon-Wiener Index. Similar surveys along the Sutlej River reported 266 individuals across 12 species, with rodents being the most dominant group (Sial et al., 2024). These findings suggest that the Ravi River's riparian corridors may support comparable assemblages of small and medium-sized mammals, depending on habitat conditions and human disturbance.

Survey Results

The mammalian survey conducted across the five major habitats wetlands, Belas (islands in floodplains), forested habitats, agricultural lands, and river channel and marshy areas revealed a community dominated by small to medium-sized mammals, with varying habitat preferences and relative abundances. The most abundant species recorded was the Indian Hare (12.06%), which was frequently observed in agricultural fields and open scrub, indicating its strong adaptability to cultivated and semi-natural environments. Similarly, Wild Boar (11.35%) showed high abundance, particularly in forested and floodplain areas, suggesting these habitats provide sufficient cover and foraging opportunities.

Rodents formed a significant component of the community, with both the House Rat (*Rattus rattus*) and House Mouse (*Mus musculus*) each contributing 9.93% to the overall abundance. Their presence across settlements, croplands, and marshy areas highlights their synanthropic tendencies and ecological flexibility. The Indian Porcupine (8.51%) and Kelaart's Pipistrelle (8.51%), both moderately abundant, were recorded in multiple habitats, including forested patches and Belas, indicating the presence of nesting and roosting niches in those areas.

The two mongoose species Indian Grey Mongoose (7.80%) and Small Indian Mongoose (7.09%) were commonly recorded near agricultural lands and riverbanks, likely due to the availability of prey such as rodents and insects. The Asiatic Jackal (6.38%) showed a wider distribution but was most frequently encountered in floodplain islands and forested edges, pointing to its generalist and opportunistic behavior.

Species with lower relative abundances, such as the Jungle Cat (2.13%), Soft-furred Field Rat, Palm Squirrel, and House Shrew (each around 4.26%), were more habitat-specific. For instance, Jungle Cats were primarily detected in marshy and wooded habitats, indicating their preference for less-disturbed environments. The presence of the Long-eared Hedgehog (3.55%) also suggests a diversity of microhabitats, especially within semi-arid open lands and Belas. The list of Mammalian fauna presented in Table 4-6.

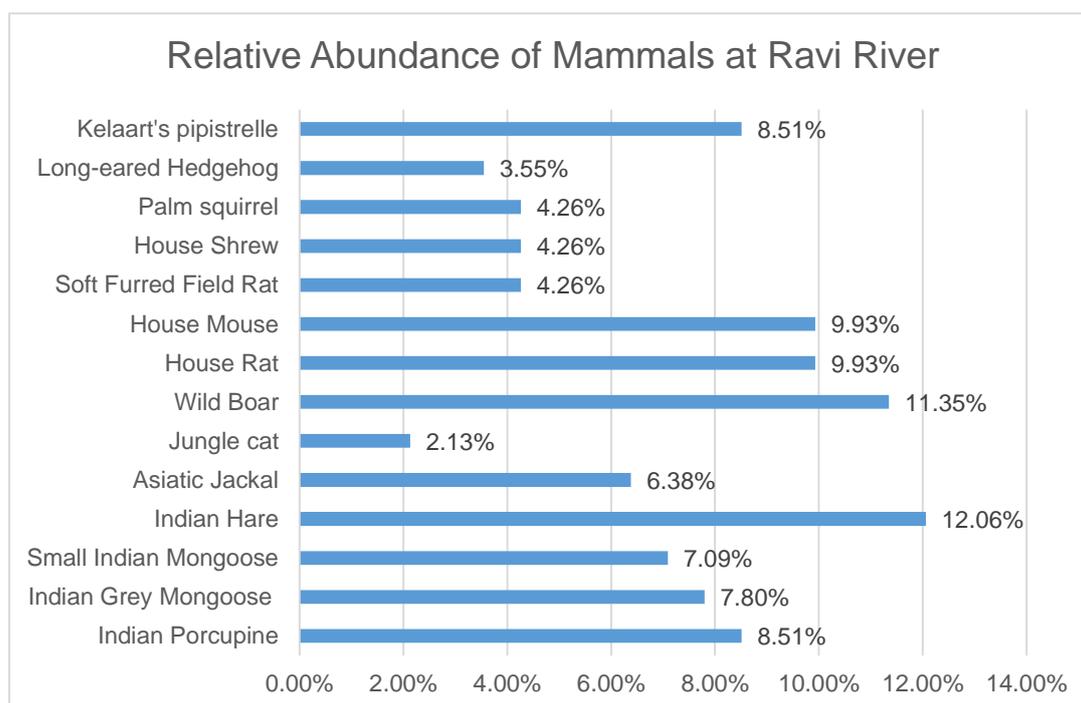
The mammalian fauna reflects a mix of generalist and specialist species, utilizing a variety of habitat types across the landscape. High relative abundances of species like hares, rodents, mongooses, and porcupines indicate both healthy trophic structures and habitat heterogeneity, making this data crucial for understanding mammalian community dynamics and guiding future conservation and land-use management decisions.

Table 4-6 List of Mammalian Fauna

Sr. #	Name of Species	Scientific Name	IUCN Status	Relative Abundance (%)
1	Indian Porcupine	<i>Hystrix indica</i>	Least Concern	8.51%
2	Indian Grey Mongoose	<i>Herpestes edwardsi</i>	Least Concern	7.80%
3	Small Indian Mongoose	<i>Herpestes javanicus</i>	Least Concern	7.09%
4	Indian Hare	<i>Lepus nigricollis</i>	Least Concern	12.06%
5	Asiatic Jackal	<i>Canis Aureus</i>	Least Concern	6.38%
6	Jungle cat	<i>Felis chaus</i>	Least Concern	2.13%
7	Wild Boar	<i>Sus scrofa</i>	Least Concern	11.35%
8	House Rat	<i>Rattus rattus</i>	Least Concern	9.93%
9	House Mouse	<i>Mus musculus</i>	Least Concern	9.93%
10	Soft Furred Field Rat	<i>Millardia meltada</i>	Least Concern	4.26%
11	House Shrew	<i>Suncus Murinus</i>	Least Concern	4.26%
12	Palm squirrel	<i>Funambulus pennantii</i>	Least Concern	4.26%
13	Long-eared Hedgehog	<i>Hemiechinus collaris</i>	Least Concern	3.55%
14	Kelaart's pipistrelle	<i>Pipistrellus ceylonicus</i>	Least Concern	8.51%

IUCN Conservation Status

All mammalian species observed within the project area along the Ravi River are classified as Least Concern (LC) according to the IUCN Red List of Threatened Species. The forested habitats along the riverbed provide essential cover, food resources, and shelter necessary to support



these species. Importantly, no species listed as threatened or of special conservation concern were recorded during the survey, indicating that the current mammalian community is relatively stable within this landscape. Continued conservation of these habitats will be vital to maintain the ecological balance and ensure the persistence of these mammal populations.

Figure 4-14 The Relative abundance of Mammalian species at project site

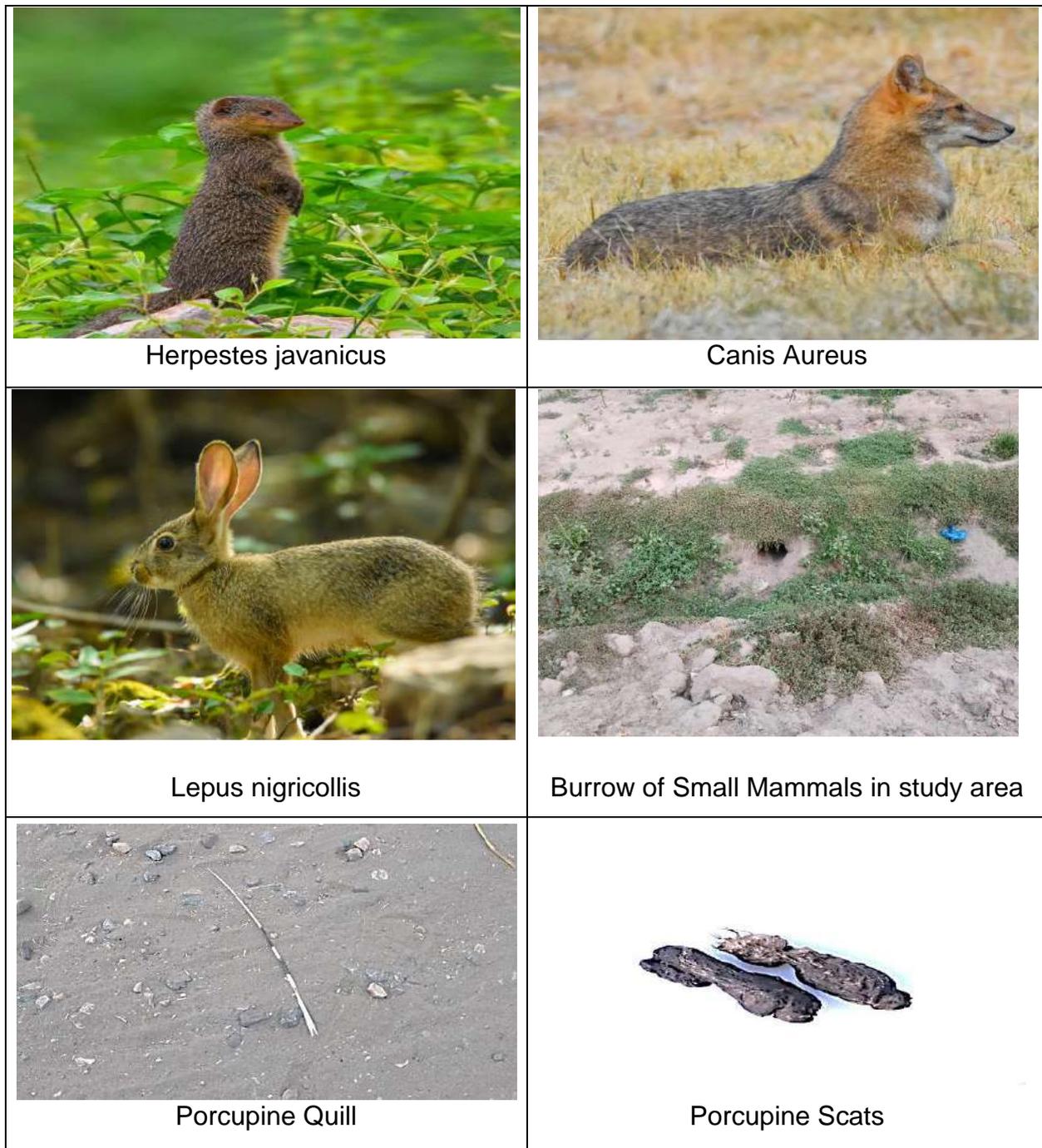


Figure 4-15 Small Mammalian Species

4.2.6.3 Birds

Punjab, Pakistan, is home to a rich diversity of bird species due to its varied landscapes, including wetlands, rivers, grasslands, and forests. The region hosts over 300 species of birds, including both migratory and resident species. Wetland areas, such as the Harike Wetland and the

Rasulpur Marshes, provide critical habitats for waterfowl like the bar-headed goose (*Anser indicus*), northern pintail (*Anas acuta*), and common coot (*Fulica atra*). Grasslands and agricultural fields are home to species like the Indian bush lark (*Mirafra assamica*), Eurasian skylark (*Alauda arvensis*), and common myna (*Acridotheres tristis*). Forested areas, particularly in the north, support species such as the white-throated kingfisher (*Halcyon smyrnensis*) and the Indian treepie (*Dendrocitta vagabunda*). Punjab also serves as a vital stopover for migratory birds on the Central Asian Flyway, with species such as the Siberian crane (*Grus leucogeranus*) and the Eurasian wigeon (*Mareca penelope*) passing through during their seasonal migrations. Despite the abundance of bird species, habitat destruction, hunting, and pollution pose significant threats to avian populations in the region. Conservation efforts, including the establishment of protected areas and wetland conservation, are crucial to safeguard these bird species and maintain biodiversity.¹⁸ Most common species in the area include Grey Heron *Ardea cinerea*, Little Egret *Egretta garzetta*, Intermediate Egret *Ardea intermedia*, Black Partridge *Melanoperdix niger*, Indian Grey Partridge *Francolinus pondicerianus*, Common Quail *Coturnix*, Black Winged Stilt *Himantopus*, Red Wattled Lapwing *Vanellus indicus*, Common Teal *Anas crecca*, Garganey Teal *Spatula querquedula*, Mallard *Anas platyrhynchos*, Rock Pigeon *Columba livia*, Indian Ring Dove *Streptopelia decaocto*, Laughing Dove *Spilopelia senegalensis*, Rose Ringed Parakeet *Psittacula krameri*, Spotted Little Owl *Athene brama*, Long Tailed Nightjar *Caprimulgus macrurus*, White Throated Kingfisher *Halcyon smyrnensis*, Eurasian Kingfisher *Alcedo atthis*, Little Green Bee Eater *Merops orientalis*, Pied Bushchat *Saxicola caprata* and Red Vented Bulbul *Pycnonotus cafer*.¹⁹

Survey Results

The analysis of bird species relative abundance provides valuable insights into the ecological composition and habitat quality of the study area. The results show that a few species dominate the avian community, with Black Kite (13.70%), Bank Myna (7.67%), House Sparrow (7.12%), House Crow (6.58%), and Green Bee-eater (5.21%) having the highest relative abundances. These species are highly adaptable generalists and are commonly associated with human-modified landscapes such as urban settlements, agricultural fields, and open spaces. Their dominance suggests a significant level of anthropogenic influence on the ecosystem, likely due to habitat alteration, fragmentation, or urban expansion.

In contrast, a larger number of species exhibit moderate relative abundance values (1–5%), including the Red-Wattled Lapwing (4.66%), Common Myna (4.93%), Blue-tailed Bee-eater (3.01%), and Cattle Egret (2.74%), among others. These species, while not as dominant, are still commonly observed and may indicate the presence of semi-natural or mixed-use habitats. Their

¹⁸ Grimmett, Richard, Tom J. Roberts, Tim Inskipp, and Clive Byers. *Birds of Pakistan*. A&C Black, 2008.

¹⁹ Avibase, The World Birds Data, Available at: <https://avibase.bsc-eoc.org/checklist.jsp?region=PKis01>, Accessed on December 26, 2024.

distribution across various ecological niches underscores the area's habitat heterogeneity, which supports a range of avian guilds.

Species with low relative abundance (less than 1%) form the majority of the species list. These include birds such as the Greater Painted Snipe (0.27%), Black Bellied Tern (0.27%), Little Grebe (0.27%), and various prinias and babblers. While these species occur infrequently, their presence is ecologically significant as they often represent habitat specialists, migratory visitors, or taxa sensitive to environmental changes. Their low abundance may reflect specific habitat requirements, seasonal variability, or the effects of habitat degradation and disturbance. The details of bird's species along with their relative abundance given in Table 4.

Notably, the presence of wetland-dependent species such as Kingfishers, Common Moorhen, and White-breasted Water hen indicates the availability of aquatic or marshy habitats, though their relatively low abundance suggests these ecosystems may be fragmented or under pressure. Conversely, species typically associated with forested areas were observed at lower frequencies, implying that forest habitats within the study area may be limited in extent or quality.

Overall, the relative abundance data highlights a bird community structure shaped by a mixture of natural and human-influenced habitats. The dominance of generalist species suggests ecological simplification, while the continued presence of less common species points to remnant or microhabitat diversity. These findings serve as a useful ecological baseline, essential for monitoring changes in biodiversity over time and for informing habitat conservation and land-use management strategies in the region.

The avifaunal survey across the five major habitat types wetlands, Belas (islands in floodplains), forested habitats, agricultural lands, and river channel and marshy habitats revealed distinct patterns of habitat usage by bird species. Agricultural lands supported the highest bird diversity and abundance, with species such as House Sparrow, Bank Myna, Black Kite, and Common Myna being particularly prevalent. These species are well adapted to open and modified landscapes and benefit from human-associated resources. Belas and floodplain islands also showed high bird activity, especially for species like Green Bee-eater, Red-Wattled Lapwing, and House Crow, which exploit the mixed vegetation and open spaces typical of these areas.

Wetlands and marshy river channels were crucial habitats for several water-dependent birds such as White-breasted Waterhen, Common Kingfisher, Pied Kingfisher, and Indian Pond Heron, highlighting the ecological importance of aquatic habitats in supporting specialist species. Although fewer in number, forested habitats hosted a range of canopy and understory birds including the Black-rumped Flameback, Coppersmith Barbet, and Spotted Owlet, suggesting the presence of fragmented yet functional woodland patches. The distribution of birds across these habitats indicates a mosaic landscape where both generalist and specialist species coexist, each utilizing different ecological niches. These habitat-specific observations provide a comprehensive baseline for evaluating habitat integrity, biodiversity health, and future conservation planning.

It is important to note that the practice of providing food offerings, locally known as "sadqa," for birds near river bridges has resulted in an unnatural concentration of Black Kites and House Crows. This artificial food source encourages their overpopulation, leading to increased disturbance and competition, which can negatively impact the natural composition and behavior of the local bird community. Managing such practices is essential to maintaining ecological balance and preserving the diversity of native avifauna of Ravi River. Table 4-7 List of Avian Fauna recorded during the ecological survey at Project site.

Table 4-7 List of Avian Fauna

Sr. #	Name of Species	Scientific Name	IUCN Status	Relative Abundance (%)
1	Common Quail	Coturnix coturnix	Least Concern	1.369863
2	Black-Rumped Flameback	Dinopium benghalense	Least Concern	0.821918
3	Coppersmith Barbet	Psilopogon haemacephalus	Least Concern	0.5479
4	Common Hoopoe	Upopa epops	Least Concern	1.09589
5	Indian roller	Coracias benghalensis	Least Concern	0.5479
6	Common Kingfisher	Alcedo atthis	Least Concern	1.09589
7	White Thorated Kingfisher	Halcyon smyrnensis	Least Concern	1.9178
8	Pied kingfisher	Ceryle rudis	Least Concern	0.821918
9	Green bee eater	Merops orientalis	Least Concern	5.2054
10	Blue tailed bee eater	Merops philippinus	Least Concern	3.0136
11	Greater Coucal	Centropus sinensis	Least Concern	0.821918
12	Rose Ringed Parakeet	Psittacula krameri	Least Concern	0.5479
13	House Swift	Apus affinis	Least Concern	1.6438
14	Spotted Owlet	Athene brama	Least Concern	0.821918
15	Blue Rock Pigeon	Columba livia	Least Concern	2.4657

16	little brown dove	Streptopelia senegalensis	Least Concern	1.9178
17	Collared Dove	Streptopelia decaocto	Least Concern	1.6438
18	White breasted hen	Amaurornis phoenicurus	Least Concern	1.6438
19	Common Moorhen	Gallinula chloropus	Least Concern	0.5479
20	Common Sand piper	Actitis hypoleucos	Least Concern	0.5479
21	Greater Painted Snipe	Rostratula benghalensis	Least Concern	0.2739
22	Little Ringed Plover	Charadrius dubius	Least Concern	0.5479
23	Red-Wattled Lapwing	Hoplopterus indicus	Least Concern	4.6575
24	Black Bellied Tern	Sterna acuticauda	Least Concern	0.2739
25	Black Shouldered Kite	Elanus axillaris	Least Concern	1.3698
26	Black Kite	Milvus migrans	Least Concern	13.6986
27	Shikra	Accipiter badius	Least Concern	0.821918
28	White Eyed Buzzard	Butastur teesa	Least Concern	0.2739
29	Little Grebe	Tachybaptus ruficollis	Least Concern	0.2739
30	Little Egret	Egretta garzetta	Least Concern	0.5479
31	Cattle Egret	Bubulcus ibis	Least Concern	2.7397
32	Indian Pond Heron	Ardeola grayii	Least Concern	2.7397
33	Bay Backed Shrike	Lanius vittatus	Least Concern	1.3698

34	Long Tailed Shrike	Lanius schach	Least Concern	0.2739
35	Rufous Treepie	Dendrocitta vagabunda	Least Concern	0.5479
36	House Crow	Corvus splendens	Least Concern	6.5753
37	Black Drongo	Dicrurus macrocerus	Least Concern	1.9178
38	Indian Robin	Copsychus fulicatus	Least Concern	1.09589
39	Pied Bushchat	Saxicola caprata	Least Concern	0.821918
40	Common Myna	Acridotheres tristis	Least Concern	4.9315
41	Bank Myna	Acridotheres ginginianus	Least Concern	7.67123
42	Plain Martin	Riparia paludicola	Least Concern	0.821918
43	Red Vented Bulbul	Pycnonotus cafer	Least Concern	0.2739
44	Rufous Vented Prinia	Laticilla burnesii	Least Concern	0.2739
45	Rufous Fronted Prinia	Prinia buchanani	Least Concern	0.2739
46	Plain Prinia	Prinia inornata	Least Concern	0.2739
47	Oriental White Eye	Zosterops palpebrosus	Least Concern	0.5479
48	Common Tailorbird	Orthotomus sutorius	Least Concern	0.2739
49	Yellow Eyed Babbler	Chrysomma sinense	Least Concern	0.821918
50	Common Babbler	Argya caudata	Least Concern	1.09589
51	Jungle Babbler	Argya striata	Least Concern	1.9178
52	Crested Lark	Galerida cristata	Least Concern	0.821918
53	Purple Sunbird	Cinnyris asiaticus	Least Concern	1.09589

54	House Sparrow	<i>Passer domesticus</i>	Least Concern	7.1232
55	White Browed Wagtail	<i>Motacilla maderaspatensis</i>	Least Concern	0.5479
56	Baya Weaver	<i>Ploceus philippinus</i>	Least Concern	0.5479
57	Indian Silverbill	<i>Euodice malabarica</i>	Least Concern	0.821918



House Crow



House Sparrow



Crested Lark



White Throated Kingfisher



Bay Backed Shrike



Black Kite



Red Wattled Lapwing



Ringed Plover



White Burrowed Wagtail



Black Kites



Bank Myna



Little Egret

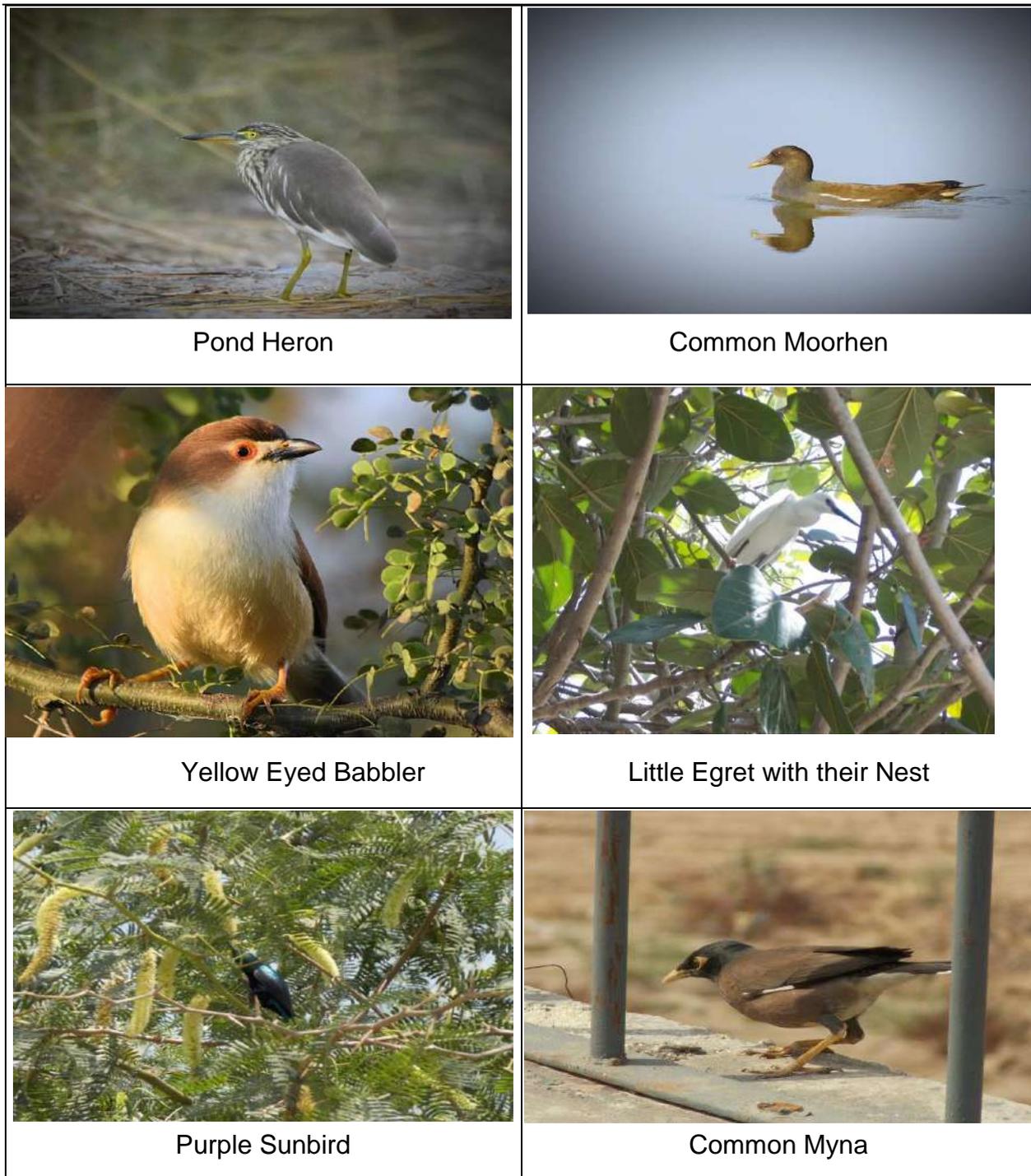


Figure 4-16 Avian fauna

IUCN Conservation Status

All bird species recorded within the project area along the Ravi River are listed as Least Concern according to the IUCN Red List of Threatened Species. The project site, located along the riverbed, includes forested and riparian habitats that provide essential resources such as food, nesting sites, and cover for various avian species. No bird species of conservation concern were observed during the survey. As the survey was conducted during the summer season, migratory bird species were not recorded. However, the presence of species such as the Greater Painted Snipe, Black-bellied Tern, Little Grebe, and Little Ringed Plover indicates that the habitat holds potential for supporting migratory and wetland-dependent birds. With appropriate conservation

measures, such as habitat protection and management, these areas could serve as important stopover or wintering grounds. Additionally, the presence of Rubber Dams/Weirs may create future opportunities for wetland development, potentially enhancing the site's value for migratory birds during the winter months. If managed properly, this could significantly improve the ecological character of the area in terms of avifaunal diversity and abundance.

4.2.6.4 Herpetofauna

Reptiles are highly habitat-specific, and therefore occupy small niches. Unlike birds and mammals that have very wide foraging ranges, reptiles have a restricted home range. Except for monitor lizards and large snakes, other species usually stay within an area of about a square kilometer (m²) for feeding and breeding. Pakistan represented a total of 219 species of herpetofauna including 24 amphibians and 195 reptiles. Of them nine amphibian and 13 reptilian species are endemic to Pakistan.²⁰

Punjab, supports a diverse range of reptile and amphibian species, due to its varied ecosystems, including wetlands, grasslands, and riverine areas. The region is home to several species of snakes, lizards, and turtles, such as the common krait (*Bungarus caeruleus*), the Indian cobra (*Naja naja*), and the monitor lizard (*Varanus bengalensis*). The Indus River and its tributaries provide habitats for aquatic reptiles like the Indian softshell turtle (*Nilssonina gangetica*) and the marsh crocodile (*Crocodylus palustris*). Amphibians in the region include species like the Indian bullfrog (*Hoplobatrachus tigerinus*) and the common toad (*Bufo bufo*), which thrive in the region's wetlands and agricultural fields. These species play vital roles in maintaining ecosystem health by controlling insect populations and acting as prey for larger animals. However, habitat loss, pollution, and over-exploitation for the pet trade and traditional medicine pose significant threats to many reptile and amphibian species in Punjab. Conservation efforts are crucial to preserve these species and their habitats.^{21 22}

Herpeto faunal diversity near the Ravi River is supported by a range of microhabitats including riverbanks, wetlands, and forest patches. Rais et al. (2012) recorded 35 species in North Punjab, including 30 reptiles and 5 amphibians. A more extensive survey by Ali (2020) documented 43 herpetofaunal species across Punjab, including frogs, turtles, lizards, and snakes. These species play crucial roles in ecosystem functioning and serve as bio indicators of environmental health.

²⁰ Ali, W., Javid, A., Hussain, A., & Bukhari, S. M. (2018). Diversity and habitat preferences of amphibians and reptiles in Pakistan: a review. *Journal of Asia-Pacific Biodiversity*, 11(2), 173-187.

²¹ Ahmad, M., & Tufail, M. (2013). Amphibians and Reptiles of Punjab, Pakistan. *Journal of Biodiversity and Environmental Sciences*, 3(6), 122-130.

²² Khan, M. S. (2006). *The Reptiles of Pakistan*. Oxford University Press.

Survey Results

The herpetofaunal assessment across five major habitat types wetlands, Belas (floodplain islands), forested habitats, agricultural lands, and river channels and marshy areas documented a diverse group of reptiles and amphibians, with clear patterns of habitat preference and ecological distribution. Amphibians were notably abundant in moist habitats, with the Indus Valley Toad (15.38%) and Skittering Frog (15.38%) being the most frequently recorded, primarily in seasonal wetlands, agricultural fields, and lowland floodplains. The Indian Bull Frog (10.25%) was widely observed in riverine habitats and irrigated lands, highlighting its affinity for open water bodies.

Among reptiles, species such as the Oriental Garden Lizard, Bengal Monitor Lizard, and Rat Snake (each 7.69%) were commonly distributed across agricultural zones, Belas, and forest edges, demonstrating their ecological flexibility. The Marbled Balloon Frog (7.69%) also appeared frequently in temporary pools and cultivated lands, thriving in monsoon-dependent microhabitats.

Species with lower relative abundance like the Spiny-tailed Lizard (2.56%), Indian Krait (2.56%), and the Indian Softshell Turtle (2.56%) were more habitat-restricted and of greater conservation concern. The Spiny-tailed Lizard, categorized as Vulnerable, was found only in arid and sandy patches of floodplain islands, and is under pressure due to illegal poaching for meat and traditional medicine. Similarly, the Indian Flapshell Turtle and Brown Roofed Turtle (each 5.12%), and particularly the Endangered Indian Softshell Turtle, are increasingly at risk due to habitat loss and illicit wildlife trade, especially in local wet markets and for consumption. The relative abundance of species presented in Table No. 5.

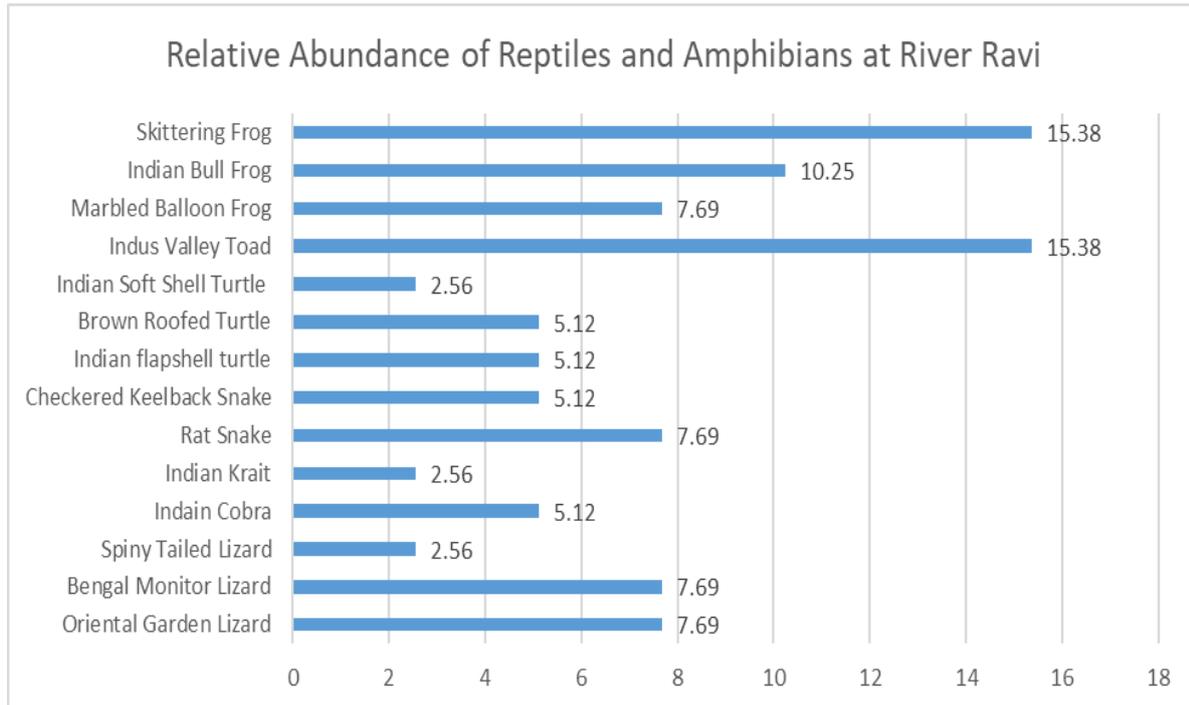
The results reflect a complex and ecologically rich assemblage of herpetofauna shaped by the mosaic of habitats in the region. The presence of both ecological generalists and specialist species, including several facing illegal trade threats, underscores the urgent need for habitat protection, enforcement against poaching, and awareness programs as part of broader biodiversity conservation and management efforts. Table 4-8 List of Herpetofauna recorded during the ecological survey at Project site.

