

Environmental Impact Assessment

July 2017

PAK: Jalalpur Irrigation Project

Project No. 46528-002

Part 6 of 9 of the Main Report

Prepared by Irrigation Department, Government of Punjab for the Asian Development Bank (ADB).

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**Irrigation Department
Government of Punjab**

DETAILED DESIGN OF JALALPUR IRRIGATION PROJECT

**ENVIRONMENTAL IMPACT ASSESSMENT
(EIA)**

MAY 2017



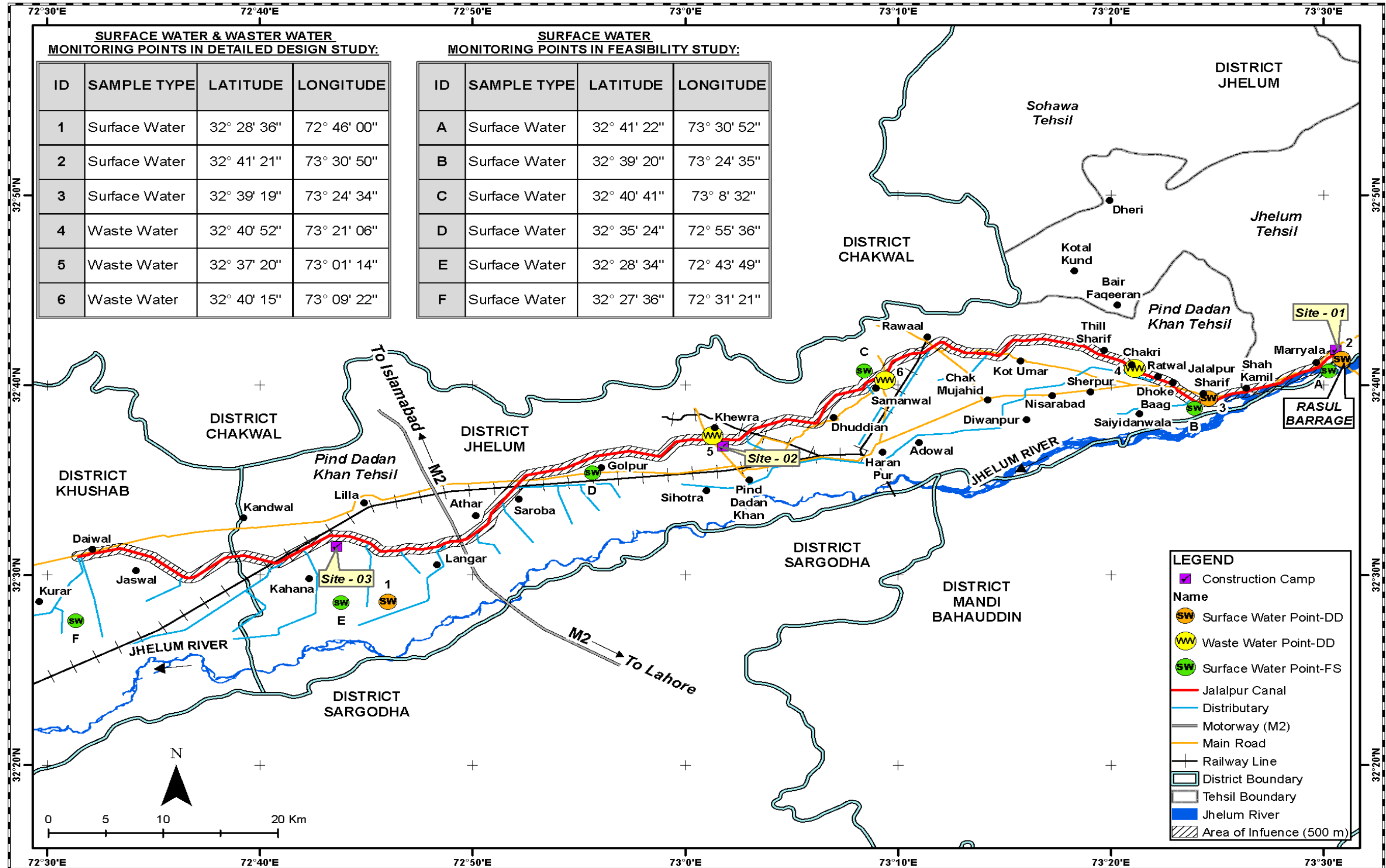


Figure 6.19: Surface water and Wastewater Sampling Points at Feasibility and Detailed Design Stage

d. Wastewater Quality

253. Wastewater sampling was carried out at the detailed design stage from the settlements within the project's AOI in order to assess the level of contamination prior to construction of the proposed project. The results for wastewater sampling were compared with the PEQS for Municipal and Liquid Industrial Effluents, limiting values of the corresponding parameters. Refer Figure 6.21 for wastewater sampling locations. A summary table depicting testing results of wastewater samples collected in winter is provided in **Table 6.14** below;

Table 6.14: Wastewater Quality Analysis Results

Sr. No.	Parameter	Unit	Sahuwal	Chakri Karam Khan	Near ICI Soda Ash Plant Khewra	PEQS into Inland Waters
1	Temperature	°C	29.0	29.0	27.5	≤ 3°C
2	pH	---	7.42	8.02	7.20	6-9
3	COD	mg/l	130	138	93	150
4	BOD ₅	mg/l	76	62	42	80
5	TDS	mg/l	680	1124	984	3500
6	TSS	mg/l	74	148	72	200
7	Oil & Grease	mg/l	2.5	4.2	BDL	10
8	Chromium (Hexa & Trivalent)	mg/l	0.18	0.32	0.28	1.0
9	Sulphate (SO ₄ ²⁻)	mg/l	136	286	246	600
10	Iron (Fe)	mg/l	2.45	2.8	1.62	8
11	Chlorine (Cl ₂) Free	mg/l	0.15	0.12	0.05	1.0
12	Fluoride (F ⁻)	mg/l	3.2	2.1	2.24	10
13	Chloride	mg/l	218	384	358	1000
14	Ammonia (NH ₃)	mg/l	12.5	19.5	18.4	40
15	Cadmium (Cd)	mg/l	0.02	0.01	0.02	0.1
16	Lead (Pb)	mg/l	BDL	BDL	BDL	0.5
17	Arsenic (As)	mg/l	0.02	0.21	0.14	1.0
18	Copper (Cu)	mg/l	0.34	0.48	0.24	1.0
19	Barium (Ba)	mg/l	BDL	BDL	BDL	1.5
20	Selenium (Se)	mg/l	0.01	BDL	BDL	0.5
21	Silver (Ag)	mg/l	BDL	BDL	BDL	1.0
22	Pesticides	mg/l	0.02	0.09	0.06	0.15
23	Manganese (Mn)	mg/l	BDL	BDL	BDL	1.5
24	Zinc (Zn)	mg/l	2.8	2.2	2.5	5.0
25	Nickel (Ni)	mg/l	BDL	BDL	BDL	1.0
26	Boron (B)	mg/l	BDL	BDL	BDL	6.0
27	Mercury (Hg)	mg/l	BDL	BDL	BDL	0.01
28	Total Toxic Metals	mg/l	0.23	0.54	0.44	2.0
29	Sulphide (S ²⁻)	mg/l	BDL	BDL	BDL	1.0
30	An Ionic Detergent as MBAS	mg/l	BDL	BDL	BDL	20
31	Phenolic Compounds (as phenol)	mg/l	BDL	BDL	BDL	0.1
32	Cyanide (as CN ⁻) total	mg/l	BDL	BDL	0.08	1.0
33	Dissolved Oxygen	mg/l	3.4	5.5	3.2	-
34	Aluminum	mg/l	BDL	BDL	BDL	-
35	Antimony	mg/l	BDL	BDL	BDL	-
36	Turbidity	mg/l	3	4	2	-

37	Nutrient as (K)	mg/l	0	0.02	0.009	-
38	Nutrient as (N)	mg/l	0.01	0.009	0.02	-
39	Nutrient as (P)	mg/l	0.04	0.02	0.04	-
40	Total Coliform	MPN/100 ml	152	192	142	-
41	Fecal Coliform	MPN/100 ml	84	128	62	-

BDL= Below Detection Limit

254. All the above parameters for wastewater testing are in the range of PEQS permissible limit values.

e. Groundwater Quality

255. Groundwater is relatively brackish in nature and contains more salts than the surface water. In such situations, a salinity problem of considerable magnitude can arise when irrigation is done with ground waters of poor quality.

Review of Previous Water Quality Studies³:

256. In order to assess the groundwater quality of project area, water quality surveys were carried out by different agencies and Consultants in different periods as mentioned below:

- Water Quality Surveys by WAPDA – 1977;
- Hydrogeological Investigation in Eastern Drainage Basin, Potwar Plateau, Punjab by WAPDA, GWI Report Nov. 1981; and
- Water Quality Survey by NDC, 1992.

Shallow Water Quality Survey by WAPDA, 1977:

257. A water quality survey was conducted by WAPDA during 1977 and collected water samples from seven (7) open wells and one (1) tube well. Water samples were also collected within a depth of 10 feet (3 meters), where possible at the soil sampling sites.

258. Detailed chemical analysis of the water samples was done in respect of suitability criteria of WAPDA for Total Dissolved Salts (TDS), Sodium Adsorption Ratio (SAR) and Residual Sodium Carbonate (RSC). The data indicate that only 10.8 percent area (8231 ha) was useable, 3.4 percent area (2,590 ha) was marginal and remaining 85.8 percent area (65,393 ha) having hazardous water.

Water Quality Survey by Hydrogeological Directorate of WAPDA 1981:

259. Hydrogeological Directorate of WAPDA carried out water quality surveys in Eastern Drainage Basin, Potwar Plateau, Punjab in 1981. Water samples were collected from 10 open wells for quality assessment.

260. According to the survey, the area of use-able and marginal quality water encompass jointly 27 percent while the rest of 54 percent of the project area is classified as hazardous water quality, which is unfit for irrigation purposes. The remaining 19 percent of the Jalalpur canal project area is not surveyed by Hydrogeological Directorate, WAPDA.

³ Source: Soil & Water Quality Studies Report, Jalalpur Irrigation project, NESPAK-ICS JV, November 2014

Water Quality Survey by NDC – 1992:

261. In order to study the change in ground water quality due to recharge of groundwater, rains and floods, a survey was conducted in November 1992, taking the WAPDA data on base map. Water samples were collected from open dug wells, hand pumps and tube wells operating at the time of survey in different quality zone of project area.

262. Majority of area (77.5 percent) is underlain with brackish (hazardous) water and is unfit for irrigational uses. Useable water (14.3 percent) can be used extensively in the project area without any danger of development of salinity/sodicity problems. The marginal quality area (8.2 percent) would, however, require careful management before it is put to agricultural activities.

Water Quality Studies by NESPAK - ICS Joint Venture Consultants November 2014⁴:

263. In order to update the groundwater quality of the project area, some 200 water samples were collected from different sources. These samples were tested for (EC) by the portable EC meter in the field.

264. Out of these 200 samples, 19 water samples were selected and sampled for detailed chemical analysis from the laboratory for the following determinations:

- pH and EC mS/cm at 25°C;
- Total Dissolved Solids (TDS) in ppm;
- Cations and Anions in milliequivalent/liter (me/l);
- Sodium Adsorption Ratio (SAR);
- Residual Sodium Carbonates (RSC) in me/l; and
- Boron in ppm and Chloride in me/l.

265. The ground water quality was assessed for irrigation purpose by evaluating the parameters of salinity, sodicity, toxicity and heavy metals by using the WAPDA Water Quality Standards.

Salinity:

266. The water quality data indicate that 12 % (9,137 ha) of the project area have useable category water. The useable quality data is represented by 42 tube wells and 23 hand pumps tested in the field during water quality survey. Out of these, only 8 tube wells were analysed in detail in the laboratory. Their Electric Conductivity (EC) values range from 375 to 1,350 dS/cm at 25°C and corresponding TDS value varies from 273 to 945 ppm. The useable quality water can be used extensively without any danger of development of salinity/sodicity problem in the project area.

267. As per water quality survey, seven % (5,289 ha) of the project area have marginal quality water. About 17 tube wells and 13 hand pumps fall in the marginal quality water areas which were tested in field. Out of 17 tube wells, 5 tube wells were selected for detail analysis from the laboratory. The EC and TDS values of these tube wells water are ranging from 1,820 to 2,840 μ S/cm at 25°C and 1,274 to 1,988 ppm, respectively. The marginal quality water would, however, require careful management before it is put to agricultural use. The mixing of marginal quality ground water with good quality surface water in such proportion that the quality of the resultant water falls within the permissible limits of usability.

⁴ Source: Soil & Water Quality Studies Report, Jalalpur Irrigation project, NESPAK-ICS JV, November 2014

268. The remaining 81 % (61,787 ha) of the project area is underlain with hazardous groundwater quality which is unfit for irrigation purposes. According to water quality survey, 10 tube wells, 37 hand pumps and 3 open wells fall in the hazardous quality water areas which were checked in the field for EC by the EC meter. Of these, 2 tube wells and 4 hand pumps water were selected for detailed analysis from the laboratory. The EC and TDS values range between 3,300 to 1,1360 $\mu\text{S}/\text{cm}$ at 25°C and 2,310 to 7,952 ppm, respectively.

Sodicity:

269. The sodicity or alkali hazard of groundwater quality is indicted by SAR. It refers to the relative proportion of Na^+ to Ca^{+2} and Mg^{+2} in the groundwater. As per the test results most of the water samples are well below 10. Thus, as per WAPDA standards, most of the samples are safe for irrigation use except four water samples whose SAR values range from 13.7 to 26.2 and is classed as marginal to hazardous quality water.

