NAM NGIEP 1
POWER COMPANY

**Nam Ngiep 1 Hydropower Project**

# Environment Monitoring Report
# Fourth Quarter of 2018

October to December 2018

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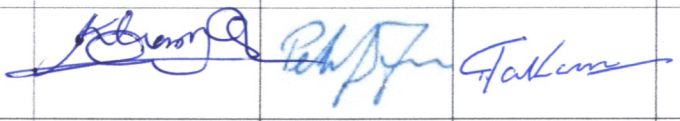
| A | |  | | | Final |
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## ABBREVIATIONS / ACRONYMS

| | |
|---|---|
| AIP | Annual Implementation Plan |
| ADB | Asian Development Bank |
| 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 |
| 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 |
| EDL | Electricite du Laos |
| EGAT | Electricity Generating Authority of Thailand |
| 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 |
| ESD | Environmental and Social Division of NNP1PC |
| ESMMP | Environmental and Social Monitoring and Management Plan |
| GOL | Government of Lao PDR |
| GIS | Geographic Information Systems |
| HMWC | Hydraulic Metal Works Contract |
| HR | Human Resources |
| IEE | Initial Environmental Examination |
| IMA | Independent Monitoring Agency |
| ISP | Intergraded Spatial Planning |
| kV | kilo-Volt |
| LEPTS | Lao Electric Power Technical Standard |

| | |
|---|---|
| LTA | Lender's Technical Advisor |
| MAF | Ministry of Agriculture and Forestry |
| MEM | Ministry of Energy and Mines, Lao PDR |
| MOM | Minutes of Meeting |
| MONRE | Ministry of Natural Resource and Environment, Lao PDR |
| MOU | Memorandum of Understanding |
| NCNX | Nam Chouane-Nam Xang |
| NCR | Non-Compliance Report |
| NN2 | Nam Ngum 2 Power Company Limited |
| NNP1PC | Nam Ngiep 1 Power Company Limited |
| NTFP | Non-Timber Forest Products |
| NT2 | Nam Theun 2 Hydropower Project |
| OC | Obayashi Corporation |
| ONC | Observation of Non-Compliance |
| OSOV | Owners' Site Office and Village |
| PAFO | Provincial Department of Agriculture and Forestry |
| PAP | Project Affected People |
| PONRE | Provincial Department of Natural Resource and Environment, MONRE |
| RCC | Roller Compacted Concrete |
| SIR | Site Inspection Report |
| 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 |
| WMP | Watershed Management Plan |
| WRPC | Watershed and Reservoir Protection Committee |
| WRPO | Watershed and Reservoir Protection Office |
| WWTS | Waste Water Treatment System |

# 1 EXECUTIVE SUMMARY

During Q4 2018, the Environmental Management Office (EMO) of NNP1PC reviewed and approved three Site Specific Environmental and Social Management and Monitoring Plans (SS-ESMMP) and one Site Decommissioning Plan. A total of five Observations of Non-Compliance (ONCs), one Non-Compliance Level-1 (NCR1) and two Non-Compliance Level-2 (NCR2) were active. Out of these, five ONCs were resolved during the reported period, one NCR-1 and two NCR-2 shall be carried over to the first quarter of 2019.

During Q4 2018, a total of 300.1 $m^3$ of solid waste was disposed at the NNP1 Project Landfill, a decrease of 130.6 $m^3$ compared to Q3 2018. A total of 18,096 kg of recyclable waste (mostly scrap metal) was collected by Khounmixay Processing Factory and transported offsite to its facilities for recycling or processing.

The Environmental Management Unit (EMU) of Bolikhamxay Province conducted a site inspection during 27 - 28 November 2018. The EMU raised concerns about waste management at LILAMA10 camp and chlorination of waste water at Song Da 5 camp No2. The EMU had no significant comments to the demolition of concrete foundations at the aggregate crushing plant, RCC Plant, and the Sino-Hydro camp.

The quarterly site inspection by the Environmental Management Unit (EMU) of Xaysomboun Province was carried out on 16 - 19 October 2018. This visit focused mainly on the reservoir water quality monitoring, and the EMU requested NNP1PC to support the construction of a new landfill for the 2LR and 2UR zones to prevent illegal disposal and burning of solid waste that is currently scattered and dumped into the NNP1 reservoir.

NNP1PC revised and re-submitted the final draft Watershed Management Plan to ADB on 5 November 2018 and received their feedback on 22 November 2018. Further comments from the IAP and ADB were discussed during the joint IAP and ADB mission during 14-15 December 2018. NNP1PC, IAP and ADB agreed that the Plan approval by ADB would be on 18 January 2019 and NNP1PC could continue the collaboration with ADB in finalizing the AIP2019 for both provinces so that the approval could be done at the same time.

The Bolikhamxay Provincial WRPO submitted the draft AIP2019 to NNP1PC-EMO on 30 October 2018. The draft is being reviewed by NNP1PC-EMO. The Governor of Xaysomboun Province issued an Agreement (No. 1134) on the restructuring of the Watershed and Reservoir Protection Committee (WRPC) and its secretariat (WRPO) on 29 November 2018. In the new structure, PAFO will lead the WRPO. The formulation of AIP2019 by the Xaysomboun Province will be resumed in January 2019.

The Xaysomboun WRPO completed a field verification survey of the boundary for the Total Protection Zone 1 (TPZ-1, Phou Samsao) and land uses in Hom District at the end of October 2018. The remaining surveys in TPZ-1 at Anouvong District and TPZ-2 (TPZ-2, Phou Khata) in Hom District was postponed until the restructuring of Xaysomboun Provincial WRPC and WRPO was completed on 29 November 2018. The survey will be continued in January 2019.

The approval of the Xaysomboun Provincial Watershed Management Regulation by the Vice-Governor has been on hold due to some internal issue between PAFO and PONRE over the roles and responsibilities for the implementation of the Provincial Regulation and the WMP. Xaysomboun Provincial Authority and the Department of Forestry (DOF), Ministry of Agriculture and Forestry (MAF) held a meeting on 23 November 2018 and the chair of the meeting urged the

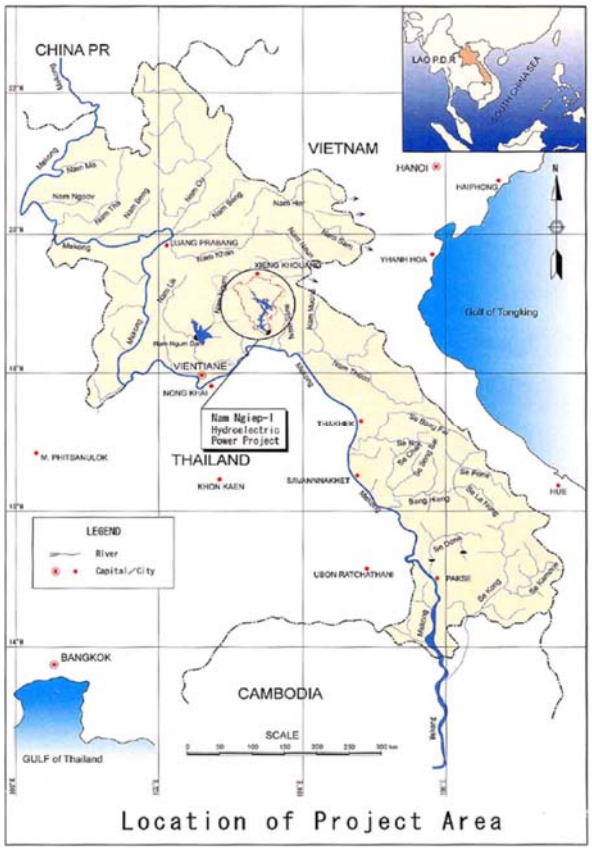
new WRPO (PAFO) to quickly improve the draft Regulation and submit the Regulation to the Provincial Assembly for endorsement before it is signed by the provincial Governor. Xaysomboun WRPO-PAFO further improved the draft Regulation and presented it at Xaysomboun WRPC coordination meeting on 20 December 2018. The meeting requested DOF-MAF and NNP1PC to review the regulation prior to submission to the Provincial Assembly Chairperson and the Provincial Governor for approval in January 2019. As requested, NNP1PC-EMO reviewed the regulation provided comments in the last week of December 2018.

The improved first draft of the NNP1 Biodiversity Offset Management Plan for Nam Chouane-Nam Xang Biodiversity Offset Site was submitted to ADB, IAP and BAC in September 2018. Further comments on the draft BOMP were discussed during the IAP and ADB mission on 14-15 December 2018. NNP1PC, IAP and ADB agreed to further improve the plan on the following aspects: the vision statement, the assessment and targets to achieve No Net Loss (NNL), the presentation of organization structure, and assessment of social impacts and compliance with ADB Social Safeguards. The final approval by ADB is expected by the end of January 2019 and the final approval by GOL is expected in March 2019.

# 2 INTRODUCTION

The Nam Ngiep originates in the mountains of Xieng Khuang 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.

The project consists of two dams. The main dam which is located 9.0 km upstream of Hat Gniun Village in Bolikhan District, will create a 70-km-long, narrow reservoir that extends up the Ngiep Valley as far as Thathom District. At 167 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 Substation 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.



Location of Project Area

This Quarterly Environment Report provides a summary of environmental monitoring activities and mitigation actions during Q4 2018. The report is published on the Company website (https://namngiep1.com/).

Related construction Site Specific Environmental and Social Monitoring and Management Plans (SS-ESMMPs) are also publicly disclosed on the Company website as required under the Concession Agreement.

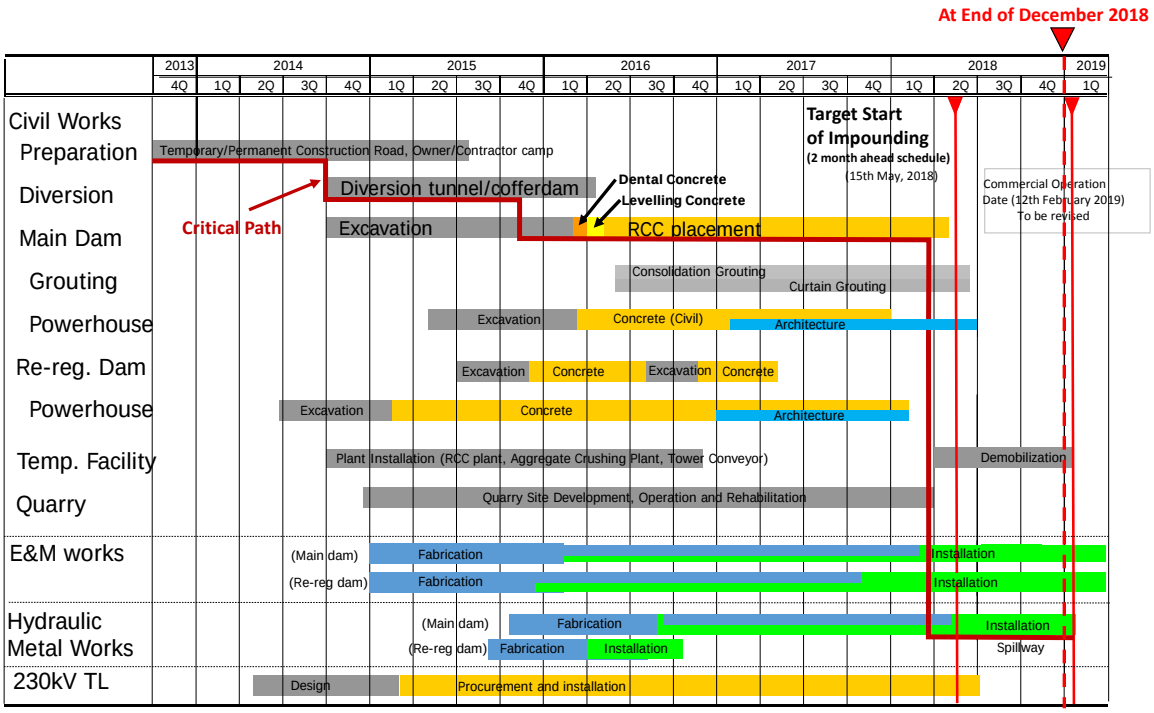
# 3 CONSTRUCTION PROGRESS

Actual overall cumulative work progress until the end of December 2018 was 97.9 %[1] (compared to planned progress of 98.3 %).

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

The overall construction schedule and progress curve (by achieved Milestone Payments) are shown in ***Figure 3-1.***

**FIGURE 3-1: OVERALL CONSTRUCTION SCHEDULE**




## 3.1 CIVIL WORK

The cumulative actual work progress of the Civil Works until the end of December 2018 was 99.2 % (compared to planned progress of 99.7 %).

## 3.2 MAIN DAM AND POWERHOUSE

The achievement of curtain drilling and grouting and drilling of drainage holes were the most critical activities that determined the ability to impound the main reservoir on 31 December 2018.

At the main powerhouse the Civil Works has 34,800 $m^3$ or 100 % of concrete in place and is substantially complete.

The plunge pool excavation was started after main dam impounding and around 33,000 $m^3$ of excavation has been completed. The diversion conduit gate of the main dam body had

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

some leakage of water initially but the casting of the concrete plug behind it was completed in the conduit in June 2018.

### 3.2.1 Re-regulation dam and powerhouse

All gate structures are complete at the re-regulation powerhouse. The building works are also substantially complete with the water supply system now under installation. Bitumen surfacing of the exterior roads has been completed.

FIGURE 3-2: COMPLETED RE-REGULATION DAM AND POWERHOUSE, AS THE END OF DECEMBER 2018

TEMPORARY WORK FACILITY

## 3.3 QUARRY

The quarry operations were completed in March 2018. No more blasting or excavation is proposed.

The excavated material from the plunge pool, currently being carried out, has been hauled to the quarry and deposited there. This was later stopped and alternate site was studied and approved by NNP1PC to transport and dispose of at the RCC Plant as part of the RCC Plant Site Decommissioning and Rehabilitation Plan for the RCC Plant. A draft Site Decommissioning and Rehabilitation Plan has been developed and government notification of this practice is under arrangement.

## 3.4 DISPOSAL AREAS

Disposal Area No.6 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. Electrical and Mechanical Works

The cumulative work progress of the Electrical and Mechanical Works by value at the end of December 2018 was 98.8 % (compared to planned progress of 98.8 %).

The assembly of the generator and hydraulic turbine for unit 1 and unit 2 is ongoing.

## 3.5 HYDRO-MECHANICAL WORKS

The actual cumulative work progress of the Hydro-Mechanical Works until the end of December 2018 was 97 % (compared to planned progress of 97%).

Removal of spider supports and painting work inside the steel penstock pipes Lines 1 and 2 at the main dam was complete 100% at the beginning of May 2018, and dry test and commissioning of line 1 and 2 was completed 100 % at the end of May 2018.

Wet test and commissioning for the riparian release conduit was conducted successfully under water pressure with reservoir water level at El. 273.5 m.

All hydro-mechanical works at the re-regulating powerhouse are complete except for wiring to the permanent power supply. The steel penstock erection and welding were completed on 23 April 2018 and the concrete encasement was completed in April 2018

## 3.6 230 KV TRANSMISSION LINE WORKS

The 230-kV line is 100% complete (compared to planned progress of 100%). Tower erection was complete on 04 April 2018 and stringing was completed on 27 April 2018. Testing was completed in June 2018.

## 3.7 115 KV TRANSMISSION LINE

The 115-kV Transmission Line from the re-regulation powerhouse to Pakxan substation is an associated facility to NNP1, owned and being constructed by Électricité du Laos (EDL).

The 115-kV transmission line will pass through Phouhomxay Village and EDL and NNP1PC has executed a lease agreement in April 2018, whereby NNP1PC will lease the right of way to EDL under certain conditions. The 115 kV Transmission Line project consists of two components, (1) a small substation at the re-regulation dam (within the project area) and (2) a 32.8 km transmission line with a 25 m wide right-of-way and 86 towers of which 9 km with 24 towers are in Phouhomxay Village.

The lease agreement requires that the construction of the line in Phouhomxay Village shall comply with applicable environmental and social measures of NNP1PC's ESMMP-CP, and in accordance with these requirements, EDL has prepared and submitted a Site Specific ESMMP to NNP1PC. NNP1PC approved the Site Specific ESMMP.

The construction of tower foundations was started in December 2017 and has reached 84 completed out of a total of 86 towers with 82 No. towers erected and all tower materials already, stringing works completed for 30.30km out of total 33km delivered to Site. Bush clearing and access are completely finished. Dong Fang (the contractor of EdL) re-started work on 10 September 2018, some 2 weeks earlier than anticipated.

# 4 ENVIRONMENTAL MANAGEMENT AND MONITORING

The environmental management and monitoring activities reported in this section document implementation of the relevant sub-plans and programmes of the Environmental and Social Management and Monitoring Plan for the Construction Phase during Q4 2018.

**ESMMP-OP**

The development of the ESMMP for the operational phase continued in Q4-2018 with assistance from a team of experts to focus on management plans for environmental flow, water quality and downstream aquatic life.

## 4.1 CONTRACTOR SS-ESMMPS

During Q4 2018, three Site Specific Environmental and Social Management Plans (SS-ESMMPs) and one Site Decommissioning and Rehabilitation Plans were reviewed and approved by the Environmental Management Office (EMO). More details can be found in ***Table 4-1***.

The status of the Site Specific ESMMPs received in Q4 2018 is shown in ***Table 4-1*** with details in ***Appendix 1***.

TABLE 4-1: *SS-ESMMP AND WORKING DRAWINGS REVIEWED DURING Q4 2018*

| Name of SS-ESMMP Document/ Working Drawings | Rev. 1 | Rev. 2 | Rev. 3 | Approved |
|---|---|---|---|---|
| **Site Specific Environmental & Social Management and Monitoring Plan (SS-ESMMP) for Installation of Cable Pit Cover at Main Power Station and Construction of Concrete Foundation for Fence and AC Power Source Box for 115 KV Switchyard at Regulating Power Station** | √ | | | √ |
| **Site Specific Environmental & Social Management and Monitoring Plan for Main Dam Tailrace Excavation** | √ | √ | | √ |
| **Site Specific Environmental & Social Management and Monitoring Plan for Spoil Disposal on the Left Bank** | √ | √ | √ | √ |
| **Site Decommissioning and Rehabilitation for KENBER Camp** | √ | Decommissioning was completed on 26 December 2018. A site closure checklist will be finalized following a receipt of the final landform map. | | |

## 4.2 RESULTS OF COMPLIANCE INSPECTIONS AT CONSTRUCTION SITES

During Q4 2018, the EMO conducted bi-weekly and weekly follow-up inspections at 29 construction sites and camps of the main construction sites around the main dam and the re-

regulation dam, the 230 kV Transmission Line, the 115 kV Transmission Line and construction sites in Phouhomxay Village. The total number of inspected sites decreased this Quarter from 30 to 29 sites because the suspension bridge construction at 2UR zone was temporarily stopped due to structural failure.

A total of five Observations of Non-Compliance (ONCs), one Non-Compliance Level-1 (NCR1) and two Non-Compliance Level-2 (NCR2) were active. Out of these, five ONCs were resolved during the reported period, one NCR-1 and two NCR-2 will be carried over to Q1 2019.

**TABLE 4-2: *STATUS OF NON-COMPLIANCE REPORT DURING Q4 2018***

| Status | ONC | NCR-Level 1 | NCR-Level 2 | NCR-Level 3 | Incident Report |
|---|---|---|---|---|---|
| Carried over ONC/NCR | 0 | 0 | 1 | 0 | 0 |
| Newly opened ONC/NCR | 5 | 1 | 1 | 0 | 0 |
| Total No. of ONC/NCR | 05 | 01 | 2 | 0 | 0 |
| Resolved ONC/NCR | 05 | 0 | 0 | 0 | 0 |
| Unresolved ONC/NCR carried forward to the next Quarter | 0 | **01** | **02** | 0 | 0 |

One of the pending NCR-2 was related to non-compliant discharge of wastewater from a contractor camp and insufficient corrective actions. The other pending NCR-2, opened in November 2019, was related to direct discharge of wastewater (black and grey water) from a sub-contractor's camp to the drains without prior treatment. The corrective actions are being implemented by the Contractor and will be reported in the next Quarter.

The status of these non-compliance reports is summarized in ***Table 4-2***, ***Figure 4-1*** and ***Figure 4-2.*** The progress of corrective actions is presented in ***Appendix 2***.

**FIGURE 4-1: *STATUS OF ONC DURING Q4 2018***

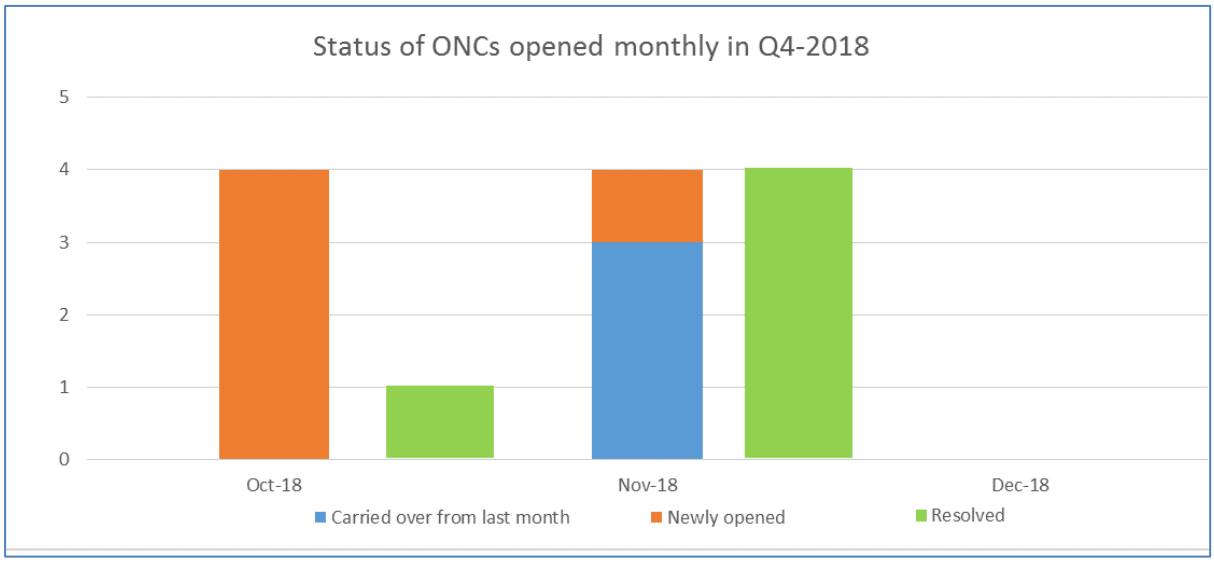
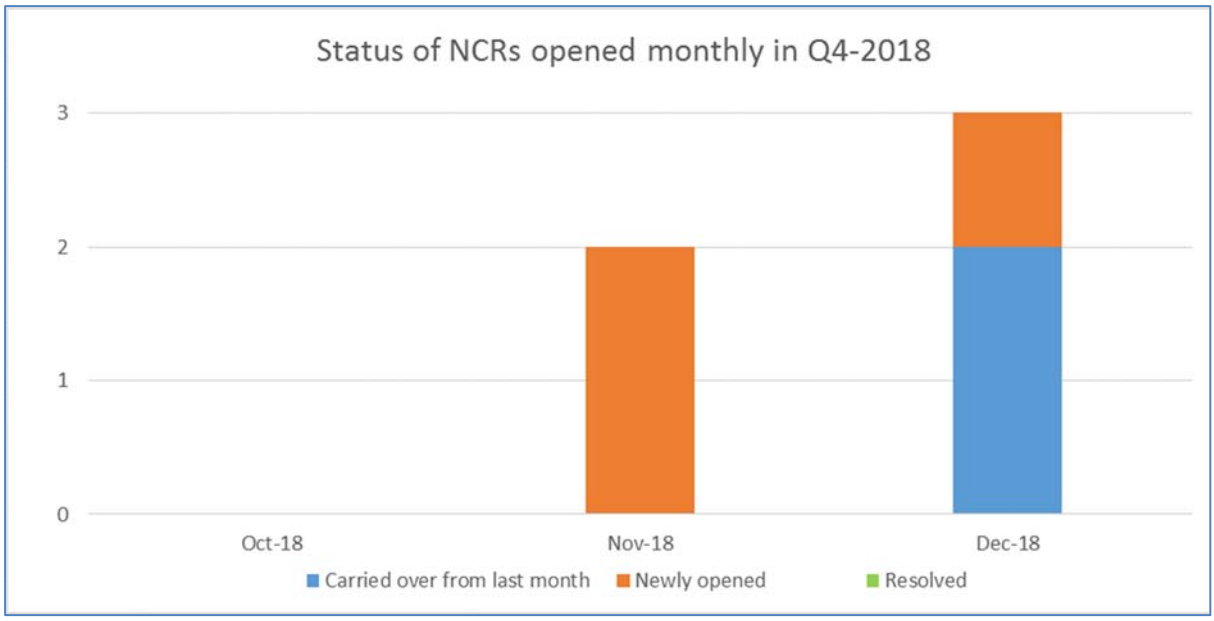


**FIGURE 4-2: *STATUS OF NCR DURING Q4 2018***




| Photograph 1: Joint Inspection on Site Decommissioning at the Aggregate Crushing Plant | Photograph 2: Joint Inspection on Site Decommissioning at The Kenber Camp |
|---|---|
|  |  |

| Photograph 3: Xaysomboun Provincial EMU Visited 2LR & 2UR Zones on 16-18 October 2018 | Photograph 4: Bolikhamxay Provincial EMU Conducted Site Inspection During 27 - 28 November 2018 |
|---|---|
|  |  |

## 4.3 WASTE MANAGEMENT AT THE CONSTRUCTION SITES

### 4.3.1 General Waste Management

During Q4 2018, a total of 300.1 $m^3$ of solid waste was disposed of at the NNP1 Project Landfill, a decrease of 130.6 $m^3$ compared to Q3 2018. EMO conducted three waste spot checks at the NNP1 Project Landfill, construction sites and the camps. It was found that waste management at the construction sites and camps has improved. The closure of NNP1 Project Landfill waste pit No.1 was completed in November 2018. The main work components included waste compaction, final soil cover, HDPE sheet cover and grass planting.

A total of 500 kg of compost was produced from grass, cow dung, rice husks, molasses, bio-extract (a liquid derived from the fermentation of vegetables and fruits with sugar and used as a natural liquid fertiliser) and vegetable and fruit waste from the canteens.

A total of 18,096 kg of recyclable waste was collected by Khounmixay Processing Factory and transported offsite to its facilities for recycling or processing as shown in ***Table 4-3***.

TABLE 4-3: *AMOUNTS OF RECYCLABLE WASTE SOLD DURING Q4 2018*

| Source and Type of Recyclables | | Unit | Total in Q4 of 2018 (A) | Sold (B) | Remaining Amount (A - B) |
|---|---|---|---|---|---|
| **Construction activity** | | | | | |
| 1 | Scrap metal | kg | 55,577 | 17,262 | 38,315 |
| **Sub-Total 1** | | **kg** | **55,577** | **17,262** | **38,315** |
| **Operation camp** | | | | | |
| 2 | Glass bottles | kg | 263 | 182 | 81 |
| 3 | Plastic bottles | kg | 233 | 180 | 53 |
| 4 | Aluminium cans | kg | 151.5 | 118.5 | 33 |
| 5 | Paper/Cardboard | kg | 382 | 353 | 29 |
| **Sub-Total 2** | | **kg** | **1,029.5** | **833.5** | **196** |
| **Grand Total 1+2** | | **kg** | **56,606.5** | **18,095.5** | **38,511** |

### 4.3.2 Hazardous Waste Management

In Q4 2018, joint hazardous materials and waste inventories were carried out monthly at the main construction sites and the contractors' camps. The amounts of hazardous waste collected, stored and disposed during Q4 2018 are shown in ***Table 4-4***. The treatment and final disposal of hazardous waste including used hydraulic oil and engine oil are outsourced to Khounmixay Processing Factory**.** The remaining waste will be collected, treated and disposed by Khounmixay Processing Factory over the next few months.

**TABLE 4-4:** ***HAZARDOUS WASTE RECORDED DURING Q4 2018***

| No. | Hazardous Waste Type | Unit | Total in Q4 2018 | Disposal | Remaining |
|---|---|---|---|---|---|
| 1 | Used hydraulic and engine oil | litre (l) | 8,650 | 2,980 | 5,670 |
| 2 | Contaminated soil, sawdust and concrete | kg | 1,190 | 675 | 515 |
| 3 | Used oil filters | No. | 288 | 83 | 205 |
| 4 | Used oil mixed with water | Litre | 200 | 0 | 200 |
| 5 | Used tyre | No. | 316 | 120 | 196 |
| 6 | Ink cartridge | No. | 188 | 0 | 188 |
| 7 | Halogen/fluorescent bulbs | No. | 154 | 0 | 154 |
| 8 | Empty paint and spray cans | can | 174 | 60 | 114 |
| 9 | Empty contaminated bitumen drum/container | drum (200 l) | 212 | 131 | 81 |
| 10 | Empty used chemical drum/container | drum (200 l) | 55 | 3 | 52 |
| 11 | Contaminated textile and material | kg | 49 | 22 | 27 |
| 12 | Lead acid batteries | No. | 22 | 0 | 22 |
| 13 | Empty used oil drum/container | drum (20 l) | 50 | 34 | 16 |
| 14 | Lithium-ion batteries | No. | 7 | 0 | 7 |
| 15 | Empty used oil drum/container | drum (200 l) | 39 | 33 | 6 |
| 16 | Clinical waste | kg | 4 | 0 | 4 |
| 17 | Empty used chemical drum/container | Drum (20 l) | 135 | 135 | 0 |
| 18 | Acid and caustic cleaners | Bottle | 0 | 0 | 0 |
| 19 | Cement bag | bag | 0 | 0 | 0 |

### 4.3.3 Sewage Sludge Disposal

A total of 46 $m^3$ of sewage sludge from Sino Hydro camp and Kenber camp was transported and disposed of at the Spoil Disposal Area No. 6 by following NNP1PC's Standard Operating Procedure (SOP) on Sewage/Black Water Disposal as part of the Camps' decommissioning activities.

## 4.4 COMMUNITY WASTE MANAGEMENT SUPPORT

### 4.4.1 Animal Fodder (Pig Feed) Collection Programme

During Q4 2018, local villagers collected a total of 15,587 kg of food waste from the Owner's Site Office and Village (OSOV) and Contractors' camps for feeding their animals. This is a decrease of 1,783 kg compared to Q3 2018. More details are shown in ***Table 4-5***.

**TABLE 4-5: *AMOUNT OF FOOD WASTE COLLECTED BY LOCAL VILLAGERS FOR USE AS PIG FEED DURING Q4 2018***

| NO. | SITE NAME | UNIT | TOTAL |
|---|---|---|---|
| 1 | Song Da 5 Camp No. 2 | kg | 2,412 |
| 2 | Song Da 5 Camp No. 1 | kg | 1,958 |
| 3 | Obayashi Corporation Camp | kg | 2,516 |
| 4 | Owner's Site Office and Village (OSOV) | kg | 4,302 |
| 5 | LILAMA 10 Camp | kg | 4,353 |
| 6 | Kenber Camp | kg | 46 |
| **Total** | | **kg** | 15,587 |

### 4.4.2 Community Recycling Programme

The Community Recycle Waste Bank collected a total of 4,278.3 kg of recyclables from villagers and 2,461.8 kg was sold to Khounmixay Processing Factory as presented in ***Table 4-6*** below.

**TABLE 4-6: AMOUNTS OF RECYCLABLES SOLD AT THE COMMUNITY RECYCLE WASTE BANK**

| Types of Waste | Unit | Purchased Amount During the Fourth Quarter of 2018 (A) | Sold (B) | Remaining Amount (A - B) |
|---|---|---|---|---|
| Scrap metal | kg | 37 | 28 | 9 |
| Glass | kg | 2,229 | 745 | 1,484 |
| Paper/cardboards | kg | 1,435.5 | 1,121.5 | 314 |
| Plastic bottles | kg | 516.6 | 508.1 | 8.5 |
| Aluminium | kg | 60.2 | 59.2 | 1 |
| **Total** | **kg** | **4,278.3** | **2,461.8** | **1,816.5** |

In addition, EMO conducted a community consultation on waste management for host villages (Thaheau and Hat Gnuin Village) and Phouhomxay Village during 15 - 16 November 2018 to improve their awareness on proper waste separation and disposal.

### 4.4.3 Houay Soup Landfill

A local contractor has serviced the operation of the Houay Soup landfill since December 2017. The work includes solid waste collection and transportation from Phouhomxay, Thahuea and Hat Gniun Villages to Houay Soup landfill three days per week (Monday, Wednesday and Friday), waste segregation, waste compaction and waste cover at the landfill.

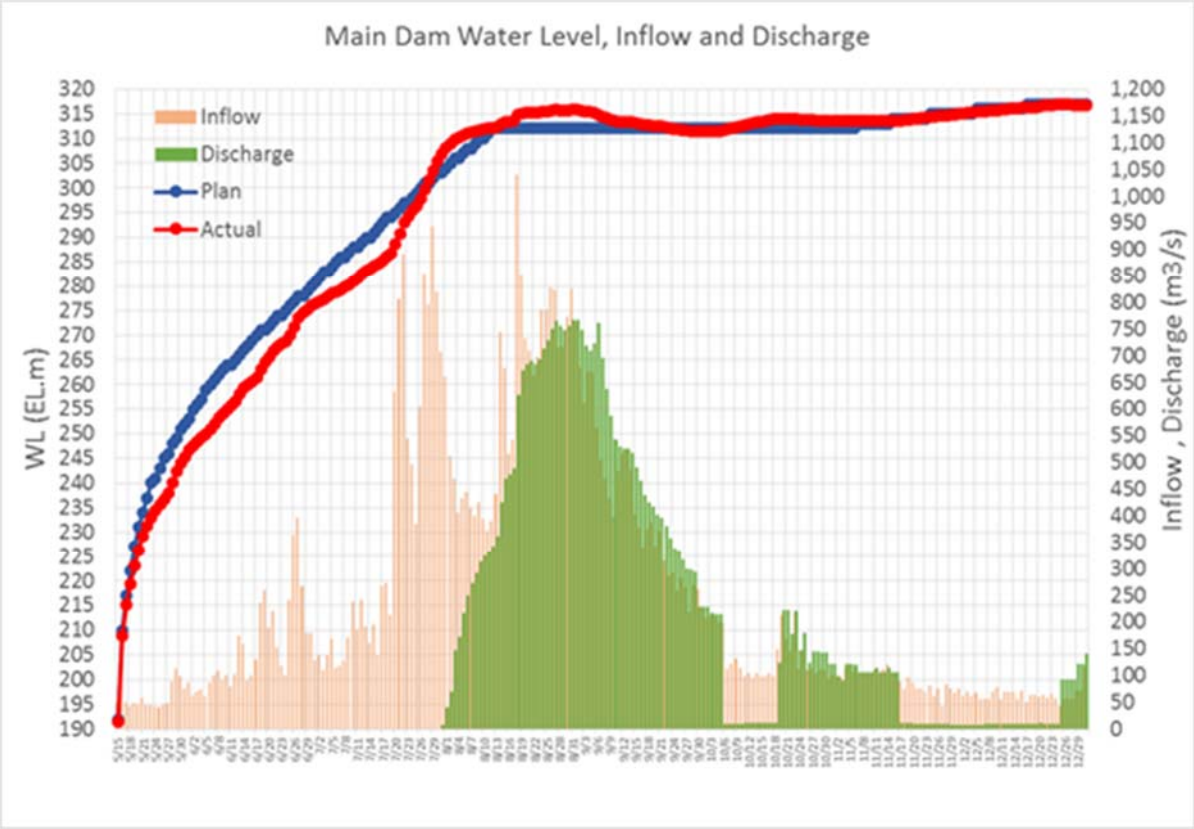
During Q4 2018, approximately 276.8 $m^3$ of solid waste was collected from the Thaheau, Hat Gniun and Phouhomxay Villages.

On 13 November 2018, a post contract completion evaluation was carried out for this local contractor and the Houay Soup landfill contract was extended to 31 December2019.

## 4.5 MAIN RESERVOIR IMPOUNDING

The progress of impounding from 15 May 2018 to 31 December 2018 is presented on the graph in ***Figure 4-3*** indicating the water level in the main reservoir, the inflow to the main reservoir and the discharge from the main reservoir into the re-regulation reservoir. The inflow data shows the gradual reduction in flows from the end of the wet season into the dry season with inflows from about 215 $m^3/s$ at the beginning of October 2018, to about 100 $m^3/s$ until middle of November 2018 followed by an average of about 70 $m^3/s$ from the middle of November until the end of December 2018.

FIGURE 4-3: *PROGRESS OF IMPOUNDING THE MAIN RESERVOIR 15 MAY – 31 DECEMBER 2018*




As also indicated in ***Figure 4-3*** the discharge from the main dam was reduced to about 10 $m^3/s$ during the period from 06-19 October 2018, while the inflow was about 115 $m^3/s$. The purpose of this was to make it possible to carry out various work along the main dam tailrace. During the remaining part of October until 16 November 2018 the discharge from the re-regulation dam was approximately equal to the inflow and the water level in the main reservoir remained at about 313.6 masl.

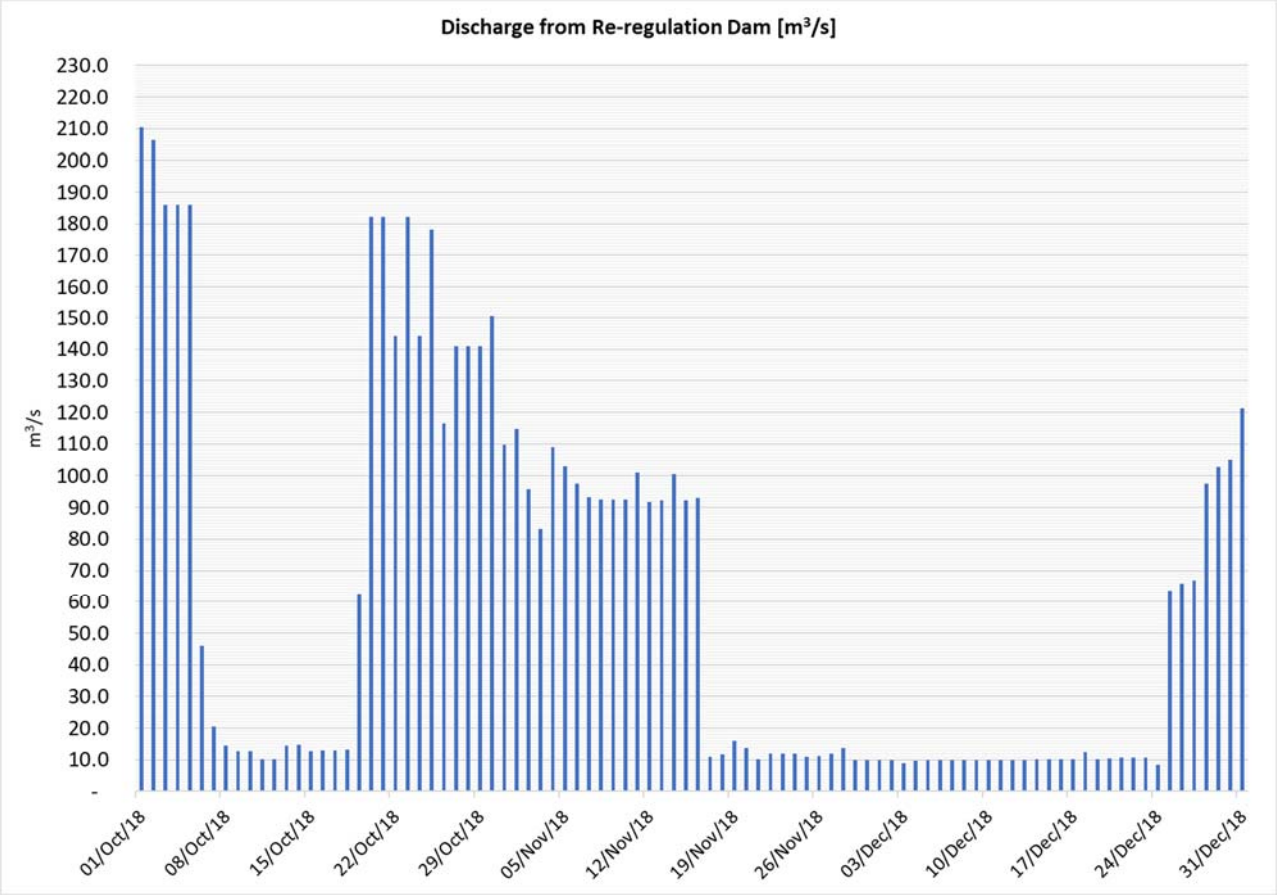
On 17 November 2018 the impounding of the main reservoir was restarted and continued until 25 December 2018. The water level in the reservoir rose with 3.2 m from 313.6 masl on 17 November 2018 to 316.8 masl on 25 December 2018. In the same period, the discharges from the main dam and the re-regulation dam were reduced (see *Figure 4-4*) and maintained close to 10 $m^3/s$, which is well above the minimum flow requirement of 5.5 $m^3/s$. On 25 December 2018 the discharge from the main dam and the re-regulation dam was increased

to equal the inflow to the main reservoir and this was maintained during the remaining part of December 2018.

The ramping up and down of discharges from the re-regulation gate were carried out in incremental steps as required by the Operational Manual for the Re-regulation Dam to ensure compliance with the maximum rate of change in the water level of Nam Ngiep.

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 4-4: *DISCHARGE MONITORING AT THE RE-REGULATION DAM IN Q4 2018***




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

Since 18 July 2018, NNP1PC has carried out weekly monitoring of river depths at 19 locations downstream the re-regulation dam as shown on ***Figure 4-5***. These locations represent cross-sections with possible shallow water depths at low discharge rates. Note that the station RWD02.a and RWD 18 were added in November 2018 because rocks were observed in the cross-section, which may pose difficulties for boat passage.

The monitoring is undertaken to confirm compliance with the water depth requirements in the Concession Agreement, Annex C and the approved Environmental Flow Assessment (at least 0.5 m measured immediately downstream the re-regulation dam).

The results of the monitoring are presented in ***Table 4-7***.

