NAM NGIEP 1
POWER COMPANY

Nam Ngiep 1 Hydropower Project

Environmental Management
Monthly Monitoring Report

November 2022

A	26 December 2022	Hendra WINASTU	Wanidaporn RODE	Khamlar PHONSAVAT	Final
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TABLE OF CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

EXECUTIVE SUMMARY

During November 2022, activities related to ISO14001:2015 implementation continued such as review of the annual ISO14001 Internal Audit results and following up on the implementation of the Environmental Management Plan and its achievements. The internal audit was completed on 03 November 2022 for all the 31 areas/work functions. The management review was postponed and planned to be completed by December 2022. The first surveillance audit (on site, two-man days) by SGS was scheduled and confirmed to be conducted on 16-17 February 2023.

During this reporting period, no new document was submitted to the Environment Management Office (EMO) for review and approval. EMO did not issue any Site Inspection Report of Observation of Non-Compliance (ONC) or Non-Compliance Reports (NCR) to any Contractor. The two pending Non-Compliance Reports (one NCR level 1 and one NCR level 2) are resolved.

The operation and adjustment of the constructed wastewater treatment systems continued in November 2022. The results of the effluent analyses of the WWTSs show improvements as a result of many adjustments and corrective actions. The concerns on non-compliance with effluent standards can be eased based on LTA's comment that the load of Nitrogen and Phosphorus from the treatment plants into the river would not result in any significant impact, rather it could promote the natural growth of plants in the effluent discharge area.

During November 2022, the water quality could not be monitored in Nam Phouan (NPH01) as access to the site was blocked by floating debris.

At R05 (in the Main Reservoir approx. 0.5 km upstream the Main Dam), the average DO concentration was 6.9 mg/L in the upper 8.5 m varying between 6.0 mg/L and 7.9 mg/L, and the oxycline was generally found at depths between 9.0 m and 18 m. DO concentration less than 0.5 mg/L (anoxic condition) were found from 38 m to the bottom. At the water intake level, DO concentrations varied between 0.1 mg/L and 0.9 mg/L. In the Re-regulation Reservoir, the mean DO concentrations in the water column of the two monitoring stations were 2.3 mg/L and 2.6 mg/L respectively.

The DO measurements downstream the Re-regulation Dam during turbine discharges were less than 6 mg/L in immediately downstream station. This is due to oxygen depletion in the deeper layers of the main reservoir, caused by decomposing submerged biomass which was left in the reservoir.

NNP1PC continues to carefully compile and assess all monitoring data to determine if any additional water aeration measures may be necessary to improve the DO levels in Nam Ngiep River downstream the Re-regulation Dam. Water quality monitoring will be maintained, and the development of the situation in the reservoir and in the downstream area will be closely followed until a satisfactory situation has been reached. In this regard, it should be noted that since the Commercial Operation Date (COD) in September 2019 no dead fish have been observed in Nam Ngiep downstream the Re-regulation Dam.

In November 2022, the communities' solid waste management and the Houay Soup Landfill operation are still under handover process to be managed by the local authorities (Bolikhan Environment Management Unit or EMU). EMO completed an annual maintenance of the landfill to

ensure that it is well-functioning and ready for operation. It is expected that the community solid waste management could be fully handed over to the local authority within 2022.

A total of 7.42 m^3 of solid waste was disposed of at the NNP1 Project Landfill, a decrease of 0.43 m^3 compared with October 2022. There was no trading of recyclable waste at the community recycle waste bank during the reporting period.

The Bolikhamxay Watershed and Reservoir Protection Office (WRPO) and Nam Chouane-Nam Xang Biodiversity Offset Management Unit (BOMU) received their AIP2022 funds for the remaining months of 2022 from DOF-MAF on 2 and 11 November 2022 respectively. Bolikhamxay WRPO implemented the forest and reservoir patrolling from 15 to 25 November 2022 and prepared a plan to deal with forest encroachment in the two villages adjacent to NNP1 watershed boundary. They are also reviewing the draft AIP2023 after further clarification and improvement by NNP1 EMO and Biodiversity Service Provider (BSP)-Wildlife Conservation Society (WCS). Bolikhamxay BOMU implemented the survey on Community Development Plan (CDP) activity as well as prepared the material for the official approval of the Totally Protected Zone (TPZ) boundary during the last week of November 2022. They are also working on completing the first draft of AIP2023 after discussion with EMO and BSP-WCS on 17 November 2022. Xaysomboun WRPO is still following up with the Forest Protection Fund (FPF) of Department of Forestry (DOF)-Ministry of Agriculture and Forestry (MAF) in November 2022 on their AIP2022 fund disbursement. EMO and BSP-WCS also followed up with Head of Xaysomboun WRPO on the establishment of Totally Protected Zone (TPZ), forest, and reservoir patrol team as part of the preparation of the Xaysomboun WRPO AIP2023.

The fish catch monitoring for October 2022 in Nam Ngiep Watershed was dominated by *Oreochromis niloticus* and *Tor sinensis* and species groups of Mastacembelus, Poropuntius and Hampala. They are classified as Least Concern (LC) according to the IUCN Red List of Threatened Species and *Oreochromis niloticus* is an exotic species.

1. ENVIRONMENTAL MANAGEMENT MONITORING

1.1. ENVIRONMENTAL MANAGEMENT SYSTEM (EMS)

During November 2022, activities related to ISO14001:2015 implementation continued such as review of the annual ISO14001 Internal Audit results and following up on the implementation of the Environmental Management Plan and its achievements. The internal audit was completed on 03 November 2022 for all the 31 areas/work functions. The management review was postponed and planned to be completed by December 2022. The first surveillance audit (on site, two-man days) by SGS was scheduled and confirmed to be conducted on 16-17 February 2023.

The confirmed plant for the first surveillance audit is shown in the table below.

Table 1.1-1: The ISO14001:2015 Surveillance Audit Plan by SGS.

SGS

Audit Plan

Organization:	Nam Ngiep 1 Power Company		
Address:	Owner's Site Office and Village, Hat Gniun Village, Bolikhan District, Bolikhamxay Province, Lao PDR.		
Visit Number:	2 = 2 MD	Actual Visit Date:	16-17 February 2023
Visit Due by Date:		For auditor information only	
Lead Auditor:	A: Bonnara Busra Dinc (TL & TE EM 25)		
Team Member(s):			
Additional Attendees and Roles			
Standard(s):	ISO14001:2015		
Audit Language:	Thai / English		
Audit Scope:	The Generation and Distribution of Electricity from 290 MW Hydropower Project		

Audit Objectives: To determine conformity of the management system, or parts of it with audit criteria and its:
- *ability to ensure applicable statutory, regulatory and contractual requirements are met,*
- *effectiveness to ensure the client can reasonably expect to achieve specified objectives*

and to identify as applicable areas for potential improvement.

1.2. COMPLIANCE MANAGEMENT

In November 2022, EMO did not receive any document for review and approval.

The operation and adjustment of the constructed wastewater treatment systems continued in November 2022. The results of the effluent analyses of the WWTSs show improvements as a result of many adjustments and corrective actions. The concerns on non-compliance with effluent standards can be eased based on LTA's comment that the load of Nitrogen and Phosphorus form the wastewater treatment plants into the river would not result in any significant impact, rather it could promote the natural growth of plants around the effluent discharged area.

EMO did not issue any Site Inspection Report (SIR) or Non-Compliance Report (NCR) to the Contractor during the reporting period. The status of compliance reports (Observation of Non-Compliance or ONC; and Non-Compliance Report or NCR) issued by NNP1PC is summarized in ***Table 1.2-1*** below.

Table 1.2-1: Summary of ONCs and NCRs

Items	ONC	NCR-1	NCR-2	NCR-3
Carried over from October 2022	0	1	1	0
Newly Opened in November 2022	0	0	0	0
Total in November 2022	**0**	**1**	**1**	**0**
Resolved in November 2022	0	1	1	0
Carried over to December 2022	0	0	0	0
Unsolved Exceeding Deadlines	**0**	**0**	**0**	**0**

1.2.1. Site Inspection by the Environment Management Unit (EMU)

The monthly site visit by the EMU of Bolikhan District and the quarterly site visit by the EMU of Xaysomboun Province were not carried out in November 2022.

1.2.2. Site Decommissioning and Rehabilitation

The land use handover is still being reviewed and considered by the leadership of the provincial authorities.

The overall rehabilitation status of the construction sites and percentage of vegetation cover have not been assessed in November 2022.

1.3. WATER QUALITY MONITORING

The analyses of Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD_5), Faecal Coliform Bacteria, Total Coliform Bacteria and *E.coli* have been carried out by NNP1PC's environmental laboratory since August 2017.

All data are reported to the Ministry of Natural Resources and Environment (MONRE) monthly, and quarterly to the ADB. The reports are also published on the Company's website at https://namngiep1.com/resources/monitoring-reports/.

1.3.1 Effluent Discharge from Camps and Construction Sites

Detailed monitoring results are provided in the *Error! Reference source not found.* of this Report. T he status of implementation of the corrective actions addressing non-compliances at the camps and key project facilities are summarized in ***Table 1.3-1.***

Table 1.3-1: Status of Corrective Actions for Non-Compliances at WWTSs in November 2022

Site	Sampling ID	Status	Corrective Actions (Expected Completion Date)
OSOV1	EF01	Non-compliance for faecal coliform and total coliform.	1) Completed proper fence installation to prevent cattle from accessing the OSOV1 wetland ponds (31 March 2022).

Site	Sampling ID	Status	Corrective Actions (Expected Completion Date)
OSOV2	EF13	Non-compliance for total coliform (first fortnightly sampling) and total nitrogen (second fortnightly sampling).	2) Completed additional planting of reeds in the OSOV1 wetland ponds (31 March 2022). 3) The second adding of the proper sludge/seeds into the Aeration Tank at OSOV2 WWTS and the Biofilm Septic Tank at the Main Powerhouse System. 4) Closely monitor the residual chlorine content in the effluents of OSOV2 and the Main Powerhouse WWTS. Chlorination dosage adjustment was successful by June 2022. 5) Closely monitor the Influent to compare with the effluent for the specific parameters to check the treatment effectiveness (continue in Q4 of 2022).
Main Powerhouse	EF19	Non-compliance for total phosphorus.	

1.3.2 Ambient Surface Water and Reservoir Water Quality Monitoring

The ambient surface water and reservoir water quality monitoring programme comprises five monitoring stations in the main reservoir (R01-R05), two stations in the Re-regulation Reservoir (R06 and R07), five stations in the mainstream Nam Ngiep (NNG01 and NNG05 to NNG08) and four stations in the main tributaries to Nam Ngiep (Nam Chiane [NCH01], Nam Phouan [NPH01], Nam Xao [NXA01] and Nam Houay Soup [NHS01]).

Weekly depth profile monitoring (pH, DO, conductivity and temperature) has been undertaken since 18 September 2018 for stations located in the Re-regulation reservoir and the main reservoir. The locations of the monitoring stations are shown in ***Figure 1.3-1*****.**

The monitoring results for key parameters (DO, TSS and BOD_5) during November 2022 are presented in ***Table 1.3-2, Table 1.3-3*** and ***Table 1.3-4.*** The full set of data for November 2022 is attached in Annex A. In addition, the trends of DO depth profile timeseries measurement graph for R05 station is shown in ***Figure 1.3-2****, the* results for DO timeseries are presented as line graphs in ***Figure 1.3-3*** and DO Long Profile graphs ***Figure 1.3-4***.