Table 4-8 List of Herpetofauna

Sr. #	Name of Species	Scientific Name	IUCN Status	Relative Abundance (%)
1	Oriental Garden Lizard	Calotes versicolor	Least Concern	7.69

2	Bengal Monitor Lizard	Varanus bengalensis	Near Threatened	7.69
3	Spiny Tailed Lizard	Saara hardwickii	Vulnerable	2.56
4	Indain Cobra	Naja naja	Least Concern	5.12
5	Indian Krait	Bungarus caeruleus	Least Concern	2.56
6	Rat Snake	Ptyas mucosa	Least Concern	7.69
7	Checkered Keelback Snake	Xenochrophis piscator	Least Concern	5.12
8	Indian flapshell turtle	Lissemys punctata	Vulnerable	5.12
9	Brown Roofed Turtle	Pangshura smithii	Near Threatened	5.12
10	Indian Soft Shell Turtle	Nilssonina gangetica	Endangered	2.56
11	Indus Valley Toad	Duttaphrynus stomaticus	Least Concern	15.38
12	Marbled Balloon Frog	Uperodon systoma	Least Concern	7.69
13	Indian Bull Frog	Hoplobatrachus tigrinus	Least Concern	10.25
14	Skittering Frog	Euphlyctis cyanophlyctis	Least Concern	15.38

Figure 4-17 Relative Abundance of Herpetofauna



Hoplobatrachus tigrinus



Duttaphrynus stomaticus



Nilssonina gangetica



Pangshura smithii

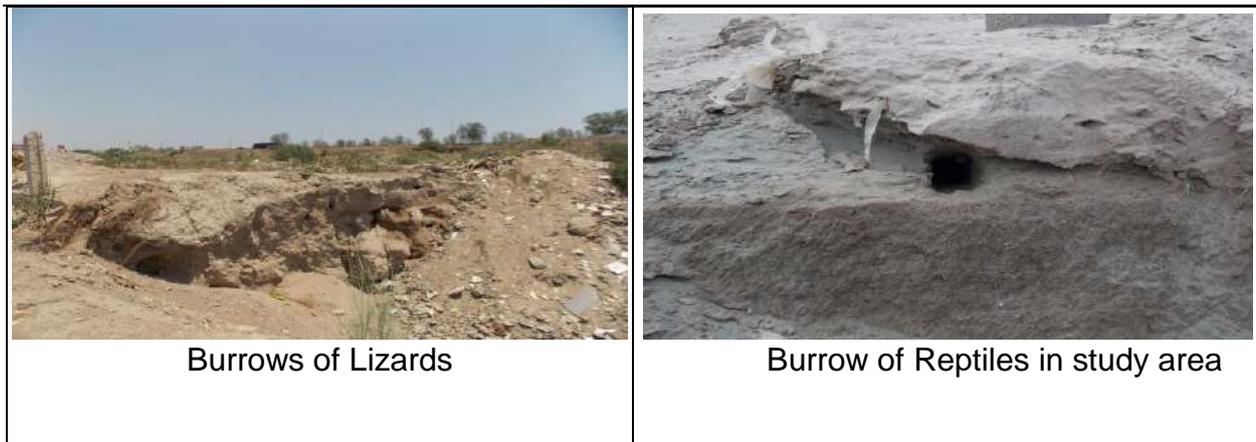


Figure 4-18 Herpetofauna

IUCN Conservation Status

The herpetofaunal survey revealed that while the majority of reptile and amphibian species recorded at the project site are listed as Least Concern on the IUCN Red List of Threatened Species, several notable exceptions highlight important conservation priorities. The Spiny-tailed Lizard (*Saara hardwickii*), categorized as Vulnerable, was observed in limited arid and sandy habitats on floodplain islands (Belas), where it remains under significant pressure from illegal poaching for its meat and perceived medicinal value. Additionally, the Indian Softshell Turtle (*Nilssononia gangetica*), listed as Endangered, was recorded in wetland areas and faces serious threats from habitat degradation and illegal trade, particularly in local wet markets. The Indian Flapshell Turtle (*Lissemys punctata*) and Brown Roofed Turtle (*Pangshura smithii*), both of which are Near Threatened, were also found in aquatic habitats and are similarly vulnerable to exploitation and environmental disturbances. These findings emphasize the urgent need for targeted conservation actions, stricter wildlife protection enforcement, and community-based awareness initiatives to safeguard the region's declining herpetofaunal diversity.

4.2.6.5 Fish Fauna

Ichthyofaunal surveys reveal high diversity but declining ecological health in the Ravi River. Rafique and Khan (2012) recorded 68 fish species from 14 families, noting the presence of invasive species like *Cyprinus carpio* and *Hypophthalmichthys molitrix*. Another study documented 50 species and observed seasonal variations in abundance, with lower diversity during dry flow periods (Ashraf et al., 2024). These shifts are linked to pollution, flow regulation, and habitat fragmentation.

Survey Results

A total of 10 fish species were recorded during the aquatic biodiversity assessment, all falling under the "Least Concern" category according to the IUCN Red List. This indicates a relatively healthy and stable fish community within the surveyed aquatic habitat, with no immediate conservation concerns identified at the species level.

Among the recorded species, Tilapia (*Oreochromis aureus*) was the most dominant, showing a relative abundance of 24.49%, making it the most frequently encountered species. Its high abundance may be attributed to its adaptability, rapid breeding, and tolerance to varying environmental conditions, which often leads to its dominance in semi-natural or managed water bodies.

Following Tilapia, Daula (*Channa punctata*) was the second most abundant species, comprising 18.37% of the total individuals observed. This native species is well-adapted to a range of freshwater habitats and plays a significant ecological role as a mid-level predator. Ray-finned fish (*Osteobrama cotio*) also contributed significantly, with a relative abundance of 14.29%, suggesting its strong presence in the local ichthyofauna.

Other important species included Gulfam (*Cyprinus carpio*) at 10.20%, Mori (*Cirrhinus mrigala*) and Silver Carp (*Hypophthalmichthys molitrix*) each at 8.16%, indicating their moderate representation. These species are commonly found in managed and natural freshwater systems across South Asia and are often associated with fisheries and aquaculture practices.

Species like Rohu (*Labeo rohita*) and Thaila or Indian Carp (*Catla catla*) were each recorded at 6.12% relative abundance, reflecting their consistent yet not dominant presence in the ecosystem. Lastly, Saul (*Channa marulius*) and Khagga (*Rita rita*) showed the lowest abundances, both at 2.04%, suggesting either natural rarity, specific habitat preference, or potential ecological pressures limiting their distribution within the study area. The List of fish fauna recorded during the ecological survey at Project site presented in Table No. 6.

The fish community structure is primarily dominated by Tilapia and Daula, with a relatively even distribution among other common species. The presence of both native and introduced species highlights a mixed composition, typical of many South Asian freshwater systems influenced by fisheries and aquaculture activities. Continued monitoring is recommended to track population trends and assess potential ecological impacts of dominant or introduced species on native fish diversity. Table 4-9 List of Fish fauna recorded during the ecological survey at Project site.

Table 4-9 List of Fish fauna

Sr. #	Name of Species	Scientific Name	IUCN Status	Relative Abundance (%)
1	Gulfam	<i>Cyprinus carpio</i>	Least Concern	10.20
2	Mori	<i>Cirrhinus mrigala</i>	Least Concern	8.16
3	Tilapia	<i>Oreochromis aureus</i>	Least Concern	24.49

4	Rohu	Labeo rohita	Least Concern	6.12
5	Daula	Channa punctate	Least Concern	18.37
6	Indian carp	Catla catla	Least Concern	6.12
7	Silver carp	Hypophthalmichthys molitrix	Least Concern	8.16
8	Ray Finned Fish	Osteobrama cotio	Least Concern	14.29
9	Saul	Channa marulius	Least Concern	2.04
10	Khagga Fish	Rita rita	Least Concern	2.04

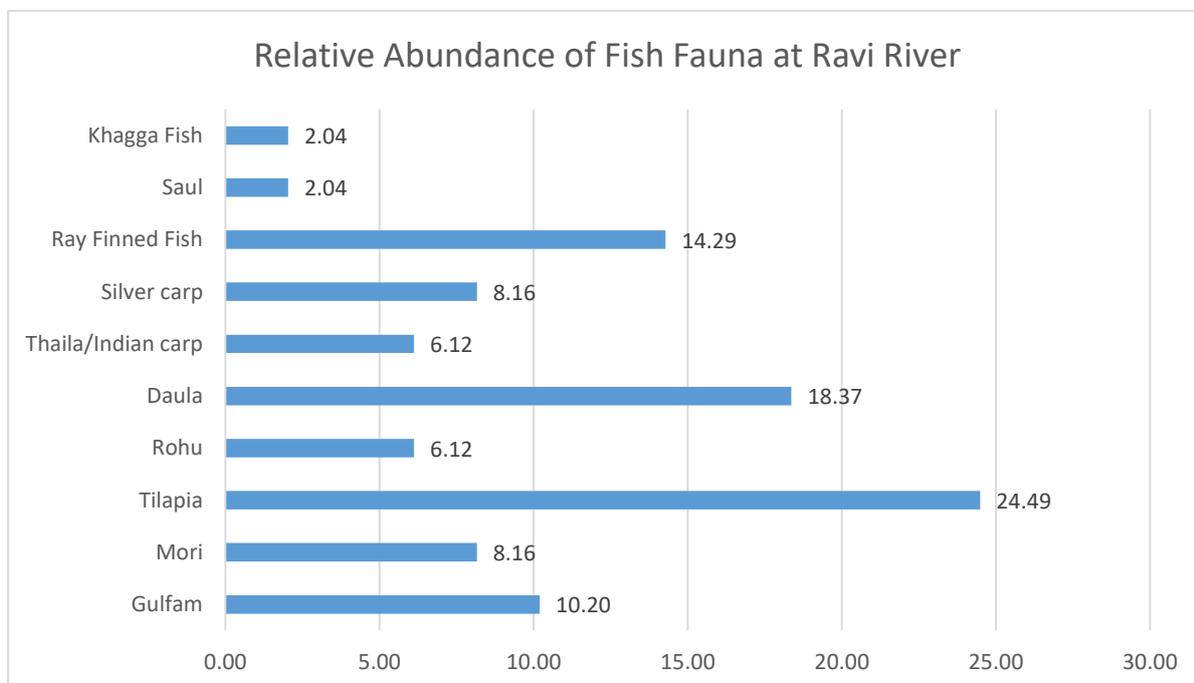


Figure 4-19 Relative Abundance of Fish fauna recorded

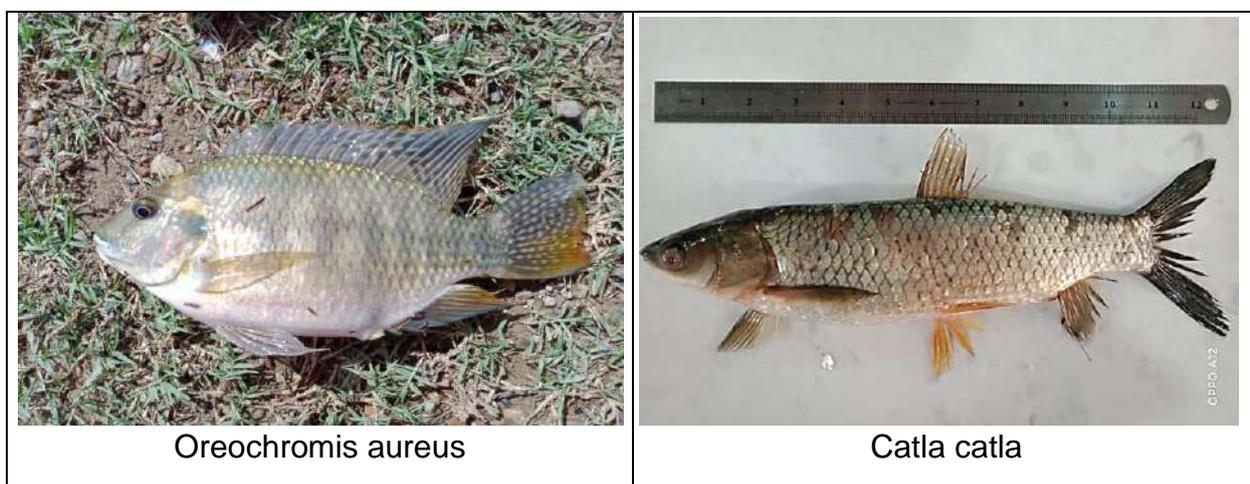




Figure 4-20 Fish fauna

IUCN Conservation Status

All ten fish species recorded during the aquatic biodiversity assessment of the Ravi River project area are classified as Least Concern (LC) according to the IUCN Red List of Threatened Species. This status indicates that none of the species currently face significant extinction risk at the global level, suggesting a relatively stable and ecologically functioning fish community within the surveyed habitats. The absence of threatened or endangered species is a positive indicator of current habitat health and water quality in this section of the river. Additionally, according to the Fisheries Department, this stretch of the river has been designated for recreational angling only, with no commercial harvesting allowed. This restriction likely contributes to the observed stability in fish populations and helps maintain biodiversity. However, ongoing monitoring is essential to detect early signs of ecological stress, especially given the presence of introduced or aquaculture-associated species like Tilapia, which may influence the composition and dynamics of native fish communities over time.

4.3 Socio-Economic Aspects

The socioeconomic baseline covers the demography, administrative and political settings, religious and cultural, economic aspects, infrastructure and facilities, security situation, gender, NGOs and CBOs and ecosystem services.

To document the socio-economic conditions of the population settled in the Project Area, social surveys of the selected House Holds (HH) were carried out. One of the major steps after the identification of the affected areas and their estimated populations during the initial survey of May 2024 was the calculation of sample size. Some of settlements fall near the Project Area comprise about 15000 individuals. Socio-economic survey was conducted in these areas. Socio-economic survey was carried out Abu-Bakr Siddique colony, Taragarh, Begum Kot and near Ravi bank areas to take maximum information of the Project Area. Based on social survey, approximate a number of HH and their population were estimated.

- The basic objectives of the social surveys were to:
- Observe and document the existing socio-cultural settings of the study area;
- Identify the potential impacts associated with the implementation of the proposed project;
- Get feedback from community about existing and potential social issues; and
- Evaluate the possibilities of addressing them in the report.

Socio-economic survey of the selected households of the study area was carried out. Baseline information was collected from direct and indirect affectees during the field visit. The people whose land, houses and shops or any other structure will be directly affected called direct PAPs while indirectly affected are those people who will have to face impacts of proposed project. Persons who are directly affected due to the land acquisition are termed as PAPs in the report.

4.3.1 General Description of the Project Area

The Project Area of proposed project falls in district Lahore. PAPs socio-economic condition, family size, educational status and concerns related to the project are same as Study area people.

4.3.2 Major settlements

- Begum Kot;
- Abubakar Colony;
- Taragarh; and
- Ravi River Bank small settlements.

4.3.3 Methodology

Relevant secondary data/information was collected from various departments at the central and the provincial level was cross checked to establish their authenticity.

Both qualitative and quantitative assessment were done for the social assessment study covering different social environment parameters of the project location by interacting with social groups and relevant stakeholders of the project area. Quantitative survey methods involved filling up of

questionnaires at local areas and household levels by investigators recruited locally. The questionnaires contained mostly structured questions for collection of the required data.

The study area for socio-economic survey includes the areas which will be directly and indirectly affected due to the proposed Project activities. Estimated population for the calculation of sample size for social survey in the study area is taken from the locals through social survey.

The sample size of 140 households was calculated based on the Standard Statistical Formula using a confidence level of 95% (which is frequently used in social research) and confidence interval of 10%. The calculated samples size was distributed proportionately among the nearby settlements. The houses of these settlements were identified and counted by using freely available Google Earth imagery and verified by conducting socio-economic field surveys. The households were selected by using random sampling technique, a type of probability sampling. Questionnaires were developed to collect the baseline data, based on the demographic and socio-economic indicators. Interviewing technique was used as a tool for data collection. In order to quantify the existing baseline conditions of the study area, collected data was digitized and analysed by using Statistical Package for Social Sciences (SPSS) software

In addition, the survey was followed by public consultations at the provincial, district and village levels through Group Discussions, Key Informant Interviews, and Participatory Observation, using a checklist of issues/ aspects. Besides, a census and socio-economic survey were conducted on the affected people and the households likely to be displaced by the project.

The detailed survey was conducted in the study area May 2025, interviewing 140 sample respondents at household level covering nearby above-mentioned settlements of the project area.

4.3.4 Task Specific Approach

During the social survey, full concentration was given to identify areas of impacts and collection of necessary data/information on the existing social environment (economic, social, cultural etc.). This was done by holding discussions / meetings followed by in-depth survey and administering structured / semi-structured questionnaires. Assessment was also made about the project impact on the livelihood of the people.

4.3.5 Discussion with Officials

The Consultant had frequent discussions with the client and the concerned project officers and the staff to get a clear understanding about the project. This facilitated sharing of ideas, conceptual clarity and minimized constraints in carrying out the task. Different government department relevant to this study was consulted in Lahore such as EPD, Forest Department, Agriculture Department, LWMC etc.

4.3.6 Reconnaissance Field visit

A reconnaissance visits to the project, before conducting detailed survey was conducted in April 2025 by the consultant, helped in collection of necessary data/information for primary assessment through consultations with project stakeholders including project beneficiaries and project affected persons. In addition, a preliminary social survey was also conducted and the results used as inputs in designing the detailed survey.

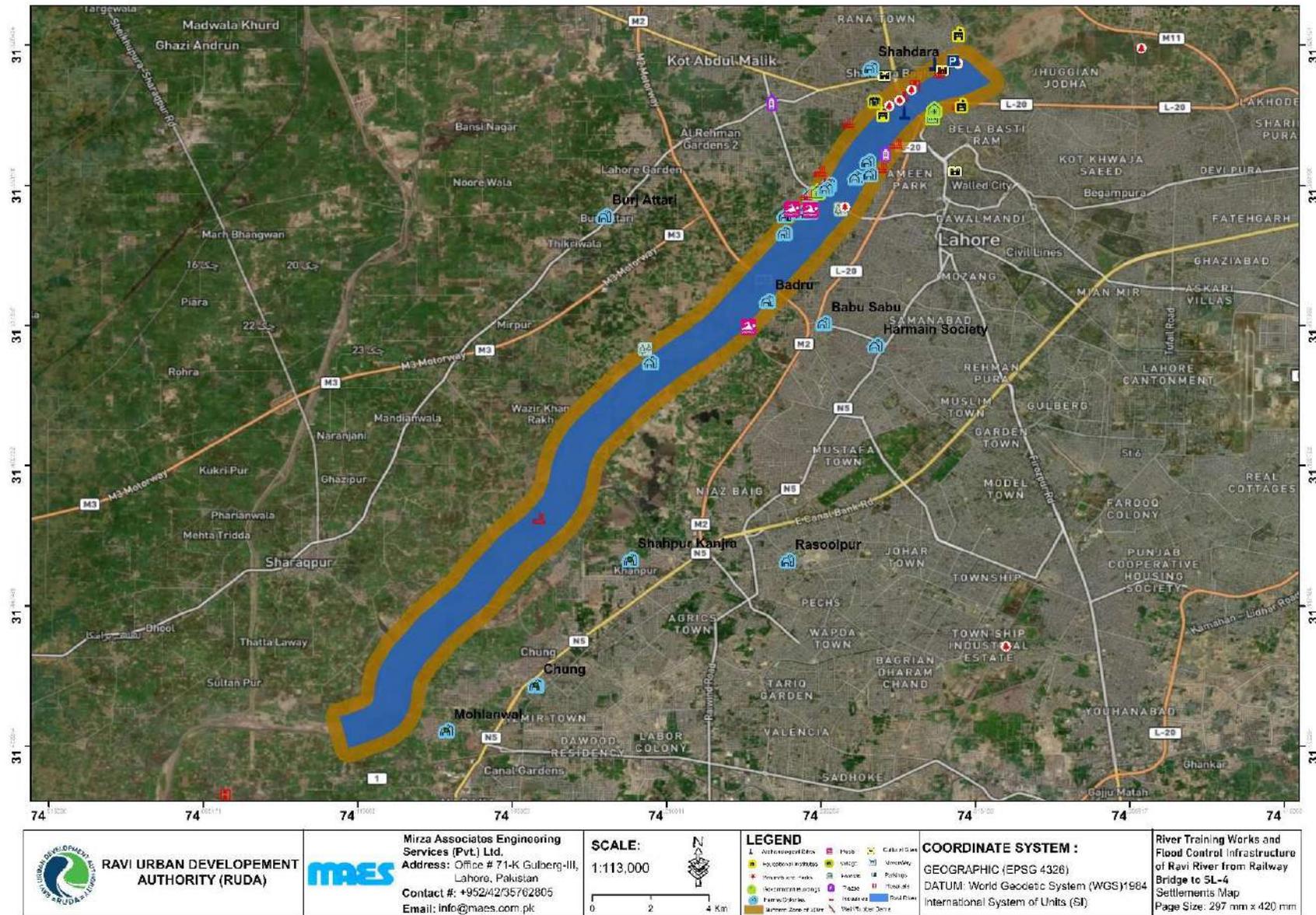


Figure 4-21 Settlements

4.3.7 Data Collection and Field Survey

The Consultant conducted field survey/investigation on various socio-economic aspects to assess the existing socio-economic environment of the project as well as identify likely impacts under a changing situation with and without the project. Accordingly, the social study covered the beneficiaries, the affected people, concerned stakeholders and NGOs working in the area and elicited their views / suggestions for mitigation / enhancement of different types of impacts. The survey adopted both qualitative and quantitative approach through structured / semi-structured questionnaire for interviews and a checklist of issues for discussions.

Figure 4-22 Public Consultation



4.3.8 Community/Stakeholders' Participation

A number of community consultations with different stakeholders, beneficiaries and affected communities of the project area were organised to facilitate stakeholders' / peoples' participation in the project activities of the proposed treatment plant and incorporate their views and feedbacks for planning/preparation of the project. Such consultations would strengthen the commitment of a wide cross-section of the affected people, public representatives, government employees, professional groups, voluntary groups including NGOs, community-based organizations by giving them an opportunity to participate in key decisions.

4.3.9 Administrative and Political Settings

The Mayor of Lahore is the leader of the municipal government of Lahore (Metropolitan Corporation Lahore) in Lahore, Punjab, Pakistan. The mayor is directly-elected in municipal elections every four years alongside 9 deputy town mayors. The mayor is responsible for the administration of government services, the composition of councils and committees overseeing Lahore City District departments and serves as the chairperson for meeting of Lahore Council.

The mayor is responsible for the administration of government services, the composition of councils and committees overseeing Lahore City District departments and serves as the chairperson for meeting of Lahore Council. The mayor also functions to help devise long term

development plans in consultation with other stakeholders and bodies to improve the condition, liveability, and sustainability of urban areas.

Lahore is comprised of two tehsils i.e. Lahore city and Lahore Cantt. While these tehsils are further divided into nine towns as under:

- Nishtar Town;
- Gulberg Town;
- Aziz Bhatti Town;
- Allama Iqbal Town;
- Ravi Town;
- Shalamar Town;
- Samanabad Town;
- Wahgah Town;
- Data GunjBakhsh Town.

Union Councils (UC) is the lowest tier of the local government and fifth tier of government in Pakistan; in rural areas, UCs are often known as "village councils". The territory represented by a village council usually comprises a large village and surrounding areas, often including nearby small villages. The term "union council" may be used for localities that are part of cities. A village council is an elected local government body headed by a mayor and a deputy mayor.

Tehsil Council is the next tier of local government. About 4 to 5 UCs fall in the Tehsil Council (TC). Tehsil is a sub-unit of the district, which is the highest tier of the local government system, dealing with the administrative matters at district level.

A district is composed of Tehsils and is governed by the District Coordination Officer (DCO). Like other districts of the Punjab, the local government system of Lahore comprise UCs consisting of members directly elected by people through an open competition, which is also from the Electoral College for the selection of the members for the next higher tier.

4.3.10 Demography

4.3.10.1 Population and Family Size

According to the District Census Report 2023, the population of Lahore District stands at 13,004,135. This marks a significant increase compared to previous census figures, which recorded 11,126,285 persons in 2017 and 6,318,745 persons in 1998. The consistent rise in population reflects rapid urbanization and migration toward Lahore, which has become the second-largest city in Pakistan and a major economic hub.

Census data 2023 also indicates that the total number of households in the district is approximately 2.01 million. The officially reported average household size is around 6.5 persons per household. However, based on localized household surveys conducted in the project area, the average household size is found to be slightly higher, estimated at around 8 persons per

household and it is thickly populated area. This suggests the prevalence of extended family systems, particularly in peri-urban and low-income areas, where families often reside in joint or multi-generational living arrangements.

To gain deeper insight into the demographic structure and social dynamics of the local population, a social survey was conducted among 140 respondent families. The primary data collected through this survey focused on the gender-wise distribution and overall family composition. The findings revealed a relatively balanced male-to-female ratio, consistent with the overall trends reported in the district census. Most families had more than two children, and a few included elderly members, indicating a mixed population structure with both dependent children and senior citizens. These results reflect the traditional household patterns commonly found in Lahore, where families often maintain close-knit living arrangements with shared responsibilities.

The gender distribution data collected through the survey provides a useful baseline for planning social interventions, assessing project impacts, and designing mitigation measures under the Environmental and Social Management Plan as shown in Table 4-10. The larger average household size observed in the survey also underscores the importance of considering family-based needs, including housing space, utility demands, and community facilities in development planning.

Table 4-10 Age and Gender of the Population

Sr. #	Age Group (Years)	Male		Female		Total	
		No.	Percentage	No.	Percentage	No.	Percentage
1	0-4	61	11.0	67	13.0	128	12.0
2	5-9	67	12.1	61	11.8	128	12.0
3	10-19	110	19.9	104	20.2	214	20.0
4	20-39	145	26.2	133	25.8	278	26.0
5	40-49	106	19.2	87	16.9	193	18
6	50-59	38	6.9	45	8.7	83	7.8
7	60 and above	26	4.7	19	3.7	45	4.2
Total		553	100.00	516	100	1069	100

Based on the social survey, the maximum population falls in the age group between 20 and 39 years and it is this group that are responsible for most daily life routine activities.

The gender ratio is an important demographic indicator, which is defined as the “number of males per hundred females”. The gender ratio based on the household was 107 males per 100 females. The sex ratio depends on the factors such as the gender ratio at birth, differential mortality rates at different ages, and losses and gains through migration. In the local culture, sons are preferred because (i) they have a higher wage-earning capacity, (ii) they continue the family line; and (iii) they are generally recipients of inheritance. Girls are often considered an economic burden because of the dowry system and after marriage they typically become members of the husband's family, ceasing to have responsibility for their parents in illness and old age.

4.3.10.2 Marriage and Marital Status

Endogamy is the prevalent style of marriage. Most of the people are monogamous as second marriage is expensive. Mothers have very little role in decision-making about marriages of their sons and daughters. Neither the groom nor the bride is allowed to choose his or her life partner in rural areas. The decision of the parents is considered final; however, sometimes the bridegroom is consulted before the final decision. As per social survey, the majority of respondents (i.e., 79%) are married and only 2% are separated from their wives while 19% are unmarried as shown below in the Figure 4-23 Marital Status of the Respondents:

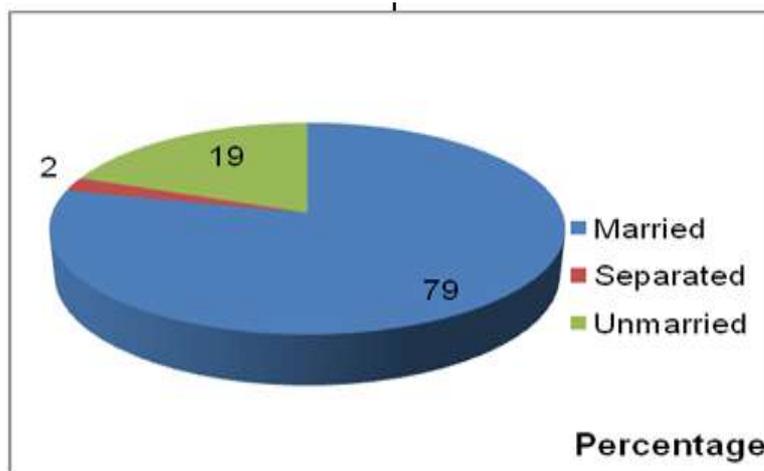


Figure 4-23 Marital Status of the Respondents

4.3.10.3 Literacy

Educational level of the respondents is shown in Table 4-11. The majority (i.e., 44.3%) are illiterate while 20.7% have primary education. The percentage of intermediates, graduates and postgraduates is very low compared to those who have done middle and matric as shown below in the Table 4-11:

Table 4-11 Educational Level of the Respondents

Sr. #	Education of the Respondent	Number	Percentage
1	Primary	29	20.7
2	Middle	17	12.1
3	Matric	16	11.4
4	Intermediate	11	7.9
5	Illiterate	62	44.3
6	Graduation	5	3.6
Total		140	100

Based on the field survey and discussion with the locals, it is noted that female literacy rate is lower compared to males. Locals give least importance to female education. However, proposed project area falls near Lahore and considered semi urban area. In Taragarh and Abu Bakar

Colony areas, low-income families do not send their girls to school. Although, there are number of schools and colleges in Begum Kot, Shahdara and Taragarh available in public and private sectors. Following are the reasons of low literacy rate among women in the area:

- The major cause of women illiteracy is increase in population, which is playing a negative role in this deprivation of female education. A family having more children and less income will prefer to educate the boys of the family, while the girls will be given embroidery or sewing skills;
- There is also misconception that females have to manage home after marriage whereas males have to earn for livelihood, so education matters only for males and not for females;
- Some families do not like their daughters to study in co-education institutes thus depriving them of higher education;
- The social setup is male dominated and girls restricted to homes and cannot go out freely thus any male of the family has to take responsibility for grocery purchasing etc. This sometimes seems difficult to them. There is also a sharp division between female oriented work and male oriented work. Females are not allowed to work in all sectors therefore their education is not considered valuable; and
- The number of schools and colleges for females are few. Girls have to travel a long distance to reach the schools or colleges. For this reason, most parents prefer to give them religious education.

4.3.10.4 Languages Spoken

Punjabi is the predominant language being spoken in the Area while Urdu is a common language.

4.3.10.5 Housing

Housing characteristics is one of the major indicators for the assessment of the living standard of the population. Most of the houses in the study area are owned by one influential resident of house who is male. However, some joint ownership also exists. Majority of the houses in the Begum Kot, Shahdara and Taragarh have ordinary construction, while nearby societies such as Rahman Garden, Jalil City and Elam din have new and modern construction buildings made of cement and bricks. Approximately 95.7% houses are pacca (made from brick, stone, and mortar) and 4.3% are semi-pacca (made of clay, inferior bricks and plastered with mortar). Types of housing structures in the area are given below in Table 4-12:

Table 4-12 Housing Condition

Sr. #	Type of House	Number	Percentage
1	Semi Pacca ²³	6	4.3

²³ Constructed using a combination of pucca (strong, high-quality) and kutchra (inferior) materials.

2	Pacca ²⁴	134	95.7
Total		140	100

The majority of the respondents have 2-3 rooms in their houses; few of them are having 4 or more rooms. The type of the toilet used by the household indicates living conditions and is strongly related to the health and hygiene of the household members. All the people (100%) have flush type of latrine.

4.3.11 Economic Aspects

4.3.11.1 Occupations

Types of occupation of the respondents in the Aol are shown in **Error! Reference source not found.** Working as a labourer is the main source of income in the whole Aol is Labour (i.e. 25.7%), followed by private job, businessman, farming, shopkeeper, private and govt. job sector. Several respondents have multiple occupations; therefore, the question was multiple response Questions. Hence, the percentage in the graph below in **Error! Reference source not found.** is not showing a total of 100%.

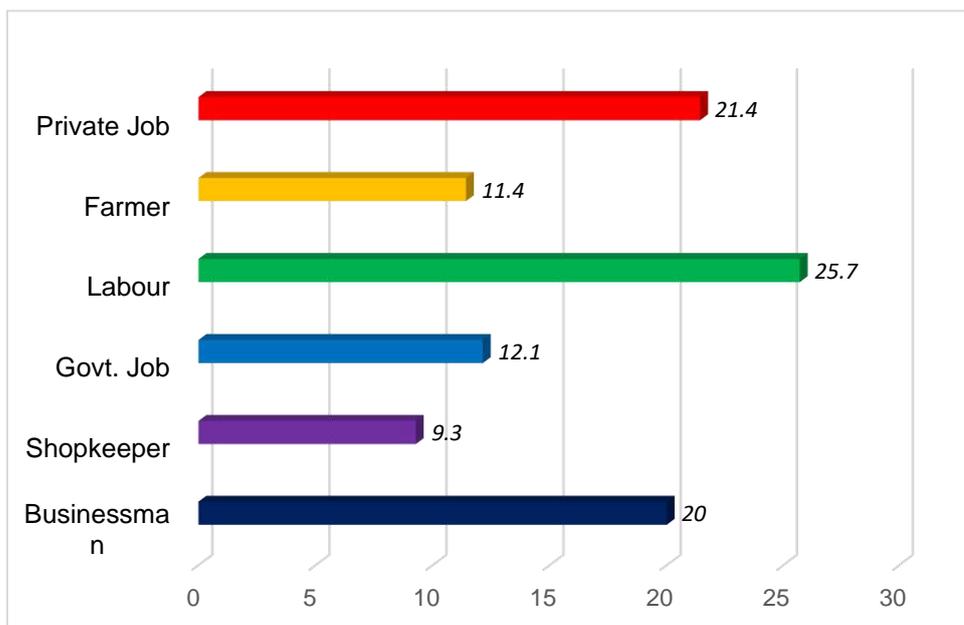


Figure 4-24 Occupations/Employment

4.3.11.2 Income Levels

Income is a vital indicator for assessing the livelihood and well-being of a household. In the context of 2025, where the officially declared minimum monthly wage in Punjab stands at Rs. 37,000, the income data collected from the social survey highlights a concerning disparity between actual earnings and the official minimum threshold. Altogether, more than 32 % of the surveyed population reported household incomes significantly below the minimum wage level of Rs. 37,000,

²⁴ Pucca housing refers to dwellings that are designed to be solid and permanent, built of substantial material such as stone, brick, cement, concrete, or timber.

indicating widespread underemployment and economic vulnerability. Only a small proportion of households, just 2% reported monthly incomes exceeding Rs. 90,000. Income groups earning between Rs. 38,000 to 40,000 are maximum, i.e., 26% as shown in the Table 4-13.

These findings suggest that a majority of families are living below the minimum wage benchmark, which directly impacts their capacity to afford essential needs such as food, healthcare, housing, education, and transport. The data reflects the informal nature of employment in the area and the need for social protection and economic uplift measures, especially in light of inflation and rising living costs in urban centers like Lahore.

Table 4-13 Average Monthly Income Pak Rs.

Sr. #	Income	Number	Percentage
1	Upto 30000	11	8%
2	Below 37000	33	24%
3	38000-40000	37	26%
4	41000-50000	25	18%
5	51000-60000	10	7%
6	61000-70000	9	6%
7	71000-80000	7	5%
8	81000-90000	6	4%
9	90,001 and above	2	1%
Total		140	100%

During the field surveys, it was observed that in case of farming households, the major sources of income were from crops and livestock (dairy products). For non-farm or landless households, the main sources of income are activities, such as business, shopkeeper, government employment, private employment, and labouring.

