Initial Environmental and Social Examination Report

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Bangladesh: Muktagacha Solar Power Project

PART 2

Prepared by EQMS Consulting Limited for the Asian Development Bank (ADB).

5.5 Environmental Quality

5.5.1 Ambient Air Quality

The objective of the ambient air quality monitoring program was to establish the baseline ambient air quality in the study area. The study area resembles a predominantly rural landscape with villages interspersed between homestead plantations and agricultural lands. The major emission sources in the study area are mainly existing industry, road dust, black smoke from diesel engine vehicles, domestic heating, and cooking, etc.

Monitoring locations were initially selected using aerial photography and imagery, locally available knowledge about villages and settlements, accessibility, and safety to determine the location of nearby sensitive receptors.

The ambient air quality was monitored at four locations across the study area during the monitoring period (April 2024). The ambient air quality parameters studied were Particulate Matter (PM_{10}, $PM_{2.5}$), Sulfur Dioxide (SO_2), Oxides of Nitrogen (NO_X), and Carbon Monoxide (CO). The ambient air parameters were monitored for 24 hours and compared with the Bangladesh Standards.

5.5.1.1 Ambient Air Quality Monitoring Locations

Monitoring locations were chosen to determine the general background concentration in close proximity to human receptors that may be affected by the project activities.

The ambient air quality monitoring locations were based on the following aspects covered in the field survey plan developed prior to the fieldwork:

- AAQ Monitoring at the Project site
- Meteorological conditions of the area.
- The topography of the study area.
- Location of sensitive receptors such as major settlements.

Details of the ambient air quality monitoring locations are presented Table 5-4 and Figure 5-16.

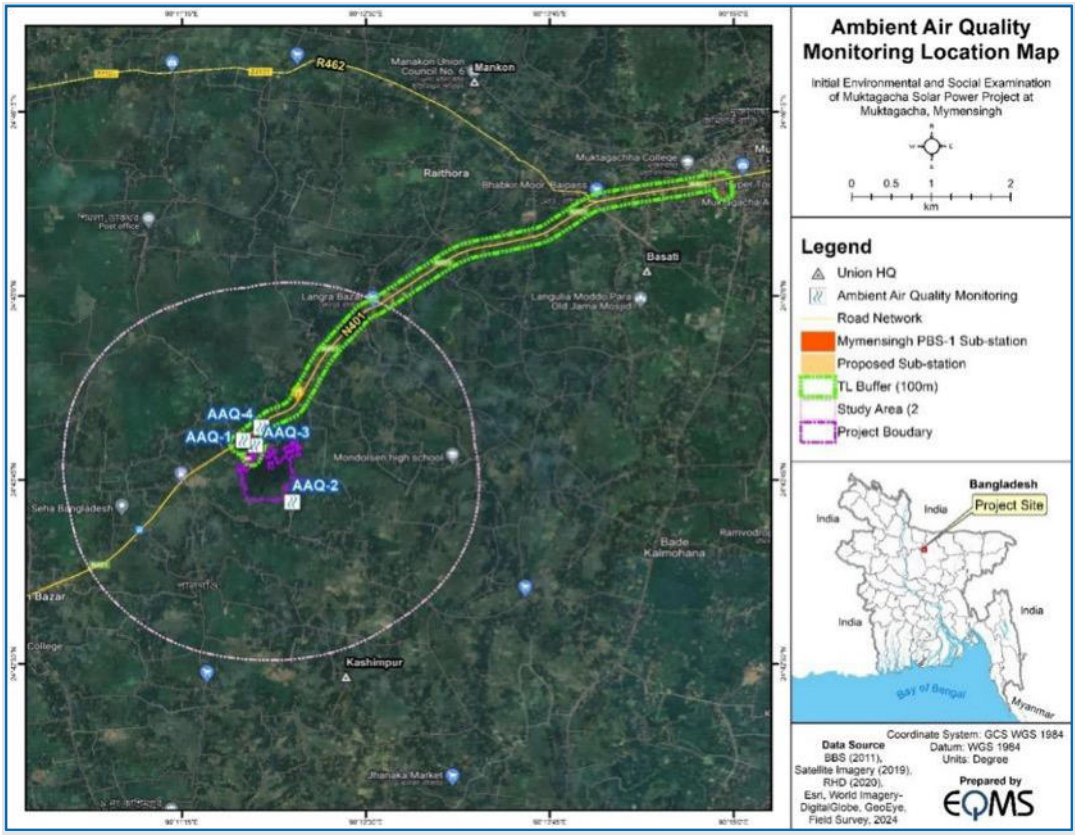
Table 5-4: Ambient Air Quality Monitoring Locations

SL#	Sampling Code	Sampling Locations	Coordinates	Monitoring Date	Selection Criteria
1	AAQ-1	Nimuria Middle Para at the northwestern side of the proposed solar power plant and at transmission line route (approximately 160 m from the solar plant area and 0 m from the transmission line)	24°44’1” N 90°11’40” E	18.04.2024	Project Site and prevailing wind blowing side
2	AAQ-2	In Front of Monir Mondal House, Raghunathpur at the southeast side of the proposed solar plant (approximately 118 m from the proposed power plant)	24°43’36” N 90°11’60” E	19.04.2024	Major Settlement
3	AAQ-3	Proposed Solar power plant	24°43’59” N 90°11’45” E	17.04.2024	Project site

SL#	Sampling Code	Sampling Locations	Coordinates	Monitoring Date	Selection Criteria
4	AAQ-4	Tota Mia House, Nimuria at the eastern side of the Transmission line route (approximately 20 m from the proposed transmission line route)	24°43'56" N 90°11'32" E	18.04.2024	Nearest Settlement

Source: Field Survey by EQMS Team, 2024

Figure 5-16: Ambient Air Quality Monitoring Location Map



Source: Field Survey by EQMS Team, 2024

Pictures taken during air quality monitoring are shown in Figure 5-17.

Figure 5-17: Photographs of Ambient Air Quality Monitoring

	
AAQ1	AAQ 2
	
AAQ 3	AAQ 4

Source: Field Survey by EQMS Team,2024

5.5.1.2 Ambient Air Quality Monitoring Results

The summary of the ambient air quality results in pre-monsoon period is presented in Table 5-5

Table 5-5: Summary of Ambient Air Quality Monitoring Results

Sl.	Sampling code	Sampling date	Ambient air pollution concentration in µg/m³				CO mg/m3
			PM10 µg/m³	PM2.5 µg/m³	SO_2 µg/m³	NO_x µg/m³	
1.	AAQ1	18.04.2024	76.67	22.75	11.54	14.33	0.20
2.	AAQ2	19.04.2024	28.47	18.17	14.16	20.24	0.14
3.	AAQ3	17.04.2024	66.15	28.82	10.38	22.73	0.12
4.	AAQ4	18.04.2024	39.78	19.27	15.62	24.40	0.19
Duration (hours)			24	24	24	24	8
Air Pollution (control) Rules, 2022			**150**	**65**	**80**	**80**	**5**

Sl.	Sampling code	Sampling date	Ambient air pollution concentration in µg/m³				CO mg/m3
			PM10 µg/m³	PM2.5 µg/m³	SO_2 µg/m³	NO_x µg/m³	
WHO Standard			**50**	**25**	**20**	**40 (Annual)**	**-**
Method of Analysis Instrument Use: Haz-Scanner TM (HIM, 6000)			Particulates Sensor Light Scattering Nephelometer		High Sensitivity Electrochemical		

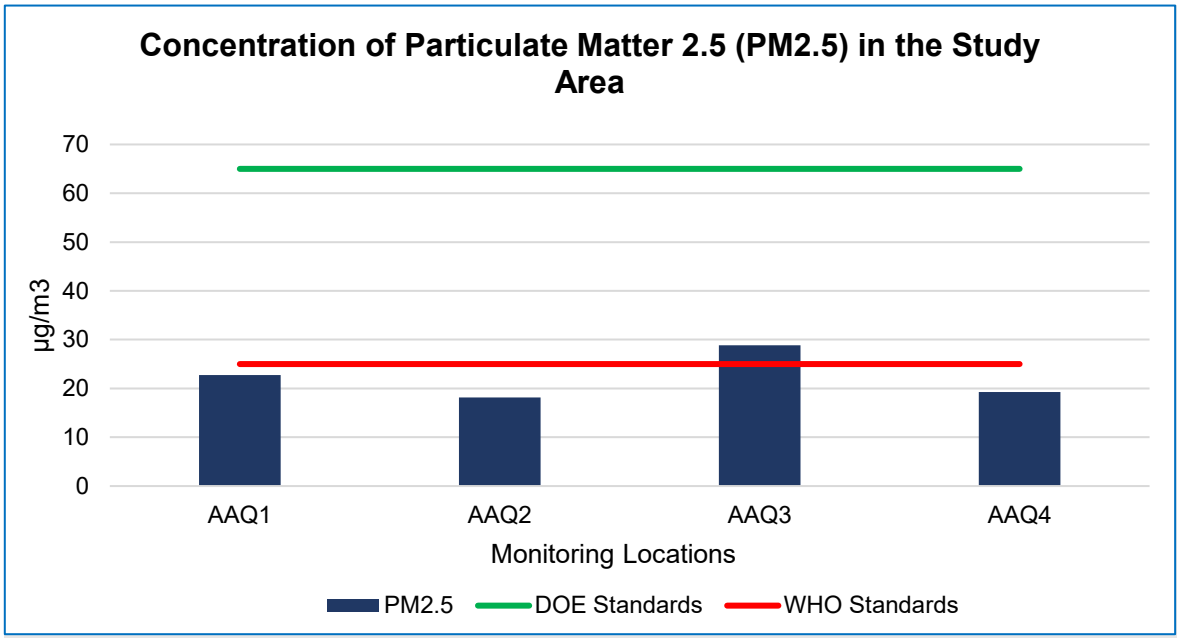
Source: Field Measurement and Laboratory Analysis by EQMS, 2024

5.5.1.3 Interpretation of Ambient Air Monitoring Results

Particulate Matter ($PM_{2.5}$)

The concentrations of $PM_{2.5}$ in the monitoring locations during study period ranged from 18.17 µg/m³ to 22.75 µg/m³. The lowest concentration was recorded in Monir Mondal House, Raghunathpur while highest concentration was recorded inside the solar power plant site due to traffic movements happened on the access road to the proposed power plant site and dust from the unpaved access road. The concentrations of $PM_{2.5}$ in the study area are shown in Figure 5-18.

Figure 5-18: Concentrations of $PM_{2.5}$ in Study Area

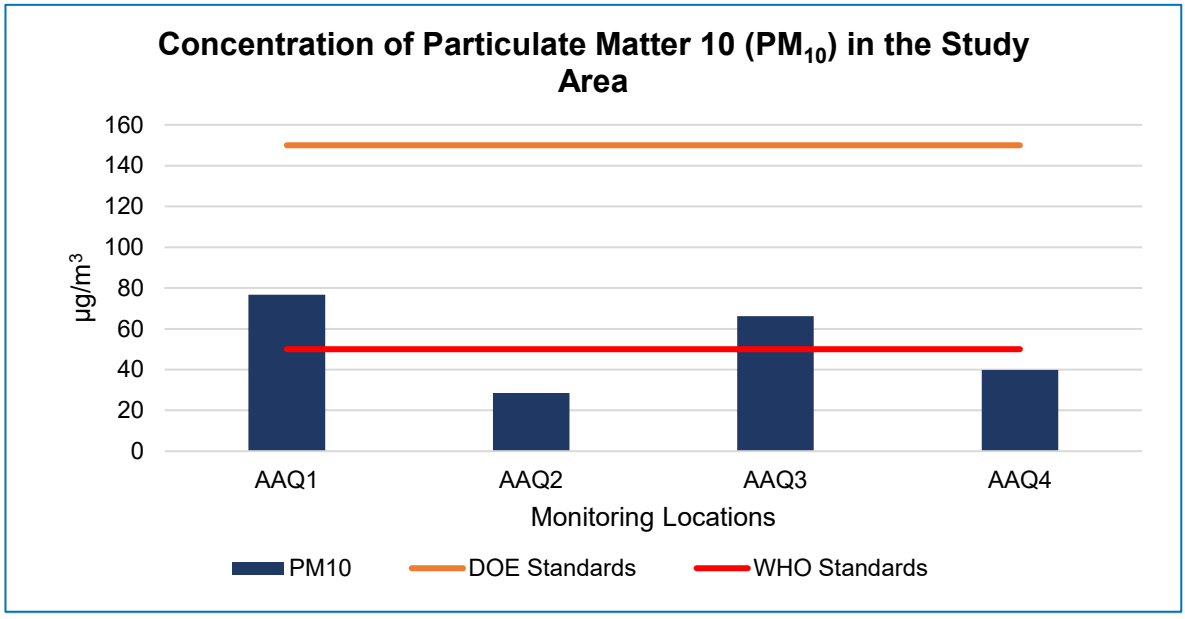


Source: Field Measurement and Laboratory Analysis by EQMS, 2024

Particulate Matter (PM_{10})

The concentrations of PM10 in the monitoring locations during the study period ranged from 28.47 µg/m3 to 76.67 µg/m3. Lowest concentration was recorded at Monir Mondal House, Raghunathpur while highest concentration was recorded inside Nimuria Middle Para. PM 10 level do not meet WHO threshold at AAQ1 and AAQ3 due to traffic movement. The concentrations of PM10 in the study area are shown in Figure 5-19.

Figure 5-19: Concentrations of PM_{10} in study area

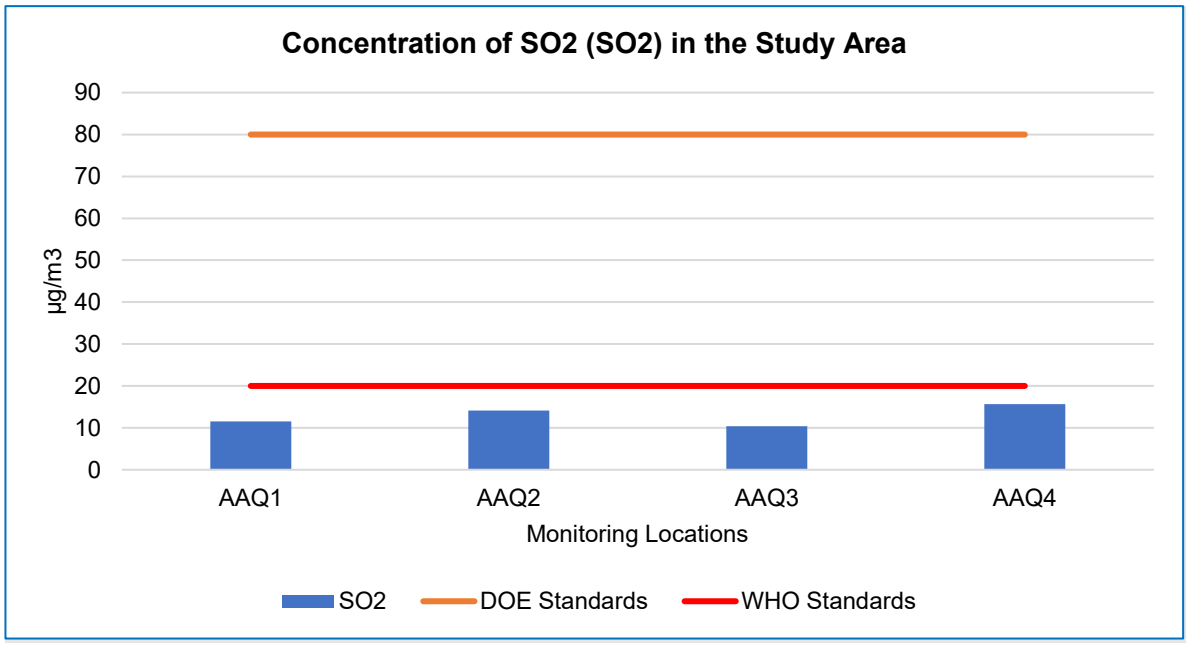


Source: Field Measurement and Laboratory Analysis by EQMS, 2024

Sulfur dioxide (SO_2)

The average concentrations of SO_2 in the monitoring locations during study period ranged from 10.38 µg/m³ to 15.62 µg/m³. The SO_2 concentrations at all stations were found to be in compliance with the WHO and Bangladesh Standards. The lowest concentration was recorded at project area while highest concentration was recorded Tota Mia House, Nimuria. The concentrations of SO_2 in the study area are shown in Figure 5-20

Figure 5-20: Concentrations of SO_2 in Study Area

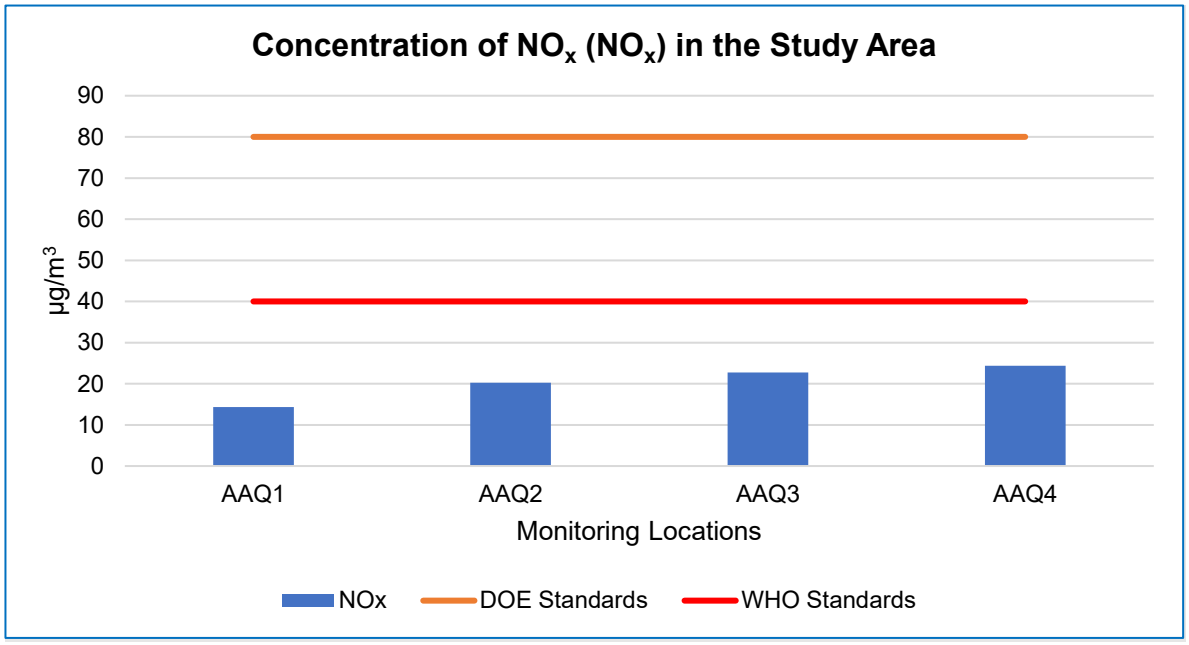


Source: Field Measurement and Laboratory Analysis by EQMS, 2024

Nitrogen Oxides (NO_X)

The average concentrations of NO_x in the monitoring locations during the study period ranged from 14.33 µg/m^3 to 24.4 µg/m^3. The SO_x concentrations at all stations were found to be in compliance with the WHO and Bangladesh Standards. The lowest concentration was recorded at Nimuria Middle Para while highest concentration was recorded at Tota Mia House, Nimuria. The concentrations of NO_X in the study area are shown in Figure 5-21.

