NAM NGIEP 1
POWER COMPANY

Nam Ngiep 1 Hydropower Project

Environmental Management Monthly Monitoring Report

December 2018

A	28 January 2019	Khamlar PHONSAVAT	Peter G JENSEN	Vilayhak SOMSOULIVONG	
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TABLE OF CONTENTS

ABBREVIATIONS / ACRONYMS

AIP	Annual Implementation Plan
ADB	Asian Development Bank
BBS	Biodiversity Baseline Survey
BAC	Biodiversity Advisory Committee
BOF	Biodiversity Offset Framework
BOMC	Biodiversity Offset Management Committee
BOMP	Biodiversity Offset Management Plan
CA	Concession Agreement between the NNP1PC and GOL,
CAP	Corrective Action Plan
COD	Commercial Operation Date
CVC	Conventional Vibrated Concrete
CWC	Civil Works Contract
CTA	Common Terms Agreement
DEB	Department of Energy Business, MEM
DEPP	Department of Energy Policy and Planning, MEM
DEQP	Department of Environment and Quality Promotion, MONRE
DESIA	Department of Environmental and Social Impact Assessment, MONRE
DFRM	Department of Forest Resources Management, MONRE
DLA	Department of Land Administration, MONRE
DSRP	Dam Safety Review Panel
EC	Electrolytic Conductivity
ECOCD	EGAT Construction Obligation Commencement Date
EDL	Electricite du Laos
EDL PPA	Power Purchase Agreement between NNP1PC and EDL
EGAT	Electricity Generating Authority of Thailand
EGATi	EGAT International Company Limited
EIA	Environmental Impact Assessment
EMMR	Environmental Management and Monitoring Reports
EMO	Environmental Management Office of ESD within NNP1PC
EMU	Environmental Monitoring Unit
EMWC	Electrical-Mechanical Works Contract
EPF	Environmental Protection Fund
ERIC	Environmental Research Institute Chulalongkhorn University

ERM	Environmental Resource Management
ESD	Environmental and Social Division of NNP1PC
ESMMP	Environmental and Social Monitoring and Management Plan
FY	Fiscal Year
GOL	Government of Lao PDR
GIS	Geographic Information Systems
HH	Household
HMWC	Hydraulic Metal Works Contract
HR	Human Resources
IEE	Initial Environmental Examination
IMA	Independent Monitoring Agency
INRMP	Integrated Natural Resources Management Plan
ISP	Intergraded Spatial Planning
km	kilometre
kV	kilo-Volt
LEPTS	Lao Electric Power Technical Standard
LHSE	Lao Holding State Enterprise
LTA	Lender's Technical Advisor
M	million
m	metre
MAF	Ministry of Agriculture and Forestry
MEM	Ministry of Energy and Mines, Lao PDR
MOF	Ministry of Finance, Lao PDR
MOM	Minutes of Meeting
MONRE	Ministry of Natural Resource and Environment, Lao PDR
MOU	Memorandum of Understanding
NBCA	National Biodiversity Conservation Area
NCI	Non-Compliance Issue
NCR	Non-Compliance Report
NN2	Nam Ngum 2 Power Company Limited
NNP1PC	Nam Ngiep 1 Power Company Limited
NPF	National Protection Forest
NTFP	Non-Timber Forest Products
NT2	Nam Theun 2 Hydropower Project
OC	Obayashi Corporation
ONC	Observation of Non-Compliance
PAFO	Provincial Department of Agriculture and Forestry

PAP	Project Affected People
PD	Property Damage
PONRE	Provincial Department of Natural Resource and Environment, MONRE
PvPA	Provincial Protection Area
RCC	Roller Compacted Concrete
SIR	Site Inspection Report
SLBMP	Salvage Logging Biomass Management Plan
SOP	Standard Operating Procedure
SMO	Social Management Office of ESD within NNP1PC
SS-ESMMP	Site Specific Environmental and Social Monitoring and Management Plan
TD	Technical Division of NNP1PC
TOR	Terms of Reference
TSS	Total Suspended Solids
UAE	United Analysis and Engineering Consultant Company Ltd.
UXO	Unexploded Ordinance
WMF	Watershed Management Fund
WMP	Watershed Management Plan
WRPC	Watershed and Reservoir Protection Committee
WRPO	Watershed and Reservoir Protection Office
WWTS	Waste Water Treatment System

EXECUTIVE SUMMARY

In December 2018, the Environmental Management Office (EMO) of Nam Ngiep 1 Power Company (NNP1PC) received no document from any contractor for review and approval.

The monthly inspection by the Environmental Management Unit (EMU) of Bolikhamxay Province was rescheduled to early January 2019.

The effluent monitoring results for the camps in December 2018 indicate that the measurements of BOD5, COD, faecal coliform and total coliform comply with the relevant effluent standards, except for Owner's Site Office and Village, Song Da 5 Camp No.2, Zhefu Camp, HM Main Camp, IHI Main Camp and IHI's subcontractor camp (276 Camp). Most of the camps struggle for compliance with total nitrogen and ammonia nitrogen, except V&K Camp. EMO discontinued the water sampling at RCC Plant, Aggregate Crushing Plant, Sino Hydro Camp and Kenber Camp because these sites were decommissioned in November 2018 and are therefore no longer in operation.

The dissolved oxygen (DO) concentrations at the surface of Nam Ngiep River in R1, R3, R4 and R5 (upstream of the main dam some 50 km, 21 km, 13 km and 0.5 km respectively) were generally above the Standard at 6 mg/L in December 2018, except R4 on 19 December 2018. The DO measurements in R6 and R7 (re-regulation reservoir) were generally above 7 mg/L, and the DO in NNG05 downstream the re-regulation dam has remained above 8 mg/L.

A total of 87 m3 of solid waste was disposed of at the NNP1 Project Landfill, a decrease of 5.7 m3 compared to November 2018. During December 2018, EMO conducted three spot checks on waste at the NNP1 Project Landfill, construction sites and the camps. It was found that waste management of the construction sites and camps had been improved. The landfill maintenance work was carried out by the Administration Division with EMO support. The work includes waste clean-up, cutting grass and plants and repairing perimeter fences. A total of 456.5 kg of recyclable waste was sold to Khounmixay Processing Factory. A total of 121 m3 of solid waste from Phouhomxay, Thahuea and Hat Gniun Villages was disposed of at the Houay Soup Landfill.

The comments from IAP and ADB were discussed during their mission on 14-15 December 2018. NNP1PC, IAP, and ADB have agreed that the plan approval by ADB will be on 18 January 2019 and NNP1PC could continue the collaboration with ADB in finalizing the Annual Implementation Plan 2019 for the two Provinces so that the approval could be given at the same time as the master plan.

Xaysomboun WRPO-PAFO have further improved the draft regulation and presented it at Xaysomboun WRPC coordination meeting on 20 December 2018. The meeting requested DOF-MAF and NNP1PC to review the draft regulation prior to submission to the Provincial Assembly Chairperson and the Provincial Governor for approval as soon as possible in January 2019. NNP1 EMO have provided its final review and comments in the last week of December 2018.

The Bolikhamxay WRPO submitted the draft AIP 2019 to NNP1 EMO on 30 October 2018. The draft is being reviewed by NNP1 EMO. The formulation of AIP 2019 by the Xaysomboun Province will be continued into January 2019.

The Xaysomboun WRPO completed a field verification survey of the boundary for the Total Protection Zone 1 (TPZ Phou Samsao) and land uses in Hom District at the end of October 2018. The remaining surveys in TPZ1 (TPZ Phou Samsao) at Anouvong District and TPZ2 (TPZ Phou Khata) at Hom District were postponed until completion of the restructuring of Xaysomboun WRPC and WRPO on 29 November 2018. The survey will be continued during January 2019.

The comments from IAP and ADB to the draft Biodiversity Offset M anagement Plan were discussed during the IAP and ADB mission on 14-15 December 2018. NNP1PC, IAP, and ADB have agreed that the plan needs to be further improved in respect of the following aspects being: the statement of vision; the assessment and target to achieve No Net Loss (NNL);

the presentation of organization structure, and the elaboration of social risk and assessment into livelihood development components. The final approval by ADB is expected by the end of January 2019 and the final approval by GOL is expected in March 2019.

The fish catch monitoring for November 2018 in Nam Ngiep watershed was dominated by three species groups and two species which are classified as Least Concern (LC) according to the IUCN Red List of Threatened Species, except Hemibagrus filamentus which is classified as Data Deficient and Amblyrhynchichthys truncates which is classified as Not Evaluated.

The recorded catch of Threatened and Near Threatened species (IUCN Red List classification) in November 2018 included one species that is classified as Endangered (EN), four Vulnerable (VU) species, and seven Near Threatened (NT) species.

1. INTRODUCTION

The Nam Ngiep originates in the mountains of Xieng Khouang Province, flowing through Khoun District into Thathom District of Xaysomboun Province, through Hom District and into Bolikhan District of Bolikhamxay Province. The Nam Ngiep meets the Mekong River just upstream from Pakxan in Bolikhamxay Province (Fig. 1-1).

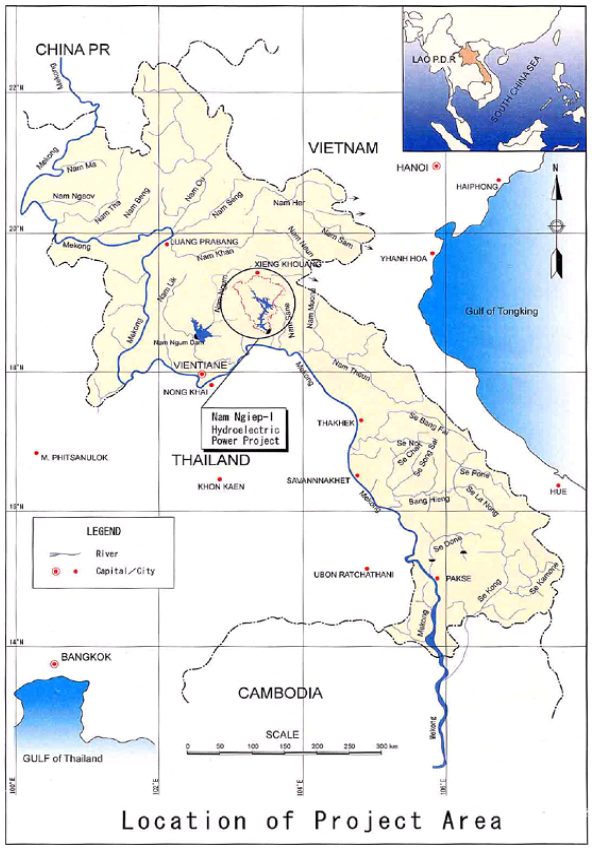


Figure 1-1: Location Map

The project will consist of two dams. The main dam which is located 9.0 km upstream of Hat Gnuin Village in Bolikhan District, will create a 70-km-long, narrow reservoir that extends up the Ngiep Valley as far as Thathom District. At almost 150 m high, the main dam will be the second largest in Lao PDR. The Power Station at this dam will generate up to 272 MW of electricity for export to Thailand. With a combined capacity of 290 MW, Nam Ngiep 1 will generate around 1,620 GWh of electricity annually. Two transmission lines will be required to transport the electricity generated by the project. From the main power station, a 230-kV line will run for 125 km to the Nabong outside Vientiane Capital. A 115-kV transmission line will be constructed by EDL from the Re-regulation Power Station to Pakxan substation over a distance of 40 km.

This Environmental Monthly Monitoring Report (EMMR) provides a summary of environmental monitoring activities and mitigation actions in January 2017. The EMMR was prepared by the Project's Environmental Management Office (EMO). It has been internally reviewed and cleared by EMO senior technical staff and management prior to submitting the report to the Government of Lao PDR (GoL) related agencies.

The EMMR and other related reports including related construction Site Specific Environmental and Social Monitoring and Management Plans (SS-ESMMPs) are publicly disclosed on the Project website in line with the ADB and GoL Public Disclosure Policies. Hard copies of the final reports will also be available upon requests at the Project's main office in Vientiane Capital and field office in Pakxan, Bolikhamxay Province.

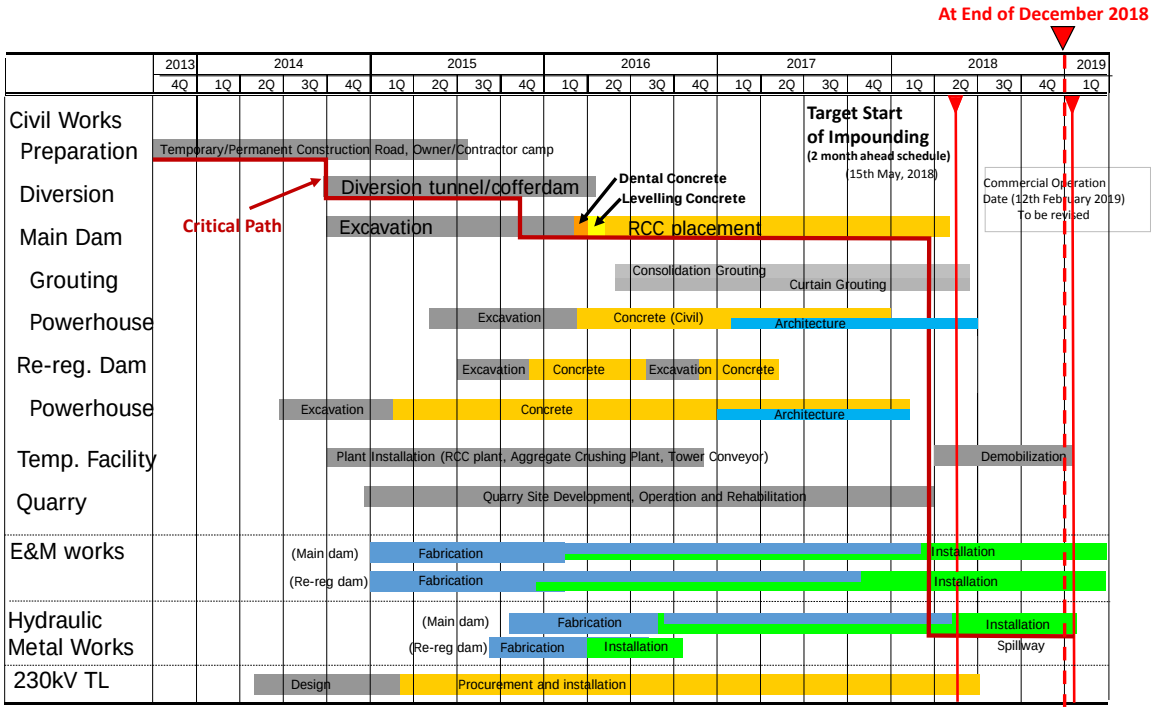
2. WORK PROGRESS OF PRINCIPAL CONTRACTORS

Construction Works for the Project are being carried out through four separate main construction contracts under the supervision of the Technical Division of NNP1PC. The four contracts are the Civil Works, the Electrical and Mechanical Works, the Hydraulic Metal or Hydro-mechanical Works and the 230 kV Transmission Line Works. Actual overall

cumulative work progress until the end of December 2018 was 97.9 %[1] (compared to planned progress of 98.3 %), based on achieved Interim Milestone Payments for all Contracts excluding the value of Advance Payments, varied works and other adjustments allowed under each Contract. In terms of the value of actual work done the percentage is understated since work completed, but not paid, is not included.