4.3.11.3 Agriculture Practice

In the proposed water treatment area, groundwater is being supplied through tube well, or river water for agriculture purposes which are the main source of irrigation water however, along the proposed pipeline near sewage is also used for agriculture purpose. Local farmers use traditional methods for farming (i.e., ploughing, tilling etc.) coupled with use of tractors and modern machinery for cultivation and harvesting. They grow crops (e.g. wheat and rice) along with almost all types of vegetables and fodder crops for their domestic animals. There are no fruit orchards in Project Aol.

The major agricultural machinery being used includes tractors, and threshers. There has been a consistent increase in the number of privately-owned agricultural machines. The farmers seem to consider increased mechanization of agriculture as they are buying more agricultural machinery, especially tractors. Scythes, sickle-type western hand tools are also being used for cutting of

Barseem and other fodder crops. Tractors are available for rent at a cost of Rs. 1,500 to Rs. 1,700 per hectares for soil preparation and other jobs. Most cow dung is used as the fuel for cooking. Fertilizers such as urea and ammonium phosphate are used by farmers to increase the crop productivity.

4.3.12 Religious, Archaeological and Cultural Aspects

4.3.12.1 Religion, Ethnic and Minority Groups

The population of the settlements in Aol is predominantly Muslim and followed by Christians.

The core unit of social organization is the caste system (“biraderi” in local language) in which groups are either defined on the basis of specific occupation or lineage. Occupationally defined caste groups are considered as lower status in the social setup. For instance, occupationally defined baradari/caste groups are Mochi (cobbler), Machi (fisherman), Nai (barber), Gujjar (dairy and livestock farmers), Julahay (weavers) while lineage based baradari/caste groups are e.g. Khokhar, Malik, Rajput, Bhatti, Jutt, Kullah, Mian, Khurral, Syed, and Cheema. The social life of the local population is traditionally on rural and urban lines.

Based on the household survey, the population in the Aol has many castes due to semi urban area of Lahore. The major caste/ethnic groups are Arian, Sheikh, Khokhar, Malik, Rehmani, Bhatti, Khurral, Muslim Sheikh, Syed, Cheema, Mochi Sindhu, Bhutter, Rana, Syed and Baloch. Among all the castes mentioned, Arian, Syed, Rahmani, Muslim Sheikh and Bhatti are the dominant castes of the Aol. Minority groups like Christians were also found in Aol.

During the field survey, it became apparent that the major castes were important because they have a key role in decision-making regarding the resolution of social issues of family matters. For instance, landlords (locally named as Chaudhry/Mian) as well as the head/or elder of the respective caste generally make decisions related to the social issues at local level as well as the social development works in their areas. Prior to any Project/ programme to be initiated, it is essential to involve these groups right from start of the Project i.e. planning, design, implementation and operation, to make the Project successful. In the Aol, local councillors, chairman and deputy chairman are the influential persons while in rural setup Numberdar and councillors have influence.

4.3.12.2 Archaeology

Bara Dari: This is situated near the project area downstream the Ravi Bridge. This historical building is just like a pavilion with a garden that was built by Kamran Mirza the son of the Emperor Baber, the first Mughal Emperor in the subcontinent in 1520. This historical architectural beauty was considered the oldest building that was built by the Mughals in Lahore with a beautiful garden where Kamran Mirza received his father, the Emperor Baber during his visit to Shahdara Lahore. This was the best place of Mughals where they mostly stayed at the summer season. Although this beautiful Baradari was built on one side of the historical and old Ravi River, but due to changes in river’s flow dynamics, now it is standing in the Ravi River. Standing on the old bridge of river the view of this historical pavilion is very beautiful. You can go there while enjoying a short travel on the simple boats that are available near the baradari along with the river.

Tomb of Shah Jahan: The Tomb of Jahangir, located in Shahdara Bagh, Lahore, is a Mughal mausoleum built for the Mughal Emperor Jahangir. It's known for its elaborate gardens, intricate interior decorations, and its status as a UNESCO World Heritage site. The tomb features a single-story square building set within a charbagh-style garden, with octagonal minarets at each corner.

4.3.12.3 Culture

The culture of Lahore is a manifestation of the lifestyle, festivals, literature, music, language, politics, cuisine and socio-economic conditions of its people. It is characterized by the blending of South Asian, Middle Eastern, Central Asian and Western influences. Lahore's culture is unique. It is sometimes referred as the cultural capital or the heart of Pakistan; the city was a seat of the Mughal Empire and the Sikh Empire as well as the capital of Punjab in Mahmud Ghaznavi's 11th century empire and in the British Empire. Presently, it is the capital of the Punjab province of Pakistan. In the Aol, locals are very warm-hearted. People have strong beliefs in reputable saints, black magic, and other superstitions (“pir-faqeers”, “jogi”, “taweez”, “manat-ka-dhaga” in local language). However, recently due to increase in literacy, people have become somewhat factual. Locals have strong belief in caste system but people are getting educated, and the boundaries / differences are getting blurred.

In the AOI, old men wear Pagri (turban), dhoti/lacha, kurta (long shirt), khusa (handcrafted footwear) while women wear colourful shalwar kameez (pantaloon and body shirt), paranda (colorful hanging worn by the Punjabi women in their hair), choli/duppata (scarf), kola puri chappal or tillay wali jutti (hand-crafted slippers with embroidery). The young generation (men and women) follow latest trends and fashion; mostly they wear different styles of shalwar kameez. Trouser and shirts are also worn by the locals but in less proportion as compared to shalwar kameez.



Figure 4-25 Public Consultations about Social and Cultural Resources

The extensive cuisine is vegetarian and non-vegetarian. In rural areas along the Ravi River, locals use ghee or clarified butter spices extensively. Traditional food is also eaten such as, Desi Ghee Paratha (flat bread in clarified butter), Makai ki Rotti (flat bread made from corn flour), Sarson ka Saag (vegetable dish made from mustard leaves).

4.3.13 Family System

Joint family system is the dominant culture in the Aol. Out of 140 households, 4 respondents have two wives. It was observed that the family structure in the area was very strong and members played a pivot role in solving their social and cultural problems.

Most of the families are living in joint family system comprising grandparents, uncles, aunties and lot of cousins, whereas only a small percentage of families are living as a single family (nuclear family system). Nuclear family also exists near urban areas such as Begum Kot, Taragarh etc. Although the joint family system is generally undergoing a radical change, with a greater influence of media and education, people of the Aol do not feel good about this change. Because while living in a joint family system a lot of emotional attachments are enhanced and they feel that by separating in nuclear family system, their relationships will be damaged and family ties will be weakened. Nonarian and Bhadro are also small settlements.

As per the locals, joint family system is basically a form of organization. In this organization there are defined norms and values to be followed strictly by all the members. All the members have their defined tasks and responsibilities to perform. There is equal share of each and every member of the family in the available resources in the form of money, food and other requirements and locals feels better in joint family system as compare to nuclear family.

During the discussion with the locals, it was clarified that large family size is also treated as the strength of the family.

4.3.14 Decision-making Methods and Conflict Resolutions System

The methods for decision-making about social conflicts in the Aol are “Panchayat” (an assembly of wise and respected elders), court, “Jirga” (traditional assembly of leaders that make decisions by consensus), caste groups and others (method constituted on the spot considering major issues and scope of the conflicts).

People prefer “Panchayat” in the Aol compared to court or other legal system because this method is more effective. “Panchayat” provide timely justice while other methods are complex and require time as well as money.

The people have a tradition to help each other in the hour of need. Common conflicts arise from time to time which are solved by the community at the local level through Consular or Deputy Mayor of the UC. Generally, in case of a conflict between two individuals, only the families or closest friends take sides of the conflicting rivals so there are rare chances that personal conflict will transform into an ethnic dispute.

4.3.15 Infrastructure Facilities

4.3.15.1 Educational Facilities

The educational facilities in the Aol exists i.e. Primary schools for boys and girls. However, to avail higher secondary level education facilities locals have to go Begum Kot or Lahore city. There are number of educational institutions exist in private and public sector in Begum Kot and Shahdara areas.

The proposed Project is close to the Lahore where almost every type of educational facilities is available. Educational facilities in Lahore are mainly being provided by the Government of Punjab, the city government and the private sector and voluntary organizations. To a limited extent the high school education is also being managed by the Federal Government through the operation of few institutes located in the cantonment area. Of the total educated persons 12.6 % are below primary, 23.2 % had passed primary, 22.5 % middle, 18.2 % Matriculation, 9.3 % Intermediate, 7.2 % Graduates, 2.6 % Post graduates while 0.6 % were certificate holders. Total number of Government schools in Lahore District is 409 out of which, 223 are boy schools and 186 are girls' schools while total number of students studying in these schools are 121,417 out of which, 46,625 are boys while 74,792 are girls. Similarly, total numbers of Municipal Corporation based schools in Lahore are 103 out of which, 44 are boy schools and 59 are girl schools. In these 44 boys' schools total number of students is 4,575 and the total number of girl students is 9,606.

Similarly, there are number of colleges and universities are dealing with all fields of science and arts. The Educational Facilities located from Qaddafi stadium to Data Darbar include The Educators, Joan McDonald School, Punjab College, ICMAP, Virtual University, M.A.O College, Punjab University, G.C. University, and University of Education etc. The numeric details of these institutes are given in Table 4-14.

Table 4-14 Population-Institution Relationship

Sr.	Type of Institutions	Number	Number of populations served
1	Higher Secondary Schools and Intermediate Colleges	36	182990
2	Degree Colleges	38	173359
3	Universities	52	48025

Source: DCR of Lahore District, 1998

During the field visit, it was noted that few institutions (private sector) provide education at matric or secondary level. At government level higher education institution exists in Shahdara or Lahore city. Locals prefer to go to Lahore for higher education as it is a first-class place of learning in Pakistan.

4.3.15.2 Health facilities

Health facilities are generally inadequate in the Aol. Bad sanitary conditions, insufficient medical facilities and meagre parental care, all contribute to the prevalence of ill health and high rate of mortality in the area. To avail health facilities locals, go to Lahore.

Ample medical and health facilities are available in the Lahore Metropolitan Corporation area and its suburbs. Shaukat Khanam Hospital is the latest addition in the medical care facilities in Lahore for the most dangerous disease in the country. i.e., Cancer. There are also other hospitals of voluntary organizations which provide health cover to the general public. King Zaid Bin Sultan Hospital is also a very advanced addition in the medical care for Lahore. Among the prominent hospitals are General Hospital, Lady Willington Hospital, Mayo Hospital, Fatima Jinnah Hospital,

The Children Hospital, Services Hospital, and Ganga Ram Hospital etc. Besides, a number of private medical practitioners, Hakims and homeopathic doctors are also practicing in the city. Some famous Health facilities located in the Project vicinity are Hameed Latif Hospital, WAPDA Hospital, and Lady Willington.

4.3.15.3 Civic Facilities

Wastewater is disposed of in the open spaces just outside the houses in the small settlements near Ravi. However, other areas have proper drainage facility.

4.3.15.4 Sources of Drinking Water

Groundwater is being used for drinking purposes and is pumped through electric and hand pumps which can be seen throughout residential areas. There is water supply scheme exist in the Aol.

4.3.16 Security Situation and Movement of the Foreigners

At present, security & safety situation in Lahore is satisfactory. During the social survey, locals informed that there has been no incident of any threat to lives or goods of foreigners visiting the area and there is no animosity towards foreigners. In the Aol, there is a reasonably liberal atmosphere for women. The local culture recommends modest dress for both men & women. Due to its historical and archaeological importance, many foreigners keep visiting Bara Dari and Jahangir Tomb.

4.3.16.1 Gender Aspects

Conditions of the women of the study area were assessed by carrying out women Focus Group Discussion and consultations. The women and girls of the study area were observed busy in doing laundry, looking after the children, preparing food etc. There is a lack of employment opportunities for women. However, in city areas such as near Shahdara and Begum Kot women doing jobs in different professions like teaching, medical and Govt. and Private Sector (medicine and textile industries) were reported.

The emancipation of women is a campaign to give women equal rights and status with men. The emancipation of women (i.e., their liberation from economic and sexual oppression, their access to higher education and their escape from narrow gender roles) is not easily achieved due to the traditional setup. In this rural society, males dominate. Cultural tradition, social practices and low female literacy ratio have left women in a vulnerable position. Women are restricted to performing



household work and are excluded from decision-making both on the domestic front and at the community level. Women’s access to education and health care is limited because such services are not available close to home in the AoI.

Figure 4-26 Public Consultation Relating to Gender Aspects

Women in the AoI are also vulnerable through economic, social and psychological poverty. Economic poverty is due to lack of assets and low endowment of human capital. Social poverty derives from the inability of the society to accept women’s equality and their economic, political and cultural rights, while psychological poverty is a product of the subjugation of women, under the dictates of customs and traditions, which deprives them even of control over their own lives.

In the rural set-up women are kept under-educated or uneducated. They are mainly dependent on male members of the family for economic reasons and cannot take decisions regarding their own lives. They have no say in family matters and are not asked about their preference for marriage. Yet for the paucity of rights, women play a vital part in the society through performing essential, albeit menial, tasks and supporting their families (e.g., collection of firewood from distant places, nurturing children, and cooking and cleaning for the family).

However, for the development of women in the area the Government has started many programs including a small loan scheme through the Punjab Rural Support Program (PRSP) and established a vocational training centre for women in Shahdara and Begum Kot areas.

Information which was collected through secondary sources and group discussion with locals shows that major problems faced by women in the area are lack of primary health care and the lack of education opportunities. Other problems include laborious work such as woods collection for cooking and heating, working in agricultural fields. These tasks not only affect their health but also take up major portion of their time.

Figure 4-27 Women Consultation



4.3.17 Women’s Concerns and Responses

The following table summarizes key concerns raised by women and the responses provided by the RUDA team and EIA consultants:

Table 4-15 Women Concerns about Project

Women's Concerns	Response/Clarification by RUDA / EIA Team
<p>1. Risk of Land and Livelihood Loss: Women feared eviction without resettlement options and losing informal livelihoods (e.g., home-based work, domestic help, farming, and livestock rearing).</p>	<p>Any land procurement will follow RUDA Procurement Model.</p>
<p>2. Access to Clean Water: Concerns were raised about potential pollution during construction or diversion affecting drinking and domestic water sources.</p>	<p>The project includes wastewater and stormwater management to improve water quality. RUDA will ensure no adverse impact on water access during implementation.</p>
<p>3. Health Risks from Construction Activities: Women were worried about increased dust, air pollution, and vector-borne diseases affecting children and pregnant women.</p>	<p>Dust suppression, noise control, and waste management will be implemented as per the Environmental Management Plan (EMP).</p>
<p>4. Safety and Mobility Restrictions: There were concerns about male-dominated construction sites creating discomfort and restricting women's movement in public spaces.</p>	<p>Contractors will be instructed to maintain code of conduct, screen construction zones, and ensure safe passage for women and children. Community liaison staff will monitor and address such concerns.</p>
<p>5. Lack of Participation in Planning: Women expressed that they were often excluded from decision-making.</p>	<p>RUDA and the EIA team are committed to inclusive consultation. Gender consultation will be done during implementation to ensure women's voices are incorporated in site-level planning and grievance redress.</p>
<p>6. Employment Opportunities: Women requested that local employment, especially for unskilled or semi-skilled work (e.g., planting, nursery work), be made available to them.</p>	<p>Women will be prioritized for local employment where feasible (e.g., afforestation, solid waste sorting, riverbank cleaning, community liaison).</p>
<p>7. Impact on Girls' Education: Concerns were raised about noise, safety, or construction routes affecting access to girls' schools.</p>	<p>Construction scheduling and traffic management plans will be designed to avoid school timings and ensure safe pedestrian access around affected areas.</p>

5 Impact Assessment & Mitigation Measures

5.1 General

The purpose of this chapter is to identify, predict, and evaluate the environmental and social impacts associated. This stretch of river is ecologically and socially sensitive due to its proximity to agricultural lands, settlements, infrastructure, and varying hydrological behaviour.

5.2 Project Context

This engineered channel is designed to enhance the urban environment, provide aesthetic and recreational benefits, and contribute to flood regulation. However, the hydraulic modifications will result in significant changes to sediment transport, water levels, and flow velocities. The dams are part of a broader strategy to rejuvenate the river, promote groundwater recharge, and support urban aesthetics and recreational activities.

However, this intervention has significant environmental and social implications, which will control river course and work for flood controls.

5.3 Critical Environmental Precondition: Wastewater and Sediment Management

The Ravi River currently receives untreated municipal and industrial wastewater through multiple open drains and nullahs, contributing to severe organic and chemical pollution. Rapid deterioration of water quality due to accumulation of high biological oxygen demand (BOD), chemical oxygen demand (COD), suspended solids, heavy metals, pathogens, and nutrient loads is demanding water pollution removal. These pollutants can cause anaerobic conditions, algal blooms, fish kills, and render the water unsuitable for any intended use including irrigation, recreation, or aesthetic enhancement.

Similarly, sediment management is a non-negotiable technical requirement. Sediment transported from the upper catchment will accumulate in the impoundment zones, reducing live storage, altering hydraulic geometry, and causing backwater effects. If not periodically flushed or mechanically removed, sediment deposition will reduce Rubber Dam/Weir operations, damage structural components, and increase downstream sediment starvation, leading to riverbed degradation and embankment instability.

5.4 Technical Recommendation and Regulatory Warning

It is therefore strongly recommended that:

- WWTPs will help the river recharge along with other sources.
- A Sediment Flushing and Dredging Strategy, including the design of sluicing gates, flow deflectors, and secure sediment disposal protocols, must be in place and integrated into the Rubber Dam/Weir operating rules.
- In the absence of these two critical components, wastewater treatment and sediment flushing infrastructure, the environmental risks to public health, aquatic ecosystems, infrastructure functionality, and downstream users will be unacceptably high.
- **Methodological Framework**

The impact assessment followed a structured, multidisciplinary approach based on national environmental regulations (e.g., Pakistan Environmental Protection Act, 1997) and international best practices. Key Impact Areas are:

- Hydrology & River Morphology
- Soil and Land Use
- Water Quality
- Biodiversity (Aquatic and Terrestrial)
- Air Quality and Noise
- Socioeconomic Environment
- Cultural Heritage
- Climate Change (GHG emissions, carbon sinks)

5.5 Impact Evaluation

Impact evaluation involved assessing the significance of predicted environmental and social impacts based on defined criteria such as magnitude, extent, duration, reversibility, and likelihood as shown in the Table 5-1. Impacts are rated as negligible, moderate, significant, or critical using a scoring matrix, allowing for prioritization of mitigation measures. This evaluation considered both the construction and operational phases, focusing on direct, indirect, and cumulative impacts. The evaluation process involved participatory, integrating expert judgment, field data, and stakeholder inputs to ensure a balanced and comprehensive assessment. This structured evaluation helped to inform decision-makers and ensured that high-significance impacts either avoided or minimized through targeted mitigation strategies.

- **Criteria:** Magnitude, extent, duration, reversibility, likelihood, and significance.
- **Classification:**
- **High:** Likely to cause irreversible damage or legal/policy violations.
- **Medium:** Manageable with mitigation; significant if unmitigated.
- **Low:** Minor, often temporary impacts.
- An **Impact Significance Matrix** is used, such as:

Table 5-1 Impact Evaluation

Criteria	Rating	Description
Magnitude	Low/Med/High	Scale/intensity of impact
Duration	Short/Med/Long	Time period over which the impact lasts
Extent	Local/Regional/National	Spatial scale

Reversibility	Reversible/Irreversible	Potential for natural recovery
Likelihood	Low/Medium/High	Probability of occurrence
Overall Significance	Negligible/Moderate/Significant/Critical	

5.6 Mitigation and Monitoring Framework

For each significant impact:

- **Mitigation Measures:** Avoidance, minimization, restoration, compensation.
- **Residual Impact Evaluation:** After applying mitigation.
- **Monitoring Indicators:** Quantitative metrics (e.g., turbidity, noise levels).

5.7 Impact Assessment & Mitigation- Design/Preconstruction Phase

5.7.1 Wastewater and Sediment Management

The Ravi River currently receives untreated municipal and industrial wastewater through multiple open drains and nullahs, contributing to severe organic and chemical pollution.

Sediment transported from the upper catchment will accumulate in the impoundment zones, reducing live storage, altering hydraulic geometry, and causing backwater effects. If not periodically flushed or mechanically removed, sediment deposition will compromise Rubber Dam/Weir operations, damage structural components, and increase downstream sediment starvation, leading to riverbed degradation and embankment instability.

5.7.2 Wastewater Contamination (Environmental Risk Assessment)

5.7.2.1 Hazard Identification

The Ravi River, already received substantial volumes of untreated municipal and industrial effluents from upstream, is at critical ecological risk. Primary hazards are:

- Accumulation of pathogens, nitrates, phosphates, and heavy metals.
- Anaerobic conditions leading to hydrogen sulfide release and odor.
- Eutrophication due to excessive nutrient load.
- Public health risks from contaminated stagnant water.

5.7.2.2 Risk Characterization

Risk characterization of the project is shown in

Table 5-2.

Table 5-2 Risk Characterization

Risk Parameter	Description	Severity	Likelihood	Risk Level
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Surface Water Quality	Stagnation will trap untreated effluents, worsening BOD, COD, DO levels	High	High	Very High
Aquatic Ecosystems	Toxicity to fish, macroinvertebrates, algae bloom formation	High	High	Very High
Public Health	Risk of waterborne diseases (e.g., typhoid, cholera, hepatitis)	High	High	Very High
Groundwater Contamination	Percolation of pollutants in shallow aquifers due to prolonged submersion	Medium	Medium	High
Odor and Aesthetic Value	Nuisance due to decomposition and organic sludge build-up	Medium	High	High
Tourism & Cultural Value	Negative impact on recreational and historic value (e.g., Kamran Baradari)	Medium	Low	Low

5.7.2.3 Sensitive Receptors

- Kamran Baradari (impoundment area) and interestingly already lying in river alignment.
- Local communities along the riverbank but will be saved due to Flood control.
- Downstream aquatic ecosystems.
- Children and elderly populations in nearby settlements.

5.7.2.4 Source-Pathway-Receptor Model

Source-Pathway-Receptor Model is shown in the given below table:

Table 5-3 Source-Pathway-Receptor Model

Source	Pathway	Receptor
Untreated sewage & industrial effluents	Direct discharge → Dam impoundment	Human health, aquatic biota, tourism
Solid and organic waste in drains	Water stagnation and sedimentation	Water quality, sediment toxicity
Leachate from urban drains	Ground infiltration in impoundment zone	Groundwater, agriculture wells

5.7.2.5 Mitigation Hierarchy

The mitigation hierarchy is a structured approach to manage and reduce environmental impacts during project planning and execution. It follows four sequential steps: Avoidance, Minimization, Rehabilitation/Restoration, and Offsetting/Compensation.

- Alternate sources of water through existing irrigation system, monsoon and treated wastewater.
- Minimization refers to actions that reduce the intensity or duration of unavoidable impacts (e.g., installing aeration systems to reduce water stagnation).
- Rehabilitation/Remediation includes measures to repair or restore affected environments. The mitigation hierarchy is shown in Figure 5-1.

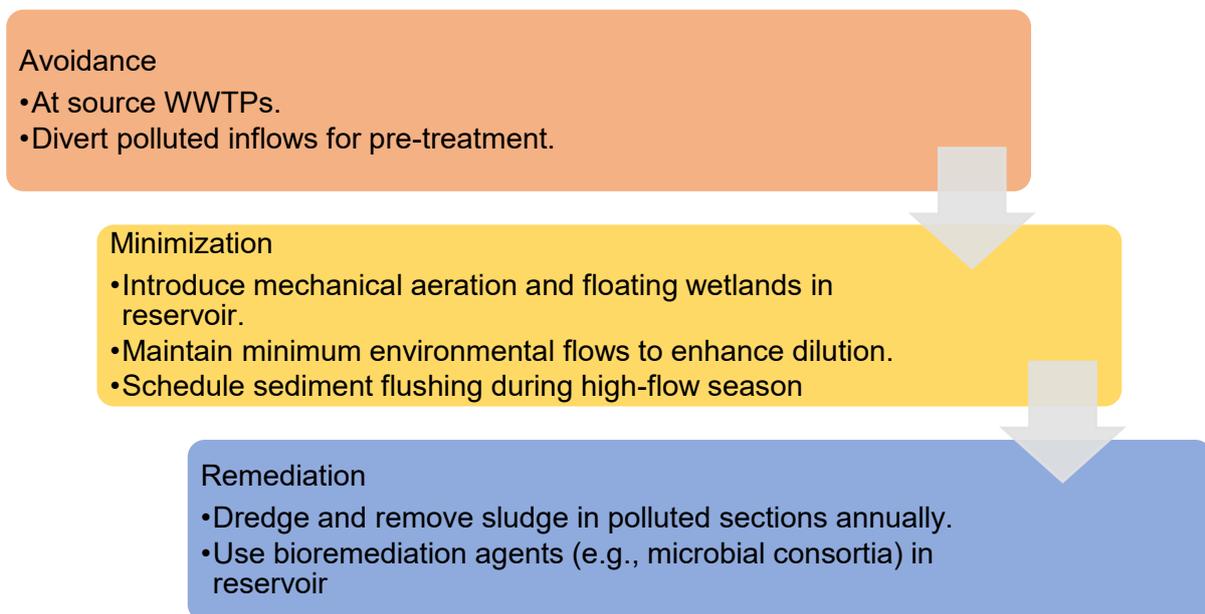


Figure 5-1 Mitigation Hierarchy

5.7.2.6 Residual Risk and Recommendation

Even after standard mitigation, residual risk remains High unless upstream wastewater is treated and dilution is increased.

Cross-Phase Perspective: Sedimentation in Reservoir

Sediment deposition in the reservoir formed by the Rubber Dam/Weir reduces storage capacity, affects hydraulic performance, increases hydrostatic pressure. If not properly managed, it shortens the dam’s effective life and causes downstream ecological imbalance. Although sediment deposition in reservoir is operational impact but its mitigation in design is required in preconstruction/design phase. Key preventive measures are written, hereunder:

5.7.2.7 Sediment Sluicing and Flushing Gates:

- Design low-level outlets or sluicing gates to enable sediment flushing during high flows.
- Include sediment bypass channels, if feasible, to reduce accumulation upstream.

- Hydraulic Modelling for Sediment Transport
- Conduct hydraulic and morphological modelling to predict sediment movement and deposition zones under different flow regimes.
- Use the modelling to optimize Rubber Dam/Weir alignment and crest level.

5.7.2.8 Reservoir Geometry Optimization:

- Avoid overly wide and deep impoundments that encourage sediment settling.
- Use narrower channels and steeper gradients to promote sediment throughput.

5.7.2.9 Provision for Dredging Access:

- Allocate zones for maintenance dredging and include dredger access routes and platforms in design.

5.7.2.10 Catchment Management Linkage:

- Integrate design provisions with upstream erosion control and land-use management programs in collaboration with watershed authorities.

5.7.2.11 Wastewater Pre-treatment Requirement:

- Treated water and irrigation system will enable to prevent organic loading of trapped sediment.
- Without this, sediment becomes more contaminated and disposal becomes a serious environmental hazard.

5.7.3 Impact Due to Wastewater Drains into the Ravi River

With the proposed construction of Rubber Dams/Weirs and river training structures leading to the impoundment of water up to 9 meters, the river's natural flow velocity will be substantially reduced. In the absence of adequate wastewater treatment infrastructure upstream, this stagnation is expected to significantly worsen water quality, leading to the concentration of pathogens, toxins, and suspended pollutants in the ponded area.

Additionally, many of these drains are mixed with stormwater and sewage, and during the monsoon season, backflow from the river into the urban drainage system is a potential risk due to increased hydraulic pressure from the elevated water levels.

Mitigation and Design Recommendations

To address this high-risk design-phase impact, the following measures are strongly recommended:

- Interception and diversion of wastewater flows from all major urban drains should be integrated into the overall drainage management plan prior to ponding.
- Separation of stormwater from sewage must be ensured through rehabilitation or restructuring of the combined sewer infrastructure to prevent flood-related contamination.

- Provision must be made for the future connection of all drains to a centralized sewage treatment system, and interim solutions such as on-site screening and pre-treatment should be considered.

Non-return valves (NRVs) or automated pumping systems must be installed at critical drain outfalls to prevent reverse flow during high water levels.

5.7.4 Impact on Aquatic and Riparian Ecosystems

The Ravi River has experienced a significant decline in biodiversity over recent decades, primarily due to untreated wastewater discharges, altered natural flows, and the encroachment of its riparian zone. Many indigenous fish species, aquatic invertebrates, and riverine flora have either vanished or become highly localized due to degraded water quality, loss of breeding grounds, and fragmentation of habitats.

The proposed River Training Works (RTW) and Rubber Dam/Weir impoundment, while aimed at flood management and urban regeneration, will further alter the hydrological regime of the river to protect the urban development and population. The creation of a permanent or semi-permanent ponded section may result in:

- Ecological flow downstream of the dam, will provide micro habitats to the for aquatic species.
- Water availability will make better the breeding grounds.
- Potential barriers to fish migration and disruption of the aquatic food web due to physical structures and stagnant zones.

Mitigation and Design Recommendations

To minimize adverse ecological impacts and promote habitat restoration, the following measures should be integrated into the project design:

- Ensure minimum ecological flow (e-flow) release downstream of the Rubber Dam/Weir to sustain aquatic life, especially during the dry season.
- Incorporate fish ladders or fish passage structures to allow migratory species to move between upstream and downstream sections.
- Avoid excessive channelization by designing meandering sections or side pockets along the river to preserve habitat heterogeneity.
- Rehabilitate the riparian buffer zone through the plantation of native species (grasses, shrubs, and trees) to stabilize banks, provide shade, and enhance ecological connectivity.
- Avoid the use of impermeable materials for river embankments where possible and adopt nature-based solutions such as bioengineering and vegetative revetments.

5.7.5 Impact on Floodplain Connectivity and Groundwater Recharge

The natural floodplains of the Ravi River have historically served critical ecological and hydrological functions, including seasonal groundwater recharge, nutrient cycling, and the

creation of temporary wetlands that support both biodiversity and agriculture. However, decades of urban encroachment, sand mining, and flow alteration have already compromised this functionality.

The construction of high embankments, Rubber Dams/Weirs, and other channel-stabilizing structures under the proposed River Training Works (RTW) may further disrupt the river–floodplain interaction, especially during high-flow periods. By containing the river within a rigid alignment, the project may:

- Prevent natural inundation of floodplains, leading to reduced groundwater recharge, particularly in peri-urban agricultural zones.
- Alter the hydro-period and soil moisture balance, degrading riparian habitats and drying out adjacent wetlands.
- Increase flow velocity downstream due to narrowed channel cross-section, potentially exacerbating erosion and flash flood risks.

Mitigation and Design Recommendations

To preserve the environmental services of the floodplain and maintain a more natural river behaviour, the following design considerations must be incorporated:

- Integrate controlled inundation zones or floodplain retention basins within the project layout, especially at historically active floodplain pockets.
- Include overflow weirs or seasonal spillways at strategic locations to allow floodwaters to enter designated recharge zones during peak flows.
- Maintain or restore selected sections of the riverbank with gentle slopes and permeable materials to enable lateral flow and infiltration.
- Where feasible, relocate embankments slightly inland to allow some seasonal floodplain activity and minimize hard channel confinement.
- Conduct hydrological modelling to simulate and validate flood routing and recharge potential under the modified design conditions.

5.7.6 Impact of Urban Drainage Backflow and Flooding Risks

At present, a large number of urban drains, including both stormwater and wastewater outfalls, discharge into the Ravi River via gravity flow. This conventional system functions under the assumption of a low river water level, allowing free drainage during routine and seasonal rainfall events. However, the proposed construction of Rubber Dams/Weirs under the River Training Works (RTW) will result in the creation of a ponded water body with a height of up to 9 meters, which will guide the river and will give flood control.

Backflow is also considered for low-lying and informal settlements along the riverbanks that already suffer from poor drainage infrastructure. The likely outcomes of such backflow events include:

- Urban flooding, with wastewater overflowing into streets, homes, and public areas.

- Contamination of stormwater systems with sewage, resulting in severe public health hazards, including the spread of waterborne diseases.
- Damage to public infrastructure, interruption of services, and heightened social vulnerability, especially in slum areas and unplanned colonies.

These impacts represent a high environmental and social risk and could undermine the long-term objectives of urban renewal and flood control under the RTW project.

Mitigation and Design Recommendations

To address the anticipated backflow and flood risks associated with the impoundment, the following measures must be included in the design and engineering of the RTW system:

- Installation of non-return valves (NRVs) at all stormwater and wastewater outfalls to prevent reverse flow from the river into the urban sewerage and drainage systems.
- Construction of automated or manually operated pumping stations at critical discharge points to actively evacuate water when river levels exceed outfall elevation.
- Elevation of drain discharge points or the use of sealed culverts with backflow prevention systems to ensure isolation of the drainage network from the river during high-water periods.
- Integration of early warning systems in coordination with local authorities to alert communities at risk of flooding.

5.7.7 Strategic Level Measures to Improve Agricultural Produce as an Offset to Agriculture Loss

- The agriculture productivity can be increased by providing modern agricultural inputs to farming community. These inputs are diversified and include approved or certified seed, good quality water for irrigation, fertilizers, weedicides and pesticides.
- Loans by the concerned department may be provided on soft term basis to the farmers for spending on inputs for agriculture production. Subsidies may be proposed to farmers on agricultural machineries, like laser tractors, solar/electric tube wells. The subsidies may also be provided to farmers to install drip irrigation equipment in fields instead of flood irrigation system. It will save lot of water, which can be used to further expand agriculture land.
- The irrigation system requires drastic reforms to make sure uninterrupted irrigation water supply through canals. The crops types must be chosen which are not water spenders. The barren areas should be converted into agriculture land by constructing new canals and water bodies. Furthermore, alternative policies and investments are needed in water storage and distribution, including canal rehabilitation, maintenance, and drainage, to keep water flowing, protect against severe floods, and meet the country's changing water needs.
- The Government must fortify its agriculture sector against weather extremes including droughts, floods, heat, and cold, and against pests and diseases. This will require public

investment and substantive policy reforms in agricultural research, extension, seed systems, and agricultural input markets to support farmers.

- The agriculture should be adaptive to climate change. The crops should be made resistant to droughts, floods, pests and diseases.