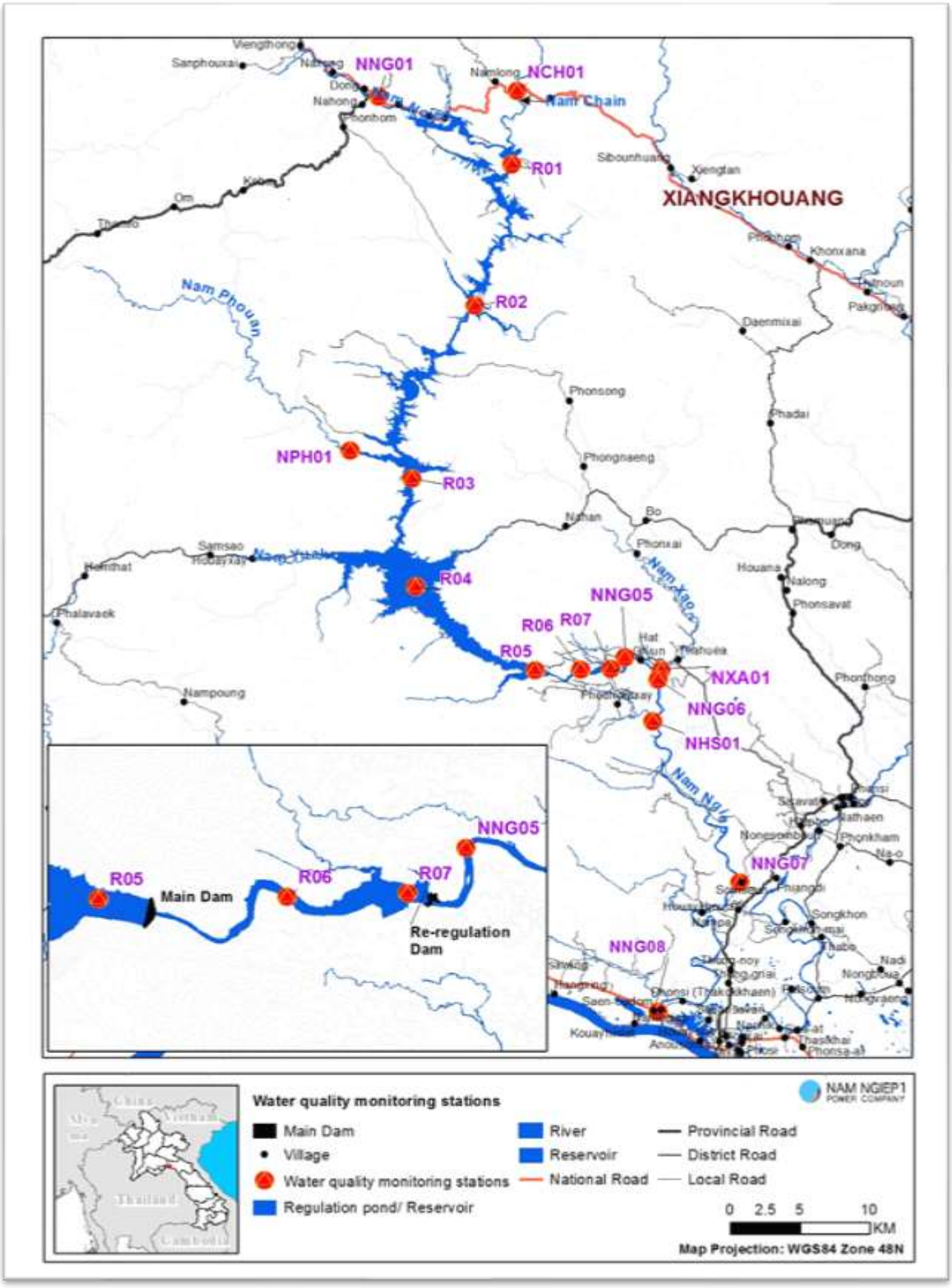

Figure 1.3-1: Surface Water and Re-regulation Reservoir Water Quality Monitoring Stations

Main Reservoir

During November 2022, the water level in the main reservoir increased from El. 318.47 m asl to El. 319.06 m asl and then decreased to 318.62 m asl at the end of the month.

At R05 (in the Main Reservoir approx. 0.5 km upstream the Main Dam), the average DO concentration was 6.9 mg/L in the upper 8.5 m varying between 6.0 mg/L and 7.9 mg/L, and the oxycline was generally found at depths between 9.0 m and 18 m. DO concentration less than 0.5 mg/L (anoxic condition) were found from 38 m to bottom. At the water intake level, DO concentrations varied between 0.1 mg/L to 0.9 mg/L.

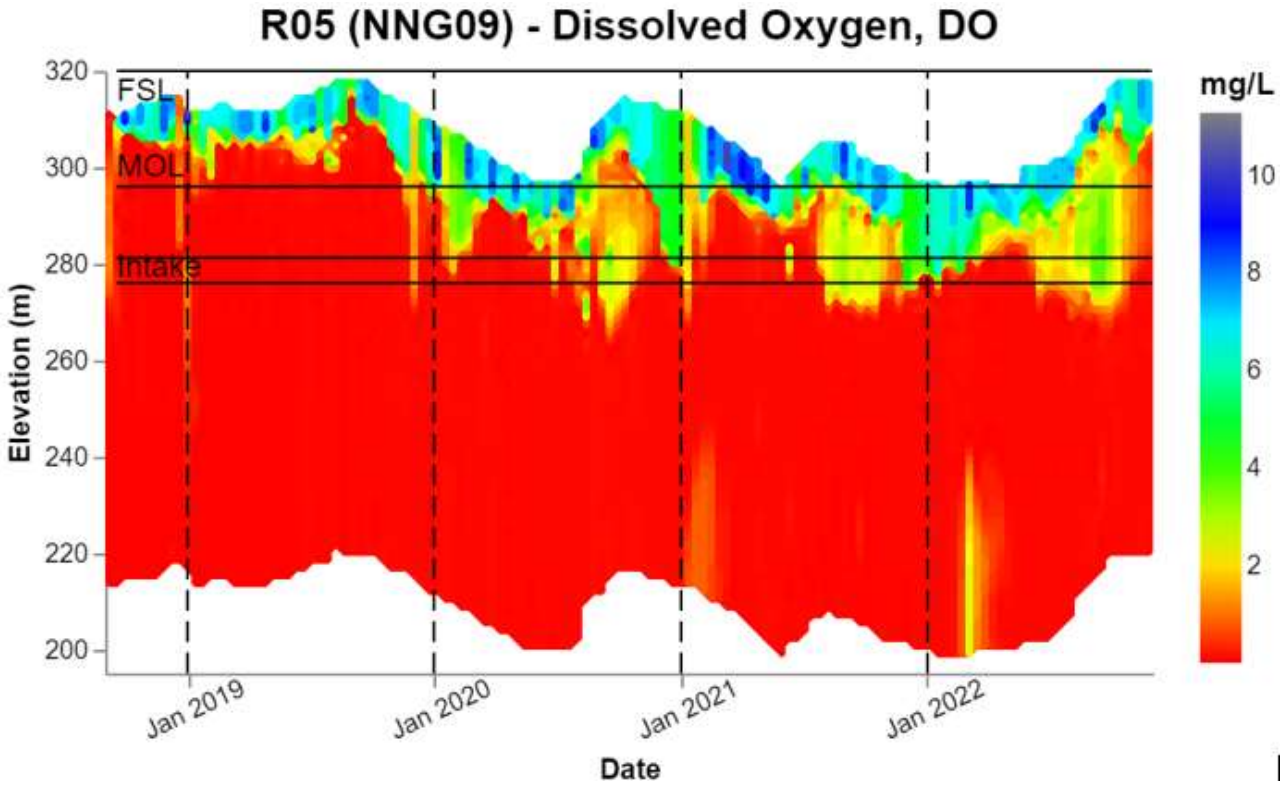

Figure 1.3-2: DO Depth Profiles Time Series in R05 (Since September 2018 to November 2022)

At R04, the DO levels in the upper 8.0 m varied between 5.3 mg/L and 7.8 mg/L. The oxycline was found at depths between 8.5 and 13 m below surface and DO concentrations in the depth interval from 8.5 m to bottom varied between 0.1 and 6.1 mg/L, and anoxic conditions (0.5 mg/L) occurred at depths below 40 m.

At R03, the DO levels in the upper 5.5 m varied between 5.3 mg/L and 7.5 mg/L with an average of 6.9 mg/L. DO concentrations in the depth interval from 6.0 m to bottom varied from 0.1 mg/L to 7.2 mg/L with anoxic condition (less than 0.5 mg/L) occurring at depths between 8.0 m – 9.5 m and 45 m to bottom on 01 November 2022, at the depths from 45 m to bottom on 09 November 2022, at the depths between 40 m and 60 m on 16 November 2022.

At R02, the DO levels in the upper 2.5 m varied between 4.1 mg/L and 8.2 mg/L with an average of 6.7 mg/L. Anoxic conditions (less than 0.5 mg/L) occurred at a depth interval from 5.0 m to 19 m on 01 November 2022, from 8.0 m to 22 m on 09 November 2022 and from 4.0 m to 22 m on 16 November 2022. DO concentrations in the depth interval from 24 m to bottom varied with a range between 0.6 mg/L and 2.6 mg/L.

At R01, the DO levels in the upper 2.5 m varied between 5.4 mg/L and 8.8 mg/L with an average of 6.6 mg/L. DO concentrations in the depth interval from 3.0 m to bottom varied with a range between 0.7 mg/L and 7.4 mg/L.

As expected, the TSS concentrations in the main reservoir have been consistently low since the start of impounding with a mean of 5 mg/L compared with the high flow season means of about 100 – 250 mg/L and low flow season means of 20 mg/L - 50 mg/L prior to impounding.

The BOD_5 measurements at R01, R03, R04 and R05 in the epilimnion were less than 1.0 mg/L. The BOD5 measurements at R03, R04 and R05 in the hypolimnion were less than 1.0 mg/L, 9.3 mg/L and less than 1.0 mg/L respectively.

Re-regulation Reservoir

In November 2022, the turbine discharges from the Main Powerhouse varied between 56 and 223 m^3/s usually interrupted by night-time periods with no discharge.

The mean DO concentration in the water column were 2.3 mg/L and 2.6 mg/L in R06 and R07 respectively.

The BOD_5 concentrations in both R06 and R07 were less than 1.0 mg/L.

Nam Ngiep Downstream

During November 2022, the downstream water quality monitoring was carried out during turbine discharge from the Re-regulation Dam. The DO concentrations were generally less than 6 mg/L in all stations (except NNG07 on 11 and 30 November 2022, and NNG08 on 11, 18 and 30 November 2022), thus not complying with the surface water quality standard. The low DO concentrations are due to oxygen depletion in the deeper layers of the main reservoir, caused by decomposing submerged biomass which was left in the reservoir.

NNP1PC continues to carefully compile and assess all monitoring data to determine if any additional water aeration measures may be necessary to improve the DO levels in Nam Ngiep River downstream the Re-regulation Dam. Water quality monitoring will be maintained, and the development of the situation in the reservoir and in the downstream area will be closely followed. In this regard, it should be noted that since the Commercial Operation Date (COD) in September 2019 no dead fish have been observed in Nam Ngiep downstream the re-regulation dam.

The BOD_5 in the downstream station (NNG05) was less than 1 mg/L and complied with the national surface water quality standard.

Main Tributaries to Nam Ngiep

All monitored parameters in the Nam Chiane (NCH01), Nam Xao (NXA01) and Nam Houaysoup (NHS01) complied with the standards.

During November 2022, the water quality could not be monitored in Nam Phouan (NPH01) as access to the site was blocked by floating debris.

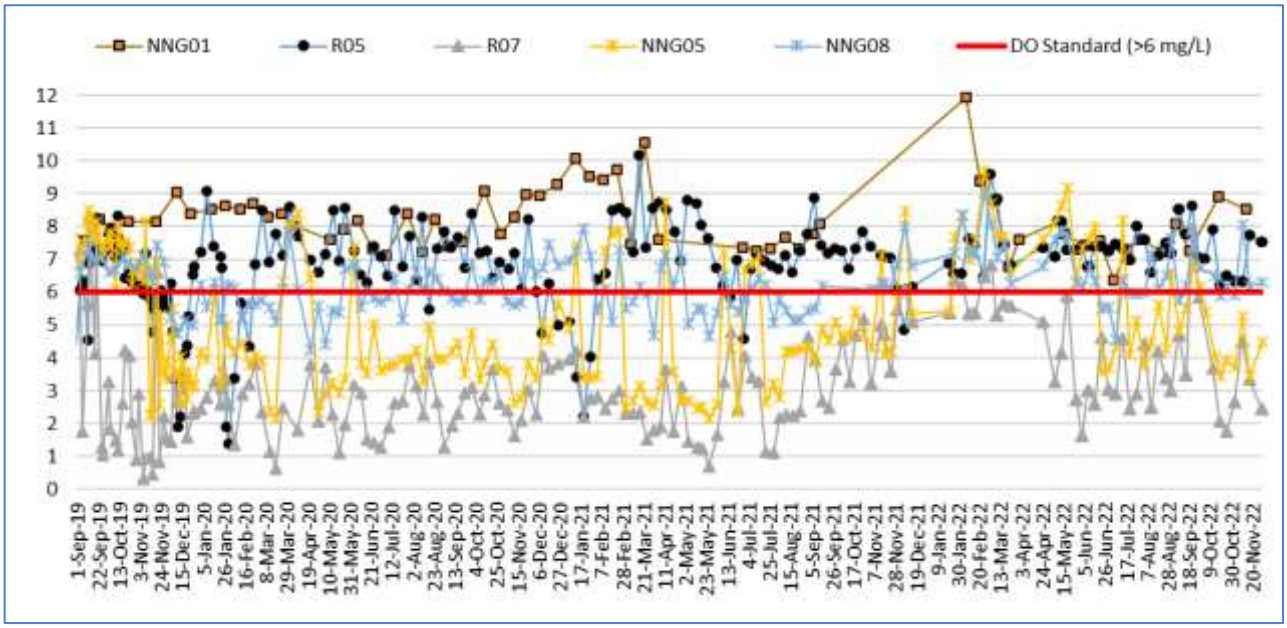

Figure 1.3-3: Concentration of Dissolved Oxygen (mg/L) in the upper 0.2 m since September 2019 to November 2022

