

# **POLLUTION SOURCE IDENTIFICATION STUDY FOR ECOLOGICAL RESTORATION OF MANCHAR LAKE**

## **(TERMS OF REFERENCE FOR CONSULTING SERVICES)**

### **Activity Reference No: PK-POSID-401757-CS-CQS**

#### **Background and Introduction:**

1. Sindh Flood Emergency Rehabilitation Project aims to rehabilitate infrastructure that was damaged by the 2022 floods and provide short-term livelihood opportunities to affected residents. In the long term, the project is aimed to build Sindh province's capacity to respond to the impacts of climate change and natural disasters. The project is also aimed to rehabilitate damaged infrastructure adopting a build-back-better approach to make it more resilient to disaster and climate impacts. This includes repairing irrigation, drainage, and flood protection infrastructure to restore agricultural production and make it more climate resilient. It will also support the reconstruction of road networks and support improvements to make the roads more climate-resilient and safer for pedestrians and commuters. The project will also fund the repair and upgrading of water supply and sanitation infrastructure damaged by the floods in selected districts. Water infrastructure will be upgraded to provide safe, treated water for residents and street drainage will be built for stormwater. The project will help make Sindh's institutions more resilient and responsive in future disasters. The project will also improve government capacity to plan, coordinate, and implement disaster management and disaster recovery activities.

2. The Sindh Flood Emergency Rehabilitation Project, financed by the World Bank, also aims to address various critical issues related to the Manchar Lake in Sindh province, Pakistan. Lake Manchar, the largest natural freshwater lake in Pakistan, is facing significant environmental degradation and ecological challenges. The lake, which is vital for local communities' livelihood and biodiversity, has been adversely affected by factors such as reduced freshwater inflow, increased salinity, pollution, and the inflow of sewage and drainage water. These challenges have resulted in a decline in water quality, marine life, and the overall aquatic ecosystem. Additionally, the lake's importance as a stopover for migratory birds and its role in irrigation has been compromised. Under SFERP, several steps are being taken in plugging the breaches which had taken place during the 2022 floods besides several steps being taken for improvement of the hydrology of the lake and the water coming in and out of the Lake. However, there is a dire need to trace the origins of pollution, and to assess the pollution load of those sources contributing to lake water contamination and to look into the aquatic health of the lake as well so that the ecosystem of the Lake could be revived and the livelihood of the people benefiting from the lake could again thrive.

#### **Manchar Lake:**

3. Manchar Lake, the biggest shallow lake has a depth ranging from 0.5 meters to 3.75 meters. It is a natural reservoir of Pakistan, which is located at 67° 3 - 67° 43 E and 26° 23 - 26° 28 N, in Jamshoro District, Sindh province. This lake is a substantial natural depression bordered by the Kirthar Hills in the west, Lakki hills in the south, flood barriers in the north and the northeast, and the Indus River in the east. The lake was originally fed by two sources i.e., storm water and hill torrents from Kirthar mountains and inundation canals from the Indus, namely Aral Wah and Danister Wah. A third inlet, the Main Nara Valley (MNV) drain was added in 1932, originally as an inundation canal but later remodeled to take wastewater from towns of upper Sindh. With the construction of MNV drain, degradation of Manchar lake started as water quality of the lake got contaminated.

4. Manchar lake has been famous for its flora and fauna. Such a large natural body of fresh water is a major resource in an arid region. The lake has been substantially supporting various economic activities like, livelihood for a

half million anglers, and irrigation water for various crops and aquatic plants including lotus. If it was maintained properly, it could contribute a lot in boosting up tourism industry. The lake has also been home to thousands of Siberian migratory birds. Its fish has been the main food for these birds. The natives of Manchar Lake, locally called Mohanas (angler or fishermen) reside in boats within the Lake and at its banks as well. There are now only 4,000 to 5,000 people living on the lake, compared to 20,000 back in the 1980s. Many boat people have been forced to sever their ties with the lake and move onto the embankments. In winters, it rains and their children die of cold. In the summers, they die in their swings. They have no village. They don't get any tanker of clean water. They have no doctor to take their children to. They have so many children but they have no schools to educate them. With no education or way to earn a living apart from fishing, the once prosperous and proud community now lives in poverty.