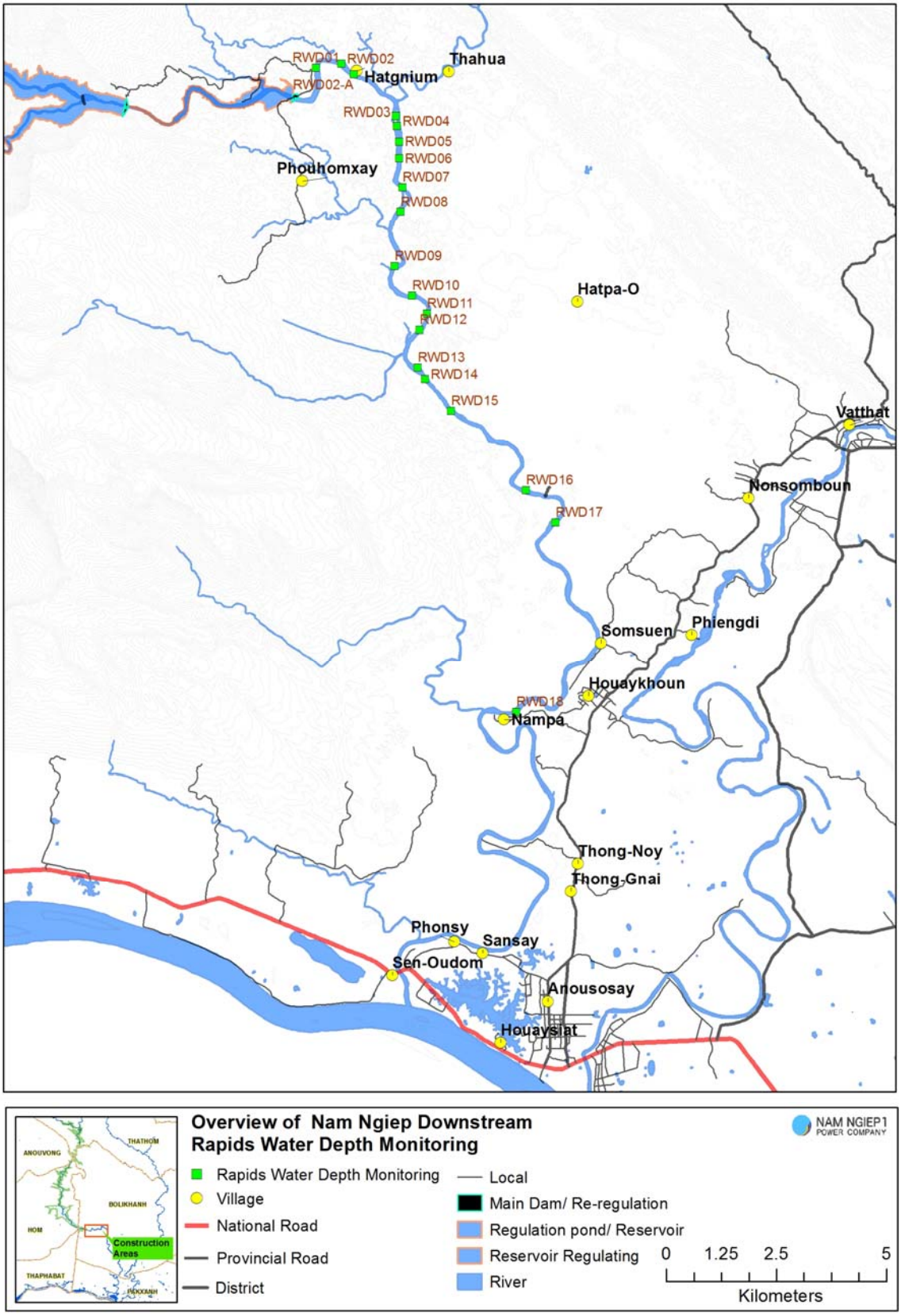
The depth with yellow highlight caused difficulties for boat passage and the depths in red font were below 0.5 m. For completeness sake all depths below 0.5 m are shown in red font.

The measurements indicate that at low discharge rates from 10-13 $m^3/s$, the water depths are likely to fall below 0.5 m and boat passage may be difficult at all cross-sections in the 14 km reach downstream from the re-regulation dam.

**TABLE 4-7 RIVER DEPTH MEASUREMENTS IN NAM NGIEP DOWNSTREAM THE RE-REGULATION DAM**

| Station ID | | RWD 01 | RWD 02 | RWD 02.a | RWD 03 | RWD 04 | RWD 05 | RWD 06 | RWD 07 | RWD 08 | RWD 09 | RWD 10 | RWD 11 | RWD 12 | RWD 13 | RWD 14 | RWD 15 | RWD 16 | RWD 17 | RWD 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Distance from Re-regulation Dam (Km) | | 1.55 | 2.43 | 2.97 | 4.9 | 5.2 | 5.66 | 6.16 | 7.13 | 8.01 | 9.97 | 11.31 | 12.08 | 12.62 | 14.1 | 14.49 | 15.77 | 19.76 | 21.58 | 30.09 |
| Date | Discharge (m3/s) | Depth (m) | Depth (m) | Depth (m) | Depth (m) | Depth (m) | Depth (m) | Depth (m) | Depth (m) | Depth (m) | Depth (m) | Depth (m) | Depth (m) | Depth (m) | Depth (m) | Depth (m) | Depth (m) | Depth (m) | Depth (m) | Depth (m) |
| 04-10-18 | *186* | 1.31 | 1.4 | | 1.93 | 2.00 | 2.1 | 2.08 | 2.24 | 2 | 2.35 | 1.7 | 2.1 | 2.2 | 2.4 | 3.4 | 3.54 | 3.12 | 3.45 | |
| 11-10-18 | *10* | 0.15 | 0.15 | | 0.3 | 0.2 | 0.35 | 0.4 | 0.5 | 0.4 | 0.5 | 0.3 | 0.5 | 0.4 | 0.53 | 1.6 | 1.8 | 1.2 | 1.5 | |
| 18-10-18 | *13* | 0.25 | 0.29 | | 0.35 | 0.38 | 0.4 | 0.44 | 0.6 | 0.52 | 0.61 | 0.37 | 0.56 | 0.5 | 0.65 | 1.7 | 1.8 | 1.4 | 1.6 | |
| 23-10-18 | *183* | 1.4 | 1.35 | | 1.54 | 1.6 | 1.7 | 1.72 | 1.87 | 1.6 | 1.85 | 1.6 | 1.75 | 1.88 | 1.9 | 2.1 | 2.8 | 2.5 | 2.7 | |
| 01-11-18 | *115* | 1.13 | 1.05 | | 1.18 | 1.2 | 1.3 | 1.34 | 1.31 | 1.25 | 1.4 | 1.3 | 1.43 | 1.55 | 1.63 | 1.9 | 2.6 | 2.3 | 2.25 | |
| 08-11-18 | *92* | 0.83 | 0.75 | | 0.88 | 0.9 | 1.00 | 1.04 | 1.01 | 1.05 | 1.1 | 1.00 | 1.13 | 1.25 | 1.33 | 1.6 | 2.3 | 2.00 | 1.95 | |
| 15-11-18 | *92* | 0.88 | 0.95 | | 1.00 | 1.2 | 1.3 | 1.38 | 1.32 | 1.15 | 1.3 | 1.2 | 1.4 | 1.65 | 1.78 | 1.9 | 2.5 | 2.01 | 1.97 | |
| 23-11-18 | *12* | 0.3 | 0.36 | 0.36 | 0.39 | 0.39 | 0.25 | 0.39 | 0.48 | 0.5 | 0.55 | 0.57 | 0.5 | 0.48 | 0.5 | 0.75 | 1.35 | 1.3 | 1.2 | 0.3 |
| 29-11-18 | *10* | 0.3 | 0.35 | 0.35 | 0.4 | 0.4 | 0.15 | 0.33 | 0.46 | 0.45 | 0.38 | 0.5 | 0.4 | 0.38 | 0.48 | 0.7 | 1.2 | 1.00 | 0.93 | 0.28 |
| 06-12-18 | *10* | 0.28 | 0.33 | 0.3 | 0.38 | 0.4 | 0.13 | 0.29 | 0.4 | 0.43 | 0.38 | 0.47 | 0.38 | 0.36 | 0.46 | 0.67 | 1.14 | 0.94 | 0.9 | 0.28 |
| 13-12-18 | *10* | 0.28 | 0.33 | 0.3 | 0.38 | 0.39 | 0.13 | 0.28 | 0.35 | 0.43 | 0.36 | 0.47 | 0.38 | 0.36 | 0.46 | 0.67 | 1.14 | 0.94 | 0.9 | 0.28 |
| 20-12-18 | *10* | 0.28 | 0.33 | 0.3 | 0.38 | 0.39 | 0.13 | 0.28 | 0.35 | 0.43 | 0.36 | 0.47 | 0.38 | 0.36 | 0.46 | 0.67 | 1.14 | 0.94 | 0.9 | 0.28 |
| 27-12-18 | *97* | 0.98 | 1.03 | 1.00 | 1.08 | 1.09 | 0.83 | 0.98 | 1.05 | 1.13 | 1.06 | 1.17 | 1.08 | 1.07 | 1.16 | 1.37 | 1.78 | 1.65 | 1.75 | 1.2 |

FIGURE 4-5 LOCATION OF RIVER DEPTH MONITORING POINTS



## 4.6 ENVIRONMENTAL MONITORING

The environmental monitoring activities followed the programmes presented in the ESMMP-CP Volume III. The programmes consist of the following components:

a) Effluent discharge from camps and construction sites
b) Ambient surface water quality monitoring
c) Groundwater quality monitoring
d) Reservoir water quality monitoring
e) Landfill leachate quality monitoring
f) Ambient air quality monitoring (particulate matter of less than 10 microns)
g) Ambient noise and noise emission monitoring.

The monitoring results are assessed against the relevant National Environmental Standards and Effluent Standards specified in the Concession Agreement Annex C[2] as applicable. This Section focuses on the key results that did not meet the Standards. All monitoring results can be found in ***Appendix 5***.

The NNP1PC Environmental Laboratory carried out water quality analyses for TSS, $BOD_5$, total coliform, faecal coliform and E. coli bacteria. All other laboratory water quality analyses are performed by United Analysis and Engineering Consultant Company Ltd (UAE) in Bangkok, Thailand.

### 4.6.1 Surface Water (River) Quality

The regular surface water quality monitoring programme was adjusted in May 2018 due to the impounding of the main reservoir, which started on 15 May 2018. The revised programme comprises:

- 5 monitoring stations in the main reservoir: R1, R2, R3, R4 and R5, where R1 and R2 are new stations and R3, R4 and R5 correspond to the location of the previous Nam Ngiep main stem stations NNG02, NNG03 and NNG09 respectively,
- 2 stations in the re-regulation reservoir: R6 and R7 where R6 corresponds to the location of the previous Nam Ngiep main stem station NNG04,
- 5 stations in the Nam Ngiep main stem (NNG01, and NNG05, NNG06, NNG07 andNNG08) and
- 4 stations in the main tributaries to Nam Ngiep (NCH01 in Nam Chiane, NPH01 in Nam Phouan, NXA in Nam Xao and NHS01 in Nam Houay Soup).
- NPH01 in Nam Phouan has been moved upstream in the Nam Phouane as the previous location is now in the reservoir.

[2] The Effluent Standards in Annex C are **the stricter of** the indicative guideline values applicable to sanitary wastewater in IFC Environmental Health and Safety Guideline, General Guidelines: Wastewater and Ambient Water Quality – and the applicable values in the Lao National Environmental Standards. Note also that the indicative guideline values in the IFC EHS Guideline are meant to apply in the absence of national values

The measurements of depth profiles in the main reservoir and re-regulation reservoir (dissolved oxygen, temperature, conductivity, pH, and total dissolved solids) started in mid-September 2018.

The monitoring programme is presented in the Table 4-8 and the locations of monitoring stations are shown in ***Table 4-8***.

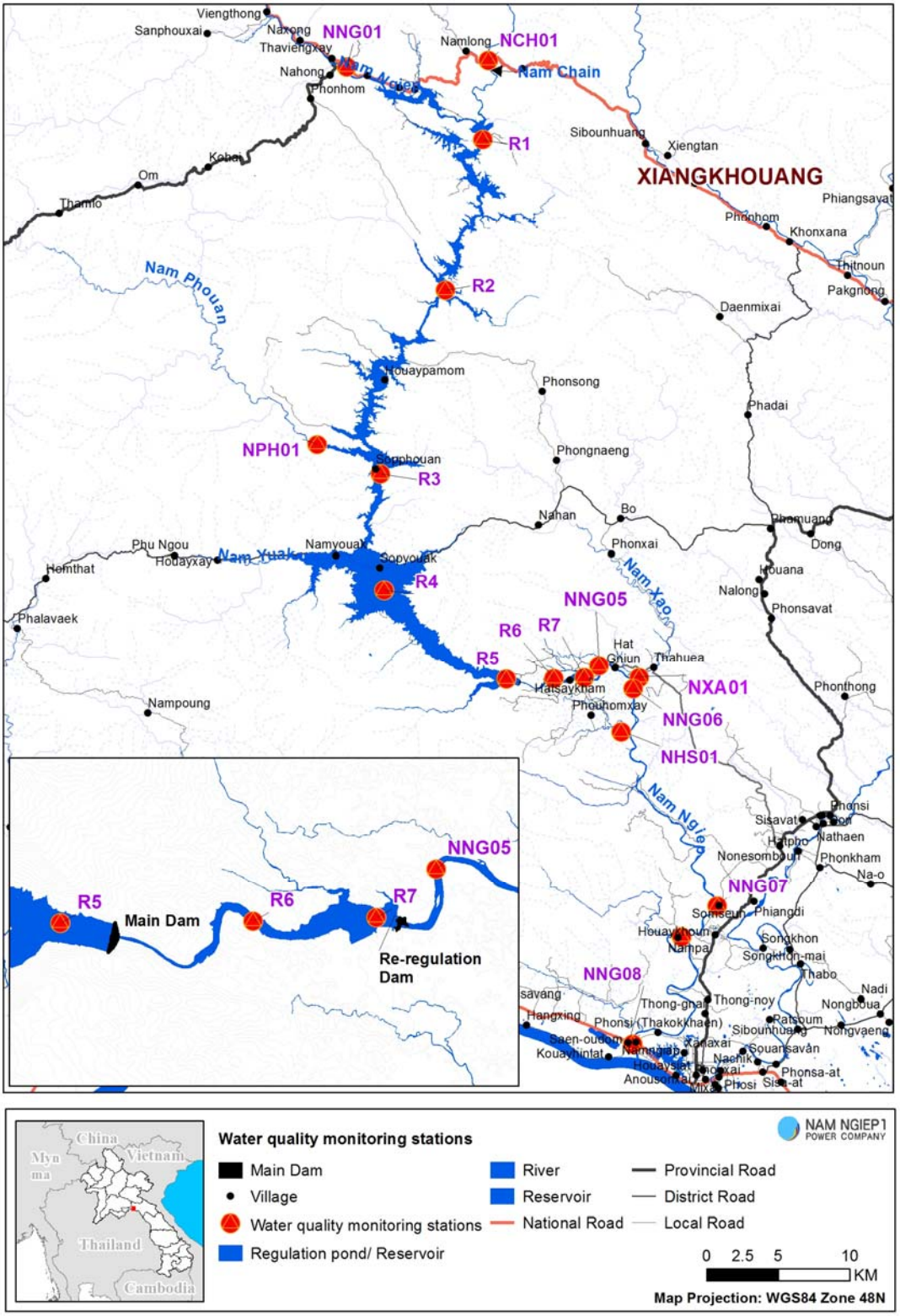
The surface water quality monitoring programme was revised in 2017 based on the results of the previous two years of monitoring. The monitoring frequencies of TKN, chloride, sulphate, alkalinity, calcium, potassium and sodium were reduced to six-monthly as the previous results indicated low concentrations with little change over time. The monitoring frequencies of lead, mercury and arsenic were also reduced; for lead to annual monitoring and for mercury and arsenic to six-monthly. The results of these three metals have consistently been below the relevant National Surface Water Quality Standard and the limit of detection. With respect to magnesium, there is no standard and the results have shown consistently low levels with little change over time. The frequency has therefore been reduced to annual measurements.

*TABLE 4-8: MONITORING FREQUENCY FOR SURFACE WATER QUALITY PARAMETERS*

| Frequency of Monitoring | Parameters (Unit) | Monitoring Sites |
|---|---|---|
| Tuesdays and Saturdays | pH, DO (%), DO (mg/l), Conductivity (µs/cm), TDS (mg/l), Temperature (°C) and Turbidity (NTU) | - R5<br>- NNG05 |
| Weekly | pH, DO (%), DO (mg/l), Conductivity (µs/cm), TDS (mg/l), Temperature (°C), Turbidity (NTU), TSS (mg/l), | - NPH01<br>- R3<br>- R4<br>- R5<br>- R6<br>- R7<br>- NNG05 |
| Weekly | $BOD_5$ (mg/l), Faecal coliform (MPN/100 ml) and Total coliform (MPN/100 ml) | - R5<br>- R6<br>- R7<br>- NNG05 |
| Fortnightly | pH, DO (%), DO (mg/l), Conductivity (µs/cm), TDS (mg/l), Temperature (°C), Turbidity (NTU) | All 16 stations |
| Monthly | TSS (mg/l), $BOD_5$ (mg/l), COD (mg/l), $NH_3$-N (mg/l), $NO_3$-N (mg/l), total coliform (MPN/100 ml), faecal coliform (MPN/100 ml) | All 16 stations |
| Quarterly | Total iron (mg/l), Manganese (mg/l), total phosphorus (mg/l), total dissolved phosphorus (mg/l), phytoplankton biomass (g dry weight/$m^3$), TOC (mg/l) | All 16 stations |
| Six-monthly | Alkalinity, Chloride, Calcium TKN, Sulphate, Potassium, Sodium | All stations except R2 |

| Frequency of Monitoring | Parameters (Unit) | Monitoring Sites |
|---|---|---|
| | Arsenic, Mercury | |
| Annually | Lead, Magnesium | All stations except R2 |

FIGURE 4-6: *SURFACE WATER QUALITY MONITORING LOCATIONS*

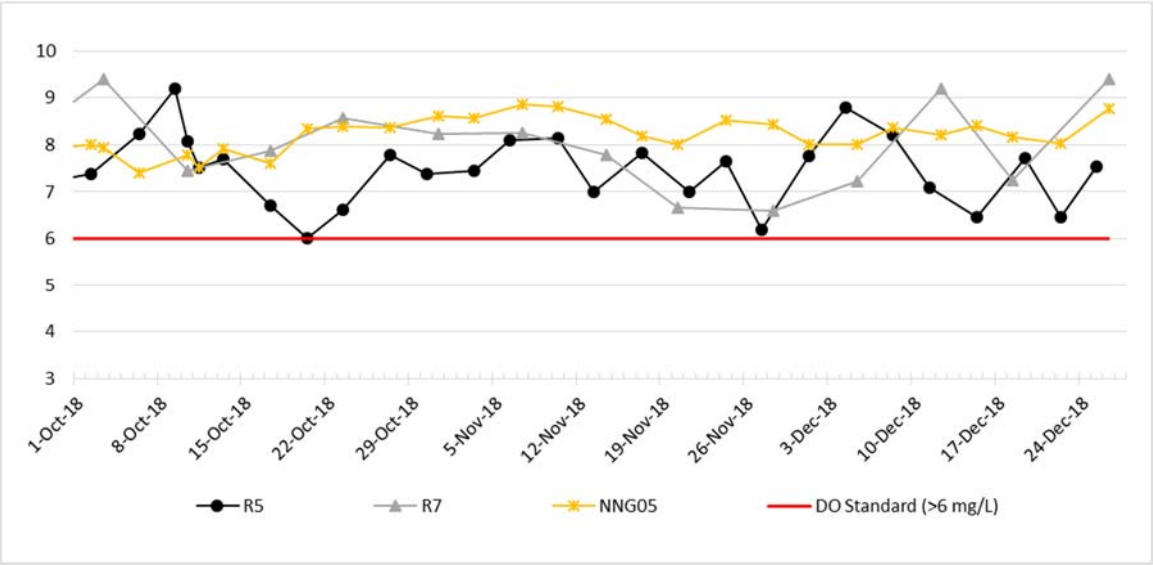


Descriptions of each monitoring station and surface water quality monitoring parameters can be found in ***Appendix 3*** and all surface water quality data for Q4 2018 are listed in ***Appendix 5.1***

### 4.6.2 Dissolved Oxygen (DO)

The results of dissolved oxygen measurements in the upper 0.2 m for the stations immediately upstream the main dam and downstream the re-regulation dam are presented in the line graph in Figure 4-7, and the full set of data are shown in Table 4-9.

FIGURE 4-7: *DISSOLVED OXYGEN IMMEDIATELY UPSTREAM AND DOWNSTREAM THE PROJECT*




During the Q4 2018, the concentration of dissolved oxygen in the upper 0.2 m have remained above the National Surface Water Quality Standard (NSWQS) of 6 mg/L in all stations. This is an improvement compared to Q3 2018 where the concentrations of dissolved oxygen in the upper water column of R5 were below the standard for long periods.

The dissolved oxygen depth profile in the main reservoir and in the re-regulation reservoir since mid-September 2018 to end of December 2018 is summarized in ***Figure 4-9***.

The depth profile monitoring indicates formation of oxyclines in all the stations in the main reservoir except the most upstream R1 at depths between 2.5 – 10.0 m.

Similarly, all the main reservoir stations except R1 have a thermocline at 2-4 m depth.

During Q4 2018, the discharge from the main dam into the re-regulation reservoir was conducted through the main dam spillways and in some periods also through the riparian release conduit. In any case, the spilling aerated the water and the DO levels in R6 and R7 in the re-regulation reservoir were consistently well above 6 mg/L with no indications of neither an oxycline nor a thermocline.

**FIGURE 4-8: MAIN RESERVOIR DISSOLVED OXYGEN AT THE END OF Q4 2018**

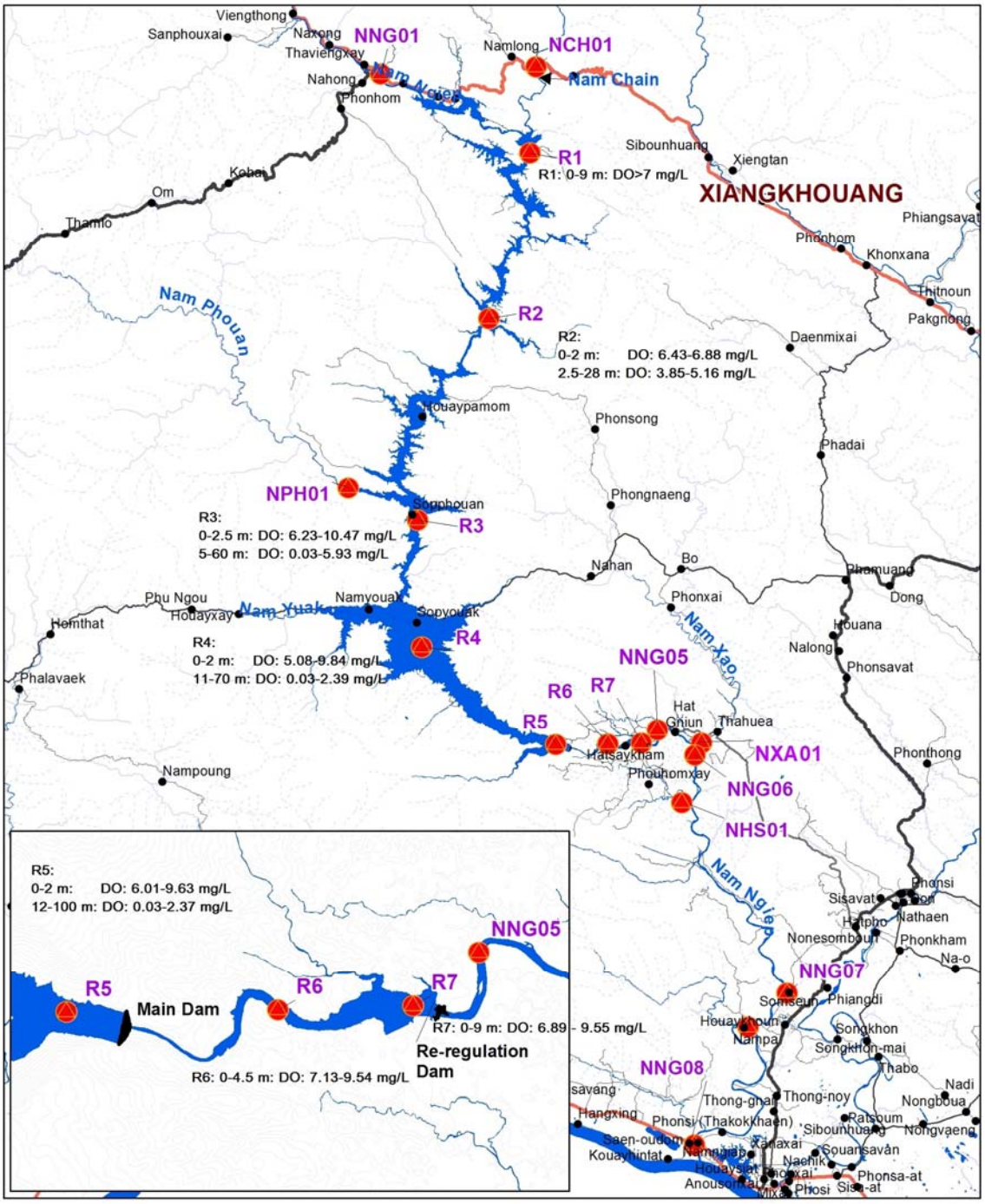
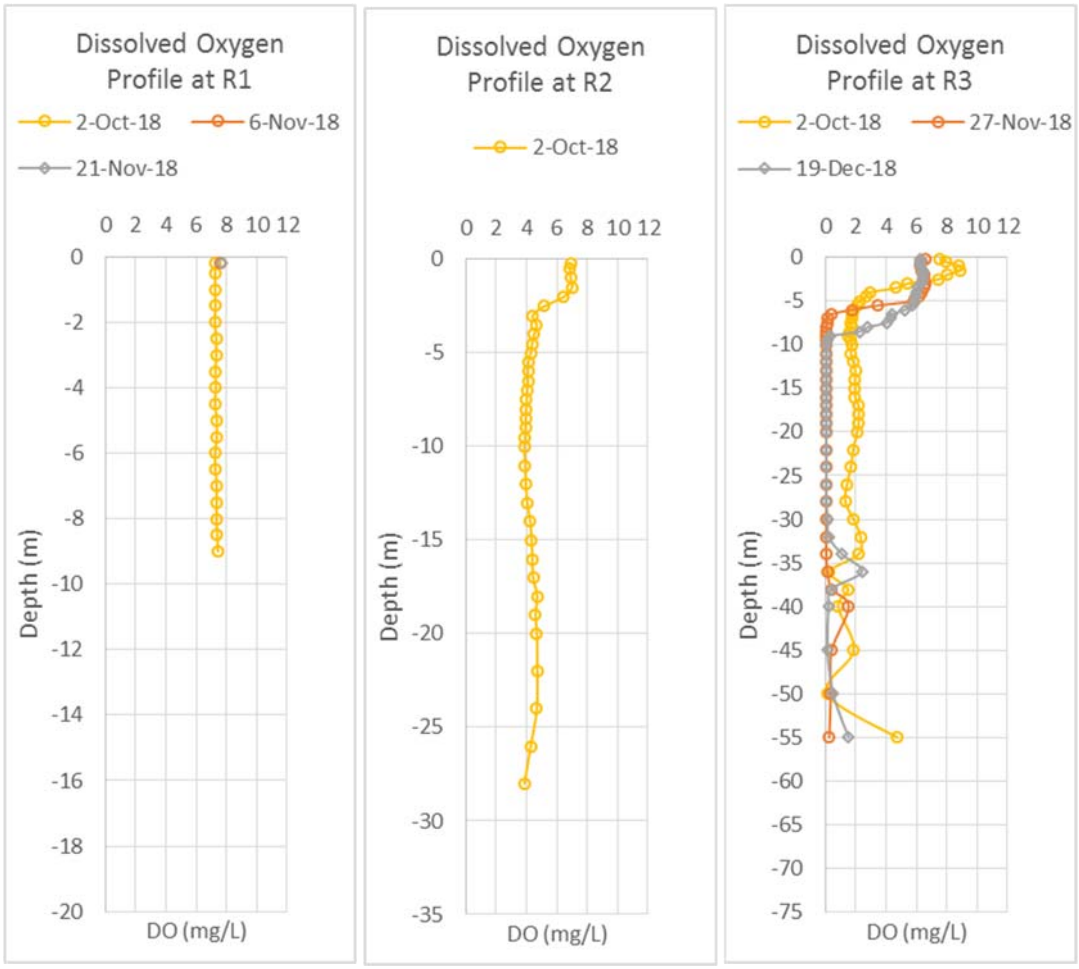
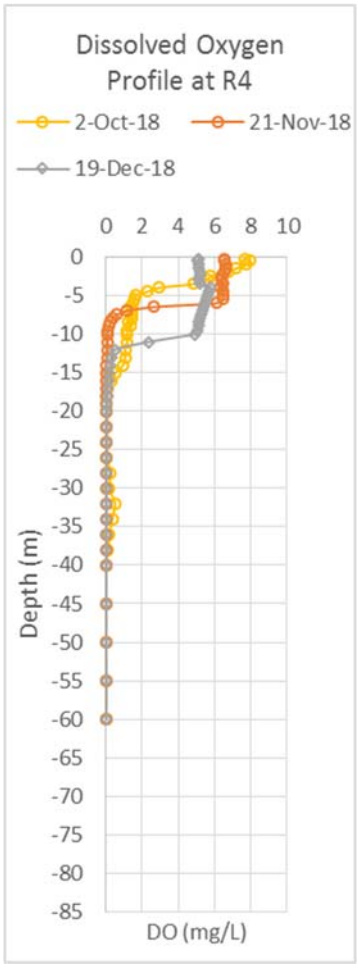
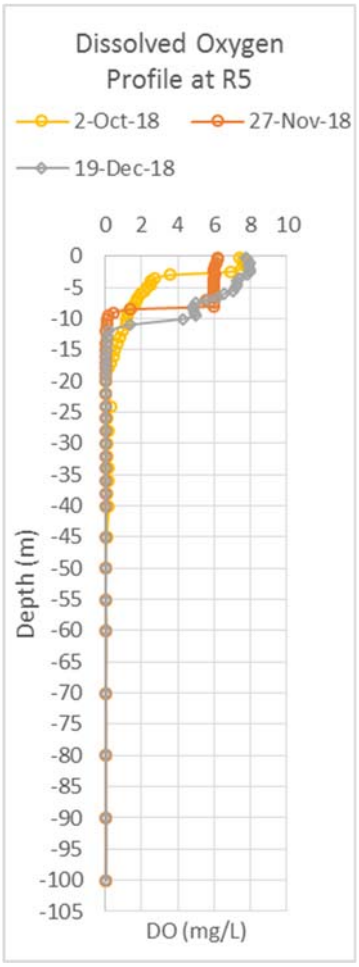
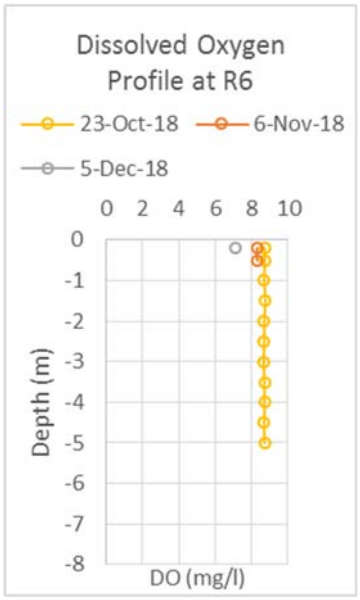


**FIGURE 4-9:** ***DISSOLVED OXYGEN – DEPTH PROFILE IN THE MAIN RESERVOIR AND RE-REGULATION RESERVOIR***




Dissolved Oxygen Profile at R4
2-Oct-18
21-Nov-18
19-Dec-18
0 2 4 6 8 10
0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -55 -60 -65 -70 -75 -80 -85
Depth (m)
DO (mg/L)


Dissolved Oxygen Profile at R5
2-Oct-18
27-Nov-18
19-Dec-18
0 2 4 6 8 10
0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -55 -60 -65 -70 -75 -80 -85 -90 -95 -100 -105
Depth (m)
DO (mg/L)


Dissolved Oxygen Profile at R6
23-Oct-18
6-Nov-18
5-Dec-18
0 2 4 6 8 10
0 -1 -2 -3 -4 -5 -6 -7 -8
Depth (m)
DO (mg/l)

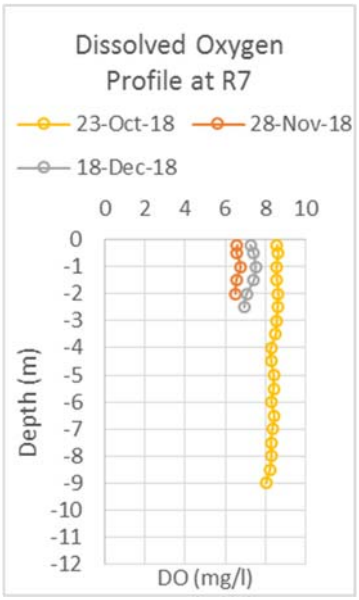

Dissolved Oxygen Profile at R7
23-Oct-18
28-Nov-18
18-Dec-18
0 2 4 6 8 10
0 -1 -2 -3 -4 -5 -6 -7 -8 -9 -10 -11 -12
Depth (m)
DO (mg/l)

**TABLE 4-9:** ***DO RESULTS OF SURFACE WATER IN MAIN RESERVOIR, RE-REGULATION RESERVOIR, NAM NGIEP AND ITS MAIN TRIBUTARIES MONITORED FROM OCTOBER TO DECEMBER 2018 (NATIONAL SURFACE WATER QUALITY STANDARD FOR DO: >6.0 MG/L)***

| Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG05 | NNG06 | NNG07 | NNG08 | NCH01 | NPH01 | NXA01 | NHS01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2-Oct-18 | 7.84 | 7.29 | 6.88 | 7.55 | 7.64 | 7.39 | | | 8.02 | | | | 7.94 | | | |
| 3-Oct-18 | | | | | | | 8.11 | 9.39 | 7.95 | 7.96 | 7.74 | 7.47 | | | 7.36 | 6.62 |
| 6-Oct-18 | | | | | | 8.23 | | | 7.4 | | | | | | | |
| 9-Oct-18 | | | | 9.73 | 9.63 | 9.19 | | | | | | | | | | |
| 10-Oct-18 | | | | | | 8.07 | 7.89 | 7.44 | 7.78 | | | | | | | |
| 11-Oct-18 | | | | | | 7.52 | | | 7.52 | | | | | | | |
| 13-Oct-18 | | | | | | 7.69 | | | 7.92 | | | | | | | |
| 17-Oct-18 | | | | | | 6.7 | 8.19 | 7.87 | 7.61 | 7.4 | 7.52 | 7.54 | | | 7.33 | 7.32 |
| 20-Oct-18 | | | | | | 6.02 | | | 8.35 | | | | | | | |
| 22-Oct-18 | 7.99 | | | | | | | | | | | | 8.16 | | | |
| 23-Oct-18 | | | | | | 6.62 | 8.71 | 8.58 | 8.38 | | | | | | | |
| 27-Oct-18 | | | | | | 7.79 | | | 8.37 | | | | | | | |
| 30-Oct-18 | | | | | | 7.39 | | | | | | | | | | |
| 31-Oct-18 | | | | | | | 8.45 | 8.23 | 8.62 | | | | | | | |
| 3-Nov-18 | | | | | | 7.45 | | | 8.57 | | | | | | | |
| 6-Nov-18 | 8.19 | 7.61 | | 9.03 | 8.36 | 8.1 | | | | | | | 8.51 | | | |
| 7-Nov-18 | | | | | | | 8.29 | 8.25 | 8.87 | 8.33 | 8.15 | 8.16 | | | 7.43 | 7.76 |
| 10-Nov-18 | | | | | | 8.15 | | | 8.82 | | | | | | | |
| 13-Nov-18 | | | | 7.69 | 6.73 | 7.01 | | | | | | | | | | |
| 14-Nov-18 | | | | | | | 8.18 | 7.79 | 8.55 | | | | | | | |
| 17-Nov-18 | | | | | | 7.84 | | | 8.18 | | | | | | | |
| 20-Nov-18 | | | | | | | 7.25 | 6.66 | 8.02 | 7.58 | 7.7 | 7.63 | | | 7.49 | 7.13 |
| 21-Nov-18 | 8.3 | 7.72 | | 6.97 | 6.56 | 7 | | | | | | | 8.92 | | | |
| 24-Nov-18 | | | | | | 7.64 | | | 8.53 | | | | | | | |
| 27-Nov-18 | | | | 6.54 | 6.19 | 6.2 | | | | | | | | | | |

| Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG05 | NNG06 | NNG07 | NNG08 | NCH01 | NPH01 | NXA01 | NHS01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 28-Nov-18 | | | | | | | 7.46 | 6.6 | 8.44 | | | | | | | |
| 1-Dec-18 | | | | | | 7.76 | | | 8.01 | | | | | | | |
| 4-Dec-18 | | | | | 8.52 | 8.79 | | | | | | | | | | |
| 5-Dec-18 | | | | | | | 7.13 | 7.22 | 8.02 | | | | | | | |
| 8-Dec-18 | | | | | | 8.22 | | | 8.36 | | | | | | | |
| 11-Dec-18 | 8.53 | 6.07 | | 6.6 | 6.38 | 7.08 | | | | | | | 8.45 | 8.8 | | |
| 12-Dec-18 | | | | | | | 9.09 | 9.19 | 8.22 | 7.89 | 8.27 | 8.29 | | | 7.46 | 7.51 |
| 15-Dec-18 | | | | | | 6.46 | | | 8.41 | | | | | | | |
| 18-Dec-18 | | | | | | | 8.34 | 7.25 | 8.17 | | | | | | | |
| 19-Dec-18 | | | | 6.28 | 5.13 | 7.71 | | | | | | | | 9.08 | | |
| 22-Dec-18 | | | | | | 6.47 | | | 8.04 | | | | | | | |
| 25-Dec-18 | 8.59 | | | 8.45 | 8.06 | 7.54 | | | | | | | 8.83 | 10.74 | | |
| 26-Dec-18 | | | | | | | 9.54 | 9.39 | 8.77 | 8.72 | 8.1 | 7.98 | | | 7.95 | 7.62 |

### 4.6.3 Ammonia Nitrogen

Since 2014, the Ammonia Nitrogen levels in the Nam Ngiep River and its tributaries have generally been below the detection limit (<0.2 mg/L). In October and November 2018, Ammonia Nitrogen exceeded the National Surface Water Quality Standard of <0.2 mg/L in some stations with levels as high as between 0.25 – 0.7 mg/L. The elevated levels of ammonia nitrogen observed in October 2018 in the main reservoir and immediately downstream could be explained by the decomposition of biomass after the impounding of the reservoir, but this cannot explain the elevated levels in the tributaries nor in the further downstream stations NNG05, NNG06 and NNG08, which therefore appear to be unrelated to NNP1 activities. The elevated ammonia Nitrogen results appear to be transient and localized and are not acute toxic to aquatic life.[3]

**TABLE 4-10: *AMMONIA NITROGEN RESULTS OF THE SURFACE WATER IN NAM NGIEP AND ITS MAIN TRIBUTARIES MONITORED FROM OCTOBER TO DECEMBER 2018 (NATIONAL SURFACE WATER QUALITY STANDARD FOR AMMONIA NITROGEN: <0.2 MG/L[4])***

| Station Code | NNG 01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 | NCH 01 | NPH 01 | NXA 01 | NHS 01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2-Oct-18 | <0.2 | <0.2 | 0.54 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | | | | | <0.2 | | | |
| 3-Oct-18 | | | | | | | | | 0.42 | 0.32 | <0.2 | 0.36 | | | 0.25 | <0.2 |
| 6-Nov-18 | <0.2 | <0.2 | | 0.7 | <0.2 | <0.2 | | | | | | | <0.2 | | | |
| 7-Nov-18 | | | | | | | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | | | <0.2 | <0.2 |
| 11-Dec-18 | <0.2 | <0.2 | | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | | | | | <0.2 | <0.2 | | |
| 12-Dec-18 | | | | | | | | | <0.2 | <0.2 | <0.2 | <0.2 | | | <0.2 | <0.2 |

### 4.6.4 Biochemical Oxygen Demand (BOD5)

Since 2014, the Biochemical Oxygen Demand ($BOD_5$) levels in the Nam Ngiep River and its tributaries have generally been below the detection limit (< 1 mg/L) with only occasional minor exceedances of the National Surface Water Quality Standard of < 1.5 mg/L. The results for Q4 2018 are within the normal ranges previously measured except in R3, R4 and R5 which showed some exceedances. Elevated levels of $BOD_5$ as measured in R3, R4 and R5 in Q4 2018 after the start of impounding would be expected as a result of the ongoing decay of biomass in the water column.

[3] USEPA, Aquatic Life Ambient Water Quality Criteria for Ammonia - Freshwater (2013)

[4] This refers to the standard stated in the Concession Agreement, Annex C, Appendix 2 which is derived from the National Environmental Standards of 2009. These standards were amended in 2017 with the issuance of the Decree on National Environmental Standards, No 81 of 21 February 2017. The standard for ammonia nitrogen in the amended decree is 0.5 mg/L

**TABLE 4-11: *$BOD_5$ RESULTS OF THE SURFACE WATER IN NAM NGIEP AND ITS MAIN TRIBUTARIES MONITORED FROM OCTOBER TO DECEMBER 2018 (NATIONAL SURFACE WATER QUALITY STANDARD FOR $BOD_5$: <1.5 MG/L[5])***

| Station Code | NNG 01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 | NC H01 | NP H0 1 | NXA 01 | NHS 01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2-Oct-18 | <1.0 | <1.0 | <1.0 | 2.98 | 4.08 | 2.64 | | | | | | | <1.0 | | | |
| 3-Oct-18 | | | | | | | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | | | <1.0 | <1.0 |
| 11-Oct-18 | | | | | | 2.78 | 1.72 | 1.07 | <1.0 | | | | | | | |
| 17-Oct-18 | | | | | | 1.57 | 1.18 | 1.31 | 1.09 | | | | | | | |
| 23-Oct-18 | | | | | | 2.25 | <1.0 | <1.0 | <1.0 | | | | | | | |
| 30-Oct-18 | | | | | | <1.0 | | | | | | | | | | |
| 31-Oct-18 | | | | | | | <1.0 | <1.0 | <1.0 | | | | | | | |
| 6-Nov-18 | 2.11 | 1.1 | | <1.0 | <1.0 | <1.0 | | | | | | | <1.0 | | | |
| 7-Nov-18 | | | | | | | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | | | <1.0 | <1.0 |
| 13-Nov-18 | | | | | | <1.0 | | | | | | | | | | |
| 14-Nov-18 | | | | | | | <1.0 | <1.0 | <1.0 | | | | | | | |
| 20-Nov-18 | | | | | | | <1.0 | <1.0 | <1.0 | | | | | | | |
| 21-Nov-18 | | | | | | <1.0 | | | | | | | | | | |
| 27-Nov-18 | | | | | | <1.0 | | | | | | | | | | |
| 28-Nov-18 | | | | | | | <1.0 | <1.0 | <1.0 | | | | | | | |
| 4-Dec-18 | | | | | | <1.0 | | | | | | | | | | |
| 5-Dec-18 | | | | | | | 1.06 | 1.33 | 1.02 | | | | | | | |
| 11-Dec-18 | <1 | 1.18 | | <1.0 | <1.0 | 1.29 | | | | | | | <1.0 | <1.0 | | |
| 12-Dec-18 | | | | | | | 1.1 | 1.4 | 1.16 | <1.0 | <1.0 | <1.0 | | | <1.0 | <1.0 |
| 18-Dec-18 | | | | | | | <1 | <1 | 1.15 | | | | | | | |
| 19-Dec-18 | | | | | | <1 | | | | | | | | | | |

### 4.6.5 Chemical Oxygen Demand (COD)

The COD measurements in Q4 2018 are presented in ***Table 4-12***.