270. The RSC is also an index of sodicity and measure of excess quantity of carbonate and bicarbonate ions compared to calcium and magnesium. In most of the water samples RSC value is negative or less than 0.7 me/l. Thus, in most of the cases water quality from sodicity viewpoint is good.

Toxicity:

271. Certain salts are essential for plant growth if in minute quantities, but can cause toxicity when the quantity exceeds safe limits. The degree of damage depends on uptake and crop sensitivity.

272. It is evident that out of 19 groundwater samples tested for toxic elements, most of the samples have boron from 0.16 to 0.59 ppm, while remaining 6 samples have from 0.86 to 0.97 ppm. According to the WAPDA standards for irrigation water, the former are of good quality, while the latter are of marginal quality.

273. The chloride content of 9 water samples have 0.1 to 2.0 me/l, which is safe as per criteria. Chloride content of 4 water samples varies from 7.1 to 9.00 me/l and is classed as marginal quality. The chloride content of remaining 6 water samples ranges from 10.6 to 65.00 me/l and is classed as unsuitable quality.

274. During the EIA study at the project preparatory/feasibility stage, the study team has conducted sampling and testing of ground water in late summer from different locations. (Refer **Appendix-III**). All the samples were collected as grab samples and after being labeled and preserved they were transported to the laboratory in Lahore for testing. These samples were tested against the twenty one parameters and compared with NEQS and FAO standards in relevant section.

275. Ground water sampling was executed in three categories at the project preparatory/feasibility stage in late summer. However at the detailed design stage two more categories were added for water sampling in winter which were devised on the basis of water usage. Explanation of categories is as follows:

- **Category-1:** This category was formed to check water quality of hand pumps installed near river bank for drinking purpose;
- **Category-2:** This covers those tube wells whose water is being used only for agriculture purpose; and
- **Category-3:** This category was devised to check the ground water quality used for household purposes or either drinking near streams carrying wastewater or located near industrial activities.

- **Category-4:** This category was devised to check the ground water quality at the proposed construction camp locations potentially to be used by labourers for drinking and other purposes during construction; and
- **Category-5:** This category was devised to check the ground water quality of natural springs in the project's AOI used for drinking and other purposes.

276. Locations of the water samples collected are shown in **Figure 6.20**. The summary of results for all Category-1 samples collected in late summer are given in **Table 6.15** below;

Table 6.15: Summary of Summer Monitoring Results for Category-1 Samples

Sr. No.	Parameter	Units	Sampling Locations				NEQS
			Bugga Sharif	Sahotra	Dewan Pur	Shah Kamil	
1.	pH	-	7.16	7.28	8.14	8.21	6.5-8.5
2.	Color	Pt-Co	25	39	23	4	15 (TCU)
3.	Taste	mg/L	Salty	Salty	Tasteless	Tasteless	Acceptable
4.	Odor	mg/L	Odorless	Odorless	Odorless	Odorless	Acceptable
5.	Turbidity	NTU	90	162	10.3	11.6	5
6.	TSS	mg/L	25	35	3	4	NGV
7.	TDS	mg/L	7750	15480	210	370	<1000
8.	Total Hardness	mg/L	1450	4600	164	176	<500
9.	Iodine	mg/L	<0.10	<0.10	<0.10	<0.10	NGV
10.	Ammonia	mg/L	<0.1	<0.1	<0.1	<0.1	NGV
11.	Fluoride	mg/L	0.65	1.40	BDL	BDL	1.5
12.	Nitrate	mg/L	0.4	0.2	1.5	0.6	50
13.	Nitrite	mg/L	0.002	BDL	0.29	0.007	3
14.	Chloride	mg/L	3649	7164	15	32	250
15.	Sulphate	mg/L	560	2000	11	27	400
16.	Sodium	mg/L	1784	2340	8.52	40.05	200
17.	Total Iron	mg/L	3.4	5.4	0.66	0.34	0.3
18.	Zinc	mg/L	<1.0	1.361	<1.0	<1.0	5
19.	Arsenic	mg/L	BDL	BDL	0.05	0.05	0.05
Biological Parameters							
20.	Total Coliforms	MPN/100mL	>23	>23	>23	>23	Nil
21.	Fecal Coliforms	MPN/100mL	>23	>23	<1.1	<1.1	Nil

277. The results given above revealed that the ground water sources near river bank are not of good quality due to presence of microbial contamination. Ground water samples taken from Bugga Sharif and Sahotra also have higher values of turbidity, TDS, total hardness, chloride, sodium, sulphates, and iron than their respective NEQS value. Higher values of sodium and chloride are mainly due to presence of salt range nearby. This is due to the fact that water of these villages is saltish too.

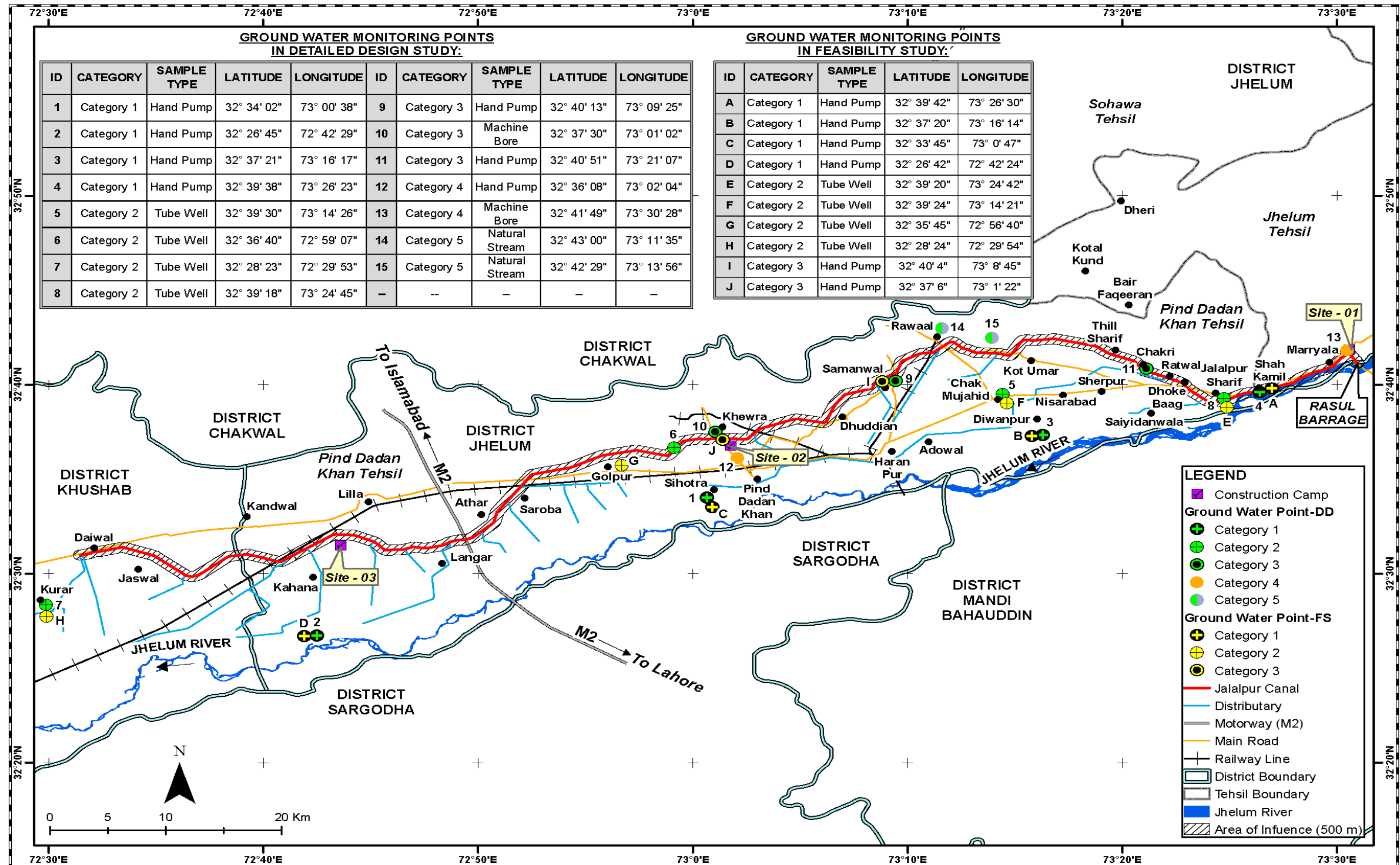


Figure 6.20: Ground water Sampling Points for all Categories at Feasibility and Detailed Design Stage

278. Similarly, the ground water sampling for Category-1 has been carried out from the same or near the above ground water sources in winter at the detailed design stage of the JIP. Locations of the ground water sources sampled in winter are referred in Figure 6.22. The summary of results for all Category-1 samples collected in winter are given in **Table 6.16** below;

Table 6.16: Summary of Winter Monitoring Results for Category-1 Samples

Sr. No.	Parameter	Unit	Dhok Noora	Near Sahotra	Dewanpur	Shah Kamir	PEQS for Drinking Water
1	Temperature	°C	22.5	21.3	20.5	22.0	----
2	pH	--	6.86	7.13	9.6	7.56	6.5-8.5
3	TDS	mg/l	1291	1519	144	399	1000
4	TSS	mg/l	BDL	06	BDL	BDL	---
5	Chloride (Cl ⁻)	mg/l	298	292	34	84	<250
6	Fluoride (F)	mg/l	0.22	0.54	0.04	0.18	≤1.5
7	Taste	Non objectionable/ Acceptable	Object.	Object.	Non object.	Non object.	Non objectionable/Acceptable
8	Odour	Non objectionable/ Acceptable	Non object.	Object.	Non object.	Non object.	Non objectionable/Acceptable
9	Colour	TCU	0	0	0	0	≤15
10	Iron	mg/l	0.05	0.14	0.05	0.09	0.3
11	Sodium	mg/l	198	214	22	68	200
12	Nitrate (as NO ₃)	mg/l	10.5	18.4	3.5	16.3	≤50
13	Nitrite (as NO ₂)	mg/l	BDL	BDL	BDL	BDL	≤3 (P)
14	Ammonia	mg/l	0	0	0	0	1.5
15	Hydrogen Sulphide (H ₂ S)	mg/l	BDL	BDL	BDL	BDL	0.05
16	Sulphate	mg/l	245	264	24	62	250
17	Lead (Pb)	mg/l	BDL	BDL	BDL	BDL	≤0.05
18	Total Hardness as CaCO ₃	mg/l	452	484	52	142	<500
19	Turbidity	NTU	0	0	0	0	<5
20	Zinc (Zn)	mg/l	0.21	0.84	0.12	0.19	5
21	Manganese (Mn)	mg/l	BDL	BDL	BDL	BDL	≤0.5
22	Benzene	mg/l	BDL	BDL	BDL	BDL	10-120
23	Aluminum (Al)	mg/l	BDL	BDL	BDL	BDL	≤0.2
24	Molybdenum	mg/l	BDL	BDL	BDL	BDL	0.070
25	Chromium (Cr)	mg/l	0.02	0.02	0.02	0.02	≤0.05
26	Cadmium (Cd)	mg/l	BDL	BDL	BDL	BDL	0.003
27	Boron (B)	mg/l	BDL	BDL	BDL	BDL	0.3
28	Barium (Ba)	mg/l	BDL	BDL	BDL	BDL	0.7
29	Antimony (Sb)	mg/l	BDL	BDL	BDL	BDL	≤0.005 (P)
30	Arsenic (As)	mg/l	0.003	BDL	BDL	0.003	≤0.05 (P)
31	Cyanide (CN)	mg/l	BDL	BDL	BDL	BDL	≤0.05
32	Mercury (Hg)	mg/l	BDL	BDL	BDL	BDL	≤0.001

33	Nickel (Ni)	mg/l	BDL	BDL	BDL	BDL	≤0.02
34	Total Coliform	Number/100ml	0	16	02	0	0/100 ml
35	E.Coli	Number/100ml	0	04	0	0	0/100 ml
36	Conductivity	μS/cm	1545	2142	188	528	--
37	Bicarbonate	mg/l	176	198	12	34	--
38	Iodine	mg/l	0.2	0.2	BDL	0.03	--
39	Magnesium (Mg)	mg/l	74	82	7	28	--
40	Calcium as (Ca)	mg/l	142	156	21	56	--
41	Phosphate	mg/l	BDL	BDL	BDL	BDL	--
42	Potassium	mg/l	4.5	4.8	3.2	4.1	--
43	SAR Iodine	mg/l	3.36	2.52	1.06	1.85	--
44	Selenium	mg/l	BDL	BDL	BDL	BDL	0.01
45	Copper	mg/l	BDL	BDL	BDL	BDL	2
46	Residual Chlorine	mg/l	BDL	BDL	BDL	BDL	--
47	Phenolic Compounds	mg/l	BDL	BDL	BDL	BDL	0.002

279. In above table ground water samples taken for Category-1 from Dhok Noora and near Sahotra have higher values of TDS, Chloride and Sodium than PEQS limits. Higher values are due to excessive salt present in salt range.

