NAM NGIEP 1
POWER COMPANY

## Nam Ngiep 1 Hydropower Project

# Environmental Management
# Monthly Monitoring Report

November 2019

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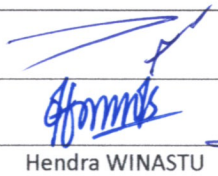
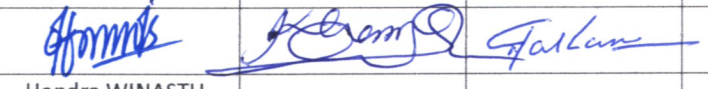
| | |  | | | |
| | |  | | | |
| A | 25 December 2019 | Hendra WINASTU<br>Khamsone SAYSOMPHOU | Khamlar PHONSAVAT | Toshihiro TAKANO | |
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# TABLE OF CONTENTS

## TABLE OF TABLES

## TABLE OF FIGURES

## 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 November 2019, the Environmental Management Office (EMO) of Nam Ngiep 1 Power Company (NNP1PC) received two Site Specific Environmental and Social Management Plan (SS-ESMMP), one environmental pre-construction site checklist and one working drawing for review and approval.

The monthly site visit by the Borikan District EMU was not carried out in November 2019.

The effluent monitoring results for the remaining camps in November 2019 indicate that the results of ammonia nitrogen and total nitrogen continue to fluctuate over the month and comply with the relevant effluent standards for some camps. Non-compliances for total coliform and faecal coliform were recorded at the Song Da 5 Camp No.1 [EF07] and OSOV [EF01]. In addition, Lilama 10 Camp was completely decommissioned and omitted from the effluent sampling mission programme.

The Dissolved Oxygen (DO) levels at the surface of the Main Reservoir (R1, R2, R3, R4 and R5) were generally between 4 mg/L to 8 mg/L. In the Re-regulation Reservoir (R6 and R7), the DO was generally below 4 mg/L during the reporting period.

The discharge from the re-regulation powerhouse alternated between discharges from the gate and turbine. DO measurements in the downstream stations (on 13, 15, 22, 23, 27, 29 and 30 November 2019) did not comply with the National Standard. About 20 dead fish were observed in re-regulation reservoir on 22 November 2019. No dead fish was observed in the Nam Ngiep downstream of the re-regulation dam.

A total of 48.5 m3 of solid waste was disposed of at the NNP1 Project Landfill, a decrease of 13.7 m3 compared to October 2019. A total of 2,030.5 kg of recyclable waste was recorded at the Community Recycle Waste Bank. A total of 65 m3 of solid waste from Phouhomxay, Thahuea and Hat Gniun Villages was disposed of at the Houay Soup Landfill.

ADB provided a no objection on 06 November 2019 for the proposed AIP2019 from Xaysomboun and Bolikhamxay Provinces. The Department of Forestry, Ministry of Agriculture and Forestry issued an official request for fund disbursement to NNP1PC on 25 November 2019. NNP1PC is processing the fund transfer and it is expected that GOL will receive the funds in the second week of December 2019.

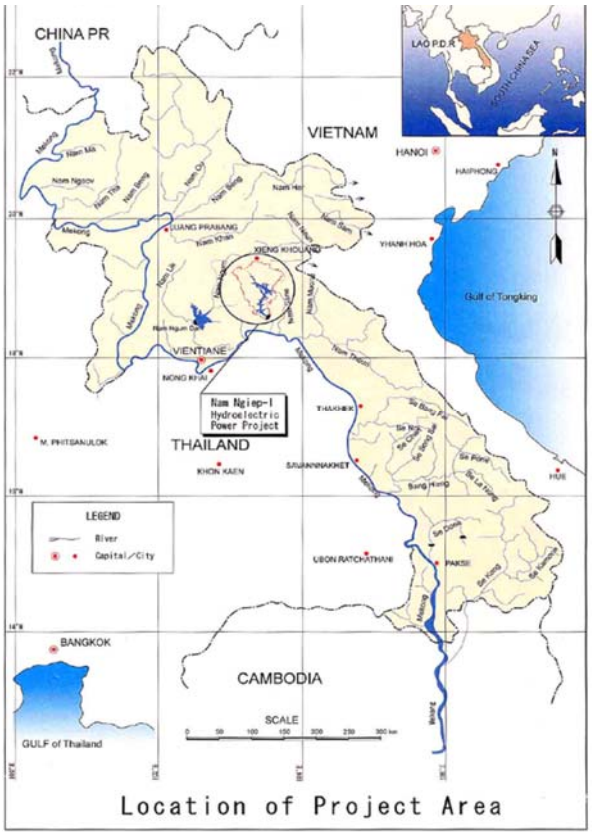
Biodiversity offset related activities under the components of spatial planning and regulation, and law enforcement were carried out according to the approved Annual Implementation Plan (AIP) 2019.

The fish catch monitoring for October 2019 in the Nam Ngiep watershed was dominated by Channa striata, Clarias batrachus, and species groups of Poropuntius, Hampala and Mastacembelus that are classified as Least Concern (LC) according to the IUCN Red List.

# 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 were 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.

***Figure 2-1*** Shows the progress of the minor and outstanding work and defects that comprise the punch list items for each of the principal contracts for the Project.

***FIGURE 2-1: SUMMARY OF PUNCH LIST PROGRESS AS OF THE END OF OCTOBER***

| Type of Contract Works | | Total Items | Items Completed | Completion by No. of Items | Total Value of Items | Value Completed | Completion by Value | Taking-Over |
|---|---|---|---|---|---|---|---|---|
| | | (No.) | (No,) | (%) | (USD) | (USD) | (%) | (Date) |
| Civil | RR Power Station | 74 | 74 | 100 | 108,890 | 108,890 | 100 | 31-Jan-19 |
| | Main Power Station | 482 | 480 | 99 | 5,507,375 | 5,307,375 | 96 | 31-Jan-19 |
| Electro-Mechanical | RRPS | 170 | 170 | 100 | 6,515 | 6,515 | 100 | 16-Mar-19 |
| | MPS | 95 | 90 | 95 | 10,950 | 9,450 | 86 | 27-Aug-19 |
| Hydro-Mechanical | RRPS | 39 | 39 | 100 | 8,825 | 8,825 | 100 | 16-Mar-19 |
| | MPS | 174 | 174 | 100 | 13,775 | 13,775 | 100 | 31-Mar-19 |
| 230 kV Transmission Line | | 301 | 301 | 100 | 150,000 | 150,000 | 100 | 31-Jul-18 |

## 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 Notice to Proceed was issued on 03 October 2014. Excavation works of the main dam, the diversion tunnel and the re-regulation dam 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 March 2019 was 100 % (compared to planned progress of 100 %) calculated as the value of achieved Interim Milestone Payments excluding advance payment.

The Civil Works overall was always on or ahead of schedule despite increased quantities of dam excavation and slope stabilisation and additional RCC placed in the shear key. During the initial dam excavation and since, it has been written in each Monthly Report, *'the complex bedding of hard over soft layers of rock and the folding nature of these layers in the foundation rock of the main dam below the old river bed had created difficulty to finalise the foundation design to the satisfaction of the Dam Safety Review Panel in all respects'.*

Accordingly, further review of the dam foundation design was carried out to create sufficient safety factor for stability against sliding of the dam on the weak zones. This resulted in further excavation and concreting of a shear key structure in the old river bed, taking the dam height to 167 m, measured from the deepest excavation level to the crest level, some 19 m higher than anticipated. The original schedule is maintained as a result of the combined efforts of the Owner, the Owner's Engineer and all the principal Contractors and their Subcontractors. The additional excavation works were completed at the end of February 2016 and RCC consolidation grouting and RCC placement for the main dam were commenced on 10 May and 19 April 2016 respectively. The concrete level at the main dam reached El. 321.9 m at the left bank on 29 April 2018 and at the right bank at the end of March 2018. The placed volume of

RCC was achieved in close to the planned schedule despite the losses of time resulting from the additional excavation and concreting in the foundation, the loss of fly-ash supply in December 2016, and the fatal accident.

Since the impounding of the Main Dam started on 15 May 2018, monitoring has been carried out to confirm the dam stability, especially to the right abutment where some anomalous results had been noted. Dam monitoring results are shown in a separate 'Monthly Report on Main Dam Instrumentation and Monitoring'. Many of the original concerns have been explained or are better understood. The unforeseen consequences which are considered likely to have been caused by the closing of bedding plane openings, as one of the possible causes considered, began unfolding with events in August 2018 when loading of the dam toe appeared to have caused an inclination of the main powerhouse to upstream and towards the old river bed such that the setting and fixing vertically of both turbine generating units within the required tolerances was not possible. This movement of the powerhouse also affected associated structures such as the penstocks and the intake valve. After the occurrence of this inclination issue, it has been found that artesian aquifer, which was not pressurized before initial impounding, exists under the main powerhouse foundation. Drainage to relieve the pressure is an important means of controlling the artesian aquifer. All current information and opinion are contained in the separate 'Root Cause Assessment of the Main Powerhouse Inclination' which was endorsed by academic authorities. This Report was sent to the insurance company in support of the insurance claim on this issue.

Monitoring of the instruments initially installed continues, more instruments were installed, further drainage drilling was carried out. As related above, all current information and opinion is contained in the separate September Monthly Report on Main Dam Instrumentation and Monitoring. This Report was sent to the Dam Safety Review Panel for review and comment. The reservoir water level of the main reservoir finally reached Full Supply Level of El. 320 m on 17 August 2019 whilst achieving dam safety. At the 19th DSRP Meeting which was held in October 2019, DSRP included in their Report a 'Dam Safety Endorsement' stating that the main dam, re-regulation dam and dyke are safe and fit for purpose, subject to a continued programme of appropriate monitoring, safe project operation and satisfactory resolution of the outstanding issues.

The leakage through drainage pipes from the Bottom Conduit Gate decreased from around 30 m3/min in June 2019 to 1 m3/min in September 2019 thanks to additional grouting using holes drilled from the main dam foundation gallery, a manageable amount, and the permanent concrete plug in this Conduit had been placed since 08 November 2018 after obtaining agreement of the DSRP and completed in 21 January 2019. NNP1PC will study various options to ensure that the reservoir water pressure is safely confined in the long term based on the recommendations of the DSRP.

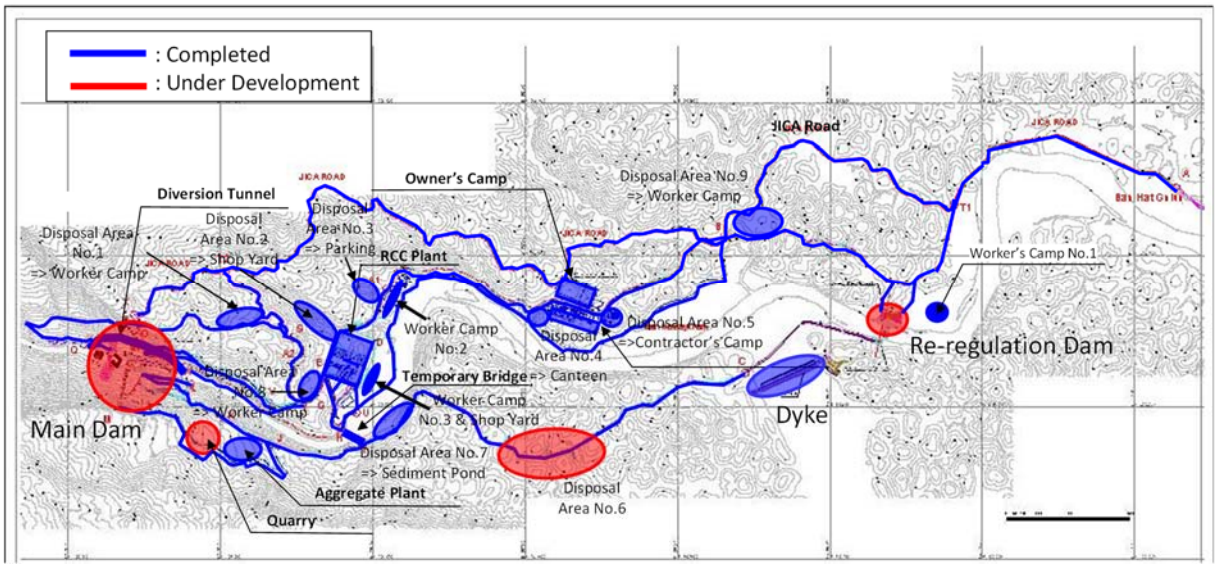
The repairs to the foundation of leg 4 of 230 kV TL Tower No.1 were completed in February 2019. The remaining excavation of the plunge pool was finished in January 2019. The reinforced concrete parapet wall was completed in December 2018 and road deck to the main dam crest and the concrete spillway chutes and piers completed in January 2019.

The issue of a Taking-over Certificate for the Civil Works for both the Re-regulation Power Station and the Main Dam and Main Powerhouse dated 31 January 2019 was made on 19 August 2019 and 22 October 2019, respectively.

### 2.1.1 ACCESS ROAD CONSTRUCTION

All main access road construction works were completed following an early December 2013 start, and maintenance of these will continue until the anticipated commissioning date in August 2019, six months after when the Civil Contract Time for Completion is reached. Temporary access roads are constructed to reach the various construction activities and others will be developed or modified as is necessary as activities change to reach current or new areas of dam concreting and consolidation grouting, the upstream and downstream cofferdams and the main powerhouse and belt conveyor support tower foundations. The layout of the access road system is as shown in ***Figure 2-2*** below. The Civil Contractor is responsible for decommissioning and rehabilitating the temporary roads as they become redundant.

***Figure 2-2: Plan of Site Access Roads with Major Work Area and Temporary Facilities***




### 2.1.2 MAIN DAM AND POWER HOUSE

After starting the main dam excavation in October 2014 on the left bank, these 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 in total than expected and part of this additional work was necessary to construct a 'shear key' structure due to the weak layers of rock encountered in the dam foundation. Following significant efforts on Site, the additional excavation work was completed at the end of February 2016. The cost of the additional excavation and RCC concrete placement necessitated expenditure of contingency amounts provided exactly for such eventualities. The dental concreting works were commenced in March 2016, and conventional levelling concrete placement for the main dam in the 'shear key' structure up to El. 170.5 m was completed in the middle of April 2016. Consolidation grouting at the main dam area was commenced on 10 May 2016 and RCC concrete placement for the main dam body was commenced on 19 April 2016. Consolidation grouting covers the whole footprint of the main dam and RCC concrete placement and consolidation grouting are implemented in parallel, section by section. The progress of RCC concrete placement is 100 % complete. The dam height has reached crest level at El. 321.9 m at both left bank and right bank. The plunge pool excavation was started after main dam

impounding and this work has been suspended because of spilling water from spillway gate during rainy season in 2018. It has resumed from the end of October when the amount of inflow has decreased to around 100 m3/s and around 121,000 m3 or 100 % of total excavation has now been completed.

The diversion conduit gate of the main dam body has some leakage of water initially and the casting of the temporary concrete plug behind it was completed in the conduit in June 2018. The permanent concrete plug had been placed since 08 November 2018 after DSRP permission was granted.

Main powerhouse sub-structure excavation works were completed in January 2016 and levelling concrete works were started in coordination with installation of the grounding system and the penstock concrete encasement. Major concrete of the main powerhouse was substantially completed in December 2017. The powerhouse concreting works has been completed in January 2019.

### 2.1.3 RE-REGULATION DAM, POWERHOUSE AND DYKE

The re-regulation powerhouse excavation and cofferdam works for the first 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 overall re-regulating dam and powerhouse works at the left bank section and the right bank and labyrinth weir are shown in ***Figure*** below. After the completion of the re-regulation dam above, impounding of the reservoir has been carried out having been commenced on 15 May and been completed on 24 May 2017. After Main Dam impounding started, the reservoir storage of the re-regulation dam has been used for the riparian discharge to downstream in accordance with the Concession Agreement.

***FIGURE 2-3: COMPLETED RE-REGULATION DAM AND POWERHOUSE AT THE END OF JUNE 2018***

### 2.1.4 TEMPORARY WORK FACILITY

#### 2.1.4.1 DIVERSION TUNNEL INLET AND OUTLET

The diversion tunnel, excavated over 600 m in length and 10 m in diameter, was commenced in October 2014 by drill and blast techniques and completed in late September 2015. The river diversion took place on 31 October 2015 after completion of inlet and outlet structures 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. Dewatering of the diversion tunnel and construction of the concrete plug was commenced during January 2018. Concrete works and the valve installation for discharge was completed before the start of main dam impounding. On 22 May 2018, the valve discharge commenced by using 3 valves with around 5 $m^3$/s discharge in total. Construction of concrete plug including valve was completed on 27 January 2019.

#### 2.1.4.2 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 for this cofferdam were completed on 02 April 2016.

#### 2.1.4.3 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. Decommissioning and rehabilitation are underway on both plants and almost completed for the Aggregate Crushing Plant.

#### 2.1.4.4 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.

#### 2.1.4.5 DISPOSAL AREAS

The disposal areas are on the right bank has been available for operation since January 2015, as was the adjacent waste Disposal Area No.9. Disposal Area No.9 along Road P1 near the start of Road T5 started operation in April 2015. Unsuitable material from the quarry has ceased to be hauled to Disposal Area No.6 and Disposal Area No.9 has been developed by the Electrical and Mechanical Works Contractor as stated above.

## 2.2 ELECTRICAL AND MECHANICAL WORKS

The EMW Contract was executed between Hitachi-Mitsubishi Hydro Corporation and NNP1PC on 13 June 2014 and the Notice to Proceed was issued in 03 October 2014. The cumulative work progress of the Electrical and Mechanical Works by value at the end of July 2019 was 98.8 % (compared to planned progress of 100.0 %). This apparent delay is simply due to the delay to issuing of the Taking-Over Certificate for the main powerhouse.