Figure 5-21: Concentrations of NO_X in Study Area

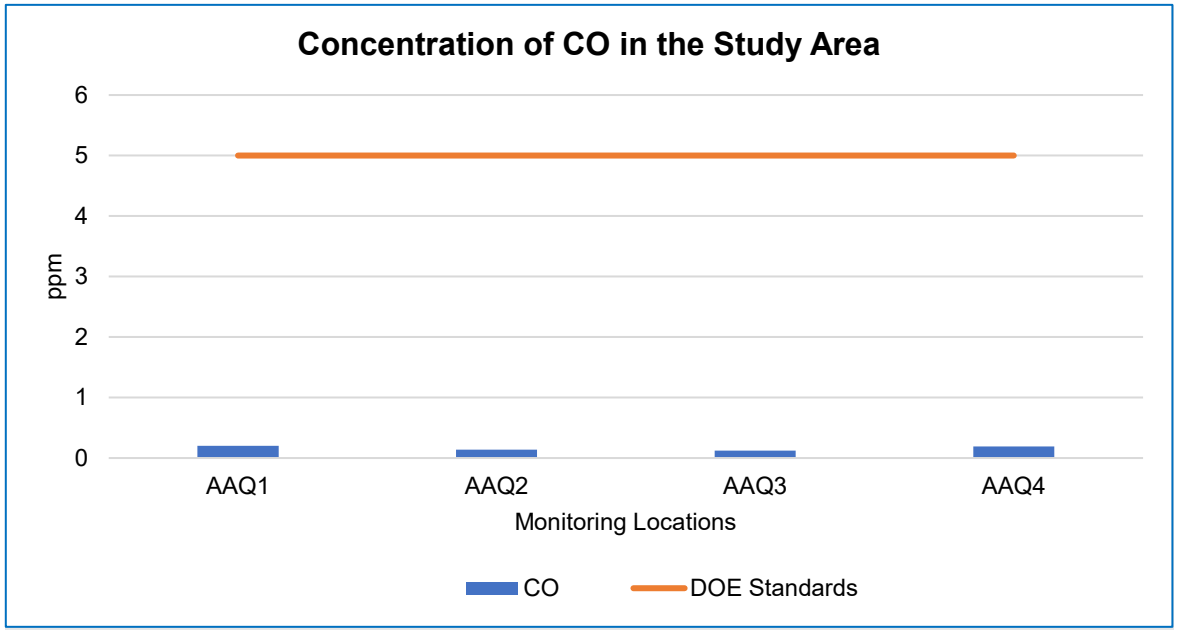


Source: Field Measurement and Laboratory Analysis by EQMS, 2024

Carbon Monoxide (CO)

The concentration of CO in the monitoring locations during study period ranged between 0.12 ppm to 0.2 ppm. The CO concentrations at all stations were found to be in compliance with the Bangladesh Standards. The concentrations of CO in the study area are shown in Figure 5-22.

Figure 5-22: Concentrations of CO in Study Area



Source: Field Measurement and Laboratory Analysis by EQMS, 2024

5.5.2 Ambient Noise Quality

Noise monitoring was conducted at five locations (Residential, Silent and Project Area) as per the DOE, Bangladesh guideline within the study area during baseline survey. The purpose of ambient noise level measurement was to determine the sound intensity at the monitoring locations. These locations are chosen in such a way that representative data could be recorded all over the study area. Noise measured is assessed against the IFC and DOE criteria. The IFC noise level guidelines and Bangladesh noise level guidelines are given in Table 5-6 and Table 5-7.

Table 5-6: IFC noise level guidelines [7]

SL#	Receptor	One Hour Leq in dB(A)	
		Day-time 07:00 – 22:00	Night-time 22:00 – 07:00
1.	Residential; institutional; educational [8]	55	45
2.	Industrial; commercial	70	70

Source: Guidelines for Community Noise, World Health Organization (WHO), 1999

Table 5-7: Bangladesh noise level guidelines

SL#	Receptor	Limit in dB(A) Leq	
		Day-time 06:00 – 21:00	Night-time 21:00 – 06:00
1.	Silent	50	40

[7] Guidelines values are for noise levels measured out of doors. Source: Guidelines for Community Noise, World Health Organization (WHO), 1999.

[8] For acceptable indoor noise levels for residential, institutional, and educational settings refer to WHO (1999).

SL#	Receptor	Limit in dB(A) Leq	
		Day-time 06:00 – 21:00	Night-time 21:00 – 06:00
2.	Residential	55	45
3.	Mixed	60	50
4.	Commercial	70	60
5.	Industrial	75	70

Source: Noise Pollution (Control) Rules, 2006

5.5.2.1 Sampling Methodology

Ambient noise levels (equivalent continuous sound pressure level with "A" frequency weighting – LAeq) were monitored at five locations to capture the ambient noise close to the proposed project location. A noise data logger was used to monitor ambient noise levels. The readings were taken every minute for 24 hours. The day noise levels were monitored from 6 am to 9 pm and night levels from 9 pm to 6 am at all the locations covered within the study area.

5.5.2.2 Ambient Noise Monitoring Locations

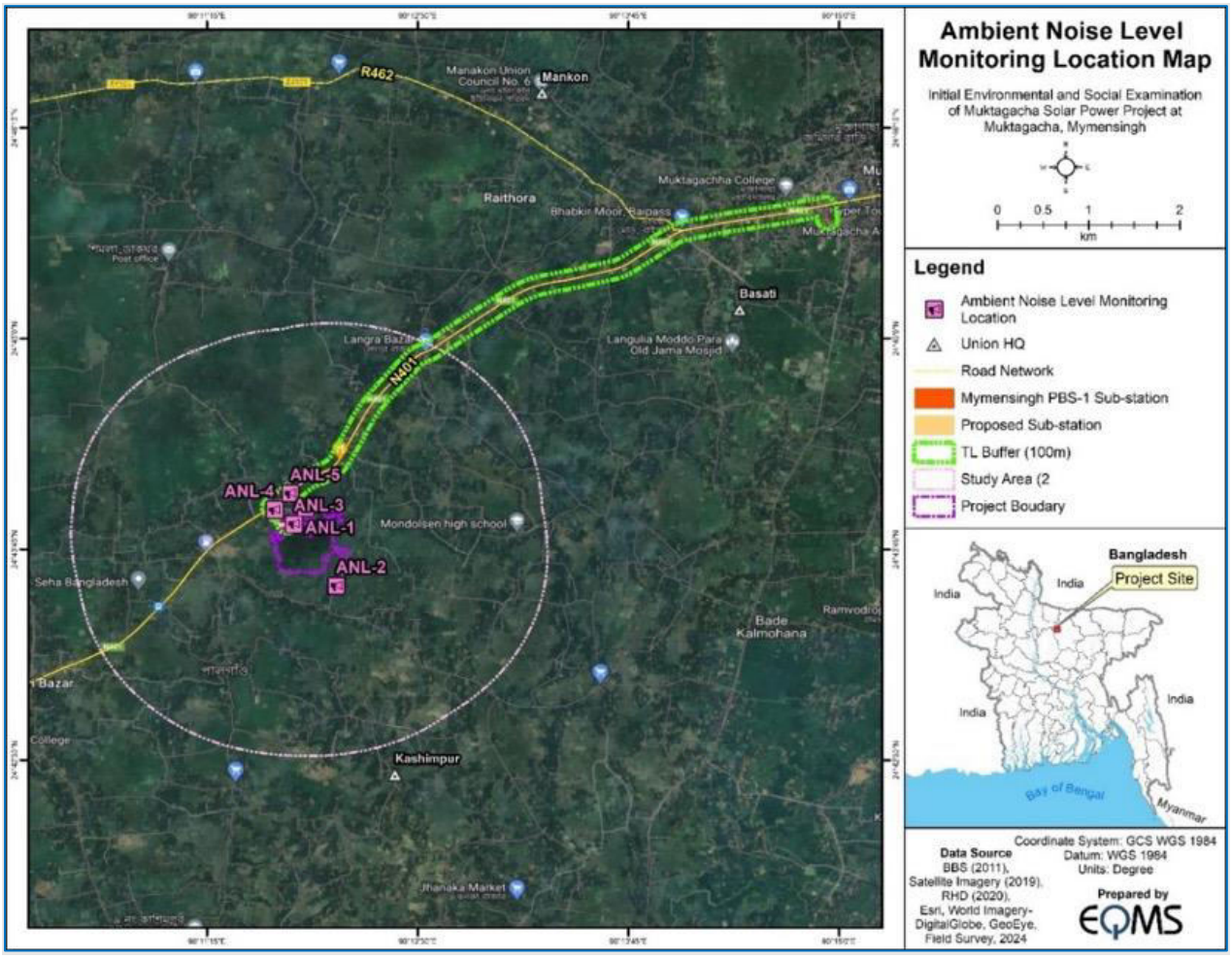
Noise monitoring was conducted at five locations within the study area during the baseline survey in April 2024. These locations are chosen in such a way that representative data could be recorded all over the study area. Details of the ambient noise monitoring locations are presented in Table 5-8 and Figure 5-23

Table 5-8: Ambient Noise Monitoring Locations

SL#	Sampling Code	Location Description	Coordinates	Monitoring Date	Category of Area/Receptor
1.	ANL-1	Forhad Khan House, Nimuria at northeastern part of the transmission line (approximately 245 m from the proposed transmission line route)	24°44’0” N 90°11’50” E	19.04.2024	Residential
2.	ANL-2	Fala Mondal Jame Madrasa and Mosque, Raghunatpur at the north side of the solar power plant (aproximately 225 m from the proposed solar plant)	24°43’32” N 90°12’1” E	19.04.2024	Silent
3.	ANL-3	Nimuria at the proposed solar power plant	24°43’54” N 90°11’46” E	17.04.2024	---
4.	ANL-4	Nimuria Middle Para, near proposed transmission line route	24°43’59” N 90°11’39” E	18.04.2024	-
5.	ANL-5	Babul Mia House, Nimuria at northwestern side of the solar power plant (approximately 180 m from the proposed solar power plant)	24°43’57” N 90°11’32” E	18.04.2024	Residential

Source: Field Survey by EQMS Team, April 2024

Figure 5-23: Ambient Noise Monitoring Location Map



Source: Field Survey by EQMS Team, 2024

Pictures taken during noise monitoring are shown in Figure 5-24

Figure 5-24: Pictures taken during Noise Monitoring in and around Project Site

ANL-1

ANL-2

	
ANL-3	ANL-4

ANL-5

Source: EQMS Field Survey, April 2024

5.5.2.3 Interpretation of Noise Monitoring Results

The equivalent daytime and night-time noise levels in comparison to the respective national and international standards are tabulated in Table 5-9.

Table 5-9: Ambient Noise Level in the Study Area

SL#	Sampling Code	Location Setting (DOE)	Location Setting (IFC)	Time	Noise Level in dB(A)[9]			Bangladesh Standard[10]	IFC Guidelines
					Leq	L_{max}	L_{min}		
1.	ANL-1	Residential	Residential	Day	44.47	69.4	30.8	55	55
				Night	33.10			45	45
2.	ANL-2	Silent	Educational Institute	Day	57.66	73.4	38.4	50	55
				Night	51.08			40	45
3.	ANL-3	Project Area (inside power plant boundary)	Project Area (inside power plant boundary)	Day	55.87	60.3	36.8	-	-
				Night	40.71			-	-
4.	ANL-4	Project Area (near transmission line)	Project Area (near transmission line)	Day	53.96	57.9	34.7	-	-
				Night	46.49			-	-
5.	ANL-5	Residential	Residential	Day	47.87	65.5	31.8	55	55
				Night	29.15			45	45

Source: Field Survey by EQMS Team, April 2024

	Exceeding Standard

[9] A-weighted decibel, abbreviated dB(A), is an expression of the relative loudness of sounds in air as perceived by the human ear. In the A-weighted system, the decibel values of sounds at low frequencies are reduced, as the ear is less sensitive to low audio frequencies, especially below 1000 Hz, than to high audio frequencies.

[10] Ministry of Environment, Forest, and Climate Change. (2006). *Noise Pollution (Control) Rules, 2006* (S.R.O. No. 212-Law/2006). The People's Republic of Bangladesh.

Ambient noise at ANL-1 and ANL-4 are within the permissible limit set by DoE and IFC. The noise level at ANL-5, was found little higher than the acceptable limit due to human activity on that particular area. As this is a Madrasha and Mosque, students and people came here which significantly increased noise level. Noise at ANL-2 and ANL-3 are the project area.

5.5.3 Water Quality

5.5.3.1 Surface Water Quality

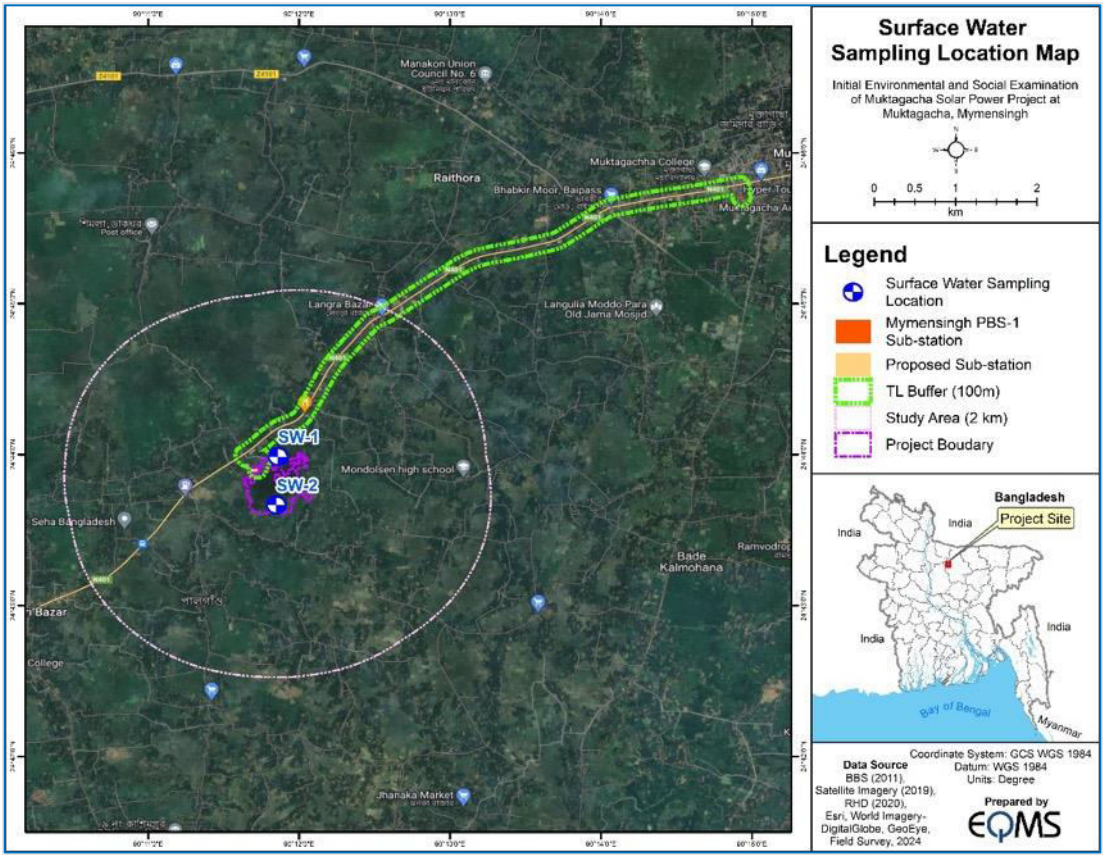
EQMS team has identified various sources of surface water in and around the proposed project site. There are many small and big ponds, beel present at the study area. Two (2) surface water samples have been collected during the baseline survey. The samples were analyzed for physical and chemical parameters. Water samples were collected as grab water samples in a pre-washed 1 -liter plastic jar for complete physiochemical tests. The samples were analyzed as per standard procedure given in the Table 5-11. The monitoring parameters are Temperature, pH, DO, TDS, BOD, COD, Nitrate, Ammonia, Total Chromium, Phosphate, Total Coliform and Fecal Coliform. The detail of the surface water sampling locations is presented in Table 5-10 and Figure 5-25

Table 5-10: Surface Water Sampling Location

SL#	Sampling Code	Location Description	Coordinates	Monitoring Date	Type of Source	Selection Criteria
1.	SWQ-1	Near Nimuria Moral Bari, at the north side of the proposed solar plant (approximately 18 m north from the proposed solar plant)	24°43’58” N 90°11’53” E	19.04.2024	Pond	Understand the existing surface water quality near the power plant area
2.	SWQ-2	Raghunathpur, inside the power plant boundary	24°43’40” N 90°11’51” E	19.04.2024	Beel	Understand the existing surface water quality inside the power plant area

Source: Field Survey by EQMS Team, 2024

Figure 5-25: Surface Water Sampling Locations



Source: Field Survey by EQMS Team, 2024

Pictures taken during sampling are shown in Figure 5-26.

Figure 5-26: Photographs taken during Surface Water Sampling

SWQ1- Nimuria

SWQ2- Raghunathpur

5.5.3.1.1 Interpretation of Surface Water Monitoring Results in pre-monsoon period

The analyzed results for surface water were compared to Bangladesh Standards (ECR,2023) and IFC EHS General Guidelines. Results of inland surface water analysis are presented in Table 5-11.

Table 5-11: Surface Water Analysis Result

SL#	Parameters	Unit	Surface Water Samples		Bangladesh Standard[11]		IFC/WB Standards[12]	Analysis Method
			SWQ-1	SWQ-2	Water Usable by Fisheries	Water Usable for Irrigation		
1.	Temperature	°C	22	22	-	-	NF	Ion electrode method
2.	pH	-	6.65	6.44	6 - 9	6.5 - 8.5	6-9	Ion electrode method
3.	DO	mg/L	5.8	5.6	5 or more	-	NF	Ion electrode method
4.	TDS	mg/L	170	170	1000	1000	NF	Ion electrode method
5.	BOD	mg/L	3.6	3.9	6 or less	12 or less	50	Ion electrode method
6.	COD	mg/L	42	45	50	100	250	USEPA 410.4 approved method
7.	Nitrate	mg/L	1.5	0.7	-	-	NF	Cadmium Reduction
8.	Ammonia	mg/L	0.25	0.29			NF	Photometric method
9.	Total Chromium	mg/L	0.004	0.003			0.5	Amino acid method
10.	Phosphate	mg/L	1.3	0.9			NF	EPA method 200.7
11.	Total Coliform	n/100 ml	64	58	-	-	NF	AFNOR approved method compared to ISO 4832 method
12.	Fecal Coliform	n/100 ml	18	15	-	-	NF	AFNOR approved method compared to NF V08-017 method.

[11] According to Schedule-2 (KA) of Environmental Conservation Rules, 2023, the Government of Bangladesh

[12] ** IFC: General EHS Guideline

All analyzed parameters of the water quality are within acceptable standard values, indicating that the water is safe and suitable for both fisheries and irrigation purposes. Some water quality parameters are discussed below.

pH

The value of pH in the surface water samples are 6.65 and 6.44. From the test result it was found that pH of the surface water is in acceptable limit**.**

TDS

TDS of SW1 and SW2 samples are 170 and 170 mg/l respectively.

Chemical Oxygen Demand (COD):

Chemical Oxygen Demand in the surface water samples are 42 and 45 mg/l.

Biochemical Oxygen Demand (BOD):

Biochemical Oxygen Demand were 3.6 and 3.9 mg/l in surface water samples.

Dissolve Oxygen (DO):

Dissolved Oxygen was observed at 5.8 and 5.6 mg/l. The water quality indicates that fish species can survive in the water body.