280. Locations of the water samples collected in the project preparatory/feasibility stage in late summer for Category-2 are shown in Figure 6.22. The summary of results for all Category-2 samples collected in late summer are given in **Table 6.17** below;

Table 6.17: Summary of Summer Monitoring Results for Category-2 Samples

Sr. No.	Parameter	Unit	Sampling Locations				FAO Standards
			Kurar	Near Bhelowal	Dhariaia Jalib	Jalalpur Sharif	
1	Conductivity	μs/cm	3410	37750	9070	912	0-3000
2	TSS	mg/L	3	4	3	3	---
3	TDS	mg/L	1370	18670	5510	680	0-2000
4	Chloride	mg/L	560	9495	1849	35	0-1065
5	Sulphate	mg/L	90	825	980	45	0-960
6	Bicarbonate	mg/L	224	300	630	348	0-610
7	Nitrate	mg/L	0.4	0.3	0.4	4.3	0-10
8	Magnesium	mg/L	20	202	127	20	0-61
9	Calcium	mg/L	25	289	151	48	0-400
10	Phosphate	mg/L	<0.05	<0.05	<0.05	<0.05	0-2
11	Sodium	mg/L	622.5	9072.5	1781	231.9	0-920
12	Potassium	mg/L	3.6	175	37	3.4	0-2
13	Ammonia	mg/L	<0.1	<0.1	<0.1	<0.1	---
14	Boron	mg/L	0.075	0.311	0.502	0.189	0-2
15	SAR	mg/L	19.62	64.66	37.78	7.06	0-15 (me/l)
Biological Parameters							
16	E. Coli	MPN/100mL	>23	>23	<1.1	16	---

281. It is evident from the results provided in above table that ground water of Kurar and Jalalpur Sharif villages is fit for irrigation, but samples taken from Dhariala Jalib and Bhelowal shows that irrigation water has higher values of TDS, Magnesium and Sodium. The concentration of Sulphate and bicarbonates is also high in Bhelowal village. Electrical conductivity of the water samples is also high due to presence of salts. The results revealed that irrigation water is saline in nature, which effects the plant growth and causes salinity issues.

282. Similarly, the ground water sampling for Category-2 has been carried out from the same or near the above ground water sources in winter at the detailed design stage of the JIP. Locations of the ground water sources sampled in winter are shown in Figure 6.22. The summary of results for all Category-2 samples collected in winter are given in **Table 6.18** below;

Table 6.18: Summary of Winter Monitoring Results for Category-2 Samples

Sr. No.	Parameter	Unit	Talokar Kurar	Dhok Wenis	Chak Mujhaid	Jalalpur Sharif	PEQS for Drinking Water
1	Temperature	°C	22.0	21.3	20.5	23.0	----
2	pH	--	7.34	7.24	6.8	7.51	6.5-8.5
3	TDS	mg/l	1417	1523	699	333	1000
4	TSS	mg/l	03	BDL	BDL	06	---
5	Chloride (Cl ⁻)	mg/l	264	310	118	78	<250
6	Fluoride (F)	mg/l	0.31	0.18	0.22	0.21	≤1.5
7	Taste	Non objectionable/ Acceptable	Object.	Object.	Non object.	Non object.	Non objectionable/ Acceptable
8	Odour	Non objectionable/ Acceptable	Non object.	Non object.	Non object.	Non object.	Non objectionable/ Acceptable
9	Colour	TCU	0	0	0	0	≤15
10	Iron	mg/l	0.12	0.03	0.04	0.1	0.3
11	Sodium	mg/l	195	228	82	48	200
12	Nitrate (as NO ₃)	mg/l	12.4	10.5	7.1	14.6	≤50
13	Nitrite (as NO ₂)	mg/l	BDL	BDL	BDL	BDL	≤3 (P)
14	Ammonia	mg/l	0	0	0	0	1.5
15	Hydrogen Sulphide (H ₂ S)	mg/l	BDL	BDL	BDL	BDL	0.05
16	Sulphate	mg/l	284	278	102	51	250
17	Lead (Pb)	mg/l	BDL	BDL	BDL	BDL	≤0.05
18	Total Hardness as CaCO ₃	mg/l	482	490	238	132	<500
19	Turbidity	NTU	1	0	0	0	<5
20	Zinc (Zn)	mg/l	0.31	0.18	0.24	0.38	5
21	Manganese (Mn)	mg/l	BDL	BDL	BDL	BDL	≤0.5
22	Benzene	mg/l	BDL	BDL	BDL	BDL	10-120
23	Aluminum (Al)	mg/l	BDL	BDL	BDL	BDL	≤0.2
24	Molybdenum	mg/l	BDL	BDL	BDL	BDL	0.070
25	Chromium (Cr)	mg/l	0.02	0.02	0.03	0.01	≤0.05
26	Cadmium (Cd)	mg/l	BDL	BDL	BDL	BDL	0.003

27	Boron (B)	mg/l	BDL	BDL	BDL	BDL	0.3
28	Barium (Ba)	mg/l	BDL	BDL	BDL	BDL	0.7
29	Antimony (Sb)	mg/l	BDL	BDL	BDL	BDL	≤0.005 (P)
30	Arsenic (As)	mg/l	0.01	0.002	BDL	0.001	≤0.05 (P)
31	Cyanide (CN)	mg/l	BDL	BDL	BDL	BDL	≤0.05
32	Mercury (Hg)	mg/l	BDL	BDL	BDL	BDL	≤0.001
33	Nickel (Ni)	mg/l	BDL	BDL	BDL	BDL	≤0.02
34	Total Coliform	Number/100ml	10	06	0	0	0/100 ml
35	E.Coli	Number/100ml	0	0	0	0	0/100 ml
36	Conductivity	μS/cm	1874	2054	980	486	--
37	Bicarbonate	mg/l	164	210	76	32	--
38	Iodine	mg/l	0.3	0.6	0.4	0.04	--
39	Magnesium (Mg)	mg/l	124	104	48	24	--
40	Calcium as (Ca)	mg/l	198	165	85	49	--
41	Phosphate	mg/l	BDL	BDL	BDL	BDL	--
42	Potassium	mg/l	3.8	5.1	3.1	3.2	--
43	SAR Iodine	mg/l	2.67	3.41	1.76	1.4	--
44	Selenium	mg/l	BDL	BDL	BDL	BDL	0.01
45	Copper	mg/l	BDL	BDL	BDL	BDL	2
46	Residual Chlorine	mg/l	BDL	BDL	BDL	BDL	--
47	Phenolic Compounds	mg/l	BDL	BDL	BDL	BDL	0.002

283. The results in Table 6.18 showed that the ground water of Chak Mujhaid and Jalalpur Sharif villages is fit for irrigation, but samples taken from Talokar Kurar and Dhok Wenis shows that irrigation water has higher values of TDS, Chloride, Sulphate and Sodium. The results revealed that irrigation water is saline in nature, which effects the agriculture and causes salinity issues.

284. Locations of the water samples collected in the project preparatory/feasibility stage in late summer for Category-3 are shown in Figure 6.22. The summary of results for all Category-3 samples collected in late summer are given in **Table 6.19** below;

Table 6.19: Summary of Summer Monitoring Results for Category-3 Samples

Sr. No.	Parameter	Units	Sampling Locations		FAO Standards
			Khewra	Sahuwal	
1.	pH	-	7.59	7.55	6.0-8.5
2.	Color	Pt-Co	8	34	---
3.	Taste	mg/L	Salty	Salty	---
4.	Odor	mg/L	Odorless	Odorless	---
5.	Turbidity	NTU	1.6	16.5	---
6.	TSS	mg/L	10	4	---
7.	TDS	mg/L	6480	3950	0-2000
8.	Total Hardness	mg/L	1467	1500	---
9.	Iodine	mg/L	<0.10	<0.10	---
10.	Ammonia	mg/L	<0.1	<0.1	---
11.	Fluoride	mg/L	1.6	0.48	---

12.	Nitrate	mg/L	5.8	1.0	0-10
13.	Nitrite	mg/L	0.041	0.008	---
14.	Chloride	mg/L	2674	1849	0-1065
15.	Sulphate	mg/L	875	18	0-960
16.	Sodium	mg/L	3976.25	1690	0-920
17.	Total Iron	mg/L	0.33	0.47	---
18.	Aluminium	mg/L	<0.02	<0.02	---
19.	Antimony	mg/L	<0.005	<0.005	---
20.	Zinc	mg/L	<1.0	<1.0	---
21.	Cadmium	mg/L	<0.002	<0.002	---
22.	Mercury	mg/L	<0.001	<0.001	---
23.	Nickel	mg/L	<0.02	<0.02	---
24.	Selenium	mg/L	<0.005	<0.005	---
25.	Barium	mg/L	<0.005	<0.005	---
26.	Boron	mg/L	0.17	0.085	0-2
27.	Magnesium	mg/L	186	180	0-61
28.	Chromium	mg/L	0.03	0.02	---
29.	Copper	mg/L	0.15	0.18	---
30.	Lead	mg/L	0.007	0.005	---
31.	Arsenic	mg/L	BDL	BDL	---
32.	Biological Parameters				
33.	Total Coliforms	MPN/100mL	>23	>23	---
34.	Faecal Coliforms	MPN/100mL	>23	2.2	---

285. The results of ground water collected from Khewra and Sahuwal given above in Table 6.19 depicts that concentrations of TDS, Total Hardness, Chloride, Magnesium, and Sodium were higher than the FAO permissible limits. The presence of microbial contamination in ground water sources shows the effect of wastewater or industrial sources. Therefore, high content of these alkali metals and dissolved salts in ground water of project area shows that the water is not fit for drinking purposes.

286. Similarly, the ground water sampling for Category-3 has been carried out from the same or near the above ground water sources in winter at the detailed design stage of the JIP. Locations of the ground water sources sampled in winter are shown in Figure 6.22. The summary of results for all Category-3 samples collected in winter are given in **Table 6.20** below;

Table 6.20: Summary of Winter Monitoring Results for Category-3 Samples

Sr. No.	Parameter	Unit	Chakri Karam Khan	Sahuwal	Islamgarh Khewra	PEQS for Drinking Water
1	Temperature	°C	21.1	21.0	20.1	----
2	pH	--	7.47	6.97	6.74	6.5-8.5
3	TDS	mg/l	738	1684	2130	1000
4	TSS	mg/l	09	18	42	---
5	Chloride (Cl ⁻)	mg/l	168	374	416	<250
6	Fluoride (F ⁻)	mg/l	0.17	0.41	0.62	≤1.5
7	Taste	Non objectionable/	Non object.	Object.	Object.	Non objectionabl

		Acceptable				e/Acceptable
8	Odour	Non objectionable/ Acceptable	Non object.	Object.	Non object.	Non objectionabl e/Acceptable
9	Colour	TCU	0	0	0	≤15
10	Iron	mg/l	0.14	0.23	0.18	0.3
11	Sodium	mg/l	106	172	314	200
12	Nitrate (as NO ₃)	mg/l	18.4	31.9	20.5	≤50
13	Nitrite (as NO ₂)	mg/l	BDL	BDL	BDL	≤3 (P)
14	Ammonia	mg/l	0	0	0	1.5
15	Hydrogen Sulphide (H ₂ S)	mg/l	BDL	BDL	BDL	0.05
16	Sulphate	mg/l	152	306	476	250
17	Lead (Pb)	mg/l	BDL	BDL	BDL	≤0.05
18	Total Hardness as CaCO ₃	mg/l	254	525	652	<500
19	Turbidity	NTU	0	0	0	<5
20	Zinc (Zn)	mg/l	0.31	0.82	0.42	5
21	Manganese (Mn)	mg/l	BDL	BDL	BDL	≤0.5
22	Benzene	mg/l	BDL	BDL	BDL	10-120
23	Aluminum (Al)	mg/l	BDL	BDL	BDL	≤0.2
24	Molybdenum	mg/l	BDL	BDL	BDL	0.070
25	Chromium (Cr)	mg/l	0.02	0.03	0.03	≤0.05
26	Cadmium (Cd)	mg/l	BDL	BDL	BDL	0.003
27	Boron (B)	mg/l	BDL	BDL	0.01	0.3
28	Barium (Ba)	mg/l	BDL	BDL	BDL	0.7
29	Antimony (Sb)	mg/l	BDL	BDL	BDL	≤0.005 (P)
30	Arsenic (As)	mg/l	0.005	0.006	0.005	≤0.05 (P)
31	Cyanide (CN)	mg/l	BDL	BDL	BDL	≤0.05
32	Mercury (Hg)	mg/l	BDL	BDL	BDL	≤0.001
33	Nickel (Ni)	mg/l	BDL	BDL	BDL	≤0.02
34	Total Coliform	Number/100ml	05	15	08	0/100 ml
35	E.Coli	Number/100ml	0	02	0	0/100 ml
36	Conductivity	μS/cm	1040	2380	1592	--
37	Bicarbonate	mg/l	84	242	297	--
38	Iodine	mg/l	0.05	0.5	1.1	--
39	Magnesium (Mg)	mg/l	69	104	142	--
40	Calcium as (Ca)	mg/l	126	196	256	--
41	Phosphate	mg/l	BDL	BDL	BDL	--
42	Potassium	mg/l	3.4	5.2	5.6	--
43	SAR Iodine	mg/l	1.82	2.47	3.9	--
44	Selenium	mg/l	BDL	BDL	BDL	0.01
45	Copper	mg/l	BDL	BDL	BDL	2
46	Residual Chlorine	mg/l	BDL	BDL	BDL	--
47	Phenolic Compounds	mg/l	BDL	BDL	BDL	0.002

287. Above results showed the presence of microbial contamination in Chakri Karam Khan and Sahawal samples due to the adjacent wastewater ponds. Samples collected from Islamgarh and Sahawal also shows the higher values of TDS, Chloride, Sulphate, Total

Hardness and Nitrate with their permissible PEQS limits. All the above Category-3 samples collected at detailed design stage are not fit for drinking due to the presence of above parameters.