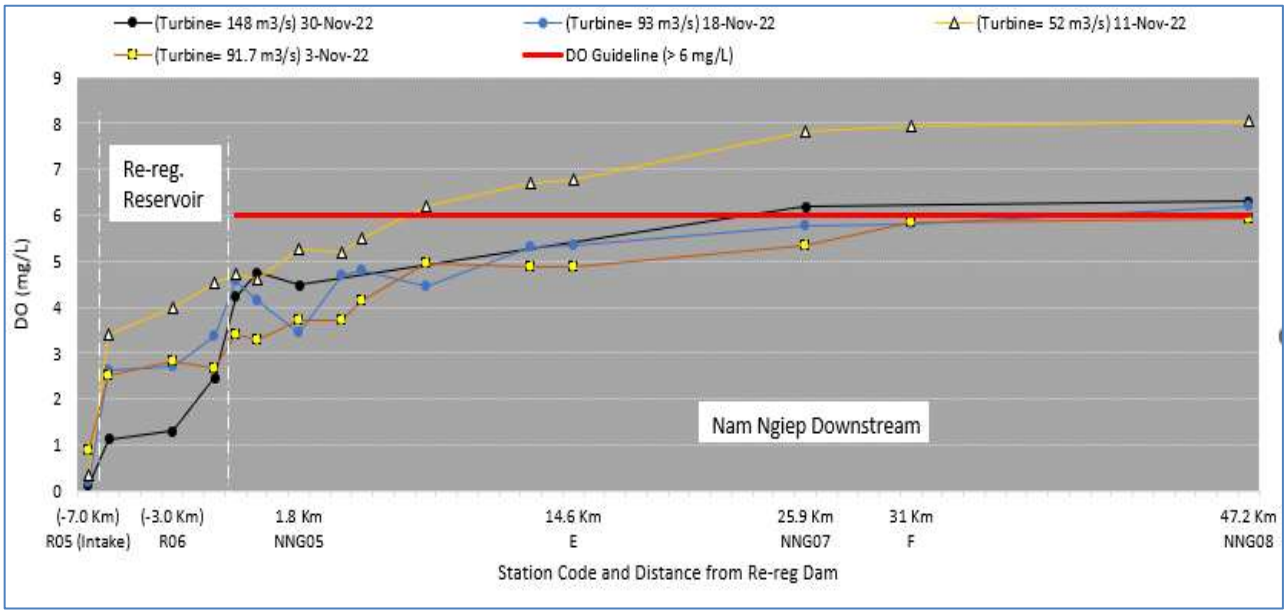

Figure 1.3-4: Dissolved Oxygen (Mg/L) Long Profile in November 2022 (from Immediately Upper Main Dam to Lower Nam Ngiep River)

Table 1.3-2: Results of Surface Water Quality Monitoring for Dissolved Oxygen (mg/L) in the upper 0.2 m, National Water Quality Standard: >6.0 mg/L

DO (mg/L)	NNG01	R01	R02	R03	R04	R05	R06	R07	NNG05	NNG06	NNG07	NNG08	NCH01	NPH01	NXA01	NHS01
1-Nov-22		5.53	7.25	6.9												
2-Nov-22					5.61	6.34	2.83	2.66								
3-Nov-22									3.71	4.15	5.36	5.93			6.93	6.82
9-Nov-22		6.77	5.9	7.33												
10-Nov-22					6.47	6.34	3.98	4.52								
11-Nov-22									5.27	5.51	7.81	8.06			7.89	7.68
14-Nov-22	8.54												8.31			
16-Nov-22		8.35	8	7.41												
17-Nov-22					7.82	7.75	2.72	3.35								
18-Nov-22									3.46	4.8	5.79	6.18			6.92	6.39
29-Nov-22					7.3	7.54	1.3	2.46								
30-Nov-22									4.48		6.19	6.31			7.56	8.86

Table 1.3-3: Results of Surface Water Quality Monitoring for Total Suspended Solids (mg/L)

Total Suspended Solids (mg/L)	NNG01	R01	R02	R03	R04	R05	R06	R07	NNG05	NNG06	NNG07	NNG08	NCH01	NPH01	NXA01	NHS01
1-Nov-22		<5		<5												
1-Nov-22 Bottom				26												
2-Nov-22					<5	<5	<5	<5								
2-Nov-22 Bottom					<5	<5										
3-Nov-22									<5	<5	<5	7.8			<5	5.4
14-Nov-22	14.2												<5			

Table 1.3-4: Results of Surface Water Quality Monitoring for BOD_5 (mg/L) - Water Quality Standard: < 1.5 mg/L

BOD_5 (mg/L)	NNG01	R01	R02	R03	R04	R05	R06	R07	NNG05	NNG06	NNG07	NNG08	NCH01	NPH01	NXA01	NHS01
1-Nov-22		<1		<1												
1-Nov-22 Bottom				<1												
2-Nov-22					<1	<1	<1	<1								
2-Nov-22 Bottom					9.3	<1										

BOD_5 (mg/L)	NNG01	R01	R02	R03	R04	R05	R06	R07	NNG05	NNG06	NNG07	NNG08	NCH01	NPH01	NXA01	NHS01
3-Nov-22									<1	<1	<1	<1			<1	<1
14-Nov-22	<1												<1			

1.3.3 Groundwater Quality Monitoring

During November 2022, community groundwater quality analyses were carried out for only five out of seven wells located in Somseun Village, Nam Pa Village, Thong Noy Village, Pou Village and Phouhomxay Village due to the water pumps in two wells of Phouhomxay Village were broken. The community groundwater samples were taken from household water taps.

The results indicate that:

- The well in Somsuen, Nam Pa and Thong Noy Villages did not comply with the Standard for faecal coliform and *E. Coli* bacteria.
- Both two wells in Pou Village fully complied with the Standards.

The community groundwater quality monitoring results are presented in ***Table 1.3-5.***

The villagers were advised to boil water before drinking. This advice is in accordance with the Law on Hygiene, Disease Prevention and Health Promotion No 01/NA of 10 April 2001, which states that domestic water supply for daily use is not required to be readily drinkable but would normally have to be boiled or otherwise treated before it would be suitable for drinking. The villagers generally use tap water for washing and cleaning. They were informed about the monitoring results and recommended to carry out the operation and maintenance improvement as well as were encouraged to boil water before drinking.

Table 1.3-5: Groundwater Quality Monitoring Results in Somsuen, Nam Pa, ThongNoy and Pou Villages

Parameter (Unit)	Site Name	Somseun Village	NamPa Village	ThongNoy Village	Pou Village	
	Station	GSXN01	GNPA01	GTHN01	GPOU01	GPOU02
	Guideline	28-Nov-22	28-Nov-22	28-Nov-22	14-Nov-22	14-Nov-22
pH	6.5 - 9.2	7.67	6.63	6.74	7.4	7.94
Sat. DO (%)		73.1	85	66.1	76.5	80.3
DO (mg/l)		5.72	6.76	5.2	6.44	6.53
Conductivity (µS/cm)		391	476	383	21	198
Temperature (°C)		28	27.06	27.53	24.05	25.96
Turbidity (NTU)	<20	0.5	0.29	0.9	1.79	0.25
Faecal coliform (MPN/100ml)	0	7.8	79	240	0	0
E.coli Bacteria (MPN/100ml)	0	7.8	79	240	0	0

1.3.4 Gravity Fed Water Supply (GFWS) Quality Monitoring

The results of the water quality analyses are presented in ***Table 1.3-6.***

Faecal Coliform and *E.coli* exceeded the standards in the water supply of Thaheua Village (WTHH02), Hat Gnuin Village (WHGN02) and Phouhomxay Village (WPHX02 – Primary School Water Tap and WPHX03 – Household Water Tap).

As observed in the field during water sampling, livestock are roaming around in the water intake areas which may contribute to the presence of Faecal Coliform Bacteria and *E.coli* in GFWS samples. The villagers were advised to boil water before drinking in accordance with the Law as mentioned in ***1.3.3*** as well as recommended to carry out the operation and maintenance improvement.

Table 1.3-6: Results of the Gravity Fed Water Supply Quality Monitoring

	Site Name	**Thaheau Village**	**Hat Gnuin Village**	**Phouhomxay Village**	
	Station	**WTHH02**	**WHGN02**	**WPHX02**	**WPHX03**
Parameter (Unit)	**Guideline**	28-Nov-22	28-Nov-22	28-Nov-22	28-Nov-22
pH	6.5 - 8.5	7.33	6.95	7.1	7.02
Sat. DO (%)		87.4	81.3	94.7	84.8
DO (mg/L)		7.01	6.46	7.4	6.65
Conductivity (µS/cm)	<1,000	60	101	15	12
Temperature (°C)	<35	26.66	27.37	28.05	27.89
Turbidity (NTU)	<10	4.96	6.86	1.35	0.79
Faecal Coliform (MPN/100 mL)	0	33	170	130	240
E.coli Bacteria (MPN/100 mL)	0	33	170	130	240

1.3.5 Landfill Leachate Monitoring

During November 2022, the landfill leachate monitoring was conducted at NNP1 Project Landfill (Last pond - LL4) and at Houay Soup Solid Waste Landfill (Last pond - LL6).

The results indicate that NNP1 Project Landfill leachate and Houay Soup Landfill Leachate did not comply with the standard for pH. The high pH is likely a result of photosynthesis by algae which will drive pH levels up as carbon dioxide is consumed. The leachate is still contained in the leachate ponds without being discharged to the environment. EMO will continue to monitor the leachate and report the results in the next monthly progress report. The landfill leachate monitoring results for November 2022 can be found ***Table 1.3-7.***

Table 1.3-7: Results of the Landfill Leachate Monitoring

		Site Name	NNP1 Landfill Leachate					Houay Soup Landfill	
		Location	Pond No.01	Pond No.02	Pond No.03	Pond No.04	Discharge Point	Last pond	Discharged Point
		Station	LL1	LL2	LL3	LL4	LL5	LL6	LL7
Date	Parameter (Unit)	Guideline							
7-Nov-22	pH	6.0-9.0				9.01		9.5	
7-Nov-22	Sat. DO (%)					145.7		186.7	
7-Nov-22	DO (mg/L)					11.04		13.74	
7-Nov-22	Conductivity (µS/cm)					63		118	
7-Nov-22	Temperature (°C)					29.97		31.7	
7-Nov-22	Turbidity (NTU)					20.9		24.6	
7-Nov-22	BOD_5 (mg/L)	<30				<6		6.3	
7-Nov-22	COD (mg/L)	<125				60.4		50.2	
7-Nov-22	Faecal Coliform (MPN/100 mL)	<400				0		2	
7-Nov-22	Total Coliform (MPN/100 mL)	<400				79		2	
7-Nov-22	Total Nitrogen (mg/L)	<10				0.79		0.76	
7-Nov-22	Lead (mg/L)	<0.2				<0.01		<0.01	
7-Nov-22	Copper (mg/L)					<0.005		<0.005	
7-Nov-22	Iron (mg/L)					0.38		0.846	
7-Nov-22	Ammonia nitrogen (mg/L)	<10				<2		<2	
7-Nov-22	Oil & Grease (mg/L)	<10				<1		<1	

1.4. DISCHARGE MONITORING

1.4.1 Main Reservoir – Water Level, Inflow and Discharge

The water level in the main reservoir, inflow to the reservoir and discharge from the reservoir have been monitored since the start of the impounding on 15 May 2018. The graph in ***Figure 1.4-1*** and ***Figure 1.4-2*** presents the values recorded since January 2020.

During November 2022, the mean inflow to the main reservoir was 82 m^3/s. The minimum and maximum inflows were 66 m^3/s (on 28 November 2022) and 102 m^3/s (on 03 November 2022) respectively.

In November 2022, the water level in the main reservoir increased from El. 318.47 m asl to El. 319.06 m asl and then decreased to 318.62 m asl at the end of the month.

During 2022, the hourly turbine discharges from the Main Powerhouse varied between 56 m^3/s and 223 m^3/s usually interrupted by night-time periods with no discharge.