The main activities carried out during this month are described below:

*Figure 4.2-1: Investigation work of generator brake and speed sensor*

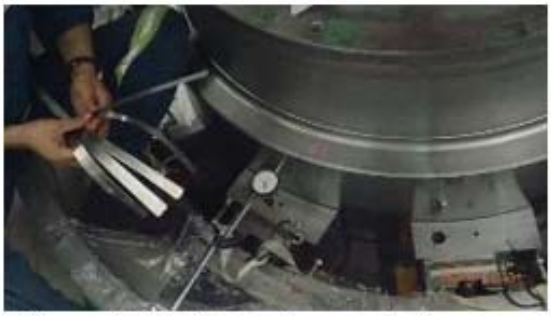


*Figure 4.2-2: Measuring work of upper guide bearing gap*

*Figure 4.2-3: Reassembly work after bearing gap measurement and adjustment*

*Figure 4.2-4: Oil flushing of upper guide bearing*

*Figure 4.2-5: Performing of unit run out check*

*Figure 4.2-6: Performing of wet test*

*Figure 4.2-7: Performing magnetic particle inspection on welding seam of bolt cover plates of runner cone*

*Figure 4.2-8: Final inspection of runner hub inside draft tube before closing manhole*

*Figure 4.2-9: Performing of wet test*

## 2.3 HYDRO-MECHANICAL WORKS

The HMW Contract 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 March 2019 was 100 % (compared to planned progress of 100 %). NNP1PC issued the Taking Over Certification for the main powerhouse and the re-regulation powerhouse, which was dated on 31 March 2019 for the main powerhouse and 16 March 2019 for the re-regulation powerhouse, to IIS on 30 September 2019 and 16 August 2019, respectively.

## 2.4 230 KV TRANSMISSION LINE WORKS

The 230 kV Transmission Line Contract was executed between Loxley-Sri Consortium and NNP1PC on 11 July 2014 and the NTP was issued to the 230 kV TL Works Contractor on 03 October 2014. The cumulative actual work progress of the Transmission Line Works at the end of July 2018 was 100 %, the same as planned progress. NNP1PC issued the Taking Over Certification, which was dated on 31 July 2018, to Loxley on 6 November 2018. The Defects Notification Period for this Contract expired on 31 July 2019.

# 3. ENVIRONMENTAL MANAGEMENT MONITORING

## 3.1 COMPLIANCE MANAGEMENT

In November 2019, the Environmental Management Office (EMO) of Nam Ngiep 1 Power Company (NNP1PC) received two SS-ESMMPs, one environmental pre-construction site checklist and one working drawing for review and approval.

***TABLE 3-1: SS-ESMMP AND DOCUMENTS REVIEW STATUS IN NOVEMBER 2019***

| Title | Date Received | Status |
|---|---|---|
| **SS-ESMMP for the Improvement of IHI and HM Camps (new ESD Office and Camp)** | 05 November 2019 (1st submission) | No objection with no further comments on 07 November 2019 |
| **Working drawing of additional fence and security gates for the main dam area** | 07 November 2019 (1st submission) | No objection with no further comments on 12 November 2019 |
| **Environmental checklist for the improvement of the entrance and water supply for the market in Zone 2UR** | 10 November 2019 (1st submission) | No objection with no further comments on 22 November 2019 |
| **DWP & SS-ESMMP for Main Dam Plunge Pool Excavation Work** | 22 November 2019 (5th submission) | No objection with no further comments on 26 November 2019 |

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

***TABLE 3-2: SUMMARY OF ONC AND NCR***

| Items | ONC | NCR-1 | NCR-2 | NCR-3 |
|---|---|---|---|---|
| Carried over from October 2019 | 2 | 0 | 0 | 0 |
| Newly Opened in November 2019 | 7 | 0 | 0 | 0 |
| **Total in November 2019** | **9** | **0** | **0** | **0** |
| Resolved in November 2019 | 4 | 0 | 0 | 0 |
| Carried over to December 2019 | 5 | 0 | 0 | 0 |
| Unsolved Exceeding Deadlines | **4** | **0** | **0** | **0** |

### 3.1.1 Inspection by Environment Management Unit

A monthly site visit by the Bolikhan District EMU was not carried out during November 2019.

## 3.2 Environmental Quality Monitoring

The analyses of Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD), faecal coliforms, E.Coli bacteria and total coliforms 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/

### 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 November 2019 indicate that the results of ammonia nitrogen and total nitrogen continue to fluctuate over the month and comply with the relevant effluent standards for some camps. In addition, non-compliances for total coliform and faecal coliform were recorded at the Song Da 5 Camp No.1 [EF07] and OSOV [EF01].

The status of implementation of the corrective actions addressing non-compliances at the camps and key construction sites that continue to have non-compliances is summarized below.

***Table 3-3: Status of Corrective Actions for Non-Compliances at Camps and Construction Sites***

| Site | Sampling ID | Status | Corrective Actions |
|---|---|---|---|
| **Owner's Site Office and Village (OSOV)** | EF01 | Non-compliance for total nitrogen and total coliform. | NNP1PC is designing the improvements to wetland pond no. 2. The improvements are expected to be completed in January 2020. |
| **Obayashi Corporation Camp** | EF02 | The site has been decommissioned. | This site will be omitted next month. |
| **Song Da 5 Camp No. 1** | EF07 | Non-compliance for faecal coliform and total coliform (first fortnight). No effluent camp sampling for the second fortnight due to no outflow from the wetland. | This camp is being decommissioned and planned to be vacated by the end of December 2019. |

| Site | Sampling ID | Status | Corrective Actions |
|---|---|---|---|
| **V&K Camp** | EF10 | The site has been decommissioned. | This site will be omitted next month. |
| **H-M Hydro**<br>**Main Camp (WWTS)** | EF13 | Non-compliance for total nitrogen, ammonia-nitrogen and COD in the second fortnight sampling. | This camp will be taken over by ESD in January 2020. A short-term consultant is being recruited to assess the current waste water treatment system and make suggestions for long-term improvements |
| **ESD Camp (former IHI Main Camp)** | EF14 | Non-compliance for total nitrogen and ammonia nitrogen. | A short-term consultant is being recruited to assess the current waste water treatment system and make suggestions for long term improvements. |
| **Main Powerhouse** | EF19 | Non-compliance for COD, total nitrogen and ammonia nitrogen in the second fortnight. No discharge during the first fortnight sampling. | The system consists of septic, biofilm and chlorination tanks, but no wetland pond is set up due to limited space. A short-term consultant is being recruited to assess the current waste water treatment system and make suggestions for long-term improvements. |
| **Spoil Disposal Area No.2** | DS04 | Full compliance. | |
| **Upstream**<br>**Spoil Disposal Area No.2** | DS04-US | Full compliance. | |

### 3.2.2 AMBIENT SURFACE WATER QUALITY MONITORING

The ambient surface water quality monitoring programme comprises five monitoring stations in the main reservoir (R1-R5), two stations in the re-regulation reservoir (R6 and R7), 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]).

In addition, weekly depth profile monitoring (pH, DO, Conductivity, TDS and Temperature) has been started since 18 September 2018 for stations located in the re-regulation and main reservoirs. The water quality programme is summarized in *Table **3-4*** and the location of the monitoring stations are shown in below

***TABLE 3-4: 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;<br>- NNG05, Nam Ngiep downstream the re-regulation dam at Hat Gniun Village. |
| Wednesday and Friday (Intensive Monitoring) | pH, DO (%), DO (mg/L), Conductivity (µs/cm), TDS (mg/L), Temperature (°C) and Turbidity (NTU) | - R5, main reservoir immediately upstream of the main dam;<br>- Tailrace main dam;<br>- Re-regulation reservoir: R6 and R7;<br>- Tailrace re-regulation dam;<br>- Nam Ngiep at the bridge;<br>- NNG05, Nam Ngiep downstream of 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) | - Main Reservoir: R1, R2, R3, R4, R5;<br>- Nam Ngiep downstream: NNG05, NNG06, NNG07 and NNG08;<br>- Tributaries: Nam Phouan [NPH01], Nam Xao [NXA01] and Nam Houay Soup [NHS01]. |
| 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) and Hydrogen sulphide (mg/L) | All stations |

The monitoring results for key parameters (DO, TSS and BOD5) during November 2019 are presented in ***Table 3-5, 3-6 and 3-7.*** The full set of data for November 2019 is attached in ***Annex A***. In addition, the results for DO are presented as line graphs in ***Figure 3-2***

**Main Reservoir**

During November 2019, the water level in the main reservoir decreased from El. 316 m asl to El. 315 m asl.

At R5, the DO level in the upper 10 m was generally between 4 mg/L and 7 mg/L, and the entire water column below 19.0 m had a DO level less than 0.5 mg/L.

At R4, the DO level in the upper 9.0 m was between 5 mg/L and 6 mg/L, and the entire water column below 14.0 m had DO levels below 1 mg/L.

The DO concentrations at R3 were recorded between 5 mg/L and 7 mg/L in the upper 5.5 m. The concentration of DO in the water column below 10.0 m was generally less than 1 mg/L. However, there were some occasional spikes at 24 m to 32 m depth of 1.66 mg/L to 2.83 mg/L.

The DO concentrations at R2 were generally recorded between 4 mg/L and 7 mg/L in the upper 2 m. The concentration of DO in the water column below 3.5 m generally fluctuated between 0.07 mg/L and 4.52 mg/L.

And at R1, the DO level was generally between 3 mg/L and 8 mg/L in the entire water column.

The measurements indicate the formation of oxy-clines in R2, R3, R4 and R5.

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 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 measurements in November 2019 were all within the standard and some of them below the limit of detection.

**Re-regulation Reservoir**

In November 2019, the turbine discharge from the main dam varied between about 100 $m^3/s$ and 200 $m^3/s$ interrupted by periods with no discharge usually at night-time. There was only one short period of 10 hours on 20 November 2019 with spillway discharge (29 $m^3/s$).

The DO measurements at R6 and R7 representing turbine discharges from the main dam generally had DO concentrations from below 1 mg/L to about 2 mg/L in the entire water column. Measurements shortly after spillway discharges had stopped, on 20 November 2019, showed higher DO concentrations ranging from 4 mg/L to 6.8 mg/L due to the aeration generated by the spills.

**Downstream**

During November 2019, the discharge from the re-regulation dam alternated between discharges from the gate and turbine. Some DO concentration was above 6 mg/L. However, DO measurements in the downstream stations (on 13, 15, 22, 23, 27, 29 and 30 November 2019) did not comply with the National Standard. No dead fish were observed in Nam Ngiep Downstream during the low DO period.

***FIGURE 3-1: SURFACE WATER AND RE-REGULATION RESERVOIR WATER QUALITY MONITORING STATIONS***

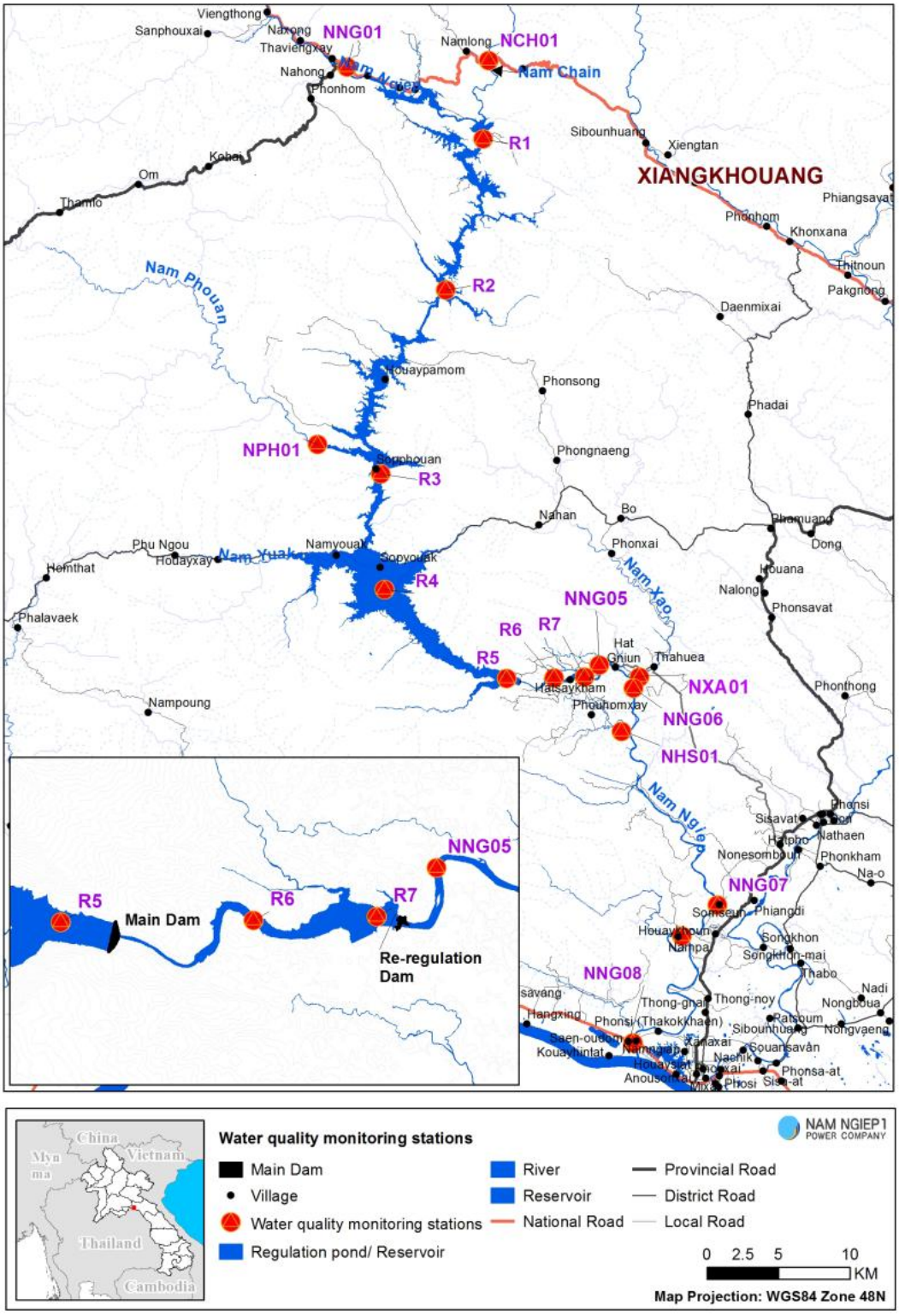


***FIGURE 3-2: CONCENTRATION OF DISSOLVED OXYGEN IN THE UPPER 0.2 M SINCE THE START OF IMPOUNDING***

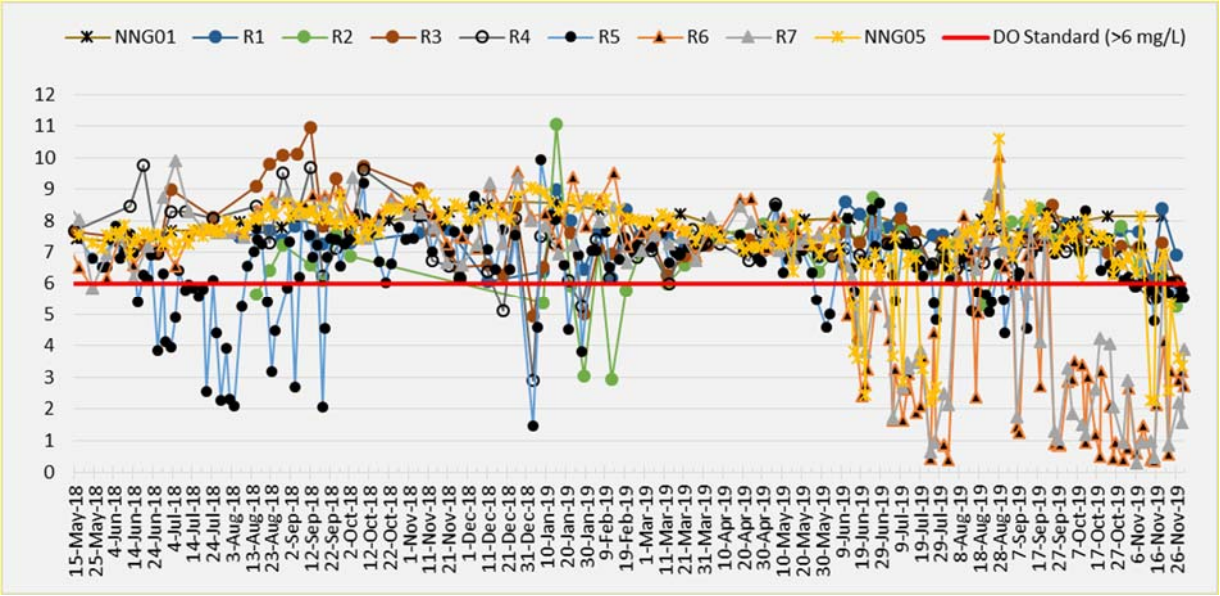



**TABLE 3-5: *RESULTS OF SURFACE WATER QUALITY MONITORING FOR DISSOLVED OXYGEN (MG/L) IN THE UPPER 0.2 M, WATER QUALITY STANDARD: >6.0 MG/L***

| DO (mg/L) | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG05 | NNG06 | NNG07 | NNG08 | NCH01 | NPH01 | NXA01 | NHS01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1-Nov-19 | | | | | | | 0.75 | 2.9 | 6.87 | 6.71 | | | | | 6.19 | |
| 2-Nov-19 | | | | | | 6.2 | 2.65 | | 6.8 | | | | | | | |
| 5-Nov-19 | | | | | 5.93 | | | | | | | | | | | |
| 6-Nov-19 | | | | | | 5.94 | 0.63 | 0.31 | 6.35 | 7.2 | 7.02 | 7.11 | | | 7.49 | 7.09 |
| 7-Nov-19 | | 7.66 | 6.5 | 7.15 | | | | | | | | | | | | |
| 8-Nov-19 | | | | | | 7.19 | 1.00 | 0.95 | 8.15 | 7.78 | | | | | 7.42 | |
| 9-Nov-19 | | | | | | 6.06 | 1.46 | | 6.96 | | | | | | | |
| 13-Nov-19 | | | | | | 5.77 | 0.39 | 0.96 | 2.26 | 2.8 | 4.79 | 6.62 | | | 6.94 | 6.78 |
| 14-Nov-19 | | 6.19 | 5.69 | 5.69 | 5.49 | | | | | | | | | 7.9 | | |
| 15-Nov-19 | | | | | | 4.8 | 0.36 | 0.47 | 2.28 | 2.87 | 4.63 | 6.32 | | | 7.02 | 6.55 |
| 16-Nov-19 | | | | | | 5.52 | 2.12 | | 6.48 | 6.3 | | | | | 6.72 | |
| 19-Nov-19 | 8.16 | 8.4 | 6.29 | 7.3 | 6.17 | | | | | | | | 8.17 | 8.5 | | |
| 20-Nov-19 | | | | | | 5.86 | 4.15 | 6.62 | 6.95 | 7.53 | 7.01 | 7.42 | | | 7.64 | 7.32 |
| 22-Nov-19 | | | | | | 5.69 | 0.57 | 0.85 | 2.6 | 3.23 | | | | | 6.11 | 6.28 |
| 23-Nov-19 | | | | | | 6.06 | 3.2 | | 5.32 | | | | | | | |
| 26-Nov-19 | | 6.91 | 5.25 | 6.1 | 6.02 | | | | | | | | | | | |
| 27-Nov-19 | | | | | | 5.54 | 2.92 | 2.2 | 3.6 | 3.74 | 5.37 | 6.92 | | | 7.0 | 7.19 |

| DO (mg/L) | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG05 | NNG06 | NNG07 | NNG08 | NCH01 | NPH01 | NXA01 | NHS01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 29-Nov-19 | | | | | | 5.78 | 3.17 | 1.55 | 3.35 | 5.25 | | | | | 6.84 | |
| 30-Nov-19 | | | | | | 5.54 | 2.71 | | 3.9 | | | | | | | |