[5] This refers to the standard stated in the Concession Agreement, Annex C, Appendix 2 which is derived from the National Environmental Standards of 2009. These standards were amended in 2017 with the issuance of the Decree on National Environmental Standards, No 81 of 21 February 2017. The amended standards do not include a standard for $BOD_5$

**TABLE 4-12: COD RESULTS FOR SURFACE WATER IN NAM NGIEP AND ITS MAIN TRIBUTARIES DURING Q4 2018 (NATIONAL SURFACE WATER QUALITY STANDARD FOR COD: < 5 MG/L)[6]**

| Station Code | NNG 01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG0 7 | NNG0 8 | NC H0 1 | NP H0 1 | NX A01 | NHS 01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2-Oct-18 | <5.0 | <5.0 | <5.0 | 14.2 | 14.4 | 11.5 | <5.0 | <5.0 | | | | | 5.7 | | | |
| 3-Oct-18 | | | | | | | | | <5.0 | <5.0 | 5.1 | 5.3 | | | <5.5 | 10.7 |
| 6-Nov-18 | <5.0 | <5.0 | | <5.0 | 6 | 6.5 | | | | | | | <5.0 | | | |
| 7-Nov-18 | | | | | | | 6.9 | <5.0 | 5 | <5.0 | <5.0 | 7.3 | | | <5.0 | 6.9 |
| 11-Dec-18 | 5.7 | 8.3 | | 8.7 | <5 | 7.1 | <5 | 5.7 | | | | | 5.5 | <5 | | |
| 12-Dec-18 | | | | | | | | | 5.9 | <5 | 5.1 | <5 | | | <5 | <5 |

The mean COD values for the high flow and low flow seasons are presented in ***Table 4-13.*** The data indicates seasonal variation with higher values during the high flow season. However, when testing a null hypothesis that there is no significant difference in COD means before and after impounding (comparing the mean for the period after impounding with the mean for the same period in 2017 – upstream, re-regulation reservoir and downstream respectively), the tests indicate that the null hypothesis cannot be rejected.

**TABLE 4-13: MEAN VALUES OF COD MEASUREMENTS**

| Mean[7] COD Values | Upstream High Flow Season Mean (Jun-Nov) (mg/L) | Upstream Low Flow Season Mean (Dec-May) (mg/L) | Downstream High Flow Season Mean (Jun-Nov) (mg/L) | Downstream Low Flow Season Mean (Dec-May) (mg/L) |
|---|---|---|---|---|
| Hydrological Year[8] 2015 | 15.3 | 6.7 | 22.0 | 5.9 |
| Hydrological Year 2016 | 10.8 | 5.6 | 10.6 | 5.4 |
| Hydrological Year 2017 | 13.9 | 7.0 | 12.4 | 4.7 |
| Hydrological Year 2018 | 14.8 | 5.0 | 7.1 | 5.7 |
| Hydrological Year 2019 | 8.6 | | 9.5 | |

[6] This refers to the standard stated in the Concession Agreement, Annex C, Appendix 2 which is derived from the National Environmental Standards of 2009. These standards were amended in 2017 with the issuance of the Decree on National Environmental Standards, No 81 of 21 February 2017. The standard for COD in the new decree is 5-7 mg/L for class 2 water bodies

[7] If the measurement is below the Limit of Detection, then the value is determined as the Limit of Detection divided by the square root of 2

[8] The hydrological year is from start of the wet season in June to the end of the dry season in May the following year. The year denotes the year of the end of the hydrological year. For the hydrological year 2015 the high flow season data only includes September-November 2014, and for the hydrological year 2018 the low flow season data only until March 2018

### 4.6.6 Faecal Coliforms

The results of the faecal coliform analyses in Q4 of 2018 are presented in ***Table 4-14***.

The basic statistics of the faecal coliform measurements in Q4 2018 are displayed in the box and whisker diagrams in ***Figure 4-10***.

The stations R5 (main reservoir immediately upstream main dam), R6 and R7 (in the re-regulation reservoir) and NNG05 (downstream at Hat Gniun Village) have a similar median value, but the mean of R5 is much higher than the means of the other stations due to an extreme outlier indicating a rare occurrence of high levels of faecal waste from humans or warm-blooded animals unrelated to project activities.

FIGURE 4-10: *BOX AND WHISKER DIAGRAMS OF FAECAL COLIFORM MEASUREMENTS Q4 2018 IN SELECTED STATIONS*

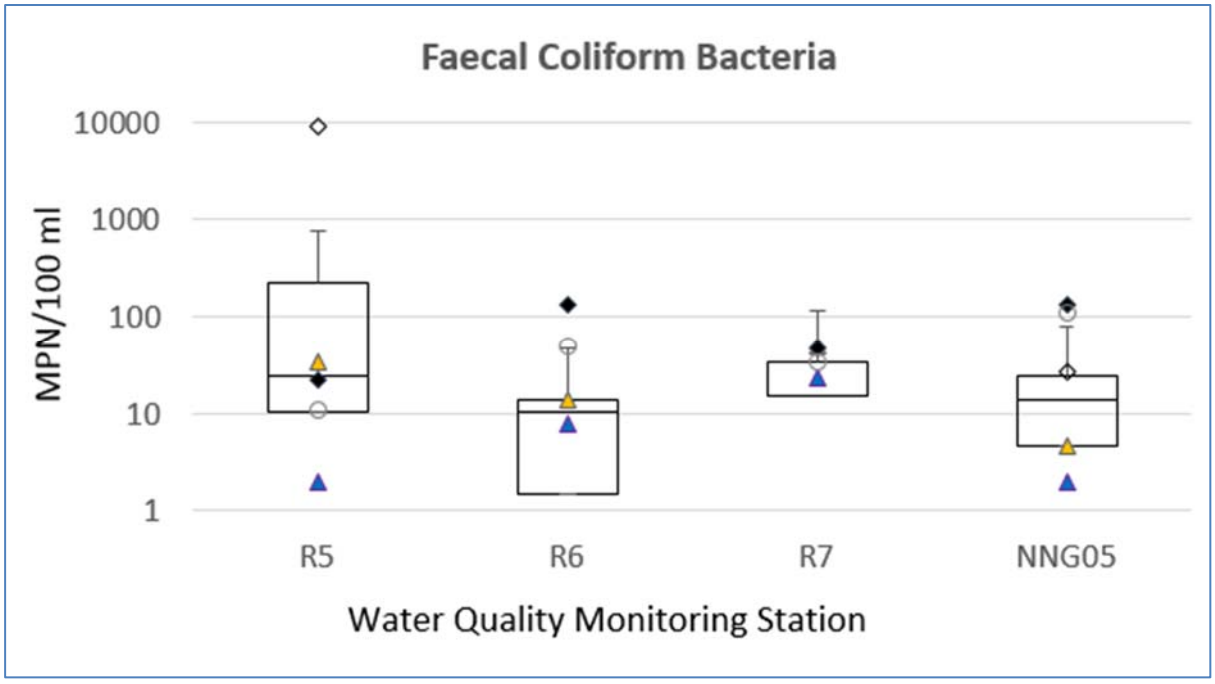



TABLE 4-14: *RESULTS OF FAECAL COLIFORMS IN NAM NGIEP AND ITS MAIN TRIBUTARIES FROM OCTOBER TO DECEMBER 2018 (NATIONAL SURFACE WATER QUALITY STANDARD FOR TOTAL COLIFORMS: < 1,000 MPN/100 ML)*

| Station Code | NNG 01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 | NCH 01 | NPH 01 | NXA 01 | NHS 01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2-Oct-18 | 280 | 47 | 22 | 33 | 23 | 33 | | | | | | | 540 | | | |
| 3-Oct-18 | | | | | | | 14 | 49 | 5 | 130 | 130 | 14 | | | 26 | 27 |
| 10-Oct-18 | | | | | | 27 | 14 | 22 | 17 | | | | | | | |
| 17-Oct-18 | | | | | | 7.8 | 13 | 33 | 11 | | | | | | | |
| 23-Oct-18 | | | | | | 540 | 5 | 5 | 17 | | | | | | | |
| 30-Oct-18 | | | | | | 240 | | | | | | | | | | |
| 31-Oct-18 | | | | | | | 0 | 0 | 0 | | | | | | | |
| 6-Nov-18 | 170 | 2 | | 0 | 0 | 0 | | | | | | | 540 | | | |
| 7-Nov-18 | | | | | | | 0 | 0 | 5 | 5 | 8 | 9 | | | 32 | 17 |
| 13-Nov-18 | | | | | | 220 | | | | | | | | | | |
| 14-Nov-18 | | | | | | | 2 | 0 | 5 | | | | | | | |

| Station Code | NNG 01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 | NCH 01 | NPH 01 | NXA 01 | NHS 01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20-Nov-18 | | | | | | | 13 | 8 | 23 | | | | | | | |
| 21-Nov-18 | | | | | | 17 | | | | | | | | | | |
| 27-Nov-18 | | | | | | 2 | | | | | | | | | | |
| 28-Nov-18 | | | | | | | 8 | 23 | 2 | | | | | | | |
| 4-Dec-18 | | | | | | 22 | | | | | | | | | | |
| 5-Dec-18 | | | | | | | 130 | 46 | 130 | | | | | | | |
| 11-Dec-18 | 920 | 14 | | 4.5 | 130 | 11 | | | | | | | | | | |
| 12-Dec-18 | | | | | | | 49 | 33 | 110 | 240 | 79 | 130 | 130 | 130 | 170 | 220 |
| 18-Dec-18 | | | | | | | 0 | 0 | 27 | | | | | | | |
| 19-Dec-18 | | | | | | 9,200 | | | | | | | | | | |

***Table 4-15*** presents seasonal (high flow season and low flow season) means of faecal coliform bacteria upstream of the main dam and downstream of the re-regulation dam. The data indicates that up until the start of the high-flow season in 2018 which corresponds to the start of impounding of the main reservoir, there was a tendency towards higher values in the high flow season. However, after start of impounding that tendency has not continued. The bacteria counts in the reservoir stations (R4, R5, R6 and R7) and the downstream stations NNG05 and NNG06 indicate significantly lower values after start of impounding.

**TABLE 4-15:** ***SEASONAL MEANS FOR FAECAL COLIFORMS UPSTREAM OF THE MAIN DAM, IN THE RE-REGULATION RESERVOIR AND DOWNSTREAM OF THE RE-REGULATION DAM***

| | Upstream | | Re-regulation Reservoir | | Downstream | |
|---|---|---|---|---|---|---|
| | High Flow Season Mean | Low Flow Season Mean | High Flow Season Mean | Low Flow Season Mean | High Flow Season Mean | Low Flow Season Mean |
| | (MPN/100 ml) | (MPN/100 ml) | (MPN/100 ml) | (MPN/100 ml) | (MPN/100 ml) | (MPN/100 ml) |
| Hydrological Year[9] 2015 | | 659 | | 372 | | 399[10] |
| Hydrological Year 2016 | 2,971 | 529 | 2,630 | 629 | 2,092 | 570 |
| Hydrological Year 2017 | 1,286 | 452 | 3,710 | 197 | 939 | 171 |
| Hydrological Year 2018 | 2,055 | 318 | 1,249 | 109 | 1,157 | 247 |
| Hydrological Year 2019 | 313 | - | 130 | - | 231 | - |

[9] The hydrological year is from start of the high flow season in June to the end of the low flow season in May the following year. The year denotes the year of the end of the hydrological year.

[10] This mean excludes an anomaly of 92,000 MPN/100 ml reported for NNG07 in January 2015

### 4.6.7 Total Coliforms

The results of measurements for total coliform bacteria are presented in ***Table 4-16***. The results indicate a somewhat similar pattern as for faecal coliform bacteria.

**TABLE 4-16: RESULTS OF TOTAL COLIFORMS IN NAM NGIEP AND ITS MAIN TRIBUTARIES FROM OCTOBER TO DECEMBER 2018 (NATIONAL SURFACE WATER QUALITY STANDARD FOR TOTAL COLIFORMS: < 5,000 MPN/100 ML)**

| Station Code | NNG 01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 | NCH 01 | NPH 01 | NXA 01 | NHS 01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2-Oct-18 | 1,600 | 1,600 | 49 | 49 | 23 | 33 | | | | | | | 920 | | | |
| 3-Oct-18 | | | | | | | 79 | 49 | 79 | 130 | 130 | 49 | | | 280 | 350 |
| 10-Oct-18 | | | | | | 130 | 130 | 240 | 170 | | | | | | | |
| 17-Oct-18 | | | | | | 1,600 | 27 | 13 | 110 | | | | | | | |
| 23-Oct-18 | | | | | | 1,600 | 27 | 13 | 110 | | | | | | | |
| 30-Oct-18 | | | | | | 350 | | | | | | | | | | |
| 31-Oct-18 | | | | | | | 130 | 130 | 280 | | | | | | | |
| 6-Nov-18 | 540 | 7 | | 0 | 0 | 0 | | | | | | | 1,600 | | | |
| 7-Nov-18 | | | | | | | 5 | 11 | 22 | 79 | 33 | 94 | | | 540 | |
| 13-Nov-18 | | | | | | 540 | | | | | | | | | | |
| 14-Nov-18 | | | | | | | 2 | 0 | 49 | | | | | | | |
| 20-Nov-18 | | | | | | | 23 | 23 | 33 | | | | | | | |
| 21-Nov-18 | | | | | | 33 | | | | | | | | | | |
| 27-Nov-18 | | | | | | 11 | | | | | | | | | | |
| 28-Nov-18 | | | | | | | 20 | 23 | 2 | | | | | | | |
| 4-Dec-18 | | | | | | 110 | | | | | | | | | | |
| 5-Dec-18 | | | | | | | 240 | 70 | 460 | | | | | | | |
| 11-Dec-18 | 1,600 | 220 | | 17 | 170 | 49 | | | | | | | 350 | 920 | | |
| 12-Dec-18 | | | | | | | 70 | 33 | 110 | 350 | 540 | 170 | | | 1,600 | 540 |
| 18-Dec-18 | | | | | | | 79 | 27 | 110 | | | | | | | |
| 19-Dec-18 | | | | | | 9,200 | | | | | | | | | | |

## 4.7 COMPLIANCE MONITORING OF EFFLUENTS FROM CAMPS

A total of 13 camps including OSOV were in use during Q4-2018 and the effluents were sampled from 12 sampling sites representing 12 of the 13 camps (the TCM Camp, EF03, had no discharge) as indicated in ***Table 4-17.*** The Wastewater Treatment System (WWTS) at the Sino Hydro Camp (EF06), TCM Camp (EF03), Kenber Camp (EF16) and Lilama10 Camp had no discharge due to smaller number of workers. Therefore, these camps were not sampled. In addition, Sino Hydro Camp, TCM Camp and Kenber Camp were being decommissioned in the Q4 as well.

The results are described in ***Table 4-17*** and the full data set is in ***Appendix 5.2***.

The status of compliance as of 30 December 2018 can be summarized as follows:

- Non-compliance with total coliform bacteria for five camps (EF01, EF07, EF09, EF13 and EF18);

- The HM Hydro camp (EF13) was non-compliant for all parameters;
- All camps have experienced varied degree of non-compliance with ammonia and total nitrogen;

**FIGURE 4-11:** ***MAP OF EFFLUENT MONITORING LOCATIONS DURING THE FOURTH QUARTER OF 2018***

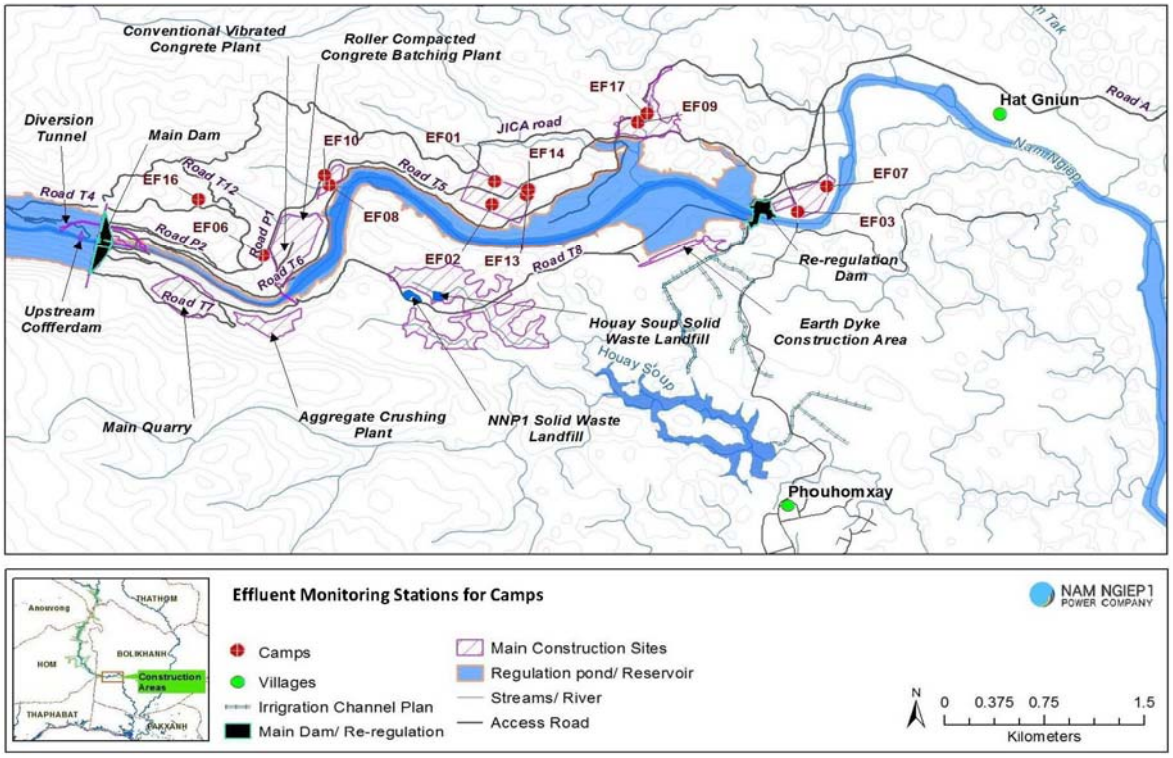


**TABLE 4-17:** ***RESULTS OF THE EFFLUENT WATER QUALITY MONITORING OF THE CAMPS FROM OCTOBER TO DECEMBER 2018***

| | | **Site Name** | Owner's Site Office and Village | Obayashi Camp | SongDa5 Camp No.1 | SongDa5 Camp No.2 | Zhefu Camp | V&K Camp | HMH Main Camp | IHI Main Camp | Kenber Camp | Lilama10 Camp | IHI Field Shop 276 Camp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Station Code** | **EF01** | **EF02** | **EF07** | **EF08** | **EF09** | **EF10** | **EF13** | **EF14** | **EF16** | **EF17** | **EF18** |
| **Date** | **Parameters (Unit)** | **Guideline** | | | | | | | | | | | |
| 05-Oct-18 | TSS (mg/l) | <50 | 10.67 | 7.22 | 16.33 | 10.55 | 32.83 | 17.26 | 54.29 | 74.68 | 7.32 | | |
| 19-Oct-18 | TSS (mg/l) | <50 | <5 | 5.28 | <5 | <5 | 51.47 | <5 | 27.79 | 48.06 | 5.84 | | |
| 02-Nov-18 | TSS (mg/l) | <50 | <5 | <5 | 12.31 | 20.9 | 32.98 | 12.67 | 21.06 | 31.14 | | | 82.9 |
| 16-Nov-18 | TSS (mg/l) | <50 | <5 | <5 | 8.78 | 14.19 | 38.94 | 5.88 | 26.24 | 19.42 | | | 24.49 |
| 07-Dec-18 | TSS (mg/l) | <50 | 15.28 | 8.04 | 8.92 | 12.09 | 40.24 | <5 | 31.69 | 16.67 | | | 47.86 |
| 17-Dec-18 | TSS (mg/l) | <50 | 5.68 | <5 | 14.02 | <5 | 40.08 | 5.61 | 12.47 | 33.75 | | | 21.09 |
| 05-Oct-18 | $BOD_5$ (mg/l) | <30 | <6 | <6 | <6 | 7.17 | <6 | <6 | <6 | <6 | 11.3 | | |
| 19-Oct-18 | $BOD_5$ (mg/l) | <30 | <6 | <6 | <6 | 13.5 | <6 | 11.58 | <6 | 17.28 | <6 | | |
| 02-Nov-18 | $BOD_5$ (mg/l) | <30 | <6 | <6 | <6 | <6 | 105.53 | <6 | 171 | <6 | | | 214 |
| 16-Nov-18 | $BOD_5$ (mg/l) | <30 | 12.09 | <6 | <6 | <6 | <6 | <6 | <6 | <6 | | | <6 |
| 07-Dec-18 | $BOD_5$ (mg/l) | <30 | 40.71 | <6 | <6 | <6 | 21.42 | 6.9 | <6 | <6 | | | 46.68 |
| 17-Dec-18 | $BOD_5$ (mg/l) | <30 | 35.1 | <6 | <6 | <6 | 41.94 | <6 | <6 | <6 | | | 82.35 |
| 05-Oct-18 | COD (mg/l) | <125 | <25 | 42.8 | 71.1 | 38.1 | 108 | 29.6 | 206 | 155 | <25 | | |
| 19-Oct-18 | COD (mg/l) | <125 | <25 | 33.8 | 30.4 | 40.1 | 113 | <25 | 202 | 134 | <25 | | |
| 02-Nov-18 | COD (mg/l) | <125 | <25 | 27.2 | 37.8 | 46.4 | 132 | 28.9 | 172 | 12.1 | | | 203 |
| 16-Nov-18 | COD (mg/l) | <125 | <25 | 25.6 | 54 | 42.7 | 129 | <25 | 132 | 134 | | | 34 |
| 07-Dec-18 | COD (mg/l) | <125 | 67.3 | 28.4 | 48.7 | 32.2 | 116 | <25 | 146 | 26.8 | | | 237 |
| 17-Dec-18 | COD (mg/l) | <125 | 38.4 | 34 | 66.3 | 44.2 | 122 | 36 | 52.6 | 152 | | | 130 |
| 05-Oct-18 | $NH_3$-N (mg/l) | <10.0 | 11.8 | 18.5 | 14.9 | 25.3 | 49.1 | 6.5 | 15.9 | 5.8 | 2.2 | | |
| 19-Oct-18 | $NH_3$-N (mg/l) | <10.0 | 18.8 | 20 | 16.4 | 26.2 | 36.4 | 7 | 21.5 | 3.1 | 2.7 | | |
| 02-Nov-18 | $NH_3$-N (mg/l) | <10.0 | 8.4 | 16 | 14.3 | 19.6 | 44.2 | 7.5 | 28.2 | <0.2 | | | 16.8 |

| | | Site Name | Owner's Site Office and Village | Obayashi Camp | SongDa5 Camp No.1 | SongDa5 Camp No.2 | Zhefu Camp | V&K Camp | HMH Main Camp | IHI Main Camp | Kenber Camp | Lilama10 Camp | IHI Field Shop 276 Camp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Station Code** | **EF01** | **EF02** | **EF07** | **EF08** | **EF09** | **EF10** | **EF13** | **EF14** | **EF16** | **EF17** | **EF18** |
| **Date** | **Parameters (Unit)** | **Guideline** | | | | | | | | | | | |
| 16-Nov-18 | $NH_3$-N (mg/l) | <10.0 | 10 | 13 | 25.7 | 10.4 | 39.7 | 7.1 | 13.9 | 6.4 | | | <0.2 |
| 07-Dec-18 | $NH_3$-N (mg/l) | <10.0 | 26.2 | 13.1 | 25.7 | 9.3 | 38.2 | 5.4 | 14.2 | <1.5 | | | 22.7 |
| 17-Dec-18 | $NH_3$-N (mg/l) | <10.0 | 18.1 | 14.1 | 19.3 | 14.6 | 44.6 | 5.1 | 12.9 | 14.8 | | | 12 |
| 05-Oct-18 | Total Nitrogen (mg/l) | <10 | 14 | 19.5 | 16.5 | 26.7 | 50.2 | 7.25 | 16.8 | 8.53 | 6.3 | | |
| 19-Oct-18 | Total Nitrogen (mg/l) | <10 | 19.9 | 22 | 17.2 | 37.3 | 40.2 | 7.33 | 36.7 | 5.5 | 8.4 | | |
| 02-Nov-18 | Total Nitrogen (mg/l) | <10.0 | 10.5 | 18.9 | 15.9 | 22.3 | 49.7 | 13.3 | 30 | 0.78 | | | 20.4 |
| 16-Nov-18 | Total Nitrogen (mg/l) | <10.0 | 21.1 | 14.6 | 32.9 | 11.6 | 42.6 | 10.9 | 14.8 | 7.23 | | | 0.81 |
| 07-Dec-18 | Total Nitrogen (mg/l) | <10.0 | 33.2 | 21.1 | 27.1 | 16.3 | 39.8 | 13.7 | 18 | 0.76 | | | 31.5 |
| 17-Dec-18 | Total Nitrogen (mg/l) | <10.0 | 21.1 | 20.1 | 26.0 | 15.2 | 45.7 | 8.35 | 18.9 | 15.7 | | | 12.9 |
| 05-Oct-18 | Total coliform (MPN/100 ml) | <400 | 33 | 0 | 0 | 0 | 7.8 | 0 | 0 | 0 | 11 | | |
| 19-Oct-18 | Total coliform (MPN/100 ml) | <400 | 79 | 0 | 0 | 7.8 | 0 | 39 | 0 | 0 | 7.8 | | |
| 02-Nov-18 | Total coliform (MPN/100 ml) | <400 | 540 | 0 | 0 | 0 | 35,000 | 2 | 54,000 | 0 | | | 54,000 |
| 16-Nov-18 | Total coliform (MPN/100 ml) | <400 | 35,000 | 0 | 4.5 | 0 | 79 | 0 | 0 | 0 | | | 0 |
| 07-Dec-18 | Total coliform (MPN/100 ml) | <400 | 160,000 | 0 | 16,000 | 0 | 16,000 | 2 | 2 | 0 | | | 540 |
| 17-Dec-18 | Total coliform (MPN/100 ml) | <400 | 3,500 | 0 | 0 | 0 | 240 | 0 | 0 | 0 | | | 49 |

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| | | Site Name | Owner's Site Office and Village | Obayashi Camp | SongDa5 Camp No.1 | SongDa5 Camp No.2 | Zhefu Camp | V&K Camp | HMH Main Camp | IHI Main Camp | Kenber Camp | Lilama10 Camp | IHI Field Shop 276 Camp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Station Code** | **EF01** | **EF02** | **EF07** | **EF08** | **EF09** | **EF10** | **EF13** | **EF14** | **EF16** | **EF17** | **EF18** |
| **Date** | **Parameters (Unit)** | **Guideline** | | | | | | | | | | | |
| 05-Oct-18 | Fecal Coliform (MPN/100 ml) | <400 | 33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| 19-Oct-18 | Fecal Coliform (MPN/100 ml) | <400 | 79 | 0 | 0 | 7.8 | 0 | 39 | 0 | 0 | 0 | | |
| 02-Nov-18 | Faecal Coliform (MPN/100 ml) | <400 | 350 | 0 | 0 | 0 | 3,500 | 2 | 54,000 | 0 | | | 16,000 |
| 16-Nov-18 | Faecal Coliform (MPN/100 ml) | <400 | 16,000 | 0 | 0 | 0 | 49 | 0 | 0 | 0 | | | 0 |
| 07-Dec-18 | Faecal Coliform (MPN/100 ml) | <400 | 160,000 | 0 | 9,200 | 0 | 16,000 | 0 | 0 | 0 | | | 110 |
| 17-Dec-18 | Faecal Coliform (MPN/100 ml) | <400 | 3,500 | 0 | 0 | 0 | 240 | 0 | 0 | 0 | | | 33 |
| 05-Oct-18 | Residual Chlorine (mg/l) | <1.0 | | 0.3 | 1.15 | 0.12 | 0.64 | 0.25 | 1.43 | 1.96 | 0.07 | | |
| 19-Oct-18 | Residual Chlorine (mg/l) | <1.0 | | 0.51 | 0.54 | 0.1 | 1.27 | 0.07 | 0.84 | 0.99 | 0.12 | | |
| 02-Nov-18 | Residual Chlorine (mg/l) | <1.0 | | 0.5 | 0.52 | 1.95 | 0 | 0.6 | 0 | 0.42 | | | 0 |
| 16-Nov-18 | Residual Chlorine (mg/l) | <1.0 | | 0.5 | 0.46 | 1.12 | 1.34 | 0.26 | 0.78 | 1.7 | | | 0.5 |
| 07-Dec-18 | Residual Chlorine (mg/l) | <1.0 | | 0.65 | 0.13 | 0.53 | 0.08 | 0.19 | 0.42 | 1.96 | | | 0.26 |
| 17-Dec-18 | Residual Chlorine (mg/l) | <1.0 | | 0.61 | 0.59 | 0.43 | 0.13 | 0.36 | 1.1 | 1 | | | 0.63 |

**TABLE 4-18: *COMPLIANCE STATUS OF EFFLUENT DISCHARGE FROM THE CAMPS IN Q4 2018***

| Site | ID | WWTS | Key Non-Compliance Issues[11] in Q4-2018 | Corrective Actions |
|---|---|---|---|---|
| Owner's Site Office and Village (NNP1PC) | EF01 | Septic tanks (kitchen and black water) and wetland (grey water), discharge: 70 $m^3$/day | - $BOD_5$ (<30 mg/L): Non-compliance in 2 out of 6. Q4 mean 15.88 mg/L.<br>- Total nitrogen (<10 mg/L): Non-compliance in 6 out of 6. Q4 mean 19.97 mg/L.<br>- Ammonia (<10 mg/L): Non-compliance in 5 out of 6. Q4 mean 15.55 mg/L.<br>- Faecal coliform (<400 MPN/100 mL): Non-compliance in 3 out of 6. Q4 mean 29,997 MPN/100 mL.<br>- Total coliform (<400 MPN/100 mL): Non-compliance in 2 out of 6. Q4 mean 33,192 MPN/100 mL. | - EMO continues to monitor, share effluent monitoring results with the Admin team. NNP1PC started improving the WWTS in November 2018 and expect to complete the work by February 2019. |
| OC Camp – WWTS01 | EF02 | Septic tanks (kitchen and black water) and wetland with chlorination system (grey water) | - Ammonia (<10 mg/L): Q4 mean 15.78 mg/L.<br>- Total nitrogen (<10 mg/L): Q4 mean 19.37 mg/L. | - EMO continues to monitor, share effluent monitoring results with the Contractor for further improvements. |
| TCM Camp | EF03 | Septic tanks (kitchen and black water) and wetland with chlorination system (grey water) | | - There was no discharge of wastewater for sampling during Q4 2018.<br>- Note: this facility was handed over to GFE subcontractor who will stay for another year |

[11] The values in brackets indicate the applicable standard

| Site | ID | WWTS | Key Non-Compliance Issues[11] in Q4-2018 | Corrective Actions |
|---|---|---|---|---|
| Sino Hydro Camp | EF06 | Septic tanks (kitchen and black water) and wetland with chlorination system (grey water) | | - This site was decommissioned in October 2018. |
| Song Da 5 Camp No. 1 | EF07 | Septic tanks (kitchen and black water) and wetland with chlorination system (grey water) | - Ammonia (<10 mg/L): Non-compliance in 6 out of 6. Q4 mean 19.38 mg/L.<br>- Total nitrogen (<10 mg/L): Non-compliance in 6 out of 6. Q4 mean 22.6 mg/L.<br>- Faecal coliform (<400 MPN/100 mL): Non-compliance in 1 out of 6. Q4 mean 1,533 MPN/100 mL.<br>- Total coliform (<400 MPN/100 mL): Non-compliance in 1 out of 6. Q4 mean 2,667 MPN/100 mL. | - The Contractor has improved the wetland maintenance including supervising the chlorine mixing, and dosing. |
| Song Da 5 Camp No. 2 | EF08 | Septic tanks (kitchen and black water) and wetland with chlorination system (grey water) | - Ammonia (<10 mg/L): Non-compliance in 5 out of 6. Q4 mean 17.57 mg/L.<br>- Total nitrogen (<10 mg/L): Non-compliance in 6 out of 6. Q4 mean 21.57 mg/L. | - During the latest EMU visit on 27-Nov-2018, no chlorine dosing was performed due to a clogged chlorine dosing pipe. This was fixed by the Contractor. |
| Zhefu Camp (HMH Worker Camp No.1) | EF09 | Septic tank (kitchen and black water), sediment ponds (grey water) | - $BOD_5$ (<30 mg/L): Non-compliance in 2 out of 6. Q4 mean 29.37 mg/L.<br>- COD (<125 mg/L): Non-compliance in 2 out of 6. Q4 mean 120 mg/L.<br>- Ammonia-nitrogen (<10 mg/L): Non-compliance in 6 out of 6. Q4 mean 42.0 mg/L.<br>- Total nitrogen (<10 mg/L): Q4 mean 44.7 mg/L.<br>- Faecal coliform (<400 MPN/100 mL): Non-compliance in 2 out of 6. Q3 mean 3,298 MPN/100 mL. | - During the monthly progress meeting in December 2018, the Contractor was instructed to improve the operation of the WWTS. The results will be monitored and reported in the next quarter. |

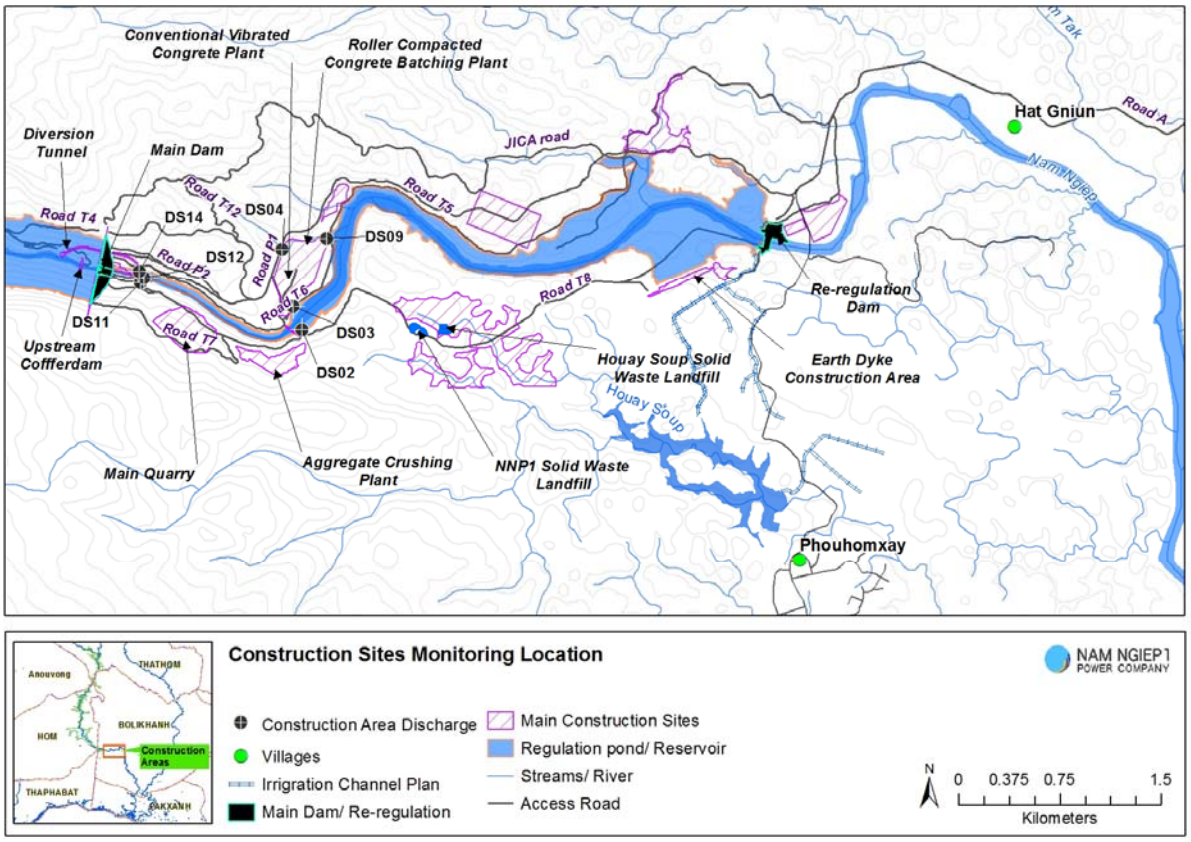
| Site | ID | WWTS | Key Non-Compliance Issues[11] in Q4-2018 | Corrective Actions |
|---|---|---|---|---|
| | | | - Total coliform (<400 MPN/100 mL): Non-compliance in 2 out of 6. Q4 mean 8,554 MPN/100 mL. | |
| V&K Camp | EF10 | Septic tanks (kitchen and black water) and wetland with chlorination system (grey water) | - Total nitrogen (<10 mg/L): Non-compliance in 3 out of 6. Q4 mean 10.14 mg/L. | - As above |
| HMH Main Camp – WWTS01 | EF13 | Septic tanks (kitchen and black water) and wetland with chlorination system (grey water) | - TSS (<50 mg/L): Non-compliance in 1 out of 6. Q4 means 28.92 mg/L.<br>- $BOD_5$ (<30 mg/L): Non-compliance in 1 out of 6. Q4 mean 30.54 mg/L.<br>- COD (<125 mg/L): Non-compliance in 5 out of 6. Q4 mean 151.77 mg/L.<br>- Ammonia (<10 mgL): Non-compliance in 6 out of 6. Q4 mean 17.77 mg/L.<br>- Total nitrogen (<10 mg/L): Non-compliance in 6 out of 6. Q4 mean 22.53 mg/L.<br>- Faecal coliform (<400 MPN/100 mL): Non-compliance in 1 out of 6. Q4 mean 9,000 MPN/100 mL.<br>- Total coliform (<400 MPN/100 mL): Non-compliance in 1 out of 6. Q4 mean 9,000 MPN/100 mL. | - The NCR level 2 was issued to the Contractor on 27 December 2018 concerning the inadequate treatment of the waste water prior to discharging to the environment. EMO will follow up on the corrective action implemented by the Contractor. |
| IHI Camp | EF14 | Septic tanks (kitchen and black water) and wetland with chlorination system (grey water) | - TSS (<50 mg/L): Non-compliance in 1 out of 6. Q4 means 37.29 mg/L.<br>- COD (<125 mg/L): Non-compliance in 4 out of 6. Q4 mean 102.32 mg/L.<br>- Ammonia (<10 mg/L): Non-compliance in 1 out of 6. Q4 mean 7.5 mg/L.<br>- Total nitrogen (<10 mg/L): Non-compliance in 1 out of 6. Q4 mean 6.42 mg/L. | - As above |

| Site | ID | WWTS | Key Non-Compliance Issues[11] in Q4-2018 | Corrective Actions |
|---|---|---|---|---|
| Kenber Camp | EF16 | Septic tanks (kitchen and black water) and wetland with chlorination system (grey water) | - Fully compliant. | This site was decommissioned in November 2018. |
| Lilama10 Camp | EF17 | Septic tanks (kitchen and black water) and wetland with chlorination system (grey water) | - No discharge from the wetland. | - EMO will continue to monitor and take the waste water sample for analysis once the waste water reaches the chlorination tank. |
| IHI Field Shop 276 Camp | EF18 | Septic tanks (kitchen and black water) with chlorination system (grey water) | - $BOD_5$ (<30 mg/L): Non-compliance in 3 out of 4. Q4 mean 86.37 mg/L.<br>- Ammonia (<10 mg/L): Non-compliance in 3 out of 4. Q4 mean 17.17 mg/L.<br>- Total nitrogen (<10 mg/L): Non-compliance in 3 out of 4. Q4 mean 16.40 mg/L.<br>- Faecal coliform (<400 MPN/100 mL): Non-compliance in 1 out of 4. Q4 mean 4,035 MPN/100mL.<br>- Total coliform (<400 MPN/100 mL): Non-compliance in 2 out of 4. Q4 mean 13,647 MPN/100 mL. | - EMO instructed the Contractor to ensure a chlorination dosage of 30 ml/mn. |

### 4.7.1 Compliance Monitoring of Discharges from Construction Sites

Discharges from the key construction sites (see ***Figure 4-12***) were monitored during the reported period. The results are presented in ***Table 4-19.*** Results that are above the prescribed standards are highlighted in yellow. The full set of data is in ***Appendix 5.3***.

FIGURE 4-12: *LOCATION OF DISCHARGE POINTS OF KEY CONSTRUCTION SITES*




Construction site discharge management continues to ensure that the discharges from the construction sites are in compliance with the standard for Total Suspended Solids (50 mg/L). Following the completion of the RCC placement work at the main dam on 29 April 2018, the production of aggregate and RCC has stopped resulting in no production process related discharge of water from the sedimentation ponds of the Aggregate Crushing Plant and the RCC Plant; however, decommissioning and rehabilitation work has been carried out at both sites and EMO has therefore monitored and checked that the surface runoff which is led through the ponds does not contain elevated levels of sediments.

The results of the discharge measurements at the the Aggregate Crushing Plant and the RCC Plant are presented in ***Figure 4-13***.