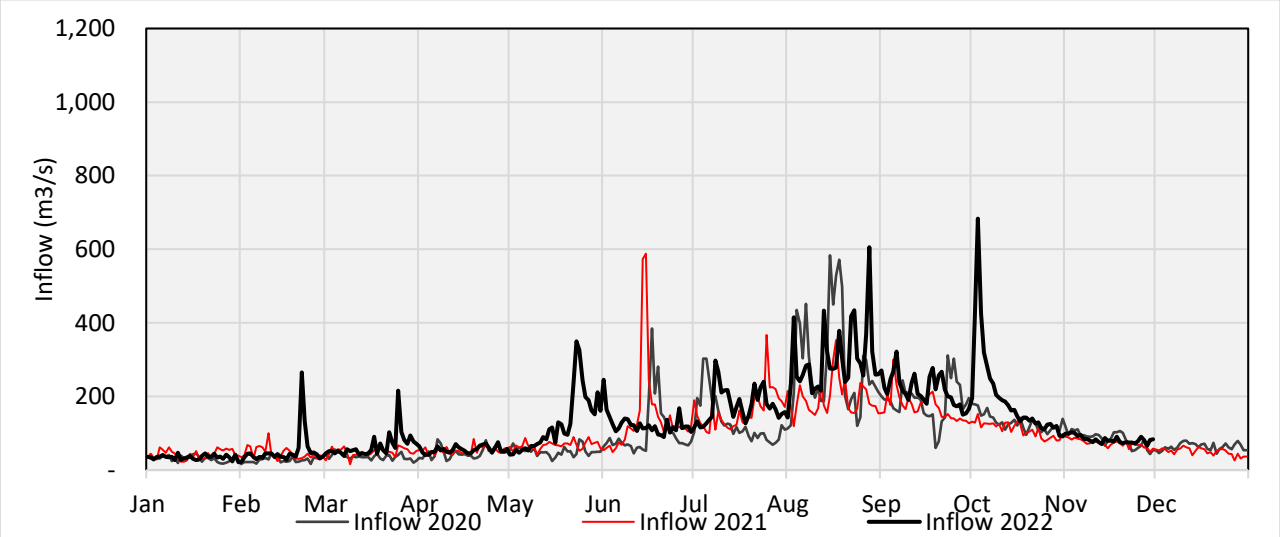

Figure 1.4-1: Inflow for the Main Reservoir during January 2020 to November 2022

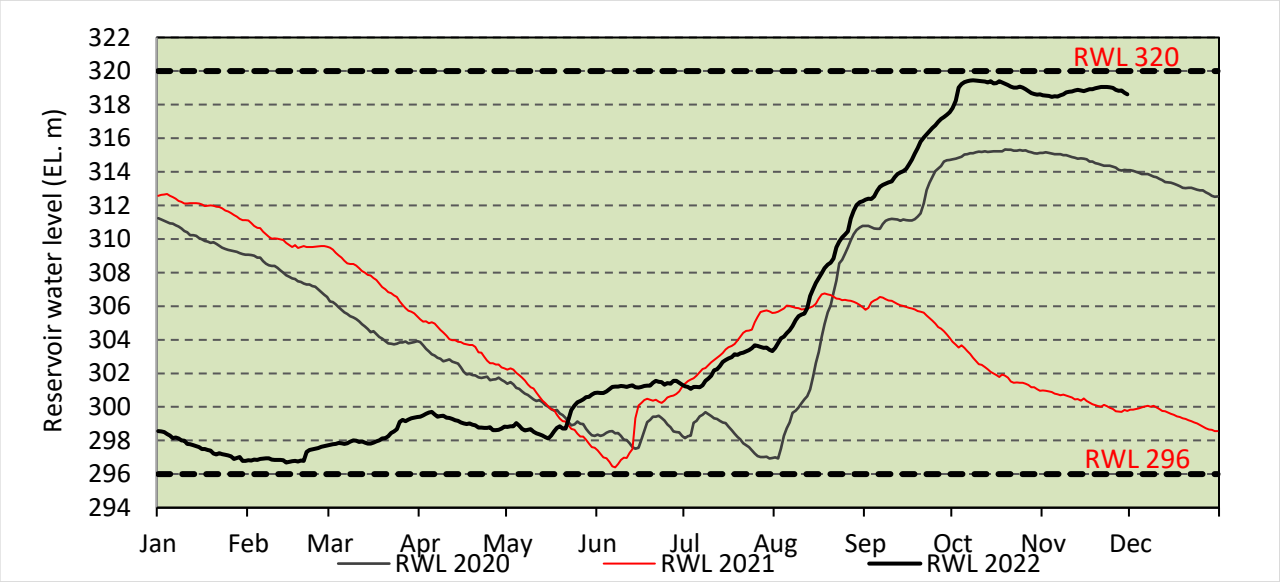

Figure 1.4-2: Water Level for the Main Reservoir during January 2020 to November 2022

1.4.2 Re-regulation Reservoir – Discharge

The daily discharge monitoring data for the Re-regulation Dam during September to November 2022 is presented in ***Figure 1.4-3***.

During November 2022, the mean daily discharge from the Re-regulation Dam was about 80 m^3/s, hourly gate discharge varied between 27 m^3/s and 91 m^3/s, hourly turbine discharge varied between 48 m^3/s and 175 m^3/s, and combination of gate and turbine discharge varied between 180 m^3/s and 190 m^3/s. The hourly discharge was kept above the minimum flow requirement of 27 m^3/s at all times.

The changes in the discharge from the Re-regulation Dam were informed in advance to the RMU and to the heads of the downstream villages, who then announced the changes to the communities over the village speaker systems.

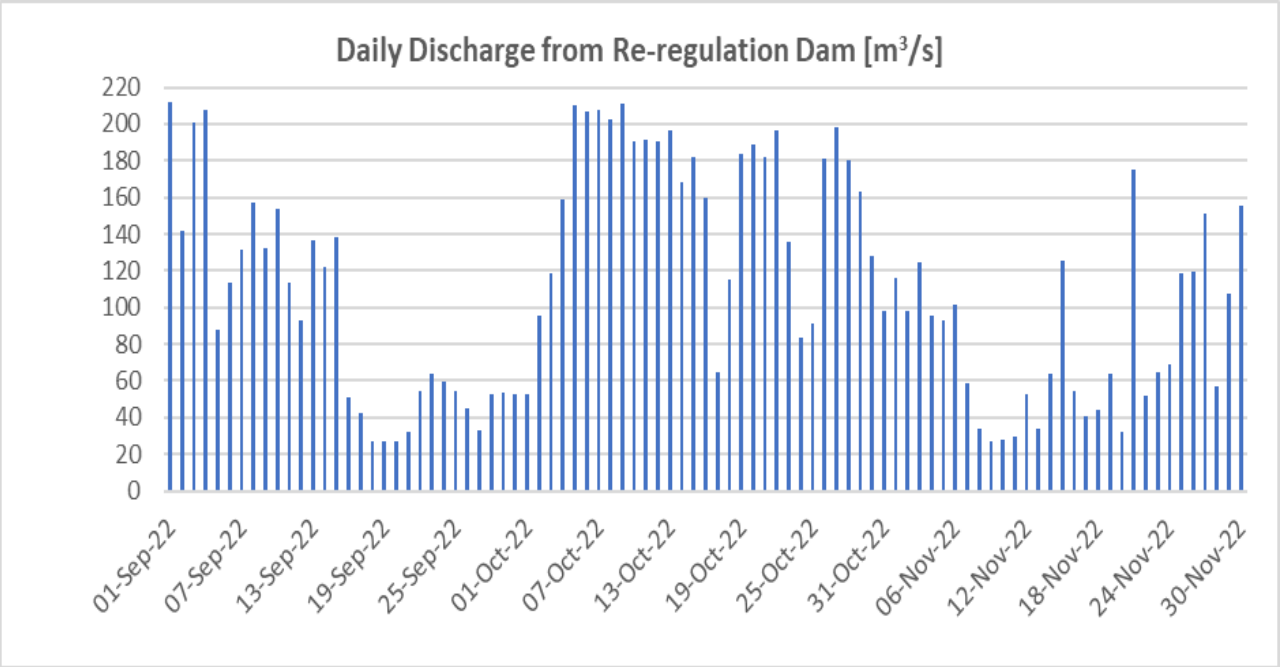

Figure 1.4-3: Discharge Monitoring at the Re-regulation Dam in September to November 2022

1.4.3 Nam Ngiep Downstream Water Depth Monitoring

In November 2022, All Regulation Dam discharges during the monitoring missions were greater than 27 m3/s, therefore, EMO did not carry out water depth monitoring in the Nam Ngiep downstream of the Re-regulation Dam.

1.5. PROJECT WASTE MANAGEMENT

1.5.1 Solid Waste Management

A total of 7.42 m^3 of solid waste was disposed of at the NNP1 Project Landfill, a decrease of 0.43 m^3 compared with October 2022.

The Contractor continued the regular waste collection from the NNP1PC's operation sites and operated the project landfill for three days per week. The work included waste segregation and disposal, waste cover and compaction, grass cutting and repairing of the perimeter fences.

Table 1.5-1: Waste management activities at NNP1 landfill during October 2022

Waste Collection, Segregation and Landfill Operation	
	

The total amount of recyclable waste selling and collection this month is summarized in ***Table 1.5-2.***

Table 1.5-2: Amounts of Recyclable Waste Sold and collection in November 2022

Source and Type of Recycled Waste		Unit	Sold	Cumulative Total by November 2022
1	Plastic bottles	kg	0	182
2	Aluminium can	kg	0	0
3	Paper/Cardboard	kg	0	41
4	Glass	kg	0	233
5	Scrap Metal	Kg	0	10
Total		**kg**	**0**	**466**

In November 2022, the villagers collected 182 kg food wastes from the OSOV1 canteen for feeding their animals.

1.5.2 Hazardous Materials and Waste Management

The types and amounts of hazardous materials and hazardous waste stored on site in November 2022 are shown in ***Table 1.5-3*** and ***Table 1.5-3*** respectively.

Table 1.5-3: Record of Hazardous Material Inventory in November 2022

No.	Type of Hazardous Material	Unit	Total in November 2022 (A)	Used (B)	Remaining at the end of November 2022 (A – B)
1	Diesel	Litre	4,828	5,153	**4,828**
2	Gasoline	Litre	612	488	**612**
3	Lubricant (Turbine oil)	Litre	5,160	9	**5,160**

No.	Type of Hazardous Material	Unit	Total in November 2022 (A)	Used (B)	Remaining at the end of November 2022 (A – B)
4	Colour Paint	Litre	299	0	**299**
5	Thinner	Litre	10	0	**10**
6	Grease Oil	Litre	150	0	**150**
7	Gear Oil	Litre	426.8	0	**427**
8	Chlorine Liquid	Litre	38	0	**38**
09	HA Cut AF	Litre	3,925	0	**3,925.0**
10	HA Cut Cat AF	Litre	372.5	0	**372.5**

Table 1.5-4: Record of Hazardous Waste Inventory

No.	Hazardous Waste Type	Unit	Total in November 2022 (A)	Disposed (B)	Remaining at the end of November 2022 (A - B)
1	Used Oil (Hydraulic + Engine)	Litre	355	0	**355**
2	Empty used oil drum/container (drum 200L)	Unit	50	0	**50**
3	Contaminated soil, sawdust and textile material	m^3	0.8	0	**1**
4	Used tyre	Drum	14	0	**14**
5	Empty used chemical drum/container (drum 20L)	Unit	31	0	**31**
6	Lead acid batteries	Unit	6	0	**6**
7	Empty paint and spray cans	Unit	36	0	**36**
8	Halogen/fluorescent bulbs	kg	312	218	**312**
9	Empty cartridge (Ink)	Unit	182	0	**182**
10	Clinic Waste	Kg	1.5	0	**2**
11	Expired Chlorine Powder	Kg	65	0	**65**

1.6. COMMUNITY WASTE MANAGEMENT

1.6.1 Community Recycling Programme

The process of handing over the community waste bank to the Bolikhan District EMU has continued in November 2022. There were no recyclable waste trade activities in the community recyclable waste bank in November 2022.

1.6.2 Community Solid Waste Management

In November 2022, the communities' solid waste management and the Houay Soup Landfill operation were still under handover process to be managed by the local authorities (Bolikhan Environment Management Unit or EMU). EMO completed an annual maintenance round of the landfill to ensure that it is well functioning and ready for operation. It's expected that the community solid waste management will be fully handed over to the local authority within 2022.