288. As mentioned above Category-4 has been devised at the project detailed design stage to check the ground water quality in the vicinity of proposed Construction camp locations of the construction contractor. Locations of the ground water sources sampled are shown in Figure 6.22. The summary of results for all Category-4 samples collected in winter are given in **Table 6.21** below;

Table 6.21: Summary of Winter Monitoring Results for Category-4 Samples

Sr. No.	Parameter	Unit	Misri More Construction Camp # 1	Pind Dadan Construction Camp # 2	PEQS for Drinking Water
1	Temperature	°C	22.5	20.9	---
2	pH	--	7.47	6.94	6.5-8.5
3	TDS	mg/l	743	1490	1000
4	TSS	mg/l	BDL	20	---
5	Chloride (Cl ⁻)	mg/l	174	242	<250
6	Fluoride (F)	mg/l	0.25	0.36	≤1.5
7	Taste	Non objectionable/ Acceptable	Non object.	Object.	Non objectionable/Acceptable
8	Odour	Non objectionable/ Acceptable	Non object.	Object.	Non objectionable/Acceptable
9	Colour	TCU	0	0	≤15
10	Iron	mg/l	0.05	0.09	0.3
11	Sodium	mg/l	98	212	200
12	Nitrate (as NO ₃)	mg/l	6.2	18.4	≤50
13	Nitrite (as NO ₂)	mg/l	BDL	BDL	≤3 (P)
14	Ammonia	mg/l	0	0	1.5
15	Hydrogen Sulphide (H ₂ S)	mg/l	BDL	BDL	0.05
16	Sulphate	mg/l	108	264	250
17	Lead (Pb)	mg/l	BDL	BDL	≤0.05
18	Total Hardness as CaCO ₃	mg/l	227	465	<500
19	Turbidity	NTU	0	0	<5
20	Zinc (Zn)	mg/l	0.21	0.18	5
21	Manganese (Mn)	mg/l	BDL	BDL	≤0.5
22	Benzene	mg/l	BDL	BDL	10-120
23	Aluminum (Al)	mg/l	BDL	BDL	≤0.2
24	Molybdenum	mg/l	BDL	BDL	0.070
25	Chromium (Cr)	mg/l	0.02	0.02	≤0.05
26	Cadmium (Cd)	mg/l	BDL	BDL	0.003
27	Boron (B)	mg/l	BDL	BDL	0.3
28	Barium (Ba)	mg/l	BDL	BDL	0.7
29	Antimony (Sb)	mg/l	BDL	BDL	≤0.005 (P)
30	Arsenic (As)	mg/l	0.004	0.002	≤0.05 (P)
31	Cyanide (CN)	mg/l	BDL	BDL	≤0.05
32	Mercury (Hg)	mg/l	BDL	BDL	≤0.001
33	Nickel (Ni)	mg/l	BDL	BDL	≤0.02
34	Total Coliform	Number/100 ml	0	15	0/100 ml

35	E.Coli	Number/100 ml	0	02	0/100 ml
36	Conductivity	µS/cm	1052	1854	--
37	Bicarbonate	mg/l	106	156	--
38	Iodine	mg/l	0.06	0.72	--
39	Magnesium (Mg)	mg/l	40	134	--
40	Calcium as (Ca)	mg/l	78	210	--
41	Phosphate	mg/l	BDL	BDL	--
42	Potassium	mg/l	3.8	2.9	--
43	SAR Iodine	mg/l	1.81	2.81	--
44	Selenium	mg/l	BDL	BDL	0.01
45	Copper	mg/l	BDL	BDL	2
46	Residual Chlorine	mg/l	BDL	BDL	--
47	Phenolic Compounds	mg/l	BDL	BDL	0.002

289. Above results shows that the sample collected from Misri More at Construction Camp No. 1 is fit for drinking and other purposes. However, the sample collected from PD Khan Construction Camp No. 2 location has higher values of TDS, Sodium and Sulphate along with microbial contamination with their permissible limits of PEQS, which is unfit for drinking. Construction Contractor has to make alternate arrangements of the water during construction at this location.

290. As discussed above Category-5 has been devised at the project detailed design stage to check the ground water quality of the natural spring in the project's AOI. Locations of the ground water sources sampled are shown in Figure 6.22. The summary of results for all Category-5 samples collected in winter are given in **Table 6.22** below;

Table 6.22: Summary of Winter Monitoring Results for Category-5 Samples

Sr. No.	Parameter	Unit	Baghanwala	Rawal	PEQS for Drinking Water
1	Temperature	°C	20.9	21.1	----
2	pH	--	7.23	7.77	6.5-8.5
3	TDS	mg/l	351	861	1000
4	TSS	mg/l	12	16	---
5	Chloride (Cl)	mg/l	68	184	<250
6	Fluoride (F)	mg/l	0.18	0.32	≤1.5
7	Taste	Non objectionable/ Acceptable	Non object.	Object.	Non objectionable/Acceptable
8	Odour	Non objectionable/ Acceptable	Non object.	Non object.	Non objectionable/Acceptable
9	Colour	TCU	0	0	≤15
10	Iron	mg/l	0.14	0.14	0.3
11	Sodium	mg/l	46	136	200
12	Nitrate (as NO ₃)	mg/l	14.6	15.1	≤50
13	Nitrite (as NO ₂)	mg/l	BDL	BDL	≤3 (P)
14	Ammonia	mg/l	0	0	1.5
15	Hydrogen Sulphide (H ₂ S)	mg/l	BDL	BDL	0.05
16	Sulphate	mg/l	75	148	250
17	Lead (Pb)	mg/l	BDL	BDL	≤0.05

18	Total Hardness as CaCO ₃	mg/l	116	284	<500
19	Turbidity	NTU	0	0	<5
20	Zinc (Zn)	mg/l	0.21	0.24	5
21	Manganese (Mn)	mg/l	BDL	BDL	≤0.5
22	Benzene	mg/l	BDL	BDL	10-120
23	Aluminum (Al)	mg/l	BDL	BDL	≤0.2
24	Molybdenum	mg/l	BDL	BDL	0.070
25	Chromium (Cr)	mg/l	0.02	0.03	≤0.05
26	Cadmium (Cd)	mg/l	BDL	BDL	0.003
27	Boron (B)	mg/l	BDL	BDL	0.3
28	Barium (Ba)	mg/l	BDL	BDL	0.7
29	Antimony (Sb)	mg/l	BDL	BDL	≤0.005 (P)
30	Arsenic (As)	mg/l	0.01	0.002	≤0.05 (P)
31	Cyanide (CN)	mg/l	BDL	BDL	≤0.05
32	Mercury (Hg)	mg/l	BDL	BDL	≤0.001
33	Nickel (Ni)	mg/l	BDL	BDL	≤0.02
34	Total Coliform	Number/100 ml	02	04	0/100 ml
35	E.Coli	Number/100 ml	0	0	0/100 ml
36	Conductivity	μS/cm	514	1224	--
37	Bicarbonate	mg/l	52	110	--
38	Iodine	mg/l	0.01	0.4	--
39	Magnesium (Mg)	mg/l	35	46	--
40	Calcium as (Ca)	mg/l	68	84	--
41	Phosphate	mg/l	BDL	BDL	--
42	Potassium	mg/l	3.2	3.5	--
43	SAR Iodine	mg/l	0.64	2.95	--
44	Selenium	mg/l	BDL	BDL	0.01
45	Copper	mg/l	BDL	BDL	2
46	Residual Chlorine	mg/l	BDL	BDL	--
47	Phenolic Compounds	mg/l	BDL	BDL	0.002

291. Above results shows the presence of coliform in the spring water sample due to the upstream use of locals for bathing and other purposes.

6.5. Natural and Biological Environment

292. One of the major objective of updating EIA was to collect baseline information on natural and biological environment (specifically for the winter season) through biodiversity surveys in the project area/project's AOI and to assess the ecological sensitivities as discussed and recommended in the previous EIA at the feasibility stage.

293. The environmental hotspots as discussed in the previous EIA are the Rasul Barrage Game Reserve and Jalalpur Wildlife Sanctuary. In accordance with the previous EIA, JIP AOI does not include any of the area of protected category (National Park, Wildlife Sanctuary and Game Reserve). However, it lies close to Jalalpur Wildlife Sanctuary, which has been identified as one of the breeding area for *Punjab Urial*. An estimated population of over 3,000 heads of *Punjab Urial* was reported (information gathered through personal communication). To keep a sizeable population of *Punjab Urial*, Punjab Wildlife department has opened trophy hunting programme through community engagements. This arrangement

is running smoothly since last couple of years. Consultant has identified and studied this biologically sensitive issues in detail which has been addressed in the subsequent section.

294. The proposed approach and methodology for conducting the biodiversity monitoring including avifaunal assessment is briefly described in the Section 2.2.8 Natural and Biological Environment of Chapter 2 of this updated EIA.

295. The natural and biological environment including biodiversity surveys have been carried out for winter season from mid of October 2016 to mid of March 2017 at the detailed design stage of the JIP. However, the first biodiversity survey was carried out by the NEC Consultant from July to Sep 2015 at the project preparatory/feasibility stage. This survey (covering ecological aspects) was done during the baseline data collection from primary and secondary sources. It broadly covers ecosystem sensitivities, vegetation and other flora, fauna.

296. The natural and biological assessment of the JIP area at the detailed design stage was studied in December 2016 and January 2017 when migratory Avi-fauna were visiting the area in winter season. JIP area representing varying dynamics of edaphic regime, which greatly influences the physiography and productivity of the area. Based on the existing edaphic regime, the area has been stratified into three zones:

- area connecting the system with Rasul Barrage;
- Facultative production zone; and
- area with marginal to no productivity.

297. The location of the sampling sites for flora and fauna monitoring representing the various zones is given in **Table 6.23**. The above zones have been analyzed using different qualitative and quantitative parametric techniques where applicable. The reported 8% forest area has been scrutinized in detail in terms of bio-dynamics.

Table 6.23: Sampling Sites for Ecological Studies

Zones	Name of Site	Latitude (N)	Longitude (E)
Rasul Barrage	Head Rasul Game Reserve area	32° 41' 15"	73° 31' 05"
	Main canal Alignment from RD 0+000 to 45+000 (Head Rasul to Jalalpur Sharif along the Jhelum River	32° 39' 54"	73° 22' 57"
Facultative Production Zone	Ladwa to Rawal	32° 42' 12"	73° 11' 28"
	Rawal to Sodhi Gujjar	32° 37' 39"	73° 02' 38"
area with Marginal to No Productivity	Sodhi Gujjar to Khewra	32° 37' 09"	73° 01' 07"
	Khewra to Behlowal	32° 34' 56"	72° 51' 30"
	Bhelowal to Daiwal	32° 31' 00"	72° 31' 35"

298. The current status biological conditions in project area *vis-à-vis* biotic environment has been updated on the basis of primary and secondary sources i.e. field surveys, previous EIA study, literature review and meetings with relevant departments (details of meetings with all the concerned departments and their concerns/suggestions are provided in the Chapter-7 Stakeholder's Consultation of this EIA). For the primary data acquisition, the Environment team has conducted the field visits in two phases, first phase field visit was conducted from December 14 to 18, 2016 and second phase from January 02 to 08, 2017 to contact the relevant departments and to gather the required information through field observations and wildlife surveys. The secondary data as reported in the previous EIA study has also been verified and visual observations have been made during detailed visits. A list of secondary sources used in compiling this section is attached as **Appendix-V**.

6.5.1. Flora

299. JIP AOI represents an elliptical shape flat plain with varying dynamics. The apparent driving factor for this variation is edaphic regime, which greatly influences the physiography and productivity of the area. The area starts with a patch of dense canopy, gradually diluting into almost an open field with grass covered (Refer **Figure 6.21** and **Figure 6.22**).

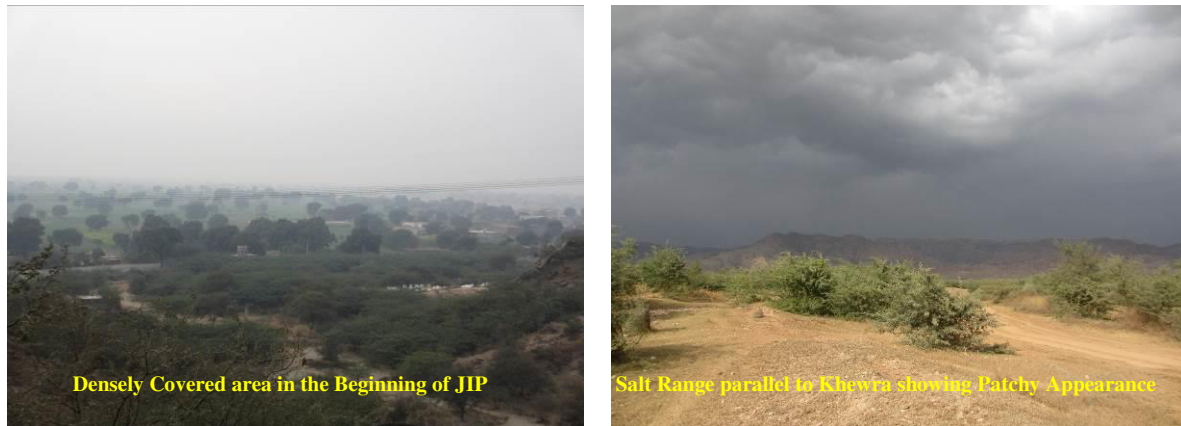


Figure 6.21: area Parallel to River Jhelum showing Dense & Patchy Appearance

300. The vegetation is categorized as sub-tropical dry evergreen scrub type (Nawaz et al., 2010). Some researchers classified this a dry from deciduous scrub type. Phulai (*Acacia modesta*) and Kahu (*Olea ferruginea*) are among the dominant tree species while Sanatha (*Dodonea viscosa*), Gurgura (*Reptonia buxifolia*) and Pataki (*Gymnosporia royleana*) are the associate species.



Figure 6.22: Dense and Meager Vegetation in the project area

301. Vegetation of the forests of Jhelum Forest Division is dry, deciduous shrub type, The stocking on the whole is poor and the forests are open. Vegetation is poor on sandstone and red marl. The southern slopes are often devoid of vegetation while north western slopes carry good forests. The forests of Jhelum Forests Division are burdened with right of grazing, browsing and firewood. Under settlement out of total area 93,566 acres (37,865 hectares) only 5,468 acres (2,213 hectares) about (45%) are right free. Remaining 55 % are open to grazing.