The overall construction schedule and progress curve (by achieved Milestone Payments) are shown in ***Figure 2-1***.

Figure 2-1: Overall Construction Schedule



2.1 Civil Work

The Civil Works Contract was executed between Obayashi Corporation and the Nam Ngiep 1 Power Company on 30 September 2013 and the NTP was issued on 03 October 2014. Excavation works of the main dam, the diversion tunnel and the re-regulation dam

[1] The progress to-date is calculated as (Cumulative Amount of Achieved Interim Milestone Payments) / (Total Agreed Original Price of Construction Contracts) and expressed as a percentage. These totals exclude varied works and other adjustments allowed under each Contract.

[2]The progress to-date is calculated as (Cumulative Value Achieved for Completed Work by Variation Order or Other Adjustment) / (Total Budget Contingency Amount)

were commenced in October 2014 and completed in February 2016, following which the concreting works were commenced.

The cumulative actual work progress of the Civil Works until the end of December 2018 was 99.2 % (compared to planned progress of 99.7 %) calculated in the same manner as described above for the value of achieved Interim Milestone Payments excluding advance payment.

2.1.1 Main dam and power house

After starting the main dam excavation works in October 2014 on the left bank, the works were about one month advanced when diversion of the Nam Ngiep River was achieved at the end of October 2015. However, excavated volumes were 20% greater than expected and part of this additional work is necessary to construct a 'shear key' structure due to the weak layers of rock encountered in the dam foundation. Following the efforts on Site, the additional excavation work was completed at the end of February 2016.

Table 2-1: Progress of Main Powerhouse Sub-Structure Concrete Works to as 31 December 2018.

Location	Total Anticipated Volume (m^3)	Completed (m^3)	Progress (%)
Main Powerhouse	34,800	34,800	100
Penstock Embedment	11,885	11,885	100
Spillway	35,500	35,410	99

2.1.2 Re-regulation dam and powerhouse

The re-regulation powerhouse excavation and cofferdam works for river diversion were commenced in early October 2014. The excavation works for the powerhouse on the left bank were fully completed down to El. 146.7 m at the end of February 2015.

Structural concrete works were commenced in March 2015, in coordination with installation of the grounding system. The progress of structural concrete works is shown in ***Figure 2-2*** below:

Figure 2-2: Completed Re-regulation Dam and Powerhouse at the End of June 2018

2.1.3 Temporary work facility

2.1.3.1 DIVERSION TUNNEL INLET AND OUTLET

The diversion tunnel works which is over 600 m in length and 10 m in diameter were commenced in October 2014 by drill and blast techniques and completed in late September 2015. The river diversion took place on 31 October 2015 together with construction of earth-fill cofferdams upstream and downstream.

The second diversion to divert the river from the diversion tunnel through the bottom outlet or conduit in the dam was implemented on 13 January 2018.

2.1.3.2 SECONDARY UPSTREAM COFFERDAM

The concrete placement works in both conventional and roller compacted concrete (CVC and RCC respectively) for the secondary upstream cofferdam were started in November 2015 and completed ahead of construction schedule in the middle of February 2016. The grout curtain works were completed on 02 April 2016.

2.1.3.3 PLANT YARDS

These comprise the Aggregate Crushing Plant, the CVC Batching Plant and the RCC Batching Plant.
Foundation work and installation of equipment were completed at all the plant yards and the belt conveyor system from the RCC plant to the main dam was completed in early April 2016.

2.1.3.4 QUARRY

After removal of overburden the excavation of raw materials for aggregate crushing were started in July 2015. The nature and type of the rock being exploited is acceptable though unsuitable soil layers are removed to spoil disposal areas, and good quarry management continues.

2.1.3.5 DISPOSAL AREAS

The disposal area on the right bank has been available for operation since January 2015, as was the adjacent waste disposal area. The Disposal Area No.9 along Road P1 near the entrance of Road T5 started operation in April 2015. Unsuitable material from the quarry continues to be hauled to Disposal Area No.6 and Disposal Area No.9 is being developed by the E&M Contractor as stated above.

2.2 Electrical and Mechanical Works

The EMWC was executed between Hitachi-Mitsubishi Hydro Corporation and NNP1PC on 13 June 2014 and the NTP was issued on 03 October 2014. The cumulative work progress of the Electrical and Mechanical Works by value at the end of December 2018 was 98.8 % (compared to planned progress of 98.8 %).

Figure 4.2-1: Upper shaft levelling measurement for Unit 1

Figure 4.2-2: Lower shaft inclination measurement for Unit 1

Figure 4.2-3: Turbine shaft inclination measurement for Unit 1

Figure 4.2-4: Turbine bottom cover levelness measurement for Unit 1

Figure 4.2-5: Lifting out of rotor for Unit 2 (Disassembly work)

Figure 4.2-6: Shaft inclination check at turbine pit for Unit 2

Figure 4.2-7: Opening and closing check and measurement of guide vane servomotor for Unit 2

Figure 4.2-8: Pulling cables from powerhouse to dam control center

Figure 4.2-9: Inspection of balance of plant before taking over

Figure 4.2-10: Testing of transformer oil separator pit

Figure 4.2-11: Operation test of oil head and measurement of oil leakage & oil return

Figure 4.2-12: Operation test of oil leakage from turbine bearing

2.3 Hydro-Mechanical Works

The HMWC was executed between IHI Infrastructure Systems (IIS) and NNP1PC on 18 April 2014 and the NTP was issued to the Contractor on 03 October 2014. The actual cumulative work progress of the Hydro-Mechanical Works until the end of December 2018 was 97 % (compared to planned progress of 97 %). The main activities carried out during this month are described below:

Figure 2-3: *Progress of Spillway Gate Erection at the Main Dam at the End of November 2018.*

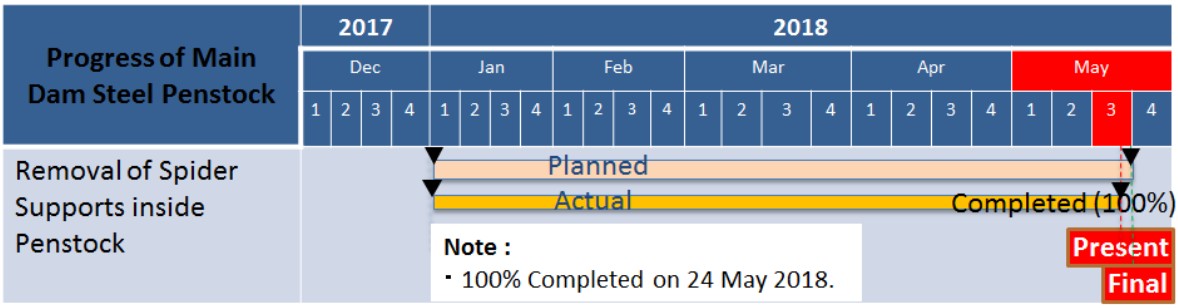


Figure 2-4: *Progress of Spillway Gate Erection at the Main Dam in December 2018*

Figure 2-5: Spillway used for discharge over stop-logs from the Spillway Gate No. 4 at the Main Dam in December 2018

2.4 230kV Transmission Line Works

The TLW Contract was executed between Loxley-Sri Consortium and NNP1PC on 11 July 2014 and the NTP was issued to the 230 kV TL Contractor on 03 October 2014. The cumulative work progress of the Transmission Line Works until the end of June 2018 was 100 % (compared to planned progress of 100 %).

Figure 2-6: Tower No. 3

Figure 2-7: Preparation for Megger Test Section PWH-T3 & Visual Check along the Line Route before the Energization Test

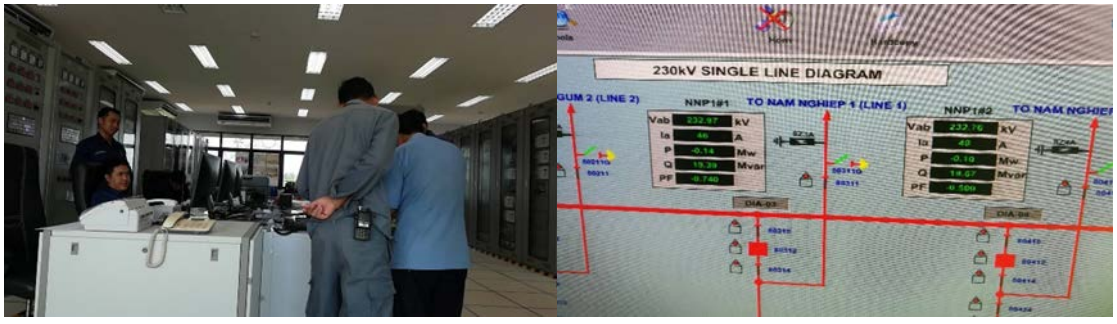
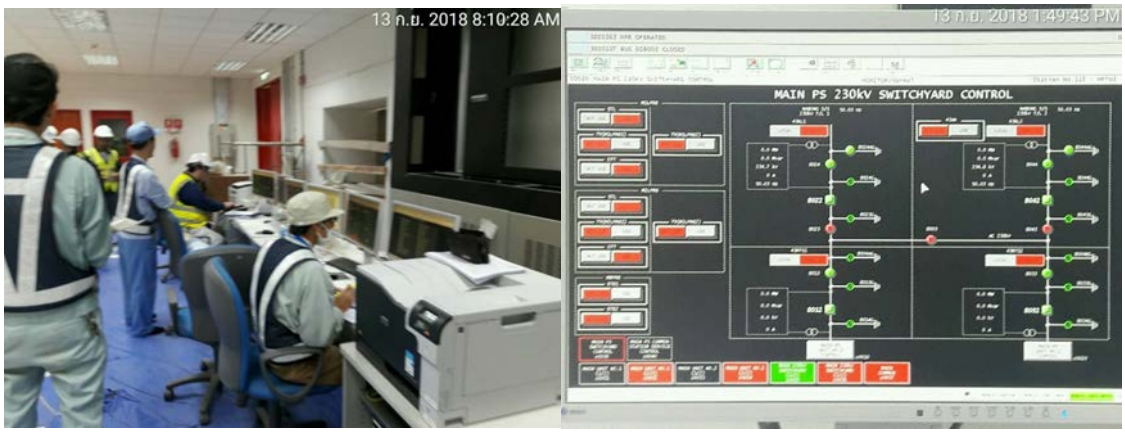


Figure 2-8: The energization work for the 230 kV Transmission Line from Nabong Substation to Main Power House NNP1



3. ENVIRONMENTAL MANAGEMENT MONITORING

3.1 Compliance Management

In December 2018, the Environmental Management Office (EMO) of Nam Ngiep 1 Power Company (NNP1PC) received no document for review and approval from any contractor.

The status of compliance reports (Observation of Non-Compliance or ONC, Non-Compliance Report or NCR) issued by NNP1PC to the Contractors.

Table 3-1*: Summary of ONC and NCR*

Items	ONC	NCR-1	NCR-2	NCR-3
Carried over from November 2018	0	0	1	0
Newly Opened in December 2018	0	1	1	0
Total in December 2018	**0**	**0**	**2**	**0**
Resolved in December 2018	0	0	0	0
Carried over to January 2019	0	1	2	0
Unsolved Exceeding Deadlines	**0**	**1**	**2**	**0**

3.1.1 Inspection by Environment Management Unit

The monthly inspection by the Environmental Management Unit (EMU) of Bolikhamxay Province was rescheduled to early January 2019.

3.2 Environmental Quality Monitoring

The analyses of Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD5), faecal coliform, E. Coli bacteria and total coliform have been carried out by NNP1PC Environmental Laboratory since August 2017.

All data are reported to the Ministry of Natural Resources and Environment (MONRE) and the Project Lenders on a monthly and quarterly basis and published on the Company website https://namngiep1.com/resources/monitoring-reports/.

3.2.1 Effluent Discharge from Camps and Construction Sites

Detailed monitoring results are provided in Annex B of this Report. The effluent monitoring results for the camps in December 2018 indicate that the measurements of BOD5, COD, faecal coliform and total coliform comply with the relevant effluent standards for a few

camps whereas the results of a few parameters for Owner's Site Office and Village, Song Da 5 Camp No.2, Zhefu Camp, HM Main Camp, IHI Main Camp and IHI Field Shop 276 Camp did not comply with the Standard.

Following the completion of the RCC placement work at the Main Dam by the end of April 2018, the production at the aggregate crushing plant and the RCC plant has stopped and the associated sediment retention ponds are therefore no longer in operation.

EMO discontinued the water sampling at the RCC Plant, Aggregate Crushing Plant, Sino Hydro Camp and Kenber Camp because these sites were decommissioned in November 2018.

The status of implementation of the corrective actions addressing non-compliances at the camps and key construction sites is summarized ***Table 3-2***.

Table 3-2: Status of Corrective Actions at Camps and Construction Sites

Site	Sampling ID	Status	Corrective Actions
Owner's Site Office and Village (OSOV)	EF01	Non-compliance for total coliform, faecal coliform, total nitrogen, ammonia-nitrogen and BOD_5.	The maintenance of the WWTS is underway. EMO suggested that the "washed sand" is needed for the top layer of the wetland to prevent the filtration problem.
Obayashi Corporation Camp	EF02	Non-compliance for total nitrogen and ammonia-nitrogen.	
SongDa5 Camp No. 1	EF07	Non-compliance for ammonia nitrogen, total nitrogen, faecal coliform and total coliform.	The Contractor has improved the wetland maintenance including supervising the chlorine mixing, and dosing. The latest water quality results will be reported next month.
Song Da 5 Camp No. 2	EF08	Non-compliance for ammonia nitrogen and total nitrogen.	During the latest EMU visit on 27 November 2018, no chlorine dosing was performed due to a clogged chlorine dosing pipe. This was fixed by the Contractor.
Zhefu Camp (Subcontractor of Hitachi-Mitsubishi Hydro)	EF09	Non-compliance for BOD_5, total coliform, faecal coliform, ammonia nitrogen and total nitrogen.	During the monthly progress meeting in December 2018, the Contractor was requested to improve the operation of the

Site	Sampling ID	Status	Corrective Actions
			WWTS. The results will be monitored and reported next month.
V&K Camp	EF10	Non-compliance for total nitrogen in first fortnightly sampling. However, fully compliance in the second fortnightly sampling.	No further corrective actions were needed.
HMH Main Camp (WWTS)	EF13	Non-compliance for COD, ammonia nitrogen and total nitrogen.	On 27 December 2018 an NCR2 was issued to the contractor on a non-compliance of waste water discharge.
IHI Main Camp	EF14	Non-compliance for COD, ammonia nitrogen and total nitrogen in the second fortnight mission.	EMO will follow up on this issue and report in the next monitoring period.
Lilama10 Camp	EF17	No discharge during the sampling mission.	
IHI Field Shop 276 Camp	EF18	Non-compliance for BOD_5, COD, total coliform, faecal coliform, ammonia nitrogen and total nitrogen.	On 21 December 2018 EMO did not accept the proposed corrective actions of the Contractor for closing the NCR-2 on a non-compliance waste water discharge from 276 camp. The Contractor has to submit a revised response incorporating comments from EMO.
Spoil Disposal Area No.2 (SongDa5 Workshop)	DS04	Fully compliance with the Standard.	
Upstream Spoil Disposal Area No.2 (SongDa5 Workshop)	DS04-US	Fully compliance with the Standard.	