2 WATERSHED AND BIODIVERSITY MANAGEMENT

2.1 WATERSHED MANAGEMENT

2.1.1 Implementation of Annual Implementation Plan (AIP)

2.1.1.1 Xaysomboun Watershed and Reservoir Protection Office (WRPO)

The progress of the actions that were discussed and agreed in the previous monthly meetings as well as the follow up discussions are summarized below:

- EMO, Biodiversity Service Provider (BSP)-Wildlife Conservation Society (WCS), Head of Hom District Energy and Mines Office, and Head of Phou Ngou Village conducted a site visit to the mining exploration site during 9-11 November 2022. EMO and BSP-WCS observed the existing mining camp and two broken excavators on 10 November 2022 and road construction that extends around 1 km from the mining camp. EMO and BSP-WCS also noted that the company had several coordination and financial issue with the provincial and district military escort, Hom District Energy and Mines Office, and Phou Ngou Village. EMO was updated by the Head of Phou Ngou Village that the two excavators had been moved out from the mining site and parked at Phou Ngou Village since 14 November 2022. EMO has observed the two excavators in the village until end of November 2022. The discussion with Xaysomboun provincial management and relevant offices including the mining company, which will be organized under the Xaysomboun AIP2022 budget had to be postponed because of the delay in fund disbursement.
- The Head of Xaysomboun WRPO informed ADB-IAP-LTA mission members, EMO, and BSP-WCS during the on-site discussion on 24 November 2022 that a provincial party meeting is scheduled during November and December 2022 and so the meeting on the role and responsibility of the NNP1 reservoir fishery management will be further postponed. It is likely that the meeting will be organized at the end of December 2022 or in January 2023.
- The Head of Xaysomboun WRPO informed ADB-IAP-LTA mission members, EMO, and BSP-WCS during the on-site discussion on 24 November 2022 that due to high inflation rate in the country, the contractor has issue with the budget for construction of the two ranger stations and two reservoir checkpoints. The Contractor is proposing to use the floating logs in the reservoir as construction materials to suit with the available budget. The Head of Xaysomboun WRPO is communicating this proposal with the Head of Xaysomboun PAFO for consideration. Therefore, the construction will be further delayed.

2.1.1.2 Bolikhamxay Watershed and Reservoir Protection Office (WRPO)

Bolikhamxay WRPO informed that they received the funds for the remaining quarter of 2022 from DOF-MAF on 2 November 2022. They implemented the forest and reservoir patrolling from 15 to 25 November 2022. The results will be recorded into SMART system with the support from BSP-WCS team and will be discussed during the monthly patrolling planning in December 2022. They are

also preparing the plan to deal with forest encroachment in Nahan and Hatgniun Village which are the adjacent villages to NNP1 watershed boundary.

2.1.1.3 NNP1PC EMO

EMO continues the program for strengthening capacity of farmers (cattle, orange and pineapple) in Hom District and farmers (cattle) in Thathom District in November 2022 under the sustainable livelihood action plan. A follow-up with three selected farmers for cattle fattening program was scheduled on 8 November 2022 at Ban PhouNgou in Hom District. The main objective is to observe the practices and note the lessons from it to be shared with other farmers. However, EMO was informed on 7 November 2022 evening that only one farmer was available to participate. EMO noted that the farmer was able to formulate the feeding by himself per knowledge he received during the training and started his cattle fattening from 14 September 2022 under the cattle feedlot structure. He fed the cattle three times per day with Ruzi grass (*Brachiaria ruziziensis*) as main fodder mixed with maize and molasses as supplementary feeds at the ratio of 30:1. After 55 days or as of 8 November 2022 he estimated by observation that the weight had increased from 150 kg to 200 kg. This is higher than daily average weight gain of 0.70 to 0.74 Kg/day under the intensive fattening with 0.23 to 0.44 Kg/day without any supplementary feeding according to Lao Journal of Agriculture and Forestry dated in 2019.

This farmer is also a member the orange and pineapple production group who received training on organic farming held on 14 August 2022 at Faculty of Agriculture (NUoL) and led the knowledge sharing session on 6 September 2022 at PhouNgou Village on making photosynthetic bacteria for improving plant growth and crop quality. The farmer informed that he regularly applies wood vinegar, fertilizer powder and photosynthetic bacteria for his orange trees around his house and his home garden. He has produced more photosynthetic bacteria but could only apply this for his orange farm and not yet for his pineapple farm because of limited labour.

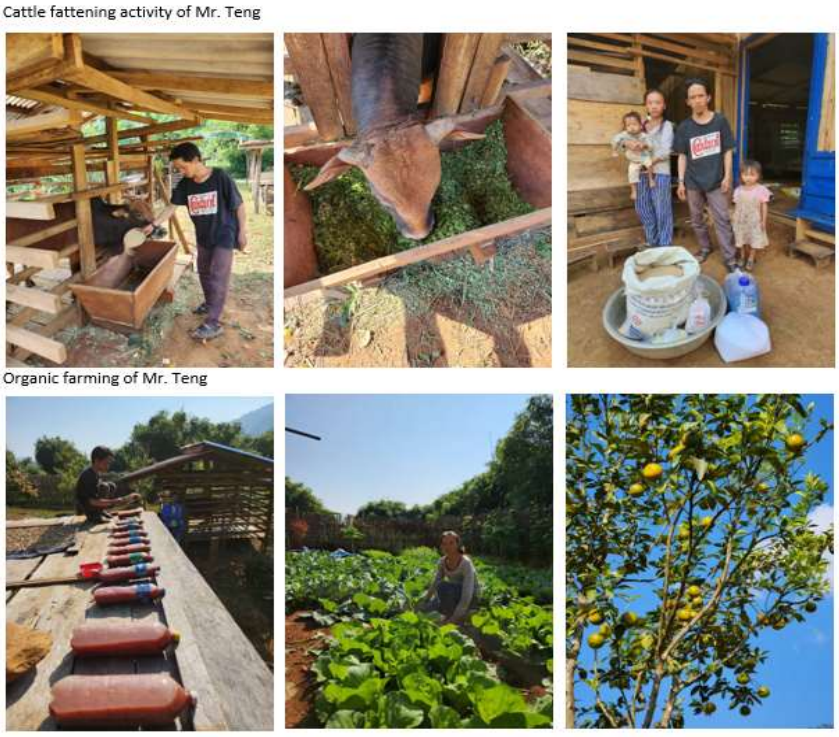

FIGURE 2.1-1. REPRESENTATIVE PHOTOGRAPHS OF CATTLE FATTENING AND ORGANIC FARMING PRACTICE IN HOM DISTRICT OBSERVED ON 10 NOVEMBER 2022.

EMO also conducted monitoring mission under the agriculture extension service program of Thathom District on the demonstration of organic Kai Noi rice farming of the three selected households/farmers comprising on 10 November 2022 at Nahong Village. The monitoring mission was participated by two staff of Thathom DAFO who are responsible for the activity, three selected farmers and one EMO team member. The key findings are summarized as follow:

- The farmers completed harvesting their Kai Noi rice during the last week of October 2022.
- The two organic farming demo plots (1,600 m^2) of one of the farmers produced 900 kg compared with 810 kg from a conventional farming plot (1,600 m^2).
- The two organic farming demo plots (1,000 m^2) of another farmer produced 360 kg compared with 472 kg from a conventional farming plot (1,000 m^2). However, this farmer informed that the figure might not be correct because he did not record the produced rice properly from each plot.
- Two organic farming deme plots (1,200 m^2) produced 460 kg for and compared with 607 kg from a conventional farming plot (1,200 m^2).
- EMO noted that the district staff who is responsible for the activity did not provide close supervision and monitoring of the application of organic mulch, marking demo plots and recording demo plot activity.
- However, all three farmers confirmed that they are satisfied with the production of the organic plots which produced good quality rice seed with plump shape and uniform size. They will continue organic rice farming and increase the organic plots next year by self-support but requested NNP1PC and DAFO to continue with the technical support to them.

The monitoring team met and discussed with the three selected farmers for organic gardening in the greenhouse during the afternoon on 10 November 2022 at Phonhom Village. Some of the key findings are summarized as follow:

- Due to a strong wind on 28 October 2022, all the poly sheet (roof section) of greenhouses were completely damaged. EMO Team brought a sample of damaged poly sheet back and surveyed a shop in Paksan about different type of poly sheet for greenhouse. It turned out that the poly sheets that Thathom DAFO staff bought and handed over to farmers are low quality and are not suitable for greenhouses. EMO advised DAFO and farmers to fix and replace with the new poly sheets of proper quality before the next rainy season.
- The farmers confirmed that they are satisfied with production of greenhouse vegetable gardening. Since the greenhouse vegetable gardening started from 5 August to 10 November 2022, the two farmers have earned a total of 1,325,3000 Kip and 3,422,000 Kip respectively from selling vegetables. They also consumed the vegetables daily and shared with others. Their planted vegetables include morning glory, Yu Choi, lettuce, Chinese cabbage, long bean, Gai choy, green onion, coriander, mint, and dill leave.

FIGURE 2.1-2. REPRESENTATIVE PHOTOGRAPHS FROM AGRICULTURE EXTENSION SERVICE IN HOM DISTRICT OBSERVED ON 10 NOVEMBER 2022.

2.1.2 Preparation of Annual Implementation Plan (AIP) 2022

2.1.2.1 Xaysomboun WRPO

Head of Xaysomboun WRPO informed ADB-IAP-LTA mission members, EMO, and BSP-WCS during the on-site discussion on 24 November 2022 that their plan is still being reviewed by Forest Protection Fund (FPF) office of the Department of Forestry (DOF)-Ministry of Agriculture and Forestry (MAF) after the submission on 12 October 2022. They are closely following up with FPF office for this and so the fund disbursement will be further delayed.

2.1.2.2 Bolikhamxay WRPO

Bolikhamxay WRPO informed that their AIP2022 fund for the remaining quarter 2022 was transferred by DOF-MAF on 2 November 2022.

2.1.3 Preparation of Annual Implementation Plan (AIP) 2023

2.1.3.1 Xaysomboun WRPO

The draft of Xaysomboun AIP2023 was further improved through discussion among EMO, BSP-WCS, and Xaysomboun WRPO in November 2022. EMO and BSP-WCS followed-up with the Head of Xaysomboun WRPO on the establishment of Totally Protected Zone (TPZ), forest, and reservoir patrol team so that the detail budget could be finalized. The draft is expected to be ready in December 2022 for further submission to ADB.

2.1.3.2 Bolikhamxay WRPO

The improved draft of Bolikhamxay AIP2023 was shared by BSP-WCS on 14 November 2022 to Bolikhamxay WRPO after series of further discussion among EMO, Bolikhamxay WRPO, and BSP-WCS. EMO and BSP-WCS will follow up with Bolikhamxay WRPO and expected the draft to be ready for further submission to ADB in December 2022.

2.2 BIODIVERSITY OFFSET MANAGEMENT

2.2.1 Implementation of BOMP Annual Implementation Plan (AIP)

The progress on the implementation of key activities by Component in October 2022 are described below:

a. Component 1 - Spatial Planning and Regulation

The meeting to officially approve the Nam Chouane-Nam Xang (NC-NX) and its Totally Protected Zone (TPZ) boundary was scheduled on 30 November 2022 under Biodiversity Offset Management Unit (BOMU) AIP2022. However, the Head of BOMU informed EMO and BSP-WCS on 24 November 2022 that the Deputy Head of Bolikhamxay Province Agriculture and Forestry Office (PAFO) advised BOMU to prepare a report that includes further details on the background of the offset site establishment and the boundary demarcation and submit it to Vice Governor of Bolikhamxay Province who is also a chairman of NC-NX Biodiversity Offset Management Committee (BOMC) for consideration and further advice. The BOMU together with EMO and BSP-WCS had further discussion and further preparation for this report during 29 November to 1 December 2022 at BOMU office.

b. Component 2 – Law Enforcement

The November 2022 monthly sub-station guarding was operating from 5 to 28 November 2022 with 3 persons for each sub-station. The December 2022 patrolling will be implemented from 1 to 20 December 2022. The SMART and first aid training for the patrol and snare removal team will be organized in the second week of January 2023.

c. Component 3 – Conservation Outreach

The outreach activities that will include a training for District Team and outreach campaign for the target audients will be further postponed to February 2023 because the key members of Bolikhamxay BOMU will be occupied with other prioritized activities such as the Community Development Plan (CDP) implementation.

d. Component 4 – Conservation linked livelihood development

EMO, BOMU, and BSP-WCS had discussion on 17 November 2022 about CDP implementation activities. It was agreed that a field visit to confirm the CDP activities with the NC-NX villages is necessary because some of the activities identified in the CDP back in 2020 may not be relevant to the need of local communities as of now. The field visit was scheduled from 05-16 December 2022.

The December 2022 snare removal was schedule from 03-18 December 2022.

2.2.2 Preparation of Annual Implementation Plan (AIP) 2022

The fund under the AIP2022 for the remaining months of 2022 was transferred by DOF-MAF to Bolikhamxay BOMU on 11 November 2022.

2.2.3 Preparation of Annual Implementation Plan (AIP) 2023

EMO, BOMU, and BSP-WCS organized a meeting on 17 November 2022 to discuss the draft AIP2023. The draft is being reviewed and further updated by BOMU. It expected to be ready in the second week of December 2022 for submission to ADB.

2.3 FISHERY MONITORING

The fishery monitoring is based on the 7-day reported catch from the Daily Catch Logbook (DCL) survey of the month by covering the upstream, upper reservoir, lower reservoir, downstream and Mekong areas.

The fish species dominating the fish catch by weight in October 2022 as listed in ***Table 2.3-1.*** All species are classified as Least Concern (LC) according to the IUCN Red List of Threatened Species[1] and *Oreochromis niloticus* is an exotic species.