**FIGURE 4-13:** ***TOTAL SUSPENDED SOLIDS IN THE WASTE WATER DISCHARGE FROM THE AGGREGATE CRUSHING PLANT***

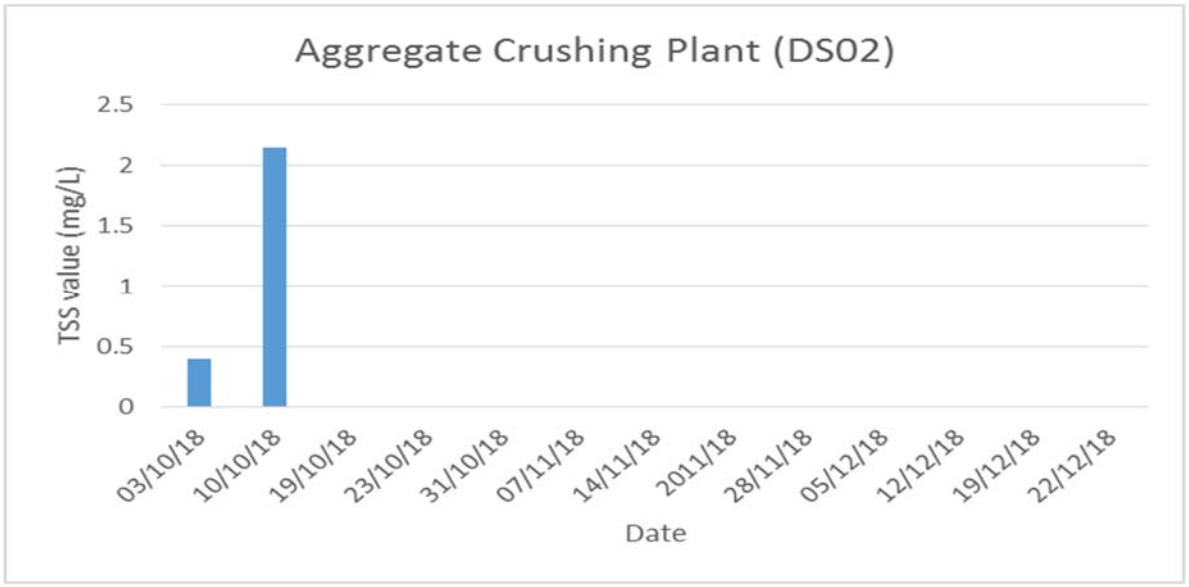



**FIGURE 4-14:** ***TOTAL SUSPENDED SOLIDS IN THE WASTE WATER DISCHARGE FROM THE RCC BATCHING PLANT***

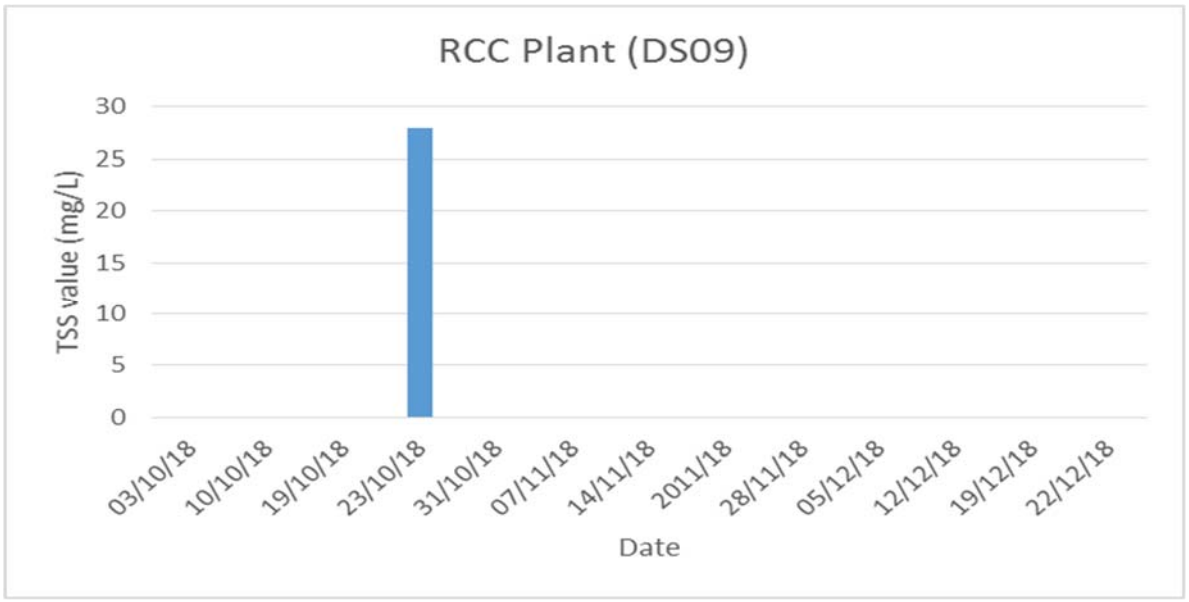


**TABLE 4-19:** ***RESULTS OF THE CONSTRUCTION AREA DISCHARGE MONITORING IN Q4 2018***

| Date | Parameter (Unit) | Site Name (Code) | Aggregate Crushing Plant (DS02) | Spoil Disposal Area No.2 (DS04) | RCC Plant (DS09) | Main Dam Construction Area Treatment No.3 (DS14) |
|---|---|---|---|---|---|---|
| | | Effluent Standard | | | | |
| 03-Oct-18 | TSS (mg/l) | <50 | 0.4 | 12.78 | | This site was decommissioned. |
| 10-Oct-18 | TSS (mg/l) | <50 | 2.14 | 10.24 | | |
| 19-Oct-18 | TSS (mg/l) | <50 | | 11.54 | | |
| 23-Oct-18 | TSS (mg/l) | <50 | | | 28.0 | |
| 31-Oct-18 | TSS (mg/l) | <50 | | 14.64 | | |
| 07-Nov-18 | TSS (mg/l) | <50 | | 6.91 | | |
| 14-Nov-18 | TSS (mg/l) | <50 | | 4.7 | | |
| 20-Nov-18 | TSS (mg/l) | <50 | | 7.28 | | |
| 28-Nov-18 | TSS (mg/l) | <50 | | 6.78 | | |
| 05-Dec-18 | TSS (mg/l) | <50 | | 2.82 | | |
| 12-Dec-18 | TSS (mg/l) | <50 | | 3.77 | | |
| 19-Dec-18 | TSS (mg/l) | <50 | | 5.25 | | |
| 22-Dec-18 | TSS (mg/l) | <50 | | | | |

**TABLE 4-20:** ***COMPLIANCE STATUS OF EFFLUENT DISCHARGE AND CORRECTIVE ACTION DURING THE FOURTH QUARTER OF 2018***

| Site | ID | Treatment System | Key Non-Compliance Issues[12] in Q2-2018 | Corrective Actions |
|---|---|---|---|---|
| Aggregate Crushing Plant | DS02 | Sediment ponds | - Full compliance. | - No corrective action is required. |
| CVC Plant | DS03 | Sediment ponds | - No discharge during Q4 2018 | |
| Spoil Disposal No.2 | DS04 | Sediment pond | - pH (6.00-9.00): Q4 median is 6.2. Insignificant non-compliance (pH 5.98) in 1 out of 13 measurements | - No corrective action is required. This is believed to be due to natural rock and soil quality that has been found since the beginning at this site. |
| RCC Plant (at Lower Ponds) | DS09 | Sediment ponds | - Full compliance. | |

[12] The values in brackets indicate the applicable standard

| Site | ID | Treatment System | Key Non-Compliance Issues[12] in Q2-2018 | Corrective Actions |
|---|---|---|---|---|
| Main Dam Construction Area (Treatment Plant No.3) | DS14 | pH adjustment and chemical flocculation | | - This site was decommissioned in August 2018 and will be removed from the list of monitoring site. |

### 4.7.2 Groundwater Quality Monitoring

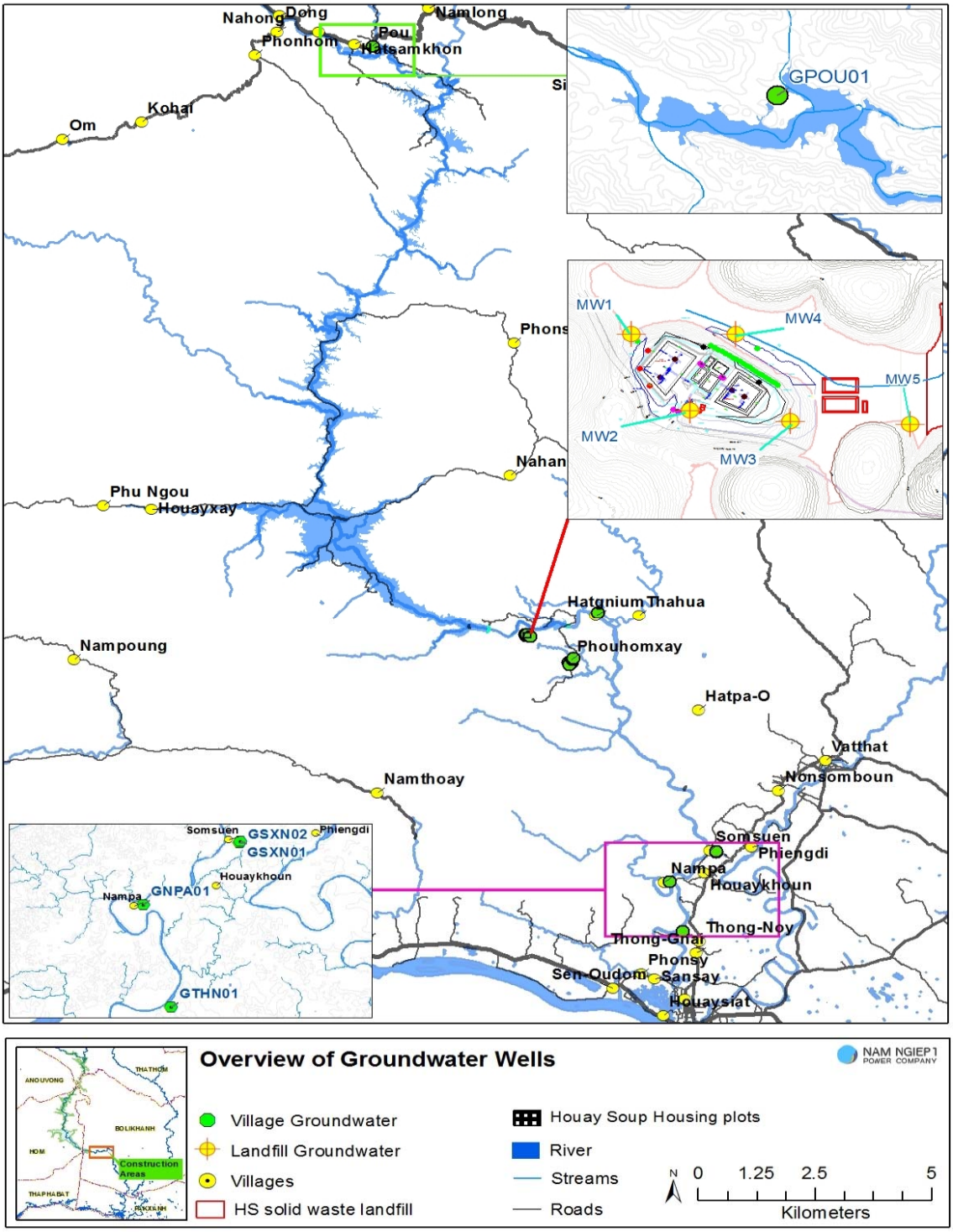
During Q4 2018, two boreholes at Somseun Village, one borehole at Nam Pa Village, one borehole at Thong Noy Village and one borehole at Pou Village (total of 5 boreholes) have been monitored for the following parameters:

a. *Monthly:* pH, DO (%), DO (mg/l), Conductivity (µs/cm), TDS (mg/l), Temperature ($^{o}$C), Turbidity (NTU), Faecal Coliform (MPN/100 ml) and E. coli (MPN/100 ml);

b. *Quarterly:* Arsenic (mg/l), Cadmium (mg/l), Iron (mg/l), Magnesium (mg/l), Manganese (mg/l), Fluoride (mg/l), Nitrate (mg/l), Nitrite (mg/l), Total Hardness (mg/l) Lead (mg/l).

The groundwater sampling locations are displayed in ***Figure 4-15*** and the groundwater monitoring data is presented in ***Appendix 5.4 and 5.7***

FIGURE 4-15: *GROUNDWATER SAMPLING LOCATIONS*




Key findings from the groundwater quality monitoring are summarized as the follows:

**Somsuen Villages:** All monitored parameters complied with the standard except for faecal coliform and E.coli bacteria in the December 2018 sample. The bacteria count was in the low end with 22 MPN/100 ml. This is the second non-compliance with bacteria content in the monthly monitoring since the start of monitoring in January 2018.

**Pou Village:** All monitored parameters complied with the standard except for pH in October and December 2018. Since the start of monitoring in June 2018, the pH (standard 6.5 < pH <

9.2) has been slightly below the lower limit with pH levels from 6.2 to 6.4 in 5 out of 7 monthly measurements. There are no health effects related to these pH values.

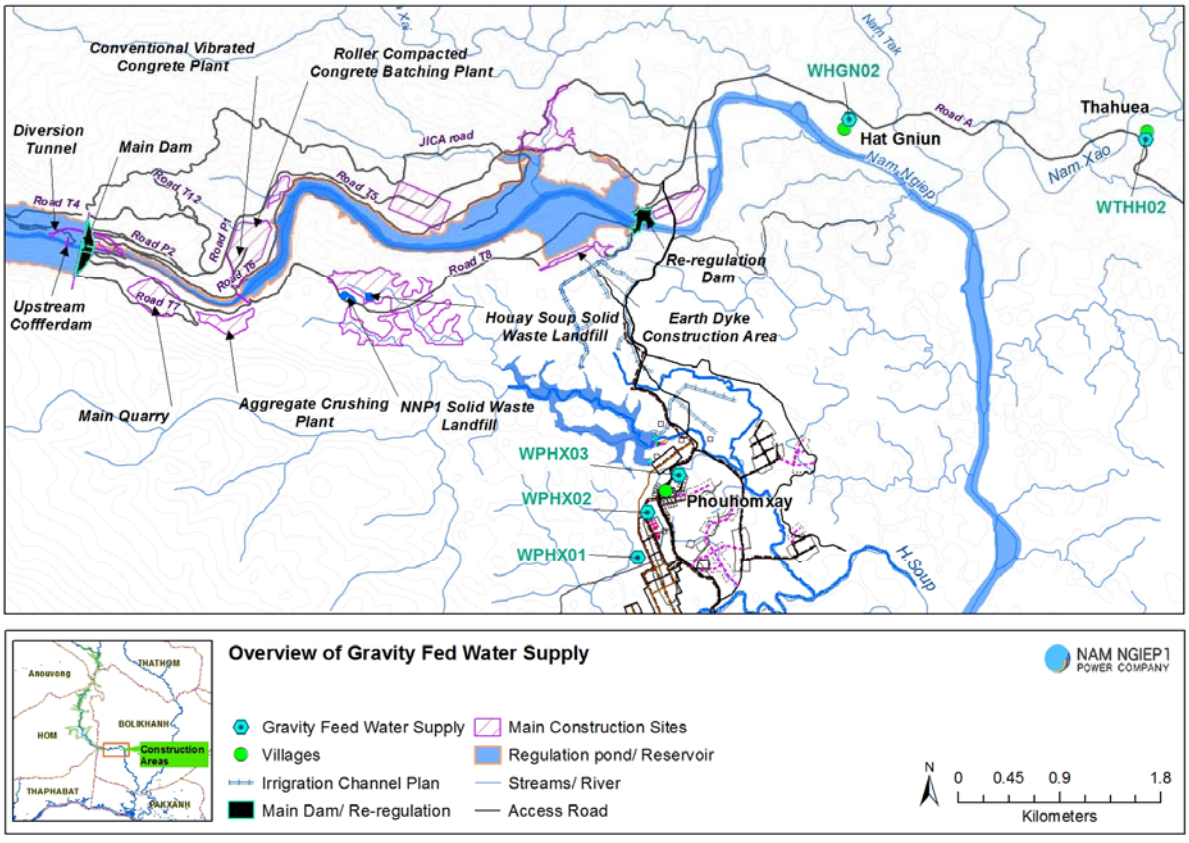
**Nam Pa Village and Thong Noy Village:** All monitored parameters complied with the standard except for faecal coliform and E.coli bacteria in the December 2018 sample. Since the start of monitoring in January 2018, similar exceedances of the standards have been measured. For Nam Pa Village once in June 2018 and for Thong Noy Village in March 2018, April 2018, May 2018 and June 2018.

The villagers were advised to boil water before drinking.

### 4.7.3 Gravity Fed Water Supply (GFWS) Monitoring

The monitoring of the GFWS aims to assess the quality of water that is being used for bathing and washing by villagers at Hat Gniun, Thahuea and Phouhomxay villages. The use of gravity fed water supply (sourced from a local stream) at Phouhomxay Village was commenced in December 2017.

FIGURE 4-16: *OVERVIEW OF GRAVITY FED WATER SUPPLY SYSTEM*




Water samples were taken from the taps for analysis during the reported period and selected results are shown in ***Table 4-21***. The full set of data is presented in ***Appendix 5.5***

TABLE 4-21: *THE GFWS MONITORING RESULT IN Q4 2018*

| | | Site Name | Thaheau Village | Hat Gnuin Village | Phouhomxay Village | | |
|---|---|---|---|---|---|---|---|
| | | Station | WTHH02 | WHGN02 | WPHX01 | WPHX02 | WPHX03 |
| Date | Parameter (Unit) | Guideline | | | | | |
| 08-Oct-18 | Faecal Coliform (MPN/100 ml) | 0 | 130 | 17 | 17 | 0 | 2 |
| 19-Nov-18 | Faecal Coliform (MPN/100 ml) | 0 | 7.8 | 7.8 | 4.5 | 2 | 0 |
| 10-Dec-18 | Faecal Coliform (MPN/100 ml) | 0 | 34 | 33 | 240 | 130 | 240 |
| 08-Oct-18 | E.Coli Bacteria (MPN/100 ml) | 0 | 130 | 17 | 17 | 0 | 2 |
| 19-Nov-18 | E.Coli Bacteria (MPN/100 ml) | 0 | 4.5 | 4.5 | 4.5 | 2 | 0 |
| 10-Dec-18 | E.Coli Bacteria (MPN/100 ml) | 0 | 34 | 33 | 130 | 130 | 130 |

**Thahuea Village (WTHH02):** all parameters complied with the National Drinking Water Standards, except for faecal coliform and E.Coli bacteria.

**Hat Gniun Village (WHGN02):** all parameters complied with the National Drinking Water Standards, except the faecal coliform and E.Coli bacteria.

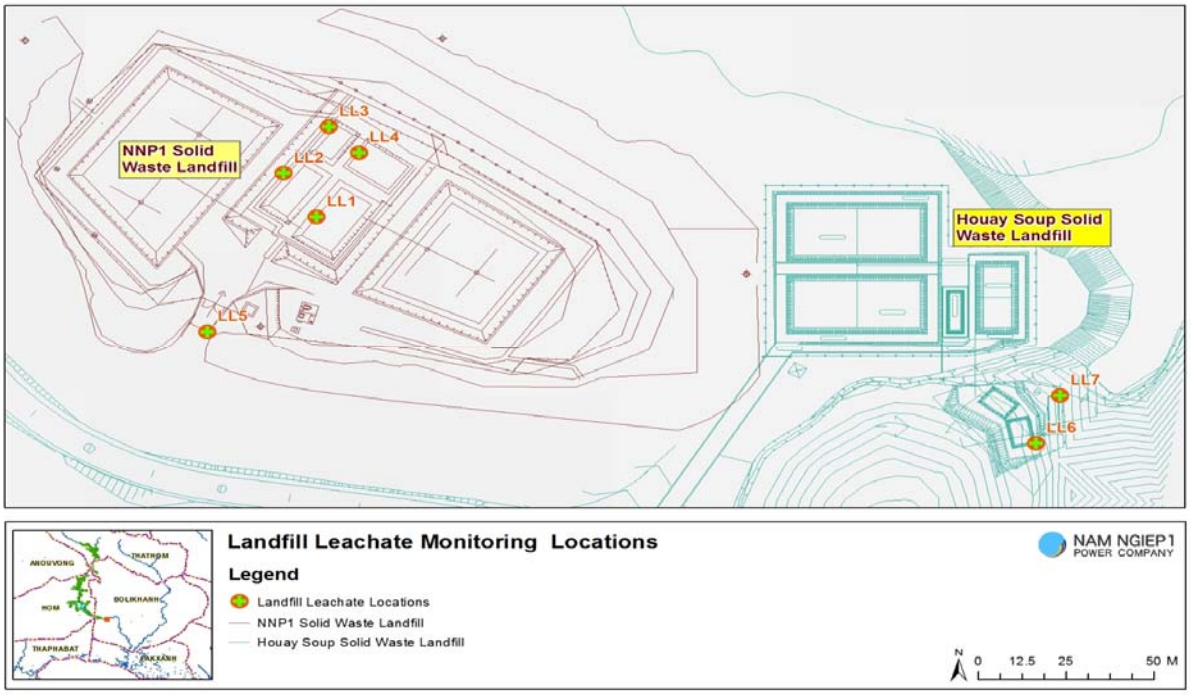
**Phouhomxay Village (WPHX01)**: raw water in the head tank before filtration, WPHX02 - tap water at primary school & WPHX03-tap water at the villager's house)**:** all parameters complied with the National Drinking Water Standards, except the faecal coliform and E.Coli bacteria.

The villagers were advised to boil water before drinking.

### 4.7.4 Landfill Leachate Monitoring

The landfill leachate treatment systems at NNP1 Project Landfill and Houay Soup Landfill are monitored to control the functioning of the treatment process and ensure compliance with effluent standards. The monitoring locations are presented in the ***Figure 4-17***.

FIGURE 4-17: *LANDFILL LEACHATE MONITORING LOCATION*




The monitoring results for Q4 2018 indicate compliance with the applicable standards for all monitored parameters. The monitoring data can be found in ***Appendix 5.6***

## 4.8 AIR QUALITY (DUST) MONITORING

### 4.8.1 Ambient Air Quality in the Host Villages

The ambient air quality monitoring for dust (measured as $PM_{10}$ – particulate matter with diameter of 10 micrometre or smaller) was carried out for 72 consecutive hours at Hat Gniun and Phouhomxay villages. The main purpose of the dust monitoring at Hat Gniun and Phouhomxay Villages is to assess if the project construction works may have caused significant dust levels in the ambient air.

The monitoring stations are displayed in

***Figure*** 4-18 and the results are summarized in ***Table 4-23.*** The measured concentrations of $PM_{10}$ in the ambient air complied with the standard during the monitored period***.***

FIGURE 4-18*: NOISE AND DUST MONITORING LOCATIONS AT THE CONSTRUCTION SITES AND NEARBY VILLAGES*

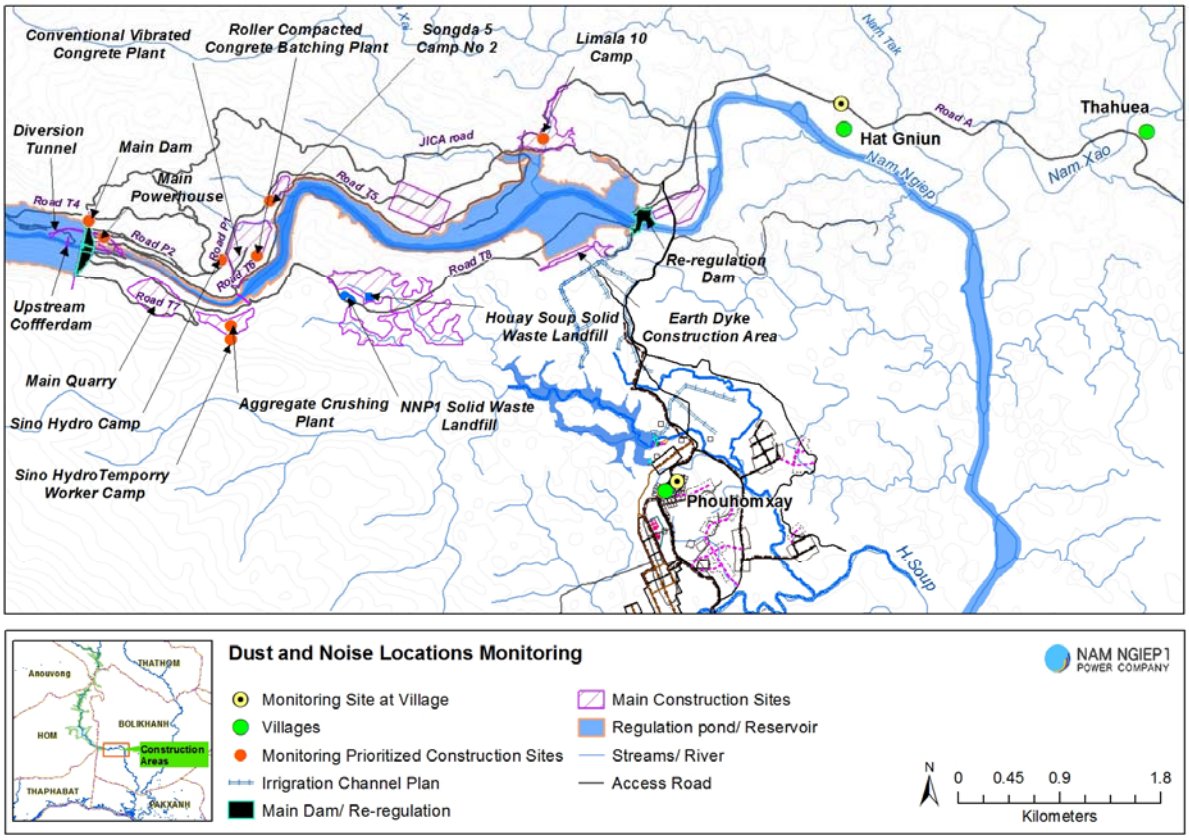



**TABLE 4-22: *RESULTS OF AIR QUALITY (DUST) MONITORING AT THE VILLAGES NEAR THE PROJECT CONSTRUCTION SITES DURING OCTOBER TO DECEMBER 2018***

| Site Name | Hat Gniun Village | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Start Time | 15-Oct-18 18:00 | 16-Oct-18 18:01 | 17-Oct-18 18:01 | 13-Nov-18 18:30 | 14-Nov-18 18:31 | 15-Nov-18 18:31 | 10-Dec-18 18:30 | 11-Dec-18 18:31 | 12-Dec-18 18:31 |
| End Time | 16-Oct-18 18:00 | 17-Oct-18 18:00 | 18-Oct-18 18:00 | 14-Nov-18 18:30 | 15-Nov-18 18:30 | 16-Nov-18 18:00 | 11-Dec-18 18:30 | 12-Dec-18 18:30 | 13-Dec-18 18:00 |
| Average Data Record - 24 hours | 0.042 | 0.038 | 0.037 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.02 |
| Guideline | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 |

| Site Name | Phouhomxay Village | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Start Time | 03-Oct-18 18:00 | 04-Oct-18 18:01 | 05-Oct-18 18:01 | 26-Nov-18 18:00 | 27-Nov-18 18:01 | 28-Nov-18 18:01 | 24-Dec-18 18:00 | 25-Dec-18 18:01 | 26-Dec-18 18:01 |
| End Time | 04-Oct-18 18:00 | 05-Oct-18 18:00 | 06-Oct-18 18:00 | 27-Nov-18 18:00 | 28-Nov-18 18:00 | 29-Nov-18 18:00 | 25-Dec-18 18:00 | 26-Dec-18 18:00 | 27-Dec-18 18:00 |
| Average Data Record - 24 hours | 0.081 | 0.079 | 0.075 | 0.080 | 0.055 | 0.044 | 0.056 | 0.055 | 0.058 |
| Guideline | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 |

### 4.8.2 Project Construction Sites

During Q4 2018, dust ($PM_{10}$) monitoring was carried out for 24 hours consecutively on a monthly basis at eight priority construction sites and camps to assess possible impacts on

workers' health. The results summarized in ***Table 4-23*** indicate compliance with the standard (0.12 mg/m$^3$ $PM_{10}$) for all the monitored construction sites.

**TABLE 4-23*: DUST MONITORING RESULTS AT THE CONSTRUCTION SITES DURING OCTOBER TO DECEMBER 2018***

| **Site Name** | **Main Dam** | | |
|---|---|---|---|
| Period | 00-24 Hours | 00-24 Hours | 00-24 Hours |
| Start Time | 29/Oct/18 18:00 | 05/Nov/18 18:00 | 19/Dec/18 18:00 |
| End Time | 30/Oct/18 18:00 | 06/Nov/18 18:00 | 20/Dec/18 18:00 |
| Average Data Record – 24 h | 0.04 | 0.03 | 0.04 |
| Guideline | 0.12 | 0.12 | 0.12 |

| **Site Name** | **Song Da5 Camp No.2** | | |
|---|---|---|---|
| Period | 00-24 Hours | 00-24 Hours | 00-24 Hours |
| Start Time | 12/Oct/18 18:00 | 07/Nov/18 18:00 | 17/Dec/18 18:00 |
| End Time | 13/Oct/18 18:00 | 08/Nov/18 18:00 | 18/Dec/18 18:00 |
| Average Data Record - 24 h | 0.03 | 0.016 | 0.021 |
| Guideline | 0.12 | 0.12 | 0.12 |

| **Site Name** | **Main Powerhouse** | | |
|---|---|---|---|
| Period | 00-24 Hours | 00-24 Hours | 00-24 Hours |
| Start Time | 22/Oct/18 18:00 | 08/Nov/18 18:30 | 20/Dec/18 18:30 |
| End Time | 23/Oct/18 18:00 | 09/Nov/18 18:00 | 21/Dec/18 18:00 |
| Average Data Record -24h | 0.027 | 0.035 | 0.044 |
| Guideline | 0.12 | 0.12 | 0.12 |

### 4.8.3 Noise Monitoring

**Nearby Communities**

Noise monitoring was carried out in Hat Gniun Village and Phouhomxay Village for 72 consecutive hours. The recorded values were measured against the standards, including average noise levels for daytime during 06:00-18:00, evening time during 18:00-22:00 and night time during 22:00-06:00.

The results (see ***Table 4-24***) showed that the noise levels at those villages were within the allowable maximum peak value at 115 dB(A), and some of the night-time average noise levels were slightly higher than the national standard in Hat Gniun and Phouhomxay Villages.

**TABLE 4-24: *NOISE MONITORING RESULTS AT THE HOST VILLAGES IN Q4 2018***

| Hat Gnuin Village -Noise Monitoring 72 consecutive hours - October 2018 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Noise Level (dB)** | 15-16/October/18 | | | 16-17/October/18 | | | 17-18/October/18 | | |
| | 18:00-22:00 | 22:01 – 06:00 | 06:01 – 18:00 | 18:00-22:00 | 22:01 – 06:00 | 06:01 – 18:00 | 18:00-22:00 | 22:01 – 06:00 | 06:01 – 18:00 |
| Maximum Value Recorded | 75.50 | 61.10 | 79.90 | 63.00 | 58.20 | 78.80 | 61.00 | 61.40 | 73.70 |
| ***Guideline Max*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** |
| Average Data Recorded | 53.53 | 48.58 | 48.20 | 50.28 | 47.59 | 49.44 | 53.10 | 47.81 | 48.70 |
| ***Guideline Averaged*** | ***55*** | ***45*** | ***55*** | ***55*** | ***45*** | ***55*** | ***55*** | ***45*** | ***55*** |
| Hat Gnuin Village - Noise Monitoring 72 consecutive hours - November 2018 | | | | | | | | | |
| **Noise Level (dB)** | 13-14/November/18 | | | 14-15/November/18 | | | 15-16/November/18 | | |
| | 18:00-22:00 | 22:01 – 06:00 | 06:01 – 18:00 | 18:00-22:00 | 22:01 – 06:00 | 06:01 – 18:00 | 18:00-22:00 | 22:01 – 06:00 | 06:01 – 18:00 |
| Maximum Value Recorded | 75.50 | 61.10 | 79.90 | 63.00 | 58.20 | 78.80 | 61.00 | 61.40 | 73.70 |
| ***Guideline Max*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** |
| Average Data Recorded | 53.53 | 48.58 | 48.20 | 50.28 | 47.59 | 49.44 | 53.10 | 47.81 | 48.70 |
| ***Guideline Averaged*** | ***55*** | ***45*** | ***55*** | ***55*** | ***45*** | ***55*** | ***55*** | ***45*** | ***55*** |
| Hat Gnuin Village - Noise Monitoring 72 consecutive hours - December 2018 | | | | | | | | | |
| **Noise Level (dB)** | 10-11/December/18 | | | 11-12/December/18 | | | 12-13/December/18 | | |
| | 18:30-22:00 | 22:01 – 06:00 | 06:01 – 18:00 | 18:00-22:00 | 22:01 – 06:00 | 06:01 – 18:00 | 18:00-22:00 | 22:01 – 06:00 | 06:01 – 18:00 |
| Maximum Value Recorded | 75.50 | 61.10 | 79.90 | 63.00 | 58.20 | 78.80 | 61.00 | 61.40 | 73.70 |
| ***Guideline Max*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** |
| Average Data Recorded | 53.53 | 48.58 | 48.20 | 50.28 | 47.59 | 49.44 | 53.10 | 47.81 | 48.70 |
| ***Guideline Averaged*** | ***55*** | ***45*** | ***55*** | ***55*** | ***45*** | ***55*** | ***55*** | ***45*** | ***55*** |

| Phouhomxay Village - Noise Monitoring 72 consecutive hours - October 2018 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Noise Level (dB)** | **03-04/October/18** | | | **03-04/October/18** | | | **03-04/October/18** | | |
| | 18:30-22:00 | 22:01 – 06:00 | 06:01 – 18:00 | 18:00-22:00 | 22:01 – 06:00 | 06:01 – 18:00 | 18:00-22:00 | 22:01 – 06:00 | 06:01 – 18:00 |
| Maximum Value Recorded | 67.10 | 71.60 | 66.70 | 68.50 | 68.50 | 78.70 | 56.90 | 65.90 | 73.80 |
| ***Guideline Max*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** |
| Average Data Recorded | 49.41 | 49.73 | 43.68 | 49.45 | 50.10 | 44.09 | 50.17 | 50.09 | 47.26 |
| ***Guideline Averaged*** | ***55*** | ***45*** | ***55*** | ***55*** | ***45*** | ***55*** | ***55*** | ***45*** | ***55*** |
| Phouhomxay Village - Noise Monitoring 72 consecutive hours - November 2018 | | | | | | | | | |
| **Noise Level (dB)** | **26-27/November/18** | | | **26-27/November/18** | | | **26-27/November/18** | | |
| | 18:30-22:00 | 22:01 – 06:00 | 06:01 – 18:00 | 18:00-22:00 | 22:01 – 06:00 | 06:01 – 18:00 | 18:00-22:00 | 22:01 – 06:00 | 06:01 – 18:00 |
| Maximum Value Recorded | 67.30 | 70.20 | 73.70 | 63.10 | 67.70 | 80.10 | 67.30 | 75.90 | 75.90 |
| ***Guideline Max*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** |
| Average Data Recorded | 44.94 | 45.50 | 50.42 | 46.49 | 45.83 | 49.75 | 44.39 | 45.23 | 44.59 |
| ***Guideline Averaged*** | ***55*** | ***45*** | ***55*** | ***55*** | ***45*** | ***55*** | ***55*** | ***45*** | ***55*** |
| Phouhomxay Village - Noise Monitoring 72 consecutive hours - December 2018 | | | | | | | | | |
| **Noise Level (dB)** | **24-25/December/18** | | | **25-26/December/18** | | | **26-27/December/18** | | |
| | 18:00-22:00 | 22:01 – 06:00 | 06:01 – 18:00 | 18:00-22:00 | 22:01 – 06:00 | 06:01 – 18:00 | 18:00-22:00 | 22:01 – 06:00 | 06:01 – 18:00 |
| Maximum Value Recorded | 50.20 | 46.20 | 72.00 | 56.00 | 61.60 | 73.70 | 62.00 | 62.00 | 64.20 |
| ***Guideline Max*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** |
| Average Data Recorded | 36.91 | 33.89 | 39.79 | 40.55 | 43.12 | 43.89 | 43.15 | 38.67 | 39.90 |
| ***Guideline Averaged*** | ***55*** | ***45*** | ***55*** | ***55*** | ***45*** | ***55*** | ***55*** | ***45*** | ***55*** |

Given the distance between the construction sites and the villages (2 km - 5 km) and the noise levels measured at the construction sites (see ***Table 4-25***), it is highly unlikely that the elevated noise levels measured in the villages are related to project construction activities.

### 4.8.4 Project Camps and Construction Sites

During Q4 2018, noise monitoring was conducted at the Song Da5 camp No.2, Lilama10 camp, Main Dam and Main Powerhouse to assess possible impacts on workers' health as well as to estimate any potential impact on the ambient noise levels in nearby communities.

The result showed that all maximum peak noise levels were within the National Standard. However, the average noise level during 22:01-06:00 at Lilama10 Camp (October and November 2018) and Main Powerhouse (November 2018) were higher than the National standard. The elevated noise levels at the main powerhouse is most likely caused by the diving water discharged over the spillway (the spill during the noise measurements in October and November was 100 $m^3/s$ to 150 $m^3/s$, while the spill during the December measurement which had considerably lower noise levels was only about 10 $m^3/s$).

**TABLE 4-25:** ***NOISE MONITORING RESULTS FOR PROJECT CONSTRUCTION SITES IN Q4 2018***

| Site Name | Main Dam | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Noise Level (dB) | 29-30/Oct/18 | | 30/Oct/18 | 05-06/Nov/18 | | 06/Nov/18 | 19-20/Dec/18 | | 20/Dec/18 |
| | 18:00 – 22:00 | 22:01 – 06:00 | 06:01-18:00 | 18:00 – 22:00 | 22:01 – 06:00 | 06:01-18:00 | 18:00 – 22:00 | 22:01 – 06:00 | 06:01-18:00 |
| Maximum Value Recorded | 66.7 | 63.6 | 69.1 | 65.5 | 63.2 | 67.9 | 57.6 | 57.9 | 78.6 |
| Guideline Max | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** |
| Average Data Recorded | 61.04 | 61.02 | 59.47 | 61.57 | 61.22 | 58.68 | 53.86 | 53.78 | 52.85 |
| Guideline Average | ***70*** | ***70*** | ***70*** | ***70*** | ***70*** | ***70*** | ***70*** | ***70*** | ***70*** |
| **Site Name** | **Song Da5 Camp No.2** | | | | | | | | |
| Noise Level (dB) | 12-13/Oct/18 | | 13/Oct/18 | 07-08/Nov/18 | | 08/Nov/18 | 17-18/Dec/18 | | 18/Dec/18 |
| | 18:00 – 22:00 | 22:01 – 06:00 | 06:01-18:00 | 18:00 – 22:00 | 22:01 – 06:00 | 06:01-18:00 | 18:00 – 22:00 | 22:01 – 06:00 | 06:01-18:00 |
| Maximum Value Recorded | 47.10 | 51.60 | 64.00 | 53.70 | 55.90 | 71.00 | 63.80 | 57.50 | 62.00 |
| Guideline Max | 115 | 115 | 115 | 115 | 115 | 115 | 115 | 115 | 115 |
| Average Data Recorded | 39.89 | 43.73 | 41.11 | 46.77 | 44.61 | 46.79 | 38.28 | 33.96 | 40.69 |
| Guideline Averaged | ***70*** | ***50*** | ***70*** | ***70*** | ***50*** | ***70*** | ***70*** | ***50*** | ***70*** |
| **Site Name** | **Lilama 10 Camp** | | | | | | | | |
| Noise Level (dB) | 09-10/Oct/18 | | 10/Oct/18 | 12-13/Nov/18 | | 13/Nov/18 | 06-07/Dec/18 | | 07/Dec/18 |
| | 18:00 – 22:00 | 22:01 – 06:00 | 06:00-18:00 | 18:00 – 22:00 | 22:01 – 06:00 | 06:00-18:00 | 18:00 – 22:00 | 22:01 – 06:00 | 06:00-18:00 |
| Maximum Value Recorded | 64 | 65.2 | 70.6 | 78.8 | 71.2 | 87.4 | 59.2 | 63.6 | 74.1 |
| Guideline Max | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** |
| Average Data Recorded | 54.37 | 56.87 | 44.56 | 54.81 | 55.20 | 48.12 | 52.83 | 43.63 | 44.32 |
| Guideline Averaged | ***70*** | ***50*** | ***70*** | ***70*** | ***50*** | ***70*** | ***70*** | ***50*** | ***70*** |
| **Site Name** | **Main Powerhouse** | | | | | | | | |
| Noise Level (dB) | **22-23/Oct/18** | | **23/Oct/18** | **08-09/Nov/18** | | **09/Nov/18** | **20-21/Dec/18** | | **21/Dec/18** |
| | 18:00 – 22:02 | 22:01 – 06:02 | 06:01-18:02 | 18:30 – 22:00 | 22:01 – 06:00 | 06:01-18:00 | 18:30 – 22:00 | 22:01 – 06:00 | 06:01-18:00 |
| Maximum Value Recorded | 69.4 | 69.4 | 85.5 | 69.4 | 71.2 | 88.6 | 60.5 | 65.9 | 78.6 |
| Guideline Max | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** | ***115*** |
| Average Data Recorded | 68.77 | 68.75 | 69.82 | 68.74 | 68.96 | 70.74 | 55.74 | 53.91 | 57.40 |
| Guideline Averaged | ***70*** | ***70*** | ***70*** | ***70*** | ***70*** | ***70*** | ***70*** | ***70*** | ***70*** |

### 4.8.5 Vibration

No blasting was undertaken during the reporting period. The construction work during Q4 2018 is unlikely to generate vibrations that would impact the human health and surrounded environment.

# 5 WATERSHED AND BIODIVERSITY MANAGEMENT

## 5.1 WATERSHED MANAGEMENT

### 5.1.1 Preparation of Watershed Management Plan

NNP1PC-EMO concluded the final review of the Plan and completed the improvements at the end of October 2018. NNP1PC re-submitted the improved final Plan to ADB on 5 November 2018 and received feedback on 22 November 2018.

The main comments of ADB and IAP were discussed during the joint IAP and ADB mission during 14-15 December 2018 and agreed on the following:

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

The Bolikhamxay Provincial WRPO is in the process of preparing an Annual Implementation Plan or AIP for 2019 for the Watershed Management Programme. The draft AIP 2019 of Bolikhamxay Provincial WRPO was submitted to NNP1PC-EMO for further review on 30 October 2018. The draft is being reviewed by NNP1PC-EMO.

Xaysomboun Provincial WRPO has started the preparation of the AIP for 2019 in the middle of October 2018. However, Xaysomboun PONRE and PAFO could not reach an agreement on the leading team for some proposed activities due to the overlapping of responsibilities between them. A meeting between Xaysomboun Provincial Authority and Department of Forestry (DOF), Ministry of Agriculture and Forestry (MAF) on 23 November 2018 concluded that Xaysomboun Provincial WRPC and WRPO will be under the leadership of Xaysomboun Provincial Agriculture and Forestry (PAFO). In addition, the meeting also agreed that NNP1 WMP will be approved by the Minister of MAF while the Annual Implementation Plan (AIP) will be approved by each Provincial Governor separately. In accordance with the resolution of the meeting, the Governor of Xaysomboun Province signed and issued an Agreement (No. 1134) on the re-structuring of the WRPC and WRPO on 29 November 2018. The preparation of AIP 2019 by the Xaysomboun Province will be continued in January 2019.