Site	Sampling ID	Status	Corrective Actions
CVC Plant	DS03	No waste water discharge during the sampling missions.	

3.2.2 Ambient Surface Water Quality Monitoring

The ambient surface water quality monitoring programme comprises of 5 monitoring stations in the main reservoir (R1-R5), 2 stations in the re-regulation reservoir (R6 and R7), 5 stations in the mainstream Nam Ngiep (NNG01 and NNG05 to NNG08) and 4 stations in the main tributaries to Nam Ngiep (Nam Chiane, Nam Phouan, Nam Xao and Nam Houay Soup).

In addition, the weekly depth profile monitoring (pH, DO, Conductivity, TDS and Temperature) was started on 18 September 2018 for stations located in the re-regulation and main reservoirs.

Table 3-3: Monitoring Frequency for Surface Water Quality Parameters

Frequency of Monitoring	Parameters (Unit)	Monitoring Sites
Saturday	pH, DO (%), DO (mg/l), Conductivity (µs/cm), TDS (mg/l), Temperature (°C) and Turbidity (NTU)	- R5, main reservoir immediately upstream the main dam; - NNG05, Nam Ngiep downstream the re-regulation dam at Hat Gniun Village
Weekly	pH, DO (%), DO (mg/l), Conductivity (µs/cm), TDS (mg/l), Temperature (°C), Turbidity (NTU), TSS (mg/l), BOD_5 (mg/l), Faecal coliform (MPN/100 ml), Total coliform (MPN/100 ml) and Hydrogen sulphide (mg/l)	- Main Reservoir: R1, R2, R3, R4, R5 - Re-regulation Reservoir: R6, R7 - Nam Ngiep downstream: NNG05 - Tributaries: NPH01, Nam Phouan
Fortnightly	pH, DO (%), DO (mg/l), Conductivity (µs/cm), TDS (mg/l), Temperature (°C), Turbidity (NTU)	All stations
Monthly	TSS (mg/l), BOD_5 (mg/l), COD (mg/l), NH_3-N (mg/l), NO_3-N (mg/l), total coliform (MPN/100 ml), faecal coliform (MPN/100 ml)	All stations
Quarterly	Total iron (mg/l), manganese (mg/l), total phosphorus (mg/l), total dissolved phosphorus (mg/l), phytoplankton biomass (g dry weight/m3), TOC (mg/l)	All stations

Frequency of Monitoring	Parameters (Unit)	Monitoring Sites
Bi-annually	Alkalinity (mg/l), sulphate (mg/l), chloride (mg/l), TKN (mg/l), potassium (mg/l), sodium (mg/l), calcium (mg/l), magnesium (mg/l), arsenic (mg/l), mercury (mg/l), lead (mg/l)	All stations

The monitoring results for key parameters (dissolved oxygen, Total Suspended Solids and BOD) since the start of impounding are presented in ***Table 3-4, Table 3-5, and Table 3-6***and the full set of data for October 2018 is attached in Annex A. In addition, the results for dissolved oxygen are presented as line graphs in

Figure 3-1.

Re-regulation Reservoir

The level of DO in both R6 and R7 has remained well above 7.13 mg/L in the whole water column and with water temperatures unchanged from the surface to the bottom of the reservoir. There are no indications of a thermocline.

Main Reservoir

At R5, the DO level in the upper 7.0 m fluctuated from about 5.59 mg/L to 9.45 mg/L. The entire water column below 11.0 m until the bottom had DO levels below 3.63 mg/L. The DO concentrations at R3 and R4 were between 5.00 mg/L to 8.91 mg/L in the upper 5.0 m and decreased to less than 3.11 mg/L below 11.0 m until the bottom. However, the DO level (1 out of 4 measurements) at the surface in R4 was 5.13 mg/L, lower than the National Standard. The DO concentrations at R1 was about 6 mg/L at the surface.

The temperature measurements indicate the start of formation of a thermocline in R3-R5.

As expected, the TSS concentrations in the main reservoir have been consistently very low since the start of impounding with a mean in R4 and R5 of 5 mg/L compared to high flow season means of about 100 mg/L – 250 mg/L and low flow season means of 20 mg/L - 50 mg/L.

The BOD_5 measurements show – as expected – increasing levels in R3, R4 and R5 in the main reservoir since about one month into impounding.

Figure 3-1: Surface Water and Re-Regulation Reservoir Water Quality Monitoring Stations

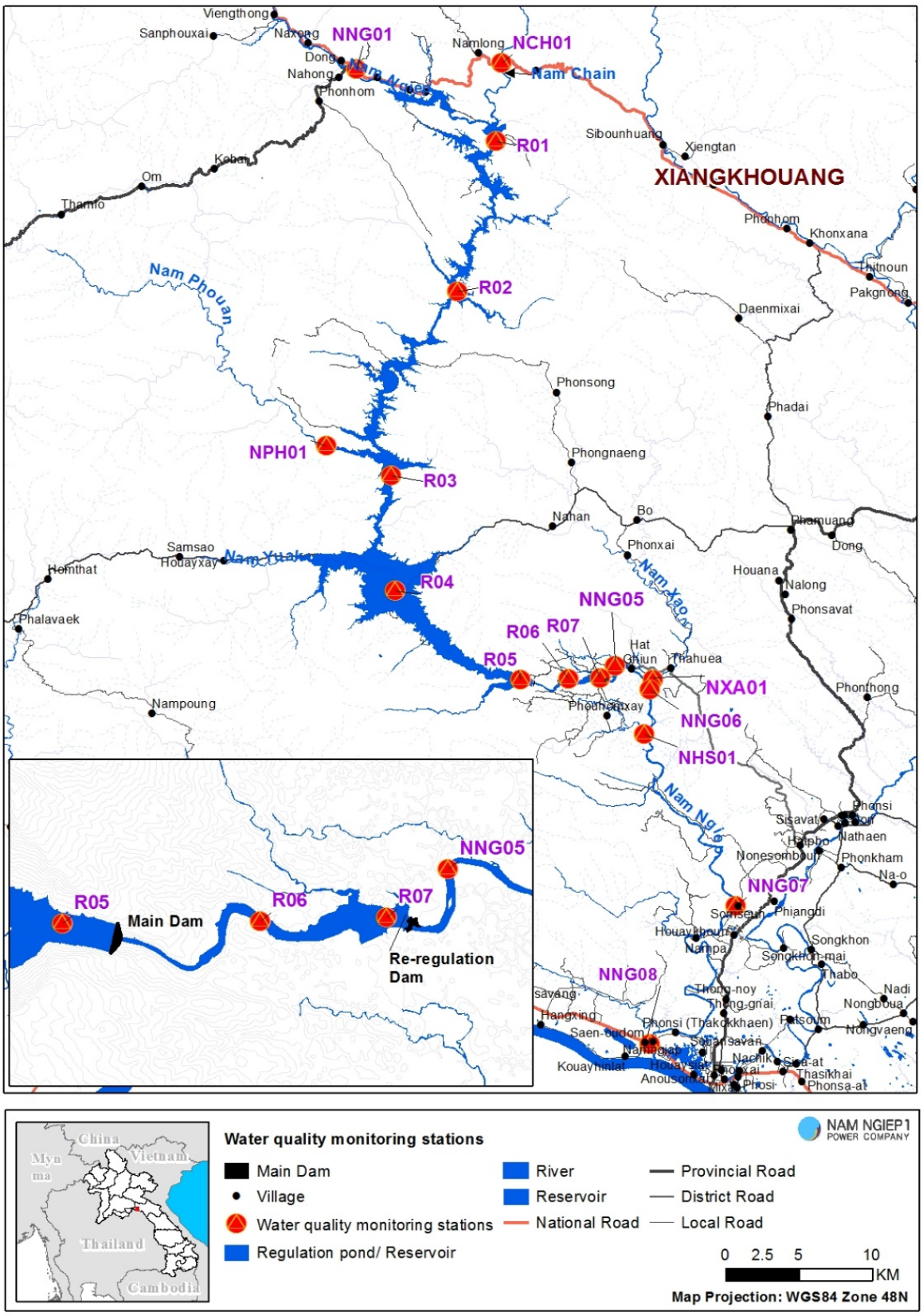


Figure 3-2: Concentration of Dissolved Oxygen since the Start of Impounding

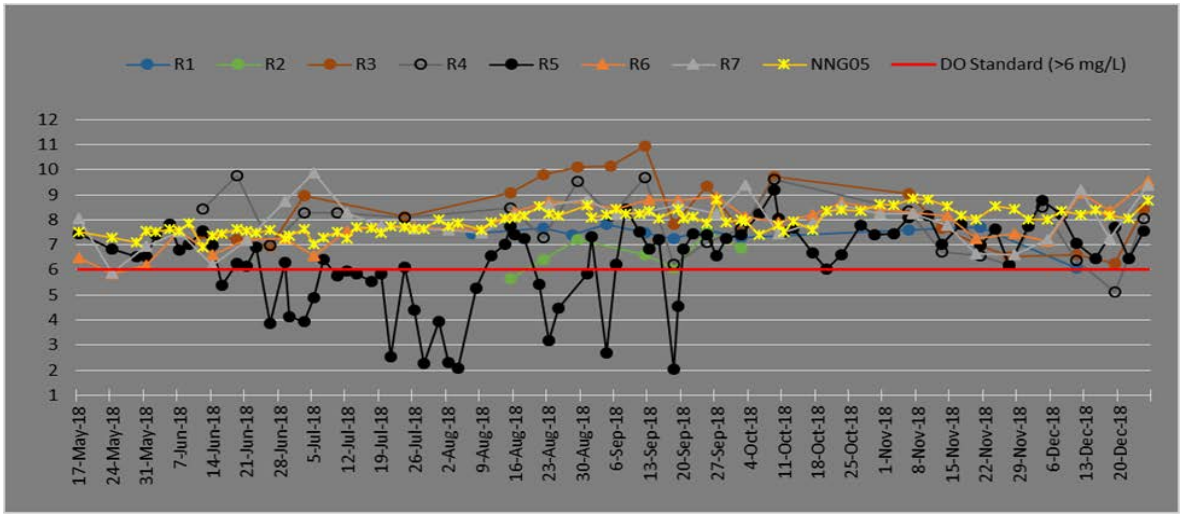


Table 3-4: Results of Surface Water Quality Monitoring for Dissolved Oxygen (mg/L) - in the upper 0.5 m - Water Quality Standard: > 6.0 mg/L

Dissolved Oxygen (mg/L)	NNG01	R1	R2	R3 (NNG0	R4 (NNG0	R5 (NNG0	R6	R7	NNG05	NNG06	NNG07	NNG08	NCH01	NPH01	NXA01	NHS01
1-Dec-18						7.76			8.01							
4-Dec-18					8.52	8.79										
5-Dec-18							7.13	7.22	8.02							
8-Dec-18						8.22			8.36							
11-Dec-18	8.53	6.07		6.6	6.38	7.08							8.45	8.8		
12-Dec-18							9.09	9.19	8.22	7.89	8.27	8.29			7.46	7.51
15-Dec-18						6.46			8.41							
18-Dec-18							8.34	7.25	8.17							
19-Dec-18				6.28	5.13	7.71								9.08		
22-Dec-18						6.47			8.04							
25-Dec-18	8.59			8.45	8.06	7.54							8.83	10.74		
26-Dec-18							9.54	9.39	8.77	8.72	8.1	7.98			7.95	7.62

Table 3-5: Results of Surface Water Quality Monitoring for Total Suspended Solids (mg/L) - Water Quality Standard: No Standard

Total Suspended Solids (mg/L)	NNG01	R1	R2	R3	R4	R5	R6	R7	NNG05	NNG06	NNG07	NNG08	NCH01	NPH01	NXA01	NHS01
4-Dec-18						<5										
5-Dec-18							<5	8.25	6.45							
11-Dec-18	13.65	<5		<5	<5	<5							6.99	<5		
12-Dec-18							<5	7.46	<5	<5	<5	8.62			<5	<5
18-Dec-18							6.81	6.02	10.3							
19-Dec-18						<5										

Table 3-6 *Results of Surface Water Quality Monitoring for BOD5 (mg/L) - Water Quality Standard: < 1.5 mg/L*

BOD5 (mg/L)	NNG01	R1	R2	R3	R4	R5	R6	R7	NNG05	NNG06	NNG07	NNG08	NCH01	NPH01	NXA01	NHS01
4-Dec-18						<1.0										
5-Dec-18							1.06	1.33	1.02							
11-Dec-18	<1	1.18		<1.0	<1.0	1.29							<1.0	<1.0		
12-Dec-18							1.1	1.4	1.16	<1.0	<1.0	<1.0			<1.0	<1.0
18-Dec-18							<1	<1	1.15							
19-Dec-18						<1										

3.2.3 Groundwater Quality Monitoring

During December 2018, community groundwater quality analyses were carried out for four water-wells located in Somseun Village, Nam Pa Village, Thong Noi Village and Pou Village.

All results of community groundwater complied with the groundwater quality standards for water supply purposes, except Pou Village (for pH) and Somseun, Nam Pa and Thong Noi Villages (for faecal coliform and E.coli bacteria).

Table 3-7: Groundwater Quality Monitoring Results, Somsuen, Nam Pa, Thongnoi and Pou Villages

	Site Name	Somseun Village	NamPa Village	ThongNoy Village	Pou Village
	Station	GSXN01	GNPA01	GTHN01	GPOU01
Parameter (Unit)	Guideline				
pH	6.5 - 9.2	7.6	7.08	7.06	6.17
Sat. DO (%)		83.4	84.6	83.3	88.1
DO (mg/l)		6.62	6.75	6.73	6.72
Conductivity (µS/cm)		266	340	322	19.18
TDS (mg/l)		133	170	161	9.5
Temperature (°C)		26.3	25.9	24.5	27.2
Turbidity (NTU)	<20	0.46	0.61	0.57	1.7
Fecal coliform (MPN/100 ml)	0	23	7.8	23	0
E.coli Bacteria (MPN/100 ml)	0	23	7.8	23	0
Arsenic (mg/)	<0.05	<0.0003	<0.0003	0.0004	<0.0003
Cadmium (mg/l)	<0.01	<0.003	<0.003	<0.003	<0.003
Total Iron (mg/l)	<1	0.019	0.048	0.016	0.034
Magnesium (mg/l)		3.66	3.38	5.26	0.115
Manganese (mg/l)	<0.5	<0.005	<0.005	<0.005	0.046
Fluoride (mg/l)	<1	0.5	0.45	0.45	0.23
Total hardness (mg/l)	<500	167	185	201	20.4
Nitrate (mg/l)	<45	0.58	0.53	1.37	0.31
Nitrite (mg/l)	<3	<0.07	<0.07	<0.07	<0.07
Lead (mg/l)	<0.05	<0.010	<0.010	<0.010	<0.010

3.2.4 Gravity Fed Water Supply (GFWS) Quality Monitoring

During December 2018, water samples from water taps at Thahuea Village, Hat Gniun Village and Phouhomxay Village were analysed. The WPHX01 represents raw water in the head tank before filtration.