Table 2.3-1: Fish Species dominating the Fish Catch in October 2022

Species	Lao Name	Fish Catch (kg)	IUCN Red List Classification
Mastacembelus armatus, Mastacembelus favus	ปาຫຼາດ	146.6	LC
Poropuntius normani, Poropuntius laoensis, Poropuntius carinatus	ปาจาด	143.2	LC
Oreochromis niloticus	ปานิม	87.7	LC
Hampala dispar, Hampala macrolepidota	ปาสูด	86.1	LC
Tor sinensis	ปาแดง	60.9	VU

The recorded catch of Threatened species (IUCN Red List classification) in October 2022 are presented in ***Table 2.3-2.*** The list includes three species that are classified as Vulnerable species (VU).

Table 2.3-2: Threatened Species of October 2022 Fish Catch

Species	Lao Name	Fish Catch (kg)	IUCN Red List Classification
Cirrhinus cirrhosus	ปาแกง/ปามอนจัม	2.6	VU
Scaphognathops bandanensis	ปาอวนไฝ/ปาป่วน	7.9	VU
Tor sinensis	ปาแดง	60.9	VU

[1] The IUCN Red List of Threatened Species is the world's most comprehensive inventory and classification of threatened species. The Red List classifies species into nine groups: Extinct (EX), Extinct in the wild (EW), Critically endangered (CR), Endangered (EN), Vulnerable (VU), Near threatened (NT), Least concern (LC), Data deficient (DD), and Not Evaluated (NE). The term "Threatened" includes Critically Endangered, Endangered, and Vulnerable.

Species abundance and occurrence is based on the 7-day reported catch from the Daily Catch Logbook (DCL) survey in October 2022. The catch is divided in three areas including above the main dam, below the main dam and Mekong area. Main biodiversity indicators in October 2022 for above dam, below dam and Mekong area are presented in ***Table 2.3-3.***

Table 2.3-3: Main Biodiversity Indicators for October 2022

Biodiversity Indicators	Mekong	Below dam	Above dam
Total number of species and groups recorded	24	36	35
Single species	21	25	24
Species groups	3	11	11
Top 15 species (% total catch weight)	94.79%	83.54%	90.81%
Proportion for species groups	8.65%	55.51%	49.18%
Diversity index (Shannon)	2.6112	3.0128	2.7856

Figure 2.3-1 shows the proportion of total number of households actively fishing by fishing zone including upstream (US), upper reservoir (UR), lower reservoir (LR), downstream (DS) and Mekong (MK). It ranges between 46% and 76% of active fishing households for all fishing zones in October 2022.

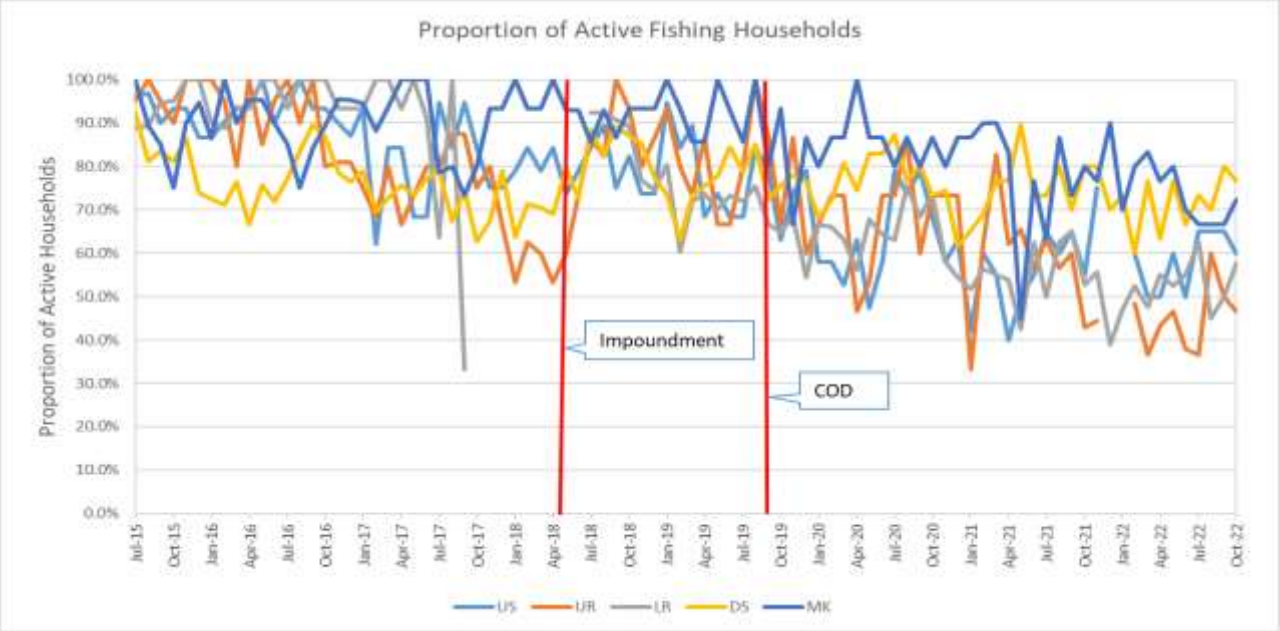

Figure 2.3-1: Proportion of total number of households actively fishing by fishing zone from July 2015 to October 2022

Note: Proportion of Active Fishing Households = (Active Fishing Households/Total Interviewed Households) x 100%.

Figure 2.3-2 shows the average (mean) of monthly household fishing days from July 2015 to October 2022 for the upstream (US), upper reservoir (UR), lower reservoir (LR), downstream (DS) and Mekong (MK) area.

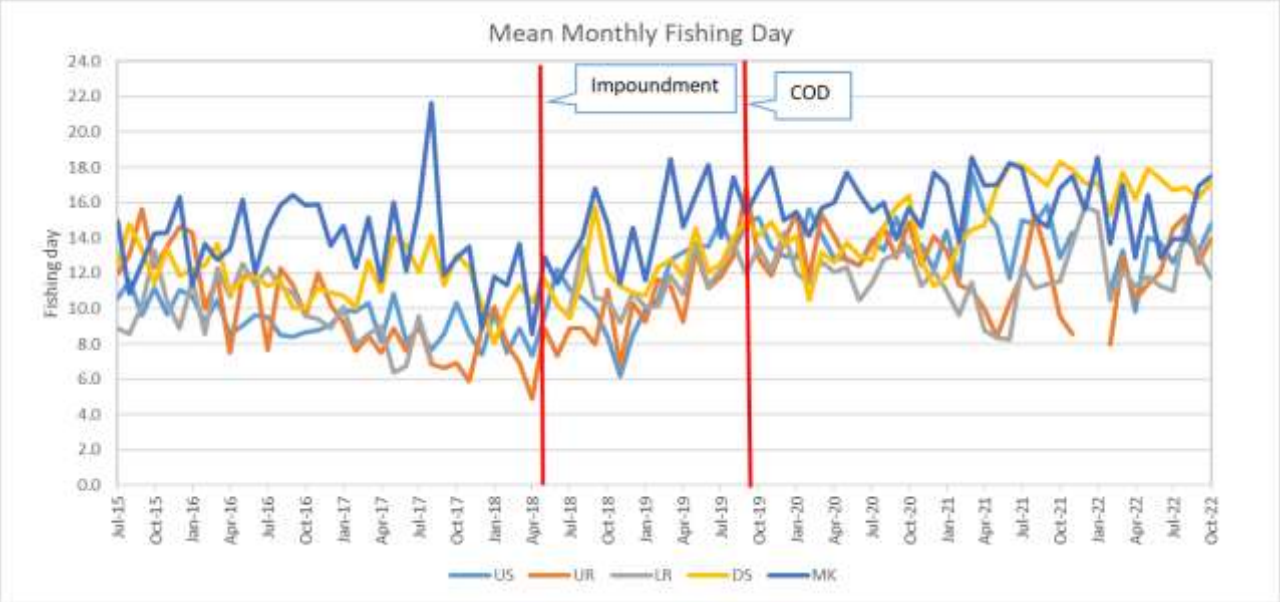

Figure 2.3-2: Mean of monthly fishing day from July 2015 to October 2022

The mean monthly number of fishing days for the month of October from 2015 to 2022 for the upstream, upper reservoir, lower reservoir, downstream and Mekong area are displayed in ***Table 2.3-4.***

Table 2.3-4: Mean reported number of fishing days by fishing zone for the month of October from 2015 to 2022

Fishing Zone	October 2015 (day)	October 2016 (day)	October 2017 (day)	October 2018 (day)	October 2019 (day)	October 2020 (day)	October 2021 (day)	October 2022 (day)
Upstream	11.17	8.65	10.33	8.41	15.13	12.95	12.88	14.76
Upper reservoir	12.34	9.60	6.89	11.07	12.84	14.90	9.60	13.92
Lower reservoir	13.29	9.60	NA	10.52	13.53	13.50	11.51	11.75
Downstream	11.45	10.01	13.04	12.06	14.14	16.37	18.27	17.14
Mekong	14.23	15.87	12.88	14.76	16.77	15.67	16.79	17.50

The mean monthly household fish catch from July 2015 to October 2022 for the upstream (US), upper reservoir (UR), lower reservoir (LR), downstream (DS) and Mekong (MK) area are presented in ***Figure 2.3-3.***

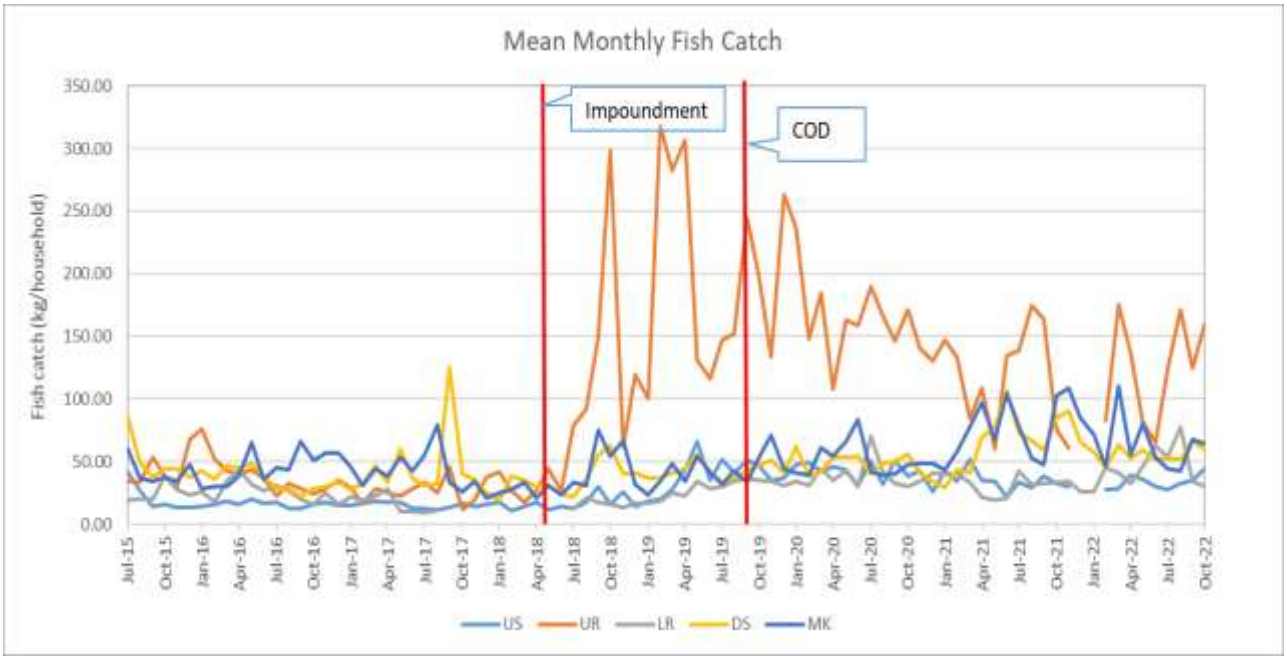

Figure 2.3-3: Mean Monthly Household Fish Catch from July 2015 to October 2022

The mean household fish catch for the month of October from 2015 to 2022 in the upstream, upper reservoir, lower reservoir, downstream and Mekong area are displayed in

Table 2.3-5***.***

Table 2.3-5: Mean Monthly Household Fish Catch for the month of October from 2015 to 2022

Fishing Zone	October 2015 (kg)	October 2016 (kg)	October 2017 (kg)	October 2018 (kg)	October 2019 (kg)	October 2020 (kg)	October 2021 (kg)	October 2022 (kg)
Upstream	15.73	16.13	16.39	15.99	46.54	38.63	32.21	44.32
Upper reservoir	38.02	24.62	11.56	298.71	196.94	171.51	75.03	159.37
Lower reservoir	38.68	15.54	NA	15.57	35.17	29.69	33.17	30.23
Downstream	44.43	28.27	40.18	63.06	47.81	56.22	85.56	59.15
Mekong	37.74	51.19	25.93	53.92	53.33	47.90	102.41	64.34