5.7.8 Impact due to Diversion of River

Before the start of the construction of the Rubber Dam/Weir structure, a River diversion arrangement has to be made. The River diversion will be accomplished by the construction of upstream and downstream cofferdams. Failure of the Cofferdam during construction includes a partial or total Failure of the Cofferdam resulting delay in the Project schedule, loss or damage to equipment, temporary or permanent damage to structures, serious injury, or even loss of life and/or the release of sediment and/or debris downstream. This impact is Site-specific, Possible and Medium Significant.

Mitigation

- Standard acceptable engineering design considers and accounts for the associated loadings or stresses which will be imposed on the Cofferdam.
- Mitigation measures include, but are not limited to, designing the Cofferdam to relevant codes and scheduling of activities to accommodate weather interruptions, and regular inspections by the Project Engineer of the Cofferdam.
- Daily inspections of the Cofferdam will identify potential weakness or soft spots in the Cofferdam which would lead to the Failure of the Cofferdam itself. Debris would be caught in the fine trash rack system and removed. Suspended sediments would be monitored in the downstream flow and in case of a sudden change, notification would be made for necessary measures.
- The safety of the cofferdams will be checked for the various combinations of load, as per international design practices. The construction method & construction planning of these will also be deliberated upon.

5.8 Impacts and Mitigations Measures during the Project Construction

Following is the brief description of impacts and their mitigation envisaged during the construction phase:

5.8.1 Physical Environment

5.8.1.1 Soil Erosion and Contamination

Due to the proposed construction activities such as construction of Rubber Dams/Weirs and river channelization, soil erosion and contamination may occur. Soil erosion may occur on Ravi River and at contractors' camps as a result of uncontrolled run-off from equipment washing yards and excavation of earth/cutting operations. Whereas contamination of the soil may be caused by oil and chemical spills at equipment washing yards, camp sites and temporary construction site office. This impact is, however, temporary and low adverse in nature.

Mitigations

- Site proposed for Rubber Dam/Weir and overhead structures where embankments are more susceptible to erosion by water runoff, stone pitching or riprap will be provided on the embankment slopes.
- Plantation will be carried out at the toe of the embankment for slope protection constituting fast growing indigenous trees with deep root system for anchoring in the soil material.
- Soil contamination can be curtailed by reducing the oil spill in the camp and at project construction areas by well maintaining the construction vehicles as well as bitumen/other contaminants in storage tanks/places.
- Confining excavations to the specified locations as per the approved engineering drawings and unnecessary excavations should be avoided;
- Excess soil should be reused where possible and residual soil can be disposed of at designated site to prevent erosion;
- Septic tanks of adequate capacities should be constructed for receiving and treating wastewater from all temporary worksite toilets and construction camps to avoid soil contamination; and
- Regular inspection of the wastewater disposal from construction camps.

5.8.1.2 Traffic Problems

The proposed project site is accessible through Grand Trunk (GT) Road, Saggian Wala Bypass Road, Bund Road Shahdara and M-2 Motorway. These roads serve as main approach roads to the proposed Project Area and due to the proposed construction activities and movement of heavy project vehicles for construction material supply, traffic problems may arise for the commuters and transporters travelling to the proposed areas. The problems will include traffic jams and inconvenience to the public passing through the Project Area. It will also increase traffic load on the existing road network or access roads ultimately deteriorating the existing condition of the roads. The movement of vehicles along the haulage routes will cause soil erosion, debris flow, dust emissions, vibrational impacts, etc. Considering these consequences, this impact can be categorized as direct, moderate, site-specific, medium term, temporary, medium probability and irreversible.

Mitigation

- Movement of vehicles carrying construction materials and equipment/machinery will be restricted during the daytime to reduce traffic load and inconvenience to the local population.
- Construction vehicles, machinery and equipment will be parked at designated areas (at construction camps site) to avoid un-necessary congestions along the major roads.
- The speed of the vehicles will be controlled to reduce the probability of severe accidents, soil erosion, debris flows due to vibrations and dust emission.

- Damages of roads due to construction vehicles will be instantly repaired and/or compensated after the completion of work.
- Proper sign boards will be provided for smooth flow of traffic.
- Period of construction and area / location of construction site shall be informed to public in general and specifically to local residents.
- Any closure of the roads (especially main roads) and deviations / diversions proposed should be informed to the riders through standard signs and displays.

5.8.1.3 Air Quality

The air quality of the project area will be affected by the exhaust emissions (NO₂, SO₂, CO and PM₁₀) produced from operation of construction machinery and equipment like batching plants, excavators, dump truck, Road Rollers, Graders, Haul Trucks, cranes and other transport vehicles etc. Most of these are using diesel engines that generate noise and exhaust emissions. All these including PM₁₀ are considered as pollution indicators.

Potential impacts on the air quality during the construction stage will be due to the fugitive dust and the exhaust gases generated in and around the construction site. Dust is a major component of air pollution, generated mainly from the following construction activities:

- Site clearance and use of heavy vehicles and machinery/equipment
- etc. at construction site;
- Procurement and transport of construction materials such as sand, cement, etc. to the construction site;
- Other Gaseous emissions during construction result from operating of construction vehicles, plant and equipment;
- Increase in air pollution levels without project and with project during construction period (for mobile & stationary sources) is predicted from construction machinery, equipment, which reveals that there shall not be significant contribution towards pollution due to the construction activity of the project if mitigation plan will be implemented and monitored in proper sense; and
- Asphalt heating, if required.
- This impact is temporary and moderate in nature.

Mitigation

All vehicles, machinery and equipment to be used during construction activities should be kept in good working condition and be properly tuned and maintained in order to minimize the exhaust emissions;

- All vehicles, machinery and equipment to be used for the construction should be plugged off or switched off immediately after completion of their work to avoid idling condition.
- Open burning of solid waste from the contractor's camps should be strictly banned.

- Only good quality oils, petroleum products and additives should be used in the machinery, generators, and the construction vehicles. Usage of used oil should be strictly prohibited.
- PEQS applicable to gaseous emissions generated by construction vehicles, equipment and machinery should be enforced during construction works.
- Air emission monitoring program for NO_x, SO_x, CO and PM₁₀ should be undertaken according to the program specified in the EMMP.
- Vehicle and equipment engines should be properly maintained to reduce exhaust emissions of CO, VOCs, and Particulate Matter. Equipment that is in good condition will also reduce fuel consumption. Equipment should be inspected prior to the start of a project. While equipment is on site, a daily inspection should be conducted and parts and hoses showing signs of wear should be promptly replaced. Damaged parts should also be repaired or replaced.
- The fugitive dust emission will be a problem for the nearby settlements, flora and fauna which will be mitigated by sprinkling of water. Also main access roads and exposed terrain should be sprayed by water trucks to minimize the dust.
- Construction workers should be provided with masks for protection against the inhalation of dust.
- During times of windy conditions, where feasible, construction operations that generate greater levels of dust may be avoided or reduced. Instead, these activities can be conducted when more favourable weather conditions occur. Increased application of other dust suppressant techniques may also be considered in times of very windy weather.

5.8.1.4 Noise and Vibration

The noise and vibration will be produced due to the operation of construction machinery and equipment like bulldozers, scrapers, excavators, compactors, trucks, large capacity dumpers, graders, heavy duty cranes, concrete batching plants and stone crushers. The operation and movement of such equipment will increase the noise and vibration in the Project Area. Noise and vibration are perceived as one of the most undesirable consequences of construction activity. The above machinery is expected to generate noise levels that would be severe in the project area. This impact is temporary and moderate in nature.

Mitigation

For the construction machinery generating noise level in excess of that prescribed in PEQS, Contractor will make arrangements to bring the noise level within applicable limits (including proper tuning of vehicles and mufflers/silencers).

- Movements of the trucks and other construction machinery causing high noise levels must be restricted at night time to avoid disturbance to the nearby locality. Truck drivers should be instructed not to play loud music at night and stop use of horn.

- Proper noise barrier boundary walls will be built on asphalt/ concrete plants which come close to any locality.
- Providing the construction workers with suitable hearing protection like ear cap, or earmuffs and training them in their use.
- Use of low noise machinery, or machinery with noise shielding and absorption.
- Contractors shall comply with submitted work schedule, keeping noisy operations away from sensitive points; implement regular maintenance and repairs; and employ strict implementation of operation procedures.

5.8.1.5 Water Resources (Surface and Groundwater Contamination)

The proposed project includes the River Training Works and Flood Control Infrastructure of Ravi River. During construction of proposed Rubber Dams/Weirs and Channelization works, surface water resource may get contaminated by sediments, fuel and chemical spills, or by solid waste and effluents generated by the kitchens and toilets at the construction camp sites. The impact on these water bodies will be only for the period of construction and will vanish as the construction work is over. In addition to that, construction waste, if left unattended will result in forming slush which may percolate through the soil strata and will reach underground water table and hence, will end up contaminating it. This impact is temporary and adverse in nature.

Mitigation

- Construction camps will be established in areas with adequate natural drainage channels in order to facilitate the flow of the treated effluents after ensuring that PEQS are met.
- The surface and groundwater reserves will be adequately protected by installing screens and barriers to protect the source of contamination such as construction and oily waste that will degrade its potable quality.
- The proponent will ensure that the construction work is confined and water bodies are prevented from pollution during construction.
- Suspended sediments would be monitored in the downstream flow and in case of a sudden change for necessary measures.
- The solid waste will be disposed of in designated landfill sites to sustain the water quality for domestic requirements.
- Regular water quality monitoring according to determined sampling schedule.
- The contractor will ensure that construction debris do not find their way into the Ravi River which may get clogged.
- Prohibit washing of machinery and vehicles in surface waters, provide sealed washing basins and collect wastewater in sedimentation/retention pond.
- Wastes will be collected, stored and taken to approved disposal site. Similarly, if the sewage after treatment is to be discharged on to the land it will meet the requirements of the PEQS for disposal of wastewater.

5.8.1.6 Change in Hydrologic Regime

The proposed project will involve the construction of a Rubber Dams/Weirs and Channelization works on Ravi River. There might be change in water flow pattern and disturbance to water flow, which will cause impact on downstream of this water. This impact is moderate in nature.

Mitigation

Rubber Damss/Weir on Ravi River and Channelization works shall be properly designed to accommodate design flows. Provision of culverts to control flood damages and provision of safety of embankments will be considered during the design of these arrangements.

5.8.1.7 Borrow/ Open Pits

Borrow/ open pits and its excavation activities may result in land disputes, soil erosion, loss of potential cropland, loss of vegetation and landscape degradation. Borrow/ Open pits may also become potential sources of mosquito breeding and may prove hazardous to human beings, livestock and wildlife. This will also degrade hygienic condition of the Project Area. This impact is permanent and moderate negative in nature.

Mitigation

- Necessary permits will be obtained for any borrow pits from the competent authorities;
- In borrow pits, the depth of the pits will be regulated so that the sides of the excavation will have a slope not steeper than 1: 4;
- Soil erosion along the borrow pit will be regularly checked to prevent/ mitigate impacts on adjacent lands;
- In case borrow pits are filled with water, measures have to be taken to prevent the creation of mosquito-breeding sites; and
- Borrow pits will be used for construction waste, but during the excavation, 6 inch top soil cover will be preserved for vegetation after the filling of the pits. This is the best way to restore the flora of that area.

5.8.1.8 Wastewater Generation

Wastewater will be generated at the construction camps by the workers. If the generated wastewater is not properly treated or disposed of, this may contaminate the surface water sources apart from soil contamination. The estimated wastewater to be generated from construction camps project assuming that on average the water demand per person is 100 litres per day (estimated) and that 80% of the water demand will become wastewater. This impact is temporary and adverse in nature.

Mitigation

- Domestic and chemical effluents from the construction camp will be disposed by the development of on-site sanitation systems i.e., septic tanks.
- Proper monitoring to check the compliance of PEQS will be carried out.

- Sewage from construction camps will be disposed of after proper pre-treatment.
- The Contractor(s) will be responsible to submit details of site-specific wastewater management plan along with details of wastewater collection, transportation and its disposal.

5.8.1.9 Solid Waste (Municipal and Construction)

Different type of waste is likely to be generated during the construction phase of the project. The municipal waste will be in the form of food, cans and paper from construction camps toilets and washing yards. Considering the labourers (about 200 in numbers) residing in the construction camp and the locally available labour, an average solid waste generation rate of 0.5 kg/capita/day⁹ is adopted for the estimation of solid waste generation. Based on this assumption, a total of about 100 kg of solid waste will be generated from construction camps on daily basis. Construction waste may include excavated soil, sand, gravel, pieces of concrete, bricks, wood, metal pieces and electrical waste. All these, if left unattended, can become a source of nuisance and environmental pollution in the project area. Insecure and unhygienic disposal of the solid wastes particularly garbage and trash may cause degradation of soil and land. Insecurely disposed of heaps of wastes containing kitchen garbage and food waste can serve as breeding grounds for the disease spreading vectors and rodents. Throwing away of solid wastes into water channels and the wastewater network can result into choking of the latter.

These impacts are temporary and moderate adverse in nature.

Mitigation

- Solid waste generated during construction and camp sites should be safely disposed of at designated waste disposal sites.
- Proper labelling of waste containers, including the identification and quantity of the contents should be carried out.
- Construction workers and supervisory staff should be encouraged and educated to practice waste minimization, reuse and recycling to reduce quantity of the waste.
- Waste disposal plan must be reviewed during the entire construction phase in the light of changing weather conditions.
- Close coordination should be carried out between RUDA, construction contractor and LWMC / concerned department for the proper disposal of construction waste.

5.8.1.10 Discovery of Heritage Sites/ Structures during Excavation

During construction activities, there is a chance of finding archaeological site. In case of finding any artefact, the contractor shall immediately report through Supervision Consultant to Directorate General (DG) of Archaeology Department, Government of Punjab to take further suitable action to preserve those antiques or sensitive remains. This impact is site specific.

Mitigation

Project may involve deep excavation. Therefore, the possibility of chance find is not ignorable. In case of any chance find, the contractor will immediately report through Supervision Consultant to Directorate General (DG) of Archaeological Department, Punjab, to take further suitable action to preserve those antique or sensitive remains. Representative of the DG will visit the site and observe the significance of the antique, artefact and Cultural (religious) properties and significance of the project. The report will be prepared by representative and will be given to the DG. The documentation will be completed and if required, suitable action will be taken to preserve those antiques and sensitive remains. In case any artefact, antiques and sensitive remains are discovered, chance find procedures should be adopted by contractor' workers as follows:

- Stop the construction activities in the areas of chance find; Delineate the discovered site or area;
- Consult with the local community and provincial Archaeological Department.
- The suggestion of the local communities and the concerned authorities will be suitably incorporated during taking the preventive measures to conserve the antique, artefact and cultural (religious) properties.
- Secure the site to prevent any damage or loss of removable objects. In case of removable antiquities or sensitive remain, a night guard shall be arranged until the responsible local authorities take over.
- After stopping work, the contractor must immediately report the discovery to the Supervision Engineer.

5.8.1.11 Emergency Response

The construction of the proposed project may encounter emergencies. In addition, disasters such as earthquakes and fires may occur. Lack of Emergency Response Plan (ERP) or an inefficient response plan may lead to an accident or critical injury. This impact is negative, temporary and moderate in nature.

Mitigation

- An ERP for earthquakes and manmade disasters should be developed by contractor in coordination with supervisory consultant and RUDA. It should be implemented in close consultation with the RESCUE Services and other concerned departments;
- Training of the staff and employees regarding the emergency procedures and plans should be regularly conducted, the nature of emergency will be determined as per designated plans;
- Emergency numbers should be clearly posted at all disposal stations; and Minor incidents and near misses should be reported, and preventive measures should be formulated accordingly by the RUDA Management.

5.8.2 Ecological Environment

5.8.2.1 Permanent Loss of Habitat

Due to the construction of a Rubber Dams/Weirs and Channelization of Ravi River, few habitats may be affected e.g., the riverbanks. In addition, water-land interface is necessary for many amphibians which may be affected due to formation of concrete walls which are necessary for flood protection.

Mitigation

- Embankment slopes should be given along with the river. The slope is then planted with grasses, sedges and herbs. This will mitigate the permanent loss of habitat for the threaten species of fresh water turtle. Planting on such bank slopes would increase the value of habitat by providing vertical structural diversity and will provide a compensation for the lost land-water interface for the movement of reptile and amphibian species. It also provides compensation for clearance of vegetation along banks of river.
- The mobility of construction machinery should be planned to minimize and on selected routes.
- Incorporate technical design measures to minimize removal of trees, if possible such as change in the alignment without affecting the technical safety.
- The construction camp management plan during the planning stage must consider fencing and gating to check the entry of animals in search of eatable goods.
- Similarly, waste management plan of the camps must be considered at the planning stage to prevent wild animals and birds.

5.8.2.2 Impacts on Aquatic Life

Various construction phase activities like; controlling the flow of water while construction of Rubber Dams/Weirs and river channelization wall to change water flow, can affect the aquatic life. As fish needs particular instream flow of water which is disturbed by water pollution, existing low water levels, the construction activities will also affect it but maintaining water flows, aquatic life will revive.

Fish ladders can also be provided as a useful structure for the fish mobility path, depending on the success of the design. Those fish that successfully navigate the Rubber Dam/Weir structure, would then pass into the calmer basin where the change in current flows, sedimentation, directional clues and predation could either benefit or dis-benefit differing species (The Severn Rubber Dam/Weir, 2007). There are two categories of threats to fish:

- **Direct:** Injury and mortality due to strikes and water conditions (for example water pressure) resulting in damage or disorientation.
- **Indirect:** Loss and degradation of habitat which may be important for feeding and spawning; and disruption to movement.

The current development intends to maintain the natural meander of the river but fixing the river width will reduce meander and cause straightening of river as compared to its natural course.

Mitigation

- Rubber Dam/Weir and Channelization works shall be properly designed to accommodate design flows. Provision to control flood damages and provision of safety of embankments will be considered during the design of these arrangements
- Control of wastewater and sediment releases to river.
- Contractor will be required to implement the water quality management protocols.
- Ensure the minimum ecological flow at downstream area.
- A monitoring program will be initiated for the impact of the construction activities on the aquatic habitat and key species.
- All vehicles, machinery, equipment and generators used during construction activities will be kept in good working condition and be properly tuned to minimize the adverse impact on waterfowl habitat by reducing noise, exhaust and land disturbance.
- Communities are given awareness and are involved in the proper protection of the Biota inside and around the project area.
- Proper monitoring to check the compliance of PEQS will be carried out.

5.8.2.3 Impacts on Fish Fauna

The fish fauna of the Ravi River, though currently composed of species categorized as Least Concern by the IUCN, is under increasing pressure from habitat loss and anthropogenic stressors. These include water pollution from agricultural runoff, industrial effluents, and untreated domestic sewage, which degrade water quality and reduce the availability of suitable aquatic habitats. As a result, fish health, reproductive success, and population dynamics are adversely affected. The recorded species, including Tilapia (*Oreochromis aureus*), Daula (*Channa punctata*), and Ray-finned Fish (*Osteobrama cotio*). Saul (*Channa marulius*) and Khagga (*Rita rita*) exhibit local migration behavior for feeding and breeding rather than long-distance dispersal. Therefore, maintaining suitable habitat conditions within the immediate project area is essential for sustaining and enhancing fish populations and local fishery productivity.

Mitigation

- To mitigate these impacts, it is essential to schedule construction activities outside of peak fish breeding periods and employ effective sediment control measures, such as silt curtains and settling basins, to limit turbidity and prevent siltation of breeding grounds.
- Maintaining ecological flow downstream of Rubber Dams/Weirs is also critical to preserve hydrological continuity and habitat quality.
- Post-construction mitigation should include habitat restoration and continuous water quality monitoring to track recovery and adapt management practices as needed.

Although the Ravi River site is already ecologically degraded and under significant anthropogenic pressure, the implementation of these mitigation measures is vital to protect the remaining fish fauna. By minimizing further habitat disturbance, managing sedimentation, and ensuring the continuity of ecological flows, the project can support the survival of existing populations and potentially contribute to the gradual improvement of aquatic biodiversity and ecosystem health over time.

5.8.2.4 Impacts on Vegetation

The Ravi River site selected for river training works lies within a severely degraded ecological zone, where natural vegetation has declined significantly due to prolonged anthropogenic pressure. Although some mature native tree species such as Banyan (*Ficus benghalensis*), Pipal (*Ficus religiosa*), Kikar (*Acacia nilotica*), and Sheesham (*Dalbergia sissoo*) are still present along the riverbank and roadside, the overall ecological integrity of the area is compromised. These river training activities, if not managed carefully, could intensify existing disturbances by altering the soil structure, removing topsoil, and disrupting remnant vegetation patches.

Key environmental pressures at the site include historic tree cutting, removal of fertile topsoil, pollution from untreated effluents, dumping of construction debris, and compaction of soil from unregulated activities.

Mitigation

- To control erosion and protect remaining soil fertility, bio-engineering techniques such as mulching, temporary vegetation cover, and use of geotextiles on embankments will be applied. Excavation and earth-moving operations will be carefully planned to avoid destabilizing areas where vegetation can naturally regenerate.
- Post-construction, an extensive plantation campaign will be initiated to rehabilitate disturbed areas using native tree and shrub species well adapted to floodplain and riparian environments. These plantings will contribute to slope stabilization, biodiversity enhancement, and natural buffering against future erosion. Shrub layers, in particular, will provide low-lying cover for wildlife and act as natural filters for runoff.
- Enforcement against illegal dumping and further soil extraction will be coordinated with local authorities. Regular inspections and physical barriers will be introduced to control unauthorized access and prevent further degradation of rehabilitated zones.

5.8.2.5 Wildlife Disturbance

The ecological survey of the Ravi River project area revealed a rich yet human impacted biodiversity profile, dominated by generalist mammals, birds, and herpetofauna across a composite of habitats. However, the dominance of synanthropic species (e.g., House Rat, Black Kite, and House Crow) and the relatively low abundance of habitat specialists (e.g., Jungle Cat, Spiny-tailed Lizard, and Black-bellied Tern) indicate ongoing habitat degradation and anthropogenic pressure.

For mammals, construction and development activities poses threats through vegetation clearance, noise, and disruption of movement corridors. Generalist species like Indian Hare, Wild

Boar, and mongooses are likely to persist, but less adaptable species such as the Jungle Cat and Long-eared Hedgehog may decline further without intervention. To reduce impacts, vegetation removal should be minimized, particularly in Belas and riparian forest patches. Habitat buffers (10–20 m) must be maintained, especially near forested and marshy areas, and post-construction replanting with native species should be prioritized. Nighttime work should be limited to prevent wildlife disturbance of nocturnal species.

Bird species, particularly ground-nesters and wetland-dependent species like Red-wattled Lapwing, Kingfishers, and Cattle Egrets, face direct threats from habitat loss and altered water regimes. Artificial food provisioning has led to unnatural concentrations of scavengers (e.g., Black Kite, House Crow), further disrupting avian community structure. To mitigate these impacts, tree and shrub removal during peak breeding months (March–June) should be avoided. Public education campaigns should discourage bird feeding near bridges. Wetland areas disturbed during works should be restored or enhanced with shallow water zones, and native vegetation re-established to support nesting and foraging.

Herpetofauna, especially amphibians and aquatic reptiles like the Indian Softshell Turtle (Endangered) and Spiny-tailed Lizard (Vulnerable), are highly sensitive to water pollution, poaching, and microhabitat loss. Construction must include erosion and sediment control measures near wetlands and floodplain islands. Known turtle and lizard habitats should be marked and avoided; if unavoidable, relocation under expert supervision is required. Strict prohibition of wildlife trade and poaching around the site should be enforced through monitoring, signage, and coordination with wildlife authorities.

Mitigation

Mitigation measures for wildlife during and after the river training works at the Ravi River site should focus on

- minimizing habitat disturbance and ensuring safe displacement of fauna.
- Vegetation clearance and construction activities must be confined to designated zones,
- Wildlife crossings or buffer strips near active habitats can help reduce fragmentation.
- For reptiles, especially species of conservation concern like the Spiny-tailed Lizard and Indian Softshell Turtle, coordination with the Wildlife Department is essential to monitor any displacement or risk of poaching. During post-construction activities, there is a potential risk of reptiles such as snakes and monitor lizards dispersing into nearby human settlements due to habitat displacement.
- To address this, coordination with the relevant Wildlife Department and emergency response services (e.g., Rescue 1122 and wildlife 1107) will be essential to ensure safe capture and release of these animals back into suitable natural habitats, minimizing harm to both wildlife and local communities.
- Additionally, awareness sessions for workers and nearby communities can reduce conflict and support conservation efforts.

- Replanting of native vegetation and periodic biodiversity monitoring will be important to facilitate long-term ecological recovery.

5.8.2.6 Concrete Boundary of River

River banks are used as corridor for bridging land and terrestrial life. These banks should be as natural as possible of earthen material, grass concrete or pebbles rather than concrete.

Mitigation

The establishment of grasscrete in the foreshore areas like viewpoints, parking lots and walking tracts can be made with grasscrete using native grasses. “Foreshore is the part of a shore between the water and cultivated or developed land.”

5.8.3 Socio-Economic Environment

5.8.3.1 Impacts on Local Population

The population residing in and the surroundings of the Project Area will be temporarily affected during the construction phase as follows:

- During the construction phase, the general mobility of the local residents and their livestock in the Project Area is likely to be hindered as cause accidents.
- Security problems may arise for the local population due to the Contractor’s workers during the construction phase.
- Community may face the noise and dust problems during the construction activities.
- Theft problems to the community by the Contractor’s workers and vice versa.

Mitigations

- Contractor should select specific timings for heavy machinery operation so as to cause least disturbance to the population considering their peak movement hours.
- Effective construction controls may be made by the Contractor to avoid inconvenience to the population due to noise, smoke and fugitive dust.
- Haul-trucks carrying concrete, aggregate and sand fill materials will be kept covered with tarpaulin to help contain the construction materials being transported to the specific site.
- The Contractor should warn the workers not to involve in any theft activities and if anyone would involve in such type of activities, he will have to pay heavy penalty and would be handed over to police. Similarly, at the time of hiring labour/workers, Contractor has to ensure that the workers should be of good repute/character.
- In order to improve the project ownership among local residents, the contractors should engage local semi-skilled and un-skilled labour on project during construction phase.
- Proper arrangements in the form of alternative routes should be made to ensure that the mobility of locals should not be disturbed.

- A proper traffic management plan has been prepared by the contractor in consultation with Traffic Police Department to reduce the problems of traffic jams during construction.

5.8.3.2 Visual Impacts and Aesthetics

Possible visual impacts during construction phase activities are likely to arise from fugitive dust, on-site storage of construction material, storage of construction debris, physical presence and operation of labour camp which may affect visual and aesthetic aspects of the proposed project area especially Shahdara area and Rubber Dam/Weir-III site. This impact is temporary and low adverse in nature.

Mitigation

- The construction site should be fenced and all the construction activities should be restricted within the demarcated site;
- Condition of the site approach road should be kept free of dust and mud as much as possible through implementation of dust suppression measures; and
- All temporary structures, surplus materials and wastes should be completely removed on completion of works.

5.8.3.3 Disturbance to Public Properties

Due to the proposed Project activities, houses, mosques, shrines existing in and around the Project Area may get affected indirectly due to noise and dust.

Mitigation

As there is no direct impact, therefore no mitigation is required. The indirect impact of dust and noise can be reduced by sprinkling water and reducing the noisy activities during the prayer timings.

5.8.3.4 Accessibility Issue

Closure of existing unpaved / deteriorated road and other pathways during the construction phase of the project will cause inconvenience to the nearby residents and affecting their daily life activities.

Mitigation

Mitigation measures will include public awareness through media, proper traffic diversion plans, appropriate sign boards and timely completion of the project.

5.8.4 Impacts on Public Health and Safety Hazards

The construction activities and vehicular movement at construction sites may result in roadside accidents particularly inflicting local communities who are not familiar with presence of heavy equipment. Quality of groundwater and surface water resources available in the nearby local communities may be affected due to the construction activities, oil spillage and leakage, roadside accidents, etc. The proposed project will also have potential of air (dust pollution), noise and vibrational impacts on nearby community. The labour works with different transmittable diseases

may cause spread out of those diseases in the local residents. The construction areas located near the residential, settlements, may cause accident for the people moving near to those areas. Conflicts may arise between the local community and the construction workers, which may be related to religious, cultural or ethnic differences, or based on competition for local resources. Tensions may also arise between different groups within the labour force, and pre-existing conflicts in the local community may be exacerbated. Ethnic and regional conflicts may also be aggravated if workers from one group are moving into the territory of the other.

Mitigation

- Contractor will ensure the provision of medicines, first aid kits, emergency vehicles, etc. at the work place.
- The labourers screening will help and with different transmittable diseases will be restricted within the construction site.
- Ensure that the site is restricted for the entry of irrelevant people particularly children.
- Training of workers in the construction safety procedures, environmental awareness, and equipping all construction workers with safety boots, helmets, gloves, ear plugs, and protective masks, and monitoring their proper and sustained usage.
- Provision of proper safety and diversion signage, particularly at urban areas and at sensitive/accident-prone spots.
- Setting up speed limits in close consultation with the local stakeholders.
- The mitigation measures provided in the for air and noise shall be adopted to reduce the air pollution, noise pollution and vibrational impacts on nearby community.
- Effective implementation GRM and reduce this impact.

5.8.4.1 Occupational Health and Safety

Occupational Health and Safety (OH&S) related impacts will arise during construction phase activities including clearing of earth, levelling, compaction, carpeting, pavement finishing and testing & commissioning. Eye injury can be caused by stone or metal particles. Hazard of being hit by falling objects, major hand-arm and whole body vibration hazards, skin and respiratory tract irritation from exposure to cement dust, overexertion and awkward postures etc. will be another impact. Welding hazards include electric shock, fumes and gases, fire and explosions, falls from height, eye and head injuries etc. Security as well as the safety of the Contractor and Consultant staff will be major issue. Operating mechanical and electrical equipment will trigger the H&S issues e.g., struck by moving vehicles or other equipment, slips or trips, struck by flying objects, such as dirt or splashed fluids, caught in pinch points, shear points, crush points, falling from machine etc. Considering these consequences, this impact temporary and medium probability.

Mitigation

- Providing basic medical training to specified work staff and basic medical service and supplies to workers;

- Complying with the safety precautions for the construction workers as per International Labour Organization (ILO) Convention No. 62, as far as applicable to the Project Contract;
- Training of workers in construction safety procedures, environmental awareness, equipping all construction workers with safety boots, helmets, gloves and protective masks, goggles, shields and monitoring their proper and sustained usage;
- Contractor will ensure the provision of medicines, first aid kits, ambulance etc. at the camp site;
- Work areas will be cordoned off where necessary;
- Contractors will instruct their staff to use Personnel Protective Equipment (PPE) (e.g., wire containment, displaying warning signs along the work site, communicating advance warnings to mats) to enhance the safety; and
- Safety lookouts will be built to prevent people and vehicles from passing at the time of hot or cold work; and
- An emergency management plan must be devised by the contractor in close coordination with the provincial emergency services.

5.8.5 Workforce from other Region

This can be particularly acute in smaller communities hosting a largely male workforce and/or a workforce from other regions which may result in conflicts between locals and non-locals concerning employment opportunities, wages and natural resources. Mobile workers can also contribute significantly to gender-based social impacts and risks. Conflicts may arise between the local community and the construction workers, which may be related to religious, cultural or ethnic differences, or based on competition for local resources

The influx of workers and service providers into communities may increase the rate of crimes and/or a perception of insecurity by the local community. Such illicit behaviour or crimes can include theft, physical assaults, substance abuse, prostitution and human trafficking. Local law enforcement may not be sufficiently equipped to deal with the temporary increase in local population.

The influx of people may bring communicable diseases to the project area, including Sexually Transmitted Diseases (STDs), COVID- 19 or the incoming workers may be exposed to diseases to which they have low resistance. This can result in an additional burden on local health resources. Workers with health concerns relating to substance abuse, mental issues or STDs may not wish to visit the project's medical facility and instead go anonymously to local medical providers, thereby placing further stress on local resources. Local health and rescue facilities may also be overwhelmed and/or ill- equipped to address the industrial accidents that can occur in a large construction site.

Large populations of workers generate increased amounts of waste, for which no sufficient local waste management capacities may exist, which would likely lead to improper disposal practices. The camp use can result in increase in noise and light pollution especially at night. The

construction of new access roads can also lead vegetation removal and landscape transformation.

Mitigation

- The Contractor will prepare the plan related to construction camp and labour management. This will be reviewed and approved by RUDA.
- The Contractor will select the specific timings for the construction activities particularly near the settlements, so as to cause least disturbance to the local population, particularly women.
- Local population will be given preference in construction related jobs. Most unskilled workers will be hired from local communities, while for skilled manpower also, first choice will be given to local area residents.
- Contractor will take due care of the local community and observe sanctity of local customs and traditions by his staff. Contractor will warn the staff strictly not to involve in any unethical activities and to obey the local norms and cultural restrictions.
- The contractor will also ensure that solid waste and wastewater is disposed of in an approved method only.
- The contractor will explore alternative water sources and ensure that water usage by the project does not affect or compete with water requirements of the local community.
- SOPs related to COVID-19, should be implemented by the contractor and should be strictly monitored.

5.8.6 Archaeological / Monument / Cultural Site

During field survey it was observed Jhangir Tomb and Kamran Baradari is present in project Aol, which is a monument declared as “Special Premises” by Punjab Government under Punjab Special Premises (Preservation) Ordinance, 1985. It is also an archaeological site / monument protected by the Federal Government located in Punjab Province under Guidelines for Protected Areas, 1997. The Kamran baradari is situated within the impoundment area of Rubber Dam/Weir II, while Jahangir tomb is situated at the distance of approx. 500m on left side.

Mitigation

- **Hydraulic Design Modification:** Introduce flow deflectors or silt curtains to reduce water stagnation around the structure.
- **Protective Bund Construction:** Construct a dedicated ring bund or retaining wall around the Baradari to prevent direct inundation.
- **Waterproofing and Drainage:** Sub-surface drainage and moisture barriers may be installed around the Baradari to reduce capillary rise and water damage.
- **Monitoring and Early Warning:** Install real-time water level sensors and initiate a heritage-specific monitoring protocol to detect any early signs of structural stress or deterioration.

- **Stakeholder Engagement and Heritage Clearance:** Collaborate with the Department of Archaeology and local heritage stakeholders to ensure all interventions with respect to the cultural significance of the site.
- **Contingency Planning:** Prepare a site-specific emergency response and preservation plan, including options for temporary relocation of movable artifacts if applicable.
- A heritage preservation contingency plan with emergency intervention protocols is prepared and annexed with this report as Annex:4.