The results of the water quality analyses are presented in ***Table 3-8***. All parameters complied with the National Drinking Water Standards except for faecal coliforms and E.Coli at WTHH02, WHGN02, WPHX01, WPHX02 (tap water at the primary school in Phouhomxay Village) and WPHX03 (tap water at a house in Phouhomxay Village). The villagers were informed about the results and encouraged to boil the water before drinking.

Table 3-8: Result Gravity Fed Water Supply (GFWS) Quality Monitoring

		Site Name	Thaheau Village	Hat Gnuin Village	Phouhomsay Village		
		Station	WTHH02	WHGN02	WPHX01	WPHX02	WPHX03
Date	Parameter (Unit)	Guideline					
10-Dec-18	pH	6.5 - 8.6	6.73	6.4	8.31	7.66	7.27
10-Dec-18	Sat. DO (%)		101.4	100.3	99.3	101.6	100.7
10-Dec-18	DO (mg/l)		8.12	8	7.94	8.31	8.03
10-Dec-18	Conductivity (µS/cm)	<1,000	45.3	67.2	11.84	9.69	10.35
10-Dec-18	TDS (mg/l)	<600	22.5	33.5	5.9	4.8	5.1
10-Dec-18	Temperature (°C)	<35	25.6	25.7	25.5	25.9	27
10-Dec-18	Turbidity (NTU)	<10	1	1.7	0.65	0.66	0.58
10-Dec-18	Faecal Coliform (MPN/100 ml)	0	34	33	240	130	240
10-Dec-18	E.coli Bacteria (MPN/100 ml)	0	34	33	130	130	130

3.2.5 Landfill Leachate Monitoring

During December 2018, 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 the treated leachate of both landfills complies with the relevant effluent standards.

Table 3-9: Landfill Leachate Monitoring Results

	Site Name	NNP1 Landfill Leachate	Houay Soup Landfill
	Location	Pond No.04	Last Pond
	Station	LL4	LL6
	Date	7-Dec-18	7-Dec-18
Parameter (Unit)	Guideline		
pH	6.0-9.0	8.18	8.29
Sat. DO (%)		135.5	122
DO (mg/l)		10.13	8.97

	Site Name	NNP1 Landfill Leachate	Houay Soup Landfill
	Location	Pond No.04	Last Pond
	Station	LL4	LL6
	Date	7-Dec-18	7-Dec-18
Parameter (Unit)	**Guideline**		
Conductivity (µS/cm)		192.3	224
TDS (mg/l)		86	112
Temperature (°C)		28.9	29.2
Turbidity (NTU)		2.59	5.51
BOD (mg/l)	<30	6.84	7.86
COD (mg/l)	<125	42.7	49
Faecal Coliform (MPN/100ml)		7.8	2
Total Coliform (MPN/100ml)	<400	17	11
Mercury (mg/l)		<0.0005	<0.0005
Total nitrogen (mg/l)	<10	1.61	2
Arsenic (mg/l)		0.0009	0.0017
Manganese (mg/l)		0.066	0.308
Lead (mg/l)	<0.2	<0.010	<0.010
Iron (mg/l)		0.325	0.148
Total Petroleum Hydrocarbons (mg/l)		<1	<1

3.2.6 Dust Monitoring

The results indicate that the dust levels at all monitoring stations complied with the National Standard. The results were shared with EMO-compliance and TD-safety teams as a reference for inspection to ensure proper establishment of health and safety procedures (traffic access restriction, wear proper personal protective equipment including masks and eye protection).

3.2.7 Noise Monitoring

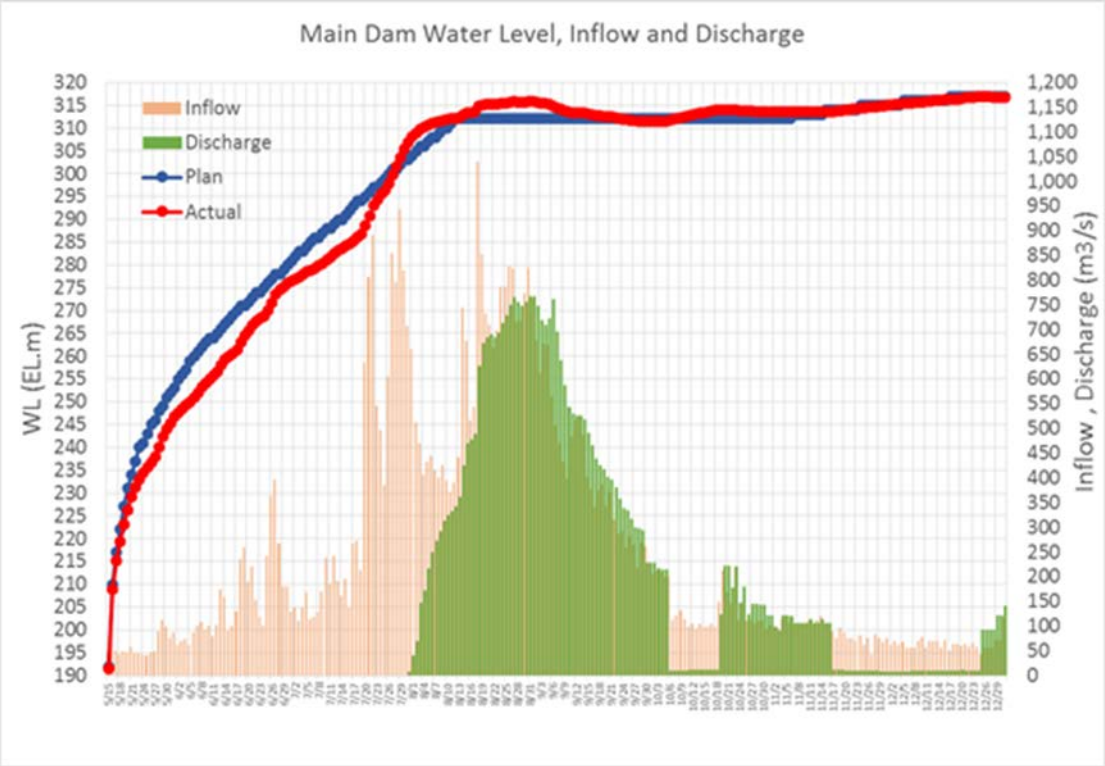
During December 2018, noise monitoring was conducted for 72 consecutive hours at Hat Gniun Village and Phouhomxay Village, and for 24 consecutive hours at the Main Dam, Song Da 5 Camp No.2, Lilama 10 Camp, and the Main Powerhouse.

The results indicate that the recorded maximum noise levels and averaged noise levels complied with the Standard for all stations.

3.2.8 Discharge Monitoring

The progress of impounding from 15 May 2018 to 31 December 2018 is presented on the graph in ***Figure 3-3*** indicating the water level in the main reservoir, the inflow to the main reservoir and the discharge from the main reservoir into the re-regulation reservoir. The inflow data shows the gradual reduction in flows from the end of the wet season into the dry season with inflows from about 100 m3/s at the beginning of November 2018 to an average of about 70 m3/s during December 2018.

Figure 3-3: Progress of Impounding the Main Reservoir

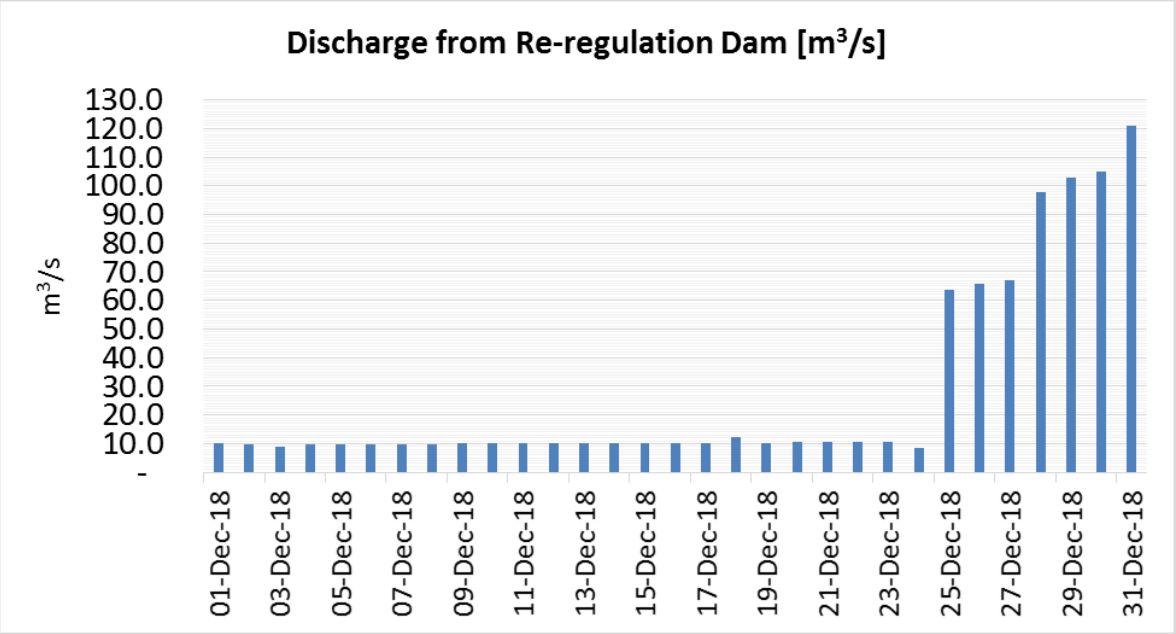


On 17 November 2018 the impounding of the main reservoir was restarted and continued until 25 December 2018. The water level in the reservoir rose with 3.2 m from 313.6 masl on 17 November 2018 to 316.8 masl on 25 December 2018. In the same period, the discharges from the main dam and the re-regulation dam were reduced (see

Figure 3-4) and maintained close to 10 m3/s, which is well above the minimum flow requirement of 5.5 m3/s. On 25 December 2018 the discharge from the main dam and the re-regulation dam was increased to equal the inflow to the main reservoir and this was maintained during the remaining part of December 2018.

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 3-4: **Discharge Monitoring at the Re-regulation Dam.**



During the restarted impounding, the water level in the re-regulation reservoir was lowered to about 173 masl (Normal Water Level is 179 masl) and this combined with the reduced spillway discharge has enabled various construction works and plunge pool excavations near the main dam to be undertaken.

3.2.9 Nam Ngiep Downstream Water Depth Monitoring

In December 2018, EMO carried out four boat missions to monitor the water depth in Nam Ngiep downstream of the re-regulation dam. EMO has currently identified 19 sites with potential shallow water depths. The monitoring showed that all these sites had water depths from 0.13 – 2.15 m and some difficulties navigating on the river were recorded for 9 sites on 06 December 2018 and 10 sites on 13 and 20 December 2018 due to the reduced discharge from the re-regulation dam as mentioned in Section 1.3 above.

3.3 Project Waste Management

3.3.1 Solid Waste Management

In December 2018, a total of 87 m3 of solid waste was disposed of at the NNP1 Project Landfill, a decrease of 5.7 m3 compared to November 2018. During December 2018, EMO conducted three waste spot checks at the NNP1 Project Landfill, construction sites and the camps. It was found that waste management of the construction sites and camps was improved. The NNP1 Project landfill maintenance work is carried out by Administration Department with EMO support. The work includes waste cleaning-up, grass cutting and repairing perimeter fences.

A total of 456.5 kg of recyclable waste was sold to Khounmixay Processing Factory by the Contractors. The remaining scrap metal will be sold or transported off site by the Contractor later on.

Table 3-10: Amounts of Recyclable Waste Sold

Source and Type of Recycled Waste		Unit	Sold	Cumulative Total by 31 December 2018
Construction Activity				
1	Scrap metal	kg	0	38,315
Sub-Total 1		**kg**	**0**	**38,315**
Camp Operations				
2	Glass bottles	kg	69	81
3	Plastic bottles	kg	56	53
4	Paper/Cardboard	kg	269	29
5	Aluminium cans	kg	62.5	16
Sub-Total 2		**kg**	**456.5**	**179**
Grand Total 1+2		**kg**	**456.5**	**38,494**

The villagers of Phouhomsay Village collected a total of 4,768 kg of food waste from selected camps for animal feed in December 2018, a decrease of 720 kg compared to November 2018 as a result of Kenber Camp decommissioning and withdrawals of some construction workers from Song Da 5 Camps.

Table 3-11 Amounts of Food Waste Collected by Villagers

No.	Site Name	Unit	Total
1	Song Da 5 Camp No. 2	kg	329
2	Song Da 5 Camp No. 1	kg	551
3	Obayashi Corporation Camp	kg	844
4	Owner's Village and Site Office (OSOV)	kg	1,736
5	LILAMA 10 Camp	kg	1,308
Total		**kg**	**4,768**

In addition, as part of the site decommissioning, a total of 10 m^3 of sewage sludge from KENBER sub-contractor was transported and disposed of at the Spoil Disposal Area #6 following NNP1PC's relevant Standard Operating Procedure.

3.3.2 Hazardous Materials and Waste Management

The types and amounts of hazardous waste collected and transported for off-site treatment and final disposal at Khounmixay Processing Factory in December 2018.

Table 3-12: Results of Hazardous Material Inventory

No.	Hazardous Waste Type	Unit	Total in December 2018 (A)	Disposed (B)	Remainder (A - B)
1	Used hydraulic and engine oil	Litre	4,870	200	4,670
2	Contaminated soil, sawdust and concrete	bag	515	0	515
3	Used oil filters	Piece	205	0	205

No.	Hazardous Waste Type	Unit	Total in December 2018 (A)	Disposed (B)	Remainder (A - B)
4	Used oil mixed with water	Litre	200	0	200
5	Used tyre	Piece	196	0	196
6	Ink cartridge	unit	188	0	188
7	Halogen/fluorescent bulbs	unit	154	0	154
8	Empty paint and spray cans	can	114	0	114
9	Empty contaminated bitumen drum/container	Drum (200L)	81	0	81
10	Empty used chemical drum/container	Drum (200L)	52	0	52
11	Contaminated textile and material	kg	27	0	27
12	Lead acid batteries	unit	22	0	22
13	Empty used oil drum/container	Drum (20 L)	16	0	16
14	Lithium-ion batteries	unit	7	0	7
15	Empty used oil drum/container	Drum (200 L)	6	0	6
16	Clinic Waste	Kg	4.4	0	4.4

3.4 Community Waste Management

3.4.1 Community Recycling Programme

In December 2018, a total of 1,816 kg of recyclable waste was recorded at the Community Waste Bank, a decrease of 300 kg compared to November 2018.