**TABLE 3-6:** ***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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-Nov-19 | | | | | | <5 | 5 | <5 | <5 | | | | | | | |
| 13-Nov-19 | | | | | | <5 | <5 | <5 | <5 | <5 | <5 | 7.53 | | | <5 | <5 |
| 14-Nov-19 | | <5 | <5 | <5 | <5 | | | | | | | | | 5.69 | | |
| 19-Nov-19 | 7.4 | | | | | | | | | | | | 5.15 | | | |
| 20-Nov-19 | | | | | | <5 | <5 | 8.36 | 26.66 | | | | | | | |
| 27-Nov-19 | | | | | | <5 | <5 | <5 | <5 | | | | | | | |

**TABLE 3-7:** ***RESULTS OF SURFACE WATER QUALITY MONITORING FOR $BOD_5$ (MG/L) - WATER QUALITY STANDARD: < 1.5 MG/L***

| $BOD_5$ (mg/L) | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG05 | NNG06 | NNG07 | NNG08 | NCH01 | NPH01 | NXA01 | NHS01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-Nov-19 | | | | | | <1.0 | 4.24 | 2.3 | <1.0 | | | | | | | |
| 13-Nov-19 | | | | | | <1.0 | 4.88 | 4.86 | 4.18 | 3.95 | 1.19 | <1.0 | | | <1.0 | <1.0 |
| 14-Nov-19 | | 1.49 | <1.0 | <1.0 | <1.0 | | | | | | | | | <1.0 | | |
| 19-Nov-19 | <1.0 | | | | | | | | | | | | <1.0 | | | |
| 20-Nov-19 | | | | | | <1.0 | 2.97 | <1.0 | <1.0 | | | | | | | |
| 27-Nov-19 | | | | | | <1.0 | 3.26 | 3.9 | 2.3 | | | | | | | |

### 3.2.3 GROUNDWATER QUALITY MONITORING

During November 2019, community groundwater quality analyses were carried out for four wells located in Somseun Village, Nam Pa Village, Thong Noy Village and Pou Village.

All results of community groundwater complied with the groundwater quality standards for water supply purposes, except faecal coliform and E.Coli bacteria in Somseun, Thong Noy and NamPa Villages as per below Table.

***TABLE 3-8: GROUNDWATER QUALITY MONITORING RESULTS IN SOMSUEN, NAM PA, THONG NOI AND POU VILLAGES***

| Parameter (Unit) | Site Name | Somseun Village | NamPa Village | ThongNoy Village | Pou Village |
|---|---|---|---|---|---|
| | Station | GSXN01 | GNPA01 | GTHN01 | GPOU01 |
| | Guideline | | | | |
| pH | 6.5 - 9.2 | 7.12 | 6.93 | 6.82 | 7.02 |
| Sat. DO (%) | | 99.2 | 85.1 | 72.5 | 86.9 |
| DO (mg/L) | | 7.42 | 6.59 | 5.6 | 6.41 |
| Conductivity (µS/cm) | | 199.7 | 196.1 | 302 | 12.58 |
| TDS (mg/L) | | 99.5 | 98 | 151 | 6 |
| Temperature (°C) | | 26.1 | 27.5 | 28.4 | 29 |
| Turbidity (NTU) | <20 | 1.86 | 1.42 | 1.65 | 1.28 |
| Fecal coliform (MPN/100 ml) | 0 | 0 | 6.8 | 130 | 13 |
| E.Coli Bacteria (MPN/100 ml) | 0 | 0 | 6.8 | 130 | 0 |

### 3.2.4 GRAVITY FED WATER SUPPLY (GFWS) QUALITY MONITORING

During November 2019, water samples from water taps at Hat Gniun Village and Phouhomxay Village were analysed. The WPHX01 represents raw water in the head tank before the filtration system.

The results of the water quality analyses are presented in Table 1-9. All parameters complied with the National Drinking Water Standards except for faecal coliforms and E. Coli at WTHH02, WHGN02, WPHX01 (intake), WPHX02 (tap water at the primary school in Phouhomxay Village) and WPHX03 (tap water at a house in Phouhomxay Village). The villagers generally use tap water for washing and cleaning. They were informed about the results and were encouraged to boil water before drinking.

***TABLE 3-9: RESULTS OF THE GRAVITY FED WATER SUPPLY QUALITY MONITORING***

| Date | Parameter (Unit) | Site Name | Thaheau Village | Hat Gnuin Village | Phouhomxay Village | | |
|---|---|---|---|---|---|---|---|
| | | Station | WTHH02 | WHGN02 | WPHX01 | WPHX02 | WPHX03 |
| | | Guideline | | | | | |
| 21-Nov-19 | pH | 6.5 - 8.6 | 6.38 | 6.35 | 6.49 | 7.61 | 7.5 |
| 21-Nov-19 | Sat. DO (%) | | 106.1 | 100.5 | 94.5 | 88.8 | 86 |
| 21-Nov-19 | DO (mg/L) | | 8.61 | 8.9 | 7.79 | 6.9 | 6.9 |
| 21-Nov-19 | Conductivity (µS/cm) | <1,000 | 38 | 69.5 | 8.56 | 8.76 | 8.75 |

| | | Site Name | Thaheau Village | Hat Gnuin Village | Phouhomxay Village | | |
|---|---|---|---|---|---|---|---|
| | | Station | WTHH02 | WHGN02 | WPHX01 | WPHX02 | WPHX03 |
| Date | Parameter (Unit) | Guideline | | | | | |
| 21-Nov-19 | TDS (mg/L) | <600 | 19 | 34.5 | 4.2 | 4.3 | 4.4 |
| 21-Nov-19 | Temperature (°C) | <35 | 24.8 | 24.3 | 23.7 | 27.1 | 24.7 |
| 21-Nov-19 | Turbidity (NTU) | <10 | 4.01 | 3.85 | 1.5 | 1.64 | 1.47 |
| 21-Nov-19 | Faecal Coliform (MPN/100 mL) | 0 | 22 | 220 | 920 | 170 | 110 |
| 21-Nov-19 | E.coli Bacteria (MPN/100 mL) | 0 | 22 | 110 | 920 | 170 | 110 |

### 3.2.5 LANDFILL LEACHATE MONITORING

During November 2019, 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 did not comply with the total coliform and Houay Soup Landfill did not comply with the standard for faecal coliform and total coliform. However, the leachate was contained in the leachate ponds without discharging to the environment. EMO will continue to monitor the results and report in the next MPR. The landfill leachate monitoring results for November 2019 can be found in Table below.

***Table 3-10*: *RESULTS OF THE LANDFILL LEACHATE MONITORING***

| | | Site Name | NNP1 Landfill Leachate Monitoring | | | | | Houay Soup Landfill Leachate Monitoring | |
|---|---|---|---|---|---|---|---|---|---|
| | | Location | Pond No.01 | Pond No.02 | Pond No.03 | Pond No.04 | Discharge Point | Last pond | Discharge Point |
| | | Station | LL1 | LL2 | LL3 | LL4 | LL5 | LL6 | LL7 |
| Date | Parameter (Unit) | Guideline | | | | | | | |
| 4-Nov-19 | pH | 6.0-9.0 | | | | 7.79 | | 7.19 | |
| 4-Nov-19 | Sat. DO (%) | | | | | 128.6 | | 159.6 | |
| 4-Nov-19 | DO (mg/L) | | | | | 9.71 | | 11.42 | |
| 4-Nov-19 | Conductivity (µS/cm) | | | | | 90.1 | | 396 | |
| 4-Nov-19 | TDS (mg/L) | | | | | 45.5 | | 198 | |
| 4-Nov-19 | Temperature (°C) | | | | | 28.2 | | 31.4 | |
| 4-Nov-19 | Turbidity (NTU) | | | | | 7.82 | | 10.83 | |
| 4-Nov-19 | $BOD_5$ (mg/L) | <30 | | | | 17.04 | | 11.73 | |
| 4-Nov-19 | COD (mg/L) | <125 | | | | 78.7 | | 118 | |

| | | Site Name | NNP1 Landfill Leachate Monitoring | | | | | Houay Soup Landfill Leachate Monitoring | |
|---|---|---|---|---|---|---|---|---|---|
| | | Location | Pond No.01 | Pond No.02 | Pond No.03 | Pond No.04 | Discharge Point | Last pond | Discharge Point |
| | | Station | LL1 | LL2 | LL3 | LL4 | LL5 | LL6 | LL7 |
| Date | Parameter (Unit) | Guideline | | | | | | | |
| 4-Nov-19 | Faecal Coliform (MPN/100 ml) | <400 | | | | 220 | | 920 | |
| 4-Nov-19 | Total Coliform (MPN/100 ml) | <400 | | | | 1,600 | | 1,600 | |

### 3.2.6 Dust Monitoring

The results indicate that the dust levels at all monitoring stations comply with the National Standard during the monitored period in November 2019. The results were shared internally with NNP1PC Technical Department as a reference for following-up inspection to ensure proper establishment of health and safety procedures.

### 3.2.7 Noise Monitoring

During November 2019, there was no noise monitoring due to equipment failure. Unfortunately, the equipment representative in Vietnam informed that they would not be able to provide maintenance services. The equipment will be sent to the supplier in the US for maintenance in early 2020. Regardless, noise was not a major issue at the nearby villages after all the construction activities were completed in August 2019.

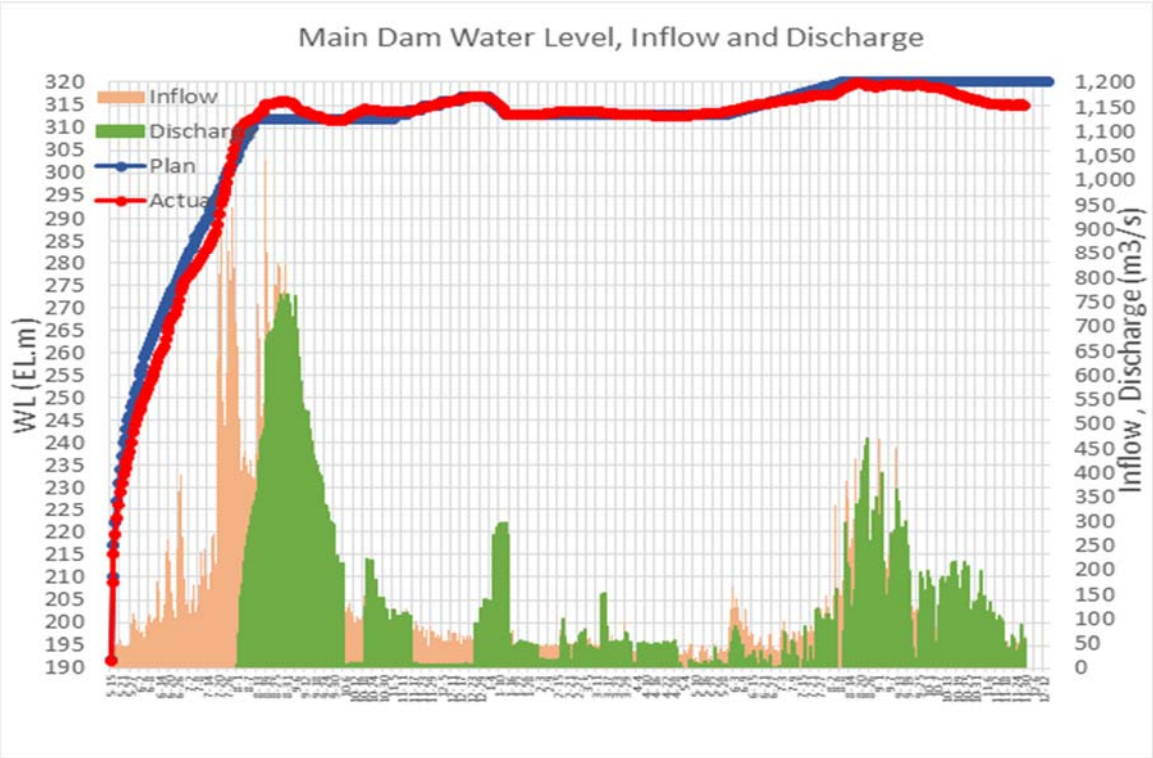
### 3.2.8 Discharge Monitoring

The water level in the main reservoir, inflow to the reservoir and discharge from the reservoir since the start of the impounding on 15 May 2018 is presented in the graph in Figure 3-3.

During November 2019, the mean inflow to the main reservoir was 54 m3/s (min 22 m3/s and max 87 m3/s) decreasing from about 70 m3/s to 40 m3/s over the course of the month as the wet season draws to an end. The water level in the main reservoir gradually dropped 1 m from El. 316 m asl to El. 315 m asl.

In November 2019, the total turbine discharge from both units at the main dam varied between about 100 m3/s and 200 m3/s interrupted, usually during night-time periods, with no discharge.

***FIGURE 3-3: PROGRESS OF IMPOUNDING THE MAIN RESERVOIR***

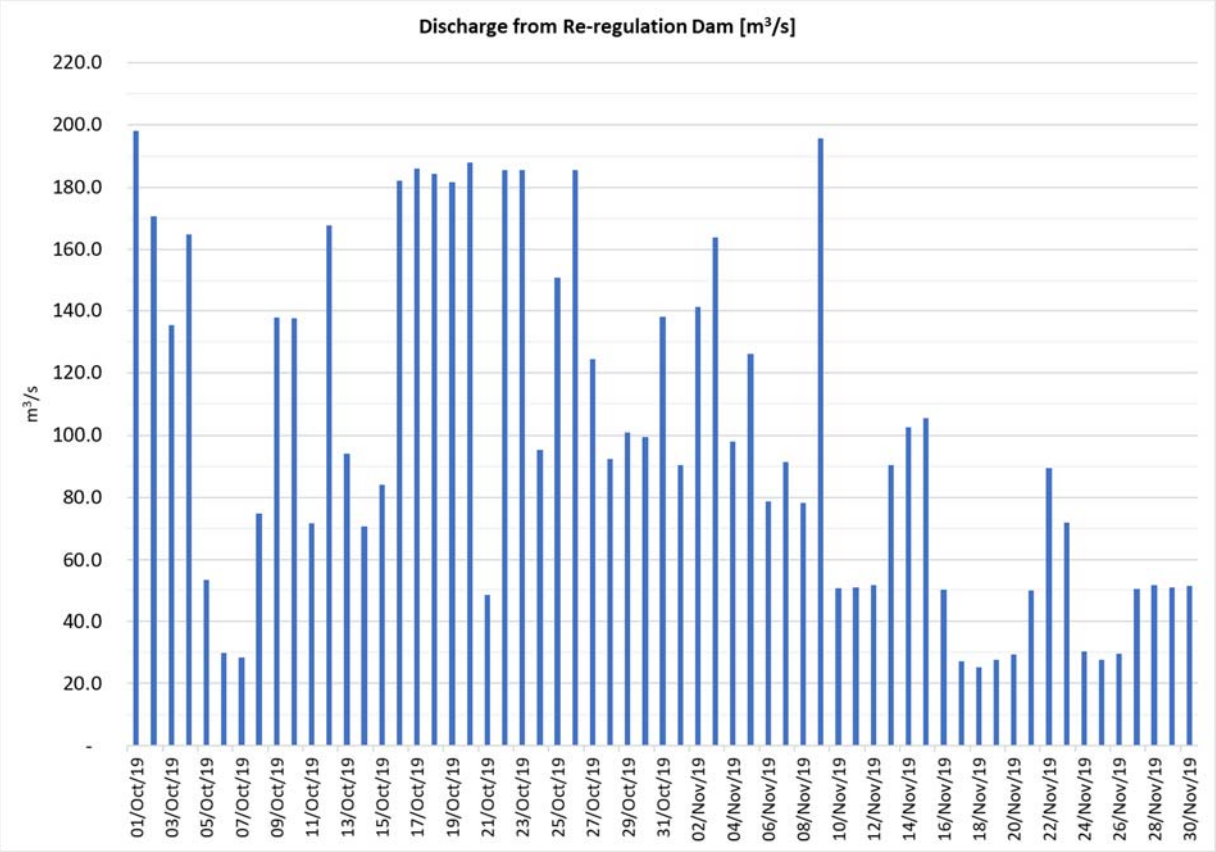



The discharge monitoring data for the re-regulation dam during October and November 2019 is presented in Figure below;

The turbine at the re-regulation powerhouse has been under repair and out of operation from end of August 2019 to 09 November 2019, and during that period all discharges from the re-regulation dam has passed through the gate and/or over the labyrinth weir – with a mean total discharge of 120 m3/s from 01 November to 09 November. During the remaining part of November 2019, the turbine has been in operation about 2/3 of the time with discharges varying between 50 m3/s and 160 m3/s, and the gate has been in use a third of the time with a mean discharge of about 30 m3/s, only interrupted by short periods (about 4% of the time) with discharge from both the turbine and the gate.