5.9 Impacts and Mitigations Measures during the Project Operations

5.9.1 Sedimentation

During the operational phase, the formation of a reservoir behind the Rubber Dam/Weir slows river flow, reducing its sediment-carrying capacity. As a result:

- Sediment deposition increases in the impoundment zone, particularly upstream of the Rubber Dam/Weir.
- Gradual loss of live storage reduces the water-holding capacity and shortens the functional lifespan of the reservoir.
- Increased hydrostatic pressure from accumulated silt can stress dam structures.
- Backwater effects can alter sediment transport dynamics and floodplain connectivity.
- Downstream sediment starvation may cause riverbed degradation (bed incision), destabilizing banks and affecting aquatic habitats.
- Sediment-laden water may block sluice gates and damage mechanical components if not properly managed.
- If sediment is contaminated (from untreated wastewater inflows), it may also degrade water quality and create sludge management challenges.
- Ecological and Agricultural Impact associated with Sedimentation and erosion:
- Sediments naturally carry nutrients important for floodplain fertility.
- Disruption in sediment flow affects aquatic species, especially spawning and feeding habitats for fish and benthic organisms.
- Agricultural areas downstream may experience loss of fertility over time due to lack of sediment replenishment.

Impact Significance: High Negative if not managed.

Mitigation

To ensure the long-term sustainability of the river morphology, water conveyance efficiency, and ecological balance, a comprehensive sediment management approach is required. Key actions are as follows:

- **Scheduled Sediment Flushing:** Regular flushing of the river channel is essential to remove deposited sediments, particularly in impoundment and low-velocity zones. While natural flushing may occur during high-flow or monsoon periods, contingency protocols must be in place to initiate controlled mechanical or hydraulic flushing during dry or low-flow periods.
- **Sediment Sluicing Infrastructure:** Rubber Dam/Weir and Rubber Dam/Weir structures will incorporate dedicated sediment sluicing gates designed to facilitate efficient sediment release during high-discharge events. These gates should be operable to align with ecological flow requirements and minimize sediment accumulation.
- **Dredging and Sediment Disposal:** In areas of persistent deposition, targeted dredging operations will be conducted. A Sediment Disposal Plan will be prepared to ensure that dredged material is disposed of at designated, environmentally acceptable sites without impacting downstream water quality or aquatic habitats.
- **Grade Control and Morphological Stabilization:** To mitigate risks of downstream channel incision or bed lowering, grade control structures, submerged sills, or engineered riffles will be constructed. These features will help maintain longitudinal river profile and reduce sediment transport imbalances.
- **Bank Stabilization and Bioengineering:** Following construction, riverbanks prone to erosion will be stabilized using bioengineering methods such as live staking, brush layering, and native vegetative cover. These techniques will enhance slope stability, reduce sediment yield, and improve riparian biodiversity.
- **Downstream Afforestation Measures:** Strategic afforestation programs will be implemented along downstream riverbanks, beyond the immediate project area, to protect against erosion, improve flood resilience, and enhance ecosystem services.
- **Sediment and River Basin Management Plan:** A comprehensive Sedimentation Management Plan (SMP) will be developed as an integral component of the River Basin Management Plan prior to the operational phase. This plan will include flushing schedules, structural measures, sediment modeling, and adaptive protocols.
- **River Ecology and Sediment Monitoring Program:** A River Ecology Monitoring Program will be established to monitor sediment dynamics, aquatic habitat conditions, water quality, and species health. The data collected will guide adaptive management of sediment control measures and ensure compliance with environmental performance benchmarks.

5.9.2 Aquatic Weeds Formation in River Basin

The condition of proposed river will be ideal for the aquatic weeds formation because the aquatic weeds are ideal to form with decrease in flow of river and trapped sediments in a favorable climatic condition (25-42 °C) like Lahore. Due to aquatic weeds formation, there will be negative impacts on Entire River and its related ecosystem. The impacts are given as follow:

- An aquatic weed reduces the effectiveness of river water body for fish production.

- Aquatic weeds can assimilate large quantities of nutrients from the river water reducing their availability for planktonic algae.
- They may also cause reduction in oxygen levels and present gaseous exchange with river water resulting in adverse fish production.
- The excessive weed growth may provide protective cover in river water for small fish growth it may also interfere with fish harvesting.
- Dense growth of aquatic weeds may provide ideal habitat for the development of mosquitoes causing malaria, encephalitis and filariasis.
- These weeds greatly reduce the aesthetic value of river water body from a recreational point of view.
- They cause tremendous loss of water from water bodies like lakes and dams through evapo-transpiration.

Mitigation:

The aquatic weeds can be controlled biologically by the introduction of various herbivorous species. Introduce grass carp with common carp, turtles, Ducks and Geese are well known for aquatic weed feeders. The grass carp and turtles are very much effective in controlling aquatic weed because they feed directly on these weeds. The common carp feed on bottom dwelling plants and sediments and important to root out of these plants. This measure will be very much effective in controlling aquatic weeds although still if problem exist then mechanical aquatic harvester should be employed for cutting and removing all the weeds present in the river water body.

5.9.3 Impact on Downstream Rubber Dam/Weir

Due to increase in volume of water and flow velocity especially during monsoon, there may be impact on downstream areas.

Mitigation

- The increased volume of water will be managed by constructing Rubber Dams/Weirs.
- The Rubber Dams/Weirs will be designed to deal with extra water flow if encountered at any stage.

5.9.4 Impact on Micro Climate

The sizeable water body is likely to have only minor effect on the local micro-climate as compared to the no project situation. There is likely to increase in humidity in nearby areas due to increase in volume of water and the presence of the water body could reduce the summer maximums.

Mitigation

Development and Implementation of Plantation plan.

5.9.5 River Ecology

River training works (such as embankments, spurs, or revetments) can significantly alter the natural hydrological behavior of the Ravi River. Regulated flow and restricted floodplain connectivity may disturb natural sediment deposition, reduce channel mobility, and impact wetland formation, all of which are vital for maintaining ecological balance. The reduction in seasonal flooding also affects nutrient distribution along riverbanks, which traditionally supports agriculture and natural vegetation.

Mitigation:

- Ensure minimum environmental flow downstream to maintain ecological processes.
- Adopt sediment management strategies to prevent excess siltation or erosion, especially during monsoon flows.
- Preserve bendy zones and natural floodplains where possible to allow periodic upgrading of riverine ecosystems.

5.9.6 River Biodiversity

The Ravi River, though degraded in some stretches, still supports diverse aquatic and species, including native fish, reptiles, amphibians, water birds and terrestrial mammals. Alterations in flow, habitat fragmentation, and water quality deterioration due to operational discharges or reduced flushing can threaten local biodiversity. Furthermore, construction of embankments may restrict access of aquatic species to side channels and breeding grounds.

Mitigation:

- Given the existing ecological degradation, fish passages should be constructed at strategic locations, where technically and environmentally feasible, to restore and maintain aquatic connectivity.
- Protect critical habitats such as fish spawning zones, wetland areas and forested habitat.

5.9.7 Cofferdams

The cofferdam structures remain during the operational phase, they may disrupt local flow patterns, leading to localized stagnation, algae growth, and habitat loss for benthic organisms.

Mitigation:

- Ensure complete removal of temporary cofferdams post-construction.
- Restore and stabilize the riverbed using natural materials and riparian indigenous vegetation.
- Monitor for hydraulic anomalies near former cofferdam sites and rectify if needed.

5.9.8 Flora and Fauna

The Ravi River's riparian zones support native plant species, birds, and small mammals as mentioned in baseline report. Operational activities and altered water levels may lead to drying of

riverbanks, degradation of natural vegetation, and disturbance to wildlife corridors. Encroachment due to increased embankment stability can also pressure natural habitats.

Mitigation:

- Carry out plantation of native riparian vegetation along embankments and spurs.
- Establish wildlife buffer zones in ecologically sensitive areas especially near forested habitats.
- Coordinate with local forestry and wildlife departments for habitat enrichment programs.

5.9.9 River Embankments

Engineered embankments can significantly alter the natural hydrodynamics of the Ravi, disconnecting the river from its historical floodplain and wetland systems.

Mitigation:

- Use bioengineering methods to reinforce embankments.
- Design controlled breaching sections to allow periodic floodplain inundation.
- Conduct regular inspection and maintenance, ensuring embankments do not block seasonal flows to adjacent wetlands.

5.10 Potential Environmental and Social Enhancement Measures

5.10.1 Ecological Uplifting of Ravi River

The Ravi River is known ecologically dead because all the ecological functions have disturbed due to industrial and sewage pollution. The birds and fishes which once thrive in the river have all gone and the river takes the form of sewerage. The current project will help in entire ecological uplifting of the river. The abundance of fresh water will have overall positive impact on ecosystem and its functions. The proposed lakes provided in the river will be habitat for many birds and native species. The food chain will be naturally created with some artificially species inductions and the fauna which once seen around the Ravi River will emanate. The Ecological uplifting will have direct benefit of providing food resources and indirect benefit in increasing aesthetic beauty of the river.

5.10.2 Recreational Activities and Tourism

The development of proposed Ravi River Front Urban Development Project opens the doors for tourism and recreational activities like boating, sport fishing, hoteling, visiting and wildlife viewing. The project has state of the art parks and floating island which will be worthwhile for watching, visiting and picnics, spaces and new places to visit, admire and enjoy. Hotels and restaurants build at bank of the river will attract national and international tourists that have overall positive impact on economy of the region. It will provide the general public with an open space for leisure and recreation and will do the revitalization of the neighbourhood. In addition, the Riverfront development will create and promote a more positive image of the Lahore city.

5.10.3 Job Opportunities

During the design, construction and operational phases of the project there will be a demand for workers, both skilled and unskilled. This will include opportunities for all relevant local peoples directly on the construction site and also indirectly in related service works such as supply of construction materials etc. During the detailed design phase of the proposed strategic plan, the clearer picture of extent of job opportunities would be estimated. Among these opportunities, the preference shall be given to locals, especially those who lose their assets and livelihood. During the operation phase, the project will have commercial centres, business centres, hotels, recreational facilities, offices and educational and health institutions. All of these interventions will create more job opportunities which will ultimately uplift the earning as well as life standards of the residents of area.

5.10.4 Economic Uplifting of the Region

The project will create new opportunities with great benefit to create one of the powerful economic zones of the country. The new city created at the banks of the river will be economic hub of the region at national and international levels with habitat diversity. The new city developed will also know as resilient economic City. It will open new horizons for business community as well as for professionals and labour class. This riverfront development will bring benefit for all city residents through generation of wealth, job and improved built environment and physical infrastructure.

The riverfront development will give economic benefits to local people and business establishments, that it will attract public and private establishments and will boost investment activity and economic regeneration. In addition, it will increase the city's value in economic competitiveness, will attract more investment, will lead to more spending and will offer substantial premiums to developers, landowners and local government. Moreover, it will increase real estate tax revenues and cause Economic spin-off's by rising the value of properties and acting as a catalyst for redevelopment and renewal of nearby places.

5.10.5 Flood Protection

Flood events are a part of nature. They have existed and will continue to exist. Floods have devastating impacts on human's losing thousands of lives, property, livestock and agriculture whenever it hits. Considering devastative impacts of flood in Pakistan, it should be prevented. River Training and Channelization is designed to cater the maximum flood that occurs in the history of Ravi River. The maximum flood observed in Ravi River was in 1988 which was around 576,000 cusecs. This was unusual event but the Ravi River has now been channelized that will cater the 1000 years return period flood of 5,86000 cusecs. So, this is one of the important benefits that will avoid the flow of flood water into the developed areas.

5.11 Conclusion and Recommendations

While the Ravi River training project offers substantial urban, hydrological, and aesthetic benefits, it presents moderate to high negative impacts in terms of cultural heritage and sediment dynamics. The Baradari, as a historically significant structure, requires a dedicated preservation and engineering strategy to prevent damage. Equally, the hydraulic regime's alteration must be

accompanied by an adaptive sediment and erosion management framework. These measures, if implemented effectively, will significantly reduce long-term risks and enhance the sustainability of the project.

6 Environmental Management Plan

6.1 General

This Chapter provides an overall approach for managing and monitoring environment-related issues and describes the institutional framework and resource allocations proposed by RUDA to implement the Environmental Management Plan (EMP) for the RTW and Rubber Dams/Weirs. The main objectives of EMP are to:

- Provide the details of the project impacts along with the proposed mitigation measures, and a corresponding implementation schedule.
- Define the responsibilities of the project proponent, contractor, supervisory consultants, and other role players, and effectively communicate environmental issues among them.
- Define a monitoring mechanism, reporting frequency, auditing, and identifying monitoring parameters to ensure that all the mitigation measures are completely and effectively implemented.
- Identify the resources required to implement the EMP and outline the corresponding financing arrangements.

6.2 Summary of Projects Impacts and Residual Impacts

The summary of Project Impacts and Residual Impacts are given in Table 6-1.

Table 6-1 Summary of Projects Impacts and Residual Impacts

Phase	Potential Impact	Impact Significance	Mitigation
Construction	Soil and groundwater contamination from wastewater, oil spills, and concrete slurry	Minor – if bunded storage, spill containment, and lined settling ponds are provided	Construction wastewater to be routed through sedimentation basins and monitored regularly
Construction	Sediment runoff and increased turbidity in river due to excavation and earthworks	Low – if silt fences, cofferdams, and dry season scheduling are followed	Erosion and sediment control measures to be implemented prior to riverbank works
Construction	Air pollution (dust from earthworks) and noise (from heavy equipment) disturbing	Moderate – especially near sensitive sites like	Water sprinkling, noise barriers, low-noise machinery,

	nearby communities and fauna	Kamran Baradari and informal settlements	and restricted working hours
Construction	Waste generation from construction camps and workforce (approx. 80–100 kg/day for 150 workers)	Low – if solid waste is segregated, organic waste composted, and non-recyclables landfilled	Contractor to establish proper camp waste handling SOPs per EMP
Construction	Increased traffic and safety risks due to heavy material transport and machinery	Moderate – unless a transport and road safety plan is implemented	Traffic Management Plan (TMP) to be coordinated with local authorities
Construction	Loss of vegetation along riverbank; potential removal of some riverine flora	Low – with limited clearance and compensatory plantation plan	Replanting of native species post-construction; avoid areas near critical habitats
Construction	Community health risks from labor influx, waterlogging, and noise pollution	Low to Moderate – if community health and safety plan is in place	Local hiring, hygiene promotion, mosquito control, and regular community consultation
Construction	Risk to heritage structures (e.g., Kamran’s Baradari) from vibration and visual disturbance	Minor – if buffer zone and protective measures are respected	Heritage Impact Assessment incorporated; vibration monitoring near Baradari
Operation	Altered river hydrology and downstream impacts from Rubber Dam/Weir operation	Moderate – if no flow release protocols or ecological flow maintained	Adaptive water release strategy to be adopted; monitored by Punjab Irrigation Department

Operation	Waste and effluents from Rubber Dam/Weir offices, staff quarters, and O&M activities	Low – with structured waste management and drainage design	Wastewater treatment units and solid waste segregation to be maintained onsite
Operation	Waste Water Management coming from WASA drains before & in between Rubber Dam/Weir 2 & 3	High – with structured waste management unit and drainage design	Wastewater treatment unit before Rubber Dam/Weir 2 & 3 at appropriate locations
Operation	Restricted access to riverside areas for local communities due to fencing and safety	Minor – mitigated by maintaining safe public access corridors	Public access areas with safety signage and fencing at sensitive points
Operation	Risk of water stagnation and breeding of disease vectors (e.g., mosquitoes) in Rubber Dam/Weir pondage area	Moderate – especially in summer, if flushing and water circulation aren't ensured	Scheduled flushing and biological vector control strategies to be implemented
Operation	Impact on aquatic life and migratory fish due to flow regulation and water impoundment	Low to Moderate – depending on ecological design of Rubber Dam/Weir	Fish ladders and ecological flow maintenance included in design

6.3 Environmental Management & Monitoring Plan

An environmental management and monitoring plan establishes the linkages between the environmental and social impacts, mitigation strategy, and the agencies responsible for execution. Thus, the EMP covers

- A comprehensive listing of mitigation measures (actions).
- The institution(s)/ person(s) responsible for the implementation of specific actions.
- The parameters to be monitored to ensure the effective implementation of the actions.
- A timescale for the implementation of actions has been indicated subject to the project life cycle and indicated as During Construction (DC) or During Restoration (DR).
- The Affects Monitoring Plan for the ongoing activities is presented in table below

Table 6-2 Environmental Management Plan

Aspect	Impact	Mitigation Measures	Responsibility	Monitoring Indicator	Frequency
During Design Phase					
Dam Location & Height	Risk of excessive inundation or heritage damage	<ul style="list-style-type: none"> Hydraulic and inundation modelling; safe distance from Kamran Baradari Optimize Rubber Dam/Weir and Rubber Dam/Weir crest elevation to minimize impoundment height near heritage site. Adjust operating rules (e.g., partial deflation during high flows) to reduce backwater pressure during sensitive periods. Reconfigure guide bunds and flow alignment to redirect hydraulic thrust away from Baradari location. 	Design Consultant	Inundation maps, clearance reports	One-time
Sediment Load	Risk of rapid siltation	<ul style="list-style-type: none"> Incorporate sediment flushing gates in design 	Design Consultant	Flushing gate design in drawings	One-time

Flood Flow Management	Obstruction to natural flood flow	<ul style="list-style-type: none"> Design overflow/bypass structures 	Design Consultant	Overflow structure drawings	One-time
Cultural Heritage	Risk to Kamran Baradari	<ul style="list-style-type: none"> Design protective embankment and drainage around Baradari 	Design & Heritage Consultant	Heritage Impact Assessment (HIA)	One-time
Pre-Construction Phase					
Land Acquisition	Resettlement/displacement	<ul style="list-style-type: none"> Conduct land and property surveys, prepare RAP 	RUDA, Revenue Dept.	RAP approval, compensation records	Monthly
Wastewater Management	Pollution risk	<ul style="list-style-type: none"> Install modular/mobile wastewater treatment units at key inflow points as a short-term solution. Use low-cost technologies like constructed wetlands, settling tanks, or aeration lagoons for preliminary treatment Deploy mechanical aerators or floating fountains within the reservoir to enhance oxygenation and reduce anaerobic conditions caused by organic load. 	RUDA, WASA	WWTP status reports	Monthly

		<ul style="list-style-type: none"> Use phytoremediation techniques (e.g., water hyacinth, vetiver grass) as natural water purifiers near inflow points. 			
Stakeholder Engagement	Lack of community support	<ul style="list-style-type: none"> Conduct consultations & disclose plans 	RUDA, Social Consultant	Meeting minutes, feedback logs	Monthly
Construction Phase					
Air Quality	Dust from earthworks	<ul style="list-style-type: none"> Regularly sprinkle water on exposed soil and haul roads, especially during dry or windy weather. Cover trucks and stockpiles with tarpaulins to prevent wind-blown dust. Limit open excavation areas and phase earthworks to reduce exposed surfaces. Compact or gravel internal roads to minimize dust from vehicle movement. Impose speed limits for construction vehicles on site. 	Contractor	Dust levels (PM ₁₀), complaints	Weekly

		<ul style="list-style-type: none"> • Maintain equipment to reduce dust emissions from engines. • Monitor air quality near sensitive locations and adjust mitigation accordingly. • Inform nearby residents before major earthworks and respond to dust-related complaints. 			
Noise Pollution	Machinery operation	<ul style="list-style-type: none"> • Machinery should be well-maintained to minimize emissions and noise, operated only during designated hours to avoid disturbance, refuelled and serviced in designated areas with spill prevention measures, • Engines must be turned off when not in use to reduce fuel consumption and air pollution. 	Contractor	Noise level (dB) near receptors	Weekly

		<ul style="list-style-type: none"> • Low-noise equipment should be preferred where feasible, • Operators must be trained in environmentally responsible handling and safety protocols. 			
Water Pollution	Contaminated runoff into river	<ul style="list-style-type: none"> • Designate and maintain fuelling and maintenance zones away from water bodies with spill containment measures. • Install silt fences, sediment traps, and temporary drainage systems to control surface runoff. • Store chemicals, fuels, and hazardous materials in secure, covered, and bunded areas. • Ensure proper disposal of wastewater and prohibit direct discharge into the river. • Implement regular inspection and 	Contractor	Water test results (BOD, COD)	Bi-weekly

		<p>maintenance of stormwater control measures.</p> <ul style="list-style-type: none"> • Train workers on spill response and waste handling procedures. • Use vegetative buffers and erosion control mats along riverbanks to filter runoff. • Ensure proper drainage planning at construction sites to prevent wastewater stagnation. • Use sedimentation tanks or temporary containment pits to collect wastewater before safe disposal. • Prevent discharge of untreated greywater or effluent into the river. • Designate specific areas for equipment washing with wastewater capture and treatment. • Monitor water quality in nearby river sections 			
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		regularly during construction.			
Waste Generation	Improper disposal	<ul style="list-style-type: none"> • Provide designated waste collection bins at construction and camp sites. • Implement a waste segregation system for recyclables, hazardous, and general waste. • Ensure timely collection and disposal of waste to approved landfill or recycling facilities. • Prohibit open dumping and burning of solid waste near the river or in open areas. • Conduct regular awareness sessions for workers on proper waste disposal practices. 	Contractor	Waste logs, site cleanliness	Weekly
Occupational Safety	Injury to workers	<ul style="list-style-type: none"> • Ensure use of personal protective equipment (PPE) such as helmets, gloves, 	Contractor	Safety audit reports, accident logs	Weekly

		<p>boots, and high-visibility clothing.</p> <ul style="list-style-type: none"> • Provide safety training and regular toolbox talks to all workers. • Implement fall protection measures for work at heights (e.g., on embankments or Rubber Dam/Weir structures). • Maintain clear signage and secure access routes around hazardous areas. • Ensure proper maintenance and safe operation of machinery and tools. • Establish first aid stations and emergency response protocols on-site. • Monitor fatigue and heat stress, especially during summer months. • Appoint a Health and Safety Officer to supervise 			
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		compliance with safety protocols.			
Public Safety	Risk to locals	<ul style="list-style-type: none"> • Install barricading around all active construction zones to restrict unauthorized access. • Erect clear and visible warning signs near hazardous areas such as excavation sites, heavy machinery routes, and waterlogged zones. • Use reflective tape, lights, or flags on barriers for visibility during night operations. • Ensure signage is multilingual and easily understandable for local workers and visitors. • Regularly inspect and maintain barricades and signs to ensure effectiveness throughout construction. 	Contractor	Site inspection records	Weekly

Impact on Kamran Baradari	Seepage risk	<ul style="list-style-type: none"> Continuous monitoring, protective bund 	Contractor, Archaeology Dept.	Groundwater/seepage logs	Monthly
Operation & Maintenance Phase					
Wastewater Accumulation	Water quality degradation	<ul style="list-style-type: none"> Coordinate with relevant agencies to ensure timely installation of WWTPs to prevent accumulation in the reservoir. Continuous WWTP operation & monitoring 	WASA/ RUDA	Water quality data (DO, BOD, COD)	Monthly
Sediment Deposition	Capacity loss of reservoir	<ul style="list-style-type: none"> Schedule periodic flushing of the reservoir through dedicated sediment sluicing gates to prevent sediment build-up. Conduct mechanical dredging in high-deposition zones to maintain water storage capacity and flow efficiency. Ensure environmentally safe sediment disposal at 	RUDA O&M Team	Sediment load, bathymetry survey	Bi-annually

		<p>designated sites approved by relevant authorities.</p> <ul style="list-style-type: none"> • Coordinate flushing operations with high-flow periods to enhance sediment transport and minimize ecological disruption. • Monitor sediment levels regularly to optimize the timing and intensity of flushing and dredging activities. 			
Vector Breeding	Health hazards (mosquitoes)	<ul style="list-style-type: none"> • Maintain optimal flow in the reservoir through periodic flushing to prevent stagnant water pockets. • Design reservoir banks with proper slopes and drainage to avoid waterlogging and pooling along edges. • Implement vegetation control along reservoir margins to limit mosquito habitat. 	RUDA, Health Dept.	Vector survey	presence Quarterly

		<ul style="list-style-type: none"> • Introduce biological control measures such as larvivorous fish (e.g., Gambusia) where ecologically appropriate. • Coordinate with health departments for routine vector surveillance and targeted control interventions. • Ensure public access areas are regularly maintained to discourage vector proliferation near human activity zones. • 			
Safety of Visitors	Accidental drowning	<ul style="list-style-type: none"> • Install safety railings and barriers along reservoir banks, promenades, and access points. • Display clear warning signs about water depth, slippery areas, and restricted zones. 	RUDA	Safety audits	Monthly

		<ul style="list-style-type: none"> • Deploy trained lifeguards or safety personnel in high-use recreational areas. • Provide life-saving equipment such as life rings and poles at regular intervals. • Develop and implement an emergency response and rescue plan with first-aid support. • Restrict access during high-flow or maintenance periods to reduce drowning risks 			
Damage to Kamran Baradari	Protection	<ul style="list-style-type: none"> • Maintain regulated water levels through operational control of Rubber Dams/Weirs • Operate sediment flushing gates routinely to avoid silt buildup and hydrostatic pressure near the structure. • Monitor waterlogging risks by installing piezometers and foundation-level 	RUDA, Archaeology Dept.	Structural integrity reports	Quarterly

		<p>moisture sensors around the Baradari.</p> <ul style="list-style-type: none"> • Conduct periodic structural assessments to detect any stress or degradation caused by fluctuating water tables. • Maintain the protective bund and drainage systems to ensure they function effectively during high-flow or flood events. • Continue coordination with heritage authorities to implement adaptive conservation measures as needed. 			
Social Acceptance	Community concerns	<ul style="list-style-type: none"> • Maintain open GRM and feedback loops • Conduct regular community consultations to address concerns and incorporate feedback into project operations. • Ensure transparency in project benefits, such as 	RUDA	GRM records, public meetings	Quarterly

		improved water access, recreational spaces, and flood protection.			
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6.4 Worker Accommodation Plan

Worker Accommodation Plan (WAP) for the Project covers guidelines, the standards and practices to be used in the design and management of workers' accommodation by RUDA, its contractors, and subcontractors. The WAP shall largely be implemented by the Construction Contractor. The scope and applicability of the WAP are limited to the design and management of the worker accommodations provided during the construction phase of the Project. RUDA and its contractors will ensure sufficient resources are allocated on an ongoing basis to achieve the effective implementation of the worker accommodation plan.

6.4.1 Accommodation Planning and Arrangement

Worker Accommodation Plan (WAP) for the Project covers guidelines, standards and practices to be used in the design and management of workers' accommodation by RUDA, its contractors and subcontractors. The WAP shall largely be implemented by the CC. The scope and applicability of the WAP are limited to the design and management of the worker accommodations provided during the construction phase of the Project. RUDA and its contractors will ensure sufficient resources are allocated on an on-going basis to achieve the effective implementation of the worker accommodation plan.

Worker accommodations will be located within the Project site and will be provided during the construction phase of the Project. The worker accommodations will be located in areas where it shall not interfere with the construction activities.

A worker accommodation plan (WAP) will be prepared by the contractor as part of SSEMP. An emergency response plan and fire management plan will also be prepared by the contractor as part of SSEMP.

6.5 Waste Management Plan

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

The solid and liquid waste to be generated from the project activities and camps is to be disposed of as per prescribed measures.

6.5.1 Non-hazardous Waste Management Plan

Construction Phase

A Waste and Hazardous Waste Management Plan will be integrated into Construction Management Plan for the construction period. The Construction Contractor is responsible for preparing a Waste and Hazardous Waste Management Plan for the construction phase of the Project.

- Reuse opportunities for waste generated from the Project will be actively investigated. Used oil and other waste will be identified, and if any, it will be stored in a separate designated and contained facility.

- As a standard practice, all metal parts (such as iron and copper) or wooden components generated as waste during the construction of the Project will be recycled or stored in a dedicated existing scrap yard for auction or other disposal.
- Even after the implementation of the control measures, it is possible that some littering may take place. Periodic monitoring and cleanup will be undertaken to minimize the residual impact.

Operational Phase

Solid waste materials will be regularly collected from the site, sorted, and stored in demarcated spaces. The waste will be disposed of in a government-approved landfill.

6.5.2 Hazardous Wastes Management Plan

The following plan outlines the identification, handling, storage, transportation, and disposal of hazardous wastes that may arise during the construction phase of the project, ensuring compliance with environmental standards and safeguarding human health and ecological systems.

6.5.3 Management and Mitigation Measures

During the implementation of the river training works and construction activities, a range of hazardous wastes may be generated due to construction and mechanical activities. These wastes include used engine oils, spent lubricants, grease, oil filters, paints, solvents, adhesives, welding materials, chemical containers, and lead-acid batteries. In some cases, contaminated sludge from water and wastewater management systems may also be classified as hazardous. It is critical to handle these materials in a controlled and environmentally responsible manner to prevent soil, air, and water contamination. All hazardous wastes will be carefully segregated at the point of generation to avoid cross-contamination with non-hazardous materials. Waste containers will be clearly labeled with their contents and appropriate hazard symbols (e.g., flammable, corrosive, or toxic). A dedicated Hazardous Waste Storage Area (HWSA) will be established at the main construction camps. This area will be constructed with an impervious surface and bund walls to prevent leakage, and will be equipped with fire extinguishers, spill kits, shaded roofing, and restricted access. Proper signage will be installed to ensure safety and awareness.

For disposal, hazardous waste will be transported only by licensed contractors approved by the Punjab Environmental Protection Agency (EPA). Waste will be packed in sealed, leak-proof containers and transported in vehicles that meet regulatory standards, including secondary containment and proper labeling. All hazardous waste will be delivered to authorized hazardous waste treatment or disposal facilities, and documentation such as waste manifests and disposal certificates will be maintained.

To address the risk of accidental spills, spill response kits will be placed at all fuel storage and chemical handling areas. In case of a spill, workers will follow standard operating procedures: isolating the source, containing the spill using absorbent materials, wearing appropriate personal protective equipment (PPE), and notifying the site supervisor or environmental officer immediately.

A detailed spill response plan will be in place, and all incidents will be recorded and reviewed to prevent recurrence.

Ongoing training will be provided to all site personnel involved in hazardous material handling. This includes awareness of hazardous waste types, safe handling practices, emergency response procedures, and proper use of PPE. Additionally, regular inspections and internal audits will be conducted to monitor the condition of the storage area, verify labeling, and ensure proper record-keeping. A hazardous waste register will be maintained, along with Material Safety Data Sheets (MSDS), transport documentation, and disposal records.

The Environmental Officer will oversee the implementation of the Hazardous Wastes Management Plan, coordinate with disposal contractors, and ensure regulatory compliance. Site supervisors will be responsible for operational-level implementation, and all staff must follow safety protocols and immediately report any leakages or unsafe conditions. The plan will be reviewed quarterly or after any major change in construction activities or legal requirements.

6.5.4 Management Level Mitigation Measures

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

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

6.5.5 Audits

- On-site audits of waste management will be undertaken regularly.
- Audits of the waste disposal contractors and waste disposal facilities will be undertaken regularly to check that procedures are being followed.

6.5.6 Records

Records of all waste generated will be maintained. Quantities of waste disposed of, recycled, or reused will be logged on a Waste Tracking Register.

6.5.7 Disposal

- All non-hazardous waste material that cannot be recycled or reused will be transferred to approved landfill sites in Karachi.
- Depending on the nature and quantity of the hazardous waste, it will either be disposed of by licensed hazardous waste contractors or will be incinerated at an incineration facility equipped to handle hazardous waste.

- The possibility of returning the packaging to the manufacturers for reuse will be explored.
- Recyclable waste will be disposed of via approved waste contractors.
- Chemical containers (including partially full containers) will be returned to vendors.
- Other management measures
- An emergency response plan will be developed for hazardous waste (and substances).
- Training will be provided to personnel for identification, segregation, and management of waste.
- All containers of hazardous waste will be appropriately labeled.
- Equipment and material containing asbestos, poly-chlorinated biphenyls (PCBs), and ozone-depleting substances (ODSs) will not be used during Project operations.
- The equipment used at substation and transmission lines does not contain any Persistent Organic Pollutants (POPs) such as polychlorinated biphenyls (PCB). The use of such chemicals has been discontinued in the early 1990s.

6.6 Spoil Management Plan

Spoil is defined as 'rock' or 'other than rock' resulting from construction excavation. This Plan addresses and details the following issues:

- Excavation, handling, haulage, disposal and reuse methodology, including on-site storage and stockpiling arrangements;
- Processes and procedures that will be used for the management of spoil;
- Measures that will be implemented to both reduce spoil quantities and maximize the beneficial reuse of spoil that will be generated during the performance of the works;
- Nominated quantities for reuse of spoil within the construction site, for beneficial reuse of spoil off-site and for spoil disposal; and
- Processes and procedures for the management of the environmental and social impacts of spoil transfer and reuse.
- The Spoil Management Plan (SMP) will be updated for each specific construction work prior to the commencement of any excavation works and other works that may generate spoil. The updated SMP will incorporate detailed information on the handling of spoil generated during construction. It should be consistent with the Traffic Management Plan to allow for ready access to spoil and spoil disposal areas and to avoid disturbance to the non-Project related traffic.
- Spoil Production
- Spoil will be produced from construction activities during the construction of grid stations and towers.

6.6.1 Mitigation Hierarchy

Where feasible and reasonable, spoil should be managed according to the following hierarchy:

- Minimization of spoil generation through design and management
- Reuse of spoil within the Project
- Beneficial reuse of spoil outside the Project for environmental and community works

- Beneficial reuse of spoil outside the Project for site leveling, development or rehabilitation
- Disposal of spoil outside the Project for non-beneficial uses (landfilling)
- On-site Management
- On-site management includes management of stockpiling sites, spoil transport, spoil tracking and spoil testing for re-use.
- Stockpiles
- On-site management of spoil material stockpiling sites involves planning for stockpiling including selection of stockpiling sites, their accessibility to the road network, management of stockpiles to minimize wind and water erosion, management of stockpiles to minimize dust from exposed surfaces and management of noise and dust during loading and unloading.

The stockpile sites need to:

- Have ready access to the road network
- Be located on leveled land where possible
- Not affect land use of adjacent properties
- Be located in areas so that the erosion control measures can be implemented
- Be located in areas so that flooding does not result in runoff
- Be located in areas such that they do not result in the disturbance of species of conservation importance
- Be positioned in areas where there are minimal visual, noise and vibration impacts anticipated on nearby residents
- Be located within the Project approved boundary
- Be located in areas such that they do not affect cultural heritage
- Ensure land care and avoid loss of habitat and spread of invasive plant species
- Avoid flooding of trees and waterlogging of soils
- Have contaminated materials stockpiled separately
- Have erosion and sedimentation controls in place
- Be subjected to regular inspection
- Stockpile must be located no less than 250 meters from the nearest residence
- Any long-term stored topsoil stockpiles are to be protected from water and wind erosion by stabilizing with hydro-seed or by covering with a geo-textile fabric until required.