Table 3-13: Types and Amounts of Recyclable Waste Traded at the Community Waste Bank

Types of Waste	Unit	Remaining in Nov 2018	Additions in Dec 2018	Sold	Remaining in Dec 2018
Scrap metal	kg	0	9	0	9
Glass bottles	kg	1,752.5	71	340	1,483.5
Paper/cardboard	kg	280.5	34	0	314.5
Aluminium cans	kg	10.5	16	25.5	1
Plastic bottles	kg	72	32.1	96.1	8
Total	**kg**	**2,115.5**	**162.1**	**461.6**	**1,816**

3.4.2 Community Solid Waste Management

In December 2018, approximately 121 m3 of solid waste was collected from Phouhomxay, Thahuea and Hat Gniun villages. The solid waste was transported to Houay Soup Landfill where recyclable materials were segregated before being disposed of at the landfill.

3.5 Watershed and Biodiversity Management

3.5.1 Watershed Management

3.5.1.1 Watershed Management Plan

The ADB and IAP comments on the Watershed Management Plan were discussed during the joint IAP and ADB mission on 14-15 December 2018. NNP1PC, IAP and ADB agreed that:

- The draft Plan will be further improved to have a simplified organization structure that will include the role of a service provider (Technical Assistance) that will be hired by ADB to support NNP1PC in achieving no net loss for biodiversity management in NNP1 watershed and biodiversity offset area as well as to have a simplified presentation of watershed management component;
- The agreed timeline for the Plan approval by ADB will be on 18 January 2019 and the final approval by GOL will be on 28 February 2019;
- NNP1PC could continue the collaboration with ADB in finalizing the AIP 2019 for both provinces so that the approval could be done at the same time with the Watershed Management Plan.

A coordination meeting between Xaysomboun Watershed and Reservoir Protection Committee (WRPC), Department of Forestry (DOF) under the Ministry of Agriculture and Forestry (MAF), Xaysomboun Salvage Logging Committee and relevant District Authority was held on 20 December 2018 to discuss pending issues on salvage logging and illegal fishing in the NNP1 reservoir areas, AIP and Watershed Management Plan. Below is a summary of a few key points discussed and agreed at the meeting:

- Job description for each Xaysomboun WRPC member should be defined for a smooth coordination and implementation;
- Three Districts in NNP1 watershed (Hom, Anouvong, Thathom) should organize meetings for disseminating the Instruction Letter of Xaysomboun WRPC Chairperson (Ref. No. 001/XSB.WRPC dated 26 Nov 2018) and raise awareness for the local village authorities on watershed protection and management objectives;
- Xaysomboun WRPO to speed up the formulation of AIP 2019;
- Ranger stations in TPZs should be surveyed and established as soon as possible to monitor and prevent any further forest encroachment, especially during the preparation for the upcoming upland cultivation season which will start soon;
- The no go zone area (TPZ in the reservoir) should be demarcated and signage should be installed to stop further destruction of water resource as well as unregulated fishing;
- All temporary approved activities by District and Provincial authority have to be stopped / cancelled and all fishing groups have to move out from reservoir until further arrangement and approval by Xaysomboun WRPC;
- Xaysomboun PAFO to make an agreement with the salvage logging contractors to settle the payment for harvested logs with a deadline on 21 Dec 2018 and the log-yard will be closed by the end of December 2018. If the Contractors could not settle the payment, the logs should be seized and Contractors should be fined for non-compliance. No

additional access road shall be allowed to be built. The salvage logging floating camp shall be pulled to shore outside TPZ areas in a designated area given by the WRPC.

The Bolikhamxay WRPO submitted a draft AIP 2019 to NNP1PC-EMO on 30 October 2018. The draft is under a review. The formulation of AIP 2019 by the Xaysomboun Province WRPO will be continued in January 2019.

The Xaysomboun WRPO completed a field verification survey of the boundary for the Total Protection Zone 1 (TPZ Phou Samsao) and land uses in Hom District at the end of October 2018. The remaining surveys in TPZ1 (TPZ Phou Samsao) at Anouvong District and TPZ2 (TPZ Phou Khata) at Hom District were postponed until the completion of the re-structuring of Xaysomboun WRPC and WRPO on 29 November 2018. These surveys will be resumed and led by PAFO in January 2019.

The operation of three checkpoints continued in December 2018. The checkpoints made 172 records of people accessing the main reservoir. Out of these, a total of 153 records of people from Houayxay Village (Hom District, Xaysomboun Province) and 19 records of people from Nahanh Village (Bolikhan District, Bolikhamxay Province). The main reasons why people access the reservoir include fishing and hunting (39 records), agriculture (55 records), livestock raising (32 records) and other purpose (46 records). Military staff appointed at the checkpoints are not law enforcement officers for Forestry Law and Wildlife and Aquatic Animal Law. Thus, they are only responsible for security checks and report the incidents to the WRPO for further actions. An approval of the WMP will be needed in order to provide the basis for the preparation and implementation of the AIP2019 that will include full patrolling activities in the TPZs and reservoir.

3.5.1.2 PREPARATION OF PROVINCIAL REGULATION FOR THE WATERSHED MANAGEMENT

Xaysomboun WRPO-PAFO has further improved the draft regulation and presented it at Xaysomboun WRPC coordination meeting on 20 December 2018. The meeting requested that DOF-MAF and NNP1PC to provide review prior to re-submission to the Provincial Assembly Chairperson and Provincial Governor for approval by January 2019. NNP1PC-EMO provided the final review and comments in the last week of December 2018.

3.5.2 Biodiversity Offset Management

3.5.2.1 PREPARATION OF BIODIVERSITY OFFSET MANAGEMENT PLAN

The IAP and ADB comments were discussed during the IAP and ADB mission held on 14-15 December 2018. NNP1PC, IAP and ADB have agreed that the Biodiversity Offset Management Plan (BOMP) needs to be further improved on the following aspects:

- The Vision statement;
- The assessment and target to achieve No Net Loss (NNL),
- The presentation of an organization structure that clearly includes the role of a service provider for Nam Chouane – Nam Xang (NC-NX) Biodiversity Offset Management; and
- The elaboration on the potential impacts on the local people's livelihoods from the access to natural resources in the TPZ areas to be demarcated inside the Biodiversity Offset Area and mitigation or impact reduction through livelihood development component.

It was also agreed that NNP1PC could continue the collaboration with ADB in finalizing the AIP2019 so that the approval could be done at the same time with the BOMP. The final approval by ADB is expected by the end of January 2019 and the final approval by GOL is expected in March 2019.

3.5.2.2 PREPARATION OF PROVINCIAL REGULATION FOR BIODIVERSITY OFFSET MANAGEMENT IN NC-NX

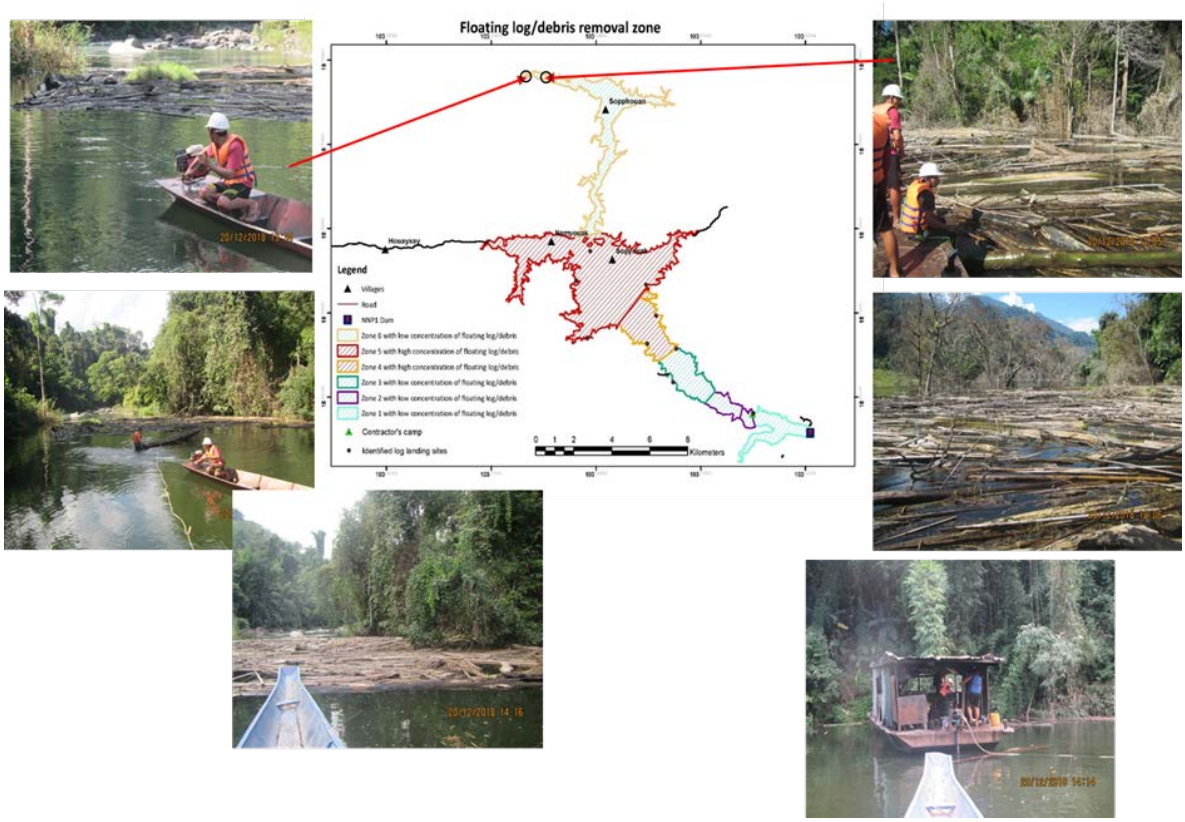
The Pre-BOMP-2B proposal was approved by ADB and agreed by BOMC at the end of September 2018. A total of USD 88,578 was disbursed in September 2018 for the continuation of checkpoint operation and patrolling from September 2018 – March 2019.

Two patrolling teams with a total of 18 people conducted forest patrolling for 16 days in both Viengthong and Xaychamphone Districts. The patrolling covered 13 small but significant biodiversity areas within the NC-NX Offset Site in these Districts. The main threats found in the area are wildlife hunting and unergulated fishing by local villagers. Four temporary hunting camps were recorded by Viengthong District's patrolling team whilst a total of seven temporary hunting camps and 51 small wire snares were recored by Xaychamphone District's patrolling team.

3.6 FLOATING DEBRIS REMOVAL

The contract for floating debris removal work completed at the end of December 2018. A total of 50 log yards were maintained in the middle of reservoir in Zone 5. Out of these, burning was completed for a total of 12 log yards.

***Figure 3-5*: Representative photographs of floating debris and logs removal operation in Zone 5 in December 2018**



4. FISHERY MONITORING

Three species groups and two species dominated the fish catch by weight in November 2018 as listed in ***Table 4-1***. These species are classified as Least Concern (LC) according to the IUCN Red List of Threatened Species, except Hemibagrus filamentus which is classified as Data Deficient and Amblyrhynchichthys truncates is classified as Not Evaluated.

Table 4-1: ***Fish Species dominating the Fish Catch in November 2018***

Species	Lao Name	Fish Catch 10-18 (kg)	IUCN Red List Classification
Hemibagrus nemurus, Hemibagrus filamentus	ปาก๊ด	259.1	LC, DD
Poropuntius normani, Poropuntius laoensis	ปาจาด	229.8	LC
Sikukia gudgeri, Amblyrhynchichthys truncatus	ปาขาวซาย	213.1	LC, NE
Channa striata	ปาถ่ำ	180.4	LC
Clarias batrachus	ปาดุก	154.1	LC

The recorded catch of Threatened and Near Threatened species (IUCN Red List classification) in November 2018 is presented in

Table 4-2. The list includes one species that are classified as Endangered (EN), four Vulnerable (VU) species, and seven Near Threatened (NT) species.

Table 4-2: ***Threatened Species of November2018 Fish Catch***

Species	Lao Name	Fish Catch (kg)	IUCN Red List Classification
Bangana behri	ปาม้อม	31.6	VU
Cirrhinus cirrhosus	ปามอบจัม	9.2	VU
Cirrhinus molitorella	ปาแกง	31.8	NT
Cyprinus carpio	ปาไม	3	VU
Luciocyprinus striolatus	ปากอมซาย	1.5	EN
Mekongina erythrospila	ปาสะอิ	1	NT
Neolissochilus stracheyi	ปาสอง	0.4	NT
Ompok bimaculatus	ปาเซือม	2.9	NT
Onychostoma gerlachi	ปาถึง	9.5	NT
Scaphognathops bandanensis	ปาอวมไฟ	39.6	VU
Syncrossus beauforti	ปาแอ้อไก้/ปาซู	0.2	NT
Wallago attu	ปาถ้าอ	0.5	NT

The total recorded monthly fish catch for the downstream and upstream fishing households and the Mekong control group involved in the monitoring programme from July 2015 to October 2018 is presented in ***Figure 4-1***. Note that the upstream fish catch excludes the fish catch from the fishing households in Zone 2LR because these households were resettled during Q4-2017.