5.5.3.2 Groundwater Quality

Groundwater is most important for drinking, household uses, commercial activities, and irrigation purposes. Groundwater is available in the study area. Two (2) groundwater (deep wells) samples have been collected during the baseline survey from the study area. Parameters such as temperature, pH, total dissolved solids (TDS) and EC were measured onsite. Water samples were collected as grab water samples in a pre-washed 2-litre plastic jerry can and a 250 mL sterilized PET bottle for complete physiochemical and bacteriological tests, respectively. The monitoring parameters are Aluminum, Ammonia (NH3), Arsenic, Calcium, Chloride, Chromium (total), Copper, Cyanide, Fluoride, Iron, Magnesium, Manganese, Nickel, Nitrate, Nitrite, Oil and grease, pH, Potassium, and Coliform (fecal)

The detail of the ground water sampling locations is presented in Table 5-12 and Figure 5-27

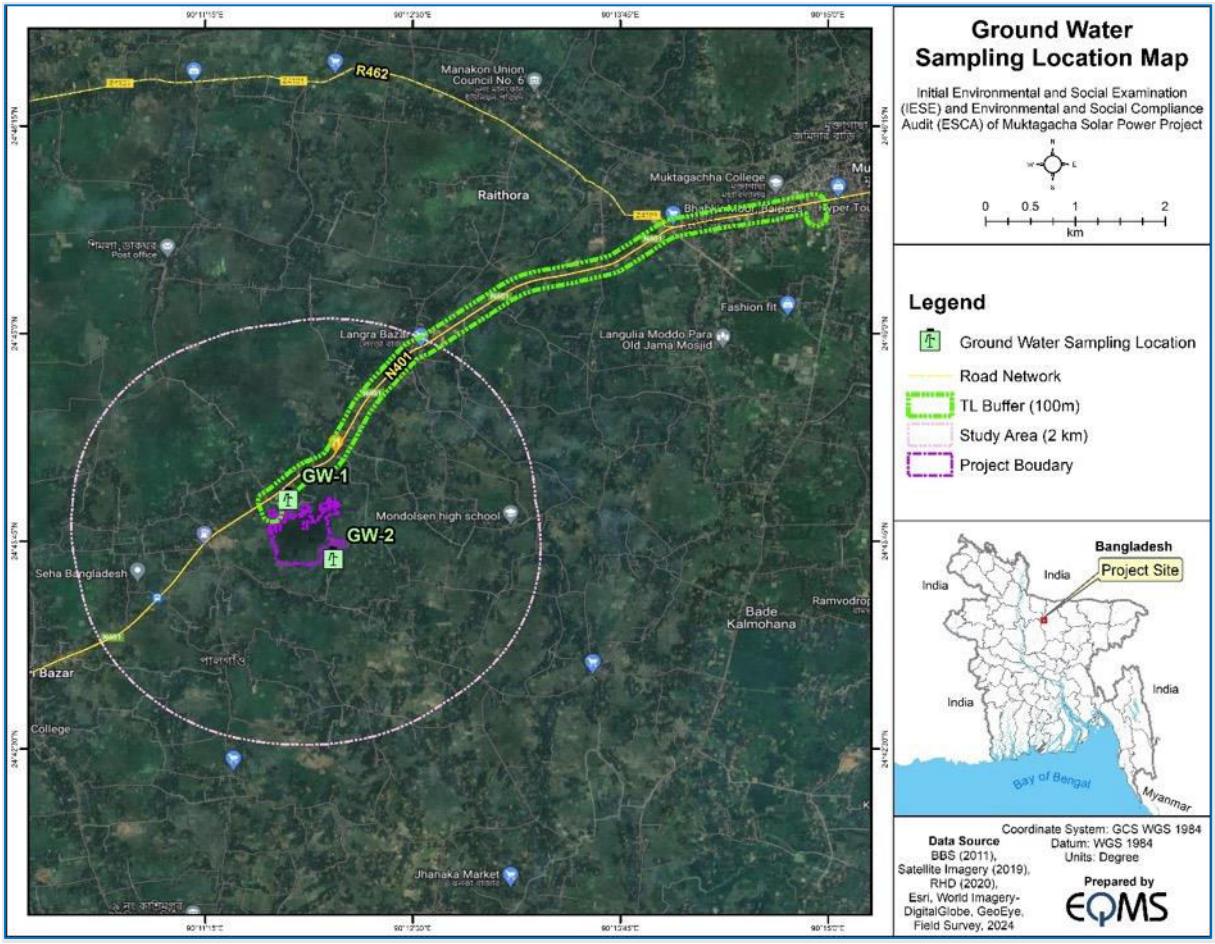
Table 5-12: Ground Water Sampling Location

SL#	Sampling Code	Location Description	Coordinates	Monitoring Date	Type of Source	Selection Criteria
1.	GWQ-1	Ruhul Amin House, Nimuria, at north side of the proposed power plan (approximately 50 m from the proposed power plant side)	24°43’60” N 90°11’45” E	19.04.2024	Tubewell	To understand the existing baseline and potential impact from project activities
2.	GWQ-2	Monir Mondal House, Raghunatpur at south east side of the prosed power plant	24°43’35” N 90°12’2” E	19.04.2024	Tubewell	To understand the existing baseline and potential impact from project activities

SL#	Sampling Code	Location Description	Coordinates	Monitoring Date	Type of Source	Selection Criteria
		(approximately 168 m form the power plant)				

Source: Field Survey by EQMS Team, 2024

Figure 5-27:Ground Water Sampling Locations



Source: Field Survey by EQMS Team, 2024

Pictures taken during pre-monsoon period sampling are shown in Figure 5-28.

Figure 5-28: Photographs taken during Ground Water Sampling

	
GWQ1- Project Area	GWQ1- Nimuria

5.5.3.2.1 Interpretation of Ground Water Monitoring Results

The analyzed results for ground water were compared to Bangladesh Standards (ECR,2023). Results of water analysis are presented in Table 5-13

Table 5-13: Groundwater Analysis Results in Pre-Monsoon Period

SL #	Parameters	Unit	Groundwater Quality				Analysis Method
			GWQ-1	GWQ-2	Bangladesh Standard[13]	IFC/WB Standard[14]	
1.	Aluminum	mg/L	<0.01	<0.01	0.20	NF	Ion electrode method
2.	Ammonia (NH3)	mg/L	0.07	<0.01	1.50	NF	High-Temperature Combustion Method
3.	Arsenic	mg/L	<0.01	<0.01	0.05	0.01	Modified Gutzit method
4.	Calcium	mg/L	10.0	12.1	75	NF	Spectrophoto metric method
5.	Chloride	mg/L	3.0	1.5	250	NF	Mercury (II) thiocyanate Method
6.	Chromium (total)	mg/L	<0.01	<0.01	0.05	0.05	EPA 200.8 method
7.	Copper	mg/L	0.06	0.03	1.5	NF	Adaptation of EPA 200.8 method

[13] According to Schedule-2 (KHA) of Environmental Conservation Rules, 2023, the Government of Bangladesh

[14] IFC: International Finance Corporation, WB: World Bank

SL #	Parameters	Unit	Groundwater Quality				Analysis Method
			GWQ-1	GWQ-2	Bangladesh Standard[13]	IFC/WB Standard[14]	
8.	Cyanide	mg/L	<0.001	<0.001	0.05	NF	Pyridine–Pyrazalone method
9.	Fluoride	mg/L	<0.01	<0.01	1.0	1.5	Photometric ion selective method
10.	Iron	mg/L	0.03	0.02	0.3-1.0	NF	EPA Phenanthroline method 315 B
11.	Magnesium	mg/L	7	10	30-35	NF	Calmagite method
12.	Manganese	mg/L	0.01	0.01	0.4	NF	Periodate method
13.	Nickel	mg/L	<0.01	<0.01	0.05	NF	Pyridylazo)-2-Naphthol by Colorimetric method
14.	Nitrate	mg/L	0.1	<0.01	45	NF	Cadmium Reduction
15.	Nitrite	mg/L	<0.01	<0.01	1.0	NF	Ferrus Sulfate method
16.	Oil and grease	mg/L	<0.01	<0.01	0.01	NF	USEPA1 Hexane Extractable Method
17.	pH	--	6.54	6.57	6.5-8.5	6-9	Ion Electrode Method
18.	Potassium	mg/L	2.1	2.4	12	NF	Turbidimetric tetraphenylborate
19.	Coliform (fecal)	mg/L	0	0	0	NF	AFNOR approved method
20.	Coliform (total)	mg/L	0	0	0	NF	AFNOR approved method

Source: Laboratory Analysis by EQMS Laboratory, 2024

The key parameters in groundwater are discussed below, compared with the Bangladesh ECR'23 Standards for drinking water.

pH

The value of pH in the surface water samples are 6.54 and 6.57. From the test result it was found that pH of the surface water is in acceptable limit**.**

Iron

Iron of GWQ-1 and GWQ-2 samples are 0.03 and 0.02 mg/l respectively.

Calcium

Calcium in the ground water samples is 10 and 12.1 mg/l.

Magnesium

Magnesium was 7 and 10 mg/l in ground water samples.

5.5.4 Soil Quality

The soil quality of the study area is assessed through primary monitoring result. As part of this study, soil quality was monitored in two locations at nearby open fields.

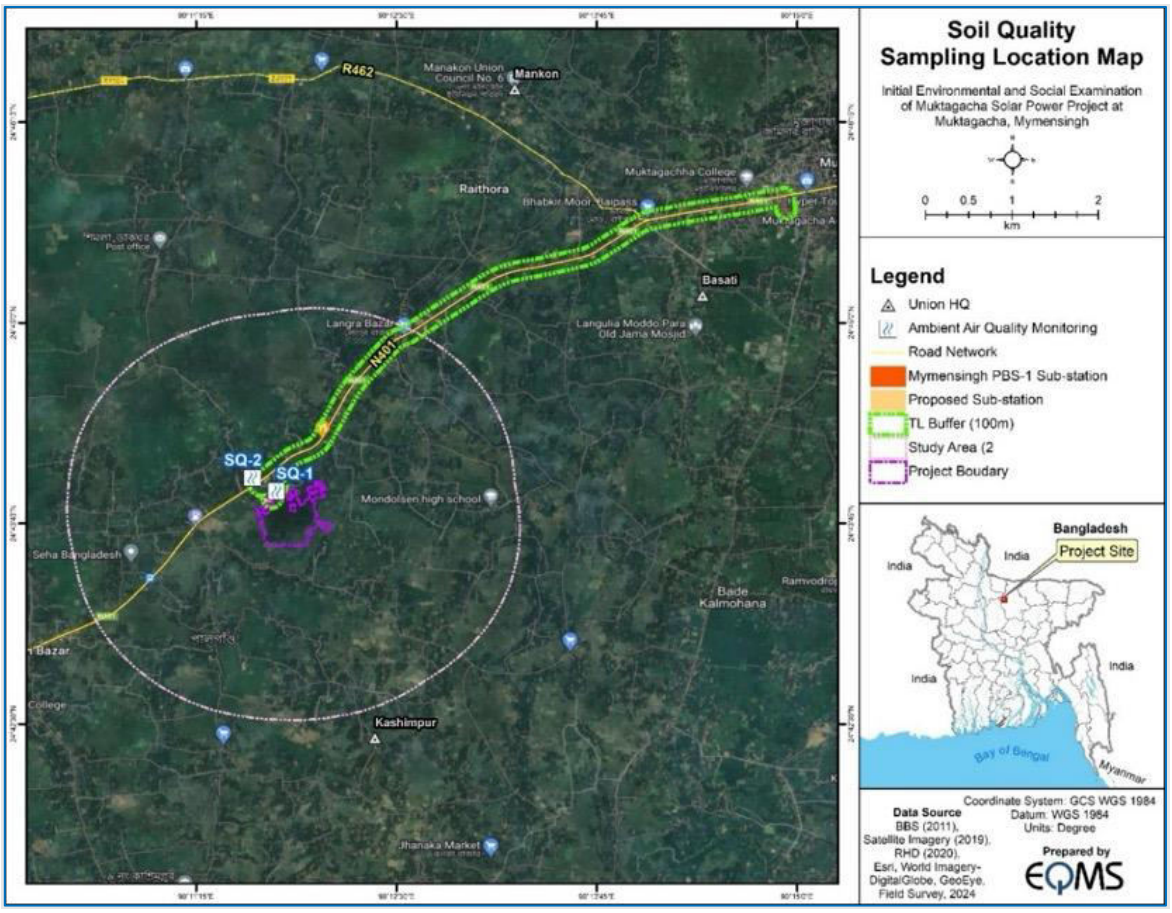
A soil sampling procedure was followed by the EQMS to ensure the quality of soil sample collection. The sample was stored in a plastic jar, sealed, and sent to the laboratory for pollution analysis. The detail of the soil sampling location is presented in Table 5-14 and Figure 5-29. Analysis of soil also includes monitoring the following parameter Cd, Ni, Zn, Cu, Pd, Cr, Fe, Mn, Hg,. and As with the objective of establishing baseline values for such contaminants (if present in the soil). A secondary literature review on certain parameters (available ones) has been discussed below as well. Lab repost test result discussion also done in the below.

Table 5-14: Soil sampling locations

SL#	Sampling Code	Location Description	Coordinates	Monitoring Date	Selection Criteria
1.	SQ-1	Inside the solar power plant area	24°43’57” N 90°11’45” E	17.04.2024	To understand the existing baseline and potential impact from project activities
2.	SQ-2	Nimuria, west side of the solar power plant area (approximately 270 m from the proposed power plant)	24°44’2” N 90°11’36” E	17.04.2024	To understand the existing baseline and potential impact from project activities

Source: Field Survey by EQMS Team, May 2024

Figure 5-29: Soil Sampling Location Map



Source: Field Survey by EQMS Team, 2024

Picture captured during soil sampling is shown in Figure 5-30

Figure 5-30: Photographs taken during Soil Sampling

SQ1: Project Area

SQ2: Nimuria

Source: Field Survey by EQMS Team 2024

5.5.4.1 Interpretation of Soil Quality Results

. The analysis result of the soil sample is given in Table 5-15.

Table 5-15: Analysis result of Soil Sample

SL#	Parameter	Unit	S-1	S-2	Standard[15]	Methods of Analysis
1.	pH	--	5.02	4.81	-	US EPA 9045D or Electrometric method for measuring pH in soils and waste samples by Ion Electrode
2.	Electrical Conductivity	dSm-1	0.089	0.079	-	Australian Method 1:5 Water Suspension Method
3.	Temperature	^{0}C	24.8	24.9	-	US EPA 9045D or Electrometric method for measuring pH in soils and waste samples by Ion Electrode
4.	Total Dissolved Solid	mg/l	56.96	50.56	-	Ion Electrode method by1:5 Water Suspension
5.	Salinity	ppt	0.057	0.050	-	1:5 Soil/Water Extract electrical conductivity method
6.	Mercury	mg/kg	1.29	2.16	36	APHA 3112.B
7.	Arsenic	ppb	1.20	1.72	10000	APHA 3114.C
8.	Zinc	ppm	1.50	1.08	-	DPTA Extraction Method/Atomic Absorption Spectrophotometric Method
9.	Copper	ppm	6.40	1.76	190	DPTA Extraction Method/Atomic Absorption Spectrophotometric Method
10.	Iron	ppm	117.63	97.07	-	DPTA Extraction Method/Atomic Absorption Spectrophotometric Method
11.	Manganese	ppm	30.55	26.36	-	DPTA Extraction Method/Atomic Absorption Spectrophotometric Method
12.	Lead	ppm	6.74	15.69	530	Nitric Perchloric Acid Digestion Method

[15] Duetch Intervention Values 2013 (Soil Remediation Circular, July 2013)

SL#	Parameter	Unit	S-1	S-2	Standard[15]	Methods of Analysis
13.	Cadmium	ppm	0.39	0.23	13	Nitric Perchloric Acid Digestion Method
14.	Chromium	ppm	48.58	27.58	-	Nitric Perchloric Acid Digestion Method
15.	Nickel	ppm	48.75	21.61	100	Nitric Perchloric Acid Digestion Method

Source: Laboratory Analysis by EQMS Laboratory, SRDI (Soil Resource Development Institute) and Bangladesh Council of Scientific and Industrial Research (BCSIR), 2024.

In the Environmental Conservation Rules (ECR), 2023 has no soil quality standard.

In the Environmental Conservation Rules (ECR),2023 has no soil and quality standard. From the Table 5-15 it is observed that the soil in these locations is slightly acidic in nature. pH values are 5.02 and 4.81, means nutrients in the soil is not much sufficient science most nutrients become available to plants in the pH range of 5.5 to 8.0 (when tested in water). Moreover, excessive nutrients (N, P, K) and heavy metal (Pb, Cd, As) concentration in soil is toxic to the plants for their growing. The concentrations of all comparable heavy metal samples are within the standards of Duetch Intervention Values 2013.

Moreover, a secondary literature review has been done on the nutrient profile of this area. as follows-

At the Muktagacha area, a soil series assessment on different depth was done on some physio-chemical parameters16. As per the report, the textural class of soil series was sandy loam at 0-10 cm, 10-15 cm and 15-33 cm depth. But in 33- 53 cm depth, the soil was silt loam. The percentage of sand, silt and clay at four depths ranged from (32.04 to 62.84), (26.06 to 50.09) and (7.16 to 17.87), respectively. It has been found that soil contains very low organic matter content.

The total N content in the soils of the Muktagacha area was low to very low. It showed negative correlation with soil pH. The available P content was medium to high in Lokdeo (Muktagacha) series. The exchangeable K, Ca and Na contents were low to very low in most of the soils series. The upper layers contained high to very high amount of available Zn compared to the lower layers. Available Cu, Fe and Mn contents were high to very high in most of the locations. The results suggest that macro nutrient contents of all soils have come down to a level that the soils need external aid in the term of manures or fertilizers to produce higher crop yield. Physio-chemical characteristics at different depth of the soil of Muktagacha is shown in Table 5-16.

[16] J. Bangladesh Agril. Univ. 13(2): 197–206, 2015 ISSN 1810-3030; Physico-chemical characterization of some selected soil series of Mymensingh and Jamalpur districts of Bangladesh

Table 5-16: Physio-chemical characteristics of the soil at different depth, Muktagacha

Soil Series	Location	Depth (cm)	Textural Class	pH	OM* (%)	Total N	Avail. P ($\mu g\ g^{-1}$)	Avail. S ($\mu g\ g^{-1}$)	Exch. K ($cmol\ kg^{-1}$)	Exch. Ca ($cmol\ kg^{-1}$)	Exch. Na ($cmol\ kg^{-1}$)	Avail. Zn ($\mu g\ g^{-1}$)	Avail. Cu ($\mu g\ g^{-1}$)	Avail. Fe ($\mu g\ g^{-1}$)	Avail. Mn ($\mu g\ g^{-1}$)
Lokdeo	Kashimpur, Muktagacha, Mymensingh	0-10	Sandy loam	5.33	1.49	0.11	10.45	25.13	0.124	2.93	0.282	4.92	3.98	127.70	28.50
		10-15	Sandy loam	6.11	0.78	0.07	12.78	15.65	0.176	2.58	0.211	3.12	3.25	122.12	22.90
		15-33	Sandy loam	6.32	0.52	0.05	22.67	13.23	0.189	2.73	0.246	2.66	2.92	109.10	14.98
		33-53	Silty loam	6.46	0.33	0.034	31.88	9.75	0.267	1.95	0.211	2.09	2.3	100.50	10.55

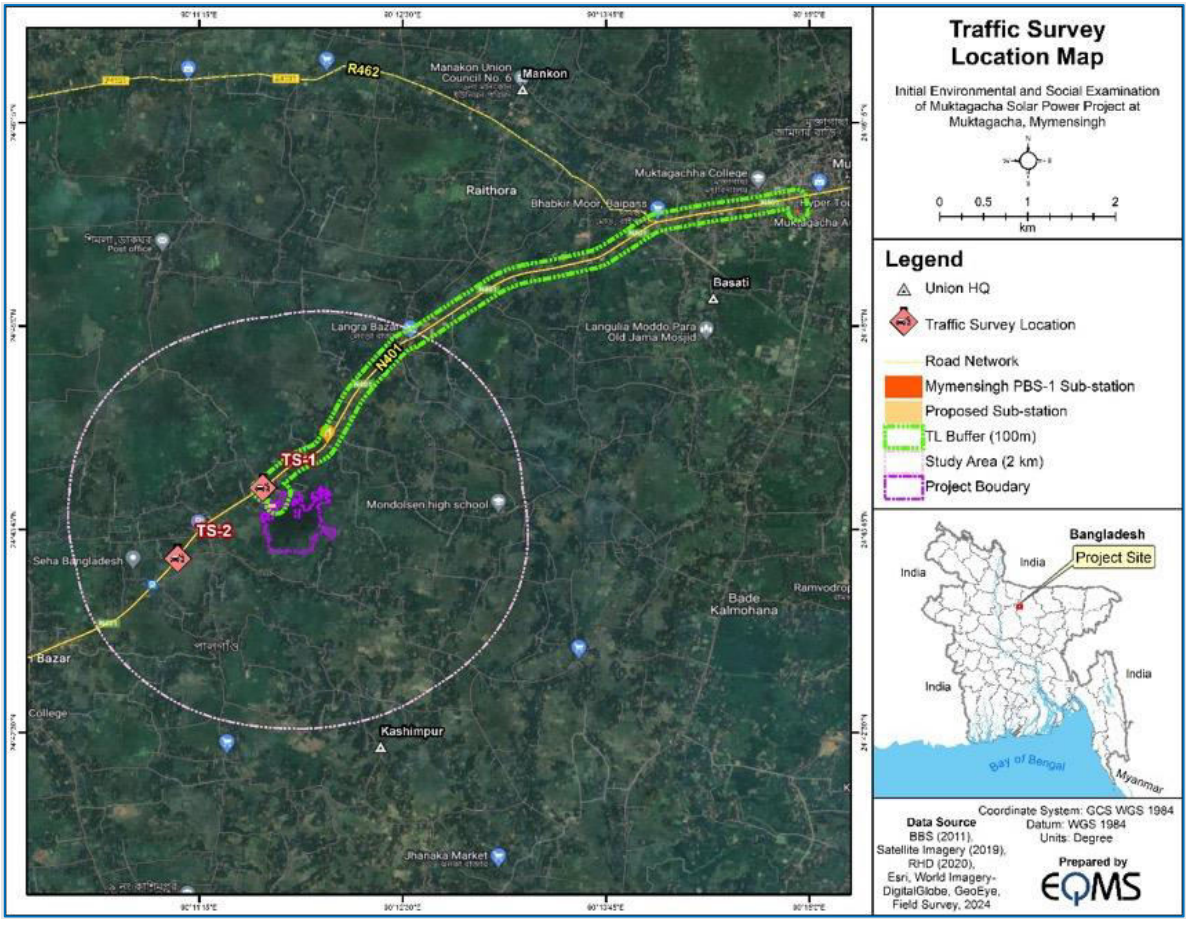
5.5.5 Traffic Volume

The project site is accessible from two sides. One is from the Nimuria end, and another is from Raghunathpur/ Ramchandrapur end. It was confirmed by the project authority that they will only use the road from Nimuria end.