6.6.2 Spoil Transport

The following need to be considered for spoil transport:

- Spoil transport/haulage routes should be identified, assessed and if necessary, upgraded
- Haulage routes should be assessed and if necessary, upgraded
- The routes should be selected to minimize impacts on sensitive receptors including people, ecology and the landscape
- Transport should be undertaken with minimization of noise and dust

6.6.3 Spoil Tracking

A spoil tracking system should be developed which should include fields such as:

- Date
- Docket Number
- Haulage Company (if other than EPC Contractor)
- Material Classification
- Quantity in Tonnes to be Transported
- Truck Identification Number
- Location of Spoil Generation Site
- Location of Spoil Reveal Site

6.6.4 Spoil Testing

It is necessary to determine if the waste material is hazardous or non-hazardous and whether or not it requires any special treatment before disposal or re-use. Spoil testing before re-use is important to answer questions such as the following:

- Are manufactured chemicals or process residues present?
- Are sulfidic ores or soil present?
- Are naturally occurring asbestos soils present?
- Is there any other waste present?

6.6.5 Traffic Management

The construction material will be transported to the project sites via the existing road network. There will be one site entrance/exit for the construction site which will be the existing entrance.

The entrance of the camp will be controlled by a security gateman located within a security hut at the site entrance. During the hours of site operation, the site entrance gates will remain open and vehicle access to the site will be controlled via a manual barrier, set back from the road to prevent vehicles from parking on the access road.

The barrier will be controlled by a security gateman at all times and all drivers will have to register upon entering and leaving the site. Drivers will also be given verbal instruction as to the correct access to be taken onto the site (dependent on construction site activities).

Following measures will be taken on the site during the construction phase to avoid traffic congestion or any traffic accident, however, a detailed traffic management plan will be prepared by the contractor for the construction phase of the project:

- Efforts will be made to minimize the use of heavy trucks by preferring transport of equipment and supplies by 4x4 pickups, wherever possible, and
- A speed limit of not more than 30 km/h shall be imposed on unpaved roads and link roads for reducing traffic accident risks and dust generation.
- All light vehicles (cars, jeeps, etc.) and heavy vehicles will be parked in a designated area.
- Speed breakers will be followed properly.
- Experienced license holders (drivers and operators) will be hired for transportation.

- All the heavy machinery will be checked properly and inspected regularly.
- Speed limit signboards will be installed at the project site.
- All the headlights, backlights, indicators, etc. of vehicles and machines will be checked and maintained regularly.
- All the warning lights, reverse alarms will be maintained properly.

6.7 Plantation Plan

As part of the environmental enhancement and mitigation strategy for the proposed River Training Works and Construction of Two Rubber Dams/Weirs, a structured and site-appropriate plantation program will be implemented throughout the project area.

The plantation initiative will focus on key intervention zones, including riverbanks, roadside corridors, embankment slopes, and available open spaces near construction camps and operational zones. These areas will be developed into functional greenbelts and landscaped buffers to improve the visual aesthetics of the area, reduce dust emissions, stabilize disturbed soil, and enhance local biodiversity. About 2000 to 2500 mature plants, comprising a balanced mix of indigenous trees, shrubs, and flowering plants, will be planted in the identified locations.

The selected plants will have an average height of 4 to 5 feet and a stem diameter at the time of plantation to ensure healthy establishment, strong root development, and early canopy formation. Special emphasis will be placed on the use of pollution-tolerant, drought-resistant, and native species, which are well-suited to the regional climate and soil conditions. These species will help in improving air quality, reducing noise, promoting ecological resilience, and supporting habitat creation for local bird and insect populations.

Plantation will be carried out in systematic rows, maintaining a spacing of 8 feet between plants and 8 to 10 feet between rows in the case of multiple-row layouts, especially along riverbanks or large embankment areas. This spacing will promote healthy growth and sufficient canopy cover without overcrowding. Plantation work will be preferably scheduled during the monsoon season (July–September) or spring season to ensure optimal soil moisture and plant survival.

It is important to note that the cost of plantation and its maintenance will not be included in the contractor's scope of work. Instead, these responsibilities, including watering, fertilizing, mulching, pruning, pest control, and plant protection, will be borne by RUDA under its environmental enhancement and maintenance budget. A dedicated horticulture team or environmental cell under RUDA's supervision will oversee the maintenance program to ensure survival and sustainable growth of the planted species.

This plantation initiative is intended not only as an environmental offset but also as a long-term commitment to sustainable development, ensuring that the river corridor and surrounding areas benefit from improved ecological function, aesthetics, and climate resilience.

6.7.1 Trees (20 ft. And above)

The trees comprising shady, flowering, fruit trees have been recommended for plantation.

Table 6-3 Tree Plantation

Sr #	Botanical Name	Description
1	<i>Pongamia glabra</i>	Large flowering tree valued for timber and drought tolerance.
2	<i>Alstonia scholaris</i>	Evergreen tropical tree with air-purifying qualities.
3	Pilkan	Medicinal plant suited for arid/semi-arid zones; low nutritional value.
4	<i>Bauhinia variegata</i>	Ornamental flowering tree known for its aesthetic value.
5	<i>Ficus religiosa</i>	Shade-giving tree with cultural and ecological significance.
6	<i>Syzygium cumini</i>	Fruiting tree that thrives in semi-arid conditions.
7	<i>Dalbergia sissoo</i>	Fast-growing, large shade tree with timber value.
8	<i>Melia azedarach</i>	Broad-canopy tree, ideal for roadside and urban plantations.

6.7.2 Shrubs (under 20 ft.)

Evergreen, flowering, and ornamental shrubs with a variety of colors have been recommended for plantation along embankments, approach roads, and open spaces within the river training and Rubber Dam/Weir construction areas to enhance landscaping and visual appeal.

Table 6-4 Shrubs

Sr #	Botanical Name	Description
1	Nerium oleander	Hardy ornamental shrub with pink/white flowers; tolerant to dry conditions.
2	Hibiscus rosa-sinensis	Flowering shrub providing aesthetic value and butterfly habitat.
3	Callistemon citrinus	Also known as bottlebrush; drought-tolerant with bright red flowers.

6.7.3 Flowering Plants

Flowering plants known for their positive psychological and aesthetic effects have been recommended for plantation near worker rest areas, offices, and recreational spaces within the river training and Rubber Dam/Weir construction zones to promote well-being and improve the visual environment.

Table 6-5 Flowering Plants

Sr #	Botanical Name	Description
1	Tecoma stans	Bright yellow flowering plant; fast-growing and hardy.
2	Tagetes erecta	Common marigold; useful for borders and pest control in plantations.
3	Petunia spp.	Seasonal flowering plant ideal for visual enhancement in public spaces.

6.8 Framework for Restoration and Rehabilitation Plan

This framework is intended to guide how RUDA and its contractor(s) will minimize the extent of land disturbance during the construction of river training works and two Rubber Dams/Weirs, ensure the development of a stable and sustainable landscape, and restore vegetation and soil conditions in all areas impacted by construction activities. The overarching goal is to reduce long-term environmental degradation by rehabilitating sites to a condition that is safe, stable, and compatible with the surrounding environment.

To accomplish this, the contractor(s) involved in the RTW and Rubber Dam/Weir construction will be required to develop and implement a Site Restoration and Rehabilitation Plan for each site where construction or associated works may result in adverse impacts on natural vegetation, riverbanks, or adjacent land areas, if left unrestored. The plan must comply with the guidelines set out in this framework and be adapted to the local terrain, soil, and hydrological conditions.

The responsibility for preparing this site-specific plan will lie with the contractor(s), who must incorporate detailed measures for slope stabilization, topsoil preservation, revegetation using native species, and erosion control. Prior to its execution, the plan must be submitted to RUDA for review and formal approval to ensure it meets project-specific environmental management requirements and applicable regulatory standards.

6.8.1 Approach and Activities

The key objective of the restoration and rehabilitation works for the River Training Works and Rubber Dams/Weirs project is to restore disturbed land and vegetation so that they return to at least their pre-existing condition, with self-sustaining native vegetation, stable landforms, and minimal visual disturbance. These efforts are essential for reducing the long-term environmental footprint of large-scale infrastructure construction within riverine and floodplain landscapes.

The Site Restoration and Rehabilitation Plan (SRRP) will be developed for all areas affected by construction, such as riverbanks, embankments, haul roads, equipment yards, and temporary campsites. The Plan will be informed in part by baseline environmental conditions described in the project's Environmental Impact Assessment (EIA) or other relevant assessment reports. If baseline data are not available, the personnel responsible for developing the Plan will undertake a field-based assessment to understand the pre-disturbance condition of vegetation, soil, and land use.

The Plan will include a comprehensive site layout and detailed descriptions of all disturbed areas, including the type, location, and extent of disturbance. It will set clear goals for post-construction land use and define timelines and techniques for rehabilitation. While the mitigation measures proposed in the EIA will serve as the foundation, the Plan will also include supplementary restoration techniques as required to meet the site-specific goals.

For all project activities that involve land clearing, vegetation removal, or major alteration of the landscape, the Plan will implement the following rehabilitation strategies:

- Minimizing the construction footprint, ensuring that only essential areas are disturbed, and undisturbed zones are clearly marked and protected.
- Concurrent reclamation will be encouraged, whereby disturbed areas not needed for ongoing works are rehabilitated as early as possible during the construction phase.
- Topsoil and subsoil will be carefully salvaged and stockpiled in a manner that preserves their fertility—pile sizes will be limited, and erosion control measures will be applied to prevent degradation.
- Prior to replanting or reseeding, disturbed areas (including embankments, slopes, and earthwork batters) will be re-covered with restored subsoil and topsoil layers, ensuring a fertile base for vegetation growth.
- Visual impacts of the project will be mitigated through strategic screening using trees or shrubbery to help built structures and disturbed areas blend into the surrounding landscape.

- Native and local species of grasses, shrubs, and trees will be used for all reinstatement and landscaping activities. Preference will be given to locally sourced seeds and planting materials, ideally from areas ecologically similar to the disturbed sites.
- The Plan will specify preferred species for each landscape zone, based on flora baseline surveys, and identify viable seed or sapling sources, including options for seed collection from nearby natural areas.
- Monitoring of rehabilitated areas will be conducted regularly during construction and for at least three years post-construction. This will ensure that vegetation is healthy, stable, and self-sustaining. Where needed, remedial actions—such as watering during dry periods, using protective plant sleeves, or replacing failed plants—will be undertaken.
- Landscaping and vegetation management measures will be maintained for as long as the project remains active, with responsibility clearly defined in operational maintenance protocols.
- The Plan will establish completion criteria to determine when a disturbed site is considered fully rehabilitated. These criteria may include indicators such as: percentage of ground cover, species diversity, shrub or tree height, canopy coverage, and comparison with pre-disturbance vegetation conditions.
- The preparation and implementation of the Plan will involve consultations with local communities and stakeholders to ensure that local knowledge, preferences, and land use needs are reflected in the final design and objectives of the rehabilitation works.

6.9 Environmental Management Team along with their Roles and Responsibilities

Institutions responsible for executing and monitoring the environmental aspects of this project are:

- RUDA: The top management of RUDA will be ultimately responsible to ensure that the EMP is implemented through a monitoring mechanism. For this purpose, ESIC will develop and maintain internal institutional capacity for environmental management.
- Contractors: RUDA construction contractors (the 'Contractors') will be primarily responsible for the implementation of the EMP. Contractors will develop an internal monitoring and reporting mechanism for all activities undertaken. Contractors are also responsible for updating or making necessary changes to the EMP if and as required as a result of any changes in design or location, and ongoing reviews and requirements.

Specific roles and responsibilities for environmental monitoring are provided in below table:

Table 6-6 Roles and Responsibilities for Implementation of EMP

Aspect	RUDA's and LDA Responsibilities	Contractor's Responsibilities	Relevant Documentation
Contracting	Ensure that the EMP implementation and internal monitoring and reporting requirements are included in the contract between RUDA and the Contractors.	Understand the requirements and estimate the required resources.	The contract between RUDA and Contractors
EMP Update	Review updated EMP if any changes to design happened	Update EMP if any changes to the design occur	Revised EMP
Resources	Ensure the availability of resources required for EMP implementation, monitoring of Contractors and preparing reports to authorities	Ensure the availability of resources required for EMP implementation and internal monitoring and reporting to RUDA.	Project EMP implementation and monitoring plans and budgets.
Environmental staff	Designate an HSE Manager for the Project	Appoint an officer dedicated to the environment (may be combined with health and safety, and for social issues).	Job descriptions.
Monitoring surveys and inspections	Undertake periodic inspections and carry out field measurements, where needed over and above those of the Contractor. Review Contractor monitoring.	Systematically observe and collect data on environmental performance, undertake inspections, and carry out surveys	Inspection and survey reports.
Environmental audit	Conduct periodic internal audits of the construction sites and commissioning third-party (external) audits	Conducting periodic internal audits.	Audit reports.
Reporting	Ensure that periodic environmental monitoring reports are received from the Contractors and are	Generate monthly environmental monitoring reports and disseminate these	Periodic reports.

Aspect	RUDA's and LDA Responsibilities	Contractor's Responsibilities	Relevant Documentation
	reviewed. Prepare reports to authorities if necessary	to the management and appropriate staff members.	
Corrective actions	Verify that the activities that are carried out comply with the EIA and EMP and identify corrective actions if needed.	Carry-out the required corrective actions.	Corrective action record.
Maintenance of record	Maintain monitoring data and record all incidents of environmental significance and related corrective measures.	Maintain monitoring data and record all incidents of environmental significance and related corrective measures.	Environmental databases.

6.10 Schedule for implementation and Environmental Budget

Personnel, including Contractors' personnel, working for or on behalf of the Project will receive training to maintain awareness of relevant environmental and social aspects, impacts, and risks associated with the Project and corresponding controls. The training will also maintain awareness of the environmental benefits of improved personal performance and the potential consequences of departure from specified procedures.

Visitors to Project sites will receive relevant environmental and social awareness training as part of site induction training. Environmental training will help to ensure that the requirements of this EIA and EMP are clearly understood and followed by all Project personnel in the course of the construction phase.

The Contractors will have primary responsibility for providing training to all construction personnel in line with the Training Plan shown in Table 6-7.

Table 6-7 Training Schedule

Target Audience	Trainers	Contents	Schedule
Contractor Supervisors/ Managers	Implementation/Training Consultant	Induction training per 'Training Plan'	Before the start of construction activities
Selected management staff from the contractor	Contractor	Key findings of EIA Mitigation measures EMP	Before the start of construction activities
All site personnel	Contractor	Mitigation measures of EMP and EIA Camp rules	Before and during construction activities
Construction crew	Contractor	EMP Waste disposal procedures	Before and during construction activities
Drivers	Contractor	Road safety Defensive driving Road access restrictions Vehicle movement restrictions Waste disposal	Before and during the construction phase
Construction Staff	Contractor	Waste disposal Vehicle movement restrictions	Before and during the construction phase
Camp staff	Contractor	Camp operation Waste disposal Natural resource conservation Housekeeping Camp Rules	Before and during the construction phase

6.11 Environment Management Budget

An estimated cost for the implementation of mitigation measures prescribed in the Environmental Management Plan (EMP). The cost includes the hiring of staff, arrangements for water sprinkling, provision of PPEs to workers, the arrangement of first aid kits at the site and waste management,

etc. The budget for landscaping is also included in the given cost where required. The cost does not cover the implementation of mitigation measures prescribed in the Environmental Management Plan (EMP) for the operational phase which will be included as part of RUDA's ongoing environment management program.

Table 6-8 Environmental Management Budget

Sr. #	Activity	Description	Cost (Rs.)	Rationale
1	Medical screening for workers	Rs. 5,000 per person for 300 employees for 3 years	4,500,000	Medical screening of the kitchen and essential staff before deployment on site and twice a year during whole construction period.
		$300 \times 5,000 \times 3$		
2	Health and Safety of Workers	For the provision of dust masks, safety shoes, gloves, first aid box, ear plugs, safety helmets and safety jackets (Hi Vis) and provision of dust bins, warning tap, safety cones and safety sign boards.	54,879,000	For detail, please refer to Annex-5
3	Staff for EMP Implementation	HSE Expert to monitor / conduct all HSE related activities e.g. TBTs, PPEs, housekeeping, safety signage, emergency preparedness, etc. during construction and operational phase	50,400,000	Cost for hiring HSE Experts along with their monthly logistics during construction phase.
		13 Environmental Specialist/ HSE Officer for 36 months, @100,000 per month		
		02 HSE Inspector for 14 months @50,000.0 per month each 36X 2 x 50,000		

4	Implementation of Mitigation Plan	Implementation of other EMP Measures during Construction such as sprinkling of water, wastewater & spill Management, etc.	100,000,000	Implementation of mitigation measures in Table 6-2
5	Handling of solid waste	Includes the cost of collection, segregation, transportation, disposal and management of domestic, commercial and construction wastes	23,400,000	Rs. 50,000 per month for 36 months to collect construction waste from 13 active sites on daily basis.
6	Instrumental Monitoring	Air, Noise, and Water Quality Monitoring (Baseline & Quarterly)	4,500,000	16 sites for Air monitoring @ 200000. 13 sites for Noise, surface water and waste water monitoring @ 100000
8	Voluntarily Tree Plantation and Environmental Enhancement Measures	Plantation of trees types and species are given in Annex-6	137,000,000	Cost will be covered under RUDA's own maintenance budget. The number of trees may be updated after consultation with forest dept.
9	Grievance Redress Mechanism (GRM)	GRM Setup, Forms, Record Keeping	3,900,000	Implementation of GRM (Section 6.18.3) at 13 active sites @300,000
10	Environmental Audit	Environmental Auditing through third party twice a year during construction and operational phase	1,600,000	Cost for at least two auditors along with logistics, travels and accommodation.

	Sub-Total-1		380,179,000	From Sr. # 1-9
11	Unforeseen Impacts	Cost for any unforeseen impact is 1 % of EMP cost	3,801,790	
	Total		382,980,790	

The total estimated cost for the environmental management, monitoring and auditing during construction and O&M (annual cost will be updated for next upcoming years accordingly) comes to about **PKR 382.9 Million**.

6.12 Reporting and Feedback Mechanism

The Contractor will be required to prepare a Construction Management Plan (CMP) detailing how they intend to comply with the mitigation measures outlined in the EMP. This CMP will be part of the contract documents and will serve as a key compliance monitoring tool. Any failure to meet EMP requirements will be considered non-compliance, potentially resulting in required corrective actions or penalties.

An Environmental Specialist within the contractor’s team will prepare monthly status reports detailing EMP implementation. These reports will include:

Types of construction and site activities conducted

- Status of environmental clearances, permits, or licenses
- Applied mitigation measures

Any environmental issues related to construction, suppliers, authorities, or communities

These reports will be based on inputs from subcontractors. The contractor will validate the accuracy of this information, fill any gaps, and assess the adequacy of implemented mitigation measures. Any non-compliance or significant environmental concerns will be highlighted, and corrective actions proposed.

- Once construction is complete, RUDA will assume responsibility for overseeing the long-term operation and maintenance of the project. The feedback mechanism will operate on two tiers:
- If a subcontractor requests modifications to the EMP, the Contractor and RUDA will jointly review the proposal.

Only changes that do not conflict with Punjab EPA’s environmental clearance conditions will be considered. RUDA, as the final decision-making authority, may conduct further assessments before approving changes.

6.12.1 Change-Record Register

A Change-Record Register will be maintained at the site to document any updates to the EMP or project design. These include construction plan changes or changes caused by environmental conditions. All changes will be handled through a formal Change Management System

6.12.2 Proposed EMP Reporting and Reviewing Procedures

The EMP must define a detailed procedure for site inspection and monitoring, which includes:

- Locations and activities to be monitored
- Measurable criteria to assess rehabilitation success and completion
- Timing and frequency of inspections
- Qualifications of personnel conducting the monitoring
- Records and logs to be maintained, along with accountability
- Reporting structure and the retention period for records

If monitoring reveals that natural regeneration is failing or rehabilitation measures are insufficient, corrective action will be defined and carried out by responsible parties.

6.13 EMP Implementation Roles and Responsibilities

The EMP must clearly define the roles and responsibilities of all key parties, including RUDA, the Contractor, and relevant subcontractors. This will be detailed in an Organogram, including individual designations responsible for implementing EMP actions.

Oversight activities—such as site inspections, performance reviews, and compliance verification—must be detailed in the EMP, including their frequency. While contractors are responsible for implementation, RUDA will retain overall accountability for ensuring compliance.

6.14 EMP Revision Protocol

The EMP must be **reviewed at least once per year**, or whenever:

- Project conditions change significantly
- A mitigation measure is found to be inadequate
- Non-compliance with environmental approvals is observed

The EMP will be revised accordingly to improve site management, align with international best practices, and ensure full legal compliance.

6.14.1 Training Needs Assessment

The EMP must identify training requirements for contractor staff and management teams. Training should be role-specific and must cover:

- EMP implementation and monitoring procedures

- Environmental incident response and reporting
- Technical and administrative skills
- Occupational health and safety protocols
- Proper use of personal protective equipment (PPE)

The plan must also identify who will conduct the training, who must be trained, and how training effectiveness will be evaluated.

6.15 Change Management

A Change Management System will be established for the project to categorize and respond appropriately to design or environmental changes during the River Training Works and Rubber Dam/Weir Construction. Changes will be classified as follows:

6.15.1 First-Order Changes (Major Environmental Impact):

Require new environmental assessment and revised IEE/EIA submission. Examples:

- Shifting project alignment by more than 1 km
- Extending project reach or Right of Way (RoW) by over 10 km
- Use of new technology with greater environmental effects
- Increasing workforce by over 50%
- Routing through ecologically sensitive areas

6.15.2 Second-Order Changes (Moderate Impact):

Require reassessment by RUDA. Examples:

- Shifting alignment by 1–5 km
- Increasing RoW by 10–50 km
- Using equivalent or less-disturbing technology
- Increasing workforce by 10–50%

6.15.3 Third-Order Changes (Minor Impact):

Require only documentation and EMP update. Examples:

- Shifting alignment by less than 1 km
- Increasing RoW by less than 10 km
- Changing camp or site layout

All such changes must be evaluated and recorded in the Change-Record Register, with appropriate actions taken as per classification.

6.16 Equipment Maintenance Details

6.16.1 Construction Phase

Heavy construction equipment such as dump trucks, cranes, excavators, loaders, and tankers will only be repaired or serviced at designated maintenance yards. These yards will include proper drainage, oil containment systems, and hazardous waste disposal measures to prevent environmental contamination.

6.16.2 Operations Phase

During the operational phase, only limited vehicular movement by maintenance teams will be permitted on a need-only basis to reduce noise, dust, and emissions.

6.17 Grievance Redress Mechanism (GRM)

A formal Grievance Redress Mechanism will be established for the construction phase of the RTW and Rubber Dam/Weir project. This will provide affected persons and communities a clear and accessible channel to report grievances related to:

- Survey and data collection activities
- Compensation rates and resettlement benefits
- Environmental nuisances such as noise, dust, or water impacts

All grievances will be documented and addressed through a transparent, time-bound process. RUDA will ensure that grievance redress procedures are communicated clearly to stakeholders and that timely resolutions are made in accordance with legal and contractual obligations.

7 Stakeholder Consultations

7.1 General

Stakeholder engagement (consultation) is an important feature of the environmental assessment, especially with the local population and key stakeholders (e.g., authorities, community leaders and organizations). Effective consultation can lead to acceptable decision-making regarding Project design and implementation and the stakeholders feel a sense of ownership. Stakeholder engagement was initiated at EIA level.

Stakeholders, especially the local population, involvement is an important feature of the environmental assessment and can lead to a better and more acceptable decision-making regarding the project design and implementation. Public involvement, undertaken in a positive manner and supported by a real desire to use the information gained to improve the Project design, will lead to better outcomes and lay the basis for on-going positive relationships between the stakeholders. Public involvement is necessary for smooth implementation of the project. The local community support is also required for the success of the Project.

Public consultation was carried out with the relevant government departments, affected individuals, institutions and PAPs in all accessible villages in the AOI during the month of May 2025. These consultations were conducted concurrently with the baseline survey.

The feedback and issues raised during the consultation were recorded and documented. Consultations with Government departments were mostly related to the proposed project, legal requirements, associated impacts, lessons learned during the implementation of previous projects, availability of requisite baseline information, specific legal requirements, information regarding any future development plans and coordination between the various concerned departments.

The stakeholder consultations had the following main objectives:

- Sharing of information with government authorities, local communities and affected persons about the proposed Project and expected environmental and social impacts;
- Understanding the stakeholders concerns regarding various aspects of the Project, and the potential impacts of the construction-related activities and operation of the Project;
- Recording the feedback of public in order to develop a mechanism to address their issues and other local level concerns and incorporation of the outcomes in final decision making; and
- Acquire the latest data, information and other approved procedures relevant to the Project from the concerned government authorities.

7.2 Stakeholder Mapping

Identification of stakeholder is an important step which ensures that all stakeholders are identified and classified as per their role about the Project. The Project identified primary as well as secondary stakeholders as defined below:

As per definition, stakeholder is a person or an institution/organization that is affected or in any way can be determined to have an interest in the proposed Project. Stakeholders can be divided into two main groups, Primary Stakeholders and Secondary Stakeholders. Primary stakeholders are those who are directly affected due to the loss of assets and conditions.

The secondary stakeholders include government departments and agencies that has an interest in or in some way through planning and implementation will be involved in the Project.

The secondary stakeholders with regard to the Project were identified to include:

- Ravi Urban Development Authority (RUDA)
- Water and Sanitation Agency (WASA)
- Punjab Irrigation Department
- Punjab Environmental Protection Agency (EPA)
- Punjab Wildlife and Fisheries Department
- Punjab Forest Department.
- Local Communities
- NGOs and Environmental Advocacy Groups
- Local Fishermen's Associations
- Farmers Associations
- Contractors and Engineering Firm
- Environmental Consultant

Details regarding roles and responsibilities of the concerned agencies and departments are given in Table 7-1.

Table 7-1 Role of Concerned Agencies/Departments

Project Stakeholder	Name	Roles
Proponent	RUDA	<ul style="list-style-type: none"> RUDA is the Project Proponent of the proposed Project.
Punjab Authorities	Environmental Protection Agency, Punjab	<ul style="list-style-type: none"> EPA, Punjab is the regulatory authorities and mainly responsible for the development and implementation of the environmental policies and strategies in order to integrate the environmental issues and sustainable development approaches into the legal and regulatory frameworks as per Punjab Environmental Protection Act, 1997; EPAs are responsible for the issuance of NOC of the Proposed Project; EPA Punjab is responsible for the compliance of EMMP and NOC provision during the construction and operation stages of the Project.

7.3 Consultation Outcomes

Consultations were carried out in the areas falling within the Col of the project. In total 16 consultation meetings were held with directly and indirectly affected villages and communities. The majority of the people who participated in these consultations were village the leaders and elders who according to local culture and custom are those who have decision power in the community. The socio-economic survey was carried out in conjunction with the consultations which took place from April to May 2025.

7.4 Stakeholder Consultations Summary

The consultations summary with stakeholders are given in Table 7-2.

Table 7-2 Stakeholder Consultation Summary

Sr. #	Department	Consultation Person	Consultation Summary
1	Project Proponent -RUDA	Ms. Nadia Tahir , Deputy Director, RUDA	Discussed project location, scope, layout, construction timelines, utility services, and integration with RUDA plans. Joint site visit confirmed land use,

			site suitability, and informed baseline and mitigation planning.
2	Regulatory Authority - Punjab EPA	Dr. Amir Farooq Director EIA	Emphasized compliance with EPA guidelines, use of updated primary data, ecological baseline, public consultations, and global best practices in urban planning. Called for a detailed Environmental Management and Monitoring Plan (EMMP).
3	Forest Department	Mr. Mehar Asif, Divisional Forest Officer, Lahore	Office staff shared common tree species (Kikar, Jhand, Bohar, Safeeda, fruit trees). Emphasized planting indigenous species.
4	Fisheries Department	Mr. Nasir Naqvi, Assistant Director (Fisheries), Lahore.	Explained fish species and non-commercial use of river segment. Expressed concern over untreated effluent. Recommended installing a sewage treatment plant to improve aquatic ecology. Suggested further consultation with DG Fisheries.
5	Wildlife Department	Mr. Waseem Khan, Assistant Director (Wildlife), Lahore	Shared wildlife species list, confirmed turtle presence, and highlighted threats from illegal trade. Recommended careful relocation of reptiles during operation and public awareness campaigns to protect fauna.
6	NGO – Mission Awareness Foundation	Mr. Fahad Malik, Environmental Activist	Reported various wildlife sightings, seasonal migratory birds, and severe pollution issues. Recommended sewage treatment before discharge. Criticized Indus Waters Treaty and stressed conservation over urbanization.
7	Academia - College of Earth & Environmental Sciences	Dr. Naeem Akhtar	Supported sustainable development aligned with global best practices. Suggested environmental planning can combat smog, pollution, and biodiversity

			loss, offering a model for eco-urban planning.
8	Researcher – Fish Fauna	Dr. Nouman Khalique, PhD	Explained impact of pollution on fish species. Supported project if environmental compliance and monitoring ensured. Believes potential exists to restore aquatic and avian ecosystems.
9	Archaeology, Punjab	Deputy Director	The Deputy Director informed that, as per the department’s official procedure, a formal application letter must be submitted by the project proponent to initiate the NOC process. Upon receipt of the application, the department will review the case and process the NOC in accordance with their standard evaluation and approval protocol.
10	Punjab Forest Department, Lahore.	Mr. Saqib Rasheed, Sub-Divisional Forest Officer.	<p>Mr. Saqib Rasheed SDFO (Lahore) confirmed that no major natural forests are currently present along the Ravi riverbed project area. New plantations have been carried out near the old Ravi Bridge by the PHA, Lahore.</p> <p>He said that if the project is initiated, a joint tree plantation campaign will be launched; The campaign would involve coordination between:</p> <ul style="list-style-type: none"> • RUDA (Ravi Urban Development Authority) • Punjab Forest Department, Lahore • PHA (Parks and Horticulture Authority), Lahore <p>To enhance green cover and support ecological sustainability along the development corridor. Aligning plantation activities with urban planning and landscape development. Future identification of suitable plantation zones within the project area will be necessary, especially along newly developed or reclaimed</p>

			riverbanks. This initiative helps to revive the forest cover that support indigenous fauna also in that area.
12	Agriculture Department, Lahore.	Dr. Adnan Ahmed Rana, Senior Research Officer	Department emphasized need to manage drainage and avoid waterlogging near RTW structures. Officials mentioned opportunities for plantation of trees and agroforestry on embankments, with support from Agriculture and Forest Departments. The role of water user associations and farmers' groups in consultation and participation was stressed.

Figure 7-1 Institutional Stakeholder Consultations



Institutional Consultation with EPA

Institutional Consultation with RUDA

Public Consultation

Consultation with Founder MAF



Consultation with Assistant Professor, Punjab University



Consultation with Environmental Monitoring Unit



Consultation with the AD (Fisheries), Lahore



Consultation with the SDFO, Lahore



Consultation with the Agriculture Department

7.5 Community Consultation

Community consultation is a core component of the Environmental Impact Assessment (EIA) process, aimed at ensuring transparency, fostering stakeholder inclusion, and integrating local knowledge and concerns into project planning. For the Proposed Project, a targeted community consultation exercise was conducted with local residents and stakeholders to inform them about the project, its potential impacts, and proposed mitigation measures, while also documenting their feedback and suggestions.

7.5.1 Objectives of Consultation

- To inform local communities about the nature, scope, and timeline of the project
- To understand community concerns, perceptions, and expectations regarding environmental, health, and social impacts
- To incorporate local knowledge into the assessment of potential risks and mitigation strategies
- To foster public participation and improve project acceptability

7.5.2 Methodology

The consultation was carried out through structured interviews, informal discussions, and focused group meetings with residents, farmers, labourers, and local opinion leaders within the project's area of influence, particularly those residing near the grid station site and along the proposed transmission line corridor.

A total of 99 households were engaged during the social survey. Data was collected through questionnaires and verbal interactions in the local language to ensure clarity and comfort for participants.

7.5.2.1 Key Concerns and Feedback

The community demonstrated a positive attitude toward the project and appreciated the opportunity to be consulted. Many participants welcomed the idea of tree plantation and expressed interest in seeing the project contribute to local environmental improvement. However, several concerns were raised:

- Residents living along the riverbank and downstream communities expressed apprehensions about possible water flow diversion, construction-related dust, noise, and restricted access to the river.
- Potential impact on local access routes.
- Fisherfolk and farmers raised concerns regarding the potential reduction in water availability and seasonal changes due to water impoundment and altered flow regimes.
- Need for local employment opportunities during construction

- Landowners and informal settlers in affected areas voiced concerns regarding land acquisition, compensation delays, and lack of clear information about eligibility for resettlement support.
- Concerns raised for wastewater management.

7.5.3 Mitigation Commitments Explained to the Community

The consultation team explained the measures incorporated into the EIA and Environmental Management Plan (EMP), including:

- Proper timing of construction (avoiding monsoon season), advance public notices, and maintenance of alternative access routes would help mitigate negative impacts. The project proponent assured that noise barriers and dust suppression techniques (e.g., water spraying and covering stockpiles) would be employed.
- Provision of downstream flow guarantees, scheduled release of water for irrigation, and periodic flow maintenance for ecological balance. The project's water management design integrates these feedback points.
- Local labour will be prioritized during construction, where feasible.
- Consultations with Punjab Archaeology Department led to the incorporation of a buffer zone and avoidance of heavy machinery operation within proximity to the structure. The project design was modified to ensure visual harmony and no physical impact on the heritage site.
- Wastewater will be managed by treatment plant.
- Landscaping and plantation will be undertaken to improve the site's visual and environmental quality.

8 Conclusion and Recommendations

8.1 Conclusion

The proposed installation of two Rubber Dams/Weirs on the Ravi River, along with associated embankments and river training works, is a significant infrastructure initiative aimed at improving water management, storage, and controlled release for downstream use.