Figure 4-1: *Total Recorded Monthly Fish Catch July 2015-November 2018*

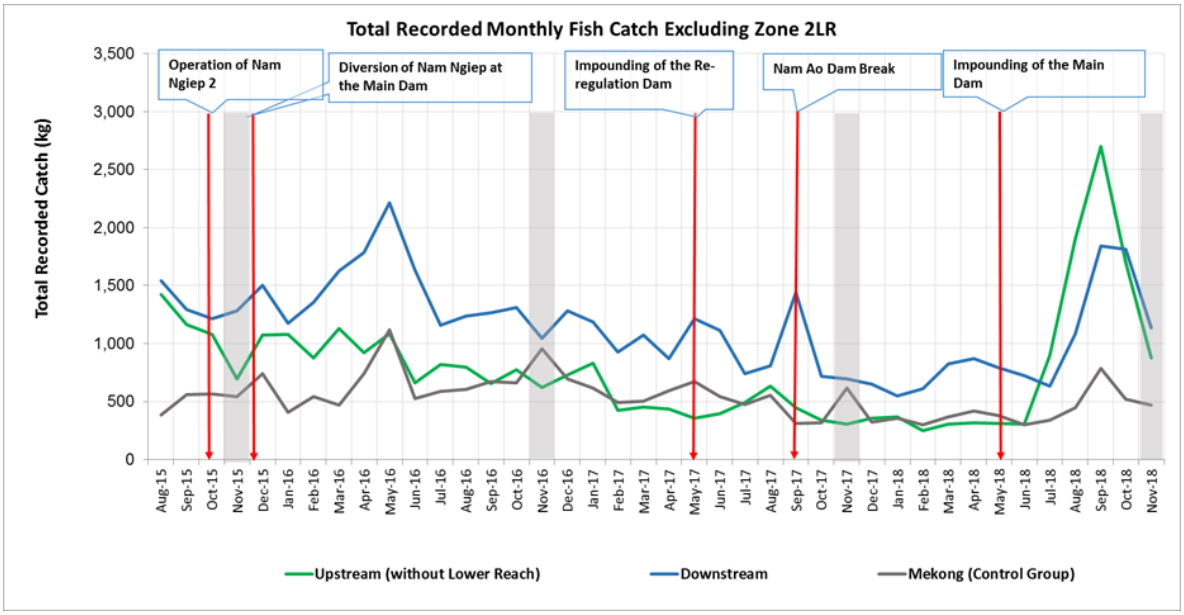


Table 4-3 and

Figure 4-2 show the total recorded fish catch for November 2015, November 2016, November 2017 and November 2018 in the upstream (excluding Zone 2LR) and downstream communities and the Mekong control group. The total fish catch data represents the total fish supply provided by the involved fishing households.

Table 4-3: *Total Recorded Fish Catch by Upstream (Excluding Zone 2LR), Downstream and Mekong Control Group Fishing Households in November 2015, November 2016, November 2017 and November 2018*

	November 2015 (kg)	November 2016 (kg)	November 2017 (kg)	November 2018 (kg)
Upstream	697	624	308	877
Downstream	1,283	1,048	696	1,137
Mekong Control Group	544	957	617	468

Figure 4-2: ***Total Recorded Fish Catch in November by Upstream (Excluding Zone 2LR), Downstream and Mekong Control Group Fishing Households***

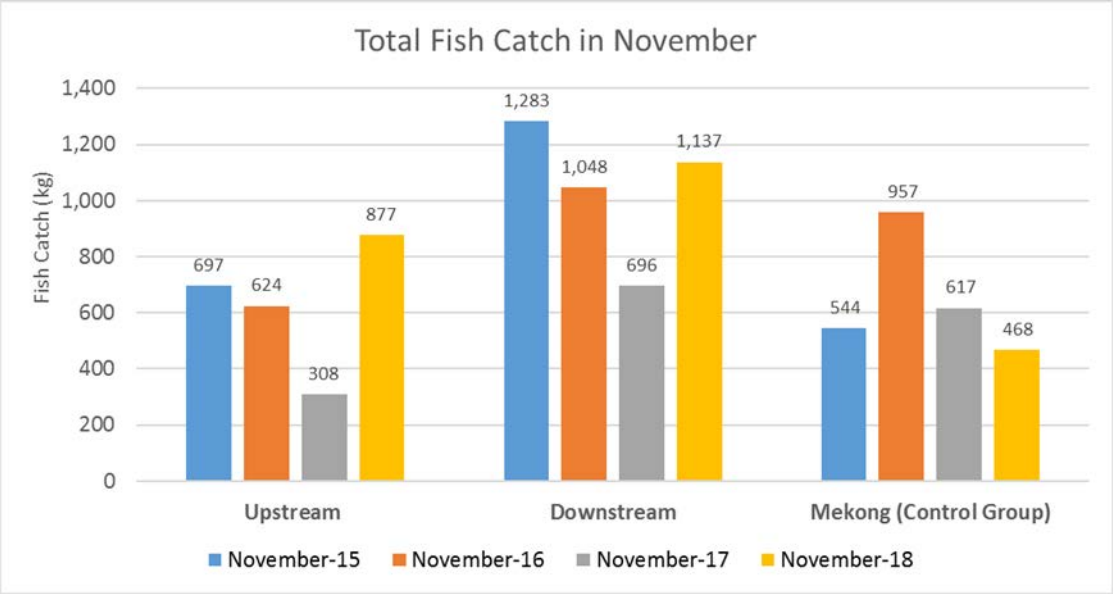


Figure 4-3: ***Number of Fishing Households Involved in the Fish Catch Monitoring Programme***

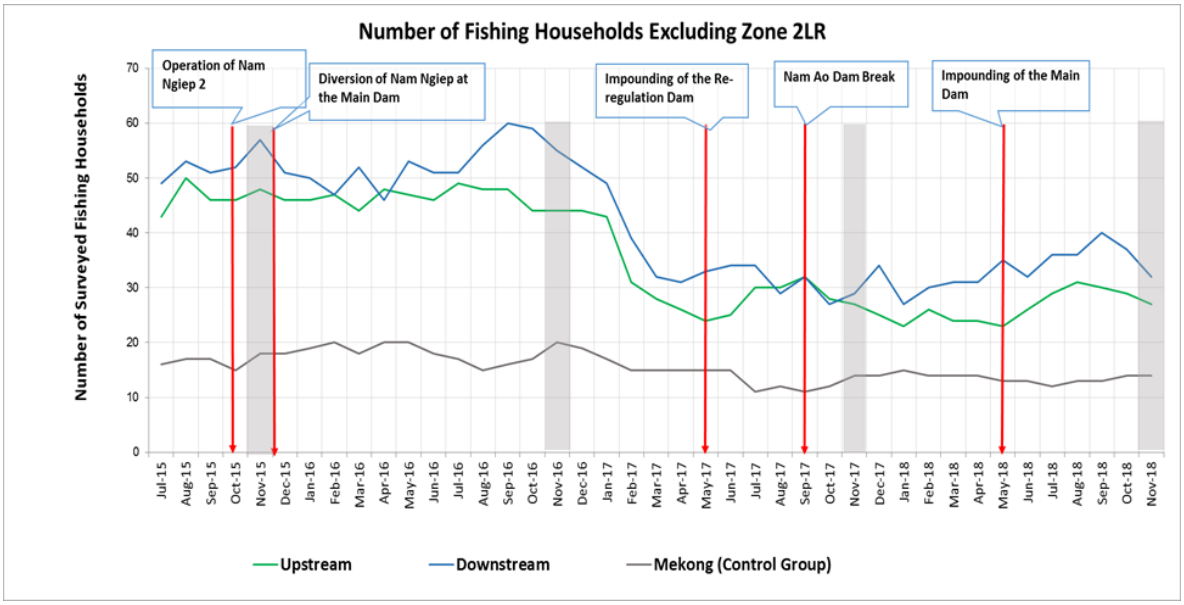


Figure 4-4: ***Mean Monthly Household Fish Catch without Zone 2LR***

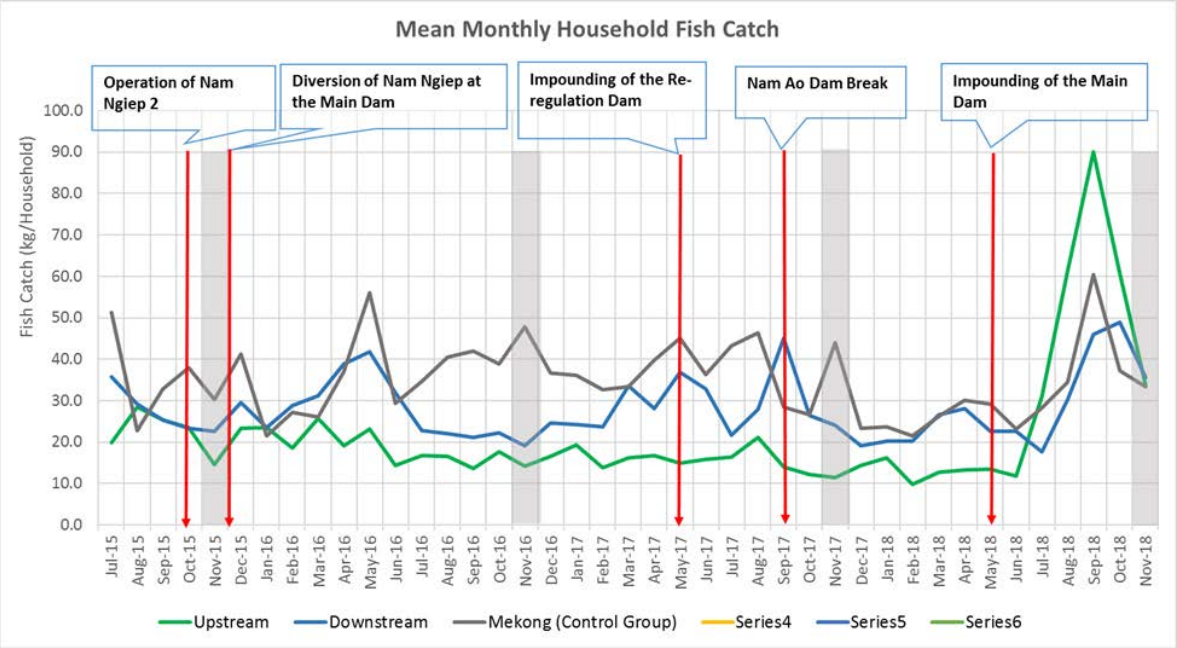


Table 4-4: ***Mean Monthly Household Fish Catch in the Upstream and Downstream Communities Excluding Zone 2LR***

Fishing Zone	November 2015 (kg)	November 2016 (kg)	November 2017 (kg)	November 2018 (kg)
Upstream	14.5	14.2	11.4	33.7
Downstream	22.5	19.0	24.0	35.5
Mekong Control Group	30.2	47.9	44.1	33.4

Figure 4-5: ***Mean Household Fish Catch per Fishing Day***

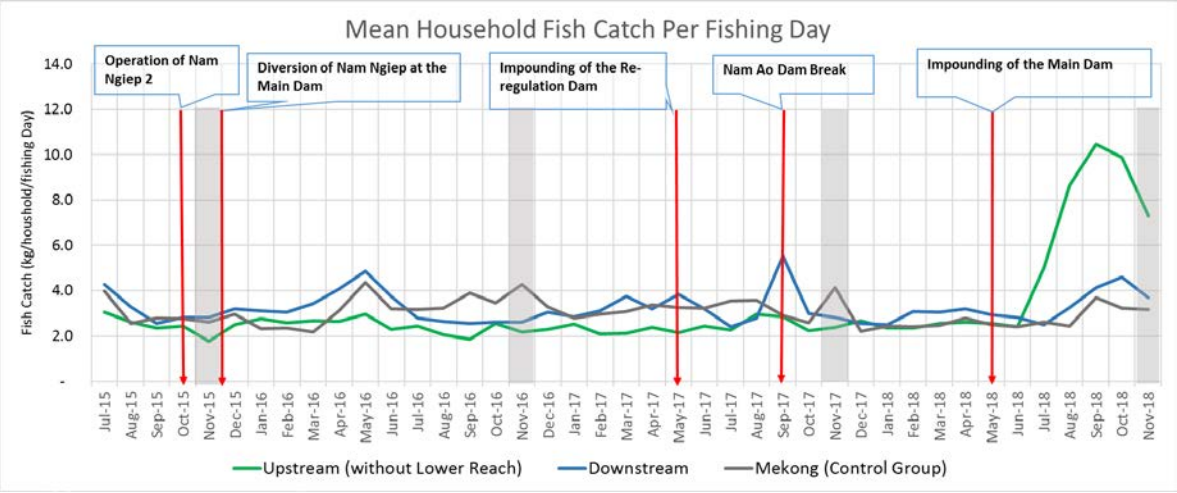


Table 4-5: ***Mean Household Fish Catch per Fishing Day in November***

Fishing Zone	November 2015 (kg)	November 2016 (kg)	November 2017 (kg)	November 2018 (kg)
Upstream (Excluding Zone 2LR)	1.8	2.19	2.39	7.31
Downstream	2.8	2.61	2.81	3.68
Mekong (Control Group)	2.6	4.27	4.14	3.16

ANNEXES

ANNEX A: Results of Surface Water Quality Analyses

Table A- 1: Results of Main Reservoir, Re-regulation Reservoir and Surface Water (Nam Ngiep River) Quality Monitoring

		Station Code	NNG01	R1	R2	R3	R4	R5	R6	R7	NNG05	NNG06	NNG07	NNG08
Date	Parameters (Unit)	Guideline												
1-Dec-18	pH	5.0 - 9.0						7.86			7.58			
4-Dec-18	pH	5.0 - 9.0					8.09	8.29						
5-Dec-18	pH	5.0 - 9.0							7.78	7.65	7.92			
8-Dec-18	pH	5.0 - 9.0						8.2			8.11			
11-Dec-18	pH	5.0 - 9.0	6.36	7.83		7.6	7.43	8.2						
12-Dec-18	pH	5.0 - 9.0							7.87	7.91	7.81	7.9	6.24	6.23
15-Dec-18	pH	5.0 - 9.0						7.57			7.91			
18-Dec-18	pH	5.0 - 9.0							7.78	8.39	7.93			
19-Dec-18	pH	5.0 - 9.0				7.68	7.49	7.67						
22-Dec-18	pH	5.0 - 9.0						7.04			7.05			
25-Dec-18	pH	5.0 - 9.0	6.75			7.73	7.41	7.48						
26-Dec-18	pH	5.0 - 9.0							8.21	7.58	7.7	7.5	7.27	7.12
1-Dec-18	Sat. DO (%)							97.7			101.5			
4-Dec-18	Sat. DO (%)						107.5	110.9						
5-Dec-18	Sat. DO (%)								87.5	91.5	107.2			
8-Dec-18	Sat. DO (%)							106.4			106.9			
11-Dec-18	Sat. DO (%)		105.7	78.8		82.1	78.9	87.1						
12-Dec-18	Sat. DO (%)								104	108.4	100.9	95.7	102.5	101.9
15-Dec-18	Sat. DO (%)							80.5			103.4			
18-Dec-18	Sat. DO (%)								100.5	88.8	100.5			
19-Dec-18	Sat. DO (%)					77.1	62.5	86.4						
22-Dec-18	Sat. DO (%)							84.4			104.5			
25-Dec-18	Sat. DO (%)		103.9			103.8	94.6	91.3						
26-Dec-18	Sat. DO (%)								113.4	112.3	106.7	100.9	99.8	99.1
1-Dec-18	DO (mg/l)	<6.0						7.76			8.01			
4-Dec-18	DO (mg/l)	<6.0					8.52	8.79						
5-Dec-18	DO (mg/l)	<6.0							7.13	7.22	8.02			
8-Dec-18	DO (mg/l)	<6.0						8.22			8.36			
11-Dec-18	DO (mg/l)	<6.0	8.53	6.07		6.6	6.38	7.08						
12-Dec-18	DO (mg/l)	<6.0							9.09	9.19	8.22	7.89	8.27	8.29
15-Dec-18	DO (mg/l)	<6.0						6.46			8.41			
18-Dec-18	DO (mg/l)	<6.0							8.34	7.25	8.17			
19-Dec-18	DO (mg/l)	<6.0				6.28	5.13	7.71						
22-Dec-18	DO (mg/l)	<6.0						6.47			8.04			
25-Dec-18	DO (mg/l)	<6.0	8.59			8.45	8.06	7.54						
26-Dec-18	DO (mg/l)	<6.0							9.54	9.39	8.77	8.72	8.1	7.98
1-Dec-18	Conductivity (µs/cm)							53.8			58.6			
4-Dec-18	Conductivity (µs/cm)						68	68						
5-Dec-18	Conductivity (µs/cm)								74	74	57.4			
8-Dec-18	Conductivity (µs/cm)							54.3			58.7			