302. Khushab district consists of agricultural lowland plains, lakes, and hills. Parts of the Thal desert touch the district and the Jhelum runs alongside it making it highly fertile for agriculture. The district is rich in natural resources (salt and coal). The Thal desert is a dry

desert with scarce vegetation, mostly thorny bushes, over a breadth of 70 miles (110 km) and is situated between the Indus river and the Jhelum river. In Thal, the whole land is arid and depends upon the weather condition, but now with the project of greater Thal canal the most part of the desert will be irrigated. The landuse distribution in District Khushab and Jhelum is shown in **Figure 6.23** and **Figure 6.24**.

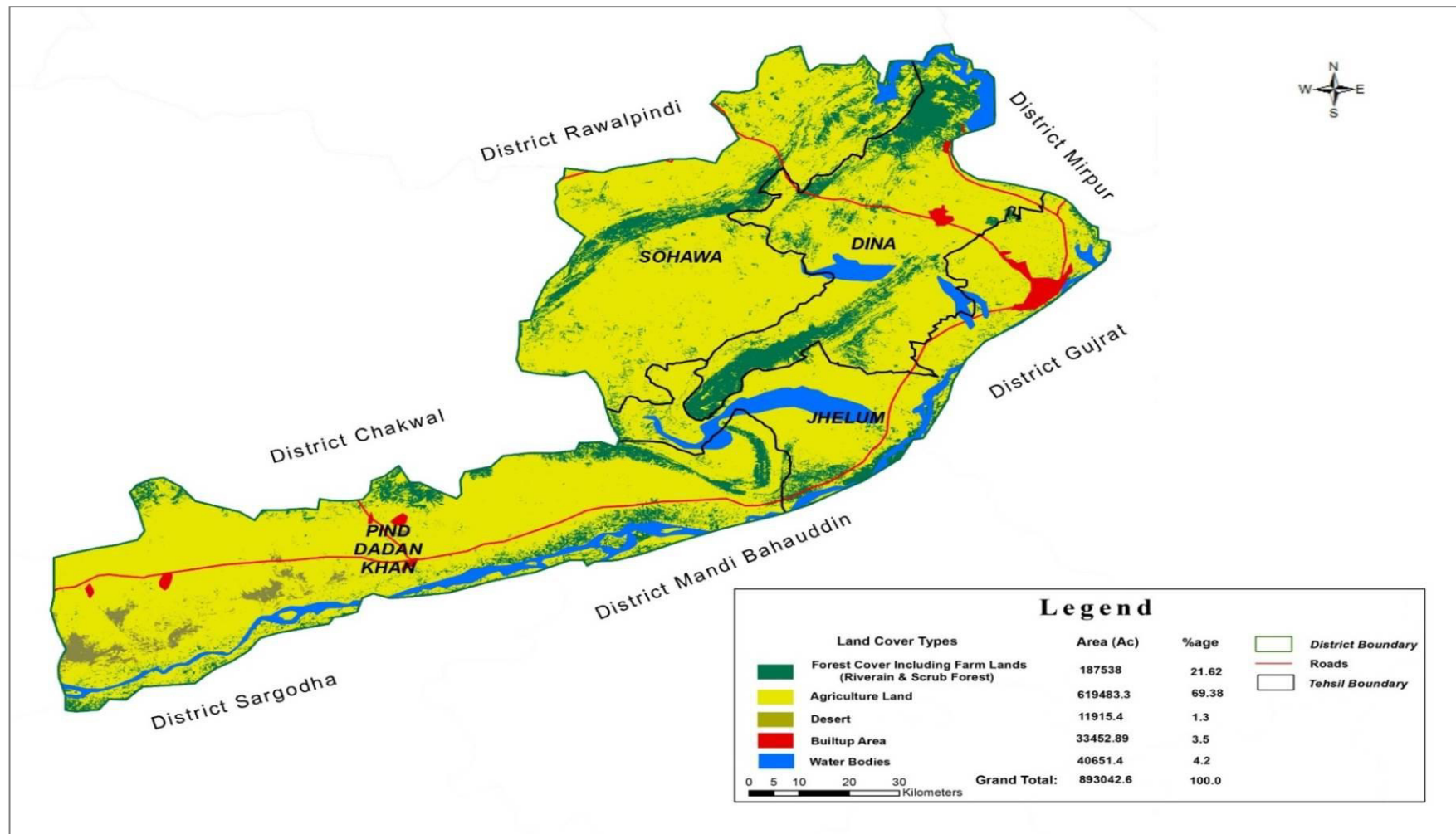
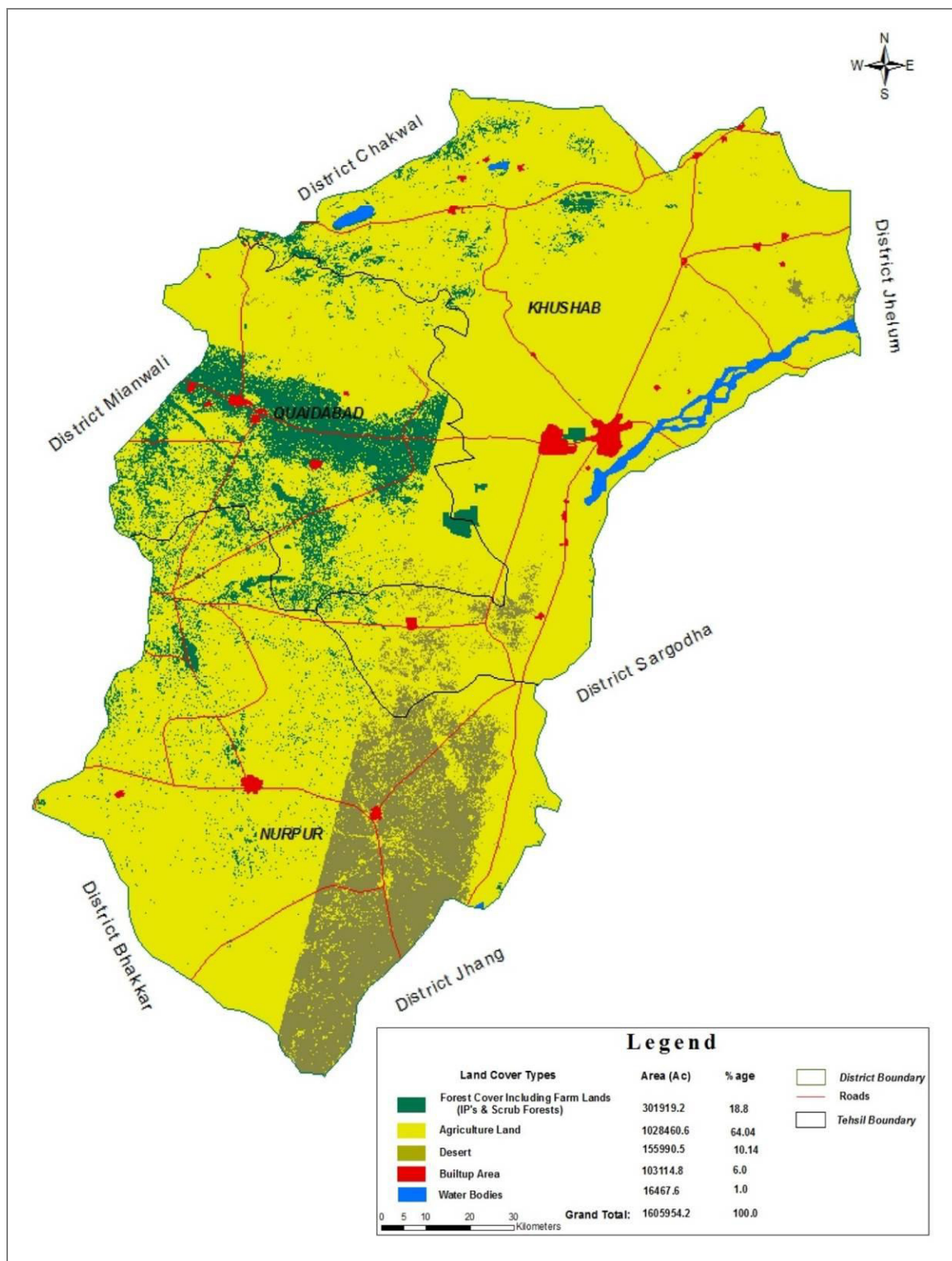


Figure 6.23: Landuse Pattern in District Jhelum

Source: Land cover ATLAS of Punjab



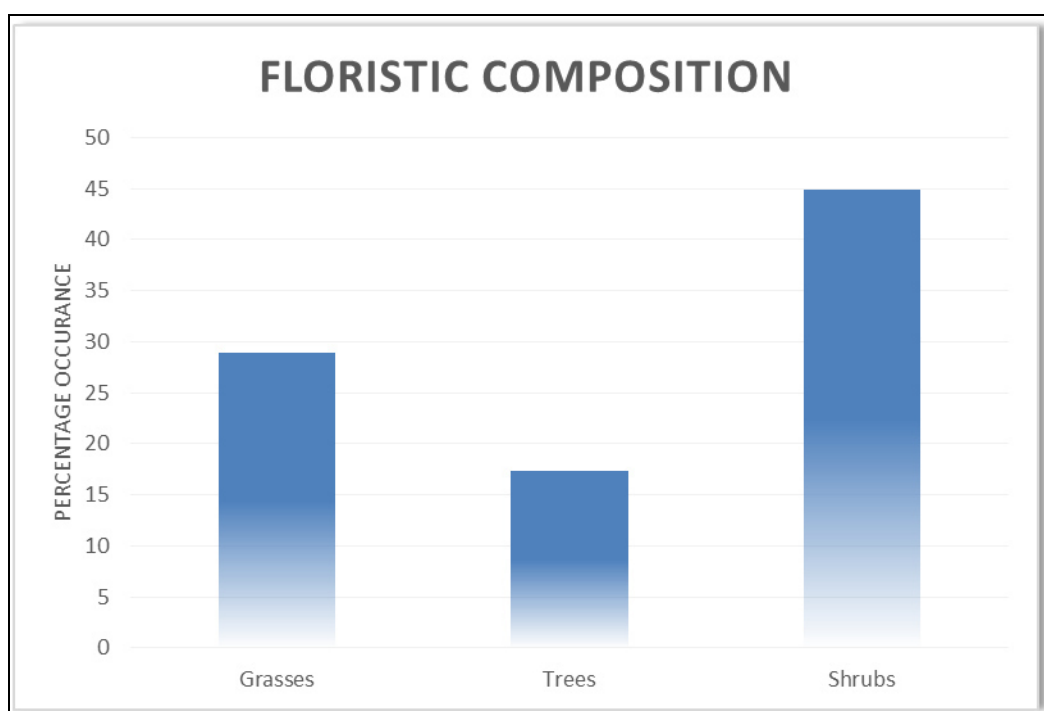
Source: Land cover ATLAS of Punjab

Figure 6.24: Landuse Pattern of Khushab District

303. There is no real forest canopy and the topsoil has been practically washed away. Grasses are abundant throughout the area. Good forages like Pharion (*Digitaria bicornis*) and Palwan (*Bothriochloa pertusa*) are found in places where the incidence of grazing is less. In areas subjected to heavy grazing, less desirable grasses like lamb (*Aristida depressa*) and khawi (*Cymbopogon jwarancusa*) take place of good quality grasses (Refer **Figure 6.25** and **Figure 6.26**).



Figure 6.25: Area Bordering Zone 2 showing Non Canopy Appearance



Source: Ahmed Husain et al 2009

Figure 6.26: Phenological Divide of the Vegetation in JIP Area

304. All forest areas are shrinking and forest is being lost at a substantially greater rate than regeneration. The area is under significant biotic pressure. The forested areas are now being progressively replaced by a mixed grassland community. The habitat of the Salt Range is under threat because of extensive mining, fuelwood extraction and increasing settlements and encroachments. There are pressures from cement factories on the habitat. This has caused increased fragmentation of the habitat. Human dependence by using it as grazing land, expanding human settlements, mining, and other industrial activities, unsustainable practices causing the habitat loss, soil erosion and proper functioning of ecosystems (Refer **Figures 6.27**).



Figure 6.27: Human Burden on the Natural Resources

305. The residents of the surrounding villages in the area have the right of taking dry and dead firewood for their private use but not for sale from the forest and such portion of other forest as may be duly closed from time to time but axes are not allowed to be taken into the forest in exercise of this right.

a) Trees, Shrubs, Herbs and Grasses

306. The representative sampling was carried out at the detailed design stage in the project's AOI from designated ecological zones (Refer Table 6.23) to record the vegetation data for trees, shrubs, herbs and grasses respectively. At the interval of about 4 to 5 km all along the length of the canal vegetation data was recorded. All the major road and railway crossings were visited to record the existing vegetation within the RoW of the main canal. Each stratum of vegetation was studied separately for different life forms (trees, shrubs, herbs, and grasses etc.). Public consultation with the local people was also carried out to seek feedback and information about the local species and distribution.