### **Degradation of the Lake:**

5. The degradation of Manchar Lake's water quality began with the construction of Main Nara Valley (MNV) drain. Disposal of untreated agricultural wastewater through MNV drain has contaminated water quality of the lake. Sediments coming along with hill torrents accumulate and contaminate the Lake. Heavy metals also enter the lake and are finally deposited in the sediments.

6. The water is no longer drinkable. The pollution has killed off flora and fauna and it has become impossible to grow vegetables in the toxic soil. The water in the Lake is highly contaminated, it stinks. When there was clean water at Manchar, there was ample fish, birds, and the prosperity. Over the years, the fish stock has plummeted. The fish catch has decreased drastically, above that whatever fish is caught is contaminated. A series of drains and canals have been built to carry municipal wastewater discharge from several major cities in Sindh, and overflow from rice paddies full of pesticides and fertilizers to the lake. The slow death of Manchar Lake has been caused by pollutants from the Right Bank Outfall Drain 3 and Main Nara Valley Outfall Drain (RBOD 1) constructed by Water and Power Development Authority (WAPDA).

7. A large number of studies / research have been carried out by academia, NGOs and research institutions. Large number of local and international media has also reported extensively on the condition of the Lake and in most of the studies, it has been emphasized that there is need to control the entry of pollution in the Lake.

8. Some of the excerpts of various studies, highlighting the need for checking the pollution at the source are written hereunder;

- i. *"Therefore, this lake water ecosystem's maintenance requires establishing an appropriate mandatory systematic monitoring system, continuous supply of freshwater through alternate sources, and **prompt government actions to prevent or reduce the risk of further contamination by managing and regulating** the sources contributing to pollution in this critically important lake."*
- ii. *"It is imperative to install an effective and efficient water quality monitoring network and manage it properly; the day-by-day worsening of the lake's quality demands a quick remedy."*
- iii. *"Overall, the results suggest that there is a need to manage and regulate the toxic pollutants entering the Manchar Lake, mainly from agricultural runoffs and urban domestic waste discharges, entering the lake through MNVD."*

9. All of the above recommendations suggest that the study, which we intend to carry out, is probably very much needed that might bring positive changes in the health of the Lake.

## SCOPE OF WORK

10. The objective of the study is to assess the pollution load and tracking the point and possibly non-point sources of pollutants entering into Manchar lake through various primary, secondary and tertiary drains / tributaries to develop a decision tree that considers appropriate methods to define sources to a level at which remedial actions can be defined, prioritized and tested on pilot basis. The primary, secondary and tertiary drains, for the purpose of this document, can be defined as under;

- i. **Primary Drains:** Primary drain or a set of drains are those drains, where the pollution enters from the source of its generation.
- ii. **Secondary Drains:** Secondary drain or a set of drains are those drains, which convey the polluted water and carry to the tertiary drains.
- iii. **Tertiary Drains:** Tertiary drains are those drains, which dump the water into Manchar Lake

### Literature Review:

11. Numerous research papers, articles, reports have been written by national and international academia, media, research institutions, NGOs and the Government Departments. The Consultant should access to all the relevant research, articles and reports on the subject at least of the last 20 years and examine as under;