		Station Code	NNG01	R1	R2	R3	R4	R5	R6	R7	NNG05	NNG06	NNG07	NNG08
Date	Parameters (Unit)	Guideline												
11-Dec-18	Conductivity (µs/cm)		79.7	68		74	69	68						
12-Dec-18	Conductivity (µs/cm)								78	79	61.8	67.6	70.9	74.3
15-Dec-18	Conductivity (µs/cm)							53.8			59.1			
18-Dec-18	Conductivity (µs/cm)								57	76	58.3			
19-Dec-18	Conductivity (µs/cm)					71	69	77						
22-Dec-18	Conductivity (µs/cm)							53.1			58.4			
25-Dec-18	Conductivity (µs/cm)		78.6			72	72	70						
26-Dec-18	Conductivity (µs/cm)								68	69	53.7	55.3	58.2	55.5
1-Dec-18	TDS (mg/l)							26.8			29.3			
4-Dec-18	TDS (mg/l)						34	34						
5-Dec-18	TDS (mg/l)								37	37	28.8			
8-Dec-18	TDS (mg/l)							27			29			
11-Dec-18	TDS (mg/l)		40	34		37	34.5	34						
12-Dec-18	TDS (mg/l)								38	38.5	30.9	33.85	34.45	37.15
15-Dec-18	TDS (mg/l)							26.8			29.5			
18-Dec-18	TDS (mg/l)								28.5	38	29.15			
19-Dec-18	TDS (mg/l)					35.5	34.5	38.5						
22-Dec-18	TDS (mg/l)							26.55			29.2			
25-Dec-18	TDS (mg/l)		39.3			36	36	35						
26-Dec-18	TDS (mg/l)								34	34.5	26.85	27.65	29	27.5
1-Dec-18	Temperature (°C)							25.98			26.4			
4-Dec-18	Temperature (°C)						27.69	27.34						
5-Dec-18	Temperature (°C)								25.88	27.35	29.1			
8-Dec-18	Temperature (°C)							26.6			26.8			
11-Dec-18	Temperature (°C)		24.1	26.8		26.59	26.36	25.99						
12-Dec-18	Temperature (°C)								22.15	23.76	25.1	24.3	24.4	24.9
15-Dec-18	Temperature (°C)							24.6			24.7			
18-Dec-18	Temperature (°C)								24	25.39	26			
19-Dec-18	Temperature (°C)					26.47	25.35	21.08						
22-Dec-18	Temperature (°C)							27.1			27.8			
25-Dec-18	Temperature (°C)		22.8			25.85	23.42	25.13						
26-Dec-18	Temperature (°C)								24.42	24.45	24.2	23.5	24.7	25.1
1-Dec-18	Turbidity (NTU)							2.32			11.91			

		Station Code	NNG01	R1	R2	R3	R4	R5	R6	R7	NNG05	NNG06	NNG07	NNG08
Date	Parameters (Unit)	Guideline												
4-Dec-18	Turbidity (NTU)						1.5	1.56						
5-Dec-18	Turbidity (NTU)								5.85	10.56	7.44			
8-Dec-18	Turbidity (NTU)							1.26			4.71			
11-Dec-18	Turbidity (NTU)		11.1	0.89		1.21	1.06	1.27						
12-Dec-18	Turbidity (NTU)								2.58	4.16	4.06	4.98	2.78	6.01
15-Dec-18	Turbidity (NTU)							2.64			7.7			
18-Dec-18	Turbidity (NTU)								3.35	4.25	6.62			
19-Dec-18	Turbidity (NTU)					0.74	0.92	0.94						
22-Dec-18	Turbidity (NTU)							1.09			4.66			
25-Dec-18	Turbidity (NTU)		14.37			1.31	1.36	1.4						
26-Dec-18	Turbidity (NTU)								5.86	6.37	7.37	8.64	32.25	8.56
4-Dec-18	TSS (mg/l)							<5						
5-Dec-18	TSS (mg/l)								<5	8.25	6.45			
11-Dec-18	TSS (mg/l)		13.65	<5		<5	<5	<5						
12-Dec-18	TSS (mg/l)								<5	7.46	<5	<5	<5	8.62
18-Dec-18	TSS (mg/l)								6.81	6.02	10.3			
19-Dec-18	TSS (mg/l)							<5						
4-Dec-18	BOD5 (mg/l)	<1.5						<1.0						
5-Dec-18	BOD5 (mg/l)	<1.5							1.06	1.33	1.02			
11-Dec-18	BOD5 (mg/l)	<1.5	<1	1.18		<1.0	<1.0	1.29						
12-Dec-18	BOD5 (mg/l)	<1.5							1.1	1.4	1.16	<1.0	<1.0	<1.0
18-Dec-18	BOD5 (mg/l)	<1.5							<1	<1	1.15			
19-Dec-18	BOD5 (mg/l)	<1.5						<1						
11-Dec-18	COD (mg/l)	<5	5.7	8.3		8.7	<5	7.1	<5	5.7				
12-Dec-18	COD (mg/l)	<5									5.9	<5	5.1	<5
11-Dec-18	NH3-N (mg/l)	<0.2	<0.2	<0.2		<0.2	<0.2	<0.2	<0.2	<0.2				
12-Dec-18	NH3-N (mg/l)	<0.2									<0.2	<0.2	<0.2	<0.2
11-Dec-18	NO3-N (mg/l)	<5	0.03	<0.02		<0.02	<0.02	<0.02	<0.02	<0.02				
12-Dec-18	NO3-N (mg/l)	<5						<0.02	<0.02		<0.02	<0.02	0.02	<0.02
11-Dec-18	NO2-N (mg/l)		<0.02	<0.02		<0.02	<0.02	<0.02	<0.02	<0.02				
12-Dec-18	NO2-N (mg/l)							<0.02			<0.02	<0.02	<0.02	<0.02
4-Dec-18	Faecal coliform (MPN/100ml)	<1,000						22						
5-Dec-18	Faecal coliform (MPN/100ml)	<1,000							130	46	130			
11-Dec-18	Faecal coliform (MPN/100ml)	<1,000	920	14		4.5	130	11						
12-Dec-18	Faecal coliform (MPN/100ml)	<1,000							49	33	110	240	79	130

		Station Code	NNG01	R1	R2	R3	R4	R5	R6	R7	NNG05	NNG06	NNG07	NNG08
Date	Parameters (Unit)	Guideline												
18-Dec-18	Faecal coliform (MPN/100ml)	<1,000							0	0	27			
19-Dec-18	Faecal coliform (MPN/100ml)	<1,000						9,200						
4-Dec-18	Total Coliform (MPN/100ml)	<5,000						110						
5-Dec-18	Total Coliform (MPN/100ml)	<5,000							240	70	460			
11-Dec-18	Total Coliform (MPN/100ml)	<5,000	1,600	220		17	170	49						
12-Dec-18	Total Coliform (MPN/100ml)	<5,000							70	33	110	350	540	170
18-Dec-18	Total Coliform (MPN/100ml)	<5,000							79	27	110			
19-Dec-18	Total Coliform (MPN/100ml)	<5,000						9,200						
11-Dec-18	TKN		<1.5	<1.5		<1.5	<1.5	<1.5	<1.5	<1.5				
12-Dec-18	TKN										<1.5	<1.5	<1.5	<1.5
11-Dec-18	Chloride (mg/l)		<2	<2		<2	<2	<2	<2	<2				
12-Dec-18	Chloride (mg/l)										<2	<2	2.4	3.4
11-Dec-18	Sulphate(mg/l)	<500	1.7	<0.3		<03	0.4	<0.3	0.5	<0.3				
12-Dec-18	Sulphate(mg/l)	<500									0.9	0.9	1.5	1.7
11-Dec-18	Alkalinity (mg/l)		54.6	53.6		39	38	43.9	40	42.9				
12-Dec-18	Alkalinity (mg/l)										65.3	58.5	52.6	45.8
11-Dec-18	Arsenic (mg/l)	<0.01	0.0006	<0.0003		<0.003	<0.003	<0.003	0.0005	<0.003				
12-Dec-18	Arsenic (mg/l)	<0.01									0.0004	<0.003	<0.003	<0.003
11-Dec-18	Calcium (mg/l)		8.06	6.38		5.5	4.91	5.21	5.78	6.17				
12-Dec-18	Calcium (mg/l)										5.87	6.74	7.26	6.78
11-Dec-18	Manganese (mg/l)	<1.0	0.04	<0.005		<0.005	<0.005	<0.005	0.069	0.067				
12-Dec-18	Manganese (mg/l)	<1.0									0.074	0.066	0.048	0.075
11-Dec-18	Mercury (mg/l)	<0.002	<0.0002	<0.0002		<0.002	<0.002	<0.002	<0.0002	<0.002				
12-Dec-18	Mercury (mg/l)	<0.002									0.0002	<0.002	<0.002	<0.002
11-Dec-18	Magnesium (mg/l)		1.66	1.53		1.32	1.17	1.24	1.21	1.25				
12-Dec-18	Magnesium (mg/l)										1.23	1.44	1.51	1.42

		Station Code	NNG01	R1	R2	R3	R4	R5	R6	R7	NNG05	NNG06	NNG07	NNG08
Date	**Parameters (Unit)**	**Guideline**												
11-Dec-18	Lead (mg/l)	<0.05	<0.010	<0.010		<0.010	<0.010	<0.010	<0.010	<0.010				
12-Dec-18	Lead (mg/l)	<0.05									<0.010	<0.010	<0.010	<0.010
11-Dec-18	Potassium (mg/l)		0.677	0.749		0.772	0.744	0.774	0.759	0.799				
12-Dec-18	Potassium (mg/l)										0.742	0.719	0.717	0.693
11-Dec-18	Sodium (mg/l)		1.63	1.47		1.35	1.26	1.33	1.23	1.32				
12-Dec-18	Sodium (mg/l)										1.18	1.52	2	1.92
11-Dec-18	Total Iron (mg/l)		1.27	0.107		0.055	0.058	0.058	0.422	0.406				
12-Dec-18	Total Iron (mg/l)										0.372	0.382	0.316	0.394
11-Dec-18	Phytoplankton Biomass (g dry wt/m3)			2.4		1.9	1.7	2.5	4.4	8.4				
11-Dec-18	Total Phosphorus (mg/l)			<0.01		<0.01	<0.01	<0.01	<0.01	<0.01				
11-Dec-18	TOC (mg/l)			1.46		1.6	1.61	1.78	1.6	1.72				
11-Dec-18	Hydrogen Sulfide (mg/l)							<0.02		<0.02				
12-Dec-18	Hydrogen Sulfide (mg/l)										<0.02			

Table A- 1: Results of Surface Water Quality Monitoring in Nam Chian, Nam Phouan, Nam Xao and Nam Houay Soup

		Station Code	NCH01	NPH01	NXA01	NHS01
Date	**Parameters (Unit)**	**Guideline**				
11-Dec-18	pH	5.0 - 9.0	8.07	7.71		
12-Dec-18	pH	5.0 - 9.0			7.74	7.93
19-Dec-18	pH	5.0 - 9.0		8.24		
25-Dec-18	pH	5.0 - 9.0	6.18	8.18		
26-Dec-18	pH	5.0 - 9.0			7	6.99
11-Dec-18	Sat. DO (%)		103	99.8		
12-Dec-18	Sat. DO (%)				90.5	90
19-Dec-18	Sat. DO (%)			100.5		
25-Dec-18	Sat. DO (%)		104.1	113.7		
26-Dec-18	Sat. DO (%)				96.2	88.5
11-Dec-18	DO (mg/l)	<6.0	8.45	8.8		
12-Dec-18	DO (mg/l)	<6.0			7.46	7.51
19-Dec-18	DO (mg/l)	<6.0		9.08		
25-Dec-18	DO (mg/l)	<6.0	8.83	10.74		
26-Dec-18	DO (mg/l)	<6.0			7.95	7.62
11-Dec-18	Conductivity (µs/cm)		26	67		
12-Dec-18	Conductivity (µs/cm)				103.6	51.8
19-Dec-18	Conductivity (µs/cm)			67		
25-Dec-18	Conductivity (µs/cm)		24.9	70		

		Station Code	NCH01	NPH01	NXA01	NHS01
Date	**Parameters (Unit)**	**Guideline**				
26-Dec-18	Conductivity (µs/cm)				107.5	53.2
11-Dec-18	TDS (mg/l)		13	33.5		
12-Dec-18	TDS (mg/l)				24.4	25.9
19-Dec-18	TDS (mg/l)			33.5		
25-Dec-18	TDS (mg/l)		12.45	35		
26-Dec-18	TDS (mg/l)				53.75	26.6
11-Dec-18	Temperature (°C)		23	21.4		
12-Dec-18	Temperature (°C)				24.4	23.8
19-Dec-18	Temperature (°C)			20.31		
25-Dec-18	Temperature (°C)		21.3	18.07		
26-Dec-18	Temperature (°C)				23.9	21.8
11-Dec-18	Turbidity (NTU)		3.86	2.53		
12-Dec-18	Turbidity (NTU)				3.76	3.58
19-Dec-18	Turbidity (NTU)			2.74		
25-Dec-18	Turbidity (NTU)		4.02	3.37		
26-Dec-18	Turbidity (NTU)				2.51	3.7
11-Dec-18	TSS (mg/l)		6.99	<5		
12-Dec-18	TSS (mg/l)				<5	<5
11-Dec-18	BOD5 (mg/l)	<1.5	<1.0	<1.0		
12-Dec-18	BOD5 (mg/l)	<1.5			<1.0	<1.0
11-Dec-18	COD (mg/l)	<5	5.5	<5		
12-Dec-18	COD (mg/l)	<5			<5	<5
11-Dec-18	NH3-N (mg/l)	<0.2	<0.2	<0.2		
12-Dec-18	NH3-N (mg/l)	<0.2			<0.2	<0.2
11-Dec-18	NO3-N (mg/l)	<5	0.03	0.07		
12-Dec-18	NO3-N (mg/l)	<5			0.04	0.07
11-Dec-18	NO2-N (mg/l)		<0.02	<0.02		
12-Dec-18	NO2-N (mg/l)				<0.02	<0.02
12-Dec-18	Faecal coliform (MPN/100ml)	<1,000	130	130	170	220
11-Dec-18	Total Coliform (MPN/100ml)	<5,000	350	920		
12-Dec-18	Total Coliform (MPN/100ml)	<5,000			1,600	540
11-Dec-18	TKN		<1.5	<1.5		
12-Dec-18	TKN				<1.5	<1.5
11-Dec-18	Chloride (mg/l)		<2	<2		
12-Dec-18	Chloride (mg/l)				3.4	3.9
11-Dec-18	Sulphate(mg/l)	<500	0.6	0.7		