307. The synthesis of field data was carried out employing the Tabular Comparison Method that showed the data in a well-organized manner so that important trends of species distribution and the local occurrence could be easily recognized. Different plant associations were recognized from the synthesized data in comparison with the International Union for Conservation of Nature (IUCN) threatened species red list. The plant communities for the project's AOI as well as information about the medicinal plants was noted from the published literature. Consultant has extracted and verified the information from the published literature sources to assess the IUCN status of the different species. A detailed list of flora prevalent in the area is provided in the previous EIA at the project preparatory/ feasibility stage attached as **Appendix-VI**. Updated list of the vegetation at the detailed design stage for different life forms observed/reported in project's AOI during vegetation sampling is provided in **Table 6.24** below;

Table 6.24: List of Flora found in the project's AOI

Sr. No.	Common Name	Scientific Name	Life Form	Local Occurrence	IUCN Status (Ver:2016-3)
1	Phulai	<i>Acacia modesta</i>	Tree	Very Common	NA
2	Kikar	<i>Acacia nilotica</i>	Tree	Very Common	NA
3	Jand	<i>Prosopis cineraria</i>	Tree	Common	NA
4	Bakain	<i>Melia azedarach</i>	Tree	Common	NA

Sr. No.	Common Name	Scientific Name	Life Form	Local Occurrence	IUCN Status (Ver:2016-3)
5	Frash	<i>Tamarix aphylla</i>	Tree	Less Common	NA
6	Shisham	<i>Dalbergia sissoo</i>	Tree	Common	NA
7	Simal	<i>Bombax ceiba</i>	Tree	Less Common	NA
8	Siris	<i>Albizia procera</i>	Tree	Common	NA
9	Lahoora	<i>Tecoma undulata</i>	Tree	Less Common	NA
10	Ber	<i>Ziziphus mauritiana</i>	Tree	Common	NA
11	Kokan Ber	<i>Ziziphus nummularia</i>	Shrub	Common	NA
12	Bohar	<i>Ficus benghalensis</i>	Tree	Common	NA
13	Pipal	<i>Ficus religiosa</i>	Tree	Common	NA
14	Sufeda	<i>Eucalyptus camaldulensis</i>	Tree	Less Common	NA
15	Mesquite	<i>Prosopis juliflora</i>	Shrub	Very Common	NA
16	Karir	<i>Capparis decidua</i>	Shrub	Very Common	NA
17	Van, Peelu	<i>Salvadora oleoides</i>	Shrub	Common	NA
18	Hansraj	<i>Adiantum capillus-veneris</i>	Shrub	Less common	LC
19	Khar shutar	<i>Alhagi maurorum</i>	Herb	Very Common	NA
20	Akk	<i>Calotropis gigantea</i>	Shrub	Very Common	NA
21	Bhang	<i>Cannabis sativa</i>	Herb	Common	NA
22	Subali	<i>Chrozophora tinctoria</i>	Herb	Less common	LC
23	Hiran khari	<i>Convolvulus arvensis</i>	Herb	Very Common	NA
24	Jamal ghoti	<i>Croton tiglium</i>	Herb	Common	NA
25	Dhatoora.	<i>Datura stramonium</i>	Herb	Common	NA
26	Bhekkar	<i>Adhatoda vasica</i>	Shrub	Common	NA
27	Astra khar	<i>Echinops echinatus</i>	Shrub	Common	NA
28	Bhaingra	<i>Eclipta prostrata</i>	Shrub	Very Common	NA
29	Khaar	<i>Haloxylon recurvum</i>	Shrub	Less Common	NA
30	Bui	<i>Otostegia limbata</i>	Shrub	Very Common	NA
31	Khatti buti,	<i>Oxalis corniculata</i>	Herb	Common	NA
32	Aspand.	<i>Peganum harmala</i>	Herb	Very Common	NA

Sr. No.	Common Name	Scientific Name	Life Form	Local Occurrence	IUCN Status (Ver:2016-3)
33	Rani phal	<i>Polygonum plebejum</i>	Herb	Common	NA
34	Khurfa	<i>Portulaca oleracea</i>	Herb	Very Common	NA
35	Arund	<i>Ricinus communis</i>	Shrub	Common	NA
36	Pataki	<i>Gymnosporia royleana</i>	Shrub	Common	NA
37	Mako	<i>Solanum miniatum</i>	Herb	Very Common	NA
38	Katai khurd	<i>Solanum surattense</i>	Herb	Very Common	NA
39	Laani	<i>Suaeda fruticosa</i>	Herb	Very Common	NA
40	Bas khapra.	<i>Trianthema govindia</i>	Herb	Common	NA
41	Chota gokhru	<i>Tribulus terrestris</i>	Herb	Common	NA
42	Asgand	<i>Withania somnifera</i>	Herb	Very Common	NA
43	Khabbal	<i>Cynodon dactylon</i>	Grass	Common	NA
44	Khawi	<i>Cymbopogon jwarancusa</i>	Grass	Common	NA
45	Sarkanda	<i>Saccharum munja</i>	Grass	Common	NA
46	Dhaman	<i>Cenchrus ciliaris</i>	Grass	Common	NA
47	Suriala	<i>Heteropogon contortus</i>	Grass	Common	NA
48	Sawank	<i>Panicum antidotale</i>	Grass	Common	NA
49	Lamb	<i>Aristida depressa</i>	Grass	Common	NA



Figure 6.28: Trees on Farmland Representing the area of Zone-2



Figure 6.29: Few of the Dominant Vegetation of Zone-3

b) Reserved Forest

308. There is no reserved forest along the main canal alignment except Thill forest which is unclassified i.e. neither reserved nor protected. The proposed alignment for the JIP mostly passes through natural tropical thorn Forest on either side of the main canal. Thill is not a reserved forest as confirmed by Forest Department Jhelum (refer **Appendices-VII & VIII**) and falls outside of the project's AOI and will not have any direct impact due to canal construction.

c) Horticulture

309. Horticulture is the branch of agriculture which deals with production of fruit plants. Now a days it is given broader meaning and vegetable culture and floriculture are also included in the practice of horticulture. Presently at this stage no horticultural practice was seen along the alignment of the canal except near Khushab where some guava and citrus orchards were seen. Main reason of very little emphasis on horticulture is shortage of water. It is anticipated that with availability of canal irrigation the pattern of agriculture will change and fruit production in the area will not only start but also multiply manifolds and cause an addition in the farm incomes. The project area has a potential to grow Malta, Kino, fruiter early, sweet lemon, plum, lichi, mulberry, guana and pomegranate. Vegetables like onion, garbi, potatoes, ginger, egg plants, arum, okra, spinach, mint, tomato turnip, carrot, cauliflower, bitter gored, pea, radish and cucumber can be raised with availability of adequate irrigation water as the climate and soil are generally suitable for the purpose.

d) Agriculture

310. At present, the "Barani" agriculture approach in the project area, cannot catch up with the food demand for the population of the project area which is growing at a rate of 3% annually. Jalalpur canal water would accelerate the agriculture production, increase the rate of production from 3.8 to 6 % per annum. Presently, the farmers in the command area of the proposed JIP mainly grow wheat and fodder under rain fed conditions, whereas maize and sugarcane is cultivated using groundwater irrigation in some areas. Farmers in the project area face low agricultural production and low farm incomes as the result of frequent crop failure, low crop yields, low farm profitability and secondary salinization.

311. The proposed JIP is designed to command a Gross Command area (GCA) of 215,000 acres (87,007 ha) with a CCA of 170,000 acres (68,797 ha). The command area of JIP is a long strip of land bounded by the Salt Range Hills on the northern side and the right bank of the Jhelum River on the southern side. The GCA and CCA located in tehsil Pind Dadan Khan and tehsil Khushab is given in **Table 6.25** below;

Table 6.25: Gross Command area & CCA

Sr. No	Tehsil	GCA (ha)	CCA (ha)	Percent of total GCA	Percent of total CCA
1	Pind Dadan Khan	74,396	53,094	80.9	82
2	Khushab	17,524	11,655	19.1	18
	Total	91,920	64,749	100	100

As per Agriculture Census Report (2010), the farms have been classified into five categories and average farm size is given **Table 6.26** below;

Table 6.26: Average Farm size in JIP project area

Sr. No	Category	Farm Size (ha)	Average Farm Size (ha)
1	Very Small	less than 2.02	0.8
2	Small	2.02-5.05	2.9
3	Medium	5.05 to 10.1	6.8
4	Large	10.1 to 20.2	11.8
5	Very Large	Above 20.2	52.8

6.5.2. Fauna

312. The immediate and surrounding area of the project has been under human interference for a long time and therefore a large number of wildlife species are already extinct or have shifted to other sites where they could find protection. The species left behind are these which have adjusted with the present state of habitat or have adopted such like habitat that they keep migrating between alternate habitats to strike their best balance with physical, biological or human factors of the environment.

313. Wildlife and other fauna in along the main canal alignment, fisheries and ecosystem sensitivities of the JIP was studied in detail during the biodiversity surveys. Head Rasul Game Reserve, Jalalpur Wildlife Sanctuary were also observed as they fall nearby project AOI. All these wildlife studies were carried out at the designated ecological zones as mentioned above. Primary and secondary data was collected to assess the wildlife in the project area. Field visits were conducted to observe the presence of mammals, reptiles and amphibians through employing the sampling techniques such as identification of faeces, footprints and general observations. Birds were also observed at designated locations along the main canal alignment in project's AOI.

a) Head Rasul Game Reserve

314. Rasul Barrage has been identified as the start-point of JIP, which was declared a wildlife sanctuary in 1973 for a period of three years under the Punjab Wildlife (Protection, Preservation, Conservation and Management) ordinance, 1972. Later on after the expiry of three years period it was subsequently re-notified for a period of five years under the Punjab Wildlife Act, 1974. Wildlife Sanctuary was de-notified many times during the hunting season 1987-88, for ducks shooting. Consequently its status was degraded to Game Reserve on 29-02-1988 under Punjab Wildlife Act, 1974. Since then it is a Game Reserve till now. It is located between 32° 42' N and 73° 33' E and comprises an area of 2,812 acres (1,138 ha). The area has been placed in category IV of IUCN.

315. Rasul Barrage Game Reserve is a reservoir of natural river water. The main function of the Head-works is storage of Jhelum River water to regularize the supply of water to Qadirabad Headworks and control of flood (Refer **Figure 6.30**). The Barrage provides

protected resting site and important staging and wintering area for a wide variety of migratory and domestic waterfowl. Rasul Barrage is situated between Jhelum District and Mandi Bahauddin District on River Jhelum with a discharge capacity of about 24,000 cubic meter per second. Total area of wetland comprises of 2,812 acres for providing protection resting site and important staging and wintering area for a wide variety of migratory and domestic waterfowl. This wetland also acts as a haven for summer breeding birds. About 80% of the Game Reserve area remains under water throughout the year, the remaining 20% comes under water during flood season. Two embankments extend out into the reservoir and hold back shallow lagoon as the water level in the main channel falls. The water level fluctuates by about 6.5 ft (2 meter) and the maximum depth is 21.3 ft (6.5 meter). The water storage reservoir with associated marshes supports extensive reed beds and an abundant growth of submerged and floating aquatic vegetation (Refer **Figure 6.31**). The aquatic vegetation includes *Carex fedia*, *Hydrilla verticillata*, *Nelumbo nucifera*, *Nymphaea lotus*, *Phragmites karka*, *Potamogeton crispus*, *P. pectinatus*, *Typha angustata*, *Vallisneria spiralis* and *Zannichelia palustris*. Details of the Fauna as acquired during biodiversity survey at Head Rasul Barrage is given in **Table 6.27** below;

Table 6.27: Fauna at Head Rasul Barrage

Common Name	Scientific Name	IUCN Status (Ver:2016-3)
Mammals, Reptiles, Amphibians		
Jackal	<i>Canis aureus</i>	LC
Pygmy White-toothed Shrew	<i>Suncus etruscus</i>	LC
Lesser House Bat	<i>Scotophilus kuhlii</i>	LC
Striped Palm Squirrel	<i>Funambulus pennantii</i>	LC
House Rat	<i>Rattus rattus</i>	LC
Mouse	<i>Mus musculus</i>	LC
Snakes	<i>Vipera xanthina xanthina</i> /Elapidae sp.	LC
Lizards	<i>Sauria</i> sp.	LC
Frog	<i>Anura ranidae</i>	LC

LC = Least Concern

**Figure 6.30: Head Regulator Rasul Qadirabad Link canal at the Rasul Barrage**

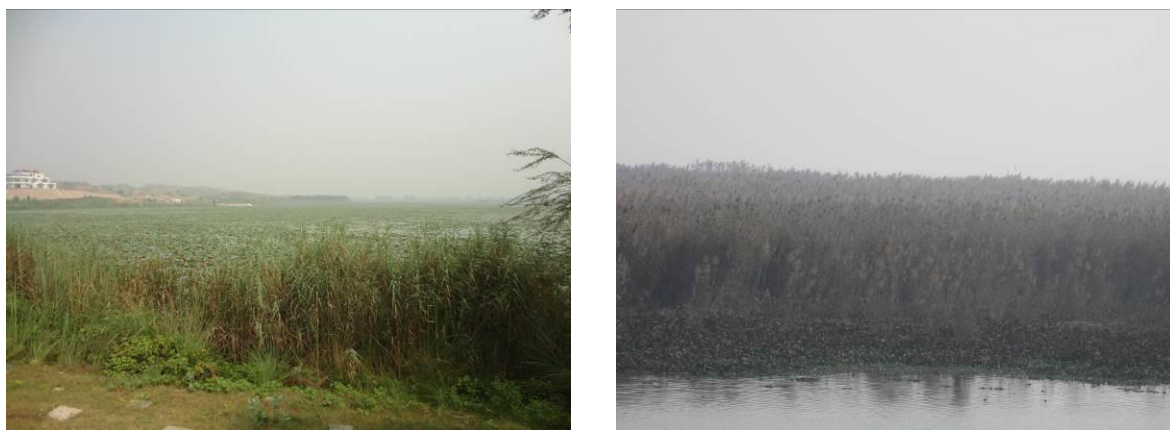


Figure 6.31: Aquatic Vegetation at the Rasul Barrage

b) Migratory Avi-fauna

316. Pakistan lies at a crossroads for bird migration, as a result of its deliberate geographical location. The Indus basin is one of the world's great migratory flyways and is the principal route followed by many bird species that breed extraliminally and spend winters in Pakistan. This includes a wide variety of birds. During their journey, the birds make stopovers at lakes and water basins in Punjab and Sindh. These birds mainly consist of water fowl, hobara bustard, cranes, teals, pintail, mallard, geeze, spoon bills, waders, palicons and gadwall. However, the project area is not situated along the regular fly way of the water fowls. Some migratory birds are seen in the pond area of Rasul Barrage during various times of the year and the river below the barrage. The distance covered by migratory birds during migration is calculated to be around 4,500 kilometers. Every year birds take flight from their homelands and travel along several routes to reach warm wintering grounds. During their journey, the birds make stopovers at lakes and water basins. These water bodies have been playing a supportive role for a number of local and migratory birds.