- i. Prepare a holistic picture of the condition of the Lake with respect to the pollution present such as biological, chemical, heavy metals etc. and changes observed in it over the years.
- ii. Carry out the trend analysis and plot on the graphs and charts showing the changes observed so far and predict the expected changes in the future, if the trend of increase in pollution remains unchanged.
- iii. Define the historical spatial and temporal changes in the condition of the lake with reference to the pollution.
- iv. Identify all sources of water i.e., drains, canals, and runoffs entering the Lake and identify the levels of pollution entering from these sources.
- v. Study the hydraulic profile of the Lake and prepare their impact on the Lake with respect to the concentration of the pollution from these sources.
- vi. The adverse effect, which these pollutants have caused over the time, may be enlisted. These effects may be, but not limited to this, the drinking water problems, agricultural productivity, biodiversity such as decreased abundance of the Siberian migratory birds, flora and fauna, decrease in tourism, spread of water related infections and diseases, and gender related issues.
- vii. The data of the pollution in the Lake as well as primary, secondary and tertiary drains should be enlisted and analyzed independently.
- viii. Accumulation of pollutants in the lakebed sediments may also be assessed.
- ix. The data should be revalidated with the latest sampling and disseminated with the historical record that would be compiled by the Consultants after literature review.

### Review of Regulatory Framework:

12. The consultants shall access all the relevant regulatory framework available with the Government of Pakistan, as well as with the Sindh Government relating to water management, municipal utilities frameworks, liquid and solid waste management, water shed management, industrial waste management, regulatory framework for use of agricultural chemicals, pesticides and any other regulation, law, act of parliament related to water, climate, environment etc. which can directly or indirectly affect the pollution level in Manchar Lake. The consultants shall also review local, national and international legal frameworks being enforced to reduce the pollution levels in Manchar Lake. After accessing the aforesaid frameworks, the consultants shall review these frameworks with following objectives;

- i. Analyze its enforcement status with the prime motive of improving the quality of Manchar Lake.
- ii. Identify the shortcomings and gaps for having innovations in these as well as challenges in their enforcement.

- iii. Propose changes for an improved enforcement process.
- iv. Prepare and submit the draft for new legislations, if needed.
- v. Suggest the mechanisms for implementation of the existing mechanism, if found discrepant.

#### **GIS mapping and Reconnaissance:**

13. It would be imperative to study the hydrology of the region and determine the catchment of the Lake. The objective of reconnaissance and site assessment is to conduct an effective and comprehensive review through the field work to develop land use map depicting natural resources, human activities, built up areas including industrial and agricultural activities, canals and drains and other features dominating the lake and the surrounding area which might have an impact on water quality of the lake. For this purpose, the consultants shall;

- i. Obtain horizontal and vertical datum of the Survey of Pakistan and plot the catchment area of Manchar Lake by defining the exact geographical boundaries of the area being drained into the Manchar Lake. These boundaries should not only be limited to the ground slopes, rather should also include all the drains and canals and rivers etc. emanating from outside the said natural slopes of the ground.
- ii. Determine the best possible routes to reach these drains and map the tracks for future reference.
- iii. Carry out the reconnaissance of the entire catchment area and plot all drains, canals, rivers and other water bodies existing within the catchment area of the Manchar Lake.
- iv. The mapping of all the drains, canals, rivers and water bodies should be GPS enabled.
- v. Identify all primary, secondary and tertiary drains and map them.
- vi. Plot all landmarks available in the catchment of Manchar Lake, such as roads, jeep tracks, towns, villages, religious buildings, schools, woods, industries and agricultural fields etc.
- vii. Measure the quantity of water in every drain.
- viii. Based on the site surveys and maps, the consulting firm is required to identify all the primary, secondary and tertiary drains, tributaries which directly or indirectly are potential source of contamination of Manchar Lake.
- ix. The consulting firm is to identify and track all point and non-point sources (including but not limited to industrial, municipal and agricultural sources entering directly or through secondary or tertiary drains/ tributaries into Manchar Lake.
- x. The Consulting firm is required to define and name all of these point sources with estimated source discharge. The study will determine the volume of sewage, industrial and agricultural discharges flowing into Lake Manchar.
- xi. The consultant will determine the quality of industrial and agricultural effluents in accordance with the National Environmental Quality Standards.
- xii. The consultant will assess the extent to which these discharges contribute to water pollution and evaluate their compliance with environmental regulations and standards.