Two Traffic surveys have been conducted on the existing access road and the highway connecting road (see sec 3.2.1) for both ends.

Traffic surveys were conducted continuously for 24 hours. Vehicles were categorized as heavy vehicles (bus/truck/trailer), light vehicle (private car, microbus, auto rickshaw, pickup/ CNG, Tempo, motorcycle) and non-motorized vehicle (rickshaw, bicycle etc.). The road traffic survey was conducted on 17 April and 18 April 2024.The survey location map is given in Figure 5-31. The details of the road traffic survey locations are shown in Table 5-17.

Figure 5-31: Location Map of Road Traffic Survey



Source: EQMS survey team,2024

Table 5-17: Road Traffic Survey location

SL#	Code	Monitoring Location	Date	Geographic Location	Selection Criteria
1.	RT1	Nimuria Middle Para, north west side of the proposed power plant	17.04.2024	24°44’0” N 90°11’38” E	To understand the traffic volume of the existing access road and the highway connecting road

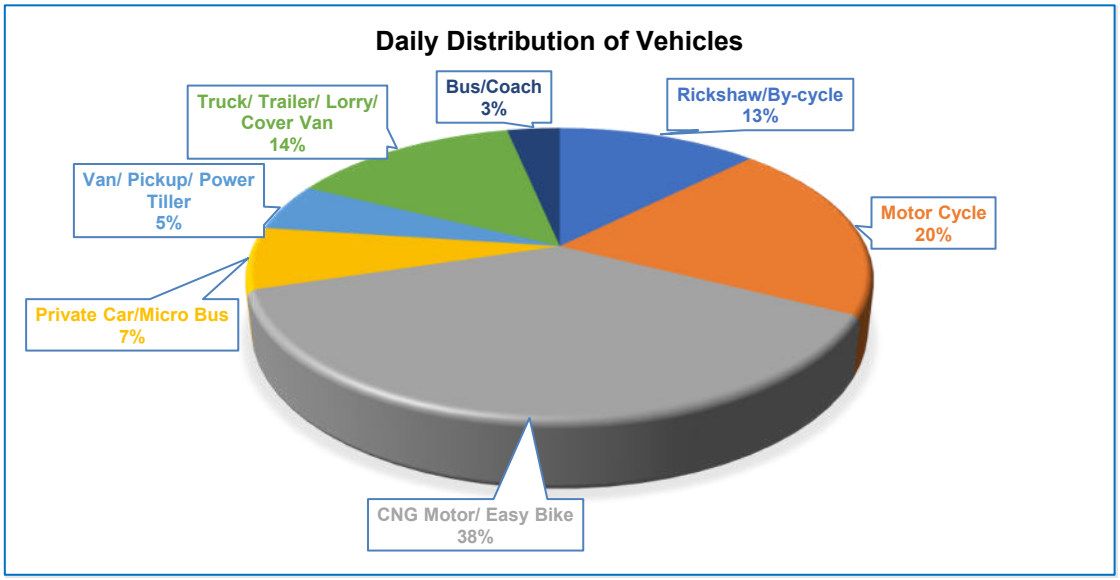
SL#	Code	Monitoring Location	Date	Geographic Location	Selection Criteria
2.	RT2	Ramchandropur south west side of the prosed power plant	18.04.2024	24°43'34" N 90°11'07" E	To understand the traffic volume of another existing access road and the highway connecting

Source: Field Survey by EQMS Team, April 2024

5.5.5.1 Road Traffic Status (Nimuria Middle Para)

A total of 6954 vehicles were counted during the traffic survey of which 997 heavies, 1232 light and 973 non-motorized vehicles on National highway. Daily vehicular distribution on the road is shown in Figure 5-32.

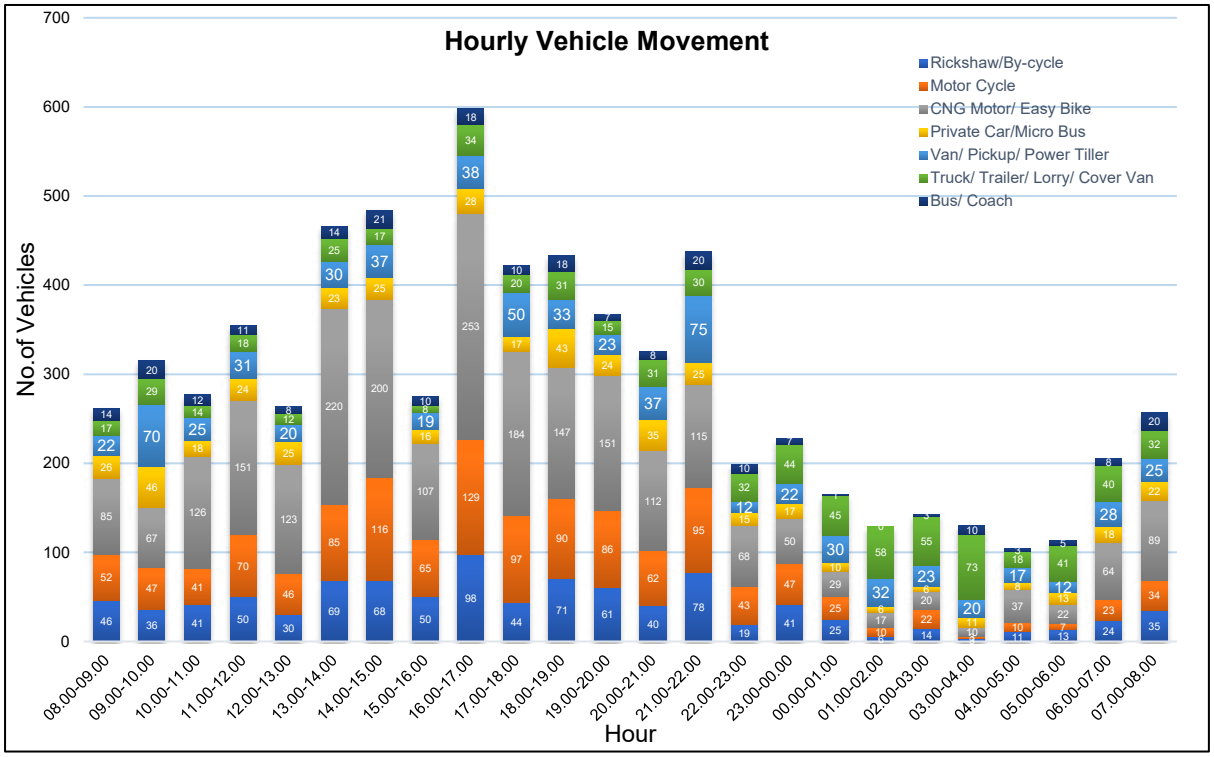
Figure 5-32: Distribution of Vehicles on National Highway Road (Nimuria Middle Para)



Source: Road traffic Survey, conducted by EQMS Team, April 2024

It is observed that only large and medium trucks as well as CNG Motor/Easy Bikes are predominant on the road. A total of 1470 large to small trucks were counted during the traffic survey. The number of CNG/Easy bikes was 2447. Movements of trailers, trucks and pickups were observed throughout the day and night time. Hourly total number of vehicles passed the counting point is shown in Figure 5-33.

Figure 5-33: Hourly vehicular movement on National Highway Road (Nimuria Middle Para)



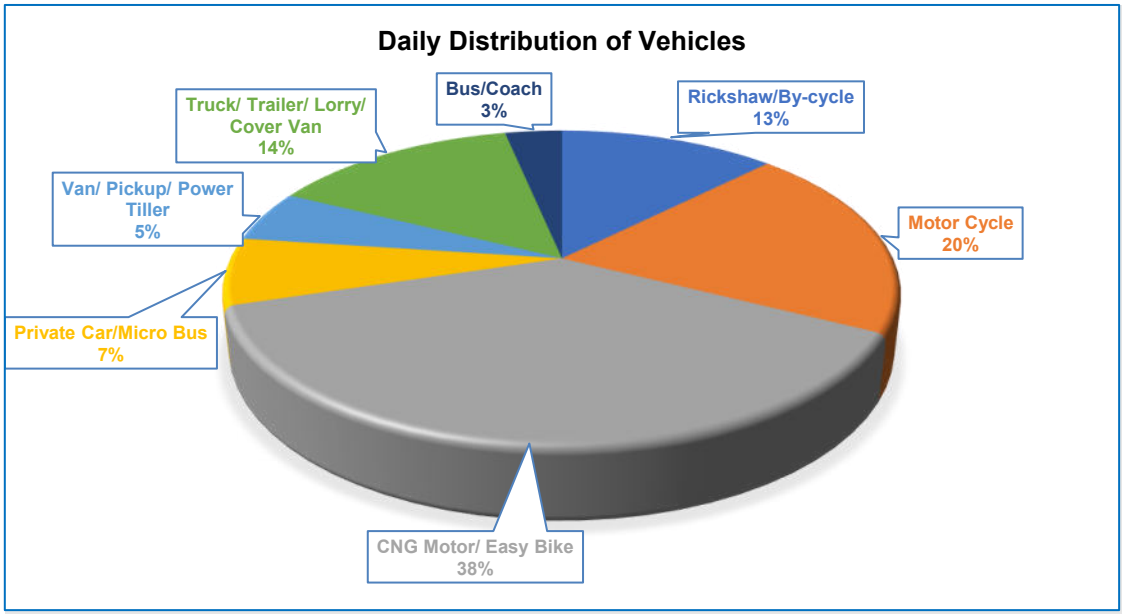
Source: Road Traffic Survey, conducted by EQMS Team, April 2024

It was observed that only a fewer number of CNG/Easy bikes, private car, rickshaw, bicycle is predominant on the access road (National highway to project site: Nimuria end/Nimuria end to National Highway). A total of 48 vehicles were counted during the traffic survey of which 19 bicycles, 27 CNG/easy bikes and 4 private cars. Movements of were observed throughout the day and nighttime.

5.5.5.2 Road Traffic Status (Ramchandrapur)

A total of 8765 vehicles were counted during the traffic survey of which 1541 heavies, 1069 light and 1094 non-motorized vehicles. Daily vehicular distribution on the road is shown in Figure 5-34.

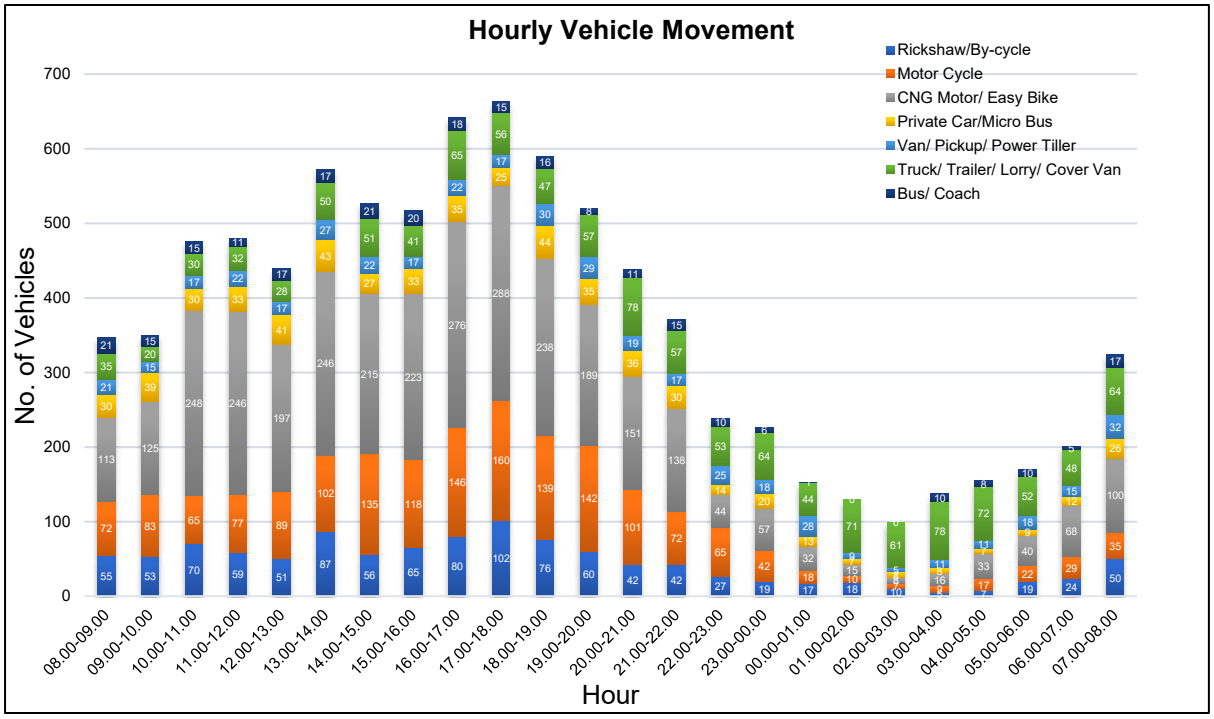
Figure 5-34: Distribution of Vehicles on National Highway Road (Rt2) (Ramchandrapur)



Source: Road traffic Survey, conducted by EQMS Team, April 2024

It is observed that large and medium trucks as well as CNG Motor/Easy Bikes are predominant in the road. A total of 1718 large to small trucks were counted during the traffic survey. The number of CNG/Easy bikes was 3306. Movements of trailers, trucks and pickups were observed throughout the day and nighttime. Hourly total number of vehicles passed the counting point is shown in Figure 5-35.

Figure 5-35: Hourly Vehicular Movement on National Highway Road (Ramchandrapur))



Source: Road traffic Survey, conducted by EQMS Team, April 2024

It was observed that only a fewer number of CNG/Easy bikes, private car, rickshaw, bicycle is predominant on the access road (National highway to Ramchandrapur end/ Ramchandrapur end to

National Highway). A total of 134 vehicles were counted during the traffic survey of which 38 bicycles, 67 CNG/easy bikes, 18 pickups and 11 private cars. Movements of were observed throughout the day and nighttime.

5.6 Natural Hazards

5.6.1 Seismicity and Faults

Bangladesh can be affected by moderate to strong earthquake events due to its proximity to the collision boundary of the Northeast moving Indian Plate and Eurasian Plate. Strong historical earthquakes with a magnitude greater than 7.0 have affected parts of Bangladesh in the last 150 years, some of them had their epicenters within the country. According to the Bangladesh National Building Code (BNBC) 2014, the country has been divided into four seismic zones with different levels of ground motion. Table 5-18 includes a description of the four seismic zones.

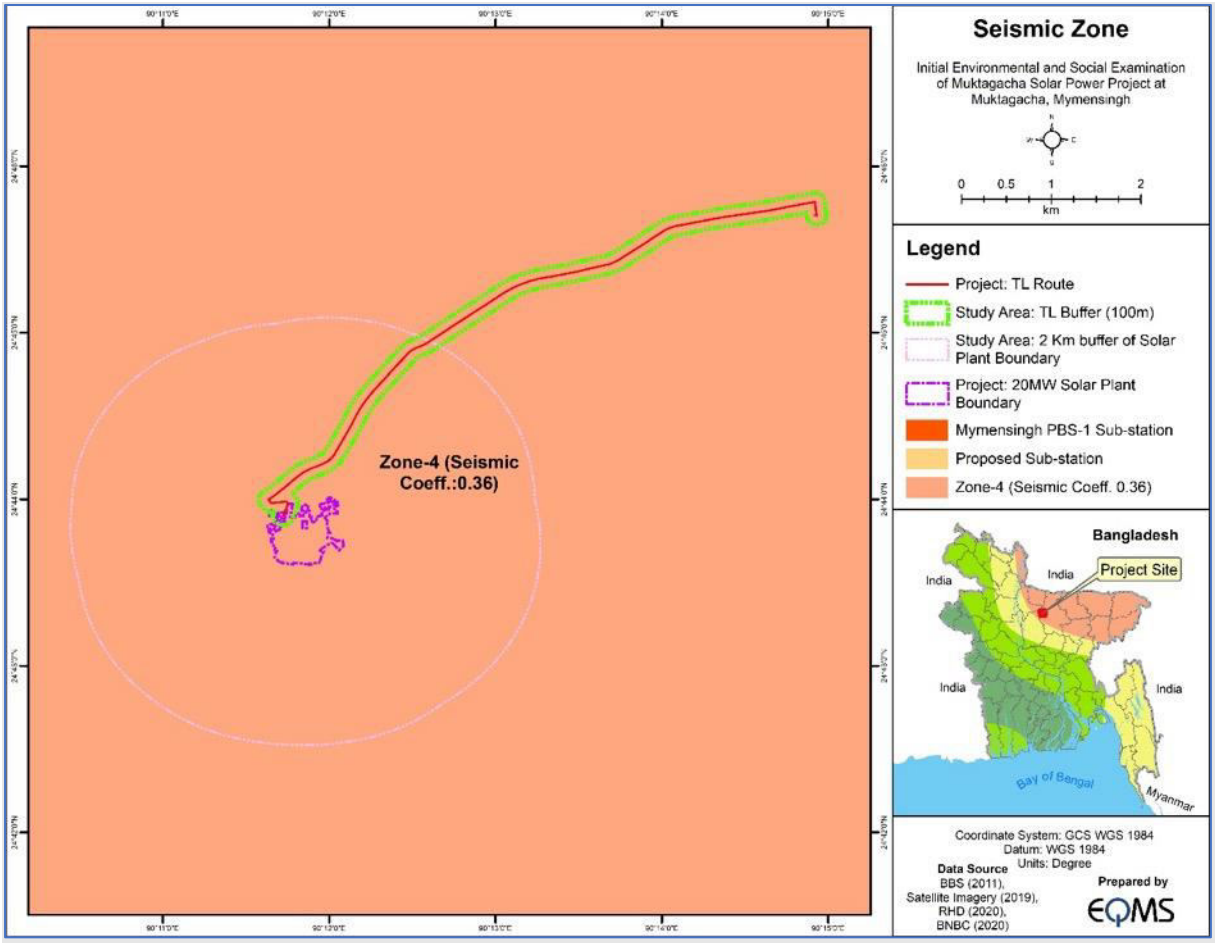
Table 5-18: Description of Seismic Zones

Seismic Zone	Location	Seismic Intensity	Seismic Zone Coefficient, Z
1	Southwestern part including Barisal, Khulna, Jessore, Rajshahi	Low	0.12
2	Lower Central and Northwestern part including Noakhali, Dhaka, Pabna, Dinajpur, as well as Southwestern corner including Sundarbans	Moderate	0.20
3	Upper Central and Northwestern part including Brahmanbaria, Sirajganj, Rangpur	Severe	0.28
4	Northeastern part including Sylhet, Mymensingh, Kurigram	Very Severe	0.36

Source: Bangladesh National Building Code (BNBC), 2020

There are four seismic zones in Bangladesh. Each zone has a seismic zone coefficient (Z) which represents the maximum considered peak ground acceleration (PGA) on very stiff soil/rock (site class SA) in units of g (acceleration due to gravity). The zone coefficients (Z) of the four zones are Z=0.12 (Zone 1), Z=0.20 (Zone 2), Z=0.28 (Zone 3), and Z=0.36 (Zone 4). According to this seismic zoning, the proposed project is located in Zone-4 (Very Severe seismic intensity), with a seismic coefficient Z=0.36g. The seismic zone map of the study area is given in Figure 5-36 .