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 IN OCTOBER AND NOVEMBER 2019*




### 3.2.9 NAM NGIEP DOWNSTREAM WATER DEPTH MONITORING

In November 2019, EMO carried out four boat missions to monitor the water depth in the Nam Ngiep downstream of the re-regulation dam. A total of 19 sites have been identified with potential shallow water depths. None of these sites were difficult to navigate.

## 3.3 PROJECT WASTE MANAGEMENT

### 3.3.1 SOLID WASTE MANAGEMENT

In November 2019, a total of 48.5 m3 of solid waste was disposed of at the NNP1 Project Landfill, a decrease of 13.7 m3 compared to October 2019. During November 2019, EMO conducted three waste spot checks at the NNP1 Project Landfill, construction sites and camps. Mixed waste inside the waste bins continued to be found at the Song Da 5 Camp No.1, and RCC Plant as part of their decommissioning activities. NNP1PC issued ONC and instructed the supervisors of all concerned Contractors and subcontractors to improve and ensure proper waste management practices.

A total of 367 kg of recyclable waste was sold to Khounmixay Processing Factory. The remaining scrap metal is expected to be sold or transported off site by the Contractor later next month.

***TABLE 3-11: AMOUNTS OF RECYCLABLE WASTE SOLD***

| Source and Type of Recycled Waste | | Unit | Sold | Cumulative Total at 31 November 2019 |
|---|---|---|---|---|
| **Construction Activity** | | | | |
| 1 | Scrap metal | kg | 0 | 0 |
| **Sub-Total 1** | | **kg** | **0** | **0** |
| **Camp Operations** | | | | |
| 2 | Glass bottles | kg | 232 | 114 |
| 3 | Plastic bottles | kg | 52 | 113 |
| 4 | Paper/Cardboard | kg | 66 | 85 |
| 5 | Aluminium cans | kg | 17 | 49 |
| **Sub-Total 2** | | **kg** | **367** | **361** |
| **Grand Total 1+2** | | **kg** | **367** | **361** |

The villagers of Phouhomxay Village collected a total of 2,455 kg of food waste from selected camps for animal feed in November 2019, a decrease of 321 kg compared to October 2019 as a result of GFE, Zhefu, 276, Lilama 10, and V&K Camp decommissioning and a reduction in the number of construction workers at the Song Da 5 Camps.

***TABLE 3-12: AMOUNTS OF FOOD WASTE COLLECTED BY VILLAGERS***

| No. | Site Name | Unit | Total |
|---|---|---|---|
| 1 | Song Da 5 Camp No. 1 | kg | 517 |
| 2 | Obayashi Corporation Camp | kg | 743 |
| 3 | Owner's Village and Site Office (OSOV) | kg | 997 |
| 4 | Lilama 10 Camp | kg | 198 |
| **Total** | | **kg** | **2,455** |

### 3.3.2 HAZARDOUS MATERIALS AND WASTE MANAGEMENT

The types and amounts of hazardous waste stored on site for treatment and final disposal at Khounmixay Processing Factory in November 2019 are shown below.

***TABLE 3-13: RESULTS OF HAZARDOUS MATERIAL INVENTORY***

| No. | Hazardous Waste Type | Unit | Total in November 2019 (A) | Disposed (B) | Remainder (A - B) |
|---|---|---|---|---|---|
| 1 | Used hydraulic and engine oils | litre | 2,960 | 0 | 2,960 |
| 2 | Ink cartridges | unit | 213 | 0 | 213 |
| 3 | Used tyres | piece | 141 | 0 | 141 |
| 4 | Used oil filters | piece | 100 | 0 | 100 |
| 5 | Contaminated soil, sawdust and concrete | bag | 45 | 0 | 45 |
| 6 | Empty used chemical drum/container | drum (200 L) | 42 | 0 | 42 |
| 7 | Empty contaminated bitumen drum/container | drum (200 L) | 20 | 0 | 20 |
| 8 | Empty used oil drum/container | drum (20 L) | 17 | 0 | 17 |
| 9 | Clinical waste | kg | 15 | 0 | 15 |
| 10 | Halogen/fluorescent bulbs | unit | 15 | 0 | 15 |
| 11 | Lead acid batteries | unit | 22 | 15 | 7 |
| 12 | Contaminated textile and material | kg | 7 | 0 | 7 |
| 14 | Empty paint and spray cans | can | 7 | 0 | 7 |
| 15 | Lithium-ion batteries | unit | 7 | 2 | 5 |

In addition, a total of 28 $m^3$ of sewage sludge/black water from toilets of V&K Camp was transported and disposed of at the Spoil Disposal Area No. 6 as part by following the NNP1PC Standard Operating Procedure (SOP) on Sewage/Black Water Disposal.

## 3.4 COMMUNITY WASTE MANAGEMENT

### 3.4.1 COMMUNITY RECYCLING PROGRAMME

In November 2019, the Community Waste Bank received 129 kg of recyclable waste making a total of 2,030.5 kg of recyclable waste remaining in the Bank.

**TABLE 3-14: *TYPES AND AMOUNTS OF RECYCLABLE WASTE TRADED AT THE COMMUNITY WASTE BANK***

| Types of Waste | Unit | Remaining in October 2019 | Additional in November 2019 | Sold | Remaining in November 2019 |
|---|---|---|---|---|---|
| Scrap metal | kg | 9.5 | 0 | 9.5 | 0 |
| Glass bottles | kg | 1,710 | 129 | 732 | 1,107 |
| Paper/cardboard | kg | 923.5 | 0 | 0 | 923.5 |
| Aluminium cans | kg | 1.5 | 0 | 1.5 | 0 |
| Plastic bottles | kg | 149 | 0 | 149 | 0 |
| **Total** | **kg** | **2,793.5** | **129** | **892** | **2,030.5** |

### 3.4.2 COMMUNITY SOLID WASTE MANAGEMENT

In November 2019, a total of 65 m3 of solid waste was collected from Phouhomxay, Thahuea and Hat Gnuin Villages. The solid waste was transported to Houay Soup Landfill, where recyclable materials were segregated before the waste was disposed of at the landfill.

On 21 November 2019, authorities and villagers of Phouhomxay Village carried out a waste clean-up and cutting grass on the both sides of the access road, village meeting hall, health centre, market and bus station, village area and other area for Mong New Year celebration at the end of this month. All the solid waste was transported and disposed of at Houay Soup landfill by the local Contractor.

## 3.5 WATERSHED AND BIODIVERSITY MANAGEMENT

### 3.5.1 WATERSHED MANAGEMENT

#### 3.5.1.1 IMPLEMENTATION OF ANNUAL IMPLEMENTATION PLAN (AIP) 2019

ADB provided a no objection to the proposed AIP2019 (October to December 2019) of Xaysomboun and Bolikhamxay Provinces on 06 November 2019. The Xaysomboun and Bolikhamxay Provincial Watershed and Reservoir Protection Offices (WRPO) further revised their proposal and submitted these to the Department of Forestry (DOF), Ministry of Agriculture and Forestry (MAF) on 22 November 2019. The DOF-MAF issued an official request for fund disbursement to NNP1PC on 25 November 2019.

The total requested budget of both Provinces' AIPs is USD 154,785 which will be funded from two different sources:

1) USD 112,034 from the Watershed Management Fund (WMF) under GoL's CA budget; and

2) USD 42,751 from NNP1PC additional No Net Loss (NNL) commitment.

NNP1PC is processing the fund disbursement and it is expected that GOL will receive the funds in the second week of December 2019.

NNP1PC-EMO together with a consultant is preparing a Fishery Co-Management Plan. The team conducted village level consultations, field visits and assessment at NNP1 watershed villages between 19 and 26 November 2019. NNP1PC expect to receive the first draft of the Plan on 16 December 2019.

NNP1PC-EMO is recruiting a local consultant to conduct an assessment of options for sustainable livelihood opportunities focussing on nine villages in Xaysomboun Province comprising Houayxay and Phu Ngou Villages in Hom District; Om, Korhai and Thamlo Villages in Anouvong District; Thaviengxay, Naxong, Nahong, and Phonehom Villages in Thathom District. The technical evaluation was concluded on 22 November 2019 and the contract is expected to be settled on 20 December 2019.

### 3.5.2 BIODIVERSITY OFFSET MANAGEMENT

#### 3.5.2.1 APPROVAL OF BIODIVERSITY SERVICE PROVIDER (BSP)

NNP1PC was informed by ADB that a letter was submitted to the Minister of the Ministry of Planning and Investment on 10 September 2019 requesting for a no objection to a proposed

ADB Technical Assistance Project called *C-TA0031-REG: Facilitating Effective Biodiversity Offsets in Private Sector Operations* that would bring the Biodiversity Service Provider (Wildlife Conservation Society) to support the NNP1 Project. It is expected that the GOL will provide a no objection soon. NNP1PC management and the Board of Directors from the EGATi and Lao Holding State Entreprise (LHSE) also planned to visit the Vice-Minister of MAF on 06 December 2019 to further discuss and obtain his guidance about the BSP (WCS) engagement.

#### 3.5.2.2 IMPLEMENTATION OF BOMP ANNUAL IMPLEMENTATION PLAN (AIP) 2019

Progresses on the implementation of activities by Component are described below:

**a. Component 1 - Spatial Planning and Regulation**

The Vice Chairman of Bolikhamxay Provincial Biodiversity Offset Management Committee (BOMC) and both District Governors of Xaychamphone and Viengthong Districts advised the Biodiversity Offset Management Unit (BOMU) in the first week of November 2019 to complete the boundary demarcation of Totally Protection Zone (TPZ) agreed with the villagers and conduct community awareness activity on the agreed boundary prior to obtaining an official recognition by GOL.

Bolikhamxay Provincial BOMU procured 60 small signs (40x40 cm), 50 concrete poles, and six big signs (2x3 m) that will be installed at designated locations along the TPZ boundary in the NC-NX as well as within six NC-NX villages. Installation of written signs and poles are standard GOL's method to inform villagers of the TPZ areas.

**b. Component 2 – Law Enforcement**

Four teams continued patrolling in November 2019.

One team focussed the patrolling efforts in the TPZ highest priority area covering Nam San, Nam Chang, Houy Xai Gnai, Houy Xai Noi, Houy Poung and Nam Xi. Two teams focussed their patrolling efforts in the TPZ higher priority area covering Nam Kha Gna, Nam Houng, Nam Kama and Nam Kapa, Nam Somfard and Houy Tong. One team conducted joint patrolling with Pu Mat National Team along the Lao-Vietnam border at Houay Wot-Wot, Houay Tong, Houay Or of Xaychamphone District.

The team in the TPZ highest priority area spent 16 days covering a distance of 37 km on road access patrolling and 61 km on forest patrolling. The teams made a total of eight direct observations and six indirect observations of the following wildlife: macaques, white-cheeked gibbon, otter, civet, black giant squirrels, phay're leaf monkey, muntjac and wild pig. There were no threats observed in the area during the patrolling.

The two teams in the TPZ higher priority area spent 12 to 16 days on forest patrolling covering a distance between 58 and 74 km. The team made a total of eight direct observations and four indirect observations of the following wildlife: macaques, muntjac, black giant squirrels, white-cheeked gibbons, brown hornbill, red-shanked douc langurs, phay're leaf monkey, Indochinese serow and wild pig. The teams encountered and destroyed five fishing camps and nine hunting camps around Nam Houng area that were suspected to have been used by the local people from Na Gnang Village. The team also encountered with one poacher who immediately dropped his home-made gun and flee from the area. The gun was confiscated by the team.

The team also observed 14 locations of tree logging around Nam Houng area close to Na Gnang Village.

The team that conducted a joint patrolling with Pu Mat National Park team spent a total of 17 days covering a distance of 18 km on road access patrolling and 51 km forest patrolling. The joint patrolling team encountered 350 small wire snares set across Lao-Vietnam border but unsure whether it was set by Vietnamese or Lao poachers/hunters. A debriefing session was organized at the Lao-Viet border post 441 and 442. A Memorandum of Understanding (MOU) was signed for the continuation of joint patrolling with the engagement of border military from both countries. The meeting also recommended NC-NX BOMU to consider using advanced equipment to support the law enforcement activities such as camera traps along the border and satellite phone to ease the communication between Lao and Vietnam patrol teams in the remote and forested area.

The monthly patrolling meeting was organized on 13 November 2019 with the following key notes:

- The teams should continue the patrolling efforts focussing on the TPZ priority area.
- A visit by BOMC is needed to solve the logging issue at Na Gnang Village. Provincial military is keen to provide their support as needed.
- Advanced equipment to support the continuation of joint patrolling especially satellite phone to be considered under AIP2020.
- The patrolling teams need to assess the skills of the villagers who are recruited as patrolling team members.
- Two teams will continue the patrolling in Nam Houng - TPZ Higher Priority Area (Na Gnang Village), one team will continue in Nam Ma - TPZ Higher Priority Area and one will continue in the TZP highest priority area.

**c. Component 4 – Conservation linked livelihood development**

NNP1PC is in progress of recruiting a consultant to prepare a Community Development Plan (CDP) for the six NC-NX villages. NNP1PC concluded the technical evaluation on 22 November 2019. The contract is expected to be settled on 20 December 2019.