		Station Code	NCH01	NPH01	NXA01	NHS01
Date	**Parameters (Unit)**	**Guideline**				
12-Dec-18	Sulphate(mg/l)	<500			3	0.5
11-Dec-18	Alkalinity (mg/l)		19.5	35.1		
12-Dec-18	Alkalinity (mg/l)				63.4	32.2
11-Dec-18	Arsenic (mg/l)	<0.01	0.0007	<0.0003		
12-Dec-18	Arsenic (mg/l)	<0.01			<0.0003	<0.0003
11-Dec-18	Calcium (mg/l)		2.35	5.85		
12-Dec-18	Calcium (mg/l)				9.37	5.62
11-Dec-18	Manganese (mg/l)	<1.0	0.028	<0.005		
12-Dec-18	Manganese (mg/l)	<1.0			0.04	0.045
11-Dec-18	Mercury (mg/l)	<0.002	<0.0002	<0.0002		
12-Dec-18	Mercury (mg/l)	<0.002			<0.0002	<0.0002
11-Dec-18	Magnesium (mg/l)		0.53	0.748		
12-Dec-18	Magnesium (mg/l)				2.3	0.642
11-Dec-18	Lead (mg/l)	<0.05	<0.01	<0.010		
12-Dec-18	Lead (mg/l)	<0.05			<0.01	<0.010
11-Dec-18	Potassium (mg/l)		0.583	0.723		
12-Dec-18	Potassium (mg/l)				0.564	0.269
11-Dec-18	Sodium (mg/l)		1.11	1.59		
12-Dec-18	Sodium (mg/l)				2.94	1.43
11-Dec-18	Total Iron (mg/l)		0.394	0.227		
12-Dec-18	Total Iron (mg/l)				0.491	0.936

ANNEX B: Results of Effluent Analyses

Table B- 1: Results of Camp Effluents in December 2018

	Site Name	Owner's Site Office and Village		Obayashi Camp		SongDa5 Camp No.1	
	Station Code	EF01		EF02		EF07	
	Date	07-Dec-18	17-Dec-18	07-Dec-18	17-Dec-18	07-Dec-18	17-Dec-18
Parameters (Unit)	**Guideline**						
pH	6.0 - 9.0	7.42	6.85	7.52	7.16	7.76	7.22
Sat. DO (%)		41.1	55.3	74.5	90.9	63.3	69.4
DO (mg/l)		3.07	4.37	5.76	7.2	5.08	5.72
Conductivity (µs/cm)		462	420	433	460	1,199	1,084
TDS (mg/l)		231	210	216.5	230	600	542
Temperature (°C)		28.9	26.2	27.3	26.2	25.7	23.6
Turbidity (NTU)		14.16	3.14	10.86	3.65	8.28	13.1
TSS (mg/l)	<50	15.28	5.68	8.04	<5	8.92	14.02
BOD5 (mg/l)	<30	40.71	35.1	<6	<6	<6	<6
COD (mg/l)	<125	67.3	38.4	28.4	34	48.7	66.3
NH3-N (mg/l)	<10.0	26.2	18.1	13.1	14.1	25.7	19.3
Total Nitrogen (mg/l)	<10.0	33.2	21.1	21.1	20.1	27.1	26.0
Total Phosphorus (mg/l)	<2	1.48	1.25	1.12	1.13	1.3	1.18
Oil & Grease (mg/l)	<10.0	<1		<1		<1	
Total coliform (MPN/100ml)	<400	160,000	3,500	0	0	16,000	0
Faecal Coliform (MPN/100ml)	<400	160,000	3,500	0	0	9,200	0
Effluent Discharge Volume (L/mn)		60	30	15	20	12	12
Chlorination Dosing Rate (ml/mn)		n/a	n/a	370	240	340	310
Residual Chlorine (mg/l)	<1.0	n/a	n/a	0.65	0.61	0.13	0.59

	Site Name	SongDa5 Camp No.2		Zhefu Camp		V&K Camp	
	Station Code	EF08		EF09		EF10	
	Date	07-Dec-18	17-Dec-18	07-Dec-18	17-Dec-18	07-Dec-18	17-Dec-18
Parameters (Unit)	**Guideline**						
pH	6.0 - 9.0	7.4	6.36	7.24	6.72	7.71	6.77
Sat. DO (%)		63.7	64.9	23.7	22	34.1	55.5
DO (mg/l)		4.92	5.28	1.84	1.73	2.68	4.56
Conductivity (µs/cm)		769	522	603	732	347	358
TDS (mg/l)		384	261	301	332	173.5	179
Temperature (°C)		27.4	25	27	26.7	27	24.4
Turbidity (NTU)		12.37	6.5	30.21	27.01	2.08	4.2
TSS (mg/l)	<50	12.09	<5	40.24	40.08	<5	5.61
BOD5 (mg/l)	<30	<6	<6	21.42	41.94	6.9	<6

COD (mg/l)	<125	32.2	44.2	116	122	<25	36
NH3-N (mg/l)	<10.0	9.3	14.6	38.2	44.6	5.4	5.1
Total Nitrogen (mg/l)	<10.0	16.3	15.2	39.8	45.7	13.7	8.35
Total Phosphorus (mg/l)	<2	1.14	1.24	1.56	1.8	0.74	0.77
Oil & Grease (mg/l)	<10.0	<1		<1		<1	
Total coliform (MPN/100ml)	<400	0	0	16,000	240	2	0
Faecal Coliform (MPN/100ml)	<400	0	0	16,000	240	0	0
Effluent Discharge Volume (L/mn)		12	15	4.2	4.2	6	15
Chlorination Dosing Rate (ml/mn)		190	130	3.1	3.1	81	49
Residual Chlorine (mg/l)	<1.0	0.53	0.43	0.08	0.13	0.19	0.36

	Site Name	**HM Main Camp**		**IHI Main Camp**		**Lilama10 Camp**		**IHI Field Shop 276 Camp**	
	Station Code	**EF13**		**EF14**		**EF17**		**EF18**	
	Date	07-Dec-18	17-Dec-18	07-Dec-18	17-Dec-18	07-Dec-18	17-Dec-18	07-Dec-18	17-Dec-18
Parameters (Unit)	**Guideline**								
pH	6.0 - 9.0	7.26	6.57	7.09	6.76			7.29	6.02
Sat. DO (%)		75.6	59.1	26.9	64.6			26.4	29.4
DO (mg/l)		5.93	4.64	2.85	5.03			2.02	2.34
Conductivity (µs/cm)		1,027	732	1,423	678			795	442
TDS (mg/l)		513	366	712	338			377.5	221
Temperature (°C)		26.5	26.6	26.7	27			27.7	25.9
Turbidity (NTU)		27.62	22.89	9.9	10.84			42.28	29.05
TSS (mg/l)	<50	31.69	12.47	16.67	33.75			47.86	21.09
BOD5 (mg/l)	<30	<6	<6	<6	<6			46.68	82.35
COD (mg/l)	<125	146	52.6	26.8	152			237	130
NH3-N (mg/l)	<10.0	14.2	12.9	<1.5	14.8			22.7	12
Total Nitrogen (mg/l)	<10.0	18	18.9	0.76	15.7			31.5	12.9
Total Phosphorus (mg/l)	<2	1.15	1.12	1.06	1.28			1.19	1.06
Oil & Grease (mg/l)	<10.0	<1		<1				7	
Total coliform (MPN/100ml)	<400	2	0	0	0			540	49
Faecal Coliform (MPN/100ml)	<400	0	0	0	0			110	33
Effluent Discharge Volume (L/mn)		4.2	4.2	4.2	4.2			4	6
Chlorination Dosing Rate (ml/mn)		3.1	3.1	3.1	3.1			12	30
Residual Chlorine (mg/l)	<1.0	0.42	1.1	1.96	1			0.26	0.63

Table B- 2: Results of the Construction Area Discharge in December 2018

	Site Name	Spoil Disposal No.2				Upstream Spoil Disposal No.2
	Station Code	DS04				DS04-US
	Date	05-Dec-18	12-Dec-18	19-Dec-18	22-Dec-18	22-Dec-18
Parameter (Unit)	**Guideline**					
pH	6.0 - 9.0	6.12	6.04	6.14	6.32	6.75
Sat. DO (%)		48.1	45.9	50.5	48.6	88.1
DO (mg/L)		3.66	3.77	4.11	3.84	6.95
Conductivity (µs/cm)		41.5	47.3	48.1	48.1	9.46
TDS (mg/l)		20.5	23.5	24	24.01	4.73
Temperature (°C)		26	25.4	24.8	26.2	26.0
Turbidity (NTU)		7.52	6.95	6.9	5.9	2.03
TSS (mg/L)	<50	2.82	3.77	5.25		
Oil & Grease (mg/L)	<10	<1				
Total Iron (mg/L)					3.87	0.25

ANNEX C: Ambient Dust Quality

Table C- 1: 24-hour Average Dust Concentrations Measured in Hat Gniun Village

Hat Gnuin Village - 24 Hours Average Particulate Matter (PM10) Concentration			
Period	00 to 24 Hours	24 to 48 Hours	48 to 72 Hours
Start Time	10-Dec-18 18:30	11-Dec-18 18:31	12-Dec-18 18:31
End Time	11-Dec-18 18:30	12-Dec-18 18:30	13-Dec-18 18:00
Average Data Record in 24h (mg/m3)	0.027	0.032	0.021
Guideline Average in 24h (mg/m3)	***0.12***	***0.12***	***0.12***

Table C- 2 24-hour Average Dust Concentrations Measured in Phouhomxay Village

Phouhomxay Village - 24 Hours Average Particulate Matter (PM10) Concentration			
Period	00 to 24 Hours	24 to 48 Hours	48 to 72 Hours
Start Time	24-Dec-18 18:00	25-Dec-18 18:01	26-Dec-18 18:01
End Time	25-Dec-18 18:00	26-Dec-18 18:00	27-Dec-18 18:00
Average Data Record in 24h (mg/m3)	0.056	0.055	0.058
Guideline Average in 24h (mg/m3)	***0.12***	***0.12***	***0.12***

Table B-3 and Table B-4: Average Results of Dust Monitoring at Song Da5 Camp No. 2 and Lilama10 Camp in December 2018

Song Da5 Camp No.2 - Dust Emission Average in 24 hours	
Period	24 Hours
Start Time	17-Dec-18 18:00
End Time	18-Dec-18 18:00
Average Data Record -24h	0.021
Guideline	***0.12***

Lilama10 Camp - Dust Emission Average in 24 hours	
Period	24 Hours
Start Time	06-Dec-18 18:00
End Time	07-Dec-18 18:00
Average Data Record -24h	0.028
Guideline	***0.12***

Table B-5 and Table B-6: Average Results of Dust Monitoring at Main Dam, and Main Powerhouse in December 2018

Main Dam - Dust Emission Average in 24 hours	
Period	**24 Hours**
Start Time	**19-Dec-18 18:00**
End Time	**20-Dec-18 18:00**
Average Data Record -24h	**0.037**
Guideline Average - 24h	***0.12***

Main Powerhouse - Dust Emission Average in 24 hours	
Period	**24 Hours**
Start Time	**20-Dec-18 18:30**
End Time	**21-Dec-18 18:00**
Average Data Record -24h	**0.044**
Guideline Average - 24h	***0.12***

ANNEX D: AMBIENT NOISE DATA

Table D- 1: Average Results of Noise Monitoring at Ban Hat Gniun in December 2018

Noise Level (dB)	10-11/December/18			11-12/December/18			12-13/December/18		
	18:30-22:00	22:01 – 06:00	06:01 – 18:00	18:00-22:00	22:01 – 06:00	06:01 – 18:00	18:00-22:00	22:01 – 06:00	06:01 – 18:00
Maximum Value Recorded	67.60	67.70	67.10	63.30	73.00	73.80	60.10	66.10	65.90
Guideline Max	***115***	***115***	***115***	***115***	***115***	***115***	***115***	***115***	***115***
Average Data Recorded	42.90	42.09	41.12	42.88	43.68	48.97	45.25	42.87	44.89
Guideline Averaged	***55***	***45***	***55***	***55***	***45***	***55***	***55***	***45***	***55***

Table D- 2: Average Results of Noise Monitoring at Phouhomxay Village in December 2018

Noise Level (dB)	24-25/December/18			25-26/December/18			26-27/December/18		
	18:00-22:00	22:01 –06:00	06:01 – 18:00	18:00-22:00	22:01 –06:00	06:01 – 18:00	18:00-22:00	22:01 –06:00	06:01 – 18:00
Maximum Value Recorded	50.20	46.20	72.00	56.00	61.60	73.70	62.00	62.00	64.20
Guideline Max	***115***	***115***	***115***	***115***	***115***	***115***	***115***	***115***	***115***
Average Data Recorded	36.91	33.89	39.79	40.55	43.12	43.89	43.15	38.67	39.90
Guideline Averaged	***55***	***45***	***55***	***55***	***45***	***55***	***55***	***45***	***55***

Table D- 3 and Table D- 4: Average Results of Noise Monitoring at Song Da5 Camp No. 2 and Sino Hydro Camp in December 2018

Song Da5 Camp No.2

Noise Level (dB)	17-18/December/18		18/December/18
	18:00 – 22:00	22:01 – 06:00	06:01-18:00
Maximum Value Recorded	63.8	57.5	62
Guideline Max	***115***	***115***	***115***
Average Data Recorded	38.28	33.96	40.69
Guideline Averaged	***70***	***50***	***70***

Lilama10 Camp

Noise Level (dB)	06-07/December/18		07/December/18
	18:00 – 22:00	22:01 – 06:00	06:00-18:00
Maximum Value Recorded	59.2	63.6	74.1
Guideline Max	***115***	***115***	***115***
Average Data Recorded	52.83	43.63	44.32
Guideline Averaged	***70***	***50***	***70***

Table D- 5 and Table D- 6: Average Results of Noise Monitoring at Main Dam, and Main Powerhouse in December 2018

Main Dam

Noise Level (dB)	19-20/December/18		20/December/18
	18:00 – 22:00	22:01 – 06:00	06:01-18:00
Data Record Max	57.6	57.9	78.6
Guideline Max	***115***	***115***	***115***
Data Record Average	53.86	53.78	52.85
Guideline Averaged	***70***	***70***	***70***

Main Powerhouse

Noise Level (dB)	20-21/December/18		21/December/18
	18:30 – 22:00	22:01 – 06:00	06:01-18:00
Data Record Max	60.5	65.9	78.6
Guideline Max	***115***	***115***	***115***
Data Record Average	55.74	53.91	57.40
Guideline Averaged	***70***	***70***	***70***