#### **Water Quality Characteristics:**

14. The Consultant shall develop a comprehensive pollution assessment sampling and laboratory analysis plan including primary, secondary, and tertiary drains, tributaries, Manchar lake, and all water bodies in the vicinity. These sampling protocols and analysis needs to be selected on scientific basis as to ensure adequate spatial and temporal representation and ability to statistically analyze to the extent possible.

15. Historical data, potential contamination sources, land use characteristics and hydrological features and site accessibility should all be considered when determining the sampling locations. Another important factor to consider while selecting location of samples is presence or absence of potential contamination sources. A maximum of three samples are considered on each identified tributary/drain one is at point source, one at upstream and one sample location to be selected downstream.

16. In addition to the above supplemental sampling locations may need to be added during the duration of the sampling period.

**Sediment Quality Characteristics:**

17. The consultants shall examine the pollutants embedded/hidden in the bed of the lake, which are concealed sources of lake pollution which get surfaced when the flood water stirs the lakebed and increases the pollution levels of lake water.

**Hydrological Assessment:**

18. Consulting firm will conduct hydrological studies to understand the lake's water balance, including inflows, and outflows. Additionally, it will evaluate the contribution of small streams from the Kirthar Mountains, canal water, and monsoon rainfall to the lake's water inflow. The goal is to understand the lake's hydrology and the factors affecting its water levels.

**Assess the impact of anthropogenic activities on Manchar Lake:**

19. The study will investigate how the man-made development activities including hydropower development, water storage structures, diversions etc. influence the water levels, flows, and overall hydrological dynamics of the lake. It will consider both the positive and negative implications, including potential benefits in terms of increased water availability during dry periods and the potential risks associated with altered water regimes.

**Efficiency of Irrigation and Drainage Systems:**

20. The study will assess the efficiency of the existing irrigation and drainage systems connected to Lake Manchar. It aims to evaluate the effectiveness of water distribution for agricultural purposes and identify areas where improvements can be made to reduce the diversion of saline water into the lake. For this purpose, the consultant shall;

- i. Evaluate the current irrigation and drainage systems in the catchment area of Lake Manchar.
- ii. Assess the distribution of freshwater resources to agricultural lands.
- iii. Identify areas where water is being diverted from the lake for irrigation and drainage.
- iv. Analyze the impact of these diversions on the salinity levels of Lake Manchar.
- v. Propose recommendations for optimizing water management practices and improved drainage to maintain the lake's ecological balance.

**Saline Water Diversion Assessment:**

21. The study will investigate and quantify the sources and volumes of saline water diversion into Lake Manchar. It aims to understand the extent to which saline water inflow is contributing to the degradation of water quality in the lake. The consultant shall;

- i. Identify and map the sources of saline water inflow into Lake Manchar, including agricultural runoff, as well as domestic and industrial discharges.
- ii. Measure and quantify the volume of saline water entering the lake from various sources.
- iii. Analyze the impact of saline water influx on the lake's salinity levels and aquatic ecosystem.
- iv. Suggest salinity management measures to reduce or mitigate saline water diversion into Lake Manchar

**Model for Evaluation of Water Pollution:**

22. As a result of all above assessments, the Consulting firm is required to use remote sensing and GIS technology to develop a cartographic model to identify water contamination sources of Manchar Lake.

**Community Engagement and Consultations with Stakeholders:**

23. Consulting firm shall identify the relevant primary and secondary stakeholders and conduct two rounds of consultations during the study period. One consultation is expected at the initial phase of the project to incorporate communities and stakeholders views and inputs on the protection and restoration of lake. Second consultation is expected at the end of the study period to get inputs on the outcomes and recommendations of the study.