**FIGURE 3-5 : MAP OF THREATS RECORDED BY TWO PATROLLING TEAMS IN OCTOBER – NOVEMBER 2019**

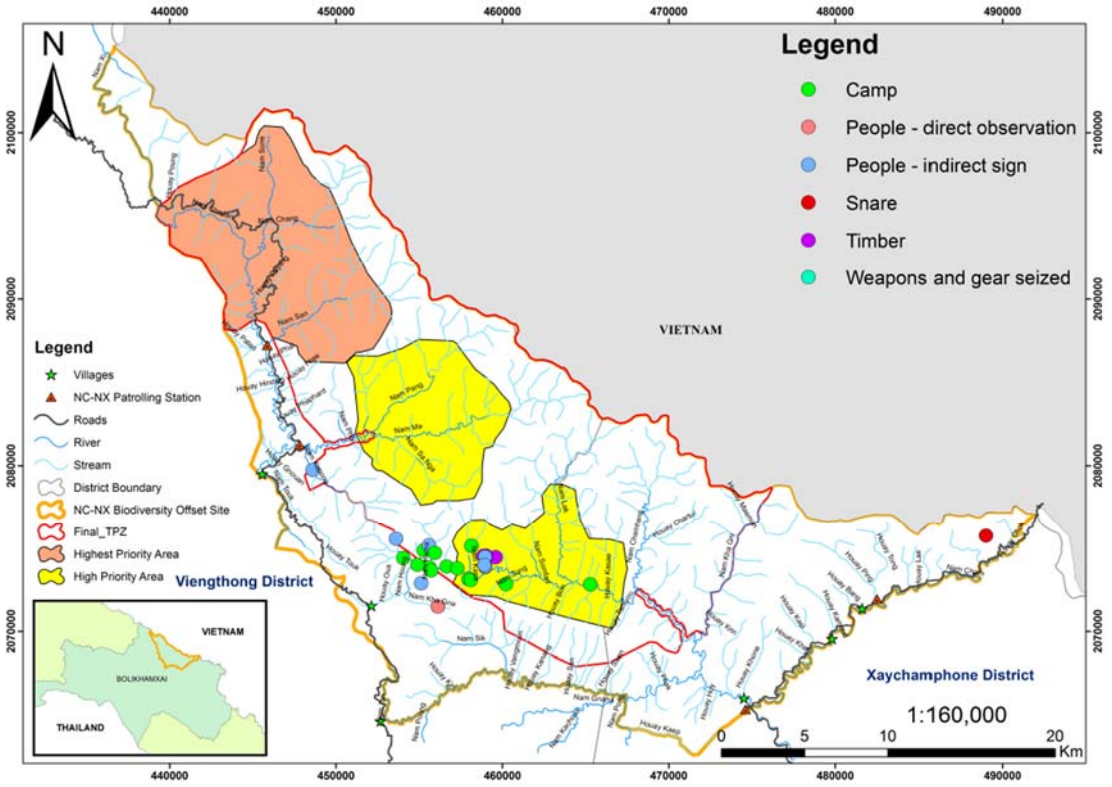



**FIGURE 3-6 : MAP OF WILDLIFE SIGNS RECORDED BY TWO PATROLLING TEAMS IN OCTOBER – NOVEMBER 2019**

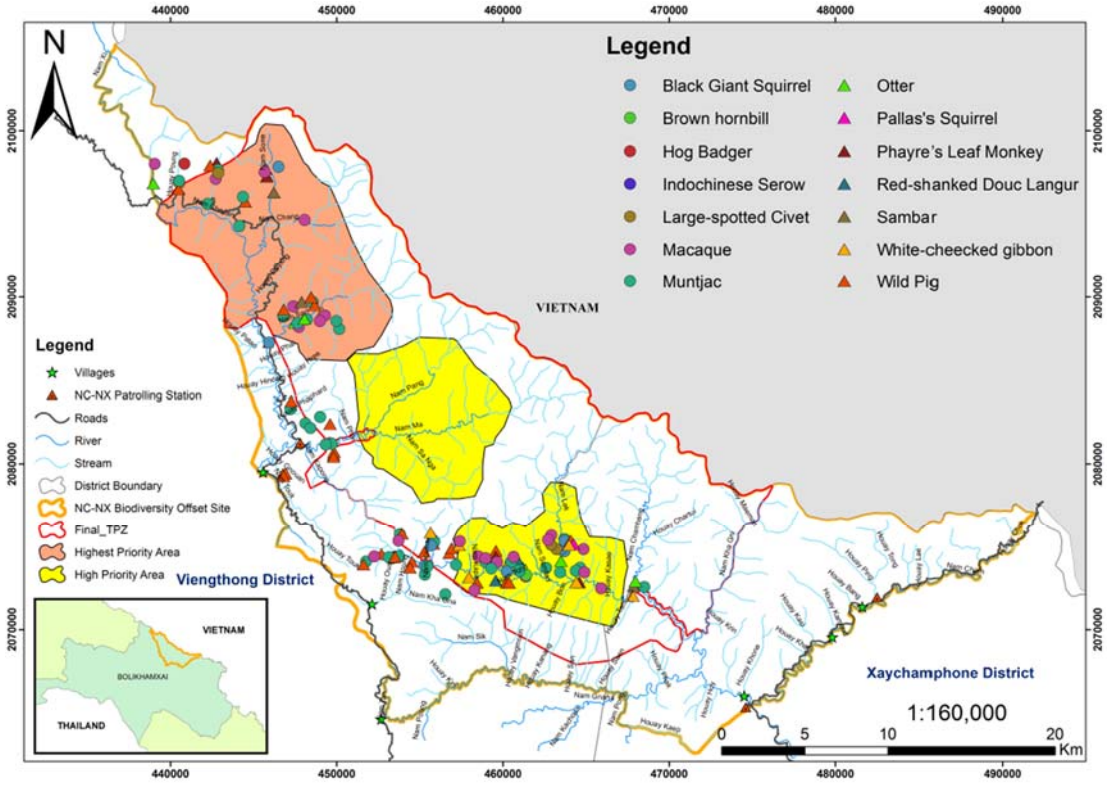



FIGURE 2-3. CUT TREE AND LOGS CLOSE TO NA GNANG VILLAGE


FIGURE 2-4. HUNTING CAMP OBSERVED AROUND NAM HOUNG – TPZ HIGHER PRIORITY AREA

FIGURE 2-5. CONFISCATED HANDMADE GUN

FIGURE 2-6. RED-SHANKED DOUC LANGURS IN NAM HOUNG AREA – TPZ HIGHER PRIORITY AREA

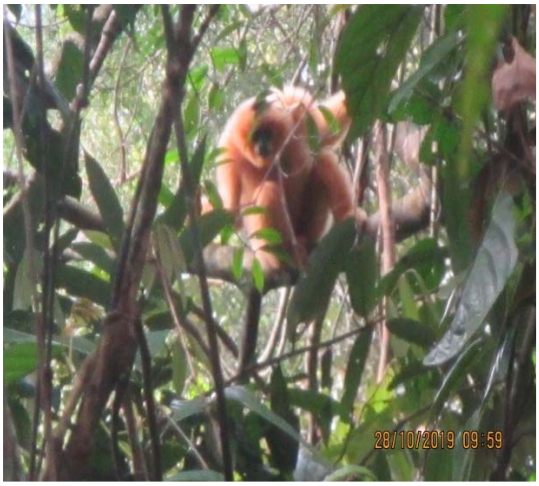



FIGURE 2-7. GIBBON IN NAM HOUNG AREA – TPZ HIGHER PRIORITY AREA

FIGURE 2-8. BROWN HORNBILL IN NAM HOUNG AREA – TPZ HIGHER PRIORITY AREA

## 3.6 FLOATING DEBRIS REMOVAL

As planned, there was no cutting and burning during this reporting period. NNP1PC-EMO conducted regular monitoring and removal of floating materials/logs from the temporary log-boom as needed.

# 4. FISHERY MONITORING

Three species groups and two species dominated the fish catch by weight in October 2019 as listed in ***Table 4-1.*** All species are classified as Least Concern (LC) according to the IUCN Red List of Threatened Species[1].

***TABLE 4-1: FISH SPECIES DOMINATING THE FISH CATCH IN OCTOBER 2019***

| Species | Lao Name | Fish Catch (kg) | IUCN Red List Classification |
|---|---|---|---|
| *Poropuntius normani, Poropuntius laoensis,Poropuntius carinatus* | ປາຈາດ | 215.5 | LC |
| *Channa striata* | ປາຖ່ໍ | 138.6 | LC |
| *Mastacembelus armatus, Mastacembelus favus* | ປາສູດ | 113.8 | LC |
| *Hampala dispar, Hampala macrolepidota* | ປາດຸກ | 85.8 | LC |
| *Clarias batrachus* | ປາຫຼາດ | 79.3 | LC |

The recorded catch of Threatened and Near Threatened species (IUCN Red List classification) in October 2019 is presented in ***Table 4-2***. The list includes one species that are classified as Endangered (EN), three Vulnerable (VU) species and six Near Threatened (NT) species.

***TABLE 4-2: THREATENED SPECIES OF OCTOBER 2019 FISH CATCH***

| Species | Lao Name | Fish Catch (kg) | IUCN Red List Classification |
|---|---|---|---|
| *Cirrhinus molitorella* | ປາແກງ | 0.5 | NT |
| *Cyprinus carpio* | ປາໄນ | 3 | 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 | Lao Name | Fish Catch (kg) | IUCN Red List Classification |
|---|---|---|---|
| *Mekongina erythrospila* | ปาสะอิ | 0.2 | NT |
| *Neolissochilus stracheyi* | ปาสอๆ | 1.6 | NT |
| *Onychostoma gerlachi* | ปาถิๆ | 2.7 | NT |
| *Probarbus jullieni* | ปาเอิม | 15 | EN |
| *Scaphognathops bandanensis* | ปาอวมไฟ/ปาป่วม | 26.2 | VU |
| *Syncrossus beauforti* | ปาแข้วไก้/ปาซู | 2.3 | NT |
| *Tor sinensis* | ปาแดๆ | 31.3 | VU |
| *Wallago attu* | ปาถ้าอ | 2.9 | 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 2019 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 - OCTOBER 2019***

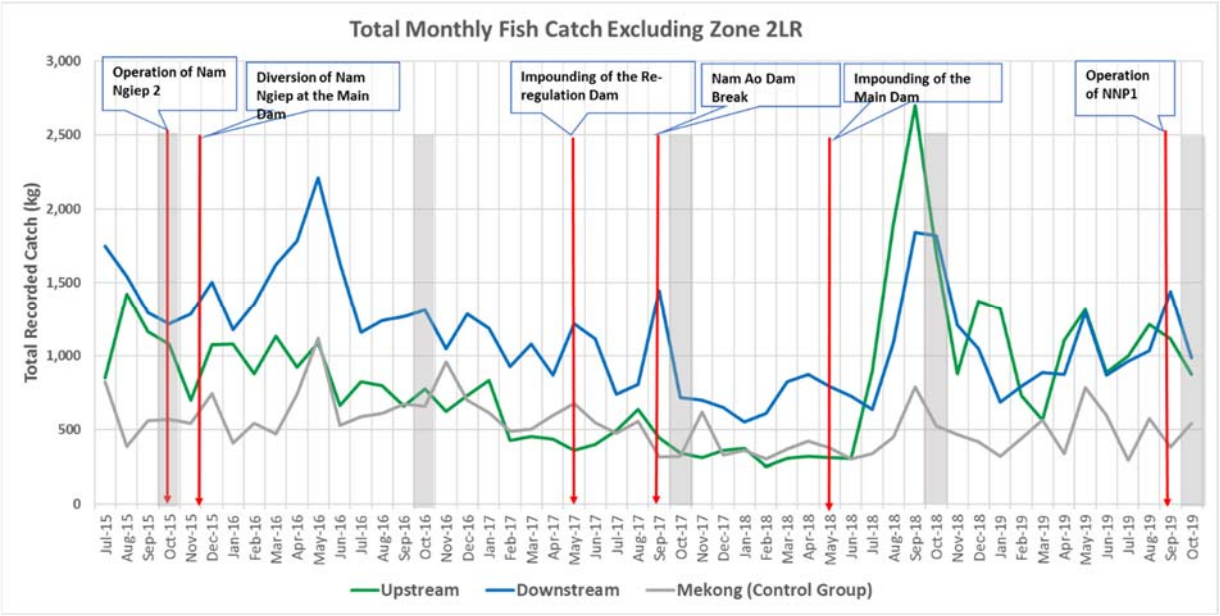
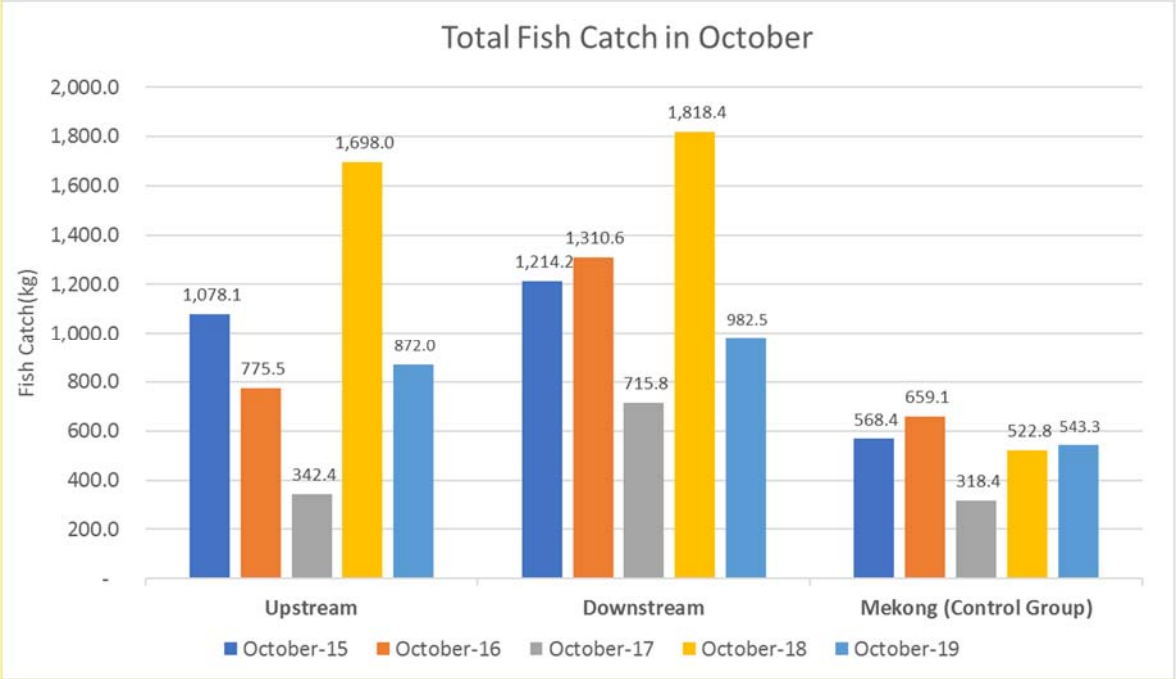



***Table 4-3*** and ***Figure 4-2*** show the total recorded fish catch for October 2015, October 2016, October 2017, October 2018 and October 2019 in the upstream (excluding Zone 2LR) and downstream communities and the Mekong control group. The total fish catch data represents the total fish supply 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 OCTOBER 2016, OCTOBER 2017, OCTOBER 2018, AND OCTOBER 2019***

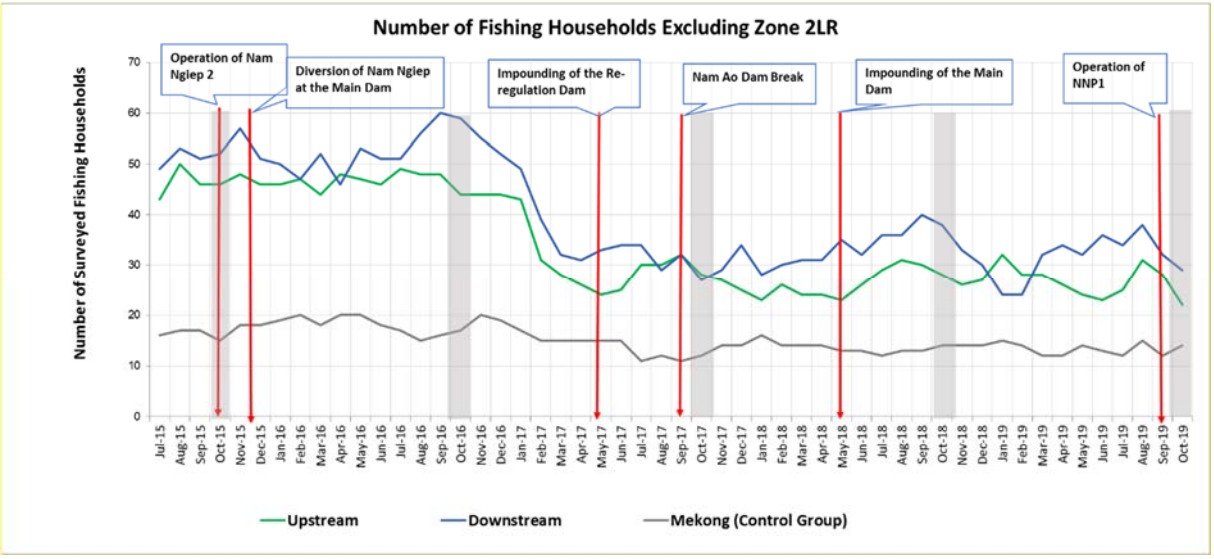
| Fishing Zone | October 2015 (kg) | October 2016 (kg) | October 2017(kg) | October 2018(kg) | October 2019 (kg) |
|---|---|---|---|---|---|
| Upstream | 1,078.1 | 775.5 | 342.4 | 1,698.0 | 872.0 |
| Downstream | 1,214.2 | 1,310.6 | 715.8 | 1,818.4 | 982.5 |
| Mekong Control Group | 568.4 | 659.1 | 318.4 | 522.8 | 543.3 |

***FIGURE 4-2: TOTAL RECORDED FISH CATCH BY UPSTREAM (EXCLUDING ZONE 2LR), DOWNSTREAM AND MEKONG CONTROL GROUP FISHING HOUSEHOLDS IN OCTOBER 2016, OCTOBER 2017, OCTOBER 2018, AND OCTOBER 2019***



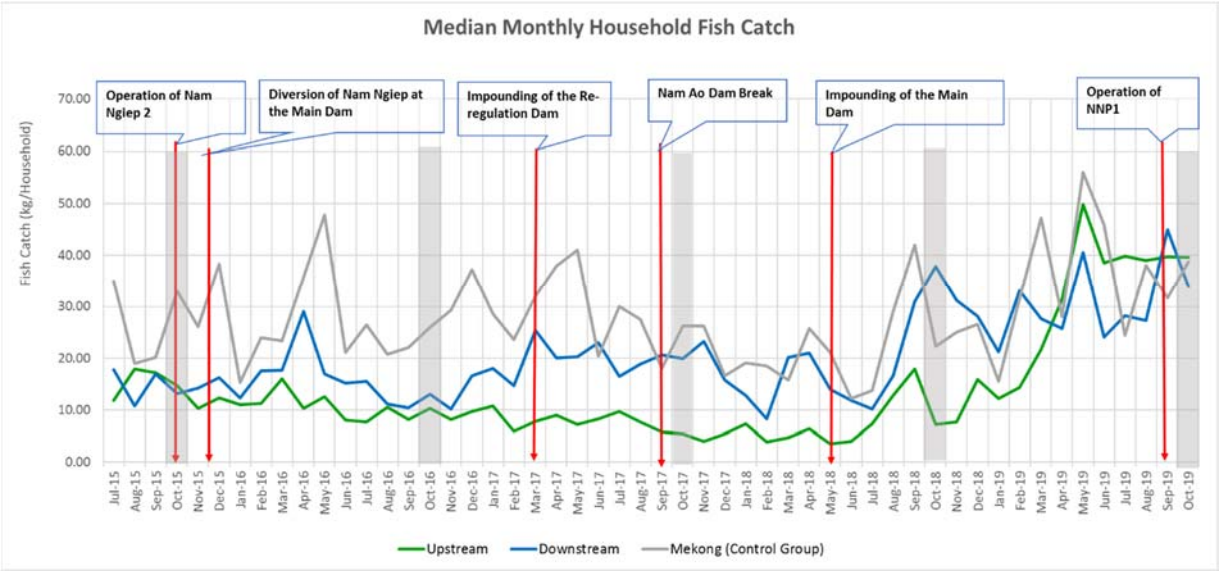

The numbers of fishing households involved in the fish catch monitoring programme are displayed in ***Figure 4-3***.

***FIGURE 4-3: NUMBER OF FISHING HOUSEHOLDS INVOLVED IN THE FISH CATCH MONITORING PROGRAMME***




The median monthly household fish catch from July 2015 to October 2019 for the upstream (excluding Zone 2LR) and downstream communities and the Mekong control group are presented in ***Figure below***.