The construction activities associated with Rubber Dams/Weirs, guide bunds, earthen embankments, retaining walls, and ancillary infrastructure are expected to cause typical environmental impacts such as dust generation, noise pollution, and localized water contamination, disruption of terrestrial and aquatic habitats, increased traffic movement, and occupational health and safety risks. These impacts will be temporary but require strict mitigation through a structured Environmental Management Plan (EMP). Mitigation measures include dust suppression through water sprinkling, noise control through regulated equipment usage and scheduling, installation of silt traps and sedimentation tanks to prevent runoff into water bodies, traffic management planning to avoid congestion and accidents, and adherence to Occupational Health & Safety (OHS) protocols including provision of PPE, site fencing, and emergency response mechanisms. Regular environmental monitoring, contractor training, and supervision by designated environmental staff will be essential to ensure effective implementation of these measures throughout the construction phase.

While the project offers socioeconomic benefits such as water security, enhanced urban aesthetics, and potential for recreation and tourism, it also poses several environmental and cultural risks that must be carefully mitigated.

The primary environmental concerns identified include:

- Alteration of natural river flow and inundation of low-lying areas, affecting riparian habitats and potentially displacing local fauna.
- Sedimentation and siltation within the impoundment zones, which could reduce reservoir efficiency and affect downstream geomorphology.
- Wastewater intrusion and water quality deterioration, due to urban and industrial effluents entering the river, especially under stagnant water conditions behind the Rubber Dams/Weirs.
- Erosion and riverbank instability, especially in newly constructed embankments.
- Significant cultural impact on Kamran Baradari, a protected historical monument located within the impoundment area, at risk of waterlogging, structural degradation, and permanent loss of heritage value.

the discharge of untreated municipal and industrial wastewater into the Ravi River is a clear violation of the Pakistan Environmental Protection Act, 1997 and the National Environmental Quality Standards (NEQS). The lack of upstream wastewater treatment plants poses a significant environmental risk, especially in the context of stagnant water conditions caused by the proposed

Rubber Dams/Weirs. Without an effective sediment management plan, the dam structure and downstream river ecosystem may suffer serious ecological and operational impacts. Environmental approval (NOC) for the project is legally conditional on both upstream wastewater treatment and an approved sediment management strategy.

Comprehensive mitigation measures, such as river training design improvements, sediment flushing mechanisms, pollution control, cultural heritage protection, and ecological restoration, have been proposed and incorporated into the Environmental and Social Management Plan (ESMP).

8.2 Recommendations

8.2.1 Hydraulic and Structural Design Modifications

- Optimize the Rubber Dam/Weir and embankment design to minimize backwater effects and reduce submergence zones near sensitive areas.
- Include sediment sluicing gates and flushing protocols in the Rubber Dam/Weir operation manual.

8.2.2 Pollution and Water Quality Control

- Implement upstream wastewater management in coordination with municipal authorities.
- Regularly monitor water quality to ensure dissolved oxygen, BOD, and heavy metal levels remain within NEQS limits.

8.2.3 Cultural Heritage Protection

- Establish a 100-meter buffer zone around Kamran Baradari.
- Construct a ring bund or retaining structure and ensure vibration and sub-surface water control measures during construction and operation.
- Collaborate closely with the Department of Archaeology for conservation supervision and emergency interventions.

8.2.4 Sedimentation and Disposal Management

- Develop and implement a Sediment Management Plan, including periodic dredging, sediment reuse, and environmentally safe disposal methods.
- Establish downstream grade control structures to prevent bed lowering.

8.2.5 Ecological Safeguards

- Develop and implement a River Ecology Monitoring Program.
- Initiate afforestation and bioengineering interventions on riverbanks to stabilize soils and restore habitat.

8.2.6 Emergency Preparedness and Monitoring

- Prepare and operationalize a Heritage Preservation Contingency Plan and Flood Management Plan.
- Regular monitoring and third-party environmental audits should be conducted to ensure ESMP compliance throughout project life.

8.2.7 Community Engagement and Grievance Redressal

- Conduct periodic stakeholder consultations with local communities, particularly those affected by inundation or heritage site changes.
- Activate a grievance redressal mechanism accessible to nearby residents and conservationists.

8.2.8 Construct and operationalize WWTPs

Prepare and submit a Sediment Flushing and Disposal Strategy, ensuring compliance with hazardous and non-hazardous waste regulations.

By adopting these recommendations and committing to stringent environmental safeguards, the project can achieve a sustainable balance between development goals and ecological and cultural conservation along the Ravi River corridor.

Annexures

Annex-1 Schedule-II

3. Commercial extraction of sand using dredger
as per notified A/E has 33/

D. Transport

- | | | |
|--|-----|------|
| 1. Airports | 300 | 1000 |
| 2. Highways, Motorways, Express ways or major roads | | |
| 3. Ports and harbor development for ships of 500 gross tons and above | | |
| 4. Railway works | | |
| 5. Flyovers, underpass and bridges having total length of more than 500 meters | | |

E. Water management, dams, irrigation and flood protection

1. Medium and large Dams and reservoirs

F. Water supply, Sewerage System and treatment

1. Water supply schemes and treatment plants (excluding the Reverse Osmosis, Ultra filtration and such like) with total cost more than Rs. 50 million
2. Wastewater channels / Sewerage System Schemes
3. Combined Wastewater Treatment Plants with treatment capacity greater than 100m³/hr

G. Waste Storage and Disposal

1. Landfill sites
2. Waste Incinerators and autoclaves
3. Hazardous substance or waste storage warehouse

H. Urban development and tourism

1. Housing Schemes more than 300 kanals
2. Large-scale tourism development projects
3. Hospitals having more than 50 Beds
4. Hotels with more than 100 rooms
5. Industrial estates (including export processing zones)

I. Environmentally Sensitive Areas

All projects situated in environmentally sensitive areas

J. Other projects

Any other project for which filing of an EIA is required by the *Provincial Agency* under sub-regulation (2) of Regulation 5.

Annex-2 Team Composition

Table-Annex- 1 Team Composition

Names	Positions
Mehwish Rehman Alvi	Team Leader / Environmental Expert
Nouman Petras	Sociologist
Najma Iftikhar	Environmental Engineer
M. Hasnain Javaid	Environmental Expert
Sakhawat Ali	Ecologist
Zeeshan Ali	Forester
Amad Atiq	GIS Analyst

Annex-3 Environmental Monitoring Report



Punjab-EPA Certified
Lahore Laboratory
Federal-EPA Certified
Islamabad Laboratory

**ENVIRONMENTAL MONITORING, SAMPLING
AND TESTING REPORT
FOR
Environmental Impact Assessment of River
Training Works and Barrages Phase-II**





CHEMICAL ANALYSIS TEST REPORT (SURFACE WATER)

Disclaimer: This report is not valid for Court Cases, Environment Protection Orders, Compliance Report for Operational Phase Approvals, or any regulatory action under Punjab Environmental Protection (Smog Prevention and Control) Rules, 2023 etc.

Sample Details			
Job Ref. No:	GCEC-PK-PU-161/2025	Client Name:	RUDA
Telephone No.	0325 4008333	Consultant Name:	Cleantech Solutions
Sample Date:	26-05-2025	Sample Matrix:	Surface Water Sample
Sample Receipt Date:	26-05-2025	Sampled By:	GCEC
Grab/Composite:	Grab Sampling	Date of Completion of Analysis:	30-05-2025
Project Name:	Environmental Impact Assessment (EIA) of River Training Works and Barrages Phase-II		
Sample Identification			
01	Near Ravi Toll Plaza		

Parameters	Analysis Method	Unit	LOR	Result
PHYSICAL & CHEMICAL ANALYSIS				
Temperature	-	°C	-	28.5
pH	APHA-4500H+ B	pH unit	0.01	7.70
Total Dissolved Solid (TDS)	APHA-2540 C	mg/l	1.0	97.0
Oil and Grease	USEPA-1664	mg/l	0.2	<0.2
Biological Oxygen Demand	APHA-5210 B	mg/l	1.0	5.0
Chemical Oxygen Demand	APHA-5220-D	mg/l	1.0	13.0
Total Suspended Solid	APHA-2540-D	mg/l	1.0	43.0
Phenolic Compound	APHA-5530 D	mg/l	0.01	<0.01
Chloride (Cl)	APHA-4500Cl- B	mg/l	0.24	7.82
Fluoride (F)	APHA-4500F- C	mg/l	0.01	<0.01
Cyanide (CN)	APHA-4500CN F	mg/l	0.01	<0.01
Detergent	APHA-5540 B	mg/l	-	ND
Sulphate	APHA-4500-SO ₄ C	mg/l	0.41	22.63
Sulphide	APHA-4500-S ₂ -E	mg/l	0.4	<0.4
Ammonia	APHA-4500-NH ₃ -B	mg/l	0.002	<0.002
Silver	APHA-3500Ag-B	mg/l	0.0032	<0.0032
Cadmium	APHA-3500Cd B	mg/l	0.0028	<0.0028
Chromium	APHA-3500Cr B	mg/l	0.0054	<0.0054
Copper	APHA-3500Cu B	mg/l	0.0045	0.0133
Lead	APHA-3500-Pb B	mg/l	0.013	<0.013
Mercury	APHA-3500-Hg B	mg/l	0.0008	<0.0008
Nickel	APHA-3500-Ni B	mg/l	0.008	<0.008
Zinc	APHA-3500-Zn B	mg/l	0.0033	0.0408
Arsenic	APHA-3500As B	mg/l	0.01	<0.01
Barium	APHA-3500Ba B	mg/l	0.031	<0.031
Manganese	APHA-3500-Mn B	mg/l	0.0016	<0.0016
Iron	APHA-3500-Fe-B	mg/l	0.1	<0.1
Boron	APHA-4500B-C	mg/l	0.1	<0.1
Total Chlorine	APHA-4500Cl-B	mg/l	0.1	<0.1
Selenium	APHA-3500Se C	mg/l	0.23	<0.23
Total Toxic Metals	By Calculation	mg/l	-	0.0133

Abbreviations:
ND: Not Detected

LOR: Limit of Reporting

Note:

*Uncertainty of all the parameters and laboratory conditions at the time of analysis will be provided as per client's requirement. The lab environmental conditions are maintained at 25±5°C and humidity at 50±20%. PEQs are not available for Surface Water.

Prepared By:

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Green Crescent

Environmental Consultants Pvt. Ltd.

Sr. No# 25A/ 7052

CHEMICAL ANALYSIS TEST REPORT (SURFACE WATER)

Disclaimer: This report is not valid for Court Cases, Environment Protection Orders, Compliance Report for Operational Phase Approvals, or any regulatory action under Punjab Environmental Protection (Smog Prevention and Control) Rules, 2023 etc.

Sample Details			
Job Ref. No:	GCEC-PK-PU-161/2025	Client Name:	RUDA
Telephone No.	0325 4008333	Consultant Name:	Cleantech Solutions
Sample Date:	26-05-2025	Sample Matrix:	Surface Water Sample
Sample Receipt Date:	26-05-2025	Sampled By:	GCEC
Grab/Composite:	Grab Sampling	Date of Completion of Analysis:	30-05-2025
Project Name:	Environmental Impact Assessment (EIA) of River Training Works and Barrages Phase-II		
Sample Identification			
02	Near Sagian Bridge		

Parameters	Analysis Method	Unit	LOR	Result
PHYSICAL & CHEMICAL ANALYSIS				
Temperature	-	°C	-	28.6
pH	APHA-4500H+ B	pH unit	0.01	7.37
Total Dissolved Solid (TDS)	APHA-2540 C	mg/l	1.0	124.0
Oil and Grease	USEPA-1664	mg/l	0.2	<0.2
Biological Oxygen Demand	APHA-5210 B	mg/l	1.0	7.0
Chemical Oxygen Demand	APHA-5220-D	mg/l	1.0	16.0
Total Suspended Solid	APHA-2540-D	mg/l	1.0	61.0
Phenolic Compound	APHA-5530 D	mg/l	0.01	<0.01
Chloride (Cl)	APHA-4500Cl B	mg/l	0.24	11.74
Fluoride (F)	APHA-4500F C	mg/l	0.01	<0.01
Cyanide (CN)	APHA-4500CN F	mg/l	0.01	<0.01
Detergent	APHA-5540 B	mg/l	-	ND
Sulphate	APHA-4500-SO ₄ C	mg/l	0.41	31.69
Sulphide	APHA-4500-S ₂ E	mg/l	0.4	<0.4
Ammonia	APHA-4500-NH ₃ -B	mg/l	0.002	<0.002
Silver	APHA-3500Ag-B	mg/l	0.0032	<0.0032
Cadmium	APHA-3500Cd B	mg/l	0.0028	<0.0028
Chromium	APHA-3500Cr B	mg/l	0.0054	<0.0054
Copper	APHA-3500Cu B	mg/l	0.0045	0.0221
Lead	APHA-3500-Pb B	mg/l	0.013	<0.013
Mercury	APHA-3500-Hg B	mg/l	0.0008	<0.0008
Nickel	APHA-3500-Ni B	mg/l	0.008	0.1927
Zinc	APHA-3500-Zn B	mg/l	0.0033	<0.0033
Arsenic	APHA-3500As B	mg/l	0.01	<0.01
Barium	APHA-3500Ba B	mg/l	0.031	<0.031
Manganese	APHA-3500-Mn B	mg/l	0.0016	<0.0016
Iron	APHA-3500-Fe-B	mg/l	0.1	<0.1
Boron	APHA-4500B-C	mg/l	0.1	<0.1
Total Chlorine	APHA-4500Cl-B	mg/l	0.1	<0.1
Selenium	APHA-3500Se C	mg/l	0.23	<0.23
Total Toxic Metals	By Calculation	mg/l	-	0.2148

Abbreviations:

ND: Not Detected

LOR: Limit of Reporting

Note:

*Uncertainty of all the parameters and laboratory conditions at the time of analysis will be provided as per client's requirement. The lab environmental conditions are maintained at 25±5°C and humidity at 50±20%. PEQs are not available for Surface Water.

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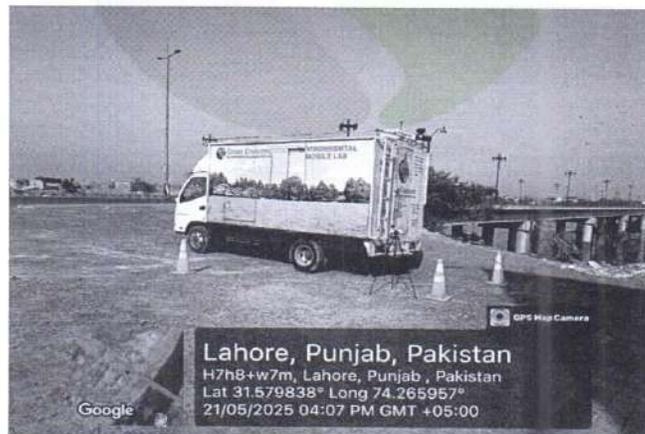




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Environmental Consultants Pvt. Ltd.

Sr. No# 25A/ 7053

Ambient Air Monitoring Location #01
SAGIAN BRIDGE
(Lahore)



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Sr. No# 25A/ 7054

Ambient Air Quality Monitoring

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Job Reference Number	GCEC-PK-PU-161/2025
Monitoring Point	Sagian Bridge
Date of Intervention	21-May-2025 to 22-May-2025
Monitoring Coordinates	31°34'47.4"N 74°15'57.5"E

Sr. #	Time	CO (mg/m ³)	NO (µg/m ³)	NO ₂ (µg/m ³)	NO _x (µg/m ³)	SO ₂ (µg/m ³)
1.	10:30	2.67	11.66	14.97	26.62	104.96
2.	11:30	2.84	11.79	12.92	24.71	140.14
3.	12:30	2.57	18.09	21.12	39.21	132.42
4.	13:30	2.70	19.16	15.79	34.95	140.14
5.	14:30	2.67	19.70	25.01	44.71	191.91
6.	15:30	2.71	21.04	28.29	49.33	224.80
7.	16:30	2.78	18.89	19.07	37.96	134.71
8.	17:30	2.72	21.57	20.30	41.87	137.85
9.	18:30	2.77	18.22	16.40	34.62	211.64
10.	19:30	2.59	18.63	14.35	32.98	114.97
11.	20:30	2.61	23.45	19.68	43.13	114.97
12.	21:30	2.65	19.56	17.63	37.19	82.08
13.	22:30	2.50	18.89	16.61	35.50	84.37
14.	23:30	2.51	4.67	14.61	19.27	52.48
15.	00:30	2.49	9.32	14.19	23.51	56.03
16.	01:30	2.47	10.61	14.00	24.61	23.73
17.	02:30	2.44	7.98	13.49	21.47	43.47
18.	03:30	2.48	5.44	14.34	19.78	39.08
19.	04:30	2.45	10.88	13.53	24.41	61.15
20.	05:30	2.48	7.30	13.41	20.71	42.41
21.	06:30	2.41	9.92	14.32	24.24	35.19
22.	07:30	2.40	12.59	13.43	26.02	35.87
23.	08:30	2.60	18.89	14.76	33.65	92.38
24.	09:30	2.59	20.64	21.32	41.96	89.80
Average Concentration		2.58	15.10	16.89	31.99	99.20

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Sr. No# 25A/ 7055

Ambient Air Quality Monitoring

Disclaimer: This report is not valid for Court Cases, Environment Protection Orders, Compliance Report for Operational Phase Approvals, or any regulatory action under Punjab Environmental Protection (Smog Prevention and Control) Rules, 2023 etc.

Job Reference Number	GCEC-PK-PU-161/2025
Monitoring Point	Sagian Bridge
Date of Intervention	21-May-2025 to 22-May-2025
Monitoring Coordinates	31°34'47.4"N 74°15'57.5"E

Parameter	Unit	Monitoring Duration	LDL	Average Obtained Concentration	PEQS
Nitrogen Dioxide (NO ₂)	µg/m ³	24 Hours	1.00	15.10	80.0
Nitrogen Oxide (NO)	µg/m ³	24 Hours	1.00	16.18	40.0
NO _x	µg/m ³	24 Hours	1.00	39.99	120.0
Sulphur Dioxide (SO ₂)	µg/m ³	24 Hours	1.00	99.20	120.0
Carbon Monoxide (CO)	mg/m ³	24 Hours	0.01	2.58	5.0*
Ozone (O ₃)	µg/m ³	24 Hours	-	17.64	130.0**
Particulate Matter (PM _{2.5})	µg/m ³	24 Hours	1.00	180.05	35.0
Particulate Matter (PM ₁₀)	µg/m ³	24 Hours	1.00	243.45	150.0
Suspended Particulate Matter (SPM)	µg/m ³	24 Hours	1.00	458.50	500.0
Lead Airborne Particles	µg/m ³	24 Hours	-	0.41	1.5

Abbreviations:

µg/m³= Micrograms per Cubic Meter
 mg/m³= Milligrams per Cubic Meter
 LDL= Lowest Detection Limit
 PEQS= Punjab Environmental Quality Standards
 *08 hour standard for CO
 **01 hour standard for O₃

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Sr. No# 25A/ 7056

Meteorological Data

Disclaimer: This report is not valid for Court Cases, Environment Protection Orders, Compliance Report for Operational Phase Approvals, or any regulatory action under Punjab Environmental Protection (Smog Prevention and Control) Rules, 2023 etc.

Job Reference Number	GCEC-PK-PU-161/2025
Monitoring Point	Sagian Bridge
Date of Intervention	21-May-2025 to 22-May-2025
Monitoring Coordinates	31°34'47.4"N 74°15'57.5"E

Time	Ambient Temperature °C	Wind Direction	Wind Velocity m/s	Humidity %	Pressure (mm of Hg)
10:30	31	NE	4.0	36	746.4
11:30	33	NW	4.2	30	747.0
12:30	43	NE	4.5	26	749.1
13:30	41	N	3.3	25	748.2
14:30	38	NE	3.4	30	747.5
15:30	37	NE	9.8	28	745.6
16:30	36	NE	9.7	30	747.8
17:30	34	NE	9.1	35	749.2
18:30	34	NE	9.3	29	747.6
19:30	30	NW	8.3	34	748.3
20:30	29	NE	8.7	36	747.7
21:30	27	NW	8.5	39	746.2
22:30	26	NW	6.7	41	747.2
23:30	26	NW	4.5	43	746.7
00:30	25	N	3.8	46	746.4
01:30	25	NE	4.7	48	749.4
02:30	24	NE	3.7	49	749.6
03:30	24	NE	4.2	50	745.9
04:30	24	NE	3.3	42	747.2
05:30	26	NE	3.8	45	747.2
06:30	27	N	4.1	44	746.7
07:30	28	NE	3.5	42	747.9
08:30	29	N	3.9	34	749.7
09:30	31	N	3.6	36	747.1

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Environmental Consultants Pvt. Ltd.

Sr. No# 25A/ 7057

Noise Level Monitoring Report

Disclaimer: This report is not valid for Court Cases, Environment Protection Orders, Compliance Report for Operational Phase Approvals, or any regulatory action under Punjab Environmental Protection (Smog Prevention and Control) Rules, 2023 etc.

Job Reference Number	GCEC-PK-PU-161/2025
Monitoring Point	Sagian Bridge
Date of Intervention	21-May-2025 to 22-May-2025
Monitoring Coordinates	31°34'47.4"N 74°15'57.5"E

Sr. #	Time	Method/Technique	Unit	Results LAavg	PEQS (Commercial)
Night Time					
1.	23:30	Noise Meter	dB	58.2	55.0
2.	00:30	Noise Meter	dB	52.4	
3.	01:30	Noise Meter	dB	55.7	
4.	02:30	Noise Meter	dB	61.7	
5.	03:30	Noise Meter	dB	79.6	
6.	04:30	Noise Meter	dB	71.7	
7.	05:30	Noise Meter	dB	69.5	
8.	06:30	Noise Meter	dB	78.6	
Night Time Average			dB	65.91	55.0
Day Time					
9.	07:30	Noise Meter	dB	58.0	65.0
10.	08:30	Noise Meter	dB	74.3	
11.	09:30	Noise Meter	dB	76.3	
12.	10:30	Noise Meter	dB	79.5	
13.	11:30	Noise Meter	dB	77.2	
14.	12:30	Noise Meter	dB	74.5	
15.	13:30	Noise Meter	dB	79.9	
16.	14:30	Noise Meter	dB	65.7	
17.	15:30	Noise Meter	dB	71.3	
18.	16:30	Noise Meter	dB	57.0	
19.	17:30	Noise Meter	dB	61.3	
20.	18:30	Noise Meter	dB	59.1	
21.	19:30	Noise Meter	dB	60.4	
22.	20:30	Noise Meter	dB	67.4	
23.	21:30	Noise Meter	dB	62.6	
24.	22:30	Noise Meter	dB	58.1	
Day Time Average			dB	67.66	65.0

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Sr. No# 25A/ 7058

Ambient Air Monitoring Location #02
NEW RAVI BRIDGE
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Sr. No# 25A/ 7059

Ambient Air Quality Monitoring

Disclaimer: This report is not valid for Court Cases, Environment Protection Orders, Compliance Report for Operational Phase Approvals, or any regulatory action under Punjab Environmental Protection (Smog Prevention and Control) Rules, 2023 etc.

Job Reference Number	GCEC-PK-PU-161/2025
Monitoring Point	New Ravi Bridge
Date of Intervention	22-May-2025 to 23-May-2025
Monitoring Coordinates	31°36'28.5"N 74°17'45.5"E

Sr. #	Time	CO (mg/m ³)	NO (µg/m ³)	NO ₂ (µg/m ³)	NO _x (µg/m ³)	SO ₂ (µg/m ³)
1.	12:00	3.29	23.72	37.93	61.64	139.85
2.	13:00	3.15	24.52	41.21	65.73	131.85
3.	14:00	3.01	20.23	38.13	58.36	140.71
4.	15:00	2.90	23.72	38.95	62.67	118.69
5.	16:00	2.73	22.38	40.39	62.76	134.88
6.	17:00	2.96	24.39	37.31	61.70	139.00
7.	18:00	2.79	19.14	101.89	121.02	143.29
8.	19:00	2.84	22.78	34.24	57.02	135.85
9.	20:00	2.63	21.84	40.80	62.64	134.42
10.	21:00	2.90	28.01	78.72	106.73	29.92
11.	22:00	2.71	19.03	27.27	46.29	43.79
12.	23:00	2.87	18.09	29.73	47.82	36.98
13.	00:00	2.84	23.66	24.67	48.33	30.08
14.	01:00	2.83	22.71	23.60	46.31	31.10
15.	02:00	2.49	25.69	22.76	48.46	49.85
16.	03:00	2.50	26.46	23.09	49.55	32.07
17.	04:00	2.53	26.72	23.65	50.37	29.65
18.	05:00	2.58	27.94	24.58	52.52	43.66
19.	06:00	2.81	28.01	24.90	52.91	33.66
20.	07:00	2.94	25.86	25.04	50.91	35.37
21.	08:00	2.90	17.96	25.22	43.17	44.33
22.	09:00	2.96	26.40	34.24	60.63	37.40
23.	10:00	2.87	29.35	28.70	58.05	134.13
24.	11:00	2.81	35.11	24.19	59.30	169.80
Average Concentration		2.81	34.35	35.35	59.71	89.89

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Ambient Air Quality Monitoring

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Job Reference Number	GCEC-PK-PU-161/2025
Monitoring Point	New Ravi Bridge
Date of Intervention	22-May-2025 to 23-May-2025
Monitoring Coordinates	31°36'28.5"N 74°17'45.5"E

Parameter	Unit	Monitoring Duration	LDL	Average Obtained Concentration	PEQS
Nitrogen Dioxide (NO ₂)	µg/m ³	24 Hours	1.00	35.36	80.0
Nitrogen Oxide (NO)	µg/m ³	24 Hours	1.00	24.35	40.0
NO _x	µg/m ³	24 Hours	1.00	59.71	120.0
Sulphur Dioxide (SO ₂)	µg/m ³	24 Hours	1.00	80.89	120.0
Carbon Monoxide (CO)	mg/m ³	24 Hours	0.01	2.81	5.0*
Ozone (O ₃)	µg/m ³	24 Hours	-	19.60	130.0**
Particulate Matter (PM _{2.5})	µg/m ³	24 Hours	1.00	243.83	35.0
Particulate Matter (PM ₁₀)	µg/m ³	24 Hours	1.00	253.01	150.0
Suspended Particulate Matter (SPM)	µg/m ³	24 Hours	1.00	531.84	500.0
Lead Airborne Particles	µg/m ³	24 Hours	-	0.52	1.5

Abbreviations:

µg/m³= Micrograms per Cubic Meter
 mg/m³= Milligrams per Cubic Meter
 LDL= Lowest Detection Limit
 PEQS= Punjab Environmental Quality Standards
 *08 hour standard for CO
 **01 hour standard for O₃

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Meteorological Data

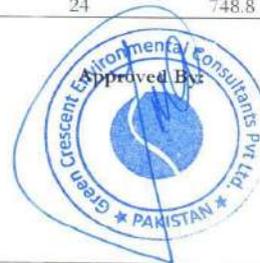
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Job Reference Number	GCEC-PK-PU-161/2025
Monitoring Point	New Ravi Bridge
Date of Intervention	22-May-2025 to 23-May-2025
Monitoring Coordinates	31°36'28.5"N 74°17'45.5"E

Time	Ambient Temperature	Wind Direction	Wind Velocity	Humidity	Pressure (mm of Hg)
	°C		m/s	%	
12:00	42	SE	3.5	25	751.1
13:00	42	NW	2.4	30	749.7
14:00	39	NW	2.4	31	749.0
15:00	38	SE	3.8	33	747.2
16:00	30	SE	3.7	36	747.5
17:00	29	NW	3.1	42	751.0
18:00	28	SE	3.2	49	749.2
19:00	28	SW	2.3	53	748.2
20:00	28	SE	2.6	53	748.8
21:00	26	SW	2.5	50	749.9
22:00	24	NW	3.7	49	748.6
23:00	24	SW	2.5	48	749.7
00:00	23	NW	2.8	48	750.0
01:00	22	SW	3.7	45	750.9
02:00	24	SE	2.8	44	747.9
03:00	26	SE	3.2	43	749.5
04:00	29	NW	2.3	43	749.7
05:00	35	SE	2.8	40	747.5
06:00	36	SW	3.2	40	748.2
07:00	37	SW	2.5	37	750.4
08:00	37	SE	3.0	32	747.6
09:00	38	NW	2.7	31	750.5
10:00	43	SE	3.0	27	748.7
11:00	44	NW	3.2	24	748.8

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Environmental Consultants Pvt. Ltd.

Sr. No# 25A/ 7062

Noise Level Monitoring Report

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Job Reference Number	GCEC-PK-PU-161/2025
Monitoring Point	New Ravi Bridge
Date of Intervention	22-May-2025 to 23-May-2025
Monitoring Coordinates	31°36'28.5"N 74°17'45.5"E

Sr. #	Time	Method/Technique	Unit	Results LAavg	PEQS (Commercial)
Night Time					
1.	23:00	Noise Meter	dB	71.3	55.0
2.	00:00	Noise Meter	dB	68.2	
3.	01:00	Noise Meter	dB	62.7	
4.	02:00	Noise Meter	dB	63.8	
5.	03:00	Noise Meter	dB	83.9	
6.	04:00	Noise Meter	dB	81.6	
7.	05:00	Noise Meter	dB	80.8	
8.	06:00	Noise Meter	dB	83.3	
Night Time Average				74.48	55.0
Day Time					
9.	07:00	Noise Meter	dB	82.8	65.0
10.	08:00	Noise Meter	dB	80.8	
11.	09:00	Noise Meter	dB	81.8	
12.	10:00	Noise Meter	dB	81.1	
13.	11:00	Noise Meter	dB	83.4	
14.	12:00	Noise Meter	dB	79.4	
15.	13:00	Noise Meter	dB	80.2	
16.	14:00	Noise Meter	dB	86.1	
17.	15:00	Noise Meter	dB	82.1	
18.	16:00	Noise Meter	dB	83.1	
19.	17:00	Noise Meter	dB	76.0	
20.	18:00	Noise Meter	dB	81.0	
21.	19:00	Noise Meter	dB	77.8	
22.	20:00	Noise Meter	dB	82.8	
23.	21:00	Noise Meter	dB	79.7	
24.	22:00	Noise Meter	dB	73.7	
Day Time Average				80.75	65.0

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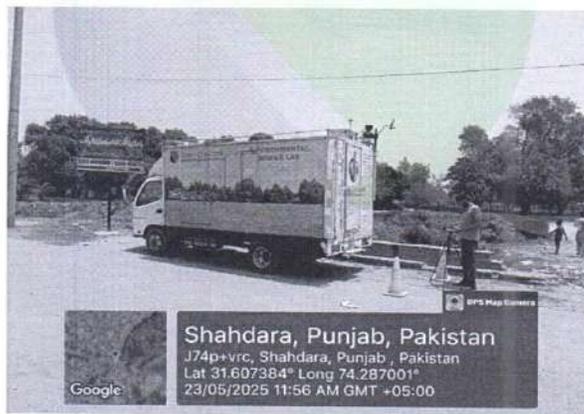




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Sr. No# 25A/ 7063

Ambient Air Monitoring Location #03
BARA DARI
(Lahore)



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Sr. No# 25A/ 7064

Ambient Air Quality Monitoring

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Job Reference Number	GCEC-PK-PU-161/2025
Monitoring Point	Bara Dari
Date of Intervention	23-May-2025 to 24-May-2025
Monitoring Coordinates	31°36'26.6"N 74°17'13.2"E

Sr. #	Time	CO (mg/m ³)	NO (µg/m ³)	NO ₂ (µg/m ³)	NO _x (µg/m ³)	SO ₂ (µg/m ³)
1.	12:00	1.97	15.68	24.60	40.28	64.35
2.	13:00	1.93	15.54	25.01	40.55	44.62
3.	14:00	1.91	15.68	25.63	41.30	45.19
4.	15:00	1.95	15.95	26.04	41.98	44.33
5.	16:00	1.94	15.41	25.42	40.83	45.76
6.	17:00	2.09	14.47	20.50	34.97	35.18
7.	18:00	1.91	14.61	20.30	34.90	60.35
8.	19:00	1.93	16.88	28.29	45.17	46.33
9.	20:00	1.89	16.21	22.96	39.17	34.03
10.	21:00	1.86	16.62	23.78	40.40	36.04
11.	22:00	1.86	16.87	23.46	40.32	35.47
12.	23:00	1.85	17.18	24.51	41.70	35.75
13.	00:00	1.84	16.87	24.37	41.23	36.98
14.	01:00	1.88	16.60	24.20	40.80	35.09
15.	02:00	1.86	16.68	24.08	40.76	36.14
16.	03:00	1.82	16.96	23.24	40.20	35.57
17.	04:00	1.85	16.60	23.42	40.01	37.02
18.	05:00	1.84	17.13	24.73	41.86	36.80
19.	06:00	1.87	17.08	24.32	41.40	36.19
20.	07:00	1.91	15.81	25.63	41.44	39.75
21.	08:00	1.93	15.95	27.88	43.83	44.62
22.	09:00	1.91	15.68	22.96	38.64	47.19
23.	10:00	1.87	15.14	25.83	40.97	48.33
24.	11:00	1.94	16.21	27.47	43.68	47.76
Average Concentration		1.90	16.16	24.52	40.68	42.04

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Reviewed By: *[Signature]*



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Sr. No# 25A/ 7065

Ambient Air Quality Monitoring

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Job Reference Number	GCEC-PK-PU-161/2025
Monitoring Point	Bara Dari
Date of Intervention	23-May-2025 to 24-May-2025
Monitoring Coordinates	31°36'26.6"N 74°17'13.2"E

Parameter	Unit	Monitoring Duration	LDL	Average Obtained Concentration	PEQS
Nitrogen Dioxide (NO ₂)	µg/m ³	24 Hours	1.00	24.52	80.0
Nitrogen Oxide (NO)	µg/m ³	24 Hours	1.00	16.16	40.0
NO _x	µg/m ³	24 Hours	1.00	40.86	120.0
Sulphur Dioxide (SO ₂)	µg/m ³	24 Hours	1.00	42.04	120.0
Carbon Monoxide (CO)	mg/m ³	24 Hours	0.01	1.90	5.0*
Ozone (O ₃)	µg/m ³	24 Hours	-	17.84	130.0**
Particulate Matter (PM _{2.5})	µg/m ³	24 Hours	1.00	267.35	35.0
Particulate Matter (PM ₁₀)	µg/m ³	24 Hours	1.00	279.87	150.0
Suspended Particulate Matter (SPM)	µg/m ³	24 Hours	1.00	582.22	500.0
Lead Airborne Particles	µg/m ³	24 Hours	-	0.48	1.5

Abbreviations:

µg/m³= Micrograms per Cubic Meter
 mg/m³= Milligrams per Cubic Meter
 LDL= Lowest Detection Limit
 PEQS= Punjab Environmental Quality Standards
 *08 hour standard for CO
 **01 hour standard for O₃

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Deputy Analyst:

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Sr. No# 25A/ 7066

Meteorological Data

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Job Reference Number	GCEC-PK-PU-161/2025
Monitoring Point	Bara Dari
Date of Intervention	23-May-2025 to 24-May-2025
Monitoring Coordinates	31°36'26.6"N 74°17'13.2"E

Time	Ambient Temperature °C	Wind Direction	Wind Velocity m/s	Humidity %	Pressure (mm of Hg)
12:00	44	SE	4.8	31	750.7
13:00	43	SW	5.5	29	752.1
14:00	43	SW	5.9	28	752.6
15:00	42	SE	5.9	28	750.8
16:00	40	S	5.9	27	753.3
17:00	37	SW	4.5	28	751.0
18:00	33	SE	4.5	34	750.1
19:00	30	SE	4.3	35	750.8
20:00	30	SE	4.2	39	750.7
21:00	29	SE	4.2	41	750.2
22:00	25	S	3.8	44	751.9
23:00	26	SE	4.2	40	753.3
00:00	26	S	4.2	38	753.2
01:00	27	SE	4.2	40	749.4
02:00	26	SE	3.8	41	749.5
03:00	24	S	3.1	43	752.1
04:00	21	S	4.8	47	752.7
05:00	25	SE	4.1	47	750.9
06:00	29	SW	3.7	46	753.6
07:00	31	SE	3.6	46	750.5
08:00	33	S	4.1	45	752.5
09:00	35	SE	4.5	42	752.4
10:00	37	SE	4.5	36	751.8
11:00	41	SW	4.3	31	749.5

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Sr. No# 25A/ 7067

Noise Level Monitoring Report

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Job Reference Number	GCEC-PK-PU-161/2025
Monitoring Point	Bara Dari
Date of Intervention	23-May-2025 to 24-May-2025
Monitoring Coordinates	31°36'26.6"N 74°17'13.2"E

Sr. #	Time	Method/Technique	Unit	Results LAavg	PEQS (Commercial)
Night Time					
1.	23:00	Noise Meter	dB	53.36	55.0
2.	00:00	Noise Meter	dB	51.37	
3.	01:00	Noise Meter	dB	49.27	
4.	02:00	Noise Meter	dB	52.84	
5.	03:00	Noise Meter	dB	48.43	
6.	04:00	Noise Meter	dB	54.62	
7.	05:00	Noise Meter	dB	46.33	
8.	06:00	Noise Meter	dB	49.48	
Night Time Average			dB	50.71	55.0
Day Time					
9.	07:00	Noise Meter	dB	56.1	65.0
10.	08:00	Noise Meter	dB	61.5	
11.	09:00	Noise Meter	dB	62.2	
12.	10:00	Noise Meter	dB	63.6	
13.	11:00	Noise Meter	dB	70.7	
14.	12:00	Noise Meter	dB	64.5	
15.	13:00	Noise Meter	dB	66.0	
16.	14:00	Noise Meter	dB	66.8	
17.	15:00	Noise Meter	dB	64.3	
18.	16:00	Noise Meter	dB	65.8	
19.	17:00	Noise Meter	dB	56.2	
20.	18:00	Noise Meter	dB	62.4	
21.	19:00	Noise Meter	dB	54.1	
22.	20:00	Noise Meter	dB	57.2	
23.	21:00	Noise Meter	dB	56.1	
24.	22:00	Noise Meter	dB	61.5	
Day Time Average			dB	61.81	65.0

Deputy Analyst:

Reviewed By:

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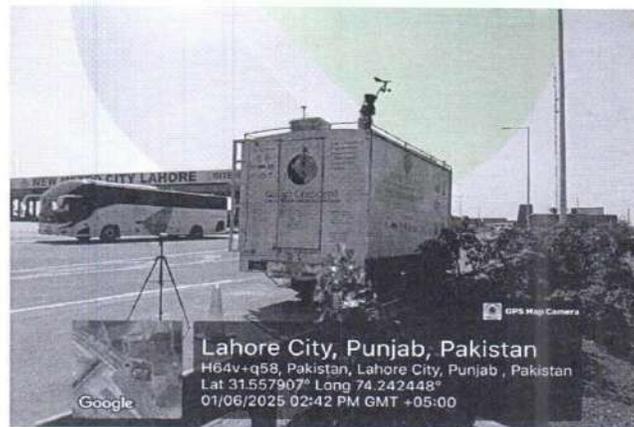




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Sr. No# 25A/ 7068

Ambient Air Monitoring Location #04
Ravi Toll Plaza M2
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Environmental Consultants Pvt. Ltd.