**Outcomes and Recommendations:**

24. As an outcome of the surveys, analysis and assessment under the given scope, the Consulting firm is expected to provide recommendations as below;

- i. **Nature-Based Solutions:** Evaluate and recommend nature-based solutions for water pollution control, such as wetlands restoration, riparian buffer zones, and vegetative filter strips. b. Assess the ecological restoration potential of these solutions and their effectiveness in reducing pollution.
- ii. **Technical Solutions:** a. Explore and propose technical measures for wastewater treatment and pollution control, including the feasibility of constructed wetlands, wastewater treatment plants, and best management practices.
- iii. Consider innovative technologies that can be applied to **reduce** pollutant discharges from industrial and municipal sources.
- iv. **Policy and Regulatory Recommendations:** Review existing environmental regulations and policies related to water pollution in Pakistan. Provide recommendations for strengthening or enhancing regulatory measures to control and mitigate water pollution at source.
- v. **Prioritization and Pilot Feasibility:** Based on above mentioned recommendations, the Consulting firm is required to prioritize the list of best possible recommendations/solutions based on technical and financial viability to reduce or minimize the pollutant load of Manchar and those can help to restore the ecology of the lake.

Consulting firm is required to conduct a detailed technical and financial feasibility of one intervention to pilot.

**Key Staff:****Time Period:**

25. The time period for the consultancy services is twelve (12) Months.

**Reporting Requirements:**

The consultant shall provide the following deliverables as per schedule agreed upon subsequently between the PIU and the consultants subject to completing the entire assignment within the stipulated time of twelve months.

Sr. No	Deliverables	Schedule Of Deliverables
1	Inception Report	Within 15 days
2	GIS mapping	Within 2 months
3	Sediment Quality Report	Within 2 ½ months
4	Hydrological Assessment	Within 3 ½ months
5	Impact of Anthropogenic Activities	Within 4 months
6	Efficiency of Irrigation and Drainage Systems	Within 5 months
7	Saline Water Diversion Assessment	Within 5 ½ months
8	Model for Evaluation of Water Pollution	Within 6 months
9	Identification and Prioritization of Solutions	Within 8 month
10	Development of Pilot Solution Project	Within 12 months

In addition to above reporting requirements, the Consultant shall submit the monthly and quarterly Progress Reports, which shall be examined and reviewed by the Client

**Qualifications of Firm:**

- The consultants should be registered and working in similar business for last ten (10) years.

- They have completed a minimum of Three (03) of similar assignments of the same scale and complexity.
- They should have adequate logistical capabilities.
- The consultants are expected to deploy staff who are appropriately educated and experiences to undertake the assignment.

S/No	Position	Qualification	Man Months	Experience
1	Team leader	PhD / M.Sc. in Civil / Environmental Engineering / Sciences	06	PhD with 5 years or M.Sc. with 10 years relevant experience
2	Water Quality and Environmental Expert	PhD / M.Sc. in Civil / Environmental Engineering / Sciences	05	PhD with 3 years or M.Sc. with 10 years relevant experience
3	Hydrology Expert	M.Sc. / B.Sc. Engg. (Civil / Mechanical)	03	M.Sc. with 05 years or B.Sc. with 8 years relevant experience
4	Natural Resource Management and Policy Expert (ffice)	M.Sc. /B.Sc. (Environmental Engineering/ Sciences)	03	M.Sc. with 05 years or B.Sc. with 8 years relevant experience
5	Gis and Remote Sensing specialist	M.Sc. / B.Sc. Computer Sciences	06	M.Sc. with 05 years or B.Sc. with 8 years relevant experience
6	Water Quality and Environmental Expert	M.Sc. /B.Sc. (Environmental Sciences)	06	M.Sc. with 05 years or B.Sc. with 8 years relevant experience

In addition to the subject experts, the consultants shall also deploy appropriate number of non-key (field , admin support staff etc) for undertaking the task.

## SELECTION PROCESS

A consulting firm will be selected in accordance with the Consultant Qualification Selection (CQS) method as set out in the "World Bank Procurement Regulations for IPF Borrowers Goods, Works, Non-Consulting and Consulting Services Fourth Edition", November 2020.