***FIGURE 4-4: MEDIAN MONTHLY HOUSEHOLD FISH CATCH WITHOUT ZONE 2LR***




The median household fish catch for October 2015, October 2016, October 2017, October 2018 and October 2019 in the upstream (excluding Zone 2LR) and downstream communities and the Mekong control group are displayed in Table below;

***TABLE 4-4: MEDIAN MONTHLY HOUSEHOLD FISH CATCH IN THE UPSTREAM AND DOWNSTREAM COMMUNITIES EXCLUDING ZONE 2LR***

| Fishing Zone | October 2015 (kg) | October 2016 (kg) | October 2017 (kg) | October 2018 (kg) | October 2019(kg) |
|---|---|---|---|---|---|
| Upstream | 14.8 | 10.3 | 5.5 | 7.2 | 39.6 |
| Downstream | 13.2 | 13.0 | 19.9 | 37.8 | 33.9 |
| Mekong Control Group | 33 | 26.0 | 26.3 | 22.3 | 38.8 |

The median daily fish catch per household are displayed in ***Figure 4-5,*** and the median fish catch per household per fishing day in October 2015, October 2016, October 2017, October 2018 and October 2019 are shown in Table below;

***FIGURE 4-5: MEDIAN DAILY FISH CATCH PER HOUSEHOLD***

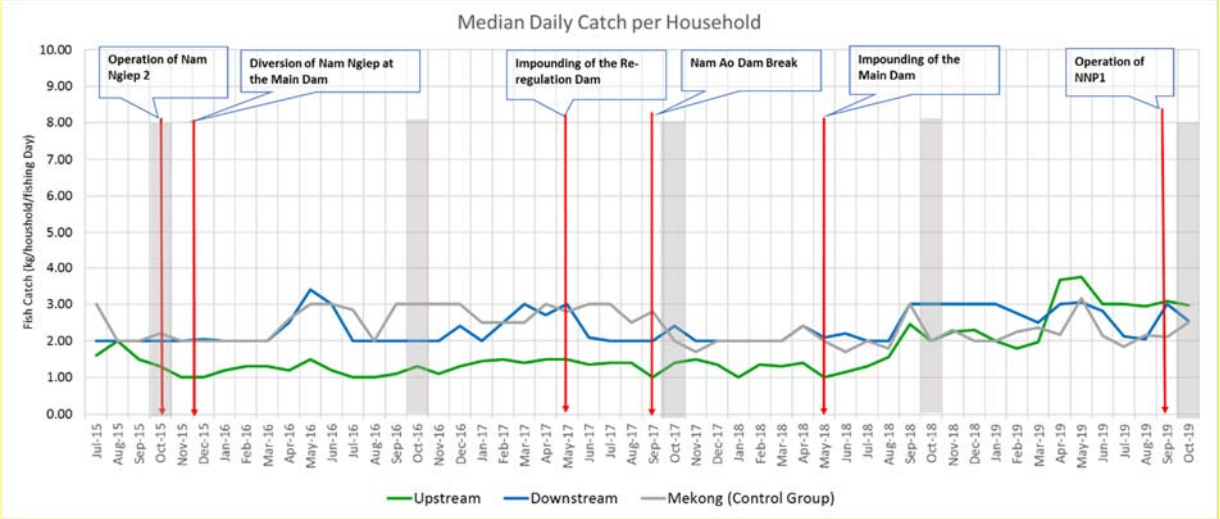



***TABLE 4-5: MEDIAN DAILY FISH CATCH PER HOUSEHOLD IN OCTOBER 2019***

| Fishing Zone | October 2015 (kg) | October 2016 (kg) | October 2017 (kg) | October 2018 (kg) | October 2019 (kg) |
|---|---|---|---|---|---|
| Upstream | 1.30 | 1.30 | 1.40 | 2.00 | 2.98 |
| Downstream | 2.00 | 2.00 | 2.40 | 3.00 | 2.55 |
| Mekong (Control Group) | 2.20 | 3.00 | 2.00 | 2.00 | 2.50 |

# ANNEXES

# ANNEX A: RESULTS OF WATER QUALITY MONITORING

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

| | | River Name | Nam Ngiep | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Zone | Location Refer to Construction Sites | | | | | | | | | | | |
| | | | Upstream | | | | | | Within / Re-regulation Reservoir | | Downstream | | | |
| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG05 | NNG06 | NNG07 | NNG08 |
| Date | Parameters (Unit) | Guideline | | | | | | | | | | | | |
| 1-Nov-19 | pH | 5.0 - 9.0 | | | | | | | 7.3 | 7.57 | 7.62 | 8.07 | | |
| 2-Nov-19 | pH | 5.0 - 9.0 | | | | | | 7.71 | 7.72 | | 7.73 | | | |
| 5-Nov-19 | pH | 5.0 - 9.0 | | | | | 7.91 | | | | | | | |
| 6-Nov-19 | pH | 5.0 - 9.0 | | | | | | 8.01 | 7.41 | 7.37 | 7.62 | 7.42 | 6.8 | 6.68 |
| 7-Nov-19 | pH | 5.0 - 9.0 | | 6.36 | 6.34 | 6.39 | | | | | | | | |
| 8-Nov-19 | pH | 5.0 - 9.0 | | | | | | 6.4 | 6.4 | 6.51 | 6.51 | 7.16 | | |
| 9-Nov-19 | pH | 5.0 - 9.0 | | | | | | 6.65 | 6.57 | | 6.52 | | | |
| 13-Nov-19 | pH | 5.0 - 9.0 | | | | | | 6.74 | 6.38 | 6.5 | 6.53 | 6.06 | 7.15 | 7.28 |
| 14-Nov-19 | pH | 5.0 - 9.0 | | 7.05 | 7.18 | 6.94 | 6.85 | | | | | | | |
| 15-Nov-19 | pH | 5.0 - 9.0 | | | | | | 7.02 | 6.57 | 6.62 | 6.51 | 7.11 | 7.61 | 7.88 |
| 16-Nov-19 | pH | 5.0 - 9.0 | | | | | | 6.74 | 6.5 | | 6.51 | 6.93 | | |
| 19-Nov-19 | pH | 5.0 - 9.0 | 7.6 | 7.27 | 7.1 | 6.84 | 6.6 | | | | | | | |
| 20-Nov-19 | pH | 5.0 - 9.0 | | | | | | 6.63 | 6.74 | 7.04 | 7.49 | 6.32 | 6.19 | 6.34 |
| 22-Nov-19 | pH | 5.0 - 9.0 | | | | | | 6.98 | 6.3 | 6.78 | 6.81 | 7.12 | | |
| 23-Nov-19 | pH | 5.0 - 9.0 | | | | | | 7.16 | 6.33 | | 6.92 | | | |
| 26-Nov-19 | pH | 5.0 - 9.0 | | 6.94 | 6.83 | 6.01 | 6.56 | | | | | | | |
| 27-Nov-19 | pH | 5.0 - 9.0 | | | | | | 6.66 | 6.66 | 6.41 | 6.42 | 6.16 | 6.72 | 7.15 |
| 29-Nov-19 | pH | 5.0 - 9.0 | | | | | | 7.09 | 6.1 | 6.47 | 6.72 | 7.29 | | |
| 30-Nov-19 | pH | 5.0 - 9.0 | | | | | | 7 | 6.32 | | 6.34 | | | |
| 1-Nov-19 | Sat. DO (%) | | | | | | | | 8.9 | 34.3 | 81.9 | 80.1 | | |
| 2-Nov-19 | Sat. DO (%) | | | | | | | 81.9 | 32.5 | | 82.1 | | | |

| | | River Name | Nam Ngiep | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Zone | Location Refer to Construction Sites | | | | | | | | | | | |
| | | | Upstream | | | | | | Within / Re-regulation Reservoir | | Downstream | | | |
| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG05 | NNG06 | NNG07 | NNG08 |
| Date | Parameters (Unit) | Guideline | | | | | | | | | | | | |
| 5-Nov-19 | Sat. DO (%) | | | | | | 76 | | | | | | | |
| 6-Nov-19 | Sat. DO (%) | | | | | l | | 75.5 | 7.5 | 4 | 76.6 | 93.5 | 91.6 | 91.1 |
| 7-Nov-19 | Sat. DO (%) | | | 98.1 | 84.7 | 91.9 | | | | | | | | |
| 8-Nov-19 | Sat. DO (%) | | | | | | | 89.5 | 11.6 | 10.5 | 98.6 | 93.7 | | |
| 9-Nov-19 | Sat. DO (%) | | | | | | | 76.4 | 17 | | 83.5 | | | |
| 13-Nov-19 | Sat. DO (%) | | | | | | | 72.1 | 4.7 | 11.6 | 27.2 | 34.7 | 58.7 | 80.8 |
| 14-Nov-19 | Sat. DO (%) | | | 77.9 | 72.1 | 71.8 | 69.1 | | | | | | | |
| 15-Nov-19 | Sat. DO (%) | | | | | | | 59.7 | 4.6 | 5.8 | 2.28 | 2.87 | 60.9 | 79.2 |
| 16-Nov-19 | Sat. DO (%) | | | | | | | 67.5 | 25.2 | | 79.3 | 76.9 | | |
| 19-Nov-19 | Sat. DO (%) | | 105.9 | 109.4 | 80.1 | 91.5 | 77.3 | | | | | | | |
| 20-Nov-19 | Sat. DO (%) | | | | | | | 72.9 | 49.5 | 82.4 | 86 | 97.4 | 89.3 | 94 |
| 22-Nov-19 | Sat. DO (%) | | | | | | | 70.5 | 6.8 | 10.2 | 31.8 | 38.8 | | |
| 23-Nov-19 | Sat. DO (%) | | | | | | | 74.6 | 38.3 | | 64.1 | | | |
| 26-Nov-19 | Sat. DO (%) | | | 88 | 65.8 | 75.1 | 73.9 | | | | | | | |
| 27-Nov-19 | Sat. DO (%) | | | | | | | 69 | 35.3 | 27.1 | 41.8 | 48.1 | 68.4 | 88.8 |
| 29-Nov-19 | Sat. DO (%) | | | | | | | 72.5 | 36.3 | 17.8 | 40.5 | 63.2 | | |
| 30-Nov-19 | Sat. DO (%) | | | | | | | 67.8 | 31.9 | | 46.7 | | | |
| 1-Nov-19 | DO (mg/L) | >6.0 | | | | | | | 0.75 | 2.9 | 6.87 | 6.71 | | |
| 2-Nov-19 | DO (mg/L) | >6.0 | | | | | | 6.2 | 2.65 | | 6.8 | | | |
| 5-Nov-19 | DO (mg/L) | >6.0 | | | | | 5.93 | | | | | | | |
| 6-Nov-19 | DO (mg/L) | >6.0 | | | | | | 5.94 | 0.63 | 0.31 | 6.35 | 7.2 | 7.02 | 7.11 |
| 7-Nov-19 | DO (mg/L) | >6.0 | | 7.66 | 6.5 | 7.15 | | | | | | | | |
| 8-Nov-19 | DO (mg/L) | >6.0 | | | | | | 7.19 | 1 | 0.95 | 8.15 | 7.78 | | |
| 9-Nov-19 | DO (mg/L) | >6.0 | | | | | | 6.06 | 1.46 | | 6.96 | | | |

| | | River Name | Nam Ngiep | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Zone | Location Refer to Construction Sites | | | | | | | | | | | |
| | | | Upstream | | | | | | Within / Re-regulation Reservoir | | Downstream | | | |
| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG05 | NNG06 | NNG07 | NNG08 |
| Date | Parameters (Unit) | Guideline | | | | | | | | | | | | |
| 13-Nov-19 | DO (mg/L) | >6.0 | | | | | | 5.77 | 0.39 | 0.96 | 2.26 | 2.8 | 4.79 | 6.62 |
| 14-Nov-19 | DO (mg/L) | >6.0 | | 6.19 | 5.69 | 5.69 | 5.49 | | | | | | | |
| 15-Nov-19 | DO (mg/L) | >6.0 | | | | | | 4.8 | 0.36 | 0.47 | 2.28 | 2.87 | 4.63 | 6.32 |
| 16-Nov-19 | DO (mg/L) | >6.0 | | | | | | 5.52 | 2.12 | | 6.48 | 6.3 | | |
| 19-Nov-19 | DO (mg/L) | >6.0 | 8.16 | 8.4 | 6.29 | 7.3 | 6.17 | | | | | | | |
| 20-Nov-19 | DO (mg/L) | >6.0 | | | | | | 5.86 | 4.15 | 6.62 | 6.95 | 7.53 | 7.01 | 7.42 |
| 22-Nov-19 | DO (mg/L) | >6.0 | | | | | | 5.69 | 0.57 | 0.85 | 2.6 | 3.23 | | |
| 23-Nov-19 | DO (mg/L) | >6.0 | | | | | | 6.06 | 3.2 | | 5.32 | | | |
| 26-Nov-19 | DO (mg/L) | >6.0 | | 6.91 | 5.25 | 6.1 | 6.02 | | | | | | | |
| 27-Nov-19 | DO (mg/L) | >6.0 | | | | | | 5.54 | 2.92 | 2.2 | 3.6 | 3.74 | 5.37 | 6.92 |
| 29-Nov-19 | DO (mg/L) | >6.0 | | | | | | 5.78 | 3.17 | 1.55 | 3.35 | 5.25 | | |
| 30-Nov-19 | DO (mg/L) | >6.0 | | | | | | 5.54 | 2.71 | | 3.9 | | | |
| 1-Nov-19 | Conductivity (µs/cm) | | | | | | | | 90 | 83 | 83 | 83 | | |
| 2-Nov-19 | Conductivity (µs/cm) | | | | | | | 76 | 84 | | 82 | | | |
| 5-Nov-19 | Conductivity (µs/cm) | | | | | | 75 | | | | | | | |
| 6-Nov-19 | Conductivity (µs/cm) | | | | | | | 72 | 85 | 80 | 80 | 57.5 | 57.3 | 56 |
| 7-Nov-19 | Conductivity (µs/cm) | | | 89 | 84 | 77 | | | | | | | | |
| 8-Nov-19 | Conductivity (µs/cm) | | | | | | | 74 | 85 | 79 | 82 | 82 | | |
| 9-Nov-19 | Conductivity (µs/cm) | | | | | | | 74 | 82 | | 84 | | | |
| 13-Nov-19 | Conductivity (µs/cm) | | | | | | | 73 | 85 | 81 | 81 | 58 | 99.7 | 103 |

| | | River Name | Nam Ngiep | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Zone | Location Refer to Construction Sites | | | | | | | | | | | |
| | | | Upstream | | | | | | Within / Re-regulation Reservoir | | Downstream | | | |
| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG05 | NNG06 | NNG07 | NNG08 |
| Date | Parameters (Unit) | Guideline | | | | | | | | | | | | |
| 14-Nov-19 | Conductivity (µs/cm) | | | 91 | 89 | 78 | 75 | | | | | | | |
| 15-Nov-19 | Conductivity (µs/cm) | | | | | | | 73 | 84 | 82 | 70.6 | 66.2 | 92.4 | 84.5 |
| 16-Nov-19 | Conductivity (µs/cm) | | | | | | | 75 | 86 | | 80 | 83 | | |
| 19-Nov-19 | Conductivity (µs/cm) | | 82.4 | 90 | 90 | 78 | 75 | | | | | | | |
| 20-Nov-19 | Conductivity (µs/cm) | | | | | | | 74 | 84 | 75 | 77 | 61.5 | 66.1 | 67.8 |
| 22-Nov-19 | Conductivity (µs/cm) | | | | | | | 73 | 87 | 85 | 81 | 84 | | |
| 23-Nov-19 | Conductivity (µs/cm) | | | | | | | 75 | 87 | | 82 | | | |
| 26-Nov-19 | Conductivity (µs/cm) | | | 90 | 90 | 80 | 76 | | | | | | | |
| 27-Nov-19 | Conductivity (µs/cm) | | | | | | | 73 | 81 | 79 | 80 | 57.3 | 58.4 | 58 |
| 29-Nov-19 | Conductivity (µs/cm) | | | | | | | 73 | 87 | 81 | 79 | 79 | | |
| 30-Nov-19 | Conductivity (µs/cm) | | | | | | | 72 | 82 | | 80 | | | |
| 1-Nov-19 | TDS (mg/L) | | | | | | | | 45 | 41.5 | 41.5 | 41.5 | | |
| 2-Nov-19 | TDS (mg/L) | | | | | | | 38 | 42 | | 41 | | | |
| 5-Nov-19 | TDS (mg/L) | | | | | | 37.5 | | | | | | | |
| 6-Nov-19 | TDS (mg/L) | | | | | | | 36 | 42.5 | 40 | 40 | 28.2 | 28.5 | 27 |
| 7-Nov-19 | TDS (mg/L) | | | 44.5 | 42 | 38.5 | | | | | | | | |
| 8-Nov-19 | TDS (mg/L) | | | | | | | 37 | 42.5 | 39.5 | 41 | 41 | | |
| 9-Nov-19 | TDS (mg/L) | | | | | | | 37 | 41 | | 42 | | | |
| 13-Nov-19 | TDS (mg/L) | | | | | | | 36.5 | 42.5 | 40.5 | 40.5 | 29 | 49.85 | 51.5 |