Figure 5-36: Map Showing Seismic Zoning Map of Bangladesh with Project Area



Source: Bangladesh National Building Code (BNBC), 2024

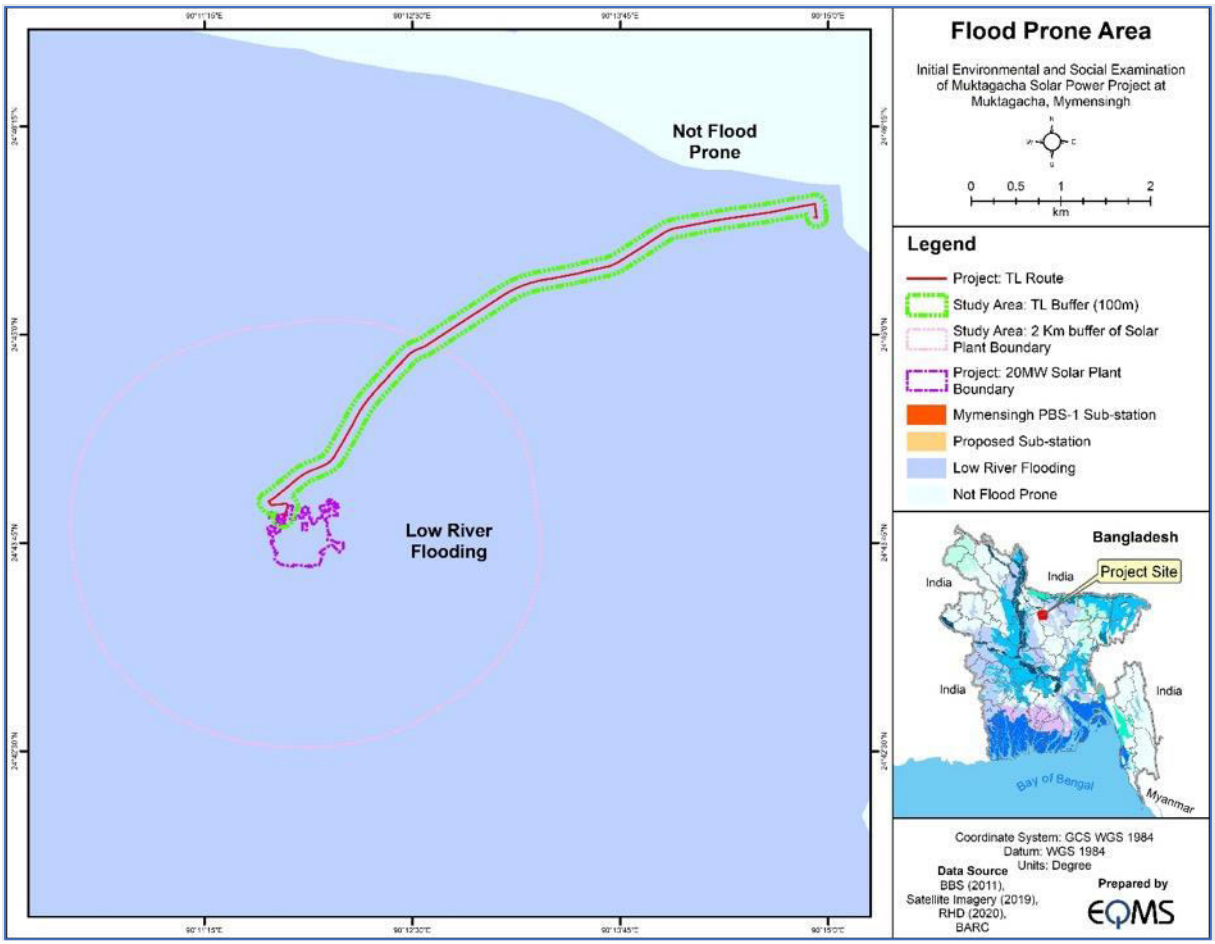
5.6.2 Flood

Flood is an annual phenomenon in Bangladesh. Normally, the most severe flood occurs in Bangladesh during July and August. Regular river floods (during monsoon season) affect 20% of the country, which may increase up to 67% in extreme years like the 1998 flood. The most disastrous floods take place in 1988, 1998, and 2004. There are four types of floods in Bangladesh:

- Monsoon floods along major rivers during the monsoon rains (June-September).
- Flash floods caused by overflowing of hilly rivers of eastern and northern Bangladesh (Normally during April-May and September-November).
- Rain floods are caused by drainage congestion during heavy rains.
- Coastal floods caused by storm surges.

In the Mymensingh region, flooding of rivers during monsoon is commonly experienced. The area of the proposed study area belongs to a low river flooding area. The flood map of the study area is given in Figure 5-37.

Figure 5-37: Flood Map of the Study Area



Source: Bangladesh Agricultural Research Council

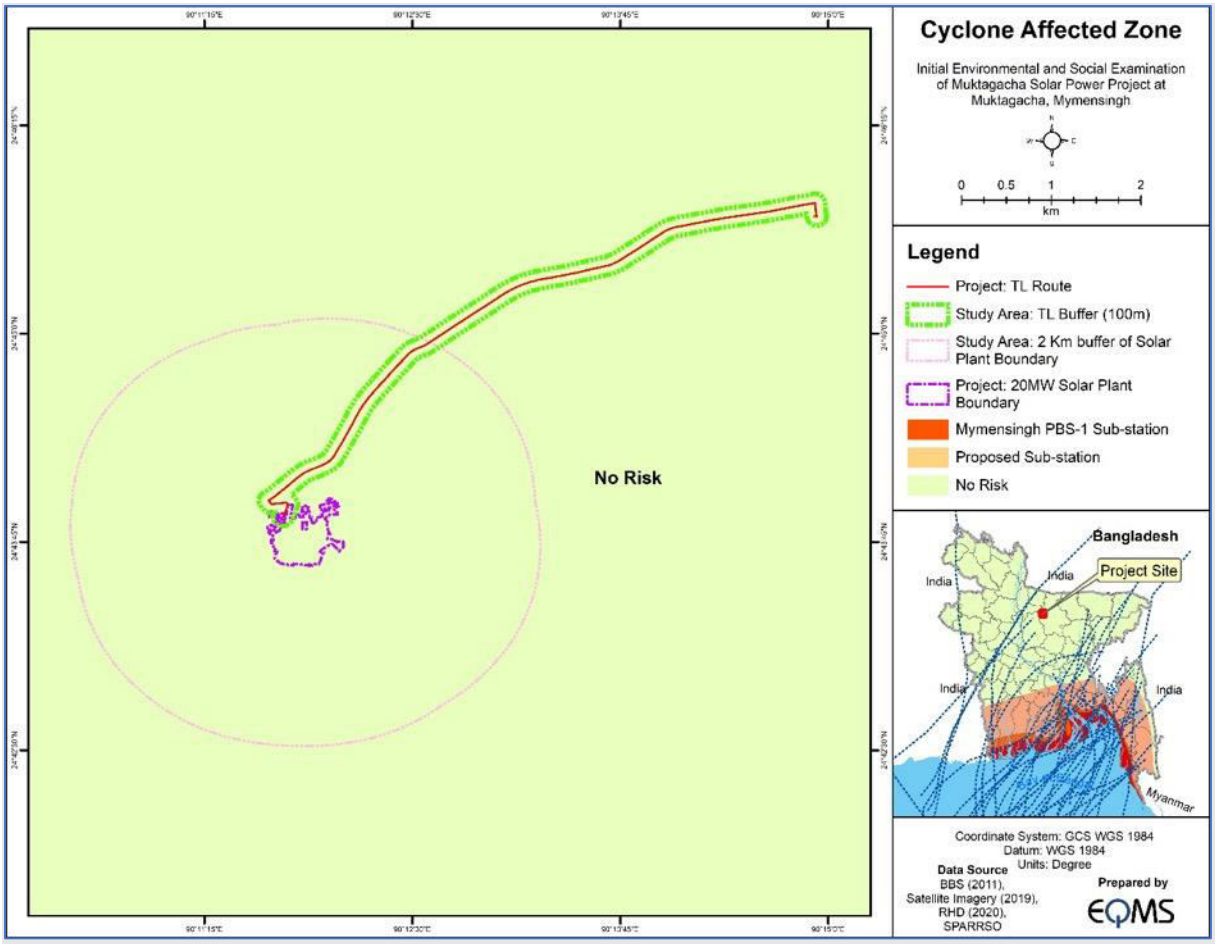
5.6.3 Cyclone

Bangladesh, due to its unique geographic location, repeatedly becomes the landing ground of cyclones formed in the Bay of Bengal. These cyclones are devastating and cause extensive damage to life, property and livestock. The cyclones occur in two seasons, April-June and October-November – i.e. before and after the rainy season. Cyclones in Bangladesh are presently classified according to their intensity and the following nomenclature is in use:

- Depression (winds up to 62 km/hr.);
- Cyclonic storm (winds from 63 to 87 km/hr.);
- Severe cyclonic storm (winds from 88 to 118 km/hr.); and
- Very severe cyclonic storm of hurricane intensity (winds above 118 km/hr.)

The proposed study area has no risk of cyclone. The cyclone map of the study area is given in Figure 5-38

Figure 5-38: Cyclone Affected Zone Map of the Study Area



Source: SPARSO

5.6.4 Tornado

Bangladesh is the most vulnerable country to several natural disasters due to its geographical location. Every year these natural calamities destroy the locality in some part of the country. The Tornado is one of the natural disasters which occurred instantly within a short period of time but keeps a large devastating footage. Bangladesh has a long history of tornado incidents. Project site is situated in the Mymensingh district, which has a long history of Tornado (Table 5-19).

Table 5-19: Chronological History of Tornados in Mymensingh

Date	Location	Tornado Count	Fatalities	Injured	Affected
March 31, 1875	Mymensingh	1	12	45	600
March 18, 1961	Mymensingh	1	32		
March 10, 1963	Mymensingh	1	20		
April 17, 1969	Mymensingh	3	32		
April 01, 1972	Mymensingh	1	200	700	10000
April 16, 1978	Mymensingh	1	150		
April 14, 2004	Mymensingh	1	111	3500	16000

Date	Location	Tornado Count	Fatalities	Injured	Affected
July 27, 2005	Mymensingh	1	66	2000	10000
August 17, 2005	Mymensingh	1	48	700	10000
April 04, 2011	Mymensingh	5	12	150	1000

5.7 Biological Environment

5.7.1 Introduction

A biological environment study is essential for any project that may have an impact on the environment. A solar power plant has the potential to significantly alter the biological environment in its surrounding area. The construction of such a plant can cause habitat fragmentation, loss of vegetation, and disruption of wildlife populations. Therefore, a comprehensive biological environment study is necessary to understand the potential impacts of the proposed power plant in Muktagacha, Mymensingh. This study will help to identify vulnerable species, evaluate the potential for habitat loss, and assess the impact of air pollution on the surrounding environment. The study can also inform the development of mitigation strategies to minimize the negative impacts of the power plant and ensure the sustainable development of the region. In this regard, an ecosystem and biodiversity assessment study were undertaken in diverse habitat types within the project Area of Influence (AoI) of the Muktagacha solar power plant project in Muktagacha Upazila of Mymensingh, Bangladesh.

Muktagacha is located at 24.7583°N 90.2667°E. It is bounded by Jamalpur Sadar upazila of Jamalpur district to the northwest, Mymensingh Sadar upazila to the northeast, Fulbaria upazila to the south and Madhupur upazila of Tangail district to the west. The project area consists of waterbodies locally known as *beel* and natural Sal Patches in the Madhupur National Park. These habitat attributes play a crucial role in the wildlife biodiversity of the Project Area.

5.7.2 Objectives of the Study

The ecosystem and biodiversity assessment study were undertaken in diverse habitat types within the Area of Influence (AoI) of the Muktagacha Solar Power Project in Muktagacha Upazila of Mymensingh district, Bangladesh. The purpose of this study was to gain an understanding of the ecological condition of the flora and fauna in the project area of influence (AoI). The following objectives were considered for this study:

- To recognize the current status of natural habitats or species, including ecological resources and vegetation cover, in the project area.
- To identify and list floral and faunal species of critical importance (i.e., those classified as Critically Endangered (CR), Endangered (EN), and Vulnerable (VU) based on the IUCN Red List of Threatened Species of Bangladesh, 2015) within the AoI.
- Collecting secondary information, including literature review, consultations, and FGDs, to understand the floral and faunal components and habitats of the AoI.
- To determine areas of conservation importance (such as protected areas like sanctuaries, national parks, biosphere reserves, landscapes, and sacred groves pertaining to terrestrial diversity) within the project AOI.

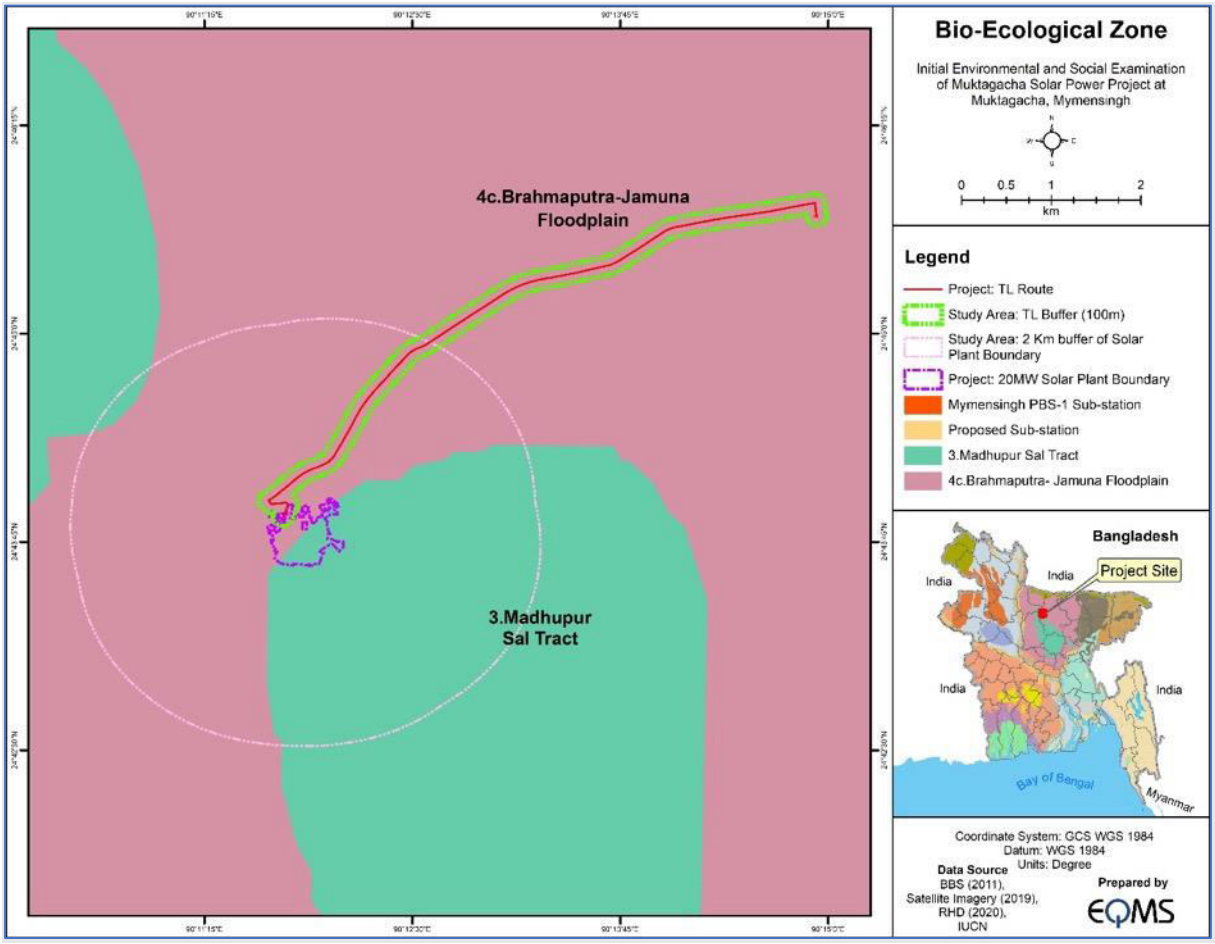
5.7.3 Bio-ecological Zone

Flora and fauna in a particular bio-geographic region or zone tend to have shared characteristics in terms of broader climatic and geographical feature preferences/requirements. Bio-geographically, Bangladesh is situated in the Oriental Region lying at the transitional point between the Indo-Himalayan

and Indo-Chinese sub-region. In the context of physiographic and biological diversity, IUCN has classified Bangladesh into Twenty-Five (25) Bio-Ecological Zones[17].

The study area has fallen under the Bio-ecological Zone of 3. Madhupur Sal Tract and 4c. Brahmaputra Jamuna Floodplain (Figure 5-39). Typical Characteristics of bio-ecological zone of Project site is provided in Table 5-20 and **Table** 5-21, and the map of bio-ecological zones of the AOI is provided in Figure 1-1.

Figure 5-39: Bio-ecological Zones Map of the Project Area



Source: IUCN, 2002[17]

5.7.3.1 3. Madhupur Sal Tract

Madhupur Tract is a large upland area in the central part of Bangladesh. The southern part of this tract is known in Bangla as Bhawal Garh and the northern part as Madhupur Garh. Geologically it is a terrace from one to ten meters above the adjacent floodplains. Though in its present form, it is of the Pleistocene age its origin may be in the late Miocene when the Bengal basin was being filled in rapidly. The total extent of this Tract is 4,244 sq km. The dominant floral and faunal species of this zone is presented in Table 5-20.

[17] Nishat, A., S.M.I. Huq, S.P. Barua, A.H.M.A. Reza and A.S.M. Khan. 2002. Bio-ecological Zones of Bangladesh. The World Conservation Union (IUCN), Dhaka, Bangladesh. 141 pp.