Xaysomboun WRPO in collaboration with District Agriculture and Forestry Office (DAFO) of Hom District carried out a field verification survey of the Totally Protection Zone 1 (TPZ-1, Phou Samsao) boundary and land uses in Hom District. The survey was completed at the end of October 2018. The remaining surveys in TPZ-1 in Anouvong District and TPZ-2 (TPZ Phou Khata) in Hom District were postponed until the re-structuring of Xaysomboun WRPC and WRPO were completed on 29 November 2018. The survey will be resumed in January 2019 led by the new WRPO secretariat (PAFO).

The staff operating the three checkpoints made 894 records of people accessing the main reservoir in October 2018. Out of these, a total of 522 records of people from Houayxay Village (Hom District, Xaysomboun Province), 132 records from Pou Village (Thathom District, Xaysomboun Province) and 240 records of people from Nahan Village (Bolikhan District, Bolikhamxay Province). The main reasons why people access the reservoir include fishing and hunting (201 records), agriculture (415 records), livestock raising (152 records) and other purpose (124 records). In addition, a total of 917 cattle which are known to belong to 77 households from eight Villages namely Nahan, Nam Kian, Bor, Phalaveak, Phamueang, Phou Ngou, Huay Xay and Homthat were reported inside the NNP1 watershed area not in the TPZs.

EMO conducted site visit and reservoir monitoring in mid of October 2018 and noted that there was a concession granted by Xaysomboun Public Works and Transport Department to a local business person to operate a boat landing site and parking service at Vangkhiew port in Houayxay area. This concession was made without prior consultation with Xaysomboun WRPC/WRPO. The patrolling team observed and recorded several boats, fishing camps, illegal hunting and logging inside the reservoir. NNP1PC is supporting WRPO to be more proactive to communicate and discuss with relevant district and village authorities to minimize the unregulated practices and in the future include a member from the Division of Forest Inspection under PAFO or DAFO to strengthen their law enforcement on protection of forest, aquatic life and wild animals.

The operation of the checkpoint in Nahan Village (Bolikhan District, Bolikhamxay Province) continued in November 2018 whilst the operation of the two checkpoints in Xaysomboun Province (Houaxay Village, Hom District and Pou Village, Thathom District) was postponed due to pending fund disbursement related to the re-structuring of WRPC and WRPO from PONRE to PAFO which affected the fund withdrawal from the DOF Designated Account. The checkpoint in Nahan Village made 78 records of people accessing the main reservoir. The main reasons found include fishing and hunting (17 records), agriculture (31 records), livestock raising (13 records) and other purposes (17 records).

A joint inspection between NNP1 EMO and Hom District authority (DAFO and DONRE) in NNP1 reservoir was conducted during 20-21 November 2018. Based on the results of inspection, all parties agreed on the following key actions:

- DAFO and DONRE will request District Governor of Hom District to issue a notification on preservation of the reservoir riparian buffer zone at 320-322 masl and that no structures will be allowed below 322 masl;
- Fishing camps will be required to move to Vangkhiew port in Houayxay area (Hom District) and the worker camp of the GOL salvage logging Contractor will be required to move to shore near the port in Nahan side (Bolikhan District). The fishing group will be required to register themselves at Xaysomboun DAFO.
- to install signage at Vangkhiew in Hom District and Nahan port in Bolikhan District to mark the reservoir riparian buffer zone where no structures below 322 masl is allowed and to inform that littering is not allowed in reservoir.

In connection to this, Xaysomboun Provincial WRPC issued an official Notification, No. 001 on 26 November 2018 to three Districts (Anouvong, Hom, Tathom) to immediately stop all unauthorized activities such as establishment and operation of hunting camps, salvage logging boat, fishing camps, etc. in the reservoir area by 15 December 2018.

The operation of three checkpoints in December 2018 made 172 records of people accessing the main reservoir. Out of these, a total of 153 records of people from Houayxay Village (Hom District, Xaysomboun Province) and 19 records of people from Nahan Village (Bolikhan District, Bolikhamxay Province). The main reasons why people access the reservoir include fishing and hunting (39 records), agriculture (55 records), livestock raising (32 records) and other purpose (46 records).

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

- Prepare clear job descriptions for the members of the Xaysomboun WRPC to ensure smooth coordination and implementation;
- The three Districts in NNP1 watershed (Hom, Anouvong, Thathom) should organize meetings for disseminating the Instruction Letter of Xaysomboun WRPC Chairperson (Ref. No. 001/XSB.WRPC dated 26 Nov 2018) and raise awareness for the local village authorities on watershed protection and management objectives;
- Xaysomboun WRPO to speed up the formulation of AIP 2019;
- Ranger stations in TPZs should be established as soon as possible to monitor and prevent any further forest encroachment, especially during the preparation for the upcoming upland cultivation season;
- The no go zone area (TPZ in the reservoir) should be demarcated and signage should be installed to stop further destruction of water resource as well as unregulated fishing;
- All temporary approved activities by District and Provincial authority have to be stopped /cancelled and all fishing groups have to move out from the reservoir until further arrangement and approval by Xaysomboun WRPC.

Xaysomboun PAFO need to make an agreement with the salvage logging contractors to settle the payment for harvested logs stockpiled at the second landing with a deadline on 21 December 2018 and the log-yard shall be closed by the end of December 2018. If the Contractors could not settle the payment, the logs should be seized, and the Contractors should be fined for non-compliance. No additional access road shall be allowed to be built. The salvage logging floating camp shall be pulled to shore outside TPZ areas in a designated area identified by the WRPC.

### 5.1.2 Preparation of Provincial Regulation for the Watershed Management

The Xaysomboun PAFO had an objection to the Provincial Watershed Management Regulations causing another internal Government meeting to be held on 8 October 2018 at the Provincial Assembly of Xaysomboun Province to discuss the comments from PAFO. Representatives from the Provincial Assembly, PONRE and PAFO participated in the meeting. The key results of the meeting are as follow:

- The Provincial Assembly will report to the Minister of MONRE in order to obtain his advice and recommendations regarding the division of roles and responsibilities of PAFO and PONRE on the implementation of the Regulations.

- PAFO will further review and improve the Regulations related to forestry, fishery and agriculture;
- PAFO and PONRE to organize a follow up discussion and report to the Provincial Assembly for further improvement of the Regulations.

Xaysomboun Provincial Authority and the Department of Forestry (DOF), Ministry of Agriculture and Forestry (MAF) held a meeting on 23 November 2018 and the chair of the meeting urged the new WRPO (PAFO? to quickly improve the draft Regulation and submit it to the Provincial Assembly for endorsement before it is signed by the Provincial Governor.

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

## 5.2 BIODIVERSITY OFFSET MANAGEMENT

### 5.2.1 Preparation of Biodiversity Offset Management Plan

The improved first draft of the NNP1 Biodiversity Offset Management Plan for Nam Chouane-Nam Xang (NCNX) Biodiversity Offset Site was submitted to ADB on 14 September 2018 for further review.

EMO conducted a small workshop with BOMC Secretariat on 10 October 2018 to present and discuss the proposed management activities within the draft Plan.

ADB provided comments during 20-23 November 2018 and IAP provided comments on 28 November 2018.

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

- The Vision statement;
- The assessment and targets to achieve No Net Loss (NNL),
- The presentation of an organization structure that clearly includes the role of a Service Provider for Nam Chouane – Nam Xang (NC-NX) Biodiversity Offset Management; and
- Assessment of social impacts including potential impacts on the local people's livelihoods and access to natural resources in the TPZ areas to be demarcated inside the Biodiversity Offset Area; and how such impacts would be addressed.

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

### 5.2.2 Preparation of Provincial Regulation for Biodiversity Offset Management in the NC-NX

The Regulation was presented to the Bolikhamxay Provincial Assembly on 17 August 2018. This Regulation was unanimously endorsed by Bolikhamxay Provincial Assembly. The Biodiversity Offset Management Regulation was later submitted to the Bolikhamxay

Provincial Governor for signing on 24 September 2018. The Biodiversity Offset Management Regulation was approved by Bolikhamxay Provincial Governor on 31 October 2018. The Biodiversity Offset Management Committee's (BOMC) Secretariat disseminated this Regulation in six villages surrounding the Offset Site during 21-30 November 2018.

### 5.2.3 Implementation of pre-Biodiversity Offset Management Plan

The Pre-BOMP-2B proposal was approved by ADB and agreed by BOMC at the end of September 2018. A total of $88,578 of fund was disbursed in October 2018 for the continuation of the patrolling activities.

In October 2018, two patrolling teams with a total of 18 people conducted forest patrolling for 15 days in Viengthong District and 12 days in Xaychamphone District. The patrolling covered 17 small but significant biodiversity areas within the NC-NX Offset Site. The main threats found in the areas are wildlife hunting and wire snares by local villagers. Two temporary hunting camps were recorded by Viengthong patrolling team whilst a total of 138 small wire snares, 151 large wire snares and 3 temporary hunting camps were collected/recored by Xaychamphone patrolling team.

In November 2018, patrolling teams conducted forest patrolling for 16 days in both Viengthong and Xaychamphone Districts. The patrolling covered 10 small but significant biodiversity areas within the NC-NX Offset Site. The main threats found in the area are wildlife hunting and wire snares by local villagers. Nine temporary hunting camps and 165 small wire snares were recorded by Viengthong District's patrolling team whilst a total of 10 temporary hunting camps and 6 small wire snares were recored by Xaychamphone District's patrolling team.

In December 2018, the patrolling teams conducted forest patrolling for 16 days in both Viengthong and Xaychamphone Districts. The patrolling covered 13 small but significant biodiversity areas within the NC-NX Offset Site in those Districts. The main threats found in the area were wildlife hunting and unergulated fishing by local villagers. Four temporary hunting camps were recorded by Viengthong District's patrolling team whilst a total of seven temporary hunting camps and 51 small wire snares were recored by Xaychamphone District's patrolling team.

# 6 FLOATING DEBRIS REMOVAL

Floating debris removal is a post biomass clearance activity that started during impounding in August 2018. However, floating debris removal is part of the overall biomass removal plan to deal with trees, logs etc. that eventually slip and float on the reservoir or logs that were cut, but not pulled above the reservoir shoreline elevation prior to impounding.

Floating debris removal work in October 2018 continued in the middle of reservoir Zone 5. Some floating debris/logs were removed and piled at the landing sites. The burning of dried debris/logs started in the middle of October 2018.

Due to the fact that the main reservoir water level is not static, the Contractor was focusing the work in November to December 2018 on capturing, tying maintaining the floating debris/logs at the shore of creeks temporary above the inundation level that was planned for the Quarter and burn later when the water level starts to drop again.

The contract for floating debris removal work completed at the end of December 2018. A total of 50 debris collection points were maintained on the shoreline of Zone 5 (see ***Figure 6-1***). Out of these, burning was completed for a total of 9 debris collection points.

FIGURE 6-1: *REPRESENTATIVE PHOTOS OF FLOATING DEBRIS AND LOGS REMOVAL OPERATION IN ZONE 5 IN OCTOBER 2018*

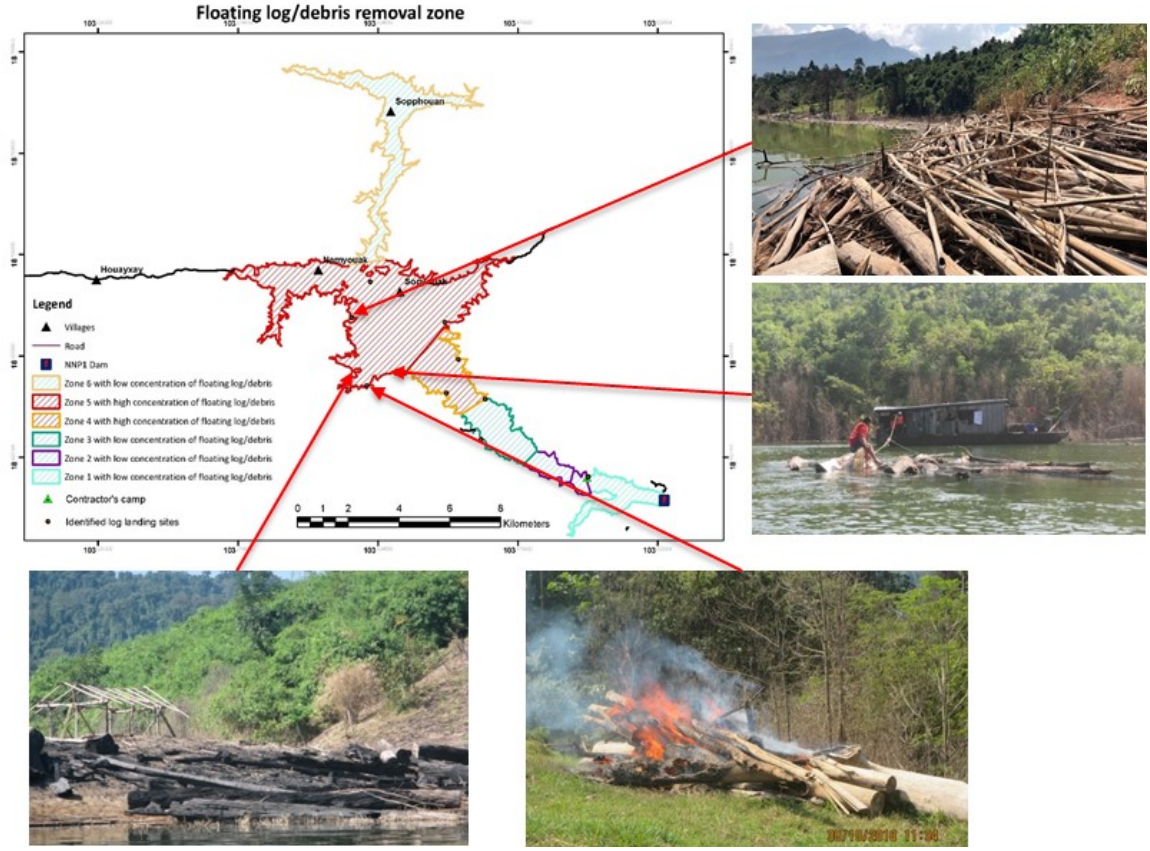


**FIGURE 6-2:** ***REPRESENTATIVE PHOTOS OF FLOATING DEBRIS AND LOGS REMOVAL OPERATION IN ZONE 5 IN NOVEMBER 2018***

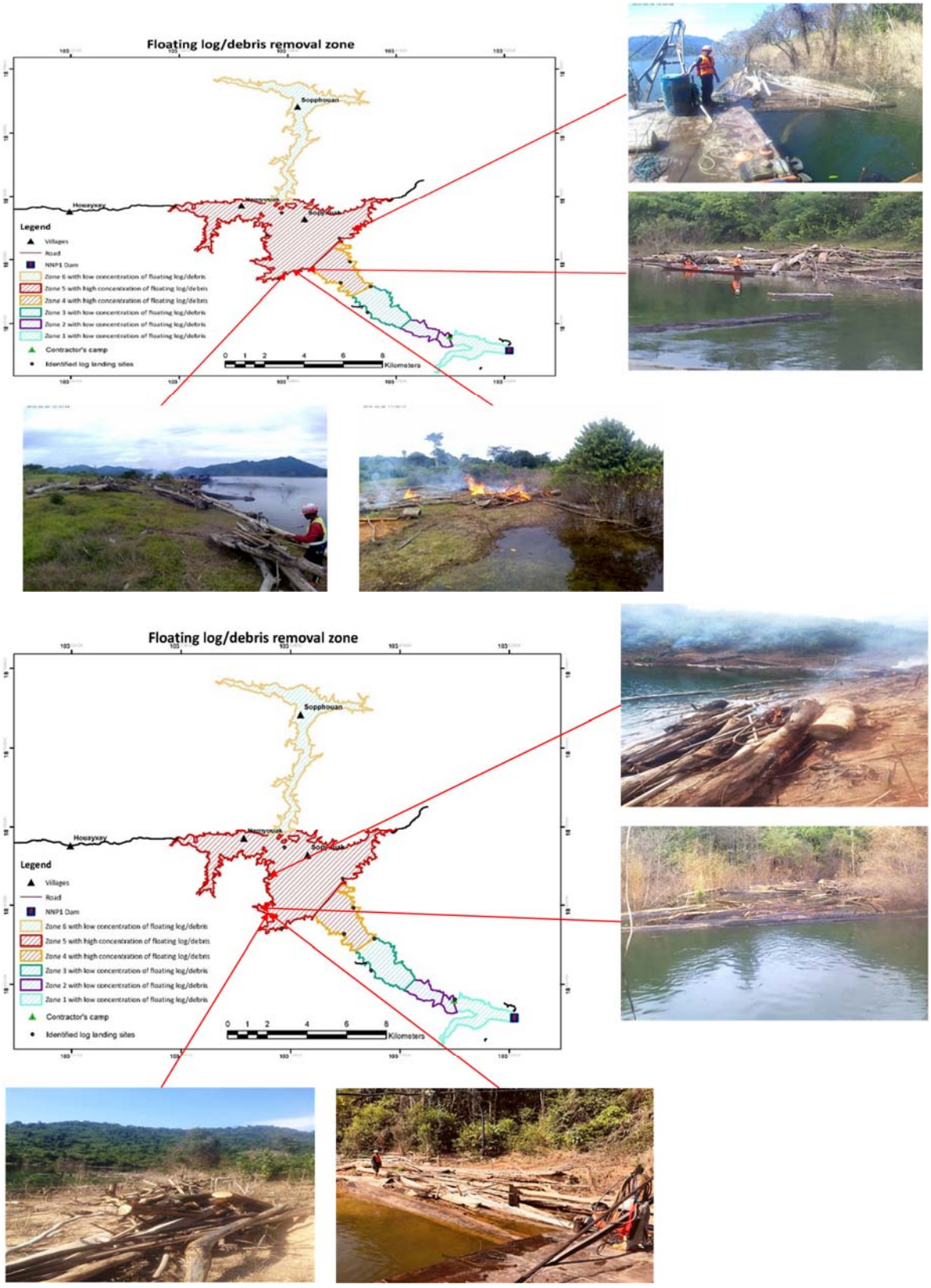


**FIGURE 6-3:** ***REPRESENTATIVE PHOTOS OF FLOATING DEBRIS AND LOGS REMOVAL OPERATION IN ZONE 5 IN DECEMBER 2018***

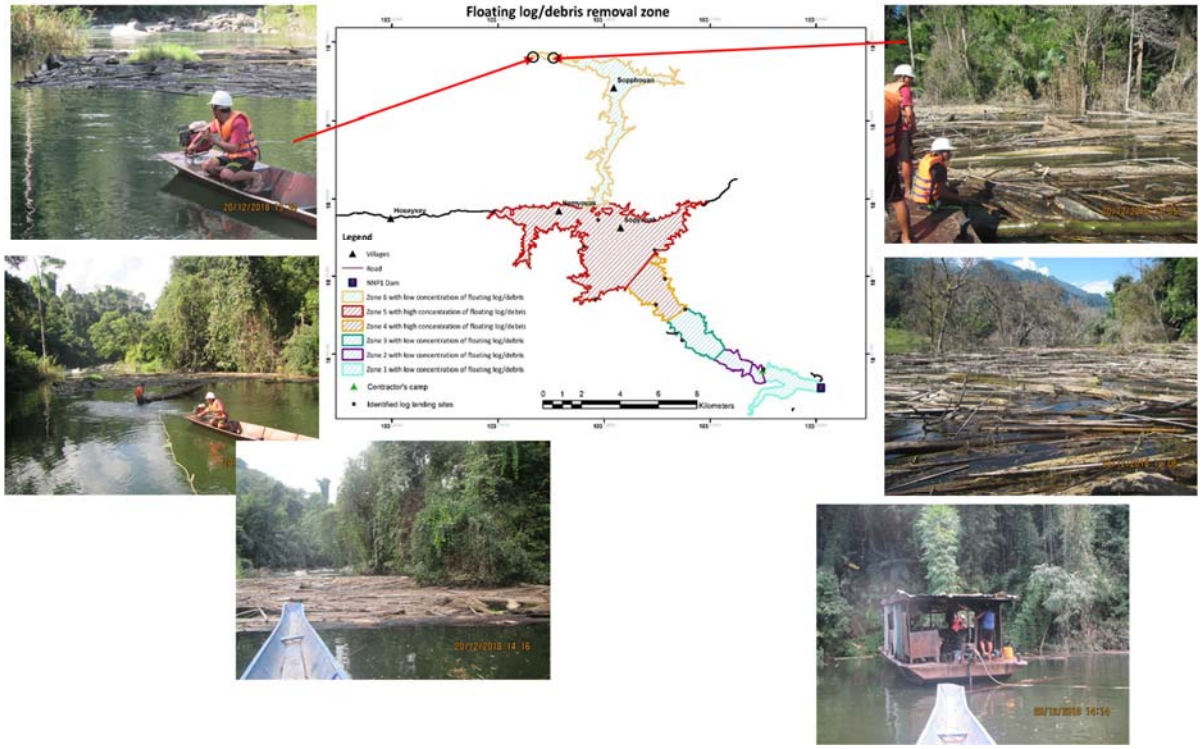



**FIGURE 6-4:** ***REPRESENTATIVE PHOTOS OF MAINTAINED LOG YARDS (LOG YARD #12-#17) IN ZONE 5 DURING FINAL INSPECTION IN DECEMBER 2018***

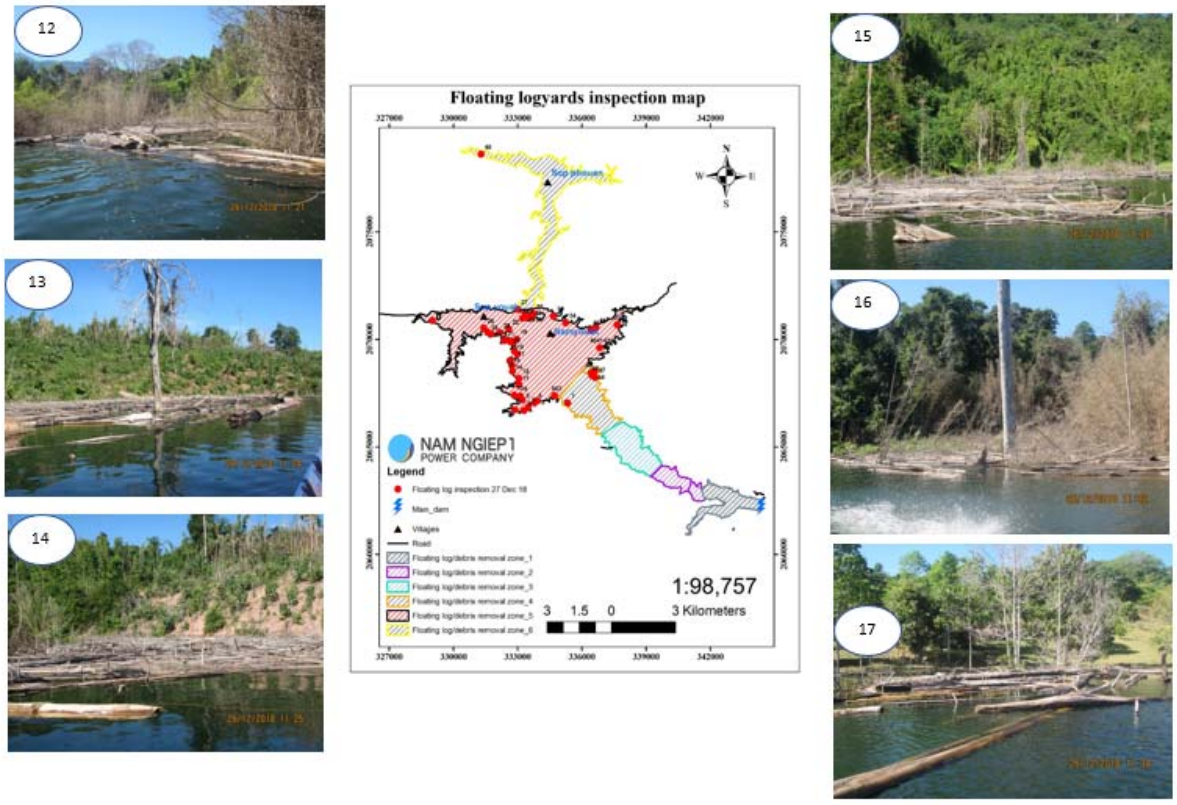
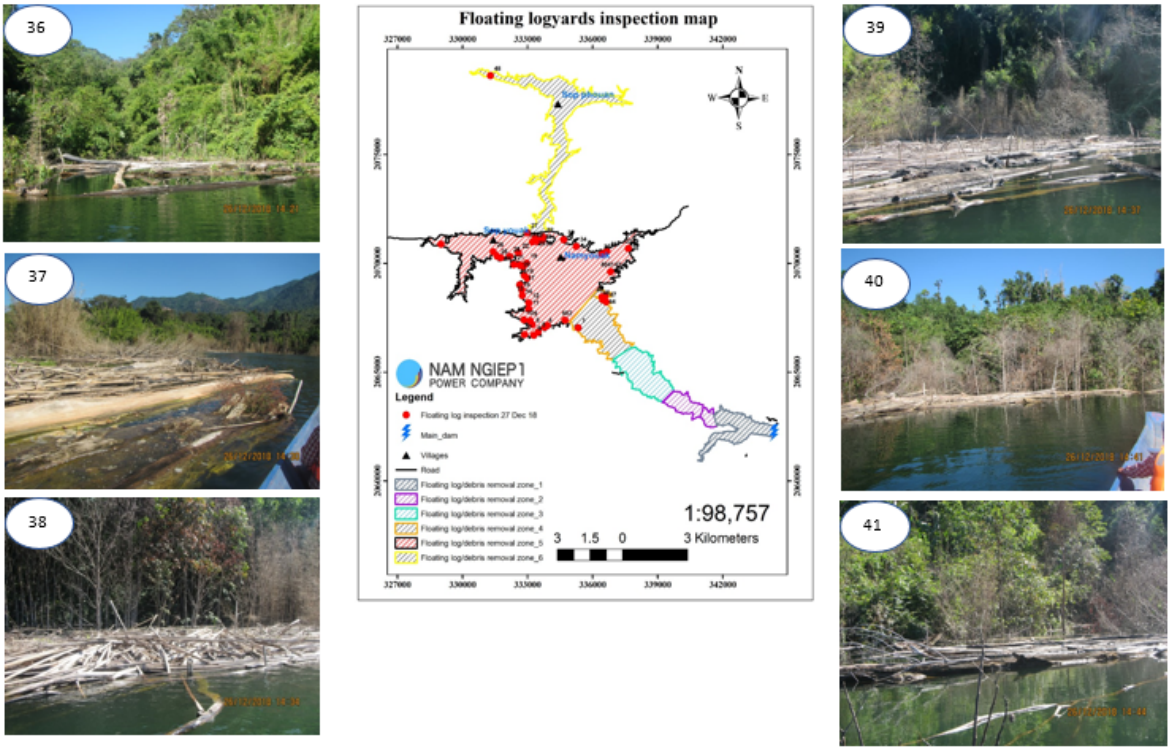


FIGURE 6-5: *REPRESENTATIVE PHOTOS OF MAINTAINED LOG YARDS (LOG YARD #36-#41) IN ZONE 5 DURING FINAL INSPECTION IN DECEMBER 2018*




# 7 FISHERY MONITORING

The daily fish catch logbook survey reported here involves 93 fishing households in 34 villages in the project area. For the purposes of identifying any trends or significant variations, the fishing households are divided into three main zones: Upstream (this includes villages in the upper reach of the reservoir and the villages along Nam Ngiep further upstream until the confluence with Nam Siem. This zone excludes the villages in the lower reach as they were relocated prior to start of impounding in May 2018), Downstream (all villages along Nam Ngiep downstream the project) and a Mekong Control Group (villages along Mekong River upstream the confluence with Nam Ngiep that exclusively fish in the Mekong River)

The five species that dominated the fish catch by weight in Q4 2018 are listed in ***Table 7-1.*** This includes one species and 4 species groups that are classified as Least Concern (LC) according to the IUCN Red List of Threatened Species[13], except *Hemibagrus filamentus* and

[13] 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.

*Sikukia gudgeri* that are Data Deficient (DD) and *Amblyrhynchichthys truncates* is classified as Not Evaluated (NE).

**TABLE 7-1: FISH SPECIES DOMINATING THE FISH CATCH IN Q4 2018**

| Species | Lao Name | Fish Catch in Q4 2018 (kg) | IUCN Red List Classification |
|---|---|---|---|
| *Poropuntius normani, Poropuntius laoensis* | ปาจาด | 1,329 | LC |
| *Hemibagrus nemurus, Hemibagrus filamentus* | ปาก๊ด | 813.9 | LC, DD |
| *Channa striata* | ปาถ่ | 743 | LC |
| *Sikukia gudgeri, Amblyrhynchichthys truncatus* | ปาฮาอฆาย | 635.6 | DD, NE |
| *Hampala dispar, Hampala macrolepidota* | ปาสูด | 573 | LC |

The recorded catch of Threatened and Near Threatened species (IUCN Red List classification) in the Q4 2018 fish catch is presented in ***Table 7-2***. The list includes one Endangered species (EN), four Vulnerable species (VU) and eleven Near Threatened species (NT).

**TABLE 7-2: THREATENED AND NEAR THREATENED SPECIES OF THE Q4 2018 FISH CATCH**

| Species | Lao Name | Fish Catch[14] in Q4 2018 (kg) | IUCN Red List Classification |
|---|---|---|---|
| *Bagarius bagarius* | ปาแฮ้ | 28.5 | NT |
| *Bagarius yarrelli* | ปาแฮ้ | 3.2 | NT |
| *Bangana behri* | ปาม้อม | 67.1 | VU |
| *Chitala blanci* | ปาตองกาย | 0.3 | NT |
| *Cirrhinus cirrhosus* | ปาแกง/ปามอมจัม | 71.5 | VU |
| *Cirrhinus molitorella* | ปาแกง | 84 | NT |
| *Cyprinus carpio* | ปาไม | 8.6 | VU |
| *Hypophthalmichthys molitrix* | ปาเก๊ดแลบ | 1 | NT |

[14] The list only includes species caught in Nam Ngiep basin – not fish caught by the Mekong Control Group

| Species | Lao Name | Fish Catch[14] in Q4 2018 (kg) | IUCN Red List Classification |
|---|---|---|---|
| *Luciocyprinus striolatus* | ปากอมຊาย | 3.8 | EN |
| *Mekongina erythrospila* | ปาสะอิ | 1 | NT |
| *Neolissochilus stracheyi* | ปาสอง | 12.4 | NT |
| *Ompok bimaculatus* | ปาเຊือม | 40.4 | NT |
| *Onychostoma gerlachi* | ปาถิง | 55.5 | NT |
| *Probarbus jullieni* | ปาเอิน | 10.9 | EN |
| *Scaphognathops bandanensis* | ปาจุมไฟ | 124.5 | VU |
| *Syncrossus beauforti* | ปาแຂ้อไก้/ปาໝู | 1 | NT |
| *Wallago attu* | ปาถ้าว | 0.5 | NT |

The occurrence of Threatened and Near Threatened species in the fish catch by Quarter since the start of species identification in Q3 2015 is displayed in ***Table 7-3***.

**TABLE 7-3: OCCURRENCE OF THREATENED AND NEAR THREATENED SPECIES IN THE FISH CATCH**

| Species | Q3 2015 | Q4 2015 | Q1 2016 | Q2 2016 | Q3 2016 | Q4 2016 | Q1 2017 | Q2 2017 | Q3 2017 | Q4 2017 | Q1 2018 | Q2 2018 | Q3 2018 | Q4 2018 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Bagarius bagarius* (NT) | | | + | + | + | + | + | + | + | + | + | + | + | + |
| *Bagarius yarrelli* (NT) | + | | | + | | | | | + | | | | | + |
| Bangana behri (VU) | + | + | + | + | + | + | + | + | + | | | + | + | + |
| *Chitala blanci* (NT) | | | | | | | | | | | | | | + |
| *Cirrhinus cirrhosus* (VU) | + | + | + | + | + | + | + | + | + | | + | + | + | + |
| *Cirrhinus molitorella* (NT) | + | + | | | | | | | | | | + | + | + |
| *Cyprinus carpio* (VU) | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| *Epalzeorhynchos munense* (VU) | | | | | | | | | | | | + | | |
| *Hypophthalmichthys molitrix* (NT) | + | | | | + | | | | | | | | | + |
| *Luciocyprinus striolatus* (EN) | + | + | + | + | | | + | + | + | + | | | + | + |
| *Mekongina erythrospila* (NT) | + | + | + | + | + | + | + | + | + | | | + | + | + |
| *Neolissochilus stracheyi* (NT) | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| *Ompok bimaculatus* (NT) | + | + | + | + | + | + | + | + | | + | + | + | + | + |
| *Onychostoma gerlachi* (NT) | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| *Pangasianodon hypophthalmus* (EN) | + | | | | | | | | | | | | | |
| *Probarbus jullieni* (EN) | + | + | + | | | + | | + | + | + | | + | | + |
| *Probarbus labeamajor* (EN) | | | | + | + | | | + | | | | | | |
| *Scaphognathops bandanensis* (VU) | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| *Syncrossus beauforti* (NT) | | + | + | + | + | + | | | | | + | | | + |
| *Wallago attu* (NT) | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| TOTAL: | 15 | | | | | | | | | | | | | 17 |

The total recorded monthly fish catch from July 2015 to June 2018 for the downstream, upstream and Mekong control group fishing households involved in the monitoring programme is presented in ***Figure 7-1***. 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 7-1: TOTAL RECORDED FISH CATCH 2015-2018**

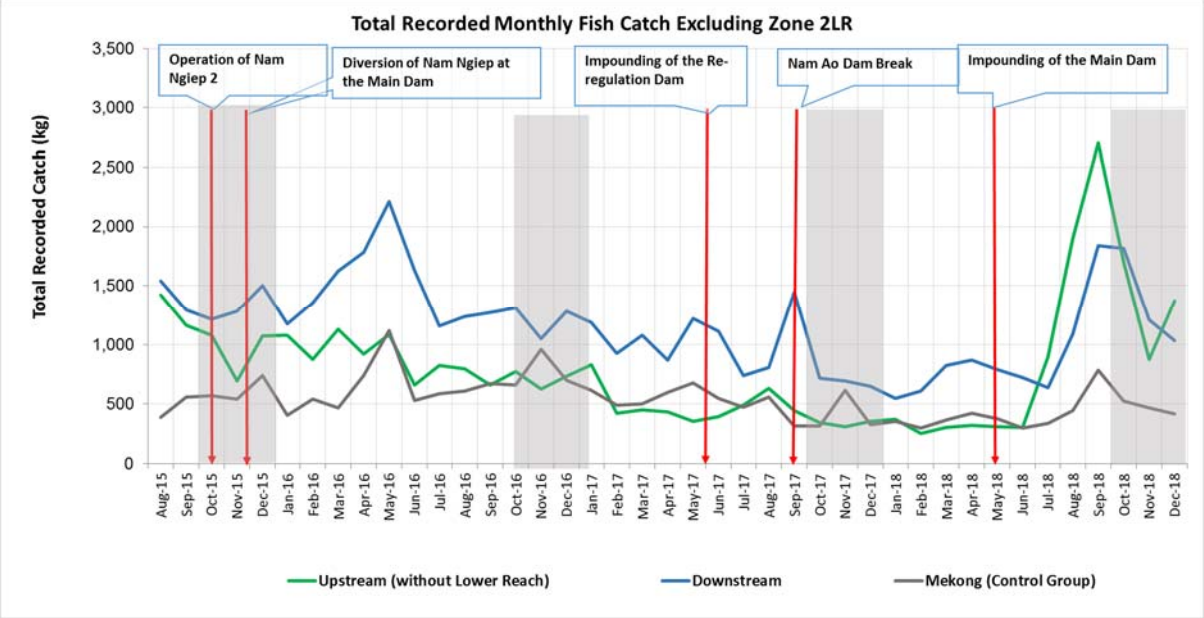
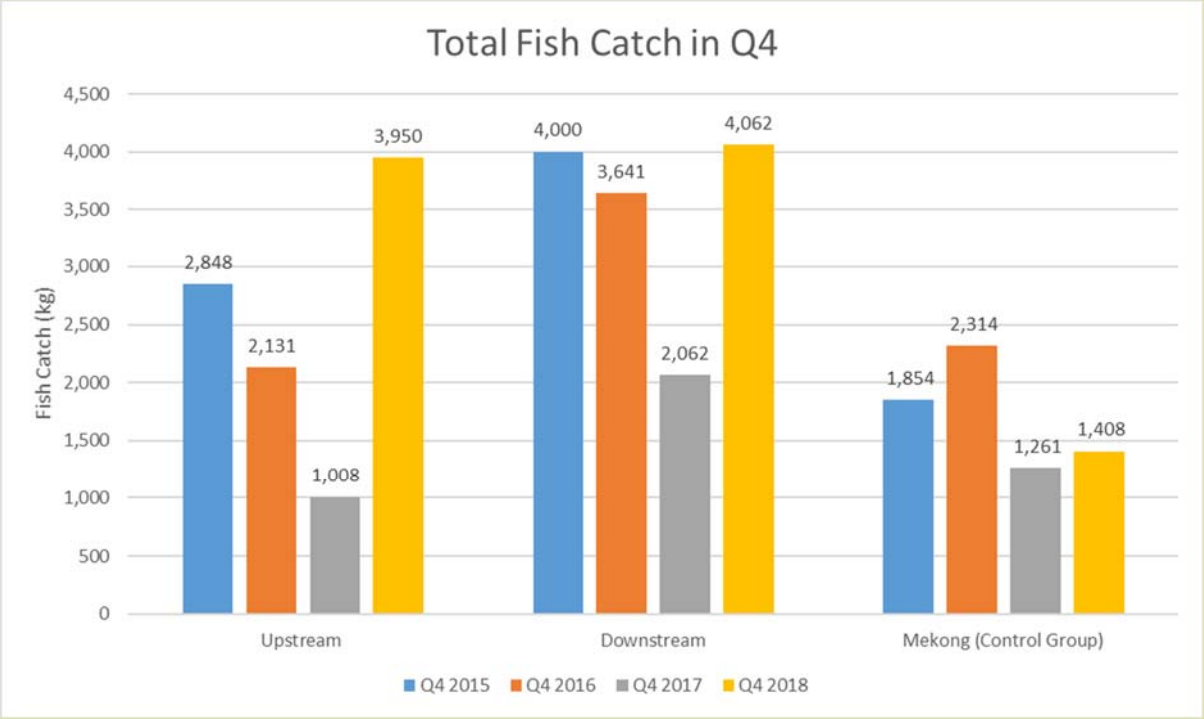



***Table 7-4*** and ***Figure 7-3*** show the total recorded fish catch for Q4 2015, Q4 2016, Q4 2017 and Q4 2018 by the upstream (excluding Zone 2LR), downstream and the Mekong control group fishing households. Both the monthly data (***Figure 7-1***) and the quarterly data in (***Table 7-4*** and ***Figure 7-2***) indicate an increasing total amount of fish caught in the upstream and downstream areas in Q4 2018 while there does not seem to be any clear tendency for the Mekong Control Group.

**TABLE 7-4: TOTAL RECORDED FISH CATCH IN Q1 BY UPSTREAM (EXCLUDING ZONE 2LR), DOWNSTREAM AND BY THE MEKONG CONTROL GROUP FISHING HOUSEHOLDS**

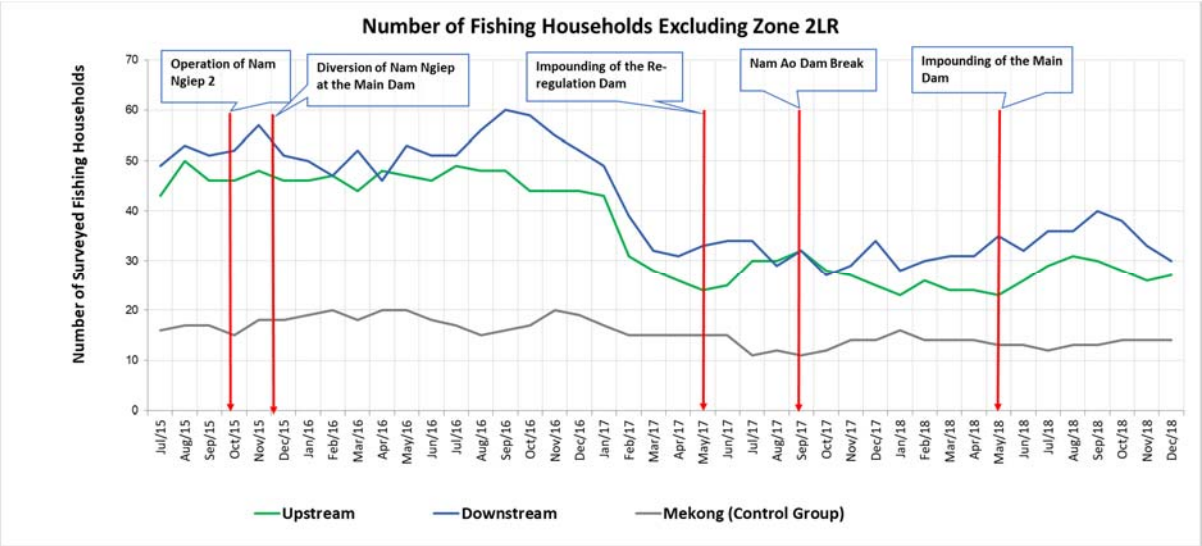
| | Q4 2015 (kg) | Q4 2016 (kg) | Q4 2017 (kg) | Q4 2018 (kg) |
|---|---|---|---|---|
| Upstream | 2,848 | 2,131 | 1,008 | 3,950 |
| Downstream | 4,000 | 3,641 | 2,062 | 4,062 |
| Mekong Control Group | 1,854 | 2,314 | 1,261 | 1,408 |

**FIGURE 7-2: *TOTAL RECORDED FISH CATCH IN Q4 BY UPSTREAM (EXCLUDING ZONE 2LR), DOWNSTREAM AND MEKONG CONTROL GROUP FISHING HOUSEHOLDS***




The number of fishing households included in the survey over the survey period from 2015 to 2018 is indicated in the graph in Figure 7-3. The numbers of fishing households remained relatively constant from the start of the programme in July 2015 until sometime around January/February 2017, when the numbers – both upstream and downstream dropped markedly and have remained at a lower number up until December 2018.