| | | River Name | Nam Ngiep | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Zone | Location Refer to Construction Sites | | | | | | | | | | | |
| | | | Upstream | | | | | | Within / Re-regulation Reservoir | | Downstream | | | |
| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG05 | NNG06 | NNG07 | NNG08 |
| Date | Parameters (Unit) | Guideline | | | | | | | | | | | | |
| 14-Nov-19 | TDS (mg/L) | | | 45.5 | 44.5 | 39 | 37.5 | | | | | | | |
| 15-Nov-19 | TDS (mg/L) | | | | | | | 36.5 | 42 | 41 | 35.3 | 33.1 | 46.2 | 42.25 |
| 16-Nov-19 | TDS (mg/L) | | | | | | | 37.5 | 43 | | 40 | 41.5 | | |
| 19-Nov-19 | TDS (mg/L) | | 41 | 45 | 45 | 39 | 37.5 | | | | | | | |
| 20-Nov-19 | TDS (mg/L) | | | | | | | 37 | 42 | 37.5 | 38.5 | 30.7 | 33 | 33.9 |
| 22-Nov-19 | TDS (mg/L) | | | | | | | 37 | 43.5 | 42.5 | 40.5 | 42 | | |
| 23-Nov-19 | TDS (mg/L) | | | | | | | 37.5 | 43.5 | | 41 | | | |
| 26-Nov-19 | TDS (mg/L) | | | 45 | 45 | 40 | 38 | | | | | | | |
| 27-Nov-19 | TDS (mg/L) | | | | | | | 36.5 | 40.5 | 39.5 | 40 | 28.65 | 29.2 | 29 |
| 29-Nov-19 | TDS (mg/L) | | | | | | | 36.5 | 43.5 | 40.5 | 39.5 | 39.5 | | |
| 30-Nov-19 | TDS (mg/L) | | | | | | | 36 | 41 | | 40 | | | |
| 1-Nov-19 | Temperature (°C) | | | | | | | | 24.33 | 24.41 | 24.22 | 24.29 | | |
| 2-Nov-19 | Temperature (°C) | | | | | | | 29.92 | 25.67 | | 24.94 | | | |
| 5-Nov-19 | Temperature (°C) | | | | | | 28.28 | | | | | | | |
| 6-Nov-19 | Temperature (°C) | | | | | | | 27.72 | 24.83 | 25.24 | 24.98 | 27.3 | 27.4 | |
| 7-Nov-19 | Temperature (°C) | | | 28.15 | 29.01 | 28.33 | | | | | | | | |
| 8-Nov-19 | Temperature (°C) | | | | | | | 26.68 | 24.49 | 24.85 | 24.91 | 24.74 | | |
| 9-Nov-19 | Temperature (°C) | | | | | | | 27.33 | 24.75 | | 24.58 | | | |
| 13-Nov-19 | Temperature (°C) | | | | | | | 26.74 | 24.57 | 24.64 | 24.72 | 25.1 | 24.6 | 24.2 |

| | | River Name | Nam Ngiep | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Zone | Location Refer to Construction Sites | | | | | | | | | | | |
| | | | Upstream | | | | | | Within / Re-regulation Reservoir | | Downstream | | | |
| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG05 | NNG06 | NNG07 | NNG08 |
| Date | Parameters (Unit) | Guideline | | | | | | | | | | | | |
| 14-Nov-19 | Temperature (°C) | | | 26.98 | 27.41 | 27.12 | 26.87 | | | | | | | |
| 15-Nov-19 | Temperature (°C) | | | | | | | 26.45 | 24.76 | 25.21 | 25.5 | 25.4 | 28.6 | 28.1 |
| 16-Nov-19 | Temperature (°C) | | | | | | | 25.65 | 24.38 | | 24.95 | 24.69 | | |
| 19-Nov-19 | Temperature (°C) | | 26.7 | 28.76 | 27.73 | 27.17 | 26.86 | | | | | | | |
| 20-Nov-19 | Temperature (°C) | | | | | | | 26.55 | 24.89 | 26.42 | 26.01 | 27.4 | 26.6 | 26.9 |
| 22-Nov-19 | Temperature (°C) | | | | | | | 26.24 | 24.59 | 24.84 | 24.89 | 24.75 | | |
| 23-Nov-19 | Temperature (°C) | | | | | | | 25.94 | 24.87 | | 24.93 | | | |
| 26-Nov-19 | Temperature (°C) | | | 27.89 | 27.3 | 26.63 | 26.99 | | | | | | | |
| 27-Nov-19 | Temperature (°C) | | | | | | | 26.61 | 24.82 | 25.28 | 24.45 | 26.9 | 26.5 | 27 |
| 29-Nov-19 | Temperature (°C) | | | | | | | 27.01 | 24.47 | 24.44 | 24.98 | 24.82 | | |
| 30-Nov-19 | Temperature (°C) | | | | | | | 25.79 | 24.39 | | 24.59 | | | |
| 1-Nov-19 | Turbidity (NTU) | | | | | | | | 1.59 | 7.14 | 9.38 | 8.54 | | |
| 2-Nov-19 | Turbidity (NTU) | | | | | | | 2.48 | 3.2 | | 7.17 | | | |
| 5-Nov-19 | Turbidity (NTU) | | | | | | 1.37 | | | | | | | |
| 6-Nov-19 | Turbidity (NTU) | | | | | | | 1.27 | 3.71 | 8.81 | 8.62 | 10.39 | 8.04 | 8.94 |

| | | River Name | Nam Ngiep | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Zone | Location Refer to Construction Sites | | | | | | | | | | | |
| | | | Upstream | | | | | | Within / Re-regulation Reservoir | | Downstream | | | |
| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG05 | NNG06 | NNG07 | NNG08 |
| Date | Parameters (Unit) | Guideline | | | | | | | | | | | | |
| 7-Nov-19 | Turbidity (NTU) | | | 2.06 | 1.88 | 1.63 | | | | | | | | |
| 8-Nov-19 | Turbidity (NTU) | | | | | | | 1.53 | 3.5 | 9.35 | 11.62 | 9.95 | | |
| 9-Nov-19 | Turbidity (NTU) | | | | | | | 1.74 | 2.37 | | 10.2 | | | |
| 13-Nov-19 | Turbidity (NTU) | | | | | | | 1.36 | 1.63 | 4.63 | 5.3 | 5.29 | 5.21 | 5.92 |
| 14-Nov-19 | Turbidity (NTU) | | | 2.33 | 1.6 | 1.31 | 1.32 | | | | | | | |
| 15-Nov-19 | Turbidity (NTU) | | | | | | | 1.15 | 1.23 | 3.87 | 11.8 | 11.71 | 8.97 | 9.34 |
| 16-Nov-19 | Turbidity (NTU) | | | | | | | 2.09 | 4.25 | | 9.01 | 8.47 | | |
| 19-Nov-19 | Turbidity (NTU) | | 2.59 | 2.55 | 2.13 | 1.82 | 1.89 | | | | | | | |
| 20-Nov-19 | Turbidity (NTU) | | | | | | | 1.61 | 2.3 | 5.66 | 15.02 | 14.5 | 31.58 | 12.84 |
| 22-Nov-19 | Turbidity (NTU) | | | | | | | 1.34 | 1.13 | 1.65 | 5.25 | 6.29 | | |
| 23-Nov-19 | Turbidity (NTU) | | | | | | | 1.28 | 3.02 | | 5.29 | | | |
| 26-Nov-19 | Turbidity (NTU) | | | 3.12 | 2.1 | 2.15 | 1.97 | | | | | | | |
| 27-Nov-19 | Turbidity (NTU) | | | | | | | 2.24 | 4.26 | 9.29 | 8.38 | 6.91 | 7.96 | 9.85 |
| 29-Nov-19 | Turbidity (NTU) | | | | | | | 1.76 | 2.58 | 15.27 | 10.92 | 10.87 | | |
| 30-Nov-19 | Turbidity (NTU) | | | | | | | 2.3 | 3.71 | | 10.44 | | | |
| 6-Nov-19 | TSS (mg/L) | | | | | | | <5 | 5 | <5 | <5 | | | |
| 13-Nov-19 | TSS (mg/L) | | | | | | | <5 | <5 | <5 | <5 | <5 | <5 | 7.53 |
| 14-Nov-19 | TSS (mg/L) | | | <5 | <5 | <5 | <5 | | | | | | | |

| | | River Name | Nam Ngiep | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Zone | Location Refer to Construction Sites | | | | | | | | | | | |
| | | | Upstream | | | | | | Within / Re-regulation Reservoir | | Downstream | | | |
| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG05 | NNG06 | NNG07 | NNG08 |
| Date | Parameters (Unit) | Guideline | | | | | | | | | | | | |
| 19-Nov-19 | TSS (mg/L) | | 7.4 | | | | | | | | | | | |
| 20-Nov-19 | TSS (mg/L) | | | | | | | <5 | <5 | 8.36 | 26.66 | | | |
| 27-Nov-19 | TSS (mg/L) | | | | | | | <5 | <5 | <5 | <5 | | | |
| 6-Nov-19 | $BOD_5$ (mg/L) | <1.5 | | | | | | <1.0 | 4.24 | 2.3 | <1.0 | | | |
| 13-Nov-19 | $BOD_5$ (mg/L) | <1.5 | | | | | | <1 | 4.88 | 4.86 | 4.18 | 3.95 | 1.19 | <1.0 |
| 14-Nov-19 | $BOD_5$ (mg/L) | <1.5 | | 1.49 | <1.0 | <1.0 | <1.0 | | | | | | | |
| 19-Nov-19 | $BOD_5$ (mg/L) | <1.5 | <1.0 | | | | | | | | | | | |
| 20-Nov-19 | $BOD_5$ (mg/L) | <1.5 | | | | | | <1.0 | 2.97 | <1.0 | <1.0 | | | |
| 27-Nov-19 | $BOD_5$ (mg/L) | <1.5 | | | | | | <1.0 | 3.26 | 3.9 | 2.3 | | | |
| 13-Nov-19 | COD (mg/L) | <5.0 | | | | | | 11.5 | <0.5 | 5.9 | 5.5 | 9.5 | 5.1 | <5.0 |
| 14-Nov-19 | COD (mg/L) | <5.0 | | 8.7 | 9.3 | 6.9 | 8.7 | | | | | | | |
| 19-Nov-19 | COD (mg/L) | <5.0 | 7.9 | | | | | | | | | | | |
| 13-Nov-19 | $NH_3$-N (mg/L) | <0.2 | | | | | | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 14-Nov-19 | $NH_3$-N (mg/L) | <0.2 | | <0.2 | <0.2 | <0.2 | <0.2 | | | | | | | |
| 19-Nov-19 | $NH_3$-N (mg/L) | <0.2 | <0.2 | | | | | | | | | | | |
| 13-Nov-19 | $NO_3$-N (mg/L) | <5.0 | | | | | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 14-Nov-19 | $NO_3$-N (mg/L) | <5.0 | | <0.02 | <0.02 | <0.02 | <0.02 | | | | | | | |
| 19-Nov-19 | $NO_3$-N (mg/L) | <5.0 | <0.02 | | | | | | | | | | | |
| 6-Nov-19 | Faecal coliform (MPN/100 mL) | <1,000 | | | | | | 21 | 9 | 7 | 14 | | | |

| | | River Name | Nam Ngiep | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Zone | Location Refer to Construction Sites | | | | | | | | | | | |
| | | | Upstream | | | | | | Within / Re-regulation Reservoir | | Downstream | | | |
| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG05 | NNG06 | NNG07 | NNG08 |
| Date | Parameters (Unit) | Guideline | | | | | | | | | | | | |
| 13-Nov-19 | Faecal coliform (MPN/100 mL) | <1,000 | | | | | | 0 | 0 | 0 | 7 | 5 | 21 | 240 |
| 14-Nov-19 | Faecal coliform (MPN/100 mL) | <1,000 | | 0 | 0 | 0 | 0 | | | | | | | |
| 19-Nov-19 | Faecal coliform (MPN/100 mL) | <1,000 | 540 | | | | | | | | | | | |
| 20-Nov-19 | Faecal coliform (MPN/100 mL) | <1,000 | | | | | | 8 | 11 | 8 | 17 | | | |
| 27-Nov-19 | Faecal coliform (MPN/100 mL) | <1,000 | | | | | | | | | | | | |
| 6-Nov-19 | Total Coliform (MPN/100 mL) | <5,000 | | | | | | 540 | 40 | 170 | 350 | | | |
| 13-Nov-19 | Total Coliform (MPN/100 mL) | <5,000 | | | | | | 79 | 540 | 350 | 920 | 540 | 350 | 350 |
| 14-Nov-19 | Total Coliform (MPN/100 mL) | <5,000 | | 13 | 13 | 13 | 17 | | | | | | | |
| 19-Nov-19 | Total Coliform (MPN/100 mL) | <5,000 | 920 | | | | | | | | | | | |
| 20-Nov-19 | Total Coliform (MPN/100 mL) | <5,000 | | | | | | 33 | 49 | 79 | 170 | | | |
| 27-Nov-19 | Total Coliform (MPN/100 mL) | <5,000 | | | | | | | | | | | | |
| 13-Nov-19 | TOC (mg/L) | | | | | | | 1.86 | 1.25 | 1.2 | | | | |
| 14-Nov-19 | TOC (mg/L) | | | 2.41 | 2.76 | 2 | 1.77 | | | | | | | |
| 13-Nov-19 | Phytoplankton Biomass (g dry wt/$m^3$) | | | | | | | 0.6 | 1.2 | 2.4 | | | | |

| | | River Name | Nam Ngiep | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Zone | Location Refer to Construction Sites | | | | | | | | | | | |
| | | | Upstream | | | | | | Within / Re-regulation Reservoir | | Downstream | | | |
| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG05 | NNG06 | NNG07 | NNG08 |
| Date | Parameters (Unit) | Guideline | | | | | | | | | | | | |
| 14-Nov-19 | Phytoplankton Biomass (g dry wt/m³) | | | 3 | 1.2 | 2.4 | 0.4 | | | | | | | |
| 13-Nov-19 | Total Phosphorus (mg/L) | | | | | | | <0.01 | <0.01 | <0.01 | | | | |
| 13-Nov-19 | Hydrogen Sulfide (mg/L) | | | | | | | <0.02 | | <0.02 | <0.02 | | | |

**TABLE A-2:** ***RESULTS OF SURFACE WATER QUALITY MONITORING IN NAM CHIAN, NAM PHOUAN, NAM XAO AND NAM HOUAY SOUP***

| | | River Name | Nam Chain | Nam Phouan | Nam Xao | Nam Houay Soup |
|---|---|---|---|---|---|---|
| | | Zone | Location Refer to Construction Sites | | | |
| | | | Tributaries Upstream | | Tributaries Downstream | |
| | | Station Code | NCH01 | NPH01 | NXA01 | NHS01 |
| **Date** | **Parameters (Unit)** | **Guideline** | | | | |
| 1-Nov-19 | pH | 5.0 - 9.0 | | | 7.79 | |
| 6-Nov-19 | pH | 5.0 - 9.0 | | | 7.37 | 7.17 |
| 8-Nov-19 | pH | 5.0 - 9.0 | | | 6.88 | |
| 13-Nov-19 | pH | 5.0 - 9.0 | | | 6.27 | 7.62 |
| 14-Nov-19 | pH | 5.0 - 9.0 | | 7.31 | | |
| 15-Nov-19 | pH | 5.0 - 9.0 | | | 7.09 | 7.79 |
| 16-Nov-19 | pH | 5.0 - 9.0 | | | 7.06 | |
| 19-Nov-19 | pH | 5.0 - 9.0 | 8.0 | 7.21 | | |
| 20-Nov-19 | pH | 5.0 - 9.0 | | | 6.71 | 6.29 |
| 22-Nov-19 | pH | 5.0 - 9.0 | | | 7.14 | 7.02 |
| 27-Nov-19 | pH | 5.0 - 9.0 | | | 6.24 | 6.14 |
| 29-Nov-19 | pH | 5.0 - 9.0 | | | 7.2 | |
| 1-Nov-19 | Sat. DO (%) | | | | 75.1 | |
| 6-Nov-19 | Sat. DO (%) | | | | 94.7 | 90.8 |
| 8-Nov-19 | Sat. DO (%) | | | | 91.2 | |
| 13-Nov-19 | Sat. DO (%) | | | | 86.2 | 84.4 |
| 14-Nov-19 | Sat. DO (%) | | | 90.3 | | |
| 15-Nov-19 | Sat. DO (%) | | | | 87.2 | 81.4 |
| 16-Nov-19 | Sat. DO (%) | | | | 80.8 | |
| 19-Nov-19 | Sat. DO (%) | | 102.9 | 96 | | |
| 20-Nov-19 | Sat. DO (%) | | | | 93.7 | 94.7 |
| 22-Nov-19 | Sat. DO (%) | | | | 73.8 | 71.6 |

| | | River Name | Nam Chain | Nam Phouan | Nam Xao | Nam Houay Soup |
|---|---|---|---|---|---|---|
| | | Zone | Location Refer to Construction Sites | | | |
| | | | Tributaries Upstream | | Tributaries Downstream | |
| | | Station Code | NCH01 | NPH01 | NXA01 | NHS01 |
| Date | Parameters (Unit) | Guideline | | | | |
| 27-Nov-19 | Sat. DO (%) | | | | 88.9 | 89.5 |
| 29-Nov-19 | Sat. DO (%) | | | | 82.3 | |
| 1-Nov-19 | DO (mg/L) | >6.0 | | | 6.19 | |
| 6-Nov-19 | DO (mg/L) | >6.0 | | | 7.49 | 7.09 |
| 8-Nov-19 | DO (mg/L) | >6.0 | | | 7.42 | |
| 13-Nov-19 | DO (mg/L) | >6.0 | | | 6.94 | 6.78 |
| 14-Nov-19 | DO (mg/L) | >6.0 | | 7.9 | | |
| 15-Nov-19 | DO (mg/L) | >6.0 | | | 7.02 | 6.55 |
| 16-Nov-19 | DO (mg/L) | >6.0 | | | 6.72 | |
| 19-Nov-19 | DO (mg/L) | >6.0 | 8.17 | 8.5 | | |
| 20-Nov-19 | DO (mg/L) | >6.0 | | | 7.64 | 7.32 |
| 22-Nov-19 | DO (mg/L) | >6.0 | | | 6.11 | 6.28 |
| 27-Nov-19 | DO (mg/L) | >6.0 | | | 7 | 7.19 |
| 29-Nov-19 | DO (mg/L) | >6.0 | | | 6.84 | |
| 1-Nov-19 | Conductivity (µs/cm) | | | | 128 | |
| 6-Nov-19 | Conductivity (µs/cm) | | | | 89.3 | 34.6 |
| 8-Nov-19 | Conductivity (µs/cm) | | | | 128 | |
| 13-Nov-19 | Conductivity (µs/cm) | | | | 95.1 | 89.2 |
| 14-Nov-19 | Conductivity (µs/cm) | | | 78 | | |
| 15-Nov-19 | Conductivity (µs/cm) | | | | 95.3 | 35.5 |
| 16-Nov-19 | Conductivity (µs/cm) | | | | 133 | |
| 19-Nov-19 | Conductivity (µs/cm) | | 24.2 | 67 | | |
| 20-Nov-19 | Conductivity (µs/cm) | | | | 95.8 | 39 |
| 22-Nov-19 | Conductivity (µs/cm) | | | | 135 | 54 |
| 27-Nov-19 | Conductivity (µs/cm) | | | | 100 | 39.2 |