317. As mentioned above and briefly discussed in the Chapter 2 of this report, the methodology adopted for avifaunal assessment was the point count method being powerful and traditionally preferred avian survey method of measuring relative abundances efficiently (Whitman *et al.*, 1997). The birds were recorded at fixed stations separated by fixed distances of about 500 m during dusk and dawn time at Head Rasul Barrage in winter season intermittently during the months from December, 2016 through January, 2017. Rasul Barrage Game Reserve reported to accommodate a large variety of birds (Refer **Figure 6.32**). During (1996-2005) a total of 88,327 birds of 43 waterfowl species were recorded from Rasul Barrage⁵. Faunal species sighted as well as their presence known through secondary sources of literature and public consultation have been listed in **Table 6.28** below;

Table No. 6.28: List of Avi-fauna at Rasul Barrage/River Jhelum

Common Name	Scientific Name	IUCN Status (Ver:2016-3)
Ring Dove	<i>Streptopelia capicola</i>	LC
Rock Pigeon	<i>Columba livia</i>	LC
Myna	<i>Acridotheres tritis</i>	LC
Crow	<i>Corvus splendens</i>	LC
Pond Heron	<i>Ardeola grayii</i>	NA
Common Snipe	<i>Gallinago gallinago</i>	LC

⁵ Water Population Estimation at Rasul Barrage, Game Reserve, Jhelum, Pakistan, 1996-2005. Pakistan Journal of Life and Social Sciences, 2010,8 (1:11-15)

Grey Partridge	<i>Perdix perdix</i>	LC
Hoopoe	<i>Upupa epops</i>	LC
Koel	<i>Eudynamys scolopacea</i>	LC
Common Bulbul	<i>Pycnonotus barbatus</i>	LC
Sparrow	<i>Passer domesticus</i>	LC
Mallard	<i>Anas platyrhynchos</i>	LC
Common teal	<i>Anas crecca</i>	LC
Moor hen	<i>Gallinula chloropus</i>	LC
Tufted duck	<i>Gallinula chloropus</i>	LC
Northern shoveler	<i>Spatula clypeata</i>	LC
Common pochard	<i>Aythya ferina</i>	VU
Tree Pie	<i>Dendrocitta vagabunda</i>	LC
Lapwing	<i>Vanellus vanellus</i>	NT
Chukor	<i>Alectoris chukar</i>	LC
Green-backed Tit redstart	<i>Parus Monticolus</i>	LC
White-capped	<i>Chaimarrornis leucocephalus</i>	LC
Plumbeous Water-redstart	<i>Rhyacornis fuliginosa</i>	LC
Scaly-bellied Woodpecker	<i>Picus squamatus</i>	LC
Little Cormorant	<i>Microcarbo niger</i>	LC
Common Kingfisher	<i>Alcedo atthis</i>	LC
Jack Snipe	<i>Lymnocyptes minimus</i>	LC
Wood Sandpiper	<i>Tringa glareola</i>	LC
Little Egret	<i>Egretta garzetta</i>	LC

LC = Least Concerned NA = Not yet Assessed VU = Vulnerable NT = Near Threatened



Moorhen



Scaly-bellied Woodpecker

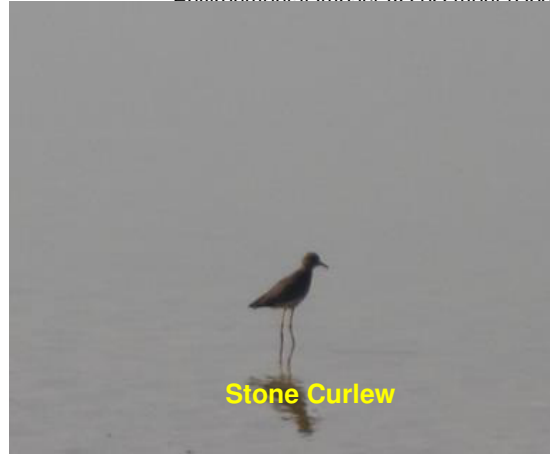


Figure 6.32: Rasul Barrage Game Reserve observed Birds

c) Jalalpur Wildlife Sanctuary

318. The area identified for JIP, does not include any of the area of protected category (National Park, Wildlife Sanctuary and Game Reserve). However, it lies close to Jalalpur Wildlife Sanctuary, which has been identified as one of the breeding area for *Punjab Urial*. According to the local Wildlife officials, there has been a marked improvement in the *Urial* population and now it is exceeding the carrying capacity of the zone. An estimated population of over 3,000 heads were reported (personal communication). It is to be noted that this *Urial* population is reported in areas lying outside the proposed JIP area. To keep a sizeable population. Punjab Wildlife Department has opened trophy hunting programme through community engagements. In year 2007, reportedly 08 hunting licenses were auctioned internationally, while the number was 12 in the year 2013, indicating that the *Urial* population has reached a satisfactory level. This is in smooth running since last couple of years.

319. *Punjab Urial* (*Ovis vignei punjabiansis*) shown in **Figure 6.33** is the key wildlife species of the area, and was classified as vulnerable by the IUCN red list. The Punjab Urial is an endemic sub species of Pakistan and is protected under all provincial laws. It is known to have a restricted distribution range and found only in the Salt and Kala Chitta Mountain ranges and is confined by a coniferous forest belt in the north, the Jhelum River in the east and south and Indus River in the west (Schaller and Mirza 1974, Schaller 1977). It formerly was distributed throughout these mountains, but it underwent a substantial decline in the twentieth century. By the early 2000's, the greatest concentration occurred within the Salt Range, mainly at Kalabagh in the western extremity near the River Indus.



Figure 6.33: *Punjab Urial* and its Droppings at Jalalpur Wildlife Sanctuary

320. There is no way to know precisely the historic population size of *Urial*. Reports from expeditions, naturalists, and hunters to the region in the early 1900's (Lydekker 1913, Burton 1920, Stockley 1922, Mounfort 1969) suggest that *Urials* were once plentiful in the mountains of northern Punjab, but no figure has ever been given. Schaller (1977) gave quantitative figure and depicted that the world population of this subspecies may not exceed 2,000 animals. Mirza et al. (1980) estimated 2,157 animals in the total range. Currently the Kalabagh Game Reserve is supporting almost 50% population of the *Punjab Urial*. Awaneet.al. (2004) estimated a total population size of about 860 *Urial* in the Salt Range, suggesting a 56% decline from 1976 (Mirza et.al. 1980). However, there has been an increase since then (source: World Wide Fund-Pakistan).

321. The main threats to the *Urial* population include habitat degradation (timber, fuel wood) encroachments on protected forest, stealing of lambs, conflicts with the livestock because of competition for grazing. Illegal hunting of *Urial* has been a major factor in the past for its decline, however, the hunting of *Urial* is now more regulated (WWF-P).

322. Efforts were made by government and non-governmental organizations on population assessment and identified critical areas within the Salt Range. There have been

various initiatives for the protection of habitat and restoration of degraded area with the help of various partners that included watershed initiatives, alternate energy such as biogas plants to reduce the dependency on fuel wood. They also helped communities within the *Urial* habitat by providing alternate livelihoods and has established information center to promote awareness, and also promoted ecotourism for the same purpose. Ecotourism provides alternate livelihood to communities and reduces their reliance on natural resources which helps in the conservation of species, (WWF-P). As the proposed JIP area does not fall inside the *Urial* habitat, these initiatives do not have any footprints in the proposed project area.

d) Other Fauna in Project's AOI

323. Primary data was collected from the designated ecological zones to observe the fauna along the main canal alignment in project's AOI. Primary data was collected through field visits in non-breeding i.e. winter season only to observe the mammals, reptiles and amphibians through employing the sampling techniques such as identification of faeces, footprints and general observations. Fauna monitoring was carried out all along the length of the main canal alignment at an approximate interval of about 4 to 5 km for 20 to 25 minutes at each point (Refer **Figure 6.35**). Fauna observation points including birds along the main canal alignment at each points with location and coordinates for the period of December, 2016 and January 2017 is shown in **Figure 6.35**. The detailed list of species observed at each point with location and coordinates along the main canal alignment in project's AOI is given in **Table 6.29**. A detailed list of fauna prevalent in the area identified at the project preparatory/feasibility stage is also attached as **Appendix-VI**.

Table 6.29: Observed Fauna in winter with Coordinates/Location in project's AOI

Sr. No.	Coordinates		Location (nearby)	Fauna Observed (20-30 minutes watch)
	Northing	Easting		
1	32° 41.813'	73° 30.469'	Misri More	Ring Dove, Crow
2	32° 42.650'	73° 31.707'	Misri More (RD Khan)	Myna, Crow
3	32° 40.919'	73° 29.571'	Muriala	Crow, Hoopoe, Lizard
4	32° 40.269'	73° 27.930'	Malikpur	-
5	32° 39.695'	73° 26.294'	Shah Kamir	Crow, Jack Snipe,
6	32° 40.183'	73° 24.401'	Alexander Monument	Crow, Little Egret
7	32° 39.900'	73° 22.946'	Road Crossing	-
8	32° 40.898'	73° 20.870'	Chakri Karam Khan	Myna, Sparrow, Crow
9	32° 41.238'	73° 20.175'	Road Crossing: Pindi Saidpur-Thil Road	Crow, Jack Snipe, Tree Pie, Kingfisher, Hoopoe
10	32° 42.329'	73° 15.536'	Khoi Mushahidi/Kukar Pindi)	Crow, Sparrow, Little Egret, Bulbul
11	32° 41.252'	73° 31.078'	Rasul Barrage area	Moor hen, shoveler, Water-redstart, Little Cormorant, Sparrow, Tufted duck,
12	32° 41.366'	73° 31.159'	Police Pond	Ring Dove, Water-redstart,
13	32° 42.117'	73° 31.342'	Police Pond	Little Egret Moor hen
14	32° 42.058'	73° 31.382'	Dhobi Ghat Point	Frog, Crow, Little Egret, Hoopoe
15	32° 41.769'	73° 31.693'	Dhobi Ghat Point	Moor hen, Water-redstart
16	32° 42.305'	73° 31.230'	Barrage Corner on Rasul Jhelum Road	Ring Dove, Sparrow, Kingfisher, Little Egret
17	32° 40.823'	73° 31.596'	Sindhi Pond	Moor hen, Ring Dove
18	32° 40.611'	73° 32.331'	Protection Bund near Kotiara Village	Ring Dove, Tree Pie, Crow, Hoopoe

Sr. No.	Coordinates		Location (nearby)	Fauna Observed (20-30 minutes watch)
19	32° 41.925'	73° 32.830'	T-bund near old Barrage	Shoveler, Sparrow, Koel
20	32° 41.735'	73° 14.392'	Umar Kot – Baghanwali Road	, Koel,, Jack Snipe, Sparrow
21	32° 41.796'	73° 13.405'	Umar Kot – Baghanwali Road	Crow, Lizard
22	32° 42.196'	73° 11.467'	Road Crossing at Factory Morr	-
23	32° 39.909'	73° 26.308'	Shah Kamir	Ring Dove, Hoopoe
24	32° 39.515'	73° 25.004'	Dhok Jumma	Crow, Ring Dove, Jack Snipe
25	32° 40.600'	73° 24.651'	J.S. Sanctuary	Frog, Lapwing, Urial
26	32° 40.541'	73° 25.226'	Nallah Sarapar	-
27	32° 40.636'	73° 24.387'	near Atomic Energy Commission Gate	Crow, Little Egret
28	32° 44.064'	73° 21.293'	CBO Western Jhelum	Sparrow, Hoopoe
29	32° 44.155'	73° 20.156'	Bair Faqeeran Village	Ring Dove
30	32° 46.094'	73° 18.354'	Kotal Kund	-
31	32° 52.085'	73° 26.961'	Nallah Andri Kas	Sparrow, Kingfisher
32	32° 40.031'	73° 27.737'	near Shrine of Tootan Wali Sarkar	Crow
33	32° 39.788'	73° 26.823'	Agri Fields (Row)	Ring Dove, Lapwing
34	32° 39.418'	73° 25.422'	within ROW, very near to River creek	Bulbul, Crow, Myna, Lizard
35	32° 39.116'	73° 24.125'	Jalalpur Sharif	Kingfisher, Crow
36	32° 40.466'	73° 21.819'	Pipli Road	Crow, Ring Dove
37	32° 42.159'	73° 09.132'	Gharib – Jotana Road	Bulbul, Crow, Hoopoe
38	32° 40.848'	73° 09.351'	Road crossing	Ring Dove Sparrow,
39	32° 40.360'	73° 08.074'	wara more Agriculture land	Frog, Crow
40	32° 39.205'	73° 06.386'	Kacha road Khoora Village near Sadhowal	Jack Snipe, Koel
41	32° 38.406'	73° 04.279'	Small hillock (Dhairee)	Hoopoe, Crow
42	32° 37.643'	73° 02.631'	Row at Rail crossing near Gharibwal	-
43	32° 40.878'	73° 29.589'	Near Shah Kamir	Ring Dove, Sparrow
44	32° 40.163'	73° 28.019'	Near Malekpur Village	-
45	32° 40.096'	73° 22.739'	Near Ladwa and Dhok Bagh	Myna, Crow, Bulbul
46	32° 40.173'	73° 22.609'	ROW between Ratwali and Ladwa	Sparrow, Crow
47	32° 40.639'	73° 21.320'	Chakri Karam Khan near Hashimpur village	Sparrow
48	32° 36.106'	73° 02.061'	Construction Camp # 2 near PD Khan-Khewra Road	Koel, Crow, Woodpecker, Jackal
49	32° 37.153'	73° 01.116'	ROW – Road crossing	-
50	32° 36.605'	72° 59.094'	Dhok Wains	Crow, Myna, Sparrow
51	32° 34.929'	72° 51.508'	Road Crossing Khewera – Lilla Road	-
52	32° 32.166'	72° 43.408'	Dhudhi Thall	Jack Snipe, Sparrow
53	32° 31.005'	72° 31.575'	canal end near Daiwal School	Crow