Table 5-20: Typical Characteristics of Madhupur Sal Tract Bio-ecological Zone

3. Madhupur Sal Tract	
Floral Diversity	
Trees	Sal (*Shorea robusta*), Ban chalta (*Lagerstroemia parviflora*), Chitrika/neul (*Bursera serrata*), Ban karpash (*Thespesia lampus*), Bhela (*Semicarpus anacardium*), Bhela (*Semicarpur anacardium*)
Shrubs	Kamela (*Mallotus philippensis*), Kestoma/Keura (*Glochidion multiloculare*), Assar (Grewia microcos), Mankanta (Randia dumetorum)
Herbs	Shamdalam *(Elephantopus scaber),* Shothi *(Curcuma zedoaria), Borreria hispida*
Climbers	Kamkui/ kantakui (*Bridelia retusa*), Goalia lata (*Spatholobus roxburghii*), Ban ritha/Kuchui (*Acacia concim*), Anantamul (*Hemidesmus indicus*)
Orchids	Pink nodding orchid (*Geodorum densiflorum*)
Faunal diversity	
Mammals	Capped langur (*Trachypithecus pileatus*), Wild boar (*Sus scrofa*), Asiatic brush-tailed porcupine (*Atherurus macrourus*), jackel (*Canis aureus*), Jungle cat (*Felis chaus*)
Birds	Indian pitta (*Pitta brachyura*), Oriental dollarbird (*Eurystomus orientalis*), Blue-tailed bee-eater (*Merops philippinus*), Dusky eagle-owl (*Bubo coromandus*), Green-billed malkoha (*Phaenicophaeus tristis*), Lesser coucal (*Centropus bengalensis*), Yellow-footed green pigeon (*Treron phoenicopterus*)
Reptiles	Indian black turtle (*Melanochelys trijuga*), Monocled cobra (*Naja kaouthia*), Cantor's kukri snake (*Oligodon cyclurus*)
Amphibians	Banded bullfrog (*Kaloula pulchra*), Ornate narrow-mouthed frog (*Microhyla ornata*), Red microhylid (*Microhyla rubra*), Taipeh frog (*Rana taipehensis*), Balloon frog (*Uperodon globulosus*)

5.7.3.2 4c. Brahmaputra-Jamuna floodplain

Brahmaputra-Jamuna River System is one of the three major river systems of Bangladesh. The floodplain and the Pleistocene terraces almost completely cover two of the six administrative divisions of the country, Rajshahi and Dhaka. The Brahmaputra-Jamuna drains the northern and eastern slopes of the Himalayas and has a catchment area of 5,83,000 sq km. The biodiversity of the Brahmaputra-Jamuna floodplain is very rich and is presented in Table 5-21.

Table 5-21: Typical Characteristics of Brahmaputra-Jamuna floodplain Bio-ecological Zone

4c. Brahmaputra-Jamuna floodplain	
Floral Diversity	
Trees	Kanthal (*Artocarpus heterophyllus*), Aam (*Mangifera indica*), Rendi koroi/Rain tree (*Samanea saman*)
Herbs and Shrubs	Danda kalash (*Leucus aspera*), Bhant (*Clerodendrum viscosum*), Assam lata (*Mikania scandens*), Motkila (*Glycosmis arborea*)
Trees Near water	Pitali (*Trewia nudiflora*), Koroj (*Pongania pinnata*), Jarul (*Lagerstroemia speciosa*), Debdaru (*Polyalthia longifolia*)

Aquatic Plants	Kachuripana (*Eichhornia crassipes*), Shada shapla (*Nymphaea nouchali*), Keshordam (*Ludwigia adscendens*)
Faunal diversity	
Mammals	Rhesus macaque (*Macaca mulatta*), Three-striped palm squirrel (*Funambulus palmarum*), Jackal (*Canis aureus*), Hispid hare (*Caprolagus hispidus*), Small Indian civet (*Viverricula indica*)
Birds	Jerdon's baza (*Aviceda jerdoni*), Black-necked stork (*Ephippiorhynchus asiaticus*), Asian openbill (*Anastomus oscitans*), River lapwing (*Vanellus duvaucelii*), Pheasant-tailed jacana (*Hydrophasianus chirurgus*)
Reptiles	Yellow monitor (*Varanus flavescens*), Bengal monitor (*Varanus bengalensis*), Common vine snake (*Ahaetulla nasutus*)
Amphibians	Tree frog (*Polypedates leucomystax*), Cricket frog (*Limnonectes limnocharis*)

5.7.4 Ecosystems and Habitats

Habitats of the Project Site

Our direct field observation (Figure 5-41) suggests that the project site predominantly consists of waterbodies locally known as *beel*, with agricultural land in the surrounding areas. The *beel* areas are filled with invasive common water hyacinth (*Pontederia crassipes*) species, along with some other native aquatic vegetation like nut grass (*Cyperus rotundus*), pink morning glory (*Ipomoea carnea*), Taro (*Colocasia esculenta*), water spinach (*Ipomoea aquatica*), arrow Leaf Pondweed (*Monochoria hastata*), asiatic pennywort (*Centella asiatica*), purple spikerush (*Eleocharis atropurpurea*), linear leaf water primrose (*Ludwigia hyssopifolia*), vetiver grass (*Chrysopogon zizanioides*), bitter vine (*Mikania micrantha*), alligator weed (*Alternanthera philoxeroides*), tropical reed (*Phragmites karka*), and Southern cattail (*Typha domingensis*). Some of the *beel* area has also been modified into aquaculture ponds for fish farming purposes.

Up until 20 years ago, the area remained largely the same; however, at that time, there was no water hyacinth, and locals used to cultivate Boro paddy, a local variety of rice suitable for low-lying areas that can withstand flooding. About 15 years ago, water hyacinth completely overtook the area, and the cost of removing these aquatic plants became prohibitively high due to their invasive nature and exponential growth. Considering the high cleaning costs, utilizing this land for growing paddy became economically unfeasible, leading the locals to abandon the area.

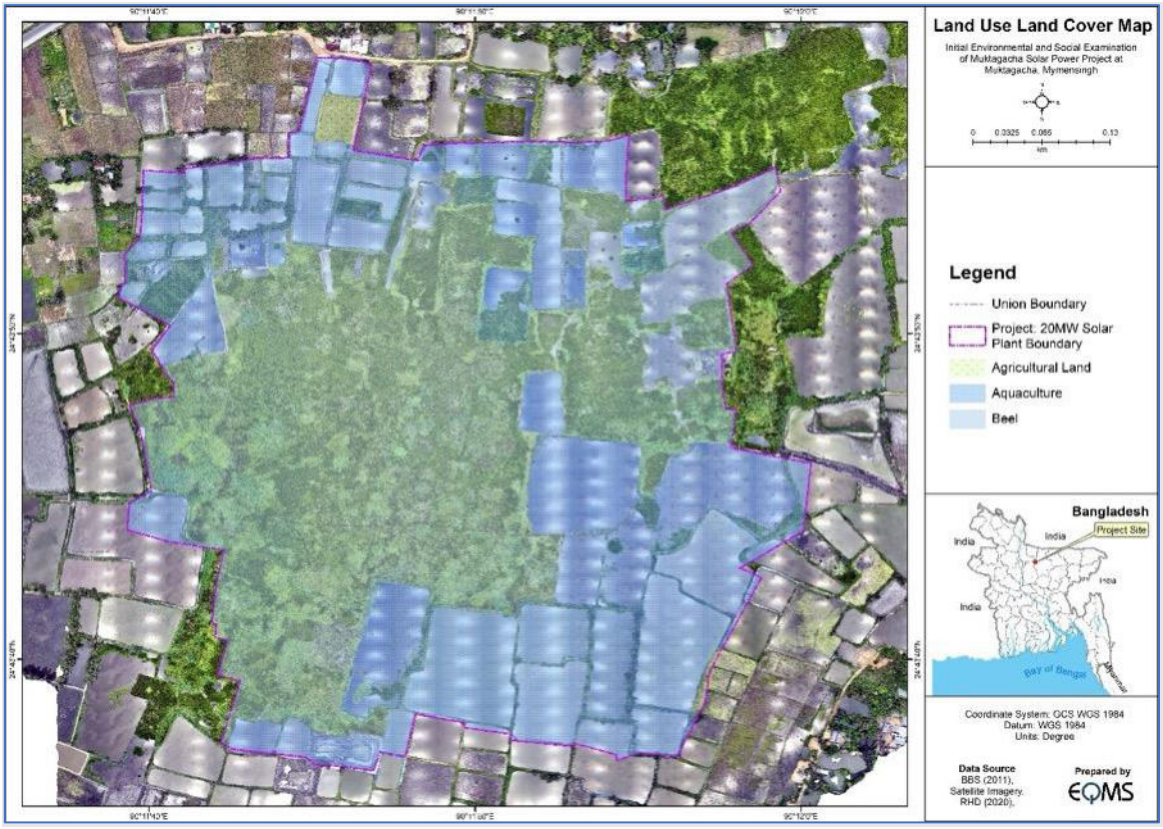
Different habitat types among the associated ecosystems of the proposed solar power plant site mainly include agricultural lands, aquaculture ponds and *Beel* area (Figure 5-40) which supports agricultural crops, culture fish species as well as riparian vegetation, aquatic plants, and some wildlife and fishes. Agricultural lands and aquaculture ponds are under regular human management for crop and fish production. Therefore, these areas can be considered as *Modified Habitat*.

The *beel* areas were naturally formed in low-lying areas and abandoned from human intervention for around 15 years. But these areas are currently dominated by an invasive alien species, Common Water Hyacinth (*Pontederia crassipes*) which has significantly altered its habitat. In Bangladesh this plant is widely recognized as a noxious weed and commonly found in almost all stagnant waterbodies. After its introduction in early 1920s due to its beautiful orchid-like flower from Brazil, the situation ended up in enacting the Bengal Water Hyacinth Act, 1936 to prohibit the cultivation of the plants due to obstructing river navigation and difficulties in cultivation of wetland crops[18]. During the monsoon it multiplies rapidly

[18] https://en.banglapedia.org/index.php/Water_Hyacinth

and spreads quickly in newly inundated flood lands. When water hyacinth grows in large quantities, it can block sunlight from reaching the waterbody, eventually rot and settle on the bed, leading to an increase in BOD and COD, which harms other aquatic plants and fish species. Water hyacinth has been shown to decrease overall biodiversity by reducing both species richness and evenness[19]. In addition, it has been reported that the presence of water hyacinth shows a strong positive correlation with the abundance of exotic fish species, while it is significantly negatively associated with the abundance of native fish species[20]. Therefore, these aquatic habitats, *beel* area, altered significantly by the introduction of an alien invasive plant can be considered as *Modified Habitat*. Habitat types of the Power Plant site is shown in Figure 5-40

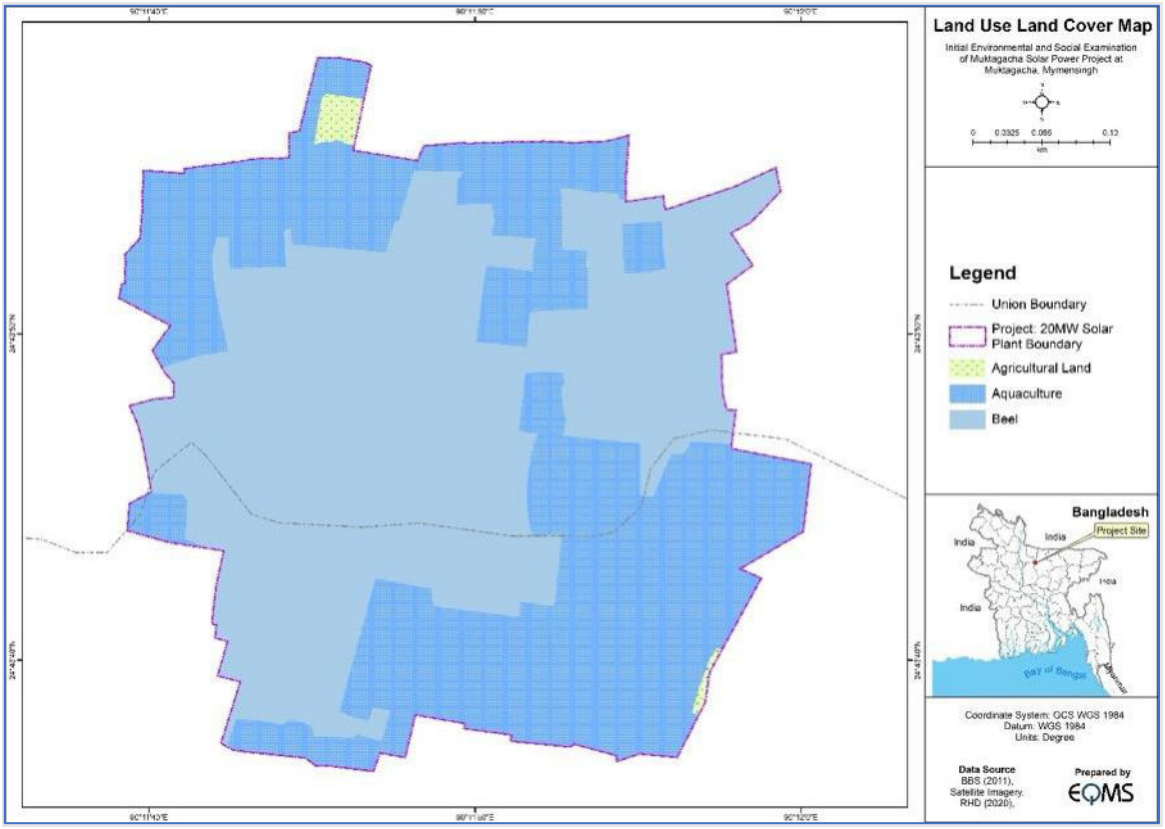
Figure 5-40: Habitat types of the Power Plant Site



[19] Harun, I., Pushiri, H., Amirul-Aiman, A. J., & Zulkeflee, Z. (2021). Invasive water hyacinth: Ecology, impacts and prospects for the rural economy. *Plants*, *10*(8), 1613.

[20] Basaula, R., Sharma, H. P., Paudel, B. R., Kunwar, P. S., & Sapkota, K. (2023). Effects of invasive water hyacinth on fish diversity and abundance in the Lake Cluster of Pokhara Valley, Nepal. *Global Ecology and Conservation*, *46*, e02565.

Figure 5-41: Land Use Land Cover of the Power Plant Site



Critical Habitat Screening

The identification of Critical Habitat-qualifying Species through IBAT is enhanced by a subsequent screening process. This process involves Key Informant Interviews (KIIs) with esteemed experts like Dr. Monirul H. Khan and Dr. M. A. Aziz, Professors of Zoology at Jahangirnagar University, Savar, Dhaka. The IUCN Red List of Threatened Species of Bangladesh is used to examine the distribution of these CH-qualifying species. The expert team conducted a two-day long field visit from May 7, 2024, to May 8, 2024, at the proposed project site to assess the presence of CH Qualifying Species. Visual Encounter Survey, Key Informant Interviews (KIIs) with forest department officials of Madhupur National Park and Upazila Fisheries Officer of Muktagacha Upazila, and Focus Group Discussions (FGDs) with local residents of the project area, Nimuria village of 6 No. Mankon union and Choughoria village of 9 No. Kashimpur union under Muktagacha upazila were carried out in the project area to determine the likelihood of encountering these species in the project site. Through this comprehensive approach, only the following species, out of the 56 identified through IBAT Tool, which might occur within the project site has been assessed further to determine the possibility of the project site to have any critical habitat.

Based on the screening conducted, the area does not qualify for critical habitat assessment due to several factors:

Location of Protected Areas and Important Bird & Biodiversity Areas: The project site is located 5 km away from the nearest protected area Madhupur National Park, which is also internationally recognized as an Important Bird and Biodiversity Area (IBA Criteria A3).

Occurrence of Threatened Species: Among the potential CH qualifying species, Fishing cat (*Prionailurus viverrinus*) and Yellow Monitor (*Varanus flavescens*) were reported to be found in the project site. However, the field observation, consultations and information on occurrence and distribution of these species reflect that the project site less likely have any critical habitats.

Therefore, it is concluded that the proposed 20MW Grid Tied Solar Power Project area has the presence of Fishing cat (*Prionailurus viverrinus*) and Yellow Monitor (*Varanus flavescens*) but considering the findings of the CH Screening, the project site does not qualify for Critical Habitat Assessment as the area is less likely to have any critical habitat within the project site. The Critical Habitat Screening Report has been included in **Appendix H**.

5.7.4.1 Terrestrial Ecosystems

5.7.4.1.1 Agricultural Lands

The most common agricultural practice observed within the project AoI is the mono-cropping of Paddy. Also, Chilli (*Capsicum annuum*), Wax gourd (*Benincasa hispida*), Gourd (*Lagenaria siceraria*), Eggplants (*Solanum melongena*), Beans (*Phaseolus vulgaris*), Pumpkin (*Cucurbita argyrosperma*), Tomatoes (*Solanum sisymbriifolium*), etc. were observed to be cultivated during the field visit. Humans extensively modify agricultural habitats to increase crop productivity, so "Agricultural Habitats" can be classified as "Modified habitat".

5.7.4.1.2 Homestead Vegetations

Maximum diversity of plant species, particularly of tree species, is expected from homestead plantations, which assemblage many flowerings and fruit-bearing trees. The homestead plantation covers most of the study area. The most common plant species observed in this habitat are Mango (*Mangifera indica),* Mehagoni (*Swietenia mahagoni),* Coconut *(Cocos nucifera),* Areca palm *(Arecha catechu),* Papaya (*Carica papaya),* Wood apple *(Aegle marmelos),* Banana *(Musa acuminate),* Guava *(Psidium guajava),* Doub palm *(Borassus flabellifer), Jack Fruit (*Artocarpus heterophyllus*),* Aakashmani (*Acacia auriculiformis),* etc. Homestead Vegetations is more diverse than agricultural habitats and they can support a significant number of native species. The species assemblage within homestead vegetation, particularly in terms of flora species, is heavily influenced by human intervention. As a result, floral species are frequently manipulated or tend to boost fruit or flower production.

5.7.4.1.3 Roadside Vegetations

The diverse plantation on the roadside is a crucial habitat within the project AOI. Roadside vegetation serves numerous essential purposes, such as a seed source for neighboring landscapes, a buffer to decrease the penetration of traffic noise and light, carbon sinks, and enhanced aesthetics for road users. In a broader context, roadside plantations offer greater ecosystem functions than adjacent agricultural lands. Some common floral species observed in the project AOI are Aakashmani (*Acacia auriculiformis)*, Mehagoni (*Swietenia mahogany)*, Eucalyptus (*Eucalyptus* sp.), Indian siris *(Albizia lebbeck),* White siris *(Albizia procera),* Areca palm (*Areca catechu),* North Indian rosewood *(Dalbergia sissoo),* Doub palm *(Borassus flabellifer),* Bamboo *(Bambusa sp.)* etc. Roadside vegetation in AoI contains a large number of non-native plant species mainly used for fuel, wood production, and aesthetic purposes.

5.7.4.1.4 Riparian vegetation

The vegetation that grows along riverbanks, ponds, canals, and other waterbodies is called riparian vegetation. These plant species significantly reduce erosion along the riverbanks, which helps maintain the river's depth. The common plant species observed are Mango (*Mangifera indica)*, Date palm (*Phoenix sylvestris),* Crown flower *(Calotropis gigantea),* Arrowleaf sida *(Sida rhombifolia),* Kans grass *(Saccharum spontaneum)*, etc. Different habitats observed from the project area have been presented in Figure 5-42.

Figure 5-42: Different Types of Terrestrial Habitats within the AOI

Agricultural lands within the project AOI

Homstead vegetations within the project AOI

Roadside vegetations within the project AOI


Riparian vegetations within the project AOI

Source: EQMS Field Survey, May 2024

5.7.4.2 Aquatic Ecosystems

The aquatic ecosystem within the AoI comprises lentic water bodies (Beels, Ponds). Different types of aquatic habitats within the AoI have been presented as follows:

5.7.4.2.1 Lentic Habitats (Beels and Ponds)

The project site itself is an aquatic habitat. Another beels and shallow ponds were observed in the project AoI, and the biodiversity of these habitats is notable. Riparian vegetation is greatly found in these aquatic habitats. Some of the most common aquatic plants found in the project site are invasive common water hyacinth (*Pontederia crassipes*) species, along with some other native aquatic vegetation like nut grass (*Cyperus rotundus*), pink morning glory (*Ipomoea carnea*), Taro (*Colocasia esculenta*), water spinach (*Ipomoea aquatica*), arrow Leaf Pondweed (*Monochoria hastata*), asiatic pennywort (*Centella asiatica*), purple spikerush (*Eleocharis atropurpurea*), linear leaf water primrose (*Ludwigia hyssopifolia*), vetiver grass (*Chrysopogon zizanioides*), bitter vine (*Mikania micrantha*), alligator weed (*Alternanthera philoxeroides*), tropical reed (*Phragmites karka*), and Southern cattail (*Typha domingensis*). Aquatic macrophytes and some water birds were also observed during the study of the project area. During the monsoon, various freshwater fish species are found as per consultation with local people and fishermen. Different types of aquatic habitats in the study area are presented in Figure 5-43.