| | | River Name | Nam Chain | Nam Phouan | Nam Xao | Nam Houay Soup |
|---|---|---|---|---|---|---|
| | | Zone | Location Refer to Construction Sites | | | |
| | | | Tributaries Upstream | | Tributaries Downstream | |
| | | Station Code | NCH01 | NPH01 | NXA01 | NHS01 |
| Date | Parameters (Unit) | Guideline | | | | |
| 29-Nov-19 | Conductivity (µs/cm) | | | | 140 | |
| 1-Nov-19 | TDS (mg/L) | | | | 64 | |
| 6-Nov-19 | TDS (mg/L) | | | | 44.5 | 17.3 |
| 8-Nov-19 | TDS (mg/L) | | | | 64 | |
| 13-Nov-19 | TDS (mg/L) | | | | 47.55 | 44.6 |
| 14-Nov-19 | TDS (mg/L) | | | 39 | | |
| 15-Nov-19 | TDS (mg/L) | | | | 47.65 | 17.75 |
| 16-Nov-19 | TDS (mg/L) | | | | 66.5 | |
| 19-Nov-19 | TDS (mg/L) | | 12 | 33.5 | | |
| 20-Nov-19 | TDS (mg/L) | | | | 47.8 | 19 |
| 22-Nov-19 | TDS (mg/L) | | | | 67.5 | 27 |
| 27-Nov-19 | TDS (mg/L) | | | | 50 | 19.6 |
| 29-Nov-19 | TDS (mg/L) | | | | 70 | |
| 1-Nov-19 | Temperature (°C) | | | | 25.02 | |
| 6-Nov-19 | Temperature (°C) | | | | 26.4 | 26.8 |
| 8-Nov-19 | Temperature (°C) | | | | 25.86 | |
| 13-Nov-19 | Temperature (°C) | | | | 25.6 | 24.9 |
| 14-Nov-19 | Temperature (°C) | | | 22.4 | | |
| 15-Nov-19 | Temperature (°C) | | | | 25.3 | 25.4 |
| 16-Nov-19 | Temperature (°C) | | | | 27.4 | |
| 19-Nov-19 | Temperature (°C) | | 24.6 | 21.36 | | |
| 20-Nov-19 | Temperature (°C) | | | | 27.1 | 26.2 |
| 22-Nov-19 | Temperature (°C) | | | | 24.37 | 21.79 |
| 27-Nov-19 | Temperature (°C) | | | | 26.2 | 25.5 |
| 29-Nov-19 | Temperature (°C) | | | | 24.56 | |

| | | River Name | Nam Chain | Nam Phouan | Nam Xao | Nam Houay Soup |
|---|---|---|---|---|---|---|
| | | Zone | Location Refer to Construction Sites | | | |
| | | | Tributaries Upstream | | Tributaries Downstream | |
| | | Station Code | NCH01 | NPH01 | NXA01 | NHS01 |
| Date | Parameters (Unit) | Guideline | | | | |
| 1-Nov-19 | Turbidity (NTU) | | | | 4.63 | |
| 6-Nov-19 | Turbidity (NTU) | | | | 4.75 | 3.04 |
| 8-Nov-19 | Turbidity (NTU) | | | | 3.35 | |
| 13-Nov-19 | Turbidity (NTU) | | | | 4.29 | 5.03 |
| 14-Nov-19 | Turbidity (NTU) | | | 2.14 | | |
| 15-Nov-19 | Turbidity (NTU) | | | | 5.49 | 4.91 |
| 16-Nov-19 | Turbidity (NTU) | | | | 5.65 | |
| 19-Nov-19 | Turbidity (NTU) | | 1.96 | 3.08 | | |
| 20-Nov-19 | Turbidity (NTU) | | | | 8.08 | 4.16 |
| 22-Nov-19 | Turbidity (NTU) | | | | 3.71 | 2.86 |
| 27-Nov-19 | Turbidity (NTU) | | | | 6.03 | 4.45 |
| 29-Nov-19 | Turbidity (NTU) | | | | 6.9 | |
| 13-Nov-19 | TSS (mg/L) | | | | <5 | <5 |
| 14-Nov-19 | TSS (mg/L) | | | 5.69 | | |
| 19-Nov-19 | TSS (mg/L) | | 5.15 | | | |
| 13-Nov-19 | $BOD_5$ (mg/L) | <1.5 | | | <1.0 | <1 |
| 14-Nov-19 | $BOD_5$ (mg/L) | <1.5 | | <1.0 | | |
| 19-Nov-19 | $BOD_5$ (mg/L) | <1.5 | <1.0 | | | |
| 13-Nov-19 | COD (mg/L) | <5.0 | | | 5.5 | 5.5 |
| 14-Nov-19 | COD (mg/L) | <5.0 | | <5.0 | | |
| 19-Nov-19 | COD (mg/L) | <5.0 | 8.4 | | | |
| 13-Nov-19 | $NH_3$-N (mg/L) | <0.2 | | | <0.2 | <0.2 |
| 14-Nov-19 | $NH_3$-N (mg/L) | <0.2 | | <0.2 | | |
| 19-Nov-19 | $NH_3$-N (mg/L) | <0.2 | <0.2 | | | |
| 13-Nov-19 | $NO_3$-N (mg/L) | <5.0 | | | 0.06 | <0.02 |

| | | River Name | Nam Chain | Nam Phouan | Nam Xao | Nam Houay Soup |
|---|---|---|---|---|---|---|
| | | Zone | Location Refer to Construction Sites | | | |
| | | | Tributaries Upstream | | Tributaries Downstream | |
| | | Station Code | NCH01 | NPH01 | NXA01 | NHS01 |
| **Date** | **Parameters (Unit)** | **Guideline** | | | | |
| 14-Nov-19 | $NO_3$-N (mg/L) | <5.0 | | 0.09 | | |
| 19-Nov-19 | $NO_3$-N (mg/L) | <5.0 | <0.02 | | | |
| 13-Nov-19 | Faecal coliform (MPN/100 mL) | <1,000 | | | 27 | 22 |
| 14-Nov-19 | Faecal coliform (MPN/100 mL) | <1,000 | | 33 | | |
| 19-Nov-19 | Faecal coliform (MPN/100 mL) | <1,000 | 11 | | | |
| 13-Nov-19 | Total Coliform (MPN/100 mL) | <5,000 | | | 350 | 920 |
| 14-Nov-19 | Total Coliform (MPN/100 mL) | <5,000 | | 220 | | |
| 19-Nov-19 | Total Coliform (MPN/100 mL) | <5,000 | 33 | | | |

# ANNEX B: RESULTS OF EFFLUENT ANALYSES

**TABLE B-1: *RESULTS OF CAMP EFFLUENTS IN NOVEMBER 2019***

| | Site Name | Owner's Site Office and Village | | Obayashi Camp | | SongDa5 Camp No.1 | |
|---|---|---|---|---|---|---|---|
| | Station Code | EF01 | | EF02 | | EF07 | |
| | Date | 04-Nov-19 | 18-Nov-19 | 04-Nov-19 | 18-Nov-19 | 04-Nov-19 | 18-Nov-19 |
| **Parameters (Unit)** | **Guideline** | | | | | | |
| pH | 6.0 - 9.0 | 6.76 | 6.62 | This site was decommissioned | | 6.66 | No samples due to no inflow to chlorination tank |
| Sat. DO (%) | | 62 | 53.1 | | | 72.2 | |
| DO (mg/L) | | 4.82 | 4.03 | | | 5.54 | |
| Conductivity (µs/cm) | | 317 | 408 | | | 623 | |
| TDS (mg/L) | | 158.5 | 204 | | | 311.5 | |
| Temperature (°C) | | 26.6 | 27.9 | | | 27.7 | |
| Turbidity (NTU) | | 1.46 | 1.64 | | | 3.29 | |
| TSS (mg/L) | <50 | <5 | <5 | | | <5 | |
| $BOD_5$ (mg/L) | <30 | 6.27 | 15.18 | | | <6 | |
| COD (mg/L) | <125 | <25 | <25 | | | <25 | |
| $NH_3$-N (mg/L) | <10.0 | 4.9 | 4.5 | | | 8.1 | |
| Total Nitrogen (mg/L) | <10.0 | 13.6 | 14.7 | | | 9.14 | |
| Total Phosphorus (mg/L) | <2 | 1.07 | 0.92 | | | 0.52 | |
| Oil & Grease (mg/L) | <10.0 | <1 | | | | <1 | |
| Total coliform (MPN/100 ml) | <400 | 920 | 920 | | | 1,600 | |
| Faecal Coliform (MPN/100 ml) | <400 | 240 | 8 | | | 540 | |
| Effluent Discharge Volume (L/mn) | | 12 | 6 | | | 0.3 | |
| Chlorination Dosing Rate (mL/mn) | | n/a | n/a | | | 10 | |
| Residual Chlorine (mg/L) | <1.0 | n/a | n/a | | | 0.04 | |

| | Site Name | V&K Camp | | HM Main Camp | | ESD Camp | | Main Powerhouse | |
|---|---|---|---|---|---|---|---|---|---|
| | Station Code | EF10 | | EF13 | | EF14 | | EF19 | |
| | Date | 04-Nov-19 | 18-Nov-19 | 04-Nov-19 | 18-Nov-19 | 04-Nov-19 | 18-Nov-19 | 04-Nov-19 | 18-Nov-19 |
| **Parameters (Unit)** | **Guideline** | | | | | | | | |
| pH | 6.0 - 9.0 | This site was decommissioned | | 6.53 | 7.05 | 6.4 | 6.4 | | 7.05 |
| Sat. DO (%) | | | | 74.4 | 36.3 | 129.2 | 61.7 | No discharge | 36.3 |
| DO (mg/l) | | | | 5.58 | 2.75 | 9.66 | 4.72 | | 2.75 |
| Conductivity (µs/cm) | | | | 829 | 637 | 482 | 531 | | 637 |
| TDS (mg/l) | | | | 414.5 | 318.5 | 241 | 265.5 | | 318.5 |
| Temperature (°C) | | | | 28.7 | 28.2 | 28.9 | 27.6 | | 28.2 |
| Turbidity (NTU) | | | | 23.25 | 39.04 | 5.76 | 3.33 | | 39.04 |
| TSS (mg/l) | <50 | | | 37.9 | 27.2 | 20.26 | 6.4 | | 27.2 |
| $BOD_5$ (mg/l) | <30 | | | <6 | <6 | <6 | <6 | | <6 |
| COD (mg/l) | <125 | | | 117 | 128 | 35.5 | <25 | | 128 |
| $NH_3$-N (mg/l) | <10.0 | | | 2.9 | 13 | 23.2 | 8.5 | | 13 |
| Total Nitrogen (mg/l) | <10.0 | | | 4.09 | 14.2 | 24.4 | 11.1 | | 14.2 |
| Total Phosphorus (mg/l) | <2 | | | 0.81 | 1.15 | 1.75 | 0.86 | | 1.15 |
| Oil & Grease (mg/l) | <10.0 | | | 4 | | <1 | | | |
| Total coliform (MPN/100 ml) | <400 | | | 0 | 0 | 0 | 0 | | 0 |
| Faecal Coliform (MPN/100 ml) | <400 | | | 0 | 0 | 0 | 0 | | 0 |
| Effluent Discharge Volume (L/mn) | | | | 12 | 6 | 4 | 4 | | 6 |
| Chlorination Dosing Rate (ml/mn) | | | | 10 | 15 | 11 | 11 | | 15 |

| | Site Name | V&K Camp | | HM Main Camp | | ESD Camp | | Main Powerhouse | |
|---|---|---|---|---|---|---|---|---|---|
| | Station Code | EF10 | | EF13 | | EF14 | | EF19 | |
| | Date | 04-Nov-19 | 18-Nov-19 | 04-Nov-19 | 18-Nov-19 | 04-Nov-19 | 18-Nov-19 | 04-Nov-19 | 18-Nov-19 |
| **Parameters (Unit)** | **Guideline** | | | | | | | | |
| Residual Chlorine (mg/l) | <1.0 | | | 1.7 | 0.9 | 0.65 | 1.23 | | 0.92 |

**TABLE B-2: *RESULTS OF THE CONSTRUCTION AREA DISCHARGE IN NOVEMBER 2019***

| | Site Name | Upstream Spoil Disposal Area No.2 | | | |
|---|---|---|---|---|---|
| | Station Code | DS04 - US | | | |
| | Date | 07-Nov-19 | 15-Nov-19 | 21-Nov-19 | 29-Nov-19 |
| **Parameter (Unit)** | **Guideline** | | | | |
| pH | 6.0 - 9.0 | 7.02 | 6.97 | 6.22 | 6.86 |
| Sat. DO (%) | | 94.1 | 86.8 | 83.9 | 93.1 |
| DO (mg/L) | | 7.51 | 6.89 | 6.76 | 7.49 |
| Conductivity (µs/cm) | | 14.2 | 15.55 | 7.92 | 8.59 |
| TDS (mg/L) | | 7.1 | 7.77 | 3.9 | 4.2 |
| Temperature (°C) | | 25.5 | 25.8 | 24.6 | 25.2 |
| Turbidity (NTU) | | 1.99 | 1.8 | 2.63 | 2.33 |
| TSS (mg/L) | <50 | 1.13 | 0.19 | 2.0 | 1.65 |
| Oil & Grease (mg/L) | <10 | | <1 | | |

| | Site Name | Spoil Disposal Area No.2 | | | |
|---|---|---|---|---|---|
| | Station Code | DS04 | | | |
| | Date | 07-Nov-19 | 15-Nov-19 | 21-Nov-19 | 29-Nov-19 |
| **Parameter (Unit)** | **Guideline** | | | | |
| pH | 6.0 - 9.0 | 6.95 | 6.69 | 6.21 | 6.45 |
| Sat. DO (%) | | 81.4 | 50.1 | 54 | 59.7 |
| DO (mg/L) | | 6.48 | 3.95 | 4.68 | 4.74 |
| Conductivity (µs/cm) | | 32.5 | 76.6 | 36.5 | 37.7 |
| TDS (mg/L) | | 16.2 | 38.3 | 18.7 | 18.85 |
| Temperature (°C) | | 25.6 | 26.2 | 24 | 25.6 |
| Turbidity (NTU) | | 3.16 | 1.82 | 2.31 | 3.38 |
| TSS (mg/L) | <50 | 2.51 | 0.8 | 0.53 | 0.74 |
| Oil & Grease (mg/L) | <10 | | <1 | | |

# 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 | 12-Nov-19 18:00 | 13-Nov-19 14:01 | 14-Nov-19 08:01 |
| End Time | 13-Nov-19 14:00 | 14-Nov-19 08:00 | 15-Nov-19 18:00 |
| Average Data Record in 24h (mg/m$^3$) | 0.035 | 0.014 | 0.017 |
| ***Guideline Average in 24h (mg/m$^3$)*** | ***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 | 18-Nov-19 18:00 | 19-Nov-19 18:01 | 20-Nov-19 18:01 |
| End Time | 19-Nov-19 18:00 | 20-Nov-19 18:00 | 21-Nov-19 18:00 |
| Average Data Record in 24h (mg/m$^3$) | 0.047 | 0.038 | 0.052 |
| ***Guideline Average in 24h (mg/m$^3$)*** | ***0.12*** | ***0.12*** | ***0.12*** |

***TABLE C-3 AND TABLE C-4: AVERAGE RESULTS OF DUST MONITORING AT SONG DA5 CAMP NO. 2 AND LILAMA10 CAMP IN NOVEMBER 2019***

| Song Da5 Camp No.2 - Dust Emission Average in 24 hours | |
|---|---|
| Period | 24 Hours |
| Start Time | 27-Nov-19 18:30 |
| End Time | 28-Nov-19 18:00 |
| Average Data Record (mg/m$^3$) -24h | 0.023 |
| ***Guideline Average (mg/m$^3$) - 24h*** | ***0.12*** |

| Lilama10 Camp - Dust Emission Average in 24 hours | |
|---|---|
| Period | 24 Hours |
| Start Time | 26-Nov-19 18:00 |
| End Time | 27-Nov-19 18:00 |
| Average Data Record (mg/m$^3$) -24h | 0.034 |
| ***Guideline Average (mg/m$^3$) - 24h*** | ***0.12*** |

***TABLE C-5 AND TABLE C-6: AVERAGE RESULTS OF DUST MONITORING AT MAIN DAM AND MAIN POWERHOUSE IN NOVEMBER 2019***

| Main Dam - Dust Emission Average in 24 hours | |
|---|---|
| **Period** | **24 Hours** |
| **Start Time** | **04-Nov-19 18:00** |
| **End Time** | **05-Nov-19 18:00** |
| **Average Data Record (mg/m$^3$) -24h** | **0.029** |
| ***Guideline Average (mg/m$^3$) - 24h*** | ***0.12*** |

| Main Powerhouse - Dust Emission Average in 24 hours | |
|---|---|
| Period | 24 Hours |
| Start Time | 05-Nov-19 17:30 |
| End Time | 06-Nov-19 17:00 |
| Average Data Record (mg/m$^3$) -24h | 0.032 |
| ***Guideline Average (mg/m$^3$) - 24h*** | ***0.12*** |