**FIGURE 7-3 NUMBER OF FISHING HOUSEHOLDS 2015-2018**

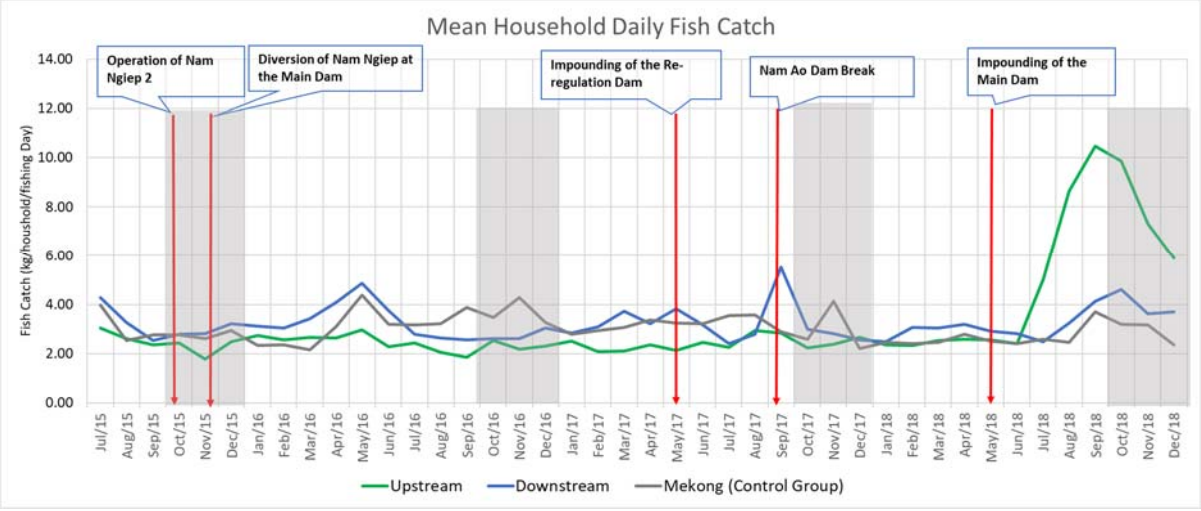


When also considering the number of fishing households involved in the monitoring programme and the number of fishing days, the picture is similar. This is presented in ***Table 7-5*** where the mean household fish catch per fishing day for Q4 2015, Q4 2016, Q4 2017 and Q4 2018 in the upstream (excluding Zone 2LR), downstream and the Mekong Control Group are displayed, and in ***Figure 7-4*** which shows the mean monthly household fish catch per fishing day from July 2015 to December 2018.

**TABLE 7-5: MEAN HOUSEHOLD FISH CATCH PER FISHING DAY IN Q4 2016, Q4 2017 AND Q4 2018**

| Fishing Zone | Q4 2015 (kg) | Q4 2016 (kg) | Q4 2017 (kg) | Q4 2018 (kg) |
|---|---|---|---|---|
| Upstream (Excluding Zone 2LR) | 2.2 | 2.3 | 2.4 | 7.7 |
| Downstream | 2.9 | 2.8 | 2.8 | 4.0 |
| Mekong (Control Group) | 2.8 | 3.7 | 3.0 | 2.9 |

**FIGURE 7-4: MEAN HOUSEHOLD DAILY FISH CATCH (EXCLUDING ZONE 2LR)**




To test whether there are any significant differences among the quarterly mean household fish catch per fishing day for each fishing zone, one-way ANOVA (analysis of variance) statistical tests have been performed on the data from each fishing zone. The null-hypothesis is that the sample means are equal, and the alternative hypothesis is that at least one of the means is statistically different. The level of significance is set to 0.05 (5%). The results of the one-way ANOVA tests are presented in ***Table 7-6.***

**TABLE 7-6: RESULTS OF ONE-WAY ANOVA TESTS ON MEAN HOUSEHOLD FISH CATCH IN Q4**

| Fishing Zone | F-Statistic | *P*-value | F-Critical | Significance |
|---|---|---|---|---|
| Upstream | 5.315 | 0.001 | 2.626 | Significant |
| Downstream | 9.257 | $5.68*10^{-6}$ | 2.622 | Highly Significant |
| Mekong Control Group | 0.626 | 0.599 | 2.653 | Not Significant |

The rule for interpreting the results of an ANOVA test is that if the F-statistic is lower than the F-Critical value then this supports that the null-hypothesis cannot be rejected (same if the *p*-value is greater than the significance level). The results of the ANOVA tests in ***Table 7-6*** indicates that the Mekong Control Group Q4 means for the years from 2015 to 2018 are not significantly different, while the upstream and downstream Q4 2018 means are significantly different from their respective preceding Q4 means.

Further statistical analyses will be carried out when longer time series become available to identify any significant trends or variations after impounding the main reservoir.

# 8 EXTERNAL MONITORING

## 8.1 INDEPENDENT ADVISORY PANEL

The Independent Advisory Panel (IAP) carried out their 12th mission to NNP1 from 9-16 December 2018. This visit was held concurrently with the ADB.

With respect to environmental issues, the IAP noted progress in several areas during the site visit:

- The recommendations of the IAP continue to be implemented effectively.
- The NNP1PC management team is providing strong leadership for implementation of environment and social activities.
- The IAP is pleased to note that NNP1PC is participating in coordinating development and investments in the Nam Ngiep basin in collaboration with MONRE.
- There has been significant progress at the NC-NX offset site under the pre-BOMP activities and additional surveys of forest types and trapping activities.
- Integration of the watershed and reservoir management plans is consistent with the fact that there is one overall Watershed and Reservoir Management Committee and one consolidated draft regulation for the watershed and reservoir prepared for Xaysomboun, (XSB) Province, which has jurisdiction over most of the sub-catchment and responsibility for watershed management, has now been reallocated to the provincial agriculture and forestry office

The IAP expressed concern about the following environmental challenges that NNP1PC is facing:

- ADB and IAP discovery of road building into the Nam Ngiep watershed.
- Since the last IAP mission in May 2018, there have been further delays in finalising and approving the Watershed Management Plan (WMP). The Plan originally was due in

January 2018 but has had several updates to reflect adjustments to the boundaries of the TPZs and additional information from field surveys on key species.

- Both the existing WMP and RMP recommend patrol activities in the watershed with joint teams supported by the Company and province but none have started yet in the field.
- NNP1PC recruited a biodiversity consultant to work part-time in-house with the Biodiversity and Environment Teams and produce a draft BOMP for activities in NC-NX over a 10-year period.
- ADB has agreed to contribute US$5 million toward recruiting TA from an international organization to support biodiversity activities in the reservoir catchment area and at the offset site at NC-NX.

The IAP report is published on NNP1PC's website:
https://namngiep1.com/resources/external-monitoring-reports/

## 8.2 GOL Environmental Management Unit

The monthly inspection by the Environmental Management Unit (EMU) of Bolikhamxay Province was conducted during 26 - 27 September 2018. During this inspection, the EMU was concerned about the heavy concrete foundations at the aggregate crushing plant and the RCC Plant. EMO addressed EMU's comments in the Project's Site Decommissioning and Rehabilitation Plan that was discussed with the principal Contractors in September 2018 and will be followed up by EMO in the Q4.

The quarterly site inspection by the Environmental Management Unit (EMU) of Xaysomboun Province was carried out on 25 September 2018. This visit focused mainly on the reservoir water quality monitoring. The EMU did not raise any concerns during their mission.

# APPENDICES

## APPENDIX 1: STATUS OF SS-ESMMPS REVIEW AND APPROVAL DURING Q4 2018

| No | Site name | List of ESMMP and SS-ESMMP | Subcontractor | Approval Status by EMO/NNP1 (date) | Detailed Site Information | Monthly Construction & Operation Status |
|---|---|---|---|---|---|---|
| 1 | Main Powerhouse and Re-regulation dam powerhouse | Site Specific Environmental & Social Management and Monitoring Plan (SS-ESMMP) for Installation of Cable Pit Cover at Main Power Station and Construction of Concrete Foundation for Fence and AC Power Source Box for 115 KV Switchyard at Regulating Power Station | EMWC | No objection with no further comment on 29 October 2018 | Installation of Cable Pit Cover at Main Power Station and Construction of Concrete Foundation for Fence and AC Power Source Box for 115 KV Switchyard at Regulating Power Station | Completed |
| 2 | Spoil Disposal area on the Left Bank | SS-ESMMP for Spoil Disposal on the Left Bank | Song Da5 | No objection with comment on 29 November 2018 | Disposal of spoil from the plunge pool excavation | On-going |
| 3 | Main Dam | SS-ESMMP for Main Dam Excavation | Song Da5 | No objection with comment on 04 December 2018 | Plunge pool excavation | On-going |
| 4 | KENBER Camp | Site Decommissioning and Rehabilitation Plan | KENBER | Closed | Main Dam grouting works | Completed |

**APPENDIX 2: ENVIRONMENTAL MONITORING CORRECTIVE ACTIONS Q4-2018**

| Issue ID | Inspection Date | Site Name | Issue/Description | Action Required/Recommendation | Deadline | Latest Follow- up Date | Status |
|---|---|---|---|---|---|---|---|
| ONC_HM-018 | 16.10.2018 | ZHEFU Camp | Improper maintenance for food waste and oil traps resulting in a release of food waste and oil to the wastewater treatment system During the previous bi-weekly joint site inspection on 25 September 2018, EMO instructed the contractor to improve food waste and oil trap, but no proper corrective action was undertaken. | 1. Provide proper screen / filter at the inlet of washing area to ensure any food waste is properly collected; 2. Provide daily clean-up of food waste and oil from the oil trap to minimize a release of food waste and oil to the treatment system;<br>3. Provide at least 02 waste bins at worker accommodation | 19.10.2018 | 27.11.2018 | |
| ONC_HM-019 | 16.10.2018 | ZHEFU Camp | Insufficient number of waste bins provided on at workers' camp and accommodation Garbage was disposed and scattered on the slope outside of camp perimeter Additionally, burning mixed waste was observed on site | 1. Collect the scattered garbage and proper dispose at NNP1 project landfill;<br>2. Stop burning waste within and around the camp. Any waste generated on site shall be segregated / managed and dispose by following the NNP1 project's waste disposal hierarchy (Reduce, | 19.10.2018 | | |

| Issue ID | Inspection Date | Site Name | Issue/Description | Action Required/Recommendation | Deadline | Latest Follow- up Date | Status |
|---|---|---|---|---|---|---|---|
| | | | | re-use, Recycle and right disposal); 3. Provide the weekly waste management training to staffs. | | | |
| ONC_OC-0283 | 30.10.2018 | Songda5 Camp #1 | Inadequate operation and maintenance of the camp's waste water treatment System:<br>- The reeds in the wetland ponds almost die without maintenance and / or replanting;<br>- Wastewater nearly overflowed to outside<br>- Water circulation system at the chlorination tanks did not work. | Check and maintain the wastewater piping system of the wetland pond to avoid wastewater overflowing to outside;<br>- Immediately fix / repair the air circulation system of the chlorination tanks ;<br>- Clean up the death reeds in the wetland ponds and plan new wetland reeds.P52 | 14.11.2018 | 14.11.2018 | |
| ONC_HM-0291 | 30.10.2018 | OBAYASHI Camp | During the last monthly progress meeting between NNP1PC and OC on 05 October 2018, EMO requested OC to maintain the waste water treatment system (harvest the old reeds , clean up dead vegetation, replant healthy reeds and clean up sludge in the chlorination tank) to | Check and maintain wastewater piping system of wetland ponds to ensure sub-surface wastewater flow to the chlorine contact tank;<br>- Harvest and clean up the old wetland plants and replace / replant new reeds. | 10.11.2018 | 13.11.2018 | |

| Issue ID | Inspection Date | Site Name | Issue/Description | Action Required/Recommendation | Deadline | Latest Follow- up Date | Status |
|---|---|---|---|---|---|---|---|
| | | | ensure it is working properly and that may assist in the treatment of BOD, COD and NH3-N which has been consistently non-compliant with the standard (see attached MOM in the item 5.3).<br>However, there was no corrective action done to improve the operation and maintenance of OC camp's waste water treatment System as per NNP1PC's recommendation | - Maintain the operation of water circulation system at the collection pond and chlorination tank. | | | |
| ONC_VSP-0010 | 06.11.2018 | VSP Camp | Electricity generator was placed on the bare ground without oil spill protection tray. As a result, oil spillage has occurred during refuelling and caused soil contamination. | Clean-up contaminated soil from the refuelling area immediately and store in the hazardous material storage area at VSP camp for proper disposal/ elimination; Provide oil spill protection tray and the tray must be always used during the operation of electricity generator. | 13.11.2018 | 20.11.2018 | |

| Issue ID | Inspection Date | Site Name | Issue/Description | Action Required/Recommendation | Deadline | Latest Follow- up Date | Status |
|---|---|---|---|---|---|---|---|
| NCR_IHI-0001 | 06.11.2018 | IHI Metal Workshop | On 02 November 2018, during the scheduled camp's effluent monitoring and sampling conducted by the EMO-Water Quality Monitoring team, the black and grey water was observed to seep from the wastewater collection tank.<br>- On 05 November 2018, EMO-Compliance team visited the 276 camp and found out that a thick concrete wall of black/ grey water collection tank was drilled in two holes to intentionally release the wastewater to the nearby drainage canals without prior treatment.<br>- Whilst on site, EMO could not find any subcontractor's staff who could talk to fix the holes. Therefore, EMO emailed the representative of IHI Contractor to inform on the non-compliant issue and stop direct wastewater discharge from 276 camp immediately. | Stop direct wastewater discharge immediately and seal the holes to avoid future discharges. The wastewater can then retained in the septic tank and treated properly before discharging;<br>- Train the subcontractor's staff on the environmental awareness and remind them to not repeating this practice. The training record shall be submitted to EMO as part of the Contractor's response on the corrective actions;<br>- Install chlorination mixing container and water circulation system for the chlorination tank; and<br>- Referring the NNP1PC's comments to the document Ref. no. 0-0065 dated 23 January 2018, please revise such pending comments and incorporate | 15.11.2018 | 25.12.2018 | **Pending**<br><br>Rejected the response letter on 21 December 2018 of contractor's proposed corrective action for revision and provides more information in term of preventive measures. |

| Issue ID | Inspection Date | Site Name | Issue/Description | Action Required/Recommendation | Deadline | Latest Follow- up Date | Status |
|---|---|---|---|---|---|---|---|
| | | | On 06 November 2018, EMO followed up the corrective action and noted that such direct wastewater discharge was stopped by the 276 subcontractor.<br>- The discharged wastewater sample was analysed by EMO at the Environmental Laboratory on site and the result of the wastewater discharge reveals very high bacteria | the as-built drawing of the wastewater treatment system for NNP1PC's final review and approval. | | | |
| NC_OC-0026 | 06.11.2018 | Main Dam Workshop | "1. With reference to the 2nd submission of the DWP and SS-ESMMP for the Main Dam body (Ref: PCL-02234 dated 10 June 2016), the Contractor proposed and confirmed that the Spoil Disposal Area No. 2 would no longer be used for the disposal of spoil, but would be used by Song Da5 as a "Main Dam Workshop".<br>2. On 04 July 2017, NNP1-EMO reported a non-compliance | The Contractor is required to implement the following corrective actions:<br>- Immediately stop the disposal of spoil and any types of waste at the site;<br>- Improperly disposed waste shall be segregated and disposed of in accordance to the NNP1PC waste management policy and the ESMMP-CP;<br>- Recheck the area for proper boundary and | 29.11.2018 | 29.11.2018 | The actual corrective action was done, however, **Pending** official response letter from the contractor. |

| Issue ID | Inspection Date | Site Name | Issue/Description | Action Required/Recommendation | Deadline | Latest Follow- up Date | Status |
|---|---|---|---|---|---|---|---|
| | | | issue for the main dam workshop (former Spoil Disposal Area No.2) (ref. No.: NNP1-ESD-EMO-NCR-OC-0021), about the continuation of new spoil disposal from the main dam body and waste dump. In the said non-compliance report, NNP1-EMO instructed the Contractor to:<br>- Stop disposing spoil on this site. New spoil shall be disposed of at the designated Spoil Disposal No. 6 as per the approved DWP & SS-ESMMP for the Main Dam Body;<br>- Stop all waste disposal on the site including hazardous waste, construction and general waste. Waste shall be segregated and disposed of in accordance with the waste management policy and the ESMMP-CP of NNP1PC; and<br>- Collect and segregate the disposed wastes on the slope for proper disposal at the | install proper signage;<br>- Prepare engineering drawings covering the entire Spoil Disposal Area No. 2 including the extension and the drainage system and submit the drawings to NNP1PC for approval. After obtaining an approval, implement the engineering design;<br>- Dispose spoil at the designated Spoil Disposal Area No. 6.<br>- Should there be changes to the previous approval, submit a request to NNP1PC to approve the use and dispose of spoil from a particular activity at the Spoil Disposal Area No 2. Such request shall include: i) more details on the estimated spoil volume and types of materials; ii) confirmation that the remaining area is sufficient | | | |

| Issue ID | Inspection Date | Site Name | Issue/Description | Action Required/Recommendation | Deadline | Latest Follow- up Date | Status |
|---|---|---|---|---|---|---|---|
| | | | landfill, Spoil Disposal Area No. 6 or authorized vender.<br>On 14 November 2018 during a routine site inspection of the main dam workshop (former spoil disposal area No.2), EMO observed that additional spoil had been disposed at the site with unknown source and volume, together with construction waste contained in big plastic bags and general waste (visible at the side-slopes as indicated on the pictures below).<br>EMO observed that the side drainage has been blocked by spoil and construction wastes and that water is ponding at the tip of the disposal site indicating that the drainage system is not functioning as it should. | and spoil can be stabilized; iii) justifications that the spoil disposal is cost effective compared to the disposal at Spoil Disposal Area No. 6; and iv) an updated SS-ESMMP for Spoil Disposal Area No. 2 with explanations on management measures and revised engineering drawings as well as attaching a completed Site Decommissioning and Rehabilitation;<br>- Submit a report to NNP1PC documenting the completion of the corrective actions. | | | |
| NCR-HM-0005 | 20.12.2018 | HM Hydro Main Camp & Office | | The Contractor (HM Hydro) is required to take the following actions:<br>- Stop the direct waste | 04.01.2019 | Not Available | Pending |

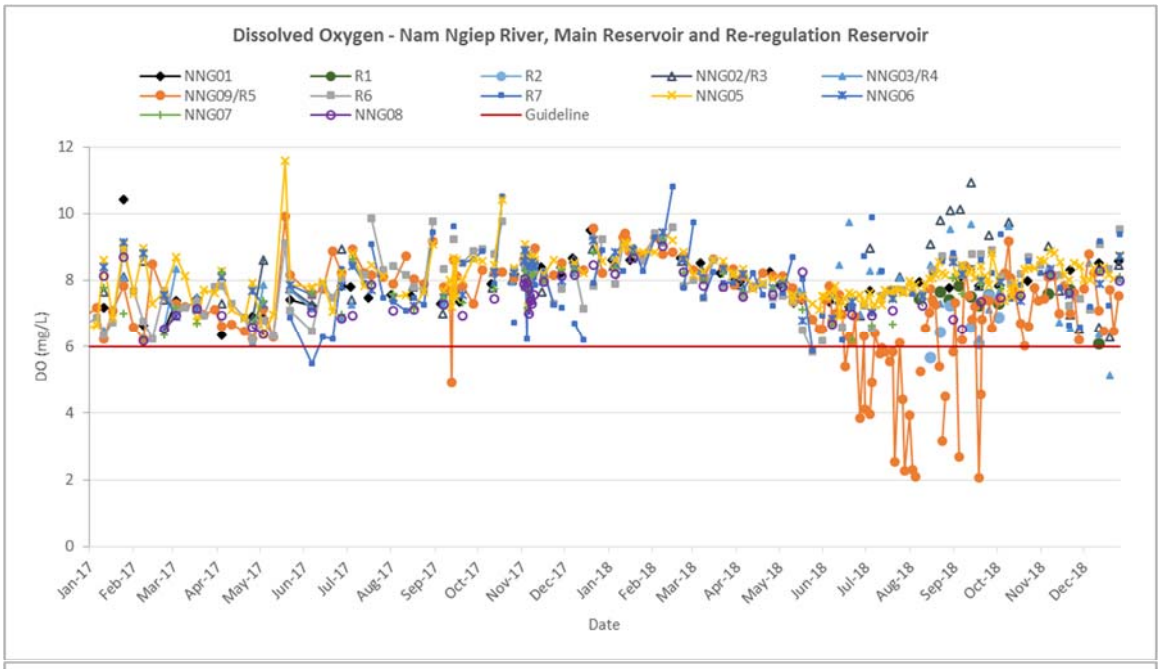
| Issue ID | Inspection Date | Site Name | Issue/Description | Action Required/Recommendation | Deadline | Latest Follow- up Date | Status |
|---|---|---|---|---|---|---|---|
| | | | | water discharge immediately during the time of inspection<br>- Provide explanation about the root cause of this second misconduct for the operation of the WWTS as well as the preventative measures to avoid repeating this issue in the future.<br>- Provide a schedule and procedure of the WWTS operation for EMO reference and monitoring. | | | |

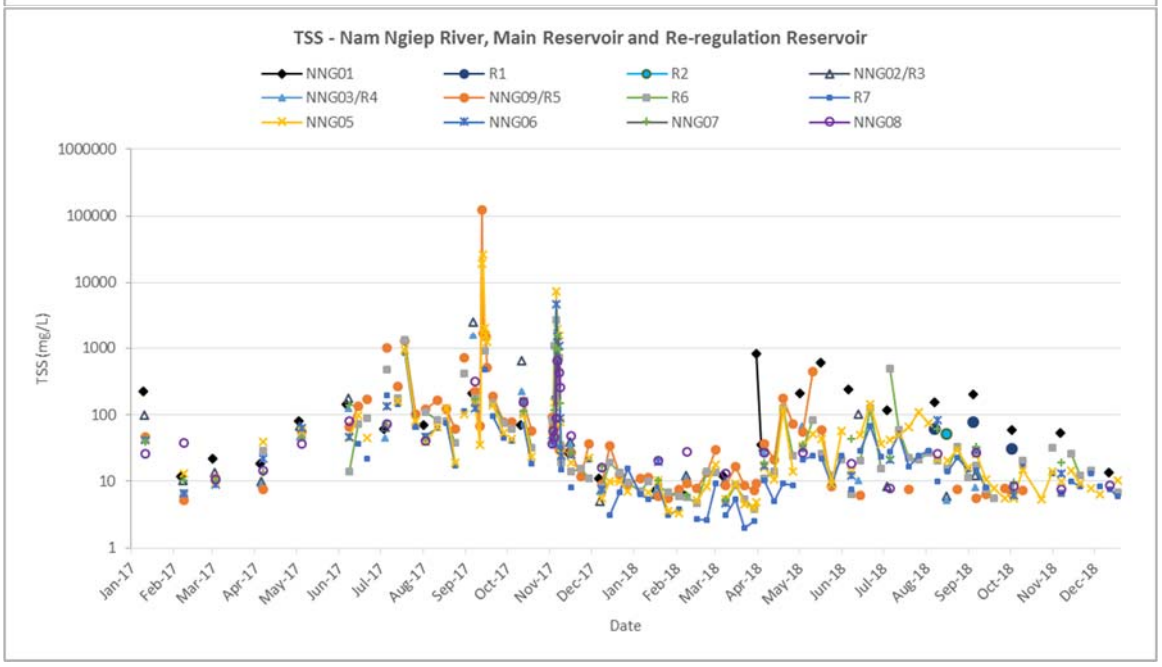
## APPENDIX 3: CODES AND LOCATIONS OF THE SURFACE WATER QUALITY MONITORING STATIONS

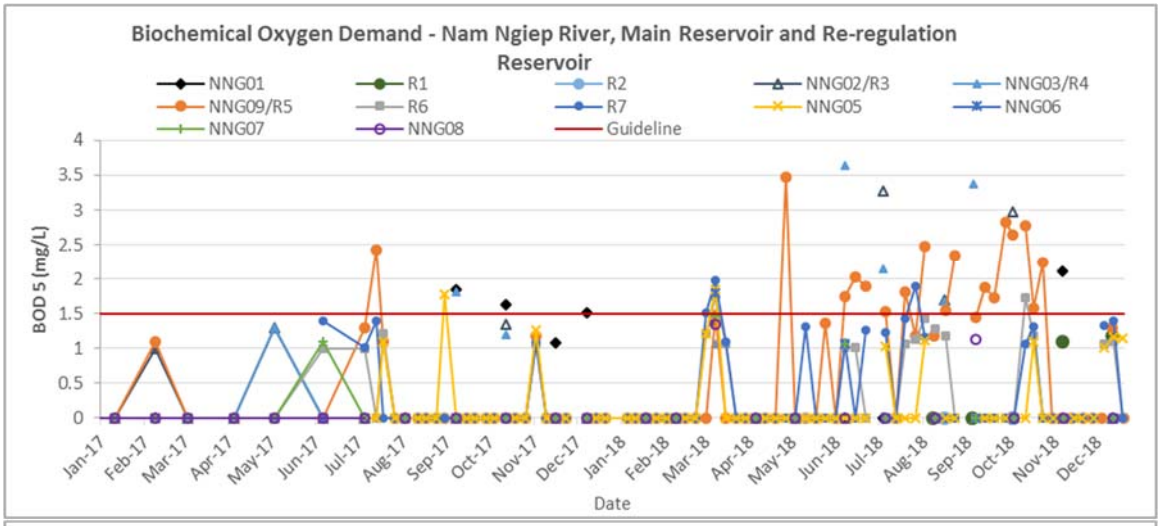
| Site Code | Location station | Zone |
|---|---|---|
| NNG01 | Nam Ngiep Upstream of Ban Phiengta | Upstream Project Construction Site |
| R1 | Main reservoir upstream main dam approx. 50 Km. | |
| R2 | Main reservoir upstream main dam approx. 35 Km. | |
| NNG02/R3 | Nam Ngiep Upstream of Nam Phouan Confluence / Main reservoir upstream main dam approx. 21 Km. | |
| NNG03/R4 | Nam Ngiep Downstream of Ban Sop-Yuak / Main reservoir upstream main dam approx. 13 Km. | |
| NNG09/R5 | Nam Ngiep Upstream Main Dam / Main reservoir upstream main dam approx. 0.5 Km | |
| NNG04 / R6 | Nam Ngiep Downstream RT Camp (Middle Re-regulation Reservoir) | Within Project Construction Site |
| R7 | Reservoir Upstream Re-Regulation Dam | |
| NNG05 | Nam Ngiep Upstream of Ban Hat Gniun | Downstream Project Construction Site |
| NNG06 | Nam Ngiep Downstream of Nam Xao Confluence | |
| NNG07 | Nam Ngiep at Ban Somsuen | |
| NNG08 | Nam Ngiep at the Bridge of Road 13 | |
| NCH01 | Nam Chiane at the Bridge of Road 1D | Tributaries Upstream of Project Construction Site |
| NPH01 | Nam Phouan Upstream of Nam Ngiep Confluence | |
| NXA01 | Nam Xao Upstream of Nam Ngiep Confluence | Tributaries Downstream of Project Construction Site |
| NSH01 | Nam Houay Soup Upstream Nam Ngiep Confluence | |

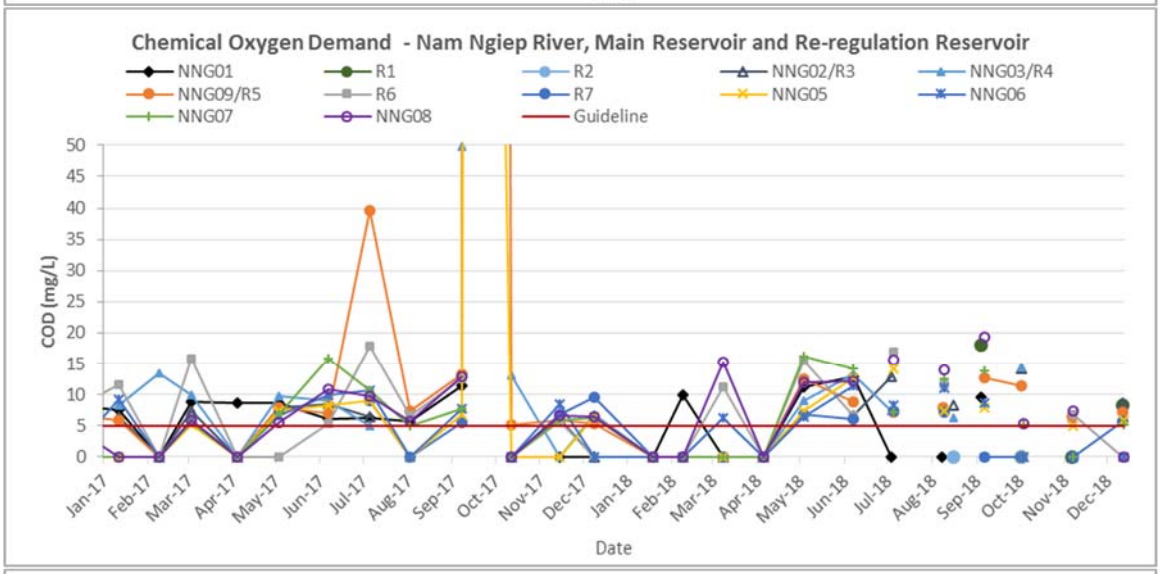
## APPENDIX 4: KEY TRENDS OF WATER QUALITY MONITORING FROM JANUARY 2017 TO END OF DECEMBER 2018 (ONLY PARAMETERS THAT EXCEEDED GUIDELINE STANDARDS)

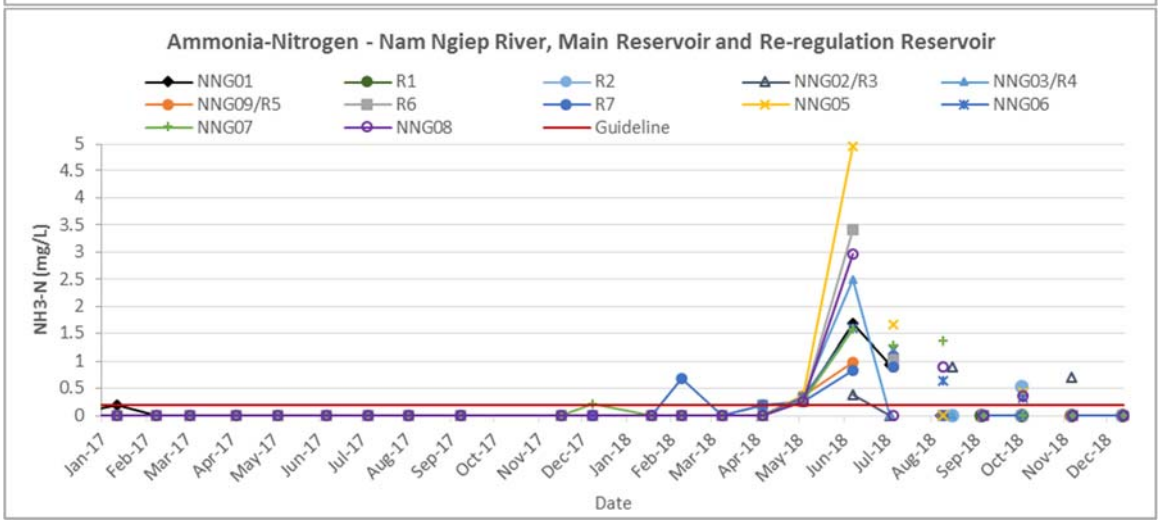
Nam Ngiep Surface Water

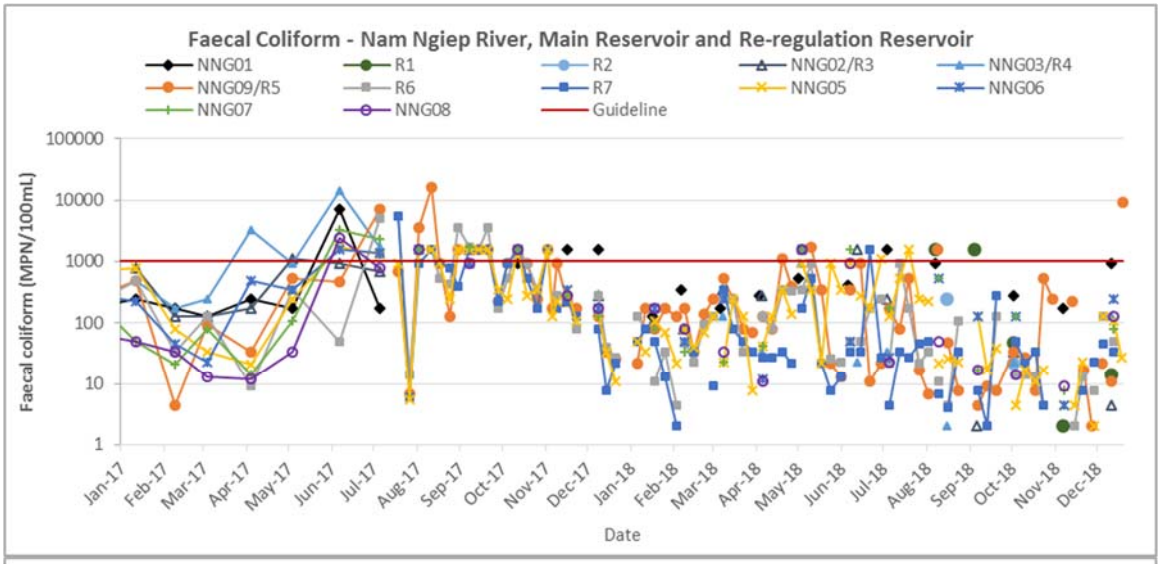


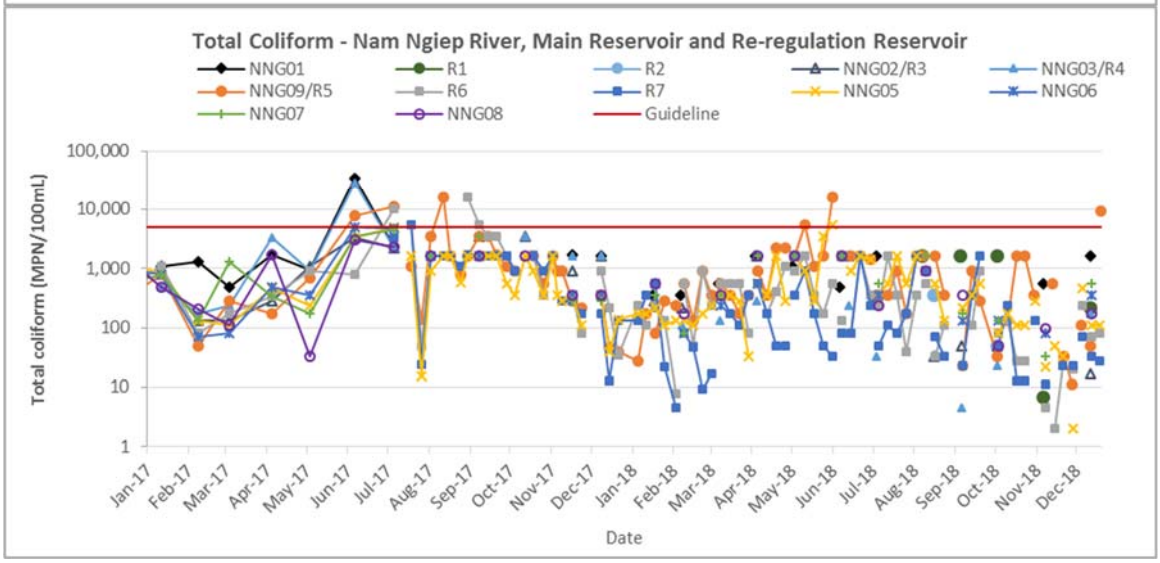




Biochemical Oxygen Demand - Nam Ngiep River, Main Reservoir and Re-regulation Reservoir
NNG01
R1
R2
NNG02/R3
NNG03/R4
NNG09/R5
R6
R7
NNG05
NNG06
NNG07
NNG08
Guideline
BOD 5 (mg/L)
Date

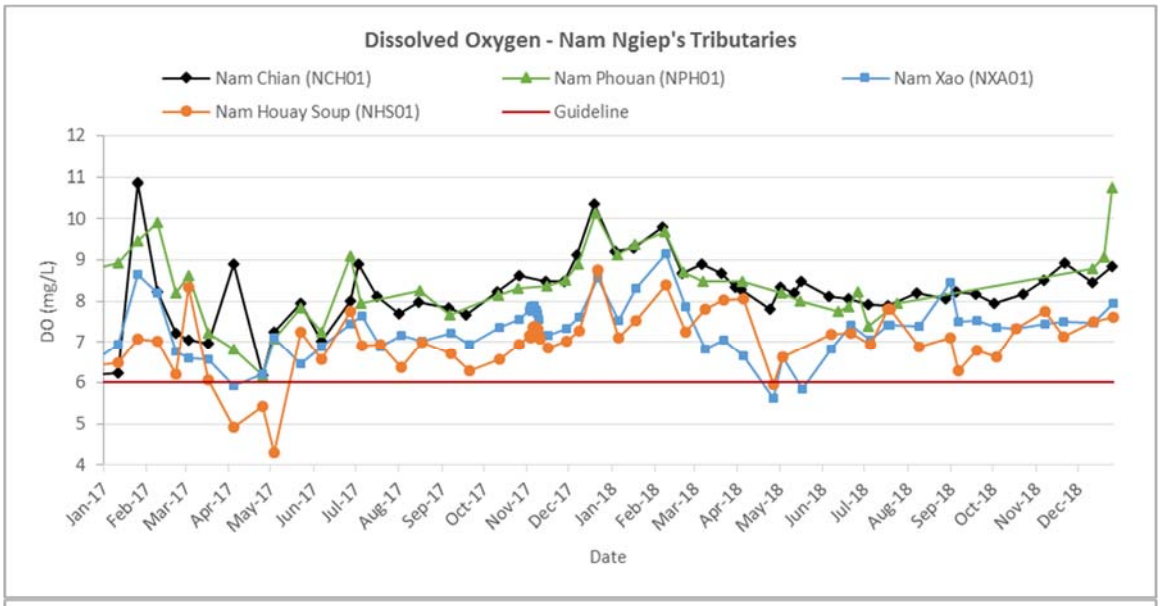

Chemical Oxygen Demand - Nam Ngiep River, Main Reservoir and Re-regulation Reservoir
NNG01
R1
R2
NNG02/R3
NNG03/R4
NNG09/R5
R6
R7
NNG05
NNG06
NNG07
NNG08
Guideline
COD (mg/L)
Date

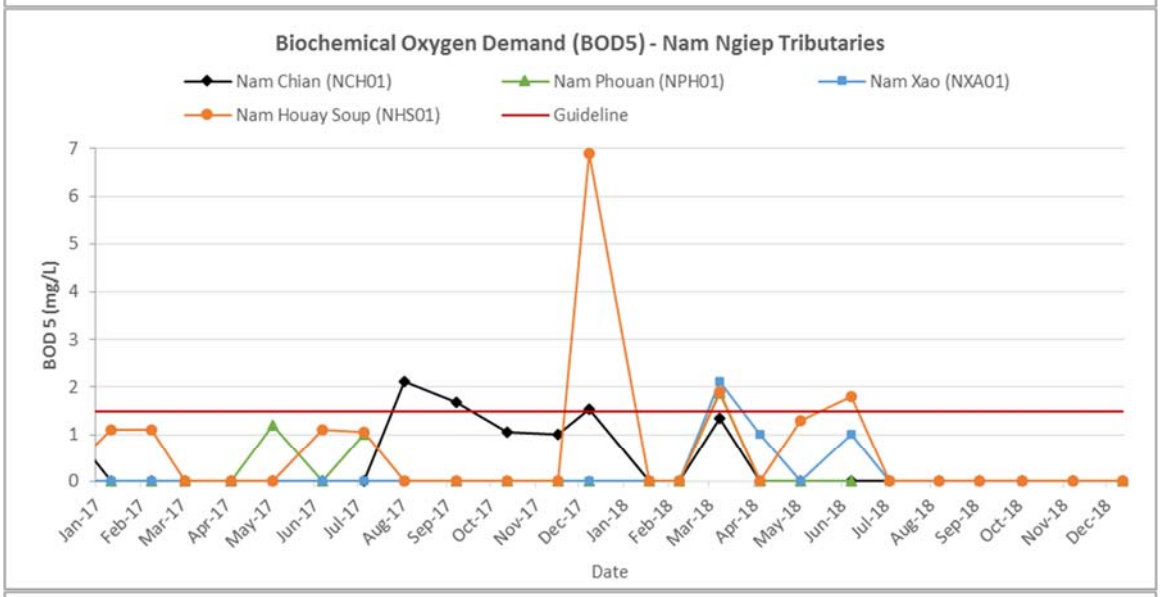

Ammonia-Nitrogen - Nam Ngiep River, Main Reservoir and Re-regulation Reservoir
NNG01
R1
R2
NNG02/R3
NNG03/R4
NNG09/R5
R6
R7
NNG05
NNG06
NNG07
NNG08
Guideline
NH3-N (mg/L)
Date

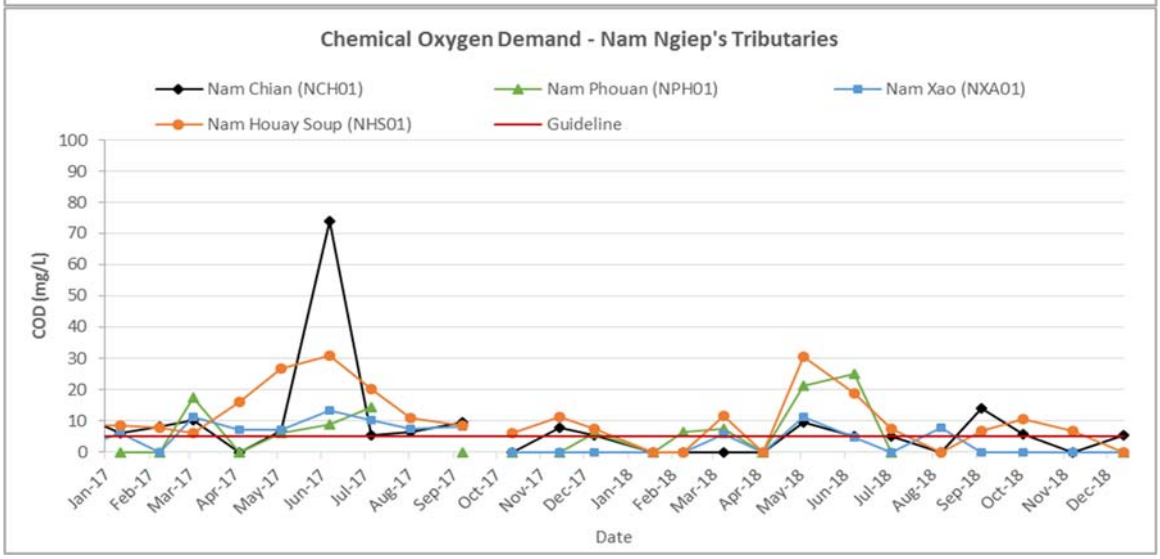

Faecal Coliform - Nam Ngiep River, Main Reservoir and Re-regulation Reservoir
NNG01
R1
R2
NNG02/R3
NNG03/R4
NNG09/R5
R6
R7
NNG05
NNG06
NNG07
NNG08
Guideline
Faecal coliform (MPN/100mL)
100000
10000
1000
100
10
1
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Jan-18
Feb-18
Mar-18
Apr-18
May-18
Jun-18
Jul-18
Aug-18
Sep-18
Oct-18
Nov-18
Dec-18
Date