The mean daily fish catch per household from July 2015 to October 2022 are displayed in ***Figure 2.3-4*** and the mean fish catch per household per fishing day for the month of October from 2015 to 2022 are shown in ***Table 2.3-6.***

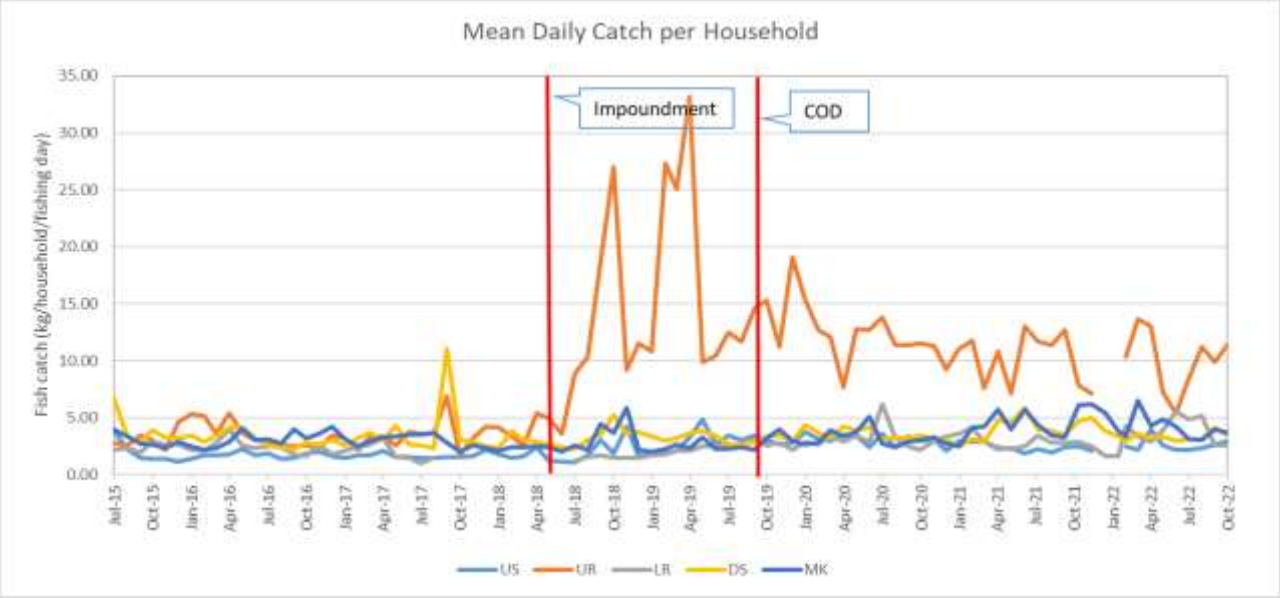

Figure 2.3-4: Mean Daily Fish Catch per Household from July 2015 to October 2022

Table 2.3-6: Mean Daily Fish Catch per Household for the month of October from 2015 to 2022

Fishing Zone	October 2015 (kg)	October 2016 (kg)	October 2017 (kg)	October 2018 (kg)	October 2019 (kg)	October 2020 (kg)	October 2021 (kg)	October 2022 (kg)
Upstream	1.41	1.87	1.59	1.90	3.08	2.98	2.50	3.00
Upper reservoir	3.08	2.57	1.68	26.98	15.33	11.51	7.82	11.45
Lower reservoir	2.91	1.62	NA	1.48	2.60	2.20	2.88	2.57
Downstream	3.88	2.82	3.08	5.23	3.38	3.43	4.68	3.45
Mekong	2.65	3.23	2.01	3.65	3.18	3.06	6.10	3.68

The survey results in October 2022 indicate that Nam Ngiep is the main fishing habitat for the upstream and downstream zone, while the main fishing habitat for the upper reservoir, lower reservoir and Mekong zones are reservoir, tributaries and streams and Mekong respectively. The proportion of fishing habitats in October 2022 are displayed in ***Table 2.3-7.***

Table 2.3-7: Proportion of the catch reported by main habitats (%) in October 2022

Habitats	US	UR	LR	DS	MK
Mekong	0.0%	0.0%	0.0%	6.2%	73.9%
Nam Ngiep	51.2%	17.2%	0.0%	51.6%	2.9%
Nam Xan	0.0%	0.0%	0.0%	0.0%	0.0%
Reservoir	0.0%	81.1%	6.1%	0.0%	0.0%
Tributaries and streams	48.1%	1.1%	91.1%	39.2%	0.0%
Wetlands	0.7%	0.5%	2.9%	3.1%	23.2%
Others	0.0%	0.0%	0.0%	0.0%	0.0%

Total proportion of other aquatic animals (OAA) in the total reported catch of fish and OAA for the same 7-day period from July 2015 to October 2022 are presented in ***Figure 2.3-5*** and the proportion of OAA catch for the month of October from 2015 to 2022 are shown in ***Table 2.3-8.***

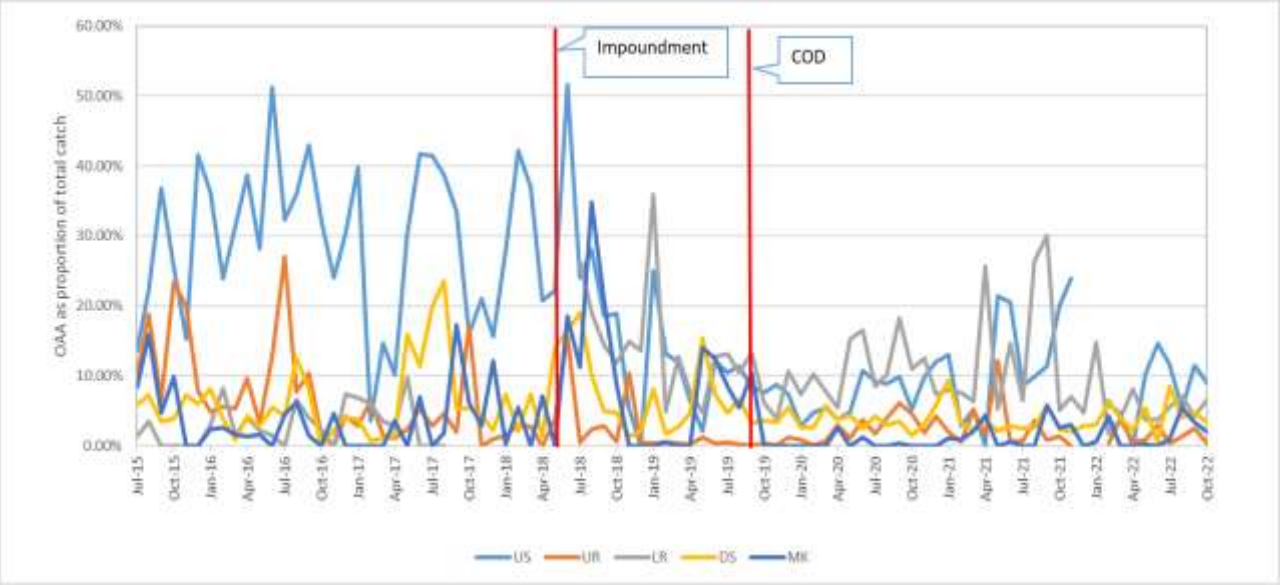

Figure 2.3-5: Proportion of OAA to the total reported number of fish and OAA for a 7-day period by fishing zone from July 2015 to October 2022

Table 2.3-8: Proportion of OAA to the total reported number of fish and OAA for the month of October from 2015 to 2022

Fishing Zone	October 2015	October 2016	October 2017	October 2018	October 2019	October 2020	October 2021	October 2022
Upstream	25.52%	32.18%	15.91%	18.88%	7.62%	5.26%	20.00%	8.95%
Upper reservoir	23.44%	1.48%	17.25%	0.59%	0.29%	4.57%	1.36%	0.38%
Lower reservoir	0.00%	2.32%	NA	11.90%	6.10%	10.94%	5.07%	6.55%
Downstream	3.81%	0.13%	5.39%	4.72%	3.63%	1.46%	2.38%	3.34%
Mekong	9.83%	0.00%	6.26%	8.69%	0.00%	0.00%	2.63%	1.93%

3 EXTERNAL MISSIONS AND VISITS

The joint mission of Asian Development Bank (ADB)-Independent Advisory Panel (IAP)-Lender Technical Advisor (LTA) was conducted onsite during 21-25 November 2022.

ANNEXES

ANNEX A: RESULTS OF WATER QUALITY MONITORING

TABLE A-1: RESULTS OF MAIN RESERVOIR, RE-REGULATION RESERVOIR AND SURFACE WATER (NAM NGIEP RIVER, NAM PHOUAN, NAM CHIAN AND NAM XAO) QUALITY MONITORING

		River Name	Nam Ngiep												Nam Chain	Nam Phouan	Nam Xao	Nam Houay Soup
		Zone	Location Refer to Construction Sites												Location Refer to Construction Sites			
			Upstream/Main Reservoir						Within / Re-regulation Reservoir		Downstream				Tributaries Upstream		Tributaries Downstream	
		Station Code	NNG 01	R01	R02	R03	R04	R05	R06	R07	NNG 05	NNG 06	NNG 07	NNG 08	NCH 01	NPH 01	NXA01	NHS01
Date	Parameters (Unit)	Guideline																
1-Nov-22	pH	5.0 - 9.0		6.8	7.04	6.99												
2-Nov-22	pH	5.0 - 9.0					6.99	7.46	7.24	7.12								
3-Nov-22	pH	5.0 - 9.0									6.65	7.54	7.59	7.49			7.58	7.6
9-Nov-22	pH	5.0 - 9.0		7.72	7.73	7.78												
10-Nov-22	pH	5.0 - 9.0					7.35	7.91	7.76	7.63								
11-Nov-22	pH	5.0 - 9.0									7.68	8.17	8.05	8.24			8.27	8.28
14-Nov-22	pH	5.0 - 9.0	8.86												8.93			
16-Nov-22	pH	5.0 - 9.0		8.6	8.48	8.03												
17-Nov-22	pH	5.0 - 9.0					8.07	7.68	7.22	7.41								
18-Nov-22	pH	5.0 - 9.0									6.87	6.86	6.74	6.79			6.7	6.94
29-Nov-22	pH	5.0 - 9.0					7.74	7.97	7.37	7.37								
30-Nov-22	pH	5.0 - 9.0									7.63		7.88	7.71			7.7	7.86
1-Nov-22	Sat. DO (%)			69.6	91.9	89.2												
2-Nov-22	Sat. DO (%)						70.7	80.5	34.3	32.4								
3-Nov-22	Sat. DO (%)										44.5	49.7	64.2	71.6			81.5	79.1
9-Nov-22	Sat. DO (%)			85.5	74.1	94.2												
10-Nov-22	Sat. DO (%)						81	79	48.5	55.3								
11-Nov-22	Sat. DO (%)										63.2	66	93.5	98.5			93.8	88.5
14-Nov-22	Sat. DO (%)		99.6												94.9			
16-Nov-22	Sat. DO (%)			107	101.9	95.6												
17-Nov-22	Sat. DO (%)						99.5	98.4	32.8	41.5								
18-Nov-22	Sat. DO (%)										41.7	58.9	70.9	77.2			83.3	75.1

		River Name	Nam Ngiep								Nam Chain	Nam Phouan	Nam Xao	Nam Houay Soup
		Zone	Location Refer to Construction Sites								Location Refer to Construction Sites			
			Upstream/Main Reservoir						Within / Re-regulation Reservoir		Downstream				Tributaries Upstream		Tributaries Downstream	
		Station Code	NNG 01	R01	R02	R03	R04	R05	R06	R07	NNG 05	NNG 06	NNG 07	NNG 08	NCH 01	NPH 01	NXA01	NHS01
Date	Parameters (Unit)	Guideline																
29-Nov-22	Sat. DO (%)						92.3	96.5	15.3	29.3								
30-Nov-22	Sat. DO (%)										53.5		76	77.2			96.5	104.1
1-Nov-22	DO (mg/L)	>6.0		5.53	7.25	6.9												
2-Nov-22	DO (mg/L)	>6.0					5.61	6.34	2.83	2.66								
3-Nov-22	DO (mg/L)	>6.0									3.71	4.15	5.36	5.93			6.93	6.82
9-Nov-22	DO (mg/L)	>6.0		6.77	5.9	7.33												
10-Nov-22	DO (mg/L)	>6.0					6.47	6.34	3.98	4.52								
11-Nov-22	DO (mg/L)	>6.0									5.27	5.51	7.81	8.06			7.89	7.68
14-Nov-22	DO (mg/L)	>6.0	8.54												8.31			
16-Nov-22	DO (mg/L)	>6.0		8.35	8	7.41												
17-Nov-22	DO (mg/L)	>6.0					7.82	7.75	2.72	3.35								
18-Nov-22	DO (mg/L)	>6.0									3.46	4.8	5.79	6.18			6.92	6.39
29-Nov-22	DO (mg/L)	>6.0					7.3	7.54	1.3	2.46								
30-Nov-22	DO (mg/L)	>6.0									4.48		6.19	6.31			7.56	8.86
1-Nov-22	Conductivity (µs/cm)			77	74	67												
2-Nov-22	Conductivity (µs/cm)						67	64	75	75								
3-Nov-22	Conductivity (µs/cm)										75	80	77	77			112	34
9-Nov-22	Conductivity (µs/cm)			77	75	67												
10-Nov-22	Conductivity (µs/cm)						67	64	77	75								
11-Nov-22	Conductivity (µs/cm)										77	80	80	83			113	40
14-Nov-22	Conductivity (µs/cm)		111												35			
16-Nov-22	Conductivity (µs/cm)			78	75	68												
17-Nov-22	Conductivity (µs/cm)						67	66	77	77								
18-Nov-22	Conductivity (µs/cm)										77	78	80	82			122	52
29-Nov-22	Conductivity (µs/cm)						67	66	78	78								
30-Nov-22	Conductivity (µs/cm)										80		81	79			132	41