Figure 5-43: Different types of Aquatic Habitats Near the Study Area

Project site beel

Aquaculture ponds in the study area

	
Shallow pond	Water birds foraging in a dried pond

Source: EQMS Field Survey, May 2024

5.7.4.3 Flora

5.7.4.3.1 Terrestrial Flora

The project AoI is mostly covered with plant species from Homestead plantations, Roadside plantations, and Agricultural lands. A total of 61 terrestrial flora species were recorded under 33 families from the field survey. Among these plant species, 37 species under 20 families of trees and 24 species under 17 families of herbs and shrubs were recorded from the primary survey of the project area. The most abundant family is Fabaceae which includes 9 (Nine) plant species. Some photographs of tree species observed in the AoI have been presented in Figure 5-45, and some photographs of herb and shrubs species are presented in Figure 5-46. In addition, a comparison of all flora species based on their family (taxonomic classification) has been shown in Figure 5-44.

Figure 5-44 Comparison of the Number of Floral Species by Family

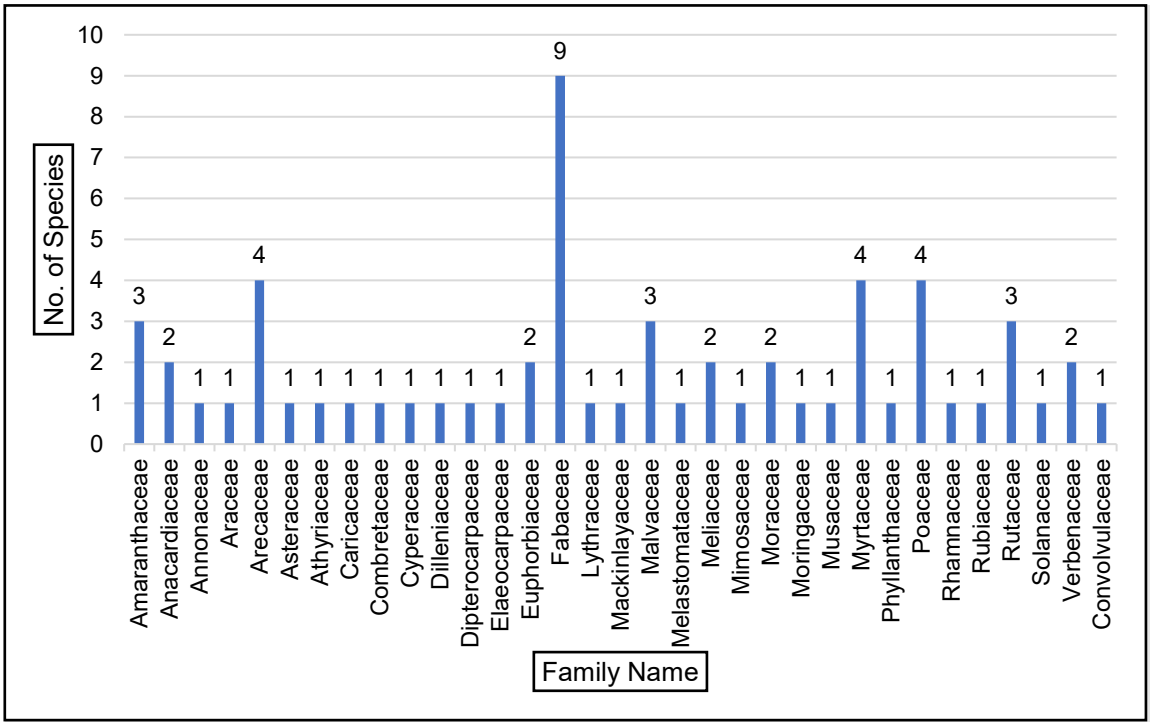


Figure 5-45: Photographs of Tree Species Recorded from the AoI

		
Hairy fig (*Ficus hispida*)	Doub palm (*Borassus flabellifer)*	Coconut (*Cocos nucifera*)
		
Malabar plum (*Syzygium cumini*)	Mango (*Mangifera indica*)	Areca palm (*Arecha catechu*)
		
Date palm (*Phoenix dactylifera*)	Eucalyptus (*Eucalyptus citriodora)*	Akashmoni *(Acacia auriculiformis)*

Source: EQMS Field Survey, May 2024

Table 5-22: Checklist of Terrestrial Floral (Tree) Species Recorded within the Project AoI

Sl No	Local Name	Common Name	Scientific name	Family	Use
1.	Aam	Mango	*Mangifera indica*	Anacardiaceae	Fruit
2.	Akashmoni	Acacia	*Acacia auriculiformis*	Fabaceae	Timber
3.	Amloki	Indian gooseberry	*Phyllanthus emblica*	Phyllanthaceae	Fruit
4.	Amra	Hog Plum	*Spondias mombin*	Anacardiaceae	Fruit
5.	Bel	Indian Bael	*Aegle marmelos*	Rutaceae	Fruit
6.	Boroi	Indian Jujube	*Ziziphus mauritiana*	Rhamnaceae	Medicinal
7.	Chalta	Elephant Apple	*Dillenia indica*	Dilleniaceae	Fruit
8.	Dumur	Hairy fig	*Ficus hispida*	Moraceae	Medicinal
9.	Eucalyptus	Eucalyptus	*Eucalyptus citriodora*	Myrtaceae	Timber
10.	Ipil Ipil	River tamarind	*Leucaena leucocephala*	Fabaceae	Timber
11.	Jam	Java Plum	*Syzygium cumini*	Myrtaceae	Fruit, Timber

Sl No	Local Name	Common Name	Scientific name	Family	Use
12.	Kala Koroi	Shirish	*Albizia lebbeck*	Fabaceae	Timber
13.	Kath Badam	Indian Almond	*Terminalia catappa*	Combretaceae	Fruit
14.	Kathal	Jackfruit	*Artocarpus heterophyllus*	Moraceae	Fruit
15.	Khejur	Date palm	*Phoenix sylvestris*	Arecaceae	Fruit
16.	Kodom	Burflower-tree	*Neolamarckia cadamba*	Rubiaceae	Aesthetic
17.	Krishnochura	Royal poinciana	*Delonix regia*	Fabaceae	Aesthetic
18.	Mahogony	Mahogoni	*Swietenia mahagoni*	Meliaceae	Timber
19.	Mangium	Mangium	*Acacia mangium*	Fabaceae	Timber
20.	Narikel	Coconut	*Cocos nucifera*	Arecaceae	Fruit
21.	Neem	Neem Tree	*Azadirachta indica*	Meliaceae	Medicinal
22.	Peyara	Guava	*Psidium guajava*	Myrtaceae	Fruit
23.	Sada Koroi	White Siris	*Albizia procera*	Fabaceae	Timber
24.	Sajne	Moringa	*Moringa oleifera*	Moringaceae	Medicinal
25.	Segun	Teak	*Tectona grandis*	Verbenaceae	Timber
26.	Shal	Sal Tree	*Shorea robusta*	Dipterocarpaceae	Timber
27.	Shimul	Cotton tree	*Bombax ceiba*	Malvaceae	Timber
28.	Sishu	Indian rosewood	*Dalbergia sissoo*	Fabaceae	Timber
29.	Supari	Areca palm	*Areca catechu*	Arecaceae	Fruit
30.	Tal	Tal palm	*Borassus flabellifer*	Arecaceae	Fruit
31.	Tetul	Tamarind tree	*Tamarindus indica*	Fabaceae	Fruit
32.	Koroi	Raintree	Albizia saman	Mimosaceae	Timber
33.	Ata	Custard Apple	Annona reticulata	Annonaceae	Fruit
34.	Dalim	Pomegranate	Punica granatum	Lythraceae	Fruit
35.	Jalpai	Indian olive	Elaeocarpus Floribundus	Elaeocarpaceae	Fruit
36.	Jambura	Pomelo	Citrus maxima	Rutaceae	Fruit
37.	Jamrul	Java Apple	Syzygium samarangense	Myrtaceae	Fruit

Source: EQMS Field Survey, May 2024

Figure 5-46: Photographs of some Herbs and Shrubs from the Project AOI

Bamboo (*Bambusa sp.*)

Banana (*Musa sapientum*)

	
Pink morning glory (*Ipomoea carnea*)	Papaya (*Carica papaya*)

Source: EQMS Field Survey, May 2024

Table 5-23: Checklist of Terrestrial Herbs & Shrubs Species Recorded within the Project AOI

Sl No	Local Name	Common Name	Scientific name	Family	Type
1.	Bansh	Bamboo	*Bambusa* sp.	Poaceae	Herb
2.	Berela	Cuban jute	*Sida rhombifolia*	Malvaceae	Herb
3.	Datranga	Malabar melastome	*Melastoma malabathricum*	Melastomataceae	Shrub
4.	Dheki Shak	Vegetable fern	*Diplazium esculentum*	Athyriaceae	Herb
5.	Dhol Kolmi	Pink morning glory	*Ipomoea carnea*	Convolvulaceae	Shrub
6.	Durba	Bermuda Grass	*Cynodon dactylon*	Poaceae	Herb
7.	Joba	China Rose	*Hibiscus rosa-sinensis*	Malvaceae	Shrub
8.	Kashful	Wild Sugarcane	*Saccharum spontaneum*	Poaceae	Herb
9.	Khurakata	Spiny amaranth	*Amaranthus spinosus*	Amaranthaceae	Herb
10.	Kochu	Taro	*Colocasia esculenta*	Araceae	Herb
11.	Kola	Banana	*Musa sapientum*	Musaceae	Herb
12.	Kontikari	Sticky Nightshade	*Solanum sisymbriifolium*	Solanaceae	Shrub
13.	Lebu	Lemon	*Citrus* spp.	Rutaceae	Shrub
14.	Lojjaboti	Mimosa plant	*Mimosa pudica*	Fabaceae	Herb
15.	Lonthon ful	Sage	*Lantana camara*	Verbenaceae	Shrub
16.	Mati Konduri	Sessile Joy weed	*Alternanthera sessilis*	Amaranthaceae	Herb
17.	Mukta Juri	Indian Nettle	*Acalypha indica*	Euphorbiaceae	Herb
18.	Mutha	Java Grass	*Cyperus rotundus*	Cyperaceae	Herb
19.	Nol khagra	Tall Reed	*Phragmites karka*	Poaceae	Herb
20.	Opango ful	Prickly Chaff Flower	*Achyranthes aspera*	Amaranthaceae	Herb
21.	Pepe	Papaya	*Carica papaya*	Caricaceae	Shrub
22.	Rabon lata	American rope	*Mikania micrantha*	Asteraceae	Herb
23.	Thankuni	Indian pennywort	*Centella asiatica*	Mackinlayaceae	Herb
24.	Venna	Castor oil plant	*Ricinus communis*	Euphorbiaceae	Shrub

Source: EQMS Field Survey, March 2023

5.7.4.3.2 Aquatic Flora

Aquatic vegetation (macrophytes) is mainly recorded in the beels and ponds within the project site and AoI. It provides cover for fish, the substrate for aquatic invertebrates, produces oxygen, and acts as

food for some fish and wildlife. Diversified macrophytes were found in the study area due to the different types of water habitats.

Major species observed in these habitats are Common water hyacinth (*Eichhornia crassipes*), Water lettuce (*Pistia stratiotes*), Taro (*Colocasia esculenta*), Water fern (*Azolla filiculoides*), Greater salvinia (*Salvinia molesta)*, Water spinach (*Ipomea aquatica*), Dwarf copperleaf (*Alternantha sessilis*), Sedges (*Cyperus* sp.), Helencha (*Enhydra fluctuans*), Alligator weed (*Alternanthera philoxeroides*), Asian watergrass (*Hygroryza aristate*), Greater duckweed (*Spirodela polyrhiza*), and Water chestnut (*Eleocharis* sp.), etc.

Figure 5-47: Aquatic Macrophytes observed in the project AOI

	
Common water hyacinth (*Eichhornia crassipes*)	Taro (*Colocasia esculenta*)
	
Native gooseberry (*Physalis minima*)	Water chestnut (Eleocharis sp.)

Source: EQMS Field Survey, May 2024

5.7.4.4 Fauna

The faunal biodiversity of the project AoI can be divided into five major classes - Avifauna, Herpetofauna (Amphibians & Reptiles), mammal and Fisheries Resources.

5.7.4.4.1 Avifauna

A total of 33 species of birds under 22 families were recorded from the study area. The highest number of birds belong to the family Alcedinidae and Sturnidae. Among the recorded bird species, Steppe Eagle (*Aquila nipalensis*) is considered as Endangered (EN) according to the IUCN Red List of Bangladesh, 2015 and Vulnerable (VU) according to Global IUCN Red List Status (Version 2024-1). Indian Spotted Eagle (*Clanga hastata*) is considered as Endangered (EN) according to Global IUCN Red List Status

(Version 2024-1). Yellow-wattled Lapwing (*Vanellus malarbaricus)* is Near Threatened (NT), according to the IUCN Red List of Bangladesh, 2015. All the other 30 bird species found in the study area are Least Concern (LC) both for Global IUCN Red List Status (Version 2024-1) and IUCN Bangladesh Red List (2015). A Comparison of Avian species based on family is presented in Figure 5-48. Some observed bird species are presented in Figure 5-49. A checklist of all recorded avian species has been provided in Table 5-24.

Figure 5-48: Comparison of the Number of Bird Species Based on their Family

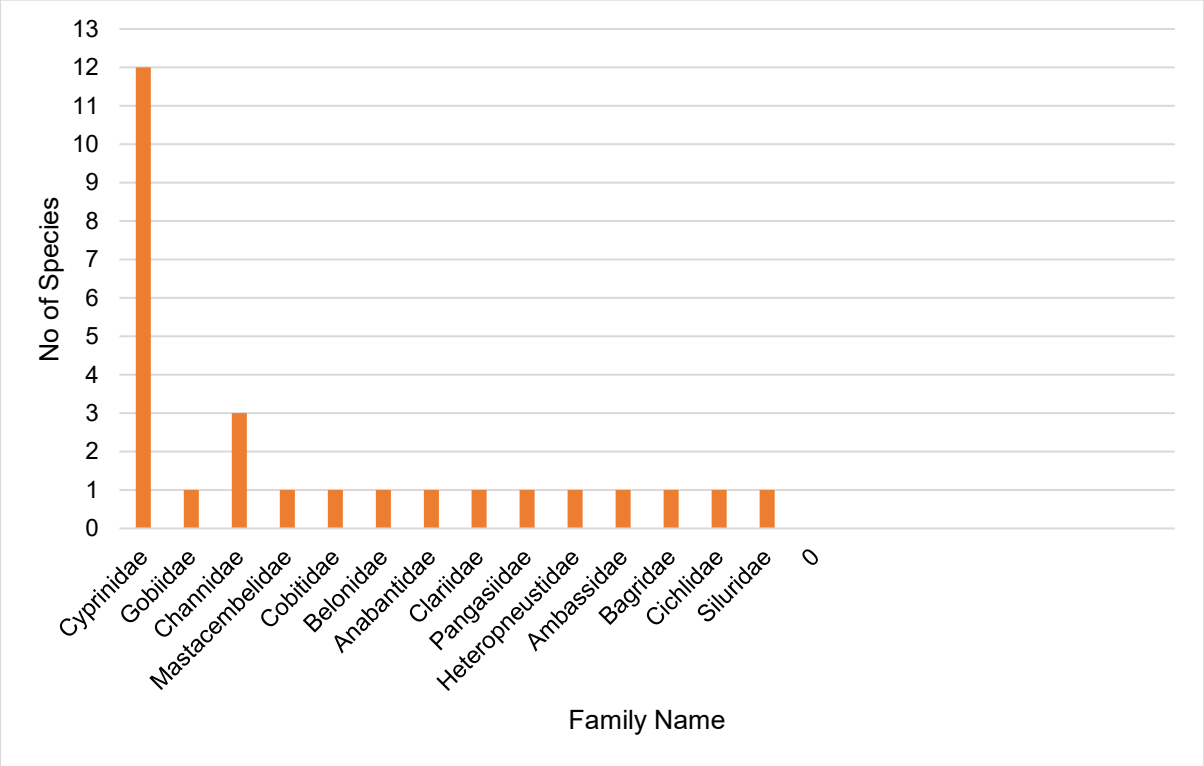


Figure 5-49: Photo Plate of Observed Bird Species from the Project Aoi

Long-tailed shrike (Lanius schach)

Magpie robin (Copsychus saularis)

Jungle myna (*Acridotheres fuscus*)

Indian pond heron (*Ardeola grayii*)

Asian Pied Starling (*Sturnus contra)*

Spotted dove (*Streptopelia chinensis)*

Source: EQMS Field Survey, May 2024

Table 5-24: Checklist of Avifaunal Species of the Project AOI

Sl No	Common Name	Local Name	Scientific name	Family	IUCN Status	
					National*	Global**
1.	Asian koel	Kokil, Koel	*Eudynamys scolopacea*	Cuculidae	LC	LC
2.	Asian pied starling	Pakra/Gubra shalik	*Sturnus contra*	Sturnidae	LC	LC
3.	Black drongo	Kala Fingey	*Dicrurus macrocercus*	Dicruridiae	LC	LC
4.	Black-rumped flameback	Sonali kaththokra	*Dinopium benghalense*	Picidae	LC	LC
5.	Brahminy Kite	Shonkho Cheel	*Haliastur indus*	Accipitridae	LC	LC
6.	Cattle egret	Go Boga	*Bubulcus ibis*	Ardeidae	LC	LC
7.	Common Kingfisher	Choto Machranga	*Alcedo atthis*	Alcedinidae	LC	LC
8.	Common myna	Bhat Salik	*Acridotheres tristis*	Sturnidae	LC	LC

Sl No	Common Name	Local Name	Scientific name	Family	IUCN Status	
					National*	Global**
9.	Common Sandpiper	Pati Batan	*Actitis hypoleucos*	Scolopacidae	LC	LC
10.	Common tailor bird	Tuntuni	*Orthotomus sutorius*	Sylviidae	LC	LC
11.	House crow	Pati Kak	*Corvus splendens*	Corvidae	LC	LC
12.	House sparrow	Pati choroi	*Passer domesticus*	Passeridae	LC	LC
13.	Indian pond heron	Kani Bok	*Ardeola grayii*	Ardidae	LC	LC
14.	Indian Spotted Eagle	Deshi Guti-eegol	*Clanga hastata*	Accipitridae	EN	VU
15.	Jungle Babbler	Bon Chatarey	*Turdoides striata*	Timalidae	LC	LC
16.	Jungle myna	Jhuti Shalik	*Acridotheres fuscus*	Sturnidae	LC	LC
17.	Large-billed crow /Jungle crow	Dar kak	*Corvus macrorhynchos*	Corvidae	LC	LC
18.	Little cormorant	Choto Pankowri	*Microcarbo niger*	Phalacrocoracidae	LC	LC
19.	Little egret	Choto boga	*Egretta garzetta*	Ardeidae	LC	LC
20.	Long-tailed shrike	Lenja Latora	*Lanius schach*	Laniidae	LC	LC
21.	Orange-headed Thrush	Komla Dama	*Zoothera citrina*	Turdidae	LC	LC
22.	Oriental magpie robin	Doel	*Copsychus saularis*	Muscicapidae	LC	LC
23.	Pied kingfisher	Pakra Machranga	*Ceryle rudis*	Alcedinidae	LC	LC
24.	Purple sunbird	Niltuni	*Cinnyris asiaticus*	Nectarinidae	LC	LC
25.	Purple-rumped sunbird	Moutusi	*Leptocoma zeylonica*	Nectarinidae	LC	LC
26.	Red turtle dove	Lal Ghugu	*Streptopelia tranquebarica*	Columbidae	LC	LC
27.	Red-vented bulbul	Bangla BHulbul	*Pycnonotus cafer*	Pycnonotidae	LC	LC
28.	Rock dove	Gola Paira/Jalali Kabutor	*Columba livia*	Columbidae	LC	LC
29.	Spotted dove	Tila Ghughu	*Streptopelia chinensis*	Rallidae	LC	LC
30.	Steppe Eagle	Nepali Eegol	*Aquila nipalensis*	Accipitridae	LC	EN
31.	White-breasted kingfisher	Dhola Gola Machranga	*Halcyon smyrnensis*	Alcedinidae	LC	LC

Sl No	Common Name	Local Name	Scientific name	Family	IUCN Status	
					National*	Global**
32.	White-breasted Waterhen	Dholabuk Dahuk	*Amaurornis phoenicurus*	Rallidae	LC	LC
33.	Yellow-wattled Lapwing	Holdegal Titi	*Vanellus malarbaricus*	Chardridae	NT	LC

Source: EQMS Field Survey, May 2024

*IUCN Bangladesh. 2015. Red List of Bangladesh Volume 3: Birds; LC=Least Concern, NT=Near Threatened

**IUCN 2024. The IUCN Red List of Threatened Species. Version 2024-1. (https://www.iucnredlist.org/)

5.7.4.4.2 Herpetofauna

A total of five (05) species of amphibians belonging to three (03) families and nine (09) species of reptiles belonging to seven (07) families were listed from the project area based on primary and secondary data.