Sr. No.	Coordinates		Location (nearby)	Fauna Observed (20-30 minutes watch)
54	32° 31.580'	72° 34.064'	Near Graveyard on Mangwal-Jaswal Road	Little Cormorant, Sparrow
55	32° 31.646'	72° 36.670'	Jaswal-Kandwal Road	Woodpecker, Sparrow, Crow
56	32° 31.307'	72° 38.190'	Dhok Basira, near dera Haibat Khan	Crow, Bulbul, Lizard
57	32° 32.229'	72° 42.072'	Point after Dhudi Thal	Grey Partridges, Jackal
58	32° 31.548'	72° 47.781'	Row just after Lillah Interchange	Jack Snipe, Myna
59	32° 38.439'	72° 58.430'	Point near Dandot Cement Factory	Little Cormorant, Pond Heron, Myna, Frog
60	32° 37.101'	72° 57.790'	Kacha road crossing near Korra village	-
61	32° 36.657'	72° 56.250'	Near Golpur village	Sparrow, Lapwing, Crow
62	32° 35.589'	72° 53.291'	Near Bhelowal village	Myna, Crow
63	32° 31.804'	72° 49.428'	On motorway near Bhera Rest area	-



Figure 6.34: Grey Partridge and Wild Jackal Observed during Fauna Monitoring

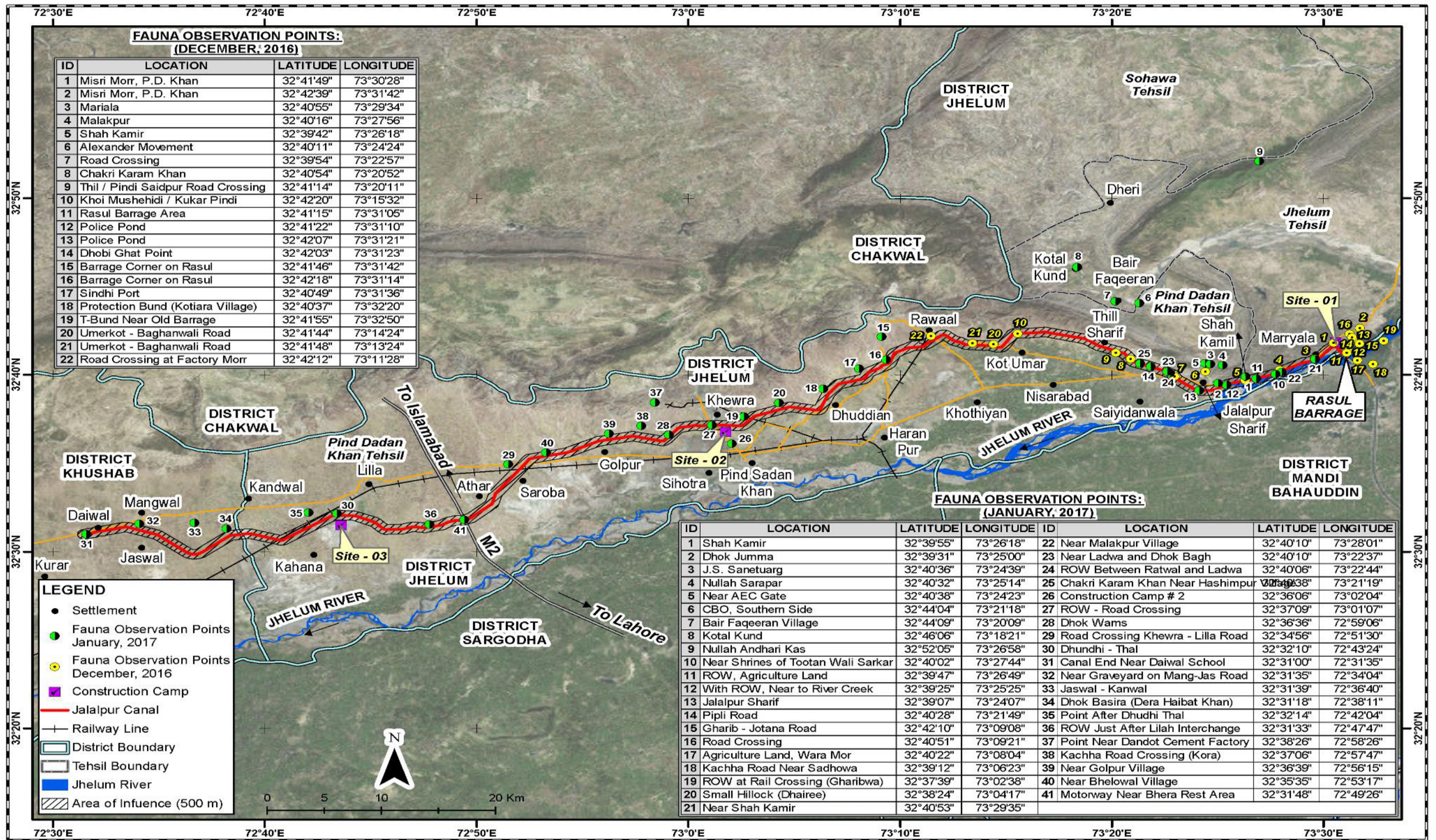


Figure 6.35: Fauna Observation Points in project area and project's AOI

6.5.3. Aquatic Ecology

324. The Punjab province has been bestowed with huge water resources wherein both types of ecosystems exist in the form of lotic and lentic waters including Jhelum. The running waters display typical characteristics with regard to temperature, turbidity, silting patterns, etc. The lentic waters are represented by natural lakes, man-made reservoirs, small dams, water-logged areas, ponds, etc. Food value of fish has been recognized all over the world. Proteins have a key role in human diet for proper growth and other vital activities and fish is regarded as an excellent source of protein.

325. Pakistan possesses immense aquatic resources particularly freshwater fisheries and River Jhelum is one of such resources where a huge water body in the form of Rasul Barrage is available in the project vicinity. Fish is the most abundant and successful of all vertebrates encountered in water. River Jhelum flows along the southern boundary of the project area upto PD Khan, after which it follows further downwards towards Khushab. Rasul Barrage is a water reservoir with about 12 km² surface area with varying depths. Fish like Gulfam, Rohu, Takla, Tilapia are reported at Rasul Barrage (Refer **Figure 6.36**). Fisheries Department is managing the aquaculture profitably. The most commonly available species is Gulfam. Fisheries Department conducts auction for sale of fish in Rasul-Qadirabad Link canal, Lower Jhelum canal and Govt. Fish Farms every year/periodically. The auction money for the year 2017 has been indicated by the government department as under:

<u>Location</u>	<u>Amount (Pak-Rupees)</u>	<u>Period of Auction</u>
i) Pond area:	Rs. 450,000	one year
ii) RQ Link:	Rs. 700,000	one year
iii) LJ canal:	Rs. 430,000	one year
iv) Govt. Fish Farms	Rs. 510,000	Three year

326. The Salt Range falls under Mehran region and has following composition of reported species as shown in **Table 6.30**. (Manual Punjab Fisheries and Tourism Department).

Table 6.30: Fish Species in project area

Sr. No.	Common Name	Family Name	Scientific Name	IUCN Status
1	Gulfam	Cyprinidae	<i>Cyprinus carpio</i>	VU
2	Malhee	Siluridae	<i>Wallago attu</i>	NT
3	Mori	Cyprinidae	<i>Cirrhinus mrigala</i>	LC
4	Rahu	Cyprinidae	<i>Labeo rohita</i>	LC
5	Silver Carp	Cyprinidae	<i>Hypophthalmichthys molitrix</i>	NT
6	Thaila	Cyprinidae	<i>Catla catla</i>	NA
7	Tilapia	Osphranomidae	<i>Oreochromis mossambica</i>	NA
8	Grass Carp	Cyprinidae	<i>Ctenopharyngodon idella</i>	NA
9	Khaga	Bagridae	<i>Rita rita</i>	LC
10	Singhari	Bagridae	<i>Aorichthys aor</i>	LC
11	Kalbans	Cyprinidae	<i>Labeo calbasu</i>	LC



Figure 6.36: Fish catching at Head Rasul and Gulfam Fish on Right Side

6.5.4. Habitat and Biodiversity Conservation

327. Biodiversity Conservation status of project's AOI is discussed according to the zones/sampling sites mentioned in Table 6.23 above.

328. *Zone-1 (Head Rasul Game Reserve area and along Main canal Alignment upto RD 0+000 to RD 45+000)*; this wetland area located at the fringe of water and land is supporting comparatively rich and diversified ecosystem. Rasul Barrage being man-made water body is a site, where migratory waterfowls are winter visitors along with local avi-faunal species. On account of prevailing nature of the area, the Zone is categorized as Modified Habitat because of the conversion of natural habitat from river flow to formation of water body for storage purposes.

329. *Zone-2 (Facultative Production Zone)*; area of this zone spreading from Ladwal to Rawal and Sodhi Gujjar, is also considered as an altered form of natural habitat due to introduction of agricultural practices in most of the area replacing the scrub and sub-tropical thorn vegetation with alien cash crops. The area has significantly changed to Modified Habitat and, thus, would require mitigation measures like tree plantation as mentioned in Tree Plantation Plan given in EMP, in accordance with Biodiversity Conservation characteristics.

330. *Zone-3 (Marginal to No Productivity area)*; This zone spreads over from Sodhi Gujjar to Khewra, Behlowal, and to Daiwal. The land is rugged with scanty, stunted and bushy or no growth of vegetation. The natural habitat has been degraded in the past on account of anthropogenic activities including persistent over-grazing and fuel wood cutting. The mitigation measures for the impacts would, therefore, essentially base on biological improvement approach such as Range Management and Forestry activities as mentioned in Impact and Mitigation section.

6.5.5. Ecosystem Sensitivities

331. At the detailed design stage, Consultant has assessed the status of the biological aspects including wildlife protected/sensitive areas along the updated alignment within the project's AOI. The sensitive areas identified in the previous EIA and updated at the detailed design stage in the vicinity of the project's AOI is as follows;

- Head Rasul Game Reserve
- Jalalpur Wildlife Sanctuary
- Rakh Kandal Wildlife Sanctuary
- CBO Western Jhelum
- Thill Unclassed Forest

332. Consultants, through PID, requested Director General Punjab Wildlife and Parks Department for the identification of the Wildlife Sensitive/Reserved/ Protected/Community

Based Organizations Protected areas in the vicinity of the proposed alignment of the canal *vide* their letter No. PMU/LBDCIP/IPD/7777 dated 28-10-2016. Consultant Environment team pursued the Department to get required details of the protected areas in the vicinity of the proposed alignment of the canal (Rasul Barrage Game Reserve, Jalalpur Wildlife Sanctuary and Community Based Organizations managed *Urial* habitats). Client's letter to the DG Punjab Wildlife and Parks Department is attached as **Appendix-VII**. The purpose of this exercise was to evaluate the ecological sensitivities of Jalalpur Irrigation project JIP, which occupies most of Pind Dadan Khan Tehsil of Jhelum district and which terminates in tehsil Khushab of Khushab district. These two tehsils Jhelum and Khushab districts have their recognition as an integral part of Salt Range. To have a better understanding an overview of the collective picture have been considered worth discussing.

333. The EIA team undertook detailed visits of the project area and its surroundings to ascertain whether the project area overlaps with any of the above mentioned wildlife parks or reserves. After a thorough review and revalidation by the concerned Government Departments, it has been found that the JIP project area does not interfere or overlap with any of the declared ecologically sensitive areas, neither does its boundary touch such an area. For the purpose of this EIA, the JIP area has been fragmented into designated zones for a more realistic analysis. Only zone 1, area connecting the system with Rasul Barrage (stretching from Barrage to Jalalpur Sharif) is found to be situated relatively closer to, but outside the boundary of ecologically sensitive locations, whereas, other zones fall far apart from any significant ecological sensitivity.

334. The concerned department confirmed that the proposed alignment of the main canal for JIP does not cross through any ecological sensitive area *vide* their letter No. 5076/DDW-SR/2016 dated 23-11-2016. Punjab Wildlife and Parks Department's letter is attached as **Appendix-VIII**. Revalidation reveals that the closest point of ecological sensitive area Jalalpur Wildlife Sanctuary is at a distance of about 1.3 km away from the project's AOI, whereas, other sensitive areas fall far apart from JIP alignment. It is also clear from the **Figure 6.37** that the AOI for the proposed project is clearly outside the eco-sensitive Salt Range, though it lies near to Rasul Barrage and Jalalpur Wildlife Sanctuary.

335. Pind Dadan Khan tehsil of Jhelum District, mainly constitute the most of JIP bounded on the south-east by the Jhelum River, and is traversed in its northern portion by the Salt Range. The hills consist of two roughly parallel ranges about 6 mile (10 km apart), with a strip of richly cultivated and fairly level uplands between. The southern slopes of the hills are steep and barren. The rest of the tehsil consists of a belt of alluvial plain, a portion of which is much affected by saline deposits. The apparent economic look of the area shows a pastoral tilt, not heavily depending on direct agriculture.