		River Name	Nam Ngiep								Nam Chain	Nam Phouan	Nam Xao	Nam Houay Soup
		Zone	Location Refer to Construction Sites								Location Refer to Construction Sites			
			Upstream/Main Reservoir					Within / Re-regulation Reservoir		Downstream			Tributaries Upstream		Tributaries Downstream	
		Station Code	NNG 01	R01	R02	R03	R04	R05	R06	R07	NNG 05	NNG 06	NNG 07	NNG 08	NCH 01	NPH 01	NXA01	NHS01
Date	Parameters (Unit)	Guideline																
1-Nov-22	Temperature (°C)			27.27	27.73	28.62												
2-Nov-22	Temperature (°C)						27.37	27.69	25.15	25.55								
3-Nov-22	Temperature (°C)										24.6	24.4	24.57	25.05			23.42	22.55
9-Nov-22	Temperature (°C)			27.23	27.04	27.81												
10-Nov-22	Temperature (°C)						26.85	26.46	25.5	27.39								
11-Nov-22	Temperature (°C)										24.52	24.28	24.91	25.52			23.95	22.35
14-Nov-22	Temperature (°C)		23.02												22.04			
16-Nov-22	Temperature (°C)			28.27	28.07	28.39												
17-Nov-22	Temperature (°C)						27.6	27.76	24.89	26.46								
18-Nov-22	Temperature (°C)										24.86	25.03	25.64	26.65			26.32	24.87
29-Nov-22	Temperature (°C)						27.5	28.17	24.53	25.26								
30-Nov-22	Temperature (°C)										24.4		25.03	25.48			27.94	23.58
1-Nov-22	Turbidity (NTU)			4.04	1.66	1.23												
2-Nov-22	Turbidity (NTU)						2.42	0.89	1.94	1.96								
3-Nov-22	Turbidity (NTU)										2	2.44	3.35	6.15			5.5	4.66
9-Nov-22	Turbidity (NTU)			2.93	2.61	1.21												
10-Nov-22	Turbidity (NTU)						1.07	0.95	2.38	5.27								
11-Nov-22	Turbidity (NTU)										3.54	3.67	7.38	8.21			5.74	
14-Nov-22	Turbidity (NTU)		13.6												2.86			
16-Nov-22	Turbidity (NTU)			2.41	2.49	1.2												
17-Nov-22	Turbidity (NTU)						1.22	1.23	1.78	1.64								
18-Nov-22	Turbidity (NTU)										2.42	2.31	3.09	7.98			5.13	2.94
29-Nov-22	Turbidity (NTU)						1.02	1.06	1.77	1.94								
30-Nov-22	Turbidity (NTU)										2.46		3.46	6.81			5.01	4.25

		River Name	Nam Ngiep												Nam Chain	Nam Phouan	Nam Xao	Nam Houay Soup
		Zone	Location Refer to Construction Sites												Location Refer to Construction Sites			
			Upstream/Main Reservoir						Within / Re-regulation Reservoir		Downstream				Tributaries Upstream		Tributaries Downstream	
		Station Code	NNG 01	R01	R02	R03	R04	R05	R06	R07	NNG 05	NNG 06	NNG 07	NNG 08	NCH 01	NPH 01	NXA01	NHS01
Date	Parameters (Unit)	Guideline																
1-Nov-22	TSS (mg/L)			<5		<5												<5
2-Nov-22	TSS (mg/L)						<5	<5	<5	<5								<5
14-Nov-22	TSS (mg/L)		14.2				<5	<5	<5	<5					<5			<5
1-Nov-22	BOD_5 (mg/L)	<1.5		<1		<1												
2-Nov-22	BOD_5 (mg/L)	<1.5					<1	<1	<1	<1								
3-Nov-22	BOD_5 (mg/L)	<1.5									<1	<1	<1	<1			<1	<1
14-Nov-22	BOD_5 (mg/L)	<1.5	<1												<1			
2-Nov-22	COD (mg/L)	<5.0							<5	<5								
3-Nov-22	COD (mg/L)	<5.0									<5	6.4	6.4	9.6			<5	<5
14-Nov-22	COD (mg/L)	<5.0	<5												<5			
1-Nov-22	NH_3-N (mg/L)	<0.2		<0.2		<0.2												
2-Nov-22	NH_3-N (mg/L)	<0.2					<0.2	<02										
14-Nov-22	NH_3-N (mg/L)	<0.2	<0.2												<0.2			
1-Nov-22	NO_3-N (mg/L)	<5.0		<0.02		<0.02												
2-Nov-22	NO_3-N (mg/L)	<5.0					<0.02	<0.02										
14-Nov-22	NO_3-N (mg/L)	<5.0	0.1												0.09			
2-Nov-22	Faecal coliform (MPN/100 mL)	<1,000							0	5								
3-Nov-22	Faecal coliform (MPN/100 mL)	<1,000									5	14	11	14			110	110
14-Nov-22	Faecal coliform (MPN/100 mL)	<1,000	17												32			
2-Nov-22	Total Coliform (MPN/100 mL)	<5,000							13	33								
3-Nov-22	Total Coliform (MPN/100 mL)	<5,000									33	220	79	280			1,600	920

		River Name	Nam Ngiep								Nam Chain	Nam Phouan	Nam Xao	Nam Houay Soup
		Zone	Location Refer to Construction Sites								Location Refer to Construction Sites			
			Upstream/Main Reservoir					Within / Re-regulation Reservoir		Downstream			Tributaries Upstream		Tributaries Downstream	
		Station Code	NNG 01	R01	R02	R03	R04	R05	R06	R07	NNG 05	NNG 06	NNG 07	NNG 08	NCH 01	NPH 01	NXA01	NHS01
Date	Parameters (Unit)	Guideline																
14-Nov-22	Total Coliform (MPN/100 mL)	<5,000	70								33	220	79	280	47		1,600	920
1-Nov-22	TKN			<1.5		<1.5												
2-Nov-22	TKN						<1.5	<1.5										
14-Nov-22	TKN		<1.5												<1.5			
2-Nov-22	TOC (mg/L)								1.07	1.15								
3-Nov-22	TOC (mg/L)										1.62	1.23	1.26	1.06			1.06	2.31
14-Nov-22	TOC (mg/L)		0.98												0.81			
1-Nov-22	Total Phosphorus (mg/L)			0.02		0.01												
2-Nov-22	Total Phosphorus (mg/L)						0.01	0.01										
14-Nov-22	Total Phosphorus (mg/L)		0.02												<0.01			
1-Nov-22	Total Dissolved Phosphorus (mg/L)			0.01		<0.01												
2-Nov-22	Total Dissolved Phosphorus (mg/L)						<0.01	<0.01										
14-Nov-22	Total Dissolved Phosphorus (mg/L)		0.01												<0.01			
1-Nov-22	Hydrogen Sulfide (mg/L)			<0.02		<0.02												
2-Nov-22	Hydrogen Sulfide (mg/L)						<0.02	<0.02										
2-Nov-22	Time							11:05	13:40	14:00								
3-Nov-22	Time										09:00	09:33	10:43	11:50			09:24	09:55
10-Nov-22	Time							11:10	14:25	14:43								
11-Nov-22	Time																	
17-Nov-22	Time							13:25	14:40	15:05								

		River Name	Nam Ngiep								Nam Chain	Nam Phouan	Nam Xao	Nam Houay Soup
		Zone	Location Refer to Construction Sites								Location Refer to Construction Sites			
			Upstream/Main Reservoir						Within / Re-regulation Reservoir		Downstream				Tributaries Upstream		Tributaries Downstream	
		Station Code	NNG 01	R01	R02	R03	R04	R05	R06	R07	NNG 05	NNG 06	NNG 07	NNG 08	NCH 01	NPH 01	NXA01	NHS01
Date	Parameters (Unit)	Guideline																
18-Nov-22	Time										09:38	09:58	10:46	11:38			10:12	
1-Nov-22	Turbidity (NTU)-bottom					1.97												
2-Nov-22	Turbidity (NTU)-bottom						1.14	0.7										
1-Nov-22	TSS (mg/L)-bottom					26.37												
2-Nov-22	TSS (mg/L)-bottom						<5	<5										
1-Nov-22	BOD_5 (mg/L)-bottom					<1												
2-Nov-22	BOD_5 (mg/L)-bottom						9.38	<1										
1-Nov-22	NH_3-N (mg/L)-bottom					<0.2												
2-Nov-22	NH_3-N (mg/L)-bottom						<02	<0.2										
1-Nov-22	NO_3-N (mg/L)-bottom					<0.02												
2-Nov-22	NO_3-N (mg/L)-bottom						<0.02	<0.02										
1-Nov-22	TKN-bottom					<1.5												
2-Nov-22	TKN-bottom						<1.5	<1.5										
1-Nov-22	Total Dissolved Phosphorus (mg/L)-bottom					0.01												
2-Nov-22	Total Dissolved Phosphorus (mg/L)-bottom						0.03	0.01										
1-Nov-22	Total Phosphorus (mg/L)-bottom					0.01												
2-Nov-22	Total Phosphorus (mg/L)-bottom						0.06	0.03										

		River Name	Nam Ngiep												Nam Chain	Nam Phouan	Nam Xao	Nam Houay Soup
		Zone	Location Refer to Construction Sites												Location Refer to Construction Sites			
			Upstream/Main Reservoir						Within / Re-regulation Reservoir		Downstream				Tributaries Upstream		Tributaries Downstream	
		Station Code	NNG 01	R01	R02	R03	R04	R05	R06	R07	NNG 05	NNG 06	NNG 07	NNG 08	NCH 01	NPH 01	NXA01	NHS01
Date	Parameters (Unit)	Guideline																
1-Nov-22	Hydrogen Sulfide (mg/L)-bottom					<0.02												
2-Nov-22	Hydrogen Sulfide (mg/L)-bottom						<0.02	0.02										

TABLE A-2: RESULTS OF CAMP EFFLUENTS IN NOVEMBER 2022

	Site Name	OSOV1 (Owner's Site Office and Village)		OSOV2 (ESD Camp)		Main Powerhouse	
	Station Code	EF01		EF13		EF19	
	Date	07-Nov-22	14-Nov-22	07-Nov-22	14-Nov-22	07-Nov-22	15-Nov-22
Parameters (Unit)	**Guideline**						
pH	6.0 - 9.0	7.02		8.08	8.62	8.05	8.22
Sat. DO (%)		76.9	No sampling due to wetlands under maintenance	114.5	89.9	75.7	49.2
DO (mg/L)		6.06		9.27	7.16	5.9	3.8
Conductivity (µs/cm)		311		268	378	1,017	958
Temperature (°C)		27.44		26.5	26.78	28.53	28.67
Turbidity (NTU)		0.77		4.55	6.29	31.5	8.83
TSS (mg/L)	<50	<5		5.24	9.38	26.3	66.7
BOD_5 (mg/L)	<30	<6		<6	<6	<6	<6
COD (mg/L)	<125	<25		<25	39	60	71
NH_3-N (mg/L)	<10.0	<2		5.6	10.0	9.1	4.2
Total Nitrogen (mg/L)	<10.0	0.43		6.6	11.3	9.9	4.8
Total Phosphorus (mg/L)	<2	1.4		0.60	1.06	4.9	5.0
Oil & Grease (mg/L)	<10.0	<1		<1		<1	
Total coliform (MPN/100 mL)	<400	9,200		1,600	0	0	0
Faecal Coliform (MPN/100 mL)	<400	5,400		210	0	0	0
Residual Chlorine (mg/L)	<1.0			0.03	1.17	0.17	0.34