All the amphibian species are included in the Bangladesh Wildlife (Conservation and Security) Act, 2012, under Schedule-II, which protects them from hunting, killing, and capturing. Amphibians recorded or reported to be present in the AOI are found to be Least Concern (LC) species.

Among the reptiles listed, the Tricarinate Hill Turtle (*Melanochelys tricarinata*) is classified as Vulnerable (VU) according to the IUCN Bangladesh Red List (2015) and Endangered (EN) on the Global IUCN Red List (2024-1). The Indian Flap-shelled Turtle (*Lissemys punctata*) is also considered Vulnerable (VU) globally. Both the Bengal Monitor (*Varanus bengalensis*) and the Yellow Monitor (*Varanus flavescens*) are listed as Near Threatened (NT) in the IUCN Bangladesh Red List (2015). However, the Yellow Monitor is categorized as Endangered (EN) on the Global IUCN Red List (2024-1). Notably, the Bengal Monitor was observed directly at the project site, and reports from Focus Group Discussions (FGDs) confirmed the presence of the Yellow Monitor in the same area. Photographs of observed herpetofauna species are given in Figure 5-50. Recorded herpetofauna species presented in Table 5-25.

Figure 5-50: Herpetofauna Species Observed from the Project AoI

Skipper frog (*Euphlyctis cyanophlyctis*)

Oriental garden lizard (*Calotes versicolor*)

Source: EQMS Field Survey, May 2024

Table 5-25: A checklist on Herpetofauna recorded from the project AOI

Sl No	Family	Common Name	Local Name	Scientific Name	IUCN Status		Wildlife conservation and security Act, 2012
					National*	Global**	
Amphibians							
1.	Bufonidae	Asian Common Toad	Kuno Bang	*Duttaphrynus melanostictus*	LC	LC	Schedule II
2.	Dicroglossidae	Indian Bullfrog	Kola bang	*Hoplobatrachus tigerinus*	LC	LC	Schedule II
3.		Indian skipper frog	Kotkoti bang	*Euphlyctis cyanophlyctis*	LC	LC	Schedule II
4.	Rhacophoridae	Common Tree Frog	Dorakata Gecho Bang	*Polypedates leucomystax*	LC	LC	Schedule II
5.		Tree Frog	Dui-dagi Khudey Gecho Bang	*Chiromantis vittatus*	LC	LC	Schedule II
Reptiles							
1.	Varanidae	Bengal monitor Lizard	Gui Shap	*Varanus bengalensis*	NT	NT	Schedule II
2.		Yellow monitor	Sona Gui, Haldey Gui	*Varanus flavescens*	NT	EN	Schedule I
3.	Gekkonidae	House Gecko	Tiktiki	*Hemidactylus frenatus*	LC	LC	Schedule II
4.	Agamidae	Common Garden Lizard	Roktochosa	*Calotes versicolor*	LC	LC	Schedule II
5.	Scincidae	Keeled Grass Skink	Angina	*Eutropis carinata*	LC	LC	Schedule II
6.	Colubridae	Checkered Keelback	Dhora Shap	*Xenochrophis piscator*	LC	LC	Schedule I
7.		Indian Rat Snake	Darash Shap	*Ptyas mucosa*	LC	LC	Schedule I
8.	Geoemydidae	Tricarinate Hill Turtle	Shila Kossop	*Melanochelys tricarinata*	VU	EN	Schedule I
9.	Trionychidae	Indian Flap-shelled Turtle	Shundhi Kasim	*Lissemys punctata*	LC	VU	Schedule II

Source: EQMS Field Survey, May 2024

*IUCN Bangladesh. 2015. Red List of Bangladesh Volume 4: Reptiles and Amphibians; LC=Least Concern; NT=Near Threatened; NE=Not Evaluated

**IUCN 2024. The IUCN Red List of Threatened Species. Version 2024-1. (https://www.iucnredlist.org/)

5.7.4.4.3 Mammals

Nine (09) terrestrial Mammal species belonging to Seven (07) families were recorded in the AoI through field survey, secondary data and consultation with local people and Forest Range Officer (Figure 5-51). Among the recorded mammals, Fishing Cat (*Prionailurus viverrinus)* and Capped Langur (*Trachypithecus pileatus*) are both Endangered (EN) according to the IUCN Bangladesh Red List (2015) and both are Vulnerable (VU) as per Global IUCN Red List Status (Version 2024-1). Seven (07) mammalian species found are Least Concern (LC) both nationally and globally, according to IUCN Red List. A detailed checklist of recorded mammals has been provided in Table 5-26.

Table 5-26: Checklist of recorded mammals from the Study AOI

Sl No	Common Name	Local Name	Scientific Name	Family	IUCN Status		Wildlife Conservation and Security Act, 2012
					National*	Global**	
1.	Common Indian Field Mouse	Metho Idur	*Mus booduga*	Muridae	LC	LC	Schedule III
2.	Capped Langur	Mukhpora Hanuman	*Trachypithecus pileatus*	Cercopithecidae	EN	VU	Schedule I
3.	Small Indian Mongoose	Choto beji	*Urva auropunctata*	Herpestidae	LC	LC	Schedule I
4.	Common House Rat	Idur	*Rattus rattus*	Muridae	LC	LC	Schedule III
5.	House Mouse	Nengti Idur	*Mus musculus*	Muridae	LC	LC	Schedule III
6.	Indian Flying Fox	Badur	*Pteropus giganteus*	Pteropodidae	LC	LC	Schedule I
7.	Golden Jackal	Pati-Shiyal	*Canis aureus*	Canidae	LC	LC	Schedule I
8.	Fishing Cat	Mechho Biral	*Prionailurus viverrinus*	Felidae	EN	VU	Schedule I
9.	Irrawaddy Squirrel	Kathbirali	*Callosciurus pygerythrus*	Sciuridae	LC	LC	Schedule I

Source: EQMS Field Survey, May 2024

*IUCN Bangladesh. 2015. Red List of Bangladesh Volume 2: Mammals; LC=Least Concern, NT= Near Threatened

**IUCN 2024. The IUCN Red List of Threatened Species. Version 2024-1. (https://www.iucnredlist.org/)

Figure 5-51: Photographic Evidence of FGDs and KIIs Conducted in Project AoI

	
FGD with Local Peoples in Nimuria village, Muktagacha	FGD with Local Peoples in Choughoria village, Muktagacha
	
KII with Forest Range Officer, Rosulpur Range, Madhupur National Park	KII with Upazila Fisheries officer, Muktagacha, Mymensing

Source: EQMS Field Survey, April-May 2024

5.7.4.4.4 Fisheries Resources

The prime objective of the fisheries study is to examine and evaluate the overall fisheries status (capture and cultured fish species) in the study area. No fishing activities were observed during the study period in the project site and within AoI due to dry season and excess amount of water hyacinth. However, beels and ponds within the project area may serve as reservoirs for fish species. Consultation with local people were conducted to know the fish species composition. The study area exhibited both types of fishing activities: (i) Capture Fishing, which involved traditional fishing methods in beels and ponds and (ii) Culture Fishing mainly pond-based freshwater aquaculture.

5.7.4.4.4.1 Capture Fishing

In the past the major source of fish production in Bangladesh was the inland open water capture fisheries. During 1960s, it contributed about 90% of the country's total fish production. Rapid growth of population coupled with lack of proper management policy, however, created increasing pressure on fish resources and aquatic environment. Due to over exploitation of fish including use of harmful fishing gears and system (fishing by dewatering), degradation and loss of fish habitats, obstruction of fish migration routes by construction of embankment and water control structures mainly to increase

agriculture production and road communication, siltation of water bodies by natural process, introduction of a number of alien invasive fish species and water pollution by industry, and agrochemicals, the natural inland fish stocks have declined significantly and fish biodiversity and poor fishers' livelihood have been affected seriously (Ali 1997[21]).

Bangladesh has a total inland water area of 6.7 million ha of which 94% is used for open water capture fishery and 6% for closed water culture fishery. The inland open water fishery resources have been playing a significant role in the economy, culture, tradition and food habit of the people of Bangladesh. (Hossain, 2015[22]). Capture fishing in the study study area mainly comprises fishing in beel along with some seasonal waterbodies and floodplain at the time of monsson. The beel is a Bengali term used for relatively large surface, static waterbody that accumulates surface run-off water through an internal drainage channel (Banglapedia, 2004[23]). This type of shallow, seasonal waterbody is common in low-lying floodplain areas throughout Bangladesh.

The abundant captured fish species recorded within the project area are Punti (*Puntius chola*), Baila (*Awaous guamensis*), Taki (Channa punctatus), Tengra *(Mystus tengra*), Mola (*Amblypharyngodon mola*), Koi (*Anabas testudineus*) etc. According to the local people and fishermen, some native fish species i.e., Shol (*Channa striatas*), Baim (*Mastacembalus* spp.), and Gutum (*Lepidocephalichthys Guntea*) are also captured from the beels and ponds during the monsoon.

5.7.4.4.4.2 Culture Fishing

There are two types of aquaculture practices are going on in Bangladesh - freshwater and coastal aquaculture. There is no marine aquaculture currently practiced in the country and no marine/coastal fin finfishes are farmed. Freshwater aquaculture comprises mainly pond farming of carps – (indigenous and exotic), Mekong pangasid catfish, tilapia, Mekong climbing perch and a number of other domesticated fish though in lesser scale. In Bangladesh, aquaculture production systems are mainly extensive and improved extensive, with some semi-intensive and in very few cases intensive systems. Inland pond culture represents the mainstay of aquaculture in Bangladesh, accounting more than 80% total recorded aquaculture production and presently dominated by carps (indigenous and exotic), Mekong pangas and tilapia.

Aquaculture production has significantly increased during the last two and a half decades with the development of technology. Due to the rapid increase of aquaculture production and sharp decrease of capture fishery production, in 2010-11, the aquaculture contributed (about 53 %) more than inland capture fisheries in total fish production of the country (DoF 2013[24]). Over the last couple of years, significant numbers of crop farmers have been converting their land to fishponds, mainly in Mymensingh and part of Rajshahi, what many think a natural phenomenon related to ever decreasing benefit-cost ratio farmers are receiving from paddy farming.

Our GIS-based LULC time series data showed that in 2003, there were no aquaculture practices in the project site, but by 2024, a total of 27% is used as aquaculture ponds for fish production, indicating no agricultural practices.

[21] Ali MY, 1997. Fish, Water and People, Reflections on Inland Openwater Fisheries Resources in Bangladesh. *The University Press Limited*, Dhaka, 154p.

[22] Hossain, M. A. R. (2015). An overview of Fisheries sector of Bangladesh. *Research in Agriculture Livestock and Fisheries*, 1(1), 109–126.

[23] Banglapedia, 2004. *National Encyclopedia of Bangladesh, Asiatic Society of Bangladesh*, 1st edn. February 2004, Dhaka, Bangladesh.

[24] (DoF (Department of Fisheries), 2013. Matshya Saptaha Saranika-2012. Department of Fisheries, Ministry of Fisheries and Livestock. The Government of the People's Republic of Bangladesh, Ramna, Dhaka. Bangladesh. 144 p.)

Consultation with locals revealed that most of the fish being sold in the market were from cultured species. The common fish species recorded in the market were Catla (*Catla catla*), Mrigal (*Cirrhina mrigala*), Grass carp (*Ctenopharyngodon idealla*), Pangas (*Pangasianodon hypophthalmus*), Silver carp (*Hypopthalmichthys nobilis*), Rui (*Labeo rohita*), Tilapia (*Oreochromis niloticus*) etc.

5.7.4.4.4.3 Fish Species Composition

A total of twenty-seven (27) species of fish under twelve (14) families were recorded. Recorded fishes were both captured and cultured. The highest number of fish species (12) belongs to the family Cyprinidae (Figure 1-13).

Among the recorded species, Butter catfish (*Ompok bimaculatus*) is Endangered (EN) as per the IUCN Red List of Bangladesh 2015. However, this species is extensively/semi intensively cultured in the project area and recorded as culture fish. In addition, Common carp (*Cyprinus carpio*) and Striped Catfish (*Pangasianodon hypophthalmus*), which are in threatened categories as per Global IUCN Red List Status (Version 2024-1), are also recorded as culture fish and extensively/semi intensively cultured in the project area. Family-based fish species diversity has been presented in Figure 5-51. A detailed checklist of different fish species recorded from the study area has been presented in **Table 5-25**.

Figure 5-13: Family-Based Fish Species Diversity in the Project Area

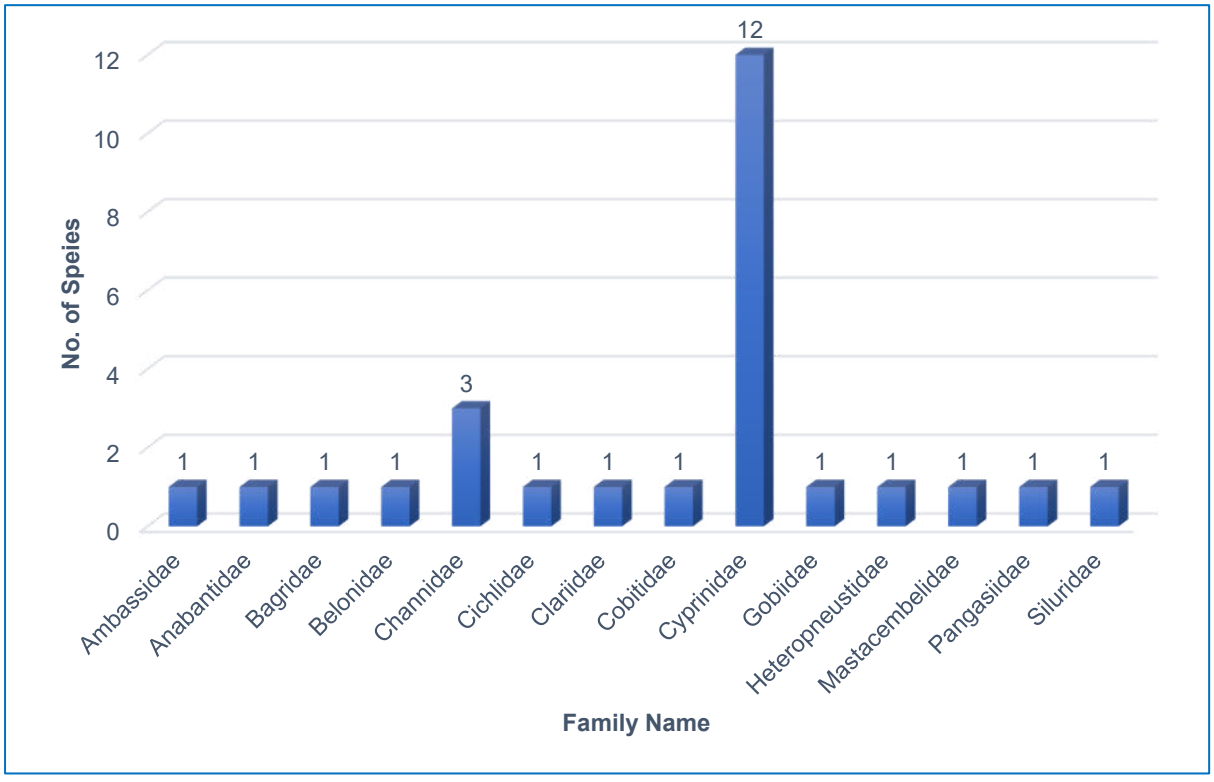


Table 5-27: Checklist of Recorded Fish Species

Sl No.	Local name	Family	English name	Scientific name	IUCN Status		Source Type	
					National*	Global**	Captured	Cultured
1	Bata	Cyprinidae	Bata Labeo	*Labeo bata*	LC	LC		ü
2	Bele	Gobiidae	Tank Goby	*Glossogobius giuris*	LC	LC	ü	
3	Bighead carp	Cyprinidae	Bighead carp	*Hypophthalmichthys nobilis*	NE	DD		ü
4	Catla	Cyprinidae	Catla carp	*Labeo catla*	LC	LC		ü
5	Shol	Channidae	Snakehead	*Channa striata*	LC	LC	ü	
6	Grass carp	Cyprinidae	Grass carp	*Ctenopharyngodon idella*	NE	LC		ü
7	Guchi Baim	Mastacembelidae	Stripped Spiny eel	*Macrognathus pancalus*	LC	LC	ü	
8	Gutum	Cobitidae	Peppered Loach, Guntea	*Lepidocephalichthys guntea*	LC	LC	ü	
9	Jat Punti	Cyprinidae	Pool Barb	*Puntius sophore*	LC	LC	ü	
10	Kakila	Belonidae	Freshwater Garfish	*Xenentodon cancila*	LC	LC	ü	
11	Kalibaus	Cyprinidae	Orange Fin Labeo	*Labeo calbasu*	LC	LC		ü
12	Karfu	Cyprinidae	common carps	*Cyprinus carpio*	NE	VU		ü
13	Koi	Anabantidae	Climbing Perch,	*Anabas testudineus*	LC	LC	ü	ü
14	Magur	Clariidae	Walking Catfish	*Clarias batrachus*	LC	LC	ü	
15	Mola	Cyprinidae	Mola Carplet	*Amblypharyngodon mola*	LC	LC	ü	
16	Mrigal	Cyprinidae	White carp	*Cirrhinus mrigala*	LC	LC		ü
17	Pangas	Pangasiidae	Striped Catfish	*Pangasianodon hypophthalmus*	NE	EN		ü
18	Rui	Cyprinidae	Ruhu carp	*Labeo rohita*	LC	LC		ü
19	Sarputi	Cyprinidae	Olive barb	*Systomus sarana*	NT	LC		ü
20	Shing	Heteropneustidae	Stinging Catfish	*Heteropneustes fossilis*	LC	LC	ü	ü
21	Shol	Channidae	Snakehead Murrel	*Channa striatus*	LC	LC	ü	

Sl No.	Local name	Family	English name	Scientific name	IUCN Status		Source Type	
					National*	Global**	Captured	Cultured
22	Silver carp	Cyprinidae	Silver Carp	*Hypophthalmichthys molitrix*	LC	NT		ü
23	Taki	Channidae	Spotted Snakehead	*Channa punctatus*	LC	LC	ü	
24	Nama Chanda	Ambassidae	Elongate glassy perchlet	*Chanda nama*	LC	LC	ü	
25	Tengra	Bagridae	Striped dwarf catfish	*Mystus vittatus*	LC	LC	ü	ü
26	Tilapia	Cichlidae	Nile Tilapia	*Oreochromis niloticus*	LC	LC		ü
27	Kani pabda	Siluridae	Butter Catfish	*Ompok bimaculatus*	EN	NT		ü

Source: EQMS Field Survey, April-May 2024

*IUCN Bangladesh. 2015. Red List of Bangladesh Volume 5: Freshwater Fishes; LC=Least Concern, NT=Near Threatened; VU=Vulnerable, EN= Endangered; NE=Not Evaluated, DD=Data Deficient

**IUCN 2024. The IUCN Red List of Threatened Species. Version 2024-1. (https://www.iucnredlist.org/)