Sr. No# 25A/ 7069

Ambient Air Quality Monitoring

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Job Reference Number	GCEC-PK-PU-161/2025
Monitoring Point	Ravi Toll Plaza M2
Date of Intervention	01-June-2025 to 02-June-2025
Monitoring Coordinates	31°33'28.5"N 74°14'32.8"E

Sr. #	Time	CO (mg/m ³)	NO (µg/m ³)	NO ₂ (µg/m ³)	NO _x (µg/m ³)	SO ₂ (µg/m ³)
1.	14:40	4.03	23.99	39.57	63.55	73.50
2.	15:40	3.98	22.78	34.24	57.02	38.90
3.	16:40	4.04	23.72	38.95	62.67	61.78
4.	17:40	4.00	22.51	43.05	65.56	60.92
5.	18:40	3.99	22.91	33.42	56.33	61.49
6.	19:40	4.03	25.86	39.98	65.84	90.38
7.	20:40	3.91	25.86	40.18	66.04	56.34
8.	21:40	3.89	26.13	40.18	66.31	61.20
9.	22:40	3.99	25.86	39.98	65.84	61.78
10.	23:40	4.03	26.00	40.39	66.38	61.78
11.	00:40	4.16	26.26	40.39	66.65	62.06
12.	01:40	4.11	26.26	40.59	66.85	62.06
13.	02:40	4.09	26.53	40.80	67.33	62.35
14.	03:40	4.00	26.40	40.80	67.19	61.49
15.	04:40	3.76	26.53	40.80	67.33	61.78
16.	05:40	3.74	25.86	40.18	66.04	61.78
17.	06:40	3.69	25.46	39.77	65.23	76.36
18.	07:40	3.90	22.38	30.14	52.51	87.52
19.	08:40	4.01	22.91	43.46	66.37	63.78
20.	09:40	4.01	25.73	39.16	64.88	64.35
21.	10:40	4.03	26.00	39.16	65.15	63.78
22.	11:40	4.00	23.32	43.87	67.19	62.92
23.	12:40	4.03	23.05	43.26	66.30	64.35
24.	13:40	4.03	22.78	43.05	65.83	64.64
Average Concentration		3.98	24.80	39.80	64.60	67.47

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Sr. No# 25A/ 7070

Ambient Air Quality Monitoring

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Job Reference Number	GCEC-PK-PU-161/2025
Monitoring Point	Ravi Toll Plaza M2
Date of Intervention	01-June-2025 to 02-June-2025
Monitoring Coordinates	31°33'28.5"N 74°14'32.8"E

Parameter	Unit	Monitoring Duration	LDL	Average Obtained Concentration	PEQS
Nitrogen Dioxide (NO ₂)	µg/m ³	24 Hours	1.00	39.80	80.0
Nitrogen Oxide (NO)	µg/m ³	24 Hours	1.00	24.80	40.0
NO _x	µg/m ³	24 Hours	1.00	64.60	120.0
Sulphur Dioxide (SO ₂)	µg/m ³	24 Hours	1.00	64.47	120.0
Carbon Monoxide (CO)	mg/m ³	24 Hours	0.01	3.98	5.0*
Ozone (O ₃)	µg/m ³	24 Hours	-	35.0	130.0**
Particulate Matter (PM _{2.5})	µg/m ³	24 Hours	1.00	223.42	35.0
Particulate Matter (PM ₁₀)	µg/m ³	24 Hours	1.00	265.09	150.0
Suspended Particulate Matter (SPM)	µg/m ³	24 Hours	1.00	523.51	500.0
Lead Airborne Particles	µg/m ³	24 Hours	-	0.41	1.5

Abbreviations:

µg/m³= Micrograms per Cubic Meter

mg/m³= Milligrams per Cubic Meter

LDL= Lowest Detection Limit

PEQS= Punjab Environmental Quality Standards

*08 hour standard for CO

**01 hour standard for O₃

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Sr. No# 25A/ 7071

Meteorological Data

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Job Reference Number	GCEC-PK-PU-161/2025
Monitoring Point	Ravi Toll Plaza M2
Date of Intervention	01-June-2025 to 02-June-2025
Monitoring Coordinates	31°33'28.5"N 74°14'32.8"E

Time	Ambient Temperature °C	Wind Direction	Wind Velocity m/s	Humidity %	Pressure (mm of Hg)
14:40	41	NW	5.6	11	757.5
15:40	41	NW	4.5	10	758.2
16:40	41	NW	3.8	10	756.9
17:40	41	NW	5.7	10	757.0
18:40	40	NW	4.8	12	758.7
19:40	38	NW	4.0	13	757.1
20:40	37	N	2.1	15	757.9
21:40	35	N	4.9	16	759.2
22:40	34	NW	4.0	18	760.4
23:40	33	NW	3.9	24	759.7
00:40	31	N	2.5	25	757.5
01:40	30	N	3.7	27	756.4
02:40	29	NE	4.1	28	755.2
03:40	29	NE	4.6	29	757.3
04:40	28	N	2.1	29	757.3
05:40	28	N	4.1	30	757.0
06:40	29	NE	2.5	30	756.3
07:40	31	NE	2.0	28	756.1
08:40	34	NW	2.5	24	758.3
09:40	35	NW	3.2	20	757.3
10:40	37	NW	4.4	18	758.7
11:40	39	NW	2.8	15	757.3
12:40	40	N	4.0	13	757.3
13:40	41	N	5.7	13	759.7

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Noise Level Monitoring Report

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Job Reference Number	GCEC-PK-PU-161/2025
Monitoring Point	Ravi Toll Plaza M2
Date of Intervention	01-June-2025 to 02-June-2025
Monitoring Coordinates	31°33'28.5"N 74°14'32.8"E

Sr. #	Time	Method/Technique	Unit	Results LAavg	PEQS (Commercial)
Night Time					
1.	23:40	Noise Meter	dB	73.3	55.0
2.	00:40	Noise Meter	dB	66.9	
3.	01:40	Noise Meter	dB	70.9	
4.	02:40	Noise Meter	dB	72.9	
5.	03:40	Noise Meter	dB	75.2	
6.	04:40	Noise Meter	dB	66.3	
7.	05:40	Noise Meter	dB	66.1	
8.	06:40	Noise Meter	dB	74.8	
Night Time Average			dB	70.8	55.0
Day Time					
9.	07:40	Noise Meter	dB	87.2	65.0
10.	08:40	Noise Meter	dB	30.7	
11.	09:40	Noise Meter	dB	89.2	
12.	10:40	Noise Meter	dB	86.7	
13.	11:40	Noise Meter	dB	88.8	
14.	12:40	Noise Meter	dB	89.1	
15.	13:40	Noise Meter	dB	88.5	
16.	14:40	Noise Meter	dB	89.7	
17.	15:40	Noise Meter	dB	92.0	
18.	16:40	Noise Meter	dB	83.3	
19.	17:40	Noise Meter	dB	85.5	
20.	18:40	Noise Meter	dB	92.3	
21.	19:40	Noise Meter	dB	84.0	
22.	20:40	Noise Meter	dB	90.0	
23.	21:40	Noise Meter	dB	86.0	
24.	22:40	Noise Meter	dB	91.4	
Day Time Average			dB	84.6	65.0

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Annex:4 EMP- Associated Plans

EMP-Sub-Plan 1. Sediment Disposal Plan

Project Component:

River Training Works & Rubber Dam/Weir Operations

Objective:

To manage and dispose of dredged or flushed sediment in a manner that minimizes environmental and social risks, supports downstream ecosystem health, and aligns with regulatory requirements.

1. Objectives of Sediment Disposal Plan

- Prevent re-suspension and secondary pollution from dredged material.
- Avoid obstruction of flow paths or harm to aquatic or riparian ecosystems.
- Ensure environmentally safe, socially acceptable, and technically sound disposal practices.
- Support adaptive sediment management through monitoring and reuse where feasible.

2. Sources of Sediment

- Siltation in Rubber Dam/Weir impoundments and side channels.
- Dredging zones in sediment-prone pockets.
- Deposits at sluicing gate outlets or low-velocity zones.

3. Sediment Characterization

Before disposal, sediments shall be sampled and analyzed for:

- Grain size distribution (silt, clay, sand proportions)
- Organic content
- Heavy metals (Pb, Hg, Cd, Cr, etc.)
- Nutrients or contaminants
- Presence of invasive aquatic species (if any)

Disposal strategy will vary depending on whether the sediment is:

- Clean/inert
- Contaminated (requiring isolation or treatment)

4. Disposal Methods

A. On-Site Reuse (Preferred for Clean Sediments)

- Reclamation/landscaping within riverbanks or bunds.
- Topsoil improvement for afforestation or buffer green zones.
- Construction fills in non-structural areas.

All reuse sites must be pre-approved and checked for slope stability and runoff control.

B. Confined Disposal Facilities (CDFs)

For large volumes or slightly contaminated sediment:

- Secure engineered basins with liners and leachate control.
- Located outside floodplain or impoundment zones.
- Designed for long-term containment with drainage and silt fences.

C. Transport to Off-Site Disposal Areas

For unsuitable or contaminated sediments:

- Transport using sealed tippers or barges.
- Dispose at designated landfill approved by local EPA.
- Maintain manifest and GPS tracking logs.

5. Environmental Safeguards

- Dust and noise control during loading/transport.
- Silt curtains or booms at dredging/flushing locations to contain turbidity.
- Sediment dewatering before disposal to reduce weight and volume.
- Spill prevention plan and emergency response for on-road transport.

6. Site Selection Criteria for Disposal/Reclamation

- Outside flood zones and sensitive habitats.
- Minimum 500 m from water bodies, wetlands, or settlements.
- Avoid cultural heritage sites or agricultural lands unless beneficial reuse is planned.

7. Institutional Roles & Responsibilities

Table-Annex- 2 Institutional Roles & Responsibilities for Sedimentation Disposal

Role	Entity
------	--------

Sediment sampling & lab testing	Contractor (with EPA-certified lab)
Site identification & clearance	PMU/Design Consultant with local EPA
Transport & disposal	Contractor (with supervision by CSC/PMU)
Monitoring & compliance	PMU/Environmental Cell, DoE

8. Monitoring & Reporting

- Pre- and post-disposal inspections at all sites.
- Quarterly reporting on disposal volumes, methods, and locations.
- Environmental audits as part of semi-annual ESMP compliance monitoring.

EMP-Sub-Plan 2. Heritage Preservation Contingency Plan for Kamran Baradari

1. Objective

To safeguard Kamran Baradari from potential direct and indirect impacts of the Rubber Dam/Weir and river training works. The plan outlines preventive, monitoring, and emergency response measures to preserve the monument's structural and cultural integrity.

2. Scope

This plan applies to the entire project duration (construction and operation phases) and includes:

- Emergency response protocols for flood, vibration, or foundation damage
- Preventive protection measures (e.g., scaffolding, drainage)
- Roles and responsibilities of key stakeholders
- Relocation strategies for any movable heritage components (if applicable)

3. Risk Scenarios Covered

Table-Annex- 3 Risk Scenarios Covered for Heritage Preservation

Sr. #	Risk Event	Potential Impact
1	High Flood/Backwater Rise	Inundation, erosion, moisture damage
2	Vibration from nearby construction	Cracking, loosening of joints, structural tilt
3	Sediment deposition & water stagnation	Capillary rise, foundation weakening
4	Unauthorized access or vandalism	Cultural loss, graffiti, material theft
5	Foundation instability	Partial collapse, lean, or sagging

4. Emergency Interventions

4.1 Water-Related Hazards

- Early Warning: Install real-time flood level sensors upstream and near the Baradari with visual/audio alarms and SMS alerts.
- Temporary Protective Bund: Deploy pre-fabricated sandbag bunds around the perimeter when flood risk threshold is crossed.
- Pump-Out Protocol: Place emergency dewatering pumps to evacuate accumulated water within protective bund limits.
- Inspection after Flooding: Conduct immediate visual and structural inspection post-inundation.

4.2 Structural Movement or Cracking

- Monitoring Tools: Install crack meters, tilt sensors, and vibration gauges.

- Immediate Response: If readings cross safe thresholds, stop nearby construction and deploy conservation experts.
- Stabilization Measures: Use bracing and light scaffolding until full analysis and repair.

5. Preventive Protection Measures

5.1 Protective Scaffolding

- Material: Use tubular, adjustable, galvanized scaffolding with protective mesh to guard against falling debris and water splash.
- Placement: Should not anchor directly into historical masonry; use freestanding design or weighted bases.
- Inspection Frequency: Weekly during construction; daily in flood-prone periods.

5.2 Physical Barriers

- Install temporary fencing with “Restricted Heritage Zone” signage.
- Use rubber matting or geotextile between machinery paths and Baradari zone to minimize ground vibration transmission.

6. Movable Heritage Component Protocol

Although Kamran Baradari is primarily a fixed masonry structure, the plan anticipates possible small movable or semi-detached elements (e.g., stone railings, decorative panels):

Table-Annex- 4 Movable Heritage Component Protocol

Step	Action
1	Identification: Undertake a detailed inventory of movable artifacts.
2	Condition Assessment: Document pre-move condition using photos, drawings.
3	Storage Preparation: Set up a secure, climate-controlled temporary storage facility.
4	Packing and Relocation: Use conservation-grade materials and trained handlers.
5	Reinstallation Plan: Ensure proper documentation for eventual reinstallation.

7. Roles and Responsibilities

Table-Annex- 5 Roles and Responsibility for Heritage Preservation

Role	Responsibility
Project Heritage Focal Person	Daily oversight of monument zone; coordination with archaeology departments
Construction Manager	Ensure machinery exclusion zones and vibration control
DoA / Archaeology Dept.	Approvals, expert guidance, and emergency conservation input
Emergency Response Team (ERT)	Execute bunding, water pumping, and scaffold erection within 24–48 hours

8. Training & Awareness

- Conduct training of site workers on working near heritage structures.
- Heritage conservation awareness signboards will be placed in local language(s).
- Conduct drills for emergency waterlogging response.

9. Budget Provisions

Table-Annex- 6 Budget for Heritage Preservation

Item	Description	Unit	Qty	Rate (PKR)	Amount (PKR)
1. Buffer Zone Fencing	Temporary protective fencing with signage (100m radius)	Meter	314	2,500	785,000
2. Signboards	Heritage warning boards (multilingual)	No.	4	15,000	60,000
3. Vibration Monitoring Equipment	Tri-axial geophones with data logger (rental + installation)	Lump Sum	1	800,000	800,000
4. Heritage Specialist	Monthly engagement of conservation expert (6 months)	Month	6	500,000	3,000,000
5. Pre/Post Documentation	3D laser scanning and photogrammetry	Lump Sum	1	1,200,000	1,200,000
6. Structural Assessment	Expert structural audit of Baradari	Lump Sum	1	600,000	600,000
7. Emergency Scaffolding & Access Platform	Erection near vulnerable sections	Lump Sum	1	400,000	400,000
8. Moisture/Drainage Control	Moisture barriers and temporary sub-drainage	Lump Sum	1	800,000	800,000
9. Emergency Conservation Fund	Reserved for minor repairs (cracks, reinforcements, sealing)	Provisional Sum	-	-	1,000,000
10. Contingency (10%)	Unforeseen preservation needs	-	-	-	866,500
Estimated Total Budget:					9,511,500

Or PKR 10 Million Lump sum

10. Reporting and Documentation

- Maintain a Heritage Risk Logbook (daily entries).
- Report any incident within 12 hours to:
- Project PMU
- Punjab Department of Archaeology

- World Bank (if applicable)

EMP-Sub-Plan 3. Standard Operating Procedure (SOP) for Sediment Flushing

Project: Rubber Dams/Weirs on Ravi River

Section: From M-2 Motorway Bridge to New Ravi Bridge

Purpose: To maintain reservoir capacity, protect structural integrity, and minimize environmental impacts by regularly removing sediment accumulation behind Rubber Dams/Weirs.

1. Purpose

This SOP outlines the process for safely and effectively flushing accumulated sediment from the reservoirs of Rubber Dams/Weirs to:

- Maintain water holding capacity
- Prevent flood risks
- Avoid ecological degradation and equipment damage

2. Scope

This SOP applies to:

- All Rubber Dams/Weirs installed in the Ravi River section
- Flushing events planned during:
 - Post-monsoon high flow periods
 - Emergency sediment build-up scenarios
 - Routine maintenance cycles (typically every 6–12 months)

3. Roles and Responsibilities

Table-Annex- 7 Roles and Responsibility for Operating Procedure

Role	Responsibility
RUDA O&M Team	Planning, supervising, and documenting flushing activities
Site Engineer	Field-level coordination, technical execution
Environmental Specialist	Monitoring water quality and ecological impacts
Health & Safety Officer	Ensuring safety compliance and risk mitigation

4. Flushing Procedure: Step-by-Step

◆ Step 1: Pre-Flushing Assessment

- Conduct bathymetric survey to assess sediment volume and location
- Analyze environmental impacts on downstream flora/fauna
- Identify ideal timing (preferably during high natural flow)
- Notify local authorities and nearby communities in advance

◆ **Step 2: Preparation**

- Inspect and service flushing gates and mechanical systems
- Place safety barriers, warning signs, and restrict public access
- Prepare and review Emergency Response Plan (ERP)
- Calibrate water quality monitoring equipment (e.g., for turbidity, TSS)

◆ **Step 3: Flushing Execution**

- Gradually open flushing gates to avoid pressure shocks
- Use natural river flow to assist sediment removal
- Limit flushing duration to 4–6 hours depending on volume
- Continuously monitor:
 - Turbidity (NTU)
 - Total Suspended Solids (TSS)
 - Dissolved Oxygen (DO)
 - pH and other basic parameters

◆ **Step 4: Post-Flushing Monitoring**

- Re-survey the reservoir bed using bathymetric equipment
- Conduct downstream water quality and aquatic health assessments
- Record observations and any community feedback
- Prepare and submit a flushing event report with photos, data logs, and any corrective recommendations

5. Environmental and Safety Precautions

- Avoid flushing during dry flow seasons or fish breeding periods
- Ensure continuous monitoring of downstream water uses (e.g., irrigation, domestic intake)
- Use sediment containment techniques if excessive pollution is detected

- Ensure all personnel wear PPE and follow safety protocols

EMP-Sub-Plan 4. Environmental Code of Practices (ECoPs)

Project: Installation of Rubber Dams/Weirs on Ravi River – Phase II

Location: M-2 Bridge to New Ravi Bridge

ECoP-01: Air Quality Management

Objective: Minimize air pollution and dust generation.

Guidelines:

- Conduct baseline air quality monitoring before construction.
 - Sprinkle water on exposed surfaces twice daily.
 - Cover stockpiles and truckloads with tarpaulin.
 - Ban idling of vehicles and use low-emission equipment.
 - Avoid construction during dry windy days near populated areas.
- Responsibility: Contractor; Supervised by RUDA's Environment Cell
Monitoring: PM₁₀, PM_{2.5} levels, visual inspections, complaints

ECoP-02: Noise and Vibration Control

Objective: Reduce noise impacts on workers, communities, and heritage sites.

Guidelines:

- Conduct ambient noise monitoring (baseline + periodic).
- Restrict high-noise activities to 8 am–6 pm.
- Install temporary noise barriers near Kamran Baradari.
- Calibrate and maintain all machinery regularly.
- Prohibit use of pressure horns near the site.
- Responsibility: Contractor; Monitored by Environment Cell
- Monitoring: Decibel readings, public complaint log

ECoP-03: Water Quality Protection

Objective: Prevent River and groundwater contamination.

Guidelines:

- Construct temporary bunds around fuel storage and workshops.

- Install sediment traps and oil-water separators.
- Treat construction wastewater before discharge.
- Monitor upstream and downstream water quality biweekly.
- Responsibility: Contractor; Verified by RUDA & WASA
- Monitoring: BOD, COD, DO levels, visible sheen, E. coli

ECoP-04: Soil Erosion and Sediment Control

Objective: Prevent siltation of the river and maintain land stability.

Guidelines:

- Construct check dams and retaining walls near excavation sites.
- Divert stormwater through lined drains.
- Stabilize exposed slopes with vegetation or matting.
- Store topsoil separately and reuse post-construction.
- Responsibility: Contractor with RUDA oversight
- Monitoring: Visual erosion signs, sediment load in runoff

ECoP-05: Solid and Liquid Waste Management

Objective: Ensure safe handling and disposal of all waste.

Guidelines:

- Segregate waste: organic, recyclable, hazardous.
- Maintain waste manifests and disposal records.
- Store waste in covered bins away from water channels.
- Engage certified waste disposal companies for removal.
- Responsibility: Contractor; Audited by RUDA
- Monitoring: Waste logs, illegal dumping incidents

ECoP-06: Hazardous Materials Management

Objective: Prevent chemical hazards and environmental exposure.

Guidelines:

- Store chemicals in ventilated, banded, and labeled areas.

- Display Material Safety Data Sheets (MSDS).
- Conduct spill-response training for staff.
- Ensure immediate cleanup and reporting of spills.
- Responsibility: Contractor HSE team
- Monitoring: Inventory logs, spill incident reports

ECoP-07: Construction Camp and Labour Camp Management

Objective: Maintain hygienic, safe, and socially acceptable labour accommodations.

Guidelines:

- Provide potable water, toilets, and separate waste bins.
- Maintain distance from ecologically or culturally sensitive areas.
- Appoint a camp manager responsible for compliance.
- Ensure code of conduct and labour grievance mechanism is in place.
- Responsibility: Contractor; Verified by RUDA & Social Team
- Monitoring: Camp audit reports, health inspections

ECoP-08: Occupational Health and Safety (OHS)

Objective: Safeguard workers' physical and mental well-being.

Guidelines:

- Conduct job-specific risk assessments.
- Supply PPE: helmets, boots, vests, gloves, goggles.
- Conduct weekly toolbox talks and monthly safety drills.
- Maintain onsite first-aid kits and emergency response plan.
- Responsibility: Contractor HSE Officer
- Monitoring: Incident/accident logs, training attendance

ECoP-09: River Ecosystem and Biodiversity Protection

Objective: Conserve aquatic and riparian biodiversity.

Guidelines:

- Avoid instream works during fish breeding season (May–August).

- Install screens to prevent fish ingress in intakes.
- Prevent discharge of untreated effluent into the river.
- Monitor aquatic fauna health periodically.
- Responsibility: Contractor; Verified by EPA/RUDA
- Monitoring: Biodiversity survey, water toxicity tests

ECOP-10: Cultural Heritage Protection

Objective: Safeguard Kamran Baradari and associated heritage values.

Guidelines:

- Establish 100-meter buffer zone and prohibit any encroachments.
- Conduct vibration monitoring near Baradari during pile driving.
- Engage heritage specialists for supervision during works.
- Implement emergency conservation protocol for discoveries.
- Responsibility: Contractor; Supervised by Archaeology Dept.
- Monitoring: HIA reports, visual inspections

ECOP-11: Traffic and Access Management

Objective: Ensure safety and minimum disruption to public movement.

Guidelines:

- Develop traffic diversion plans with local police.
- Install signage, warning cones, and flagmen.
- Provide alternate routes and minimize road blockages.
- Prohibit construction traffic during school rush hours.
- Responsibility: Contractor with Local Govt. support
- Monitoring: Traffic flow observations, complaint register

ECOP-12: Community Health and Safety

Objective: Minimize risks to local population during project activities.

Guidelines:

- Fence all active construction zones.

- Inform communities of blasting or loud activities in advance.
- Employ community liaison officers for daily updates.
- Ensure no obstruction of emergency service routes.
- Responsibility: Contractor & RUDA Social Team
- Monitoring: Community feedback, inspection reports

ECoP-13: Stormwater and Drainage Management

Objective: Avoid flooding and ensure natural hydrology.

Guidelines:

- Maintain free flow in natural drains and nullahs.
- Install temporary culverts where required.
- Avoid blockage of urban drainage systems near construction.
- Schedule excavation during dry season.
- Responsibility: Contractor; Reviewed by Design Consultant
- Monitoring: Stormwater logs, field inspections

ECoP-14: Vegetation and Tree Management

Objective: Conserve natural greenery and ensure offset planting.

Guidelines:

- Avoid cutting mature trees unless absolutely necessary.
- Mark trees for protection with fluorescent tape.
- Prepare tree inventory and compensatory plantation plan.
- Maintain greenbelt along riverbanks post-construction.
- Responsibility: Contractor & RUDA Landscape Team
- Monitoring: Tree logbook, survival rate of plantations

ECoP-15: Grievance Redress Mechanism (GRM)

Objective: Address stakeholder complaints effectively and transparently.

Guidelines:

- Set up GRM desks at project offices and construction camps.

- Acknowledge complaints within 3 days; resolve within 15 days.
- Record all grievances and corrective actions taken.
- Include women and marginalized groups in GRM access.
- Responsibility: RUDA Social Team
- Monitoring: GRM database, resolution rate

Annex:5 EMP-PPEs Cost

Table-Annex- 5 EMP-PPEs Cost

Sr. #	PPE Item	Estimated Quantity (3 Years)	Unit Cost (PKR)	Total Cost (PKR)	Remarks
1	Safety Helmets (EN 397)	1500	4000	6,000,000	Long-lasting, 1 per worker + 10% buffer
2	High-Visibility Vests	5,000	1,500	7,500,000	2- 3 vests per worker over 3 years (replaced every 18 months)
3	Safety Goggles (Reusable)	1,500	500	750,000	Includes replacements and damage over time
4	Ear Plugs/Muffs	1,200	400	480,000	Reusable but may need partial replacement
5	Dust Masks (Disposable)	30,000	250	7,500,000	Frequent replacement for 300 workers
6	Safety Gloves (Monthly)	36,000	300	10,800,000	Monthly replacement assumed
7	Safety Boots	1,500	4,500	6,750,000	Durable but replaced after 18–24 months
8	Fall Protection Harness Sets	300	18,000	5,400,000	For height workers only
9	Face Shields	300	1,500	450,000	Includes replacements
10	Flame-Resistant Clothing	500	6,000	3,000,000	For hot work teams (3 sets/worker for 3 years)
11	Rain Suits (Reusable)	500	1,800	900,000	Not required for all the workers at all time
12	Harness Anchor Points	30	12,000	360,000	Reusable, no change
	Sub-total-1	—	—	49,890,000	From item 1-
13	Contingency (10%)	—	—	4,989,000	Covers turnover, losses, damage
	★ Total PPE Cost for 3 Years	—	—	54,879,000	For inclusion in the EMP implementation budget

Annex:6 Survey Checklist

ISSUES	None	Minor /Small	Moderate /Medium	Significant /Large	Mitigation Measures/Further Actions
A. Zoning and Land Use Planning					
1. Will the project affect land use zoning and planning or conflict with prevalent land use patterns?				✓	✓
2. Will the project involve significant land disturbance or site clearance?				✓	✓
3. Will the project land be subject to potential encroachment by urban or industrial use or located in an area intended for urban or industrial development?				✓	
B. Utilities and Facilities					
4. Will the project require the setting up of ancillary facilities?			✓		
5. Will the project make significant demands on utilities and services?				✓	
6. Will the project require significant levels of accommodation or service amenities to support the workforce during construction (e.g., contractor will need more than 20 workers)?				✓	
C. Water and Soil Contamination					
7. Will the project require large amounts of raw materials or construction materials?				✓	
8. Will the project generate large amounts of residual wastes, construction material waste or cause soil erosion?				✓	
9. Will the project result in potential soil or water contamination (e.g., from oil,		✓			

grease and fuel from equipment yards)?					
10. Will the project lead to contamination of ground and surface waters by herbicides for vegetation control and chemicals (e.g., calcium chloride) for dust control?	✓				
11. Will the subproject lead to an increase in suspended sediments in streams affected by road cut erosion, decline in water quality and increased sedimentation downstream?		✓			
D. Noise and Air Pollution Hazardous Substances					
15. Will the project increase the levels of harmful air emissions?			✓		
16. Will the project increase ambient noise levels?	✓				
E. Fauna and Flora					
18. Will the project involve the disturbance or modification of existing drainage channels (rivers, canals) or surface water bodies (wetlands, marshes)?				✓	
19. Will the project lead to the destruction or damage of terrestrial or aquatic ecosystems or endangered species directly or by induced development?			✓		
F. Destruction/Disruption of Land and Vegetation					
21. Will the project lead to unplanned use of the infrastructure being developed?	✓				
22. Will the project lead to long-term or semi-permanent destruction of soils in cleared areas not suited for agriculture?			✓		
G. Cultural Property					
28. Will the project have an impact on archaeological or			✓		

historical sites, including historic urban areas?					
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Annex:7 Socio-Economic Survey Form

1. Distance to Key Services:
 - o School: 1 km | Health Facility: _____ km | Public Transport: _____ km
2. Recent Flood or River Erosion Impact? Yes No
 - o If yes, year and damages: _____
3. Does the household fall in any vulnerable category?
 - Female-Headed Widow Disabled Member Below Poverty Line

F. Health & Sanitation

1. Have you or family experienced any waterborne diseases in the last year?
 - Yes, specify: _____ No
2. Where do you dispose of household waste?
 - Proper disposal Nearby open land River/canal Burn it
3. What are the most common health issues in your area?
 - Diarrhea Respiratory Skin diseases Dengue/Malaria None

G. Natural Resource Dependency

1. Do you rely on the river for any of the following?
 - Fishing Sand Extraction Washing Drinking Water Agriculture Irrigation
2. How often do you or your family go near the riverbank?
 - Daily Weekly Occasionally Never
3. Have you experienced floods in the past 10 years? Yes No
 - If yes, years: _____ | Severity: Minor Moderate Severe
4. What was the main damage caused?
 - House Crops Livestock Business Roads None

G. Awareness & Feedback

1. Are you aware of the upcoming river training project? Yes No
2. Do you have any concerns?
 - o _____
 - o _____
 - o _____
3. Suggestions for improvement or support:
 - o _____
 - o _____
 - o _____
4. What do you think are the top 3 environmental problems in your area?
 - o _____
 - o _____
 - o _____