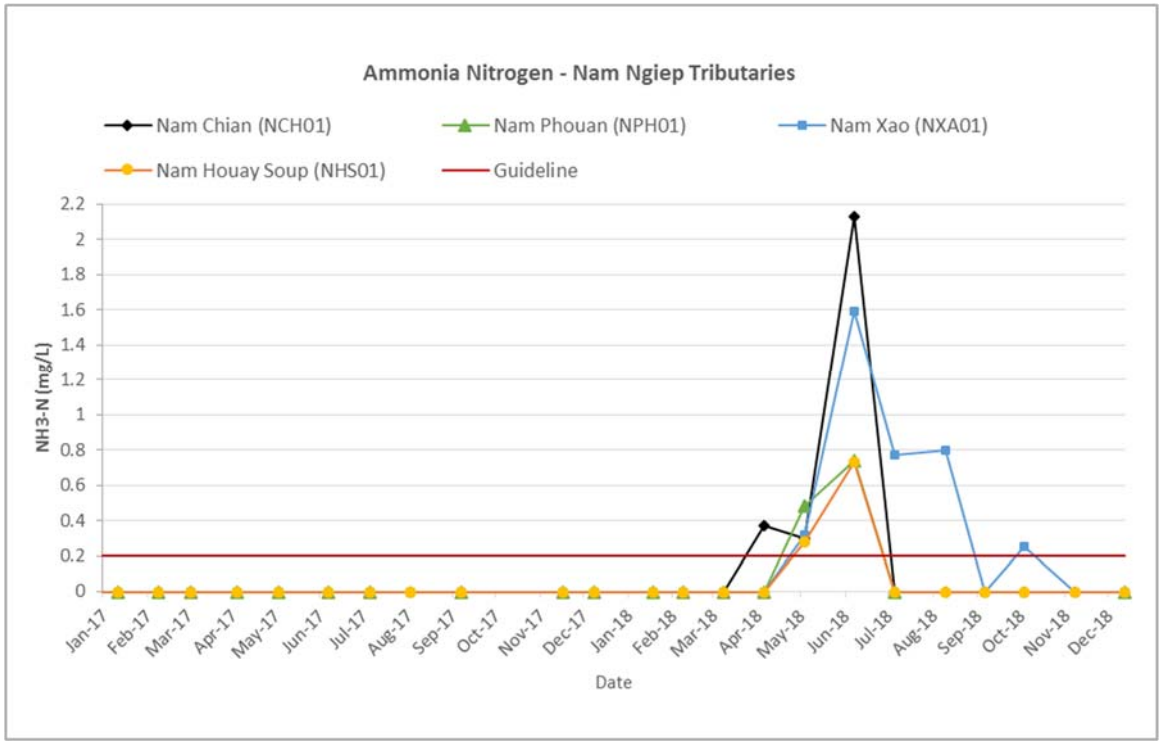

Total Coliform - Nam Ngiep River, Main Reservoir and Re-regulation Reservoir
NNG01
R1
R2
NNG02/R3
NNG03/R4
NNG09/R5
R6
R7
NNG05
NNG06
NNG07
NNG08
Guideline
Total coliform (MPN/100mL)
100,000
10,000
1,000
100
10
1
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Dec-17
Jan-18
Feb-18
Mar-18
Apr-18
May-18
Jun-18
Jul-18
Aug-18
Sep-18
Oct-18
Nov-18
Dec-18
Date

Key Water Quality Parameters for the Nam Ngiep Tributaries: Nam Chian, Nam Phouan, Nam Xao, Nam Houay Soup

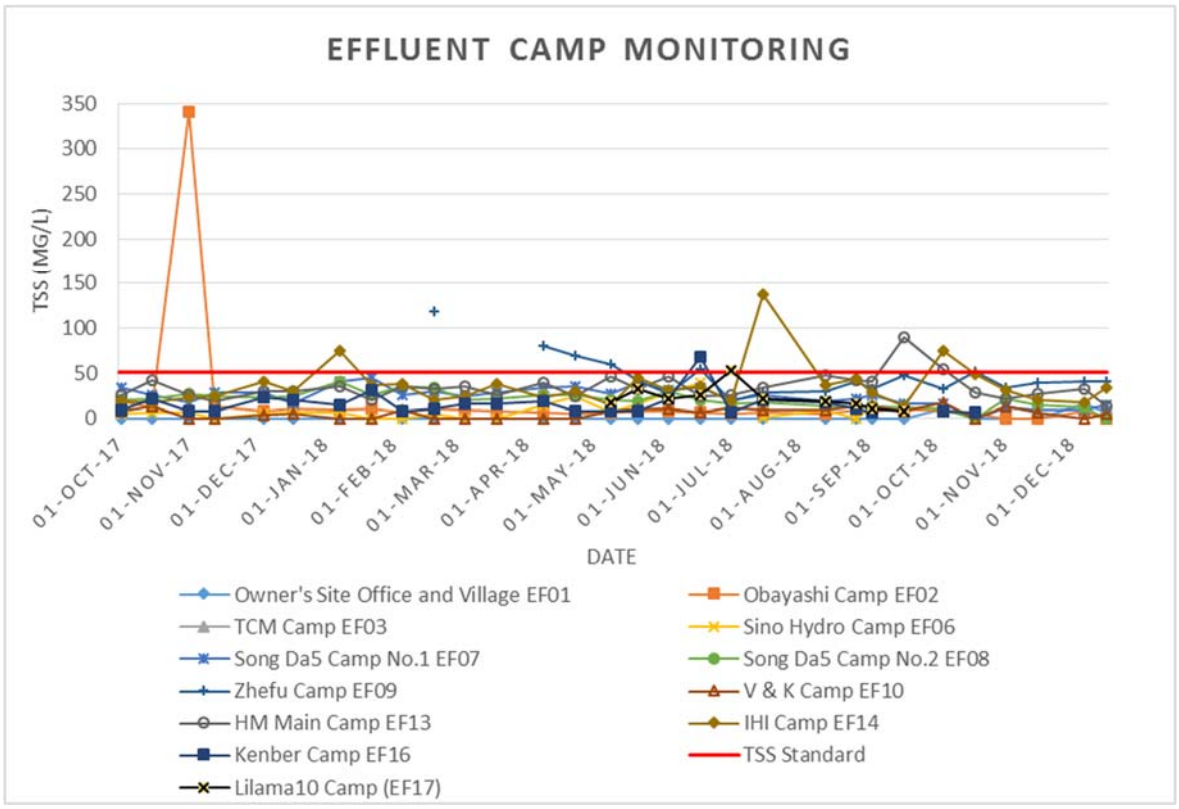


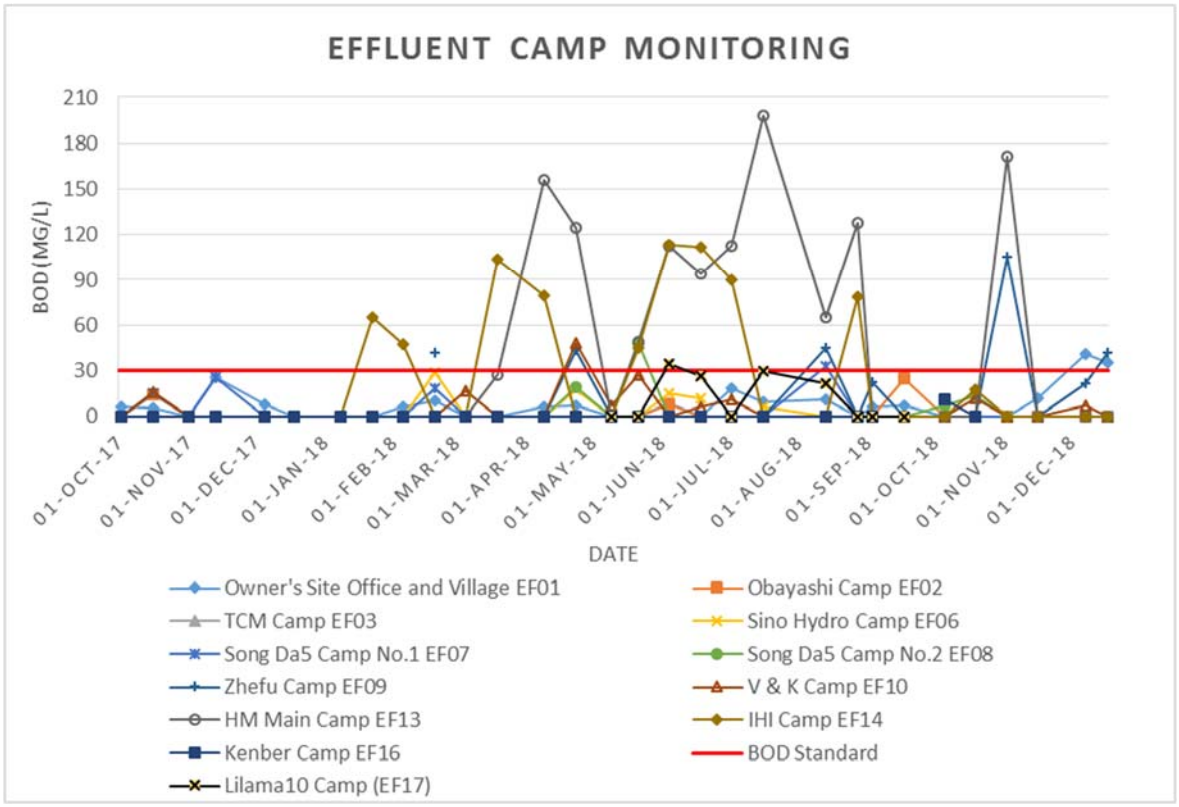



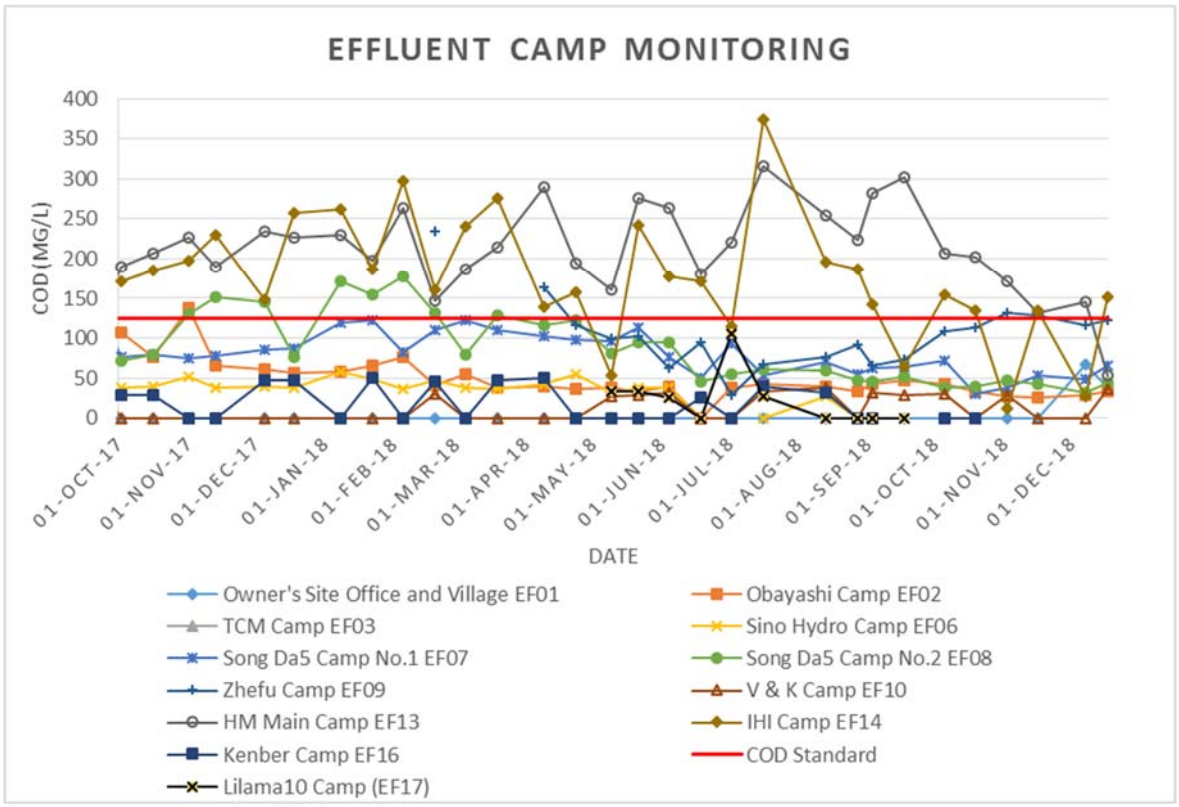



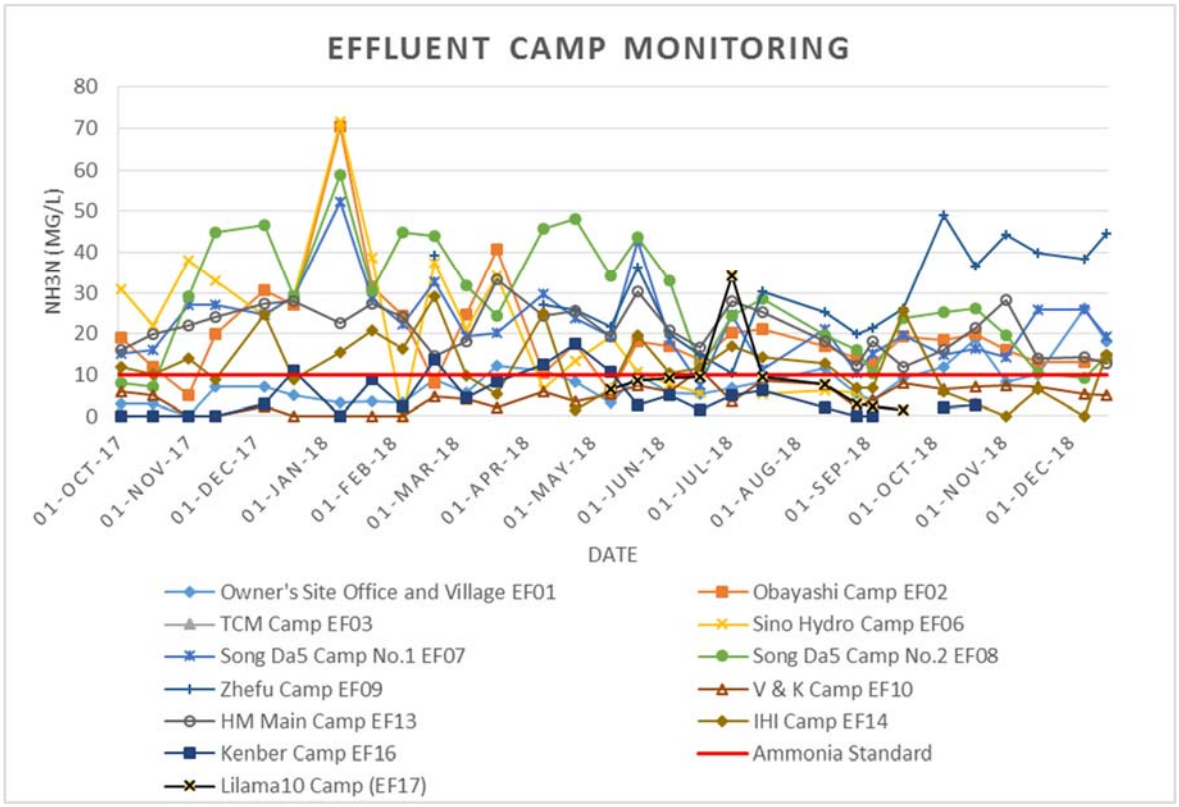


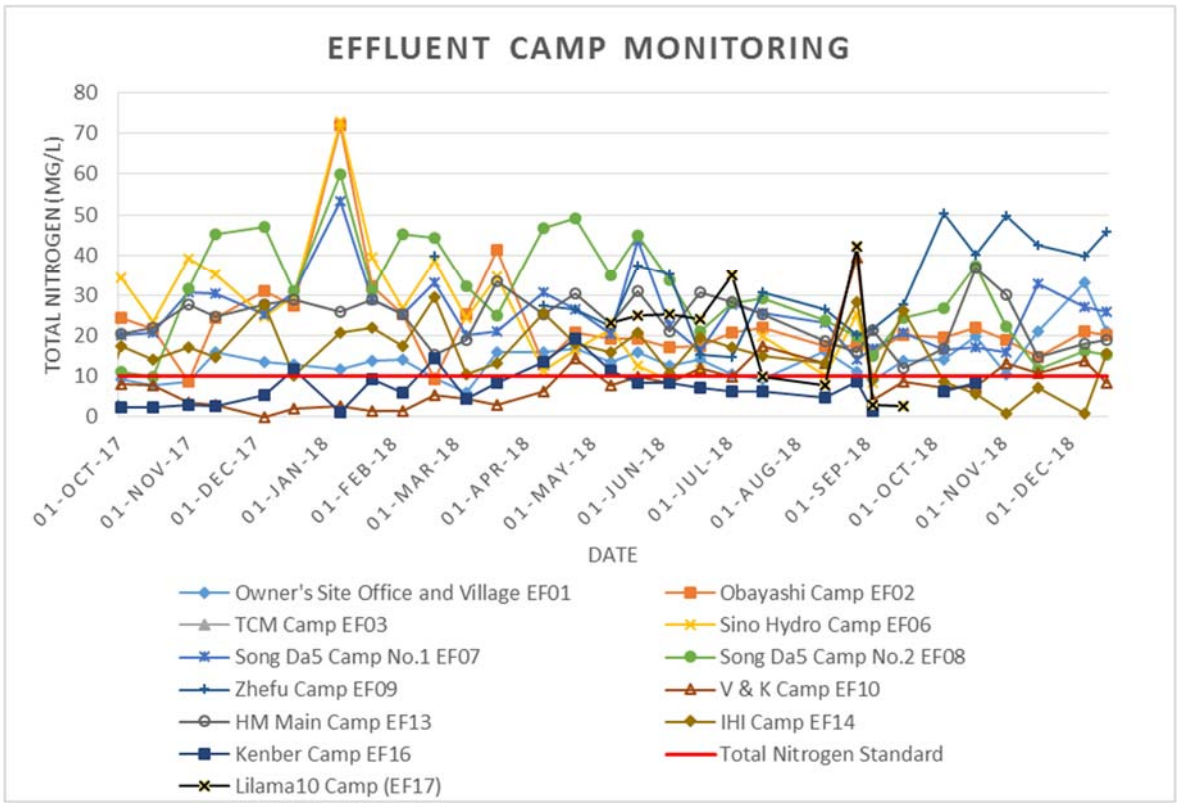

**Camps' Effluent Water Quality Trends (Since October 2017 – December 2018)**

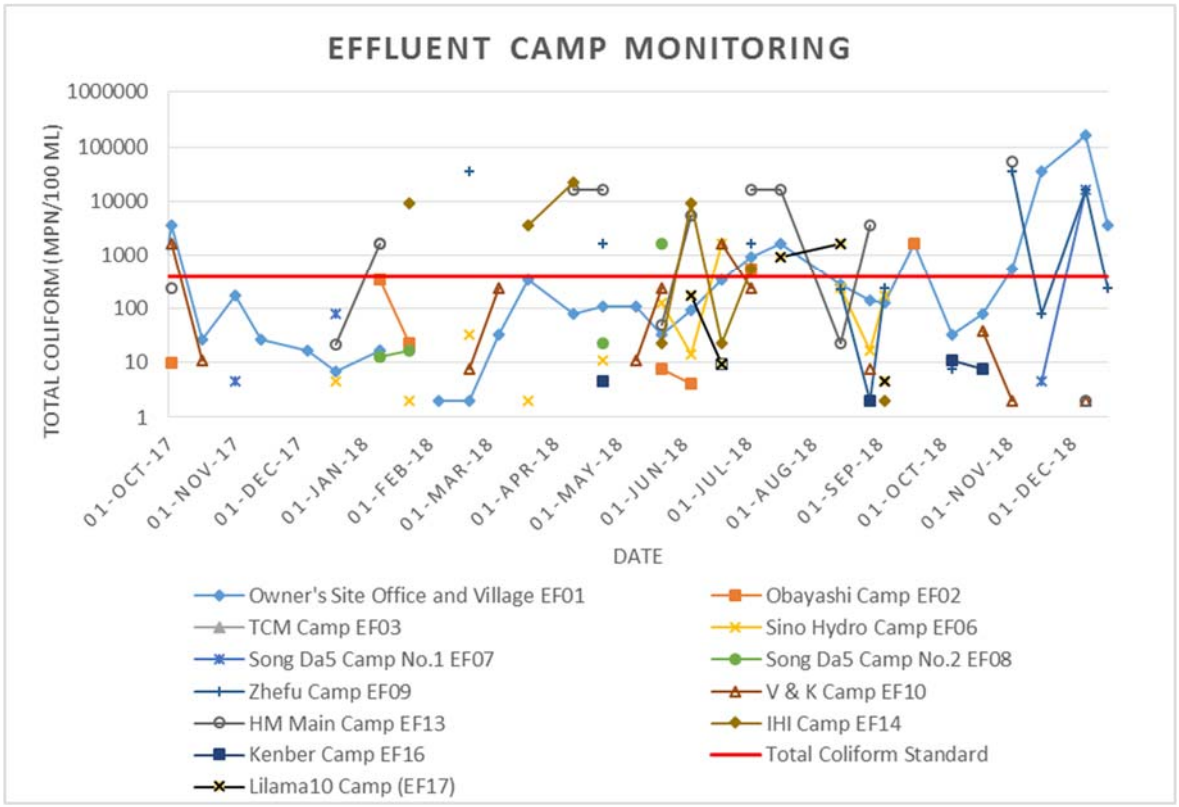



EFFLUENT CAMP MONITORING
BOD (MG/L)
210
180
150
120
90
60
30
0
01-OCT-17
01-NOV-17
01-DEC-17
01-JAN-18
01-FEB-18
01-MAR-18
01-APR-18
01-MAY-18
01-JUN-18
01-JUL-18
01-AUG-18
01-SEP-18
01-OCT-18
01-NOV-18
01-DEC-18
DATE
Owner's Site Office and Village EF01
Obayashi Camp EF02
TCM Camp EF03
Sino Hydro Camp EF06
Song Da5 Camp No.1 EF07
Song Da5 Camp No.2 EF08
Zhefu Camp EF09
V & K Camp EF10
HM Main Camp EF13
IHI Camp EF14
Kenber Camp EF16
BOD Standard
Lilama10 Camp (EF17)


EFFLUENT CAMP MONITORING
COD (MG/L)
400
350
300
250
200
150
100
50
0
01-OCT-17
01-NOV-17
01-DEC-17
01-JAN-18
01-FEB-18
01-MAR-18
01-APR-18
01-MAY-18
01-JUN-18
01-JUL-18
01-AUG-18
01-SEP-18
01-OCT-18
01-NOV-18
01-DEC-18
DATE
Owner's Site Office and Village EF01
Obayashi Camp EF02
TCM Camp EF03
Sino Hydro Camp EF06
Song Da5 Camp No.1 EF07
Song Da5 Camp No.2 EF08
Zhefu Camp EF09
V & K Camp EF10
HM Main Camp EF13
IHI Camp EF14
Kenber Camp EF16
COD Standard
Lilama10 Camp (EF17)


EFFLUENT CAMP MONITORING
NH3N (MG/L)
80
70
60
50
40
30
20
10
0
01-OCT-17
01-NOV-17
01-DEC-17
01-JAN-18
01-FEB-18
01-MAR-18
01-APR-18
01-MAY-18
01-JUN-18
01-JUL-18
01-AUG-18
01-SEP-18
01-OCT-18
01-NOV-18
01-DEC-18
DATE
Owner's Site Office and Village EF01
Obayashi Camp EF02
TCM Camp EF03
Sino Hydro Camp EF06
Song Da5 Camp No.1 EF07
Song Da5 Camp No.2 EF08
Zhefu Camp EF09
V & K Camp EF10
HM Main Camp EF13
IHI Camp EF14
Kenber Camp EF16
Ammonia Standard
Lilama10 Camp (EF17)


EFFLUENT CAMP MONITORING
TOTAL NITROGEN (MG/L)
80
70
60
50
40
30
20
10
0
01-OCT-17
01-NOV-17
01-DEC-17
01-JAN-18
01-FEB-18
01-MAR-18
01-APR-18
01-MAY-18
01-JUN-18
01-JUL-18
01-AUG-18
01-SEP-18
01-OCT-18
01-NOV-18
01-DEC-18
DATE
Owner's Site Office and Village EF01
Obayashi Camp EF02
TCM Camp EF03
Sino Hydro Camp EF06
Song Da5 Camp No.1 EF07
Song Da5 Camp No.2 EF08
Zhefu Camp EF09
V & K Camp EF10
HM Main Camp EF13
IHI Camp EF14
Kenber Camp EF16
Total Nitrogen Standard
Lilama10 Camp (EF17)


EFFLUENT CAMP MONITORING
TOTAL COLIFORM (MPN/100 ML)
1000000
100000
10000
1000
100
10
1
01-OCT-17
01-NOV-17
01-DEC-17
01-JAN-18
01-FEB-18
01-MAR-18
01-APR-18
01-MAY-18
01-JUN-18
01-JUL-18
01-AUG-18
01-SEP-18
01-OCT-18
01-NOV-18
01-DEC-18
DATE
Owner's Site Office and Village EF01
Obayashi Camp EF02
TCM Camp EF03
Sino Hydro Camp EF06
Song Da5 Camp No.1 EF07
Song Da5 Camp No.2 EF08
Zhefu Camp EF09
V & K Camp EF10
HM Main Camp EF13
IHI Camp EF14
Kenber Camp EF16
Total Coliform Standard
Lilama10 Camp (EF17)

# APPENDIX 5: WATER QUALITY MONITORING DATA

## APPENDIX 5-1: SURFACE WATER QUALITY MONITORING – Q4 2018

| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 | NCH 01 | NPH 01 | NXA 01 | NHS 01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Parameters (Unit)** | **Guideline** | | | | | | | | | | | | | | | | |
| 2-Oct-18 | pH | 5.0 - 9.0 | 7.83 | 7.14 | 7.13 | 8.65 | 8.72 | 7.36 | | | 8.0 | | | | 8.38 | | | |
| 3-Oct-18 | pH | 5.0 - 9.0 | | | | | | | 7.23 | 7.24 | 7.89 | 7.88 | 7.86 | 7.24 | | | 7.57 | 7.78 |
| 6-Oct-18 | pH | 5.0 - 9.0 | | | | | | 7.17 | | | 7.74 | | | | | | | |
| 9-Oct-18 | pH | 5.0 - 9.0 | | | | 8.34 | 8.6 | 8.5 | | | | | | | | | | |
| 10-Oct-18 | pH | 5.0 - 9.0 | | | | | | 8.23 | 7.51 | 7.17 | 7.19 | | | | | | | |
| 11-Oct-18 | pH | 5.0 - 9.0 | | | | | | 7.42 | | | 7.22 | | | | | | | |
| 13-Oct-18 | pH | 5.0 - 9.0 | | | | | | 7.81 | | | 7.42 | | | | | | | |
| 17-Oct-18 | pH | 5.0 - 9.0 | | | | | | 7.29 | 7.29 | 7.48 | 7.22 | 7.6 | 7.83 | 7.94 | | | 7.4 | 7.93 |
| 20-Oct-18 | pH | 5.0 - 9.0 | | | | | | 7.39 | | | 7.32 | | | | | | | |
| 22-Oct-18 | pH | 5.0 - 9.0 | 7.9 | | | | | | | | | | | | 8.18 | | | |
| 23-Oct-18 | pH | 5.0 - 9.0 | | | | | | 7.82 | 7.42 | 7.45 | 8.13 | | | | | | | |
| 27-Oct-18 | pH | 5.0 - 9.0 | | | | | | 7.55 | | | 7.67 | | | | | | | |
| 30-Oct-18 | pH | 5.0 - 9.0 | | | | | | 7.87 | | | | | | | | | | |
| 31-Oct-18 | pH | 5.0 - 9.0 | | | | | | | 7.68 | 7.77 | 7.77 | | | | | | | |
| 3-Nov-18 | pH | 5.0 - 9.0 | | | | | | 7.81 | | | 7.93 | | | | | | | |
| 6-Nov-18 | pH | 5.0 - 9.0 | 8 | 7.56 | | 7.58 | 7.82 | 7.65 | | | | | | | 8.65 | | | |
| 7-Nov-18 | pH | 5.0 - 9.0 | | | | | | | 7.65 | 7.8 | 7.84 | 7.99 | 7.94 | 7.68 | | | 7.86 | 7.96 |
| 10-Nov-18 | pH | 5.0 - 9.0 | | | | | | 8.06 | | | 8 | | | | | | | |
| 13-Nov-18 | pH | 5.0 - 9.0 | | | | 8.79 | 7.54 | 7.89 | | | | | | | | | | |
| 14-Nov-18 | pH | 5.0 - 9.0 | | | | | | | 7.52 | 7.89 | 7.98 | | | | | | | |
| 17-Nov-18 | pH | 5.0 - 9.0 | | | | | | 7.52 | | | 7.74 | | | | | | | |
| 20-Nov-18 | pH | 5.0 - 9.0 | | | | | | | 7.48 | 7.64 | 7.47 | 8.07 | 7.83 | 7.96 | | | 7.79 | 7.9 |
| 21-Nov-18 | pH | 5.0 - 9.0 | 8.01 | 7.88 | | 8.01 | 7.97 | 8.06 | | | | | | | 7.87 | | | |
| 24-Nov-18 | pH | 5.0 - 9.0 | | | | | | 7.96 | | | 7.67 | | | | | | | |
| 27-Nov-18 | pH | 5.0 - 9.0 | | | | 8.03 | 7.89 | 7.66 | | | | | | | | | | |
| 28-Nov-18 | pH | 5.0 - 9.0 | | | | | | | 7.91 | 7.87 | 7.93 | | | | | | | |
| 1-Dec-18 | pH | 5.0 - 9.0 | | | | | | 7.86 | | | 7.58 | | | | | | | |
| 4-Dec-18 | pH | 5.0 - 9.0 | | | | | 8.09 | 8.29 | | | | | | | | | | |

| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 | NCH 01 | NPH 01 | NXA 01 | NHS 01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Parameters (Unit)** | **Guideline** | | | | | | | | | | | | | | | | |
| 5-Dec-18 | pH | 5.0 - 9.0 | | | | | | | 7.78 | 7.65 | 7.92 | | | | | | | |
| 8-Dec-18 | pH | 5.0 - 9.0 | | | | | | 8.2 | | | 8.11 | | | | | | | |
| 11-Dec-18 | pH | 5.0 - 9.0 | 6.36 | 7.83 | | 7.6 | 7.43 | 8.2 | | | | | | | 8.07 | 7.71 | | |
| 12-Dec-18 | pH | 5.0 - 9.0 | | | | | | | 7.87 | 7.91 | 7.81 | 7.9 | 6.24 | 6.23 | | | 7.74 | 7.93 |
| 15-Dec-18 | pH | 5.0 - 9.0 | | | | | | 7.57 | | | 7.91 | | | | | | | |
| 18-Dec-18 | pH | 5.0 - 9.0 | | | | | | | 7.78 | 8.39 | 7.93 | | | | | | | |
| 19-Dec-18 | pH | 5.0 - 9.0 | | | | 7.68 | 7.49 | 7.67 | | | | | | | | 8.24 | | |
| 22-Dec-18 | pH | 5.0 - 9.0 | | | | | | 7.04 | | | 7.05 | | | | | | | |
| 25-Dec-18 | pH | 5.0 - 9.0 | 6.75 | | | 7.73 | 7.41 | 7.48 | | | | | | | 6.18 | 8.18 | | |
| 26-Dec-18 | pH | 5.0 - 9.0 | | | | | | | 8.21 | 7.58 | 7.7 | 7.5 | 7.27 | 7.12 | | | 7 | 6.99 |
| 2-Oct-18 | Sat. DO (%) | | 97.2 | 86.9 | 88 | 107.8 | 103.5 | 96.6 | | | 100.1 | | | | 98.9 | | | |
| 3-Oct-18 | Sat. DO (%) | | | | | | | | 98.8 | 114.7 | 100.4 | 100 | 98.9 | 96.5 | | | 92.7 | 84.5 |
| 6-Oct-18 | Sat. DO (%) | | | | | | | 113.9 | | | 94.1 | | | | | | | |
| 9-Oct-18 | Sat. DO (%) | | | | | 129.2 | 127.5 | 120.9 | | | | | | | | | | |
| 10-Oct-18 | Sat. DO (%) | | | | | | | 104.5 | 98.3 | 95.6 | 98.6 | | | | | | | |
| 11-Oct-18 | Sat. DO (%) | | | | | | | 99.6 | | | 96.1 | | | | | | | |
| 13-Oct-18 | Sat. DO (%) | | | | | | | 102.3 | | | 102.4 | | | | | | | |
| 17-Oct-18 | Sat. DO (%) | | | | | | | 88 | 101.3 | 102.3 | 98.4 | 94.5 | 99.9 | 101.4 | | | 94.6 | 92 |
| 20-Oct-18 | Sat. DO (%) | | | | | | | 78.6 | | | 106.2 | | | | | | | |
| 22-Oct-18 | Sat. DO (%) | | 100.5 | | | | | | | | | | | | 104.6 | | | |
| 23-Oct-18 | Sat. DO (%) | | | | | | | 87.2 | 107.2 | 106.2 | 106 | | | | | | | |
| 27-Oct-18 | Sat. DO (%) | | | | | | | 107.1 | | | 106.8 | | | | | | | |
| 30-Oct-18 | Sat. DO (%) | | | | | | | 93.9 | | | | | | | | | | |
| 31-Oct-18 | Sat. DO (%) | | | | | | | | 102.5 | 100.3 | 107.8 | | | | | | | |
| 3-Nov-18 | Sat. DO (%) | | | | | | | 99.8 | | | 109.1 | | | | | | | |
| 6-Nov-18 | Sat. DO (%) | | 105.4 | 102.1 | | 114.3 | 103.4 | 101.5 | | | | | | | 105 | | | |

| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 | NCH 01 | NPH 01 | NXA 01 | NHS 01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Parameters (Unit)** | **Guideline** | | | | | | | | | | | | | | | | |
| 7-Nov-18 | Sat. DO (%) | | | | | | | | 101.9 | 101.8 | 110.7 | 107.7 | 104.4 | 104.2 | | | 94.9 | 97 |
| 10-Nov-18 | Sat. DO (%) | | | | | | | 104.9 | | | 111.5 | | | | | | | |
| 13-Nov-18 | Sat. DO (%) | | | | | 97.1 | 84.5 | 86.5 | | | | | | | | | | |
| 14-Nov-18 | Sat. DO (%) | | | | | | | | 99.9 | 95.3 | 107.5 | | | | | | | |
| 17-Nov-18 | Sat. DO (%) | | | | | | | 104.9 | | | 106.4 | | | | | | | |
| 20-Nov-18 | Sat. DO (%) | | | | | | | | 90.8 | 84.4 | 102.3 | 95.7 | 100.3 | 100.9 | | | 94.8 | 90.8 |
| 21-Nov-18 | Sat. DO (%) | | 104 | 101.6 | | 87.3 | 81.7 | 87.2 | | | | | | | 106.2 | | | |
| 24-Nov-18 | Sat. DO (%) | | | | | | | 98.6 | | | 109.8 | | | | | | | |
| 27-Nov-18 | Sat. DO (%) | | | | | 82.2 | 76.9 | 76.8 | | | | | | | | | | |
| 28-Nov-18 | Sat. DO (%) | | | | | | | | 90.3 | 79.1 | 103.5 | | | | | | | |
| 1-Dec-18 | Sat. DO (%) | | | | | | | 97.7 | | | 101.5 | | | | | | | |
| 4-Dec-18 | Sat. DO (%) | | | | | | 107.5 | 110.9 | | | | | | | | | | |
| 5-Dec-18 | Sat. DO (%) | | | | | | | | 87.5 | 91.5 | 107.2 | | | | | | | |
| 8-Dec-18 | Sat. DO (%) | | | | | | | 106.4 | | | 106.9 | | | | | | | |
| 11-Dec-18 | Sat. DO (%) | | 105.7 | 78.8 | | 82.1 | 78.9 | 87.1 | | | | | | | 103 | 99.8 | | |
| 12-Dec-18 | Sat. DO (%) | | | | | | | | 104 | 108.4 | 100.9 | 95.7 | 102.5 | 101.9 | | | 90.5 | 90 |
| 15-Dec-18 | Sat. DO (%) | | | | | | | 80.5 | | | 103.4 | | | | | | | |
| 18-Dec-18 | Sat. DO (%) | | | | | | | | 100.5 | 88.8 | 100.5 | | | | | | | |
| 19-Dec-18 | Sat. DO (%) | | | | | 77.1 | 62.5 | 86.4 | | | | | | | | 100.5 | | |
| 22-Dec-18 | Sat. DO (%) | | | | | | | 84.4 | | | 104.5 | | | | | | | |
| 25-Dec-18 | Sat. DO (%) | | 103.9 | | | 103.8 | 94.6 | 91.3 | | | | | | | 104.1 | 113.7 | | |
| 26-Dec-18 | Sat. DO (%) | | | | | | | | 113.4 | 112.3 | 106.7 | 100.9 | 99.8 | 99.1 | | | 96.2 | 88.5 |
| 2-Oct-18 | DO (mg/l) | >6.0 | 7.84 | 7.29 | 6.88 | 7.55 | 7.64 | 7.39 | | | 8.02 | | | | 7.94 | | | |
| 3-Oct-18 | DO (mg/l) | >6.0 | | | | | | | 8.11 | 9.39 | 7.95 | 7.96 | 7.74 | 7.47 | | | 7.36 | 6.62 |
| 6-Oct-18 | DO (mg/l) | >6.0 | | | | | | 8.23 | | | 7.4 | | | | | | | |
| 9-Oct-18 | DO (mg/l) | >6.0 | | | | 9.73 | 9.63 | 9.19 | | | | | | | | | | |
| 10-Oct-18 | DO (mg/l) | >6.0 | | | | | | 8.07 | 7.89 | 7.44 | 7.78 | | | | | | | |

| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 | NCH 01 | NPH 01 | NXA 01 | NHS 01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Parameters (Unit)** | **Guideline** | | | | | | | | | | | | | | | | |
| 11-Oct-18 | DO (mg/l) | >6.0 | | | | | | 7.52 | | | 7.52 | | | | | | | |
| 13-Oct-18 | DO (mg/l) | >6.0 | | | | | | 7.69 | | | 7.92 | | | | | | | |
| 17-Oct-18 | DO (mg/l) | >6.0 | | | | | | 6.7 | 8.19 | 7.87 | 7.61 | 7.4 | 7.52 | 7.54 | | | 7.33 | 7.32 |
| 20-Oct-18 | DO (mg/l) | >6.0 | | | | | | 6.02 | | | 8.35 | | | | | | | |
| 22-Oct-18 | DO (mg/l) | >6.0 | 7.99 | | | | | | | | | | | | 8.16 | | | |
| 23-Oct-18 | DO (mg/l) | <6.0 | | | | | | 6.62 | 8.71 | 8.58 | 8.38 | | | | | | | |
| 27-Oct-18 | DO (mg/l) | <6.0 | | | | | | 7.79 | | | 8.37 | | | | | | | |
| 30-Oct-18 | DO (mg/l) | <6.0 | | | | | | 7.39 | | | | | | | | | | |
| 31-Oct-18 | DO (mg/l) | <6.0 | | | | | | | 8.45 | 8.23 | 8.62 | | | | | | | |
| 3-Nov-18 | DO (mg/l) | <6.0 | | | | | | 7.45 | | | 8.57 | | | | | | | |
| 6-Nov-18 | DO (mg/l) | <6.0 | 8.19 | 7.61 | | 9.03 | 8.36 | 8.1 | | | | | | | 8.51 | | | |
| 7-Nov-18 | DO (mg/l) | <6.0 | | | | | | | 8.29 | 8.25 | 8.87 | 8.33 | 8.15 | 8.16 | | | 7.43 | 7.76 |
| 10-Nov-18 | DO (mg/l) | <6.0 | | | | | | 8.15 | | | 8.82 | | | | | | | |
| 13-Nov-18 | DO (mg/l) | <6.0 | | | | 7.69 | 6.73 | 7.01 | | | | | | | | | | |
| 14-Nov-18 | DO (mg/l) | <6.0 | | | | | | | 8.18 | 7.79 | 8.55 | | | | | | | |
| 17-Nov-18 | DO (mg/l) | <6.0 | | | | | | 7.84 | | | 8.18 | | | | | | | |
| 20-Nov-18 | DO (mg/l) | <6.0 | | | | | | | 7.25 | 6.66 | 8.02 | 7.58 | 7.7 | 7.63 | | | 7.49 | 7.13 |
| 21-Nov-18 | DO (mg/l) | <6.0 | 8.3 | 7.72 | | 6.97 | 6.56 | 7 | | | | | | | 8.92 | | | |
| 24-Nov-18 | DO (mg/l) | <6.0 | | | | | | 7.64 | | | 8.53 | | | | | | | |
| 27-Nov-18 | DO (mg/l) | <6.0 | | | | 6.54 | 6.19 | 6.2 | | | | | | | | | | |
| 28-Nov-18 | DO (mg/l) | <6.0 | | | | | | | 7.46 | 6.6 | 8.44 | | | | | | | |
| 1-Dec-18 | DO (mg/l) | <6.0 | | | | | | 7.76 | | | 8.01 | | | | | | | |
| 4-Dec-18 | DO (mg/l) | <6.0 | | | | | 8.52 | 8.79 | | | | | | | | | | |
| 5-Dec-18 | DO (mg/l) | <6.0 | | | | | | | 7.13 | 7.22 | 8.02 | | | | | | | |
| 8-Dec-18 | DO (mg/l) | <6.0 | | | | | | 8.22 | | | 8.36 | | | | | | | |
| 11-Dec-18 | DO (mg/l) | <6.0 | 8.53 | 6.07 | | 6.6 | 6.38 | 7.08 | | | | | | | 8.45 | 8.8 | | |
| 12-Dec-18 | DO (mg/l) | <6.0 | | | | | | | 9.09 | 9.19 | 8.22 | 7.89 | 8.27 | 8.29 | | | 7.46 | 7.51 |
| 15-Dec-18 | DO (mg/l) | <6.0 | | | | | | 6.46 | | | 8.41 | | | | | | | |
| 18-Dec-18 | DO (mg/l) | <6.0 | | | | | | | 8.34 | 7.25 | 8.17 | | | | | | | |
| 19-Dec-18 | DO (mg/l) | <6.0 | | | | 6.28 | 5.13 | 7.71 | | | | | | | | 9.08 | | |
| 22-Dec-18 | DO (mg/l) | <6.0 | | | | | | 6.47 | | | 8.04 | | | | | | | |
| 25-Dec-18 | DO (mg/l) | <6.0 | 8.59 | | | 8.45 | 8.06 | 7.54 | | | | | | | 8.83 | 10.74 | | |

| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 | NCH 01 | NPH 01 | NXA 01 | NHS 01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Parameters (Unit)** | **Guideline** | | | | | | | | | | | | | | | | |
| 26-Dec-18 | DO (mg/l) | <6.0 | | | | | | | 9.54 | 9.39 | 8.77 | 8.72 | 8.1 | 7.98 | | | 7.95 | 7.62 |
| 2-Oct-18 | Conductivity (µs/cm) | | 73.4 | 73 | 71 | 65 | 61 | 59 | | | 52.1 | | | | 23.8 | | | |
| 3-Oct-18 | Conductivity (µs/cm) | | | | | | | | 64 | 64 | 51.3 | 52 | 51 | 51.7 | | | 80 | 20.02 |
| 6-Oct-18 | Conductivity (µs/cm) | | | | | | | 50.7 | | | 55.5 | | | | | | | |
| 9-Oct-18 | Conductivity (µs/cm) | | | | | 70 | 63 | 62 | | | | | | | | | | |
| 10-Oct-18 | Conductivity (µs/cm) | | | | | | | 62 | 69 | 72 | 73 | | | | | | | |
| 11-Oct-18 | Conductivity (µs/cm) | | | | | | | 51.6 | | | 55.7 | | | | | | | |
| 13-Oct-18 | Conductivity (µs/cm) | | | | | | | 49 | | | 57 | | | | | | | |
| 17-Oct-18 | Conductivity (µs/cm) | | | | | | | 51.6 | 68 | 69 | 54.5 | 64.3 | 67.5 | 66 | | | 86.6 | 26.4 |
| 20-Oct-18 | Conductivity (µs/cm) | | | | | | | 49.8 | | | 51.6 | | | | | | | |
| 22-Oct-18 | Conductivity (µs/cm) | | 71.7 | | | | | | | | | | | | 21.32 | | | |
| 23-Oct-18 | Conductivity (µs/cm) | | | | | | | 53 | 65 | 65 | 52.1 | | | | | | | |
| 27-Oct-18 | Conductivity (µs/cm) | | | | | | | 51.8 | | | 51.4 | | | | | | | |
| 30-Oct-18 | Conductivity (µs/cm) | | | | | | | 63 | | | | | | | | | | |
| 31-Oct-18 | Conductivity (µs/cm) | | | | | | | | 67 | 67 | 52.6 | | | | | | | |
| 3-Nov-18 | Conductivity (µs/cm) | | | | | | | 53.1 | | | 53.4 | | | | | | | |
| 6-Nov-18 | Conductivity (µs/cm) | | 75.6 | 114 | | 77 | 67 | 65 | | | | | | | 22.7 | | | |
| 7-Nov-18 | Conductivity (µs/cm) | | | | | | | | 59 | 59 | 52.4 | 52.2 | 54.3 | 54.4 | | | 91.2 | 45.9 |
| 10-Nov-18 | Conductivity (µs/cm) | | | | | | | 53.1 | | | 53.6 | | | | | | | |
| 13-Nov-18 | Conductivity (µs/cm) | | | | | 78 | 68 | 67 | | | | | | | | | | |
| 14-Nov-18 | Conductivity (µs/cm) | | | | | | | | 67 | 67 | 52.3 | | | | | | | |
| 17-Nov-18 | Conductivity (µs/cm) | | | | | | | 51.9 | | | 53.9 | | | | | | | |
| 20-Nov-18 | Conductivity (µs/cm) | | | | | | | | 73 | 79 | 57.4 | 65.2 | 67.2 | 68.5 | | | 98.4 | 43.7 |
| 21-Nov-18 | Conductivity (µs/cm) | | 85 | 66.9 | | 74 | 68 | 67 | | | | | | | 23.9 | | | |
| 24-Nov-18 | Conductivity (µs/cm) | | | | | | | 53.1 | | | 57.9 | | | | | | | |
| 27-Nov-18 | Conductivity (µs/cm) | | | | | 76 | 68 | 68 | | | | | | | | | | |
| 28-Nov-18 | Conductivity (µs/cm) | | | | | | | | 72 | 74 | 57.9 | | | | | | | |
| 1-Dec-18 | Conductivity (µs/cm) | | | | | | | 53.8 | | | 58.6 | | | | | | | |
| 4-Dec-18 | Conductivity (µs/cm) | | | | | | 68 | 68 | | | | | | | | | | |
| 5-Dec-18 | Conductivity (µs/cm) | | | | | | | | 74 | 74 | 57.4 | | | | | | | |
| 8-Dec-18 | Conductivity (µs/cm) | | | | | | | 54.3 | | | 58.7 | | | | | | | |

| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 | NCH 01 | NPH 01 | NXA 01 | NHS 01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Parameters (Unit)** | **Guideline** | | | | | | | | | | | | | | | | |
| 11-Dec-18 | Conductivity (µs/cm) | | 79.7 | 68 | | 74 | 69 | 68 | | | | | | | 26 | 67 | | |
| 12-Dec-18 | Conductivity (µs/cm) | | | | | | | | 78 | 79 | 61.8 | 67.6 | 70.9 | 74.3 | | | 103.6 | 51.8 |
| 15-Dec-18 | Conductivity (µs/cm) | | | | | | | 53.8 | | | 59.1 | | | | | | | |
| 18-Dec-18 | Conductivity (µs/cm) | | | | | | | | 57 | 76 | 58.3 | | | | | | | |
| 19-Dec-18 | Conductivity (µs/cm) | | | | | 71 | 69 | 77 | | | | | | | | 67 | | |
| 22-Dec-18 | Conductivity (µs/cm) | | | | | | | 53.1 | | | 58.4 | | | | | | | |
| 25-Dec-18 | Conductivity (µs/cm) | | 78.6 | | | 72 | 72 | 70 | | | | | | | 24.9 | 70 | | |
| 26-Dec-18 | Conductivity (µs/cm) | | | | | | | | 68 | 69 | 53.7 | 55.3 | 58.2 | 55.5 | | | 107.5 | 53.2 |
| 2-Oct-18 | TDS (mg/l) | | 36.7 | 36.5 | 35.5 | 32.5 | 30.5 | 29 | | | 26.05 | | | | 11.9 | | | |
| 3-Oct-18 | TDS (mg/l) | | | | | | | | 32 | 32 | 25.65 | 26 | 25.5 | 25.5 | | | 40 | 10 |
| 6-Oct-18 | TDS (mg/l) | | | | | | | 25.3 | | | 27.5 | | | | | | | |
| 9-Oct-18 | TDS (mg/l) | | | | | 35 | 31.5 | 31 | | | | | | | | | | |
| 10-Oct-18 | TDS (mg/l) | | | | | | | 31 | 34 | 36 | 36 | | | | | | | |
| 11-Oct-18 | TDS (mg/l) | | | | | | | 25.5 | | | 27 | | | | | | | |
| 13-Oct-18 | TDS (mg/l) | | | | | | | 24.5 | | | 28.5 | | | | | | | |
| 17-Oct-18 | TDS (mg/l) | | | | | | | 25.5 | 34 | 34.5 | 27.25 | 32.15 | 33.75 | 33 | | | 43.3 | 13.2 |
| 20-Oct-18 | TDS (mg/l) | | | | | | | 24.9 | | | 25.8 | | | | | | | |
| 22-Oct-18 | TDS (mg/l) | | 35.85 | | | | | | | | | | | | 10.66 | | | |
| 23-Oct-18 | TDS (mg/l) | | | | | | | 26.5 | 32.5 | 32.5 | 26 | | | | | | | |
| 27-Oct-18 | TDS (mg/l) | | | | | | | 25.9 | | | 25.7 | | | | | | | |
| 30-Oct-18 | TDS (mg/l) | | | | | | | 31.5 | | | | | | | | | | |
| 31-Oct-18 | TDS (mg/l) | | | | | | | | 33.5 | 33.5 | 26.3 | | | | | | | |
| 3-Nov-18 | TDS (mg/l) | | | | | | | 26.55 | | | 26.7 | | | | | | | |
| 6-Nov-18 | TDS (mg/l) | | 38 | 57 | | 38.5 | 33.5 | 32.5 | | | | | | | 11 | | | |
| 7-Nov-18 | TDS (mg/l) | | | | | | | | 29.5 | 29.5 | 26.2 | 26.2 | 27.1 | 27.2 | | | 45.6 | 23 |
| 10-Nov-18 | TDS (mg/l) | | | | | | | 26.55 | | | 26.8 | | | | | | | |
| 13-Nov-18 | TDS (mg/l) | | | | | 39 | 34 | 33.5 | | | | | | | | | | |
| 14-Nov-18 | TDS (mg/l) | | | | | | | | 33.5 | 33.5 | 26 | | | | | | | |
| 17-Nov-18 | TDS (mg/l) | | | | | | | 25.9 | | | 26.9 | | | | | | | |
| 20-Nov-18 | TDS (mg/l) | | | | | | | | 36.5 | 39.5 | 28.7 | 32.6 | 33.5 | 34.2 | | | 49.2 | 21.8 |
| 21-Nov-18 | TDS (mg/l) | | 42.5 | 33.5 | | 37 | 34 | 33.5 | | | | | | | 12 | | | |
| 24-Nov-18 | TDS (mg/l) | | | | | | | 26.55 | | | 29.5 | | | | | | | |

| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 | NCH 01 | NPH 01 | NXA 01 | NHS 01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Parameters (Unit)** | **Guideline** | | | | | | | | | | | | | | | | |
| 27-Nov-18 | TDS (mg/l) | | | | | 38 | 34 | 34 | | | | | | | | | | |
| 28-Nov-18 | TDS (mg/l) | | | | | | | | 36 | 37 | 29 | | | | | | | |
| 1-Dec-18 | TDS (mg/l) | | | | | | | 26.8 | | | 29.3 | | | | | | | |
| 4-Dec-18 | TDS (mg/l) | | | | | | 34 | 34 | | | | | | | | | | |
| 5-Dec-18 | TDS (mg/l) | | | | | | | | 37 | 37 | 28.8 | | | | | | | |
| 8-Dec-18 | TDS (mg/l) | | | | | | | 27 | | | 29 | | | | | | | |
| 11-Dec-18 | TDS (mg/l) | | 40 | 34 | | 37 | 34.5 | 34 | | | | | | | 13 | 33.5 | | |
| 12-Dec-18 | TDS (mg/l) | | | | | | | | 38 | 38.5 | 30.9 | 33.85 | 34.45 | 37.15 | | | 24.4 | 25.9 |
| 15-Dec-18 | TDS (mg/l) | | | | | | | 26.8 | | | 29.5 | | | | | | | |
| 18-Dec-18 | TDS (mg/l) | | | | | | | | 28.5 | 38 | 29.15 | | | | | | | |
| 19-Dec-18 | TDS (mg/l) | | | | | 35.5 | 34.5 | 38.5 | | | | | | | | 33.5 | | |
| 22-Dec-18 | TDS (mg/l) | | | | | | | 26.55 | | | 29.2 | | | | | | | |
| 25-Dec-18 | TDS (mg/l) | | 39.3 | | | 36 | 36 | 35 | | | | | | | 12.45 | 35 | | |
| 26-Dec-18 | TDS (mg/l) | | | | | | | | 34 | 34.5 | 26.85 | 27.65 | 29 | 27.5 | | | 53.75 | 26.6 |
| 2-Oct-18 | Temperature (°C) | | 24.2 | 23.96 | 28.7 | 30.83 | 31.28 | 29.29 | | | 25 | | | | 24.3 | | | |
| 3-Oct-18 | Temperature (°C) | | | | | | | | 25.43 | 25.36 | 26.2 | 26 | 26.8 | 26.3 | | | 26.1 | 26.9 |
| 6-Oct-18 | Temperature (°C) | | | | | | | 29.3 | | | 26.3 | | | | | | | |
| 9-Oct-18 | Temperature (°C) | | | | | 30.11 | 29.96 | 30.91 | | | | | | | | | | |
| 10-Oct-18 | Temperature (°C) | | | | | | | 28.39 | 27.02 | 27.89 | 26.34 | | | | | | | |
| 11-Oct-18 | Temperature (°C) | | | | | | | 28 | | | 27.3 | | | | | | | |
| 13-Oct-18 | Temperature (°C) | | | | | | | 28.4 | | | 27.7 | | | | | | | |
| 17-Oct-18 | Temperature (°C) | | | | | | | 27 | 26.75 | 28.59 | 27.5 | 26.8 | 28.7 | 29.4 | | | 27.4 | 26 |
| 20-Oct-18 | Temperature (°C) | | | | | | | 27.3 | | | 26.6 | | | | | | | |
| 22-Oct-18 | Temperature (°C) | | 24.9 | | | | | | | | | | | | 25.7 | | | |
| 23-Oct-18 | Temperature (°C) | | | | | | | 26.9 | 25.96 | 26.09 | 26.3 | | | | | | | |
| 27-Oct-18 | Temperature (°C) | | | | | | | 30.2 | | | 26.9 | | | | | | | |
| 30-Oct-18 | Temperature (°C) | | | | | | | 27.93 | | | | | | | | | | |

| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 | NCH 01 | NPH 01 | NXA 01 | NHS 01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Parameters (Unit)** | **Guideline** | | | | | | | | | | | | | | | | |
| 31-Oct-18 | Temperature (°C) | | | | | | | | 25.37 | 25.49 | 25.7 | | | | | | | |
| 3-Nov-18 | Temperature (°C) | | | | | | | 28.4 | | | 26 | | | | | | | |
| 6-Nov-18 | Temperature (°C) | | 26.1 | 28.7 | | 28.78 | 27.37 | 26.59 | | | | | | | 26.3 | | | |
| 7-Nov-18 | Temperature (°C) | | | | | | | | 25.23 | 25.28 | 25.6 | 27.6 | 26.3 | 26.9 | | | 26.2 | 25.8 |
| 10-Nov-18 | Temperature (°C) | | | | | | | 26.4 | | | 26.2 | | | | | | | |
| 13-Nov-18 | Temperature (°C) | | | | | 27.21 | 27.1 | 26.41 | | | | | | | | | | |
| 14-Nov-18 | Temperature (°C) | | | | | | | | 25.44 | 25.44 | 25.9 | | | | | | | |
| 17-Nov-18 | Temperature (°C) | | | | | | | 28.4 | | | 27.6 | | | | | | | |
| 20-Nov-18 | Temperature (°C) | | | | | | | | 26.49 | 28 | 26.8 | 26.3 | 27.6 | 28.5 | | | 26.5 | 26.8 |
| 21-Nov-18 | Temperature (°C) | | 24.7 | 27.4 | | 27.69 | 27.14 | 26.79 | | | | | | | 22 | | | |
| 24-Nov-18 | Temperature (°C) | | | | | | | 26.6 | | | 27.4 | | | | | | | |
| 27-Nov-18 | Temperature (°C) | | | | | 27.25 | 26.75 | 26.13 | | | | | | | | | | |
| 28-Nov-18 | Temperature (°C) | | | | | | | | 24.99 | 24.75 | 24.8 | | | | | | | |
| 1-Dec-18 | Temperature (°C) | | | | | | | 25.98 | | | 26.4 | | | | | | | |
| 4-Dec-18 | Temperature (°C) | | | | | | 27.69 | 27.34 | | | | | | | | | | |
| 5-Dec-18 | Temperature (°C) | | | | | | | | 25.88 | 27.35 | 29.1 | | | | | | | |
| 8-Dec-18 | Temperature (°C) | | | | | | | 26.6 | | | 26.8 | | | | | | | |
| 11-Dec-18 | Temperature (°C) | | 24.1 | 26.8 | | 26.59 | 26.36 | 25.99 | | | | | | | 23 | 21.4 | | |
| 12-Dec-18 | Temperature (°C) | | | | | | | | 22.15 | 23.76 | 25.1 | 24.3 | 24.4 | 24.9 | | | 24.4 | 23.8 |
| 15-Dec-18 | Temperature (°C) | | | | | | | 24.6 | | | 24.7 | | | | | | | |
| 18-Dec-18 | Temperature (°C) | | | | | | | | 24 | 25.39 | 26 | | | | | | | |

| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 | NCH 01 | NPH 01 | NXA 01 | NHS 01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Parameters (Unit)** | **Guideline** | | | | | | | | | | | | | | | | |
| 19-Dec-18 | Temperature (°C) | | | | | 26.47 | 25.35 | 21.08 | | | | | | | | 20.31 | | |
| 22-Dec-18 | Temperature (°C) | | | | | | | 27.1 | | | 27.8 | | | | | | | |
| 25-Dec-18 | Temperature (°C) | | 22.8 | | | 25.85 | 23.42 | 25.13 | | | | | | | 21.3 | 18.07 | | |
| 26-Dec-18 | Temperature (°C) | | | | | | | | 24.42 | 24.45 | 24.2 | 23.5 | 24.7 | 25.1 | | | 23.9 | 21.8 |
| 2-Oct-18 | Turbidity (NTU) | | 16.77 | 23.54 | 3.64 | 6.82 | 8.43 | 5.65 | | | 3.16 | | | | 9.09 | | | |
| 3-Oct-18 | Turbidity (NTU) | | | | | | | | 5.03 | 5.2 | 3.07 | 3.21 | 3.63 | 3.48 | | | 3.5 | 2.44 |
| 6-Oct-18 | Turbidity (NTU) | | | | | | | 6.81 | | | 15.6 | | | | | | | |
| 9-Oct-18 | Turbidity (NTU) | | | | | 3.98 | 6.53 | 6.29 | | | | | | | | | | |
| 10-Oct-18 | Turbidity (NTU) | | | | | | | 7.84 | 16.64 | 21.63 | 21.77 | | | | | | | |
| 11-Oct-18 | Turbidity (NTU) | | | | | | | 6.83 | | | 18.57 | | | | | | | |
| 13-Oct-18 | Turbidity (NTU) | | | | | | | 6.09 | | | 9.35 | | | | | | | |
| 17-Oct-18 | Turbidity (NTU) | | | | | | | 3.5 | 3.85 | 2.85 | 6.54 | 5.9 | 6.34 | 3.98 | | | 6.02 | 5.43 |
| 20-Oct-18 | Turbidity (NTU) | | | | | | | 3.37 | | | 5.28 | | | | | | | |
| 22-Oct-18 | Turbidity (NTU) | | 171 | | | | | | | | | | | | 15.61 | | | |
| 23-Oct-18 | Turbidity (NTU) | | | | | | | 2.95 | 1.49 | 1.42 | 3.76 | | | | | | | |
| 27-Oct-18 | Turbidity (NTU) | | | | | | | 1.88 | | | 3.25 | | | | | | | |
| 30-Oct-18 | Turbidity (NTU) | | | | | | | 1.92 | | | | | | | | | | |
| 31-Oct-18 | Turbidity (NTU) | | | | | | | | 9.64 | 8.83 | 7.26 | | | | | | | |
| 3-Nov-18 | Turbidity (NTU) | | | | | | | 2.12 | | | 7.51 | | | | | | | |
| 6-Nov-18 | Turbidity (NTU) | | 27.83 | 2.17 | | 0.57 | 0.82 | 0.79 | | | | | | | 7.01 | | | |
| 7-Nov-18 | Turbidity (NTU) | | | | | | | | 4.86 | 3.11 | 5.31 | 6.06 | 10.14 | 7.78 | | | 4.3 | 5.7 |
| 10-Nov-18 | Turbidity (NTU) | | | | | | | 1.52 | | | 4.58 | | | | | | | |
| 13-Nov-18 | Turbidity (NTU) | | | | | 1.28 | 1.13 | 1.21 | | | | | | | | | | |
| 14-Nov-18 | Turbidity (NTU) | | | | | | | | 9.28 | 5.29 | 6.08 | | | | | | | |
| 17-Nov-18 | Turbidity (NTU) | | | | | | | 1.67 | | | 7.37 | | | | | | | |
| 20-Nov-18 | Turbidity (NTU) | | | | | | | | 6.79 | 8.88 | 5.82 | 5.93 | 5.42 | 6.76 | | | 4.33 | 4.46 |
| 21-Nov-18 | Turbidity (NTU) | | 66.26 | 2.42 | | 1.67 | 1.13 | 1.17 | | | | | | | 6.58 | | | |
| 24-Nov-18 | Turbidity (NTU) | | | | | | | 2.45 | | | 4.76 | | | | | | | |

| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 | NCH 01 | NPH 01 | NXA 01 | NHS 01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Parameters (Unit)** | **Guideline** | | | | | | | | | | | | | | | | |
| 27-Nov-18 | Turbidity (NTU) | | | | | 1.76 | 1.66 | 1.89 | | | | | | | | | | |
| 28-Nov-18 | Turbidity (NTU) | | | | | | | | 5.5 | 11.47 | 7.41 | | | | | | | |
| 1-Dec-18 | Turbidity (NTU) | | | | | | | 2.32 | | | 11.91 | | | | | | | |
| 4-Dec-18 | Turbidity (NTU) | | | | | | 1.5 | 1.56 | | | | | | | | | | |
| 5-Dec-18 | Turbidity (NTU) | | | | | | | | 5.85 | 10.56 | 7.44 | | | | | | | |
| 8-Dec-18 | Turbidity (NTU) | | | | | | | 1.26 | | | 4.71 | | | | | | | |
| 11-Dec-18 | Turbidity (NTU) | | 11.1 | 0.89 | | 1.21 | 1.06 | 1.27 | | | | | | | 3.86 | 2.53 | | |
| 12-Dec-18 | Turbidity (NTU) | | | | | | | | 2.58 | 4.16 | 4.06 | 4.98 | 2.78 | 6.01 | | | 3.76 | 3.58 |
| 15-Dec-18 | Turbidity (NTU) | | | | | | | 2.64 | | | 7.7 | | | | | | | |
| 18-Dec-18 | Turbidity (NTU) | | | | | | | | 3.35 | 4.25 | 6.62 | | | | | | | |
| 19-Dec-18 | Turbidity (NTU) | | | | | 0.74 | 0.92 | 0.94 | | | | | | | | 2.74 | | |
| 22-Dec-18 | Turbidity (NTU) | | | | | | | 1.09 | | | 4.66 | | | | | | | |
| 25-Dec-18 | Turbidity (NTU) | | 14.37 | | | 1.31 | 1.36 | 1.4 | | | | | | | 4.02 | 3.37 | | |
| 26-Dec-18 | Turbidity (NTU) | | | | | | | | 5.86 | 6.37 | 7.37 | 8.64 | 32.25 | 8.56 | | | 2.51 | 3.7 |
| 2-Oct-18 | TSS (mg/l) | | 59.43 | 30.63 | <5 | 7.59 | 7.95 | 6.55 | | | | | | | 25.88 | | | |
| 3-Oct-18 | TSS (mg/l) | | | | | | | | <5 | <5 | 5.62 | 6.11 | 9.73 | 8.37 | | | 5.52 | <5 |
| 10-Oct-18 | TSS (mg/l) | | | | | | | 7.39 | 20.47 | 16.84 | 15.11 | | | | | | | |
| 23-Oct-18 | TSS (mg/l) | | | | | | | <5 | <5 | <5 | 5.29 | | | | | | | |
| 31-Oct-18 | TSS (mg/l) | | | | | | | <5 | 31.75 | 12.94 | 14.1 | | | | | | | |
| 6-Nov-18 | TSS (mg/l) | | 54.03 | <5 | | <5 | <5 | <5 | | | | | | | 8.23 | | | |
| 7-Nov-18 | TSS (mg/l) | | | | | | | | 6.59 | 6.57 | 9.79 | 13.11 | 19.14 | 7.64 | | | <5 | 6.84 |
| 13-Nov-18 | TSS (mg/l) | | | | | | | <5 | | | | | | | | | | |
| 14-Nov-18 | TSS (mg/l) | | | | | | | | 26.35 | 9.83 | 14.66 | | | | | | | |
| 20-Nov-18 | TSS (mg/l) | | | | | | | | 12.19 | 8.43 | 9.35 | | | | | | | |
| 21-Nov-18 | TSS (mg/l) | | | | | | | <5 | | | | | | | | | | |
| 27-Nov-18 | TSS (mg/l) | | | | | | | <5 | | | | | | | | | | |

| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 | NCH 01 | NPH 01 | NXA 01 | NHS 01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Parameters (Unit)** | **Guideline** | | | | | | | | | | | | | | | | |
| 28-Nov-18 | TSS (mg/l) | | | | | | | | 14.28 | 13.22 | 7.9 | | | | | | | |
| 4-Dec-18 | TSS (mg/l) | | | | | | | <5 | | | | | | | | | | |
| 5-Dec-18 | TSS (mg/l) | | | | | | | | <5 | 8.25 | 6.45 | | | | | | | |
| 11-Dec-18 | TSS (mg/l) | | 13.65 | <5 | | <5 | <5 | <5 | | | | | | | 6.99 | <5 | | |
| 12-Dec-18 | TSS (mg/l) | | | | | | | | <5 | 7.46 | <5 | <5 | <5 | 8.62 | | | <5 | <5 |
| 18-Dec-18 | TSS (mg/l) | | | | | | | | 6.81 | 6.02 | 10.3 | | | | | | | |
| 19-Dec-18 | TSS (mg/l) | | | | | | | <5 | | | | | | | | | | |
| 2-Oct-18 | BOD5 (mg/l) | <1.5 | <1.0 | <1.0 | <1.0 | 2.98 | 4.08 | 2.64 | | | | | | | <1.0 | | | |
| 3-Oct-18 | BOD5 (mg/l) | <1.5 | | | | | | | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | | | <1.0 | <1.0 |
| 11-Oct-18 | BOD5 (mg/l) | <1.5 | | | | | | 2.78 | 1.72 | 1.07 | <1.0 | | | | | | | |
| 17-Oct-18 | BOD5 (mg/l) | <1.5 | | | | | | 1.57 | 1.18 | 1.31 | 1.09 | | | | | | | |
| 23-Oct-18 | BOD5 (mg/l) | <1.5 | | | | | | 2.25 | <1.0 | <1.0 | <1.0 | | | | | | | |
| 30-Oct-18 | BOD5 (mg/l) | <1.5 | | | | | | <1.0 | | | | | | | | | | |
| 31-Oct-18 | BOD5 (mg/l) | <1.5 | | | | | | | <1.0 | <1.0 | <1.0 | | | | | | | |
| 6-Nov-18 | BOD5 (mg/l) | <1.5 | 2.11 | 1.1 | | <1.0 | <1.0 | <1.0 | | | | | | | <1.0 | | | |
| 7-Nov-18 | BOD5 (mg/l) | <1.5 | | | | | | | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | | | <1.0 | <1.0 |
| 13-Nov-18 | BOD5 (mg/l) | <1.5 | | | | | | <1.0 | | | | | | | | | | |
| 14-Nov-18 | BOD5 (mg/l) | <1.5 | | | | | | | <1.0 | <1.0 | <1.0 | | | | | | | |
| 20-Nov-18 | BOD5 (mg/l) | <1.5 | | | | | | | <1.0 | <1.0 | <1.0 | | | | | | | |
| 21-Nov-18 | BOD5 (mg/l) | <1.5 | | | | | | <1.0 | | | | | | | | | | |
| 27-Nov-18 | BOD5 (mg/l) | <1.5 | | | | | | <1.0 | | | | | | | | | | |
| 28-Nov-18 | BOD5 (mg/l) | <1.5 | | | | | | | <1.0 | <1.0 | <1.0 | | | | | | | |
| 4-Dec-18 | BOD5 (mg/l) | <1.5 | | | | | | <1.0 | | | | | | | | | | |
| 5-Dec-18 | BOD5 (mg/l) | <1.5 | | | | | | | 1.06 | 1.33 | 1.02 | | | | | | | |
| 11-Dec-18 | BOD5 (mg/l) | <1.5 | <1 | 1.18 | | <1.0 | <1.0 | 1.29 | | | | | | | <1.0 | <1.0 | | |
| 12-Dec-18 | BOD5 (mg/l) | <1.5 | | | | | | | 1.1 | 1.4 | 1.16 | <1.0 | <1.0 | <1.0 | | | <1.0 | <1.0 |
| 18-Dec-18 | BOD5 (mg/l) | <1.5 | | | | | | | <1 | <1 | 1.15 | | | | | | | |
| 19-Dec-18 | BOD5 (mg/l) | <1.5 | | | | | | <1 | | | | | | | | | | |
| 2-Oct-18 | COD (mg/l) | <5 | <5.0 | <5.0 | <5.0 | 14.2 | 14.4 | 11.5 | <5.0 | <5.0 | | | | | 5.7 | | | |
| 3-Oct-18 | COD (mg/l) | <5 | | | | | | | | | <5.0 | <5.0 | 5.1 | 5.3 | | | <5.5 | 10.7 |
| 6-Nov-18 | COD (mg/l) | <5 | <5.0 | <5.0 | | <5.0 | 6 | 6.5 | | | | | | | <5.0 | | | |

| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 | NCH 01 | NPH 01 | NXA 01 | NHS 01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Parameters (Unit)** | **Guideline** | | | | | | | | | | | | | | | | |
| 7-Nov-18 | COD (mg/l) | <5 | | | | | | | 6.9 | <5.0 | 5 | <5.0 | <5.0 | 7.3 | | | <5.0 | 6.9 |
| 11-Dec-18 | COD (mg/l) | <5 | 5.7 | 8.3 | | 8.7 | <5 | 7.1 | <5 | 5.7 | | | | | 5.5 | <5 | | |
| 12-Dec-18 | COD (mg/l) | <5 | | | | | | | | | 5.9 | <5 | 5.1 | <5 | | | <5 | <5 |
| 2-Oct-18 | NH3-N (mg/l) | <0.2 | <0.2 | <0.2 | 0.54 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | | | | | <0.2 | | | |
| 3-Oct-18 | NH3-N (mg/l) | <0.2 | | | | | | | | | 0.42 | 0.32 | <0.2 | 0.36 | | | 0.25 | <0.2 |
| 6-Nov-18 | NH3-N (mg/l) | <0.2 | <0.2 | <0.2 | | 0.7 | <0.2 | <0.2 | | | | | | | <0.2 | | | |
| 7-Nov-18 | NH3-N (mg/l) | <0.2 | | | | | | | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | | | <0.2 | <0.2 |
| 11-Dec-18 | NH3-N (mg/l) | <0.2 | <0.2 | <0.2 | | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | | | | | <0.2 | <0.2 | | |
| 12-Dec-18 | NH3-N (mg/l) | <0.2 | | | | | | | | | <0.2 | <0.2 | <0.2 | <0.2 | | | <0.2 | <0.2 |
| 2-Oct-18 | NO3-N (mg/l) | <5 | 0.07 | 0.06 | <0.02 | <0.02 | <0.02 | <0.02 | 0.06 | 0.06 | | | | | 0.06 | | | |
| 3-Oct-18 | NO3-N (mg/l) | <5 | | | | | | | | | 0.06 | <0.02 | 0.06 | 0.04 | | | 0.05 | 0.03 |
| 6-Nov-18 | NO3-N (mg/l) | <5 | 0.13 | <0.02 | | <0.02 | <0.02 | <0.02 | | | | | | | 0.14 | | | |
| 7-Nov-18 | NO3-N (mg/l) | <5 | | | | | | | <0.02 | 0.02 | <0.02 | <0.02 | <0.02 | <0.02 | | | 0.13 | 0.07 |
| 11-Dec-18 | NO3-N (mg/l) | <5 | 0.03 | <0.02 | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | | | | | 0.03 | 0.07 | | |
| 12-Dec-18 | NO3-N (mg/l) | <5 | | | | | | <0.02 | <0.02 | | <0.02 | <0.02 | 0.02 | <0.02 | | | 0.04 | 0.07 |
| 11-Dec-18 | NO2-N (mg/l) | | <0.02 | <0.02 | | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | | | | | <0.02 | <0.02 | | |
| 12-Dec-18 | NO2-N (mg/l) | | | | | | | <0.02 | | | <0.02 | <0.02 | <0.02 | <0.02 | | | <0.02 | <0.02 |
| 2-Oct-18 | Faecal coliform (MPN/100 ml) | <1,000 | 280 | 47 | 22 | 33 | 23 | 33 | | | | | | | 540 | | | |
| 3-Oct-18 | Faecal coliform (MPN/100 ml) | <1,000 | | | | | | | 14 | 49 | 5 | 130 | 130 | 14 | | | 26 | 27 |
| 10-Oct-18 | Faecal coliform (MPN/100 ml) | <1,000 | | | | | | 27 | 14 | 22 | 17 | | | | | | | |
| 17-Oct-18 | Faecal coliform (MPN/100 ml) | <1,000 | | | | | | 7.8 | 13 | 33 | 11 | | | | | | | |
| 23-Oct-18 | Faecal coliform (MPN/100 ml) | <1,000 | | | | | | 540 | 5 | 5 | 17 | | | | | | | |

| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 | NCH 01 | NPH 01 | NXA 01 | NHS 01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Parameters (Unit)** | **Guideline** | | | | | | | | | | | | | | | | |
| 30-Oct-18 | Faecal coliform (MPN/100 ml) | <1,000 | | | | | | 240 | | | | | | | | | | |
| 31-Oct-18 | Faecal coliform (MPN/100 ml) | <1,000 | | | | | | | 0 | 0 | 0 | | | | | | | |
| 6-Nov-18 | Faecal coliform (MPN/100 ml) | <1,000 | 170 | 2 | | 0 | 0 | 0 | | | | | | | 540 | | | |
| 7-Nov-18 | Faecal coliform (MPN/100 ml) | <1,000 | | | | | | | 0 | 0 | 5 | 5 | 8 | 9 | | | 32 | 17 |
| 13-Nov-18 | Faecal coliform (MPN/100 ml) | <1,000 | | | | | | 220 | | | | | | | | | | |
| 14-Nov-18 | Faecal coliform (MPN/100 ml) | <1,000 | | | | | | | 2 | 0 | 5 | | | | | | | |
| 20-Nov-18 | Faecal coliform (MPN/100 ml) | <1,000 | | | | | | | 13 | 8 | 23 | | | | | | | |
| 21-Nov-18 | Faecal coliform (MPN/100 ml) | <1,000 | | | | | | 17 | | | | | | | | | | |
| 27-Nov-18 | Faecal coliform (MPN/100 ml) | <1,000 | | | | | | 2 | | | | | | | | | | |
| 28-Nov-18 | Faecal coliform (MPN/100 ml) | <1,000 | | | | | | | 8 | 23 | 2 | | | | | | | |
| 4-Dec-18 | Faecal coliform (MPN/100 ml) | <1,000 | | | | | | 22 | | | | | | | | | | |
| 5-Dec-18 | Faecal coliform (MPN/100 ml) | <1,000 | | | | | | | 130 | 46 | 130 | | | | | | | |
| 11-Dec-18 | Faecal coliform (MPN/100 ml) | <1,000 | 920 | 14 | | 4.5 | 130 | 11 | | | | | | | | | | |
| 12-Dec-18 | Faecal coliform (MPN/100 ml) | <1,000 | | | | | | | 49 | 33 | 110 | 240 | 79 | 130 | 130 | 130 | 170 | 220 |
| 18-Dec-18 | Faecal coliform (MPN/100 ml) | <1,000 | | | | | | | 0 | 0 | 27 | | | | | | | |
| 19-Dec-18 | Faecal coliform (MPN/100 ml) | <1,000 | | | | | | 9,200 | | | | | | | | | | |
| 2-Oct-18 | Total Coliform (MPN/100 ml) | <5,000 | 1,600 | 1,600 | 49 | 49 | 23 | 33 | | | | | | | 920 | | | |
| 3-Oct-18 | Total Coliform (MPN/100 ml) | <5,000 | | | | | | | 79 | 49 | 79 | 130 | 130 | 49 | | | 280 | 350 |

| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 | NCH 01 | NPH 01 | NXA 01 | NHS 01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Parameters (Unit)** | **Guideline** | | | | | | | | | | | | | | | | |
| 10-Oct-18 | Total Coliform (MPN/100 ml) | <5,000 | | | | | | 130 | 130 | 240 | 170 | | | | | | | |
| 17-Oct-18 | Total Coliform (MPN/100 ml) | <5,000 | | | | | | 1,600 | 27 | 13 | 110 | | | | | | | |
| 23-Oct-18 | Total Coliform (MPN/100 ml) | <5,000 | | | | | | 1,600 | 27 | 13 | 110 | | | | | | | |
| 30-Oct-18 | Total Coliform (MPN/100 ml) | <5,000 | | | | | | 350 | | | | | | | | | | |
| 31-Oct-18 | Total Coliform (MPN/100 ml) | <5,000 | | | | | | | 130 | 130 | 280 | | | | | | | |
| 6-Nov-18 | Total Coliform (MPN/100 ml) | <5,000 | 540 | 7 | | 0 | 0 | 0 | | | | | | | 1,600 | | | |
| 7-Nov-18 | Total Coliform (MPN/100 ml) | <5,000 | | | | | | | 5 | 11 | 22 | 79 | 33 | 94 | | | 540 | |
| 13-Nov-18 | Total Coliform (MPN/100 ml) | <5,000 | | | | | | 540 | | | | | | | | | | |
| 14-Nov-18 | Total Coliform (MPN/100 ml) | <5,000 | | | | | | | 2 | 0 | 49 | | | | | | | |
| 20-Nov-18 | Total Coliform (MPN/100 ml) | <5,000 | | | | | | | 23 | 23 | 33 | | | | | | | |
| 21-Nov-18 | Total Coliform (MPN/100 ml) | <5,000 | | | | | | 33 | | | | | | | | | | |
| 27-Nov-18 | Total Coliform (MPN/100 ml) | <5,000 | | | | | | 11 | | | | | | | | | | |
| 28-Nov-18 | Total Coliform (MPN/100 ml) | <5,000 | | | | | | | 20 | 23 | 2 | | | | | | | |
| 4-Dec-18 | Total Coliform (MPN/100 ml) | <5,000 | | | | | | 110 | | | | | | | | | | |
| 5-Dec-18 | Total Coliform (MPN/100 ml) | <5,000 | | | | | | | 240 | 70 | 460 | | | | | | | |
| 11-Dec-18 | Total Coliform (MPN/100 ml) | <5,000 | 1,600 | 220 | | 17 | 170 | 49 | | | | | | | 350 | 920 | | |
| 12-Dec-18 | Total Coliform (MPN/100 ml) | <5,000 | | | | | | | 70 | 33 | 110 | 350 | 540 | 170 | | | 1,600 | 540 |
| 18-Dec-18 | Total Coliform (MPN/100 ml) | <5,000 | | | | | | | 79 | 27 | 110 | | | | | | | |

| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 | NCH 01 | NPH 01 | NXA 01 | NHS 01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Parameters (Unit)** | **Guideline** | | | | | | | | | | | | | | | | |
| 19-Dec-18 | Total Coliform (MPN/100 ml) | <5,000 | | | | | | 9,200 | | | | | | | | | | |
| 11-Dec-18 | TKN | | <1.5 | <1.5 | | <1.5 | <1.5 | <1.5 | <1.5 | <1.5 | | | | | <1.5 | <1.5 | | |
| 12-Dec-18 | TKN | | | | | | | | | | <1.5 | <1.5 | <1.5 | <1.5 | | | <1.5 | <1.5 |
| 11-Dec-18 | Chloride (mg/l) | | <2 | <2 | | <2 | <2 | <2 | <2 | <2 | | | | | <2 | <2 | | |
| 12-Dec-18 | Chloride (mg/l) | | | | | | | | | | <2 | <2 | 2.4 | 3.4 | | | 3.4 | 3.9 |
| 11-Dec-18 | Sulphate (mg/l) | <500 | 1.7 | <0.3 | | <03 | 0.4 | <0.3 | 0.5 | <0.3 | | | | | 0.6 | 0.7 | | |
| 12-Dec-18 | Sulphate (mg/l) | <500 | | | | | | | | | 0.9 | 0.9 | 1.5 | 1.7 | | | 3 | 0.5 |
| 11-Dec-18 | Alkalinity (mg/l) | | 54.6 | 53.6 | | 39 | 38 | 43.9 | 40 | 42.9 | | | | | 19.5 | 35.1 | | |
| 12-Dec-18 | Alkalinity (mg/l) | | | | | | | | | | 65.3 | 58.5 | 52.6 | 45.8 | | | 63.4 | 32.2 |
| 11-Dec-18 | Arsenic (mg/l) | <0.01 | 0.0006 | <0.0003 | | <0.0003 | <0.0003 | <0.0003 | 0.0005 | <0.0003 | | | | | 0.0007 | <0.0003 | | |
| 12-Dec-18 | Arsenic (mg/l) | <0.01 | | | | | | | | | 0.0004 | <0.0003 | <0.0003 | <0.0003 | | | <0.0003 | <0.0003 |
| 11-Dec-18 | Calcium (mg/l) | | 8.06 | 6.38 | | 5.5 | 4.91 | 5.21 | 5.78 | 6.17 | | | | | 2.35 | 5.85 | | |
| 12-Dec-18 | Calcium (mg/l) | | | | | | | | | | 5.87 | 6.74 | 7.26 | 6.78 | | | 9.37 | 5.62 |
| 11-Dec-18 | Manganese (mg/l) | <1.0 | 0.04 | <0.005 | | <0.005 | <0.005 | <0.005 | 0.069 | 0.067 | | | | | 0.028 | <0.005 | | |
| 12-Dec-18 | Manganese (mg/l) | <1.0 | | | | | | | | | 0.074 | 0.066 | 0.048 | 0.075 | | | 0.04 | 0.045 |
| 11-Dec-18 | Mercury (mg/l) | <0.002 | <0.0002 | <0.0002 | | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | | | | | <0.0002 | <0.0002 | | |
| 12-Dec-18 | Mercury (mg/l) | <0.002 | | | | | | | | | 0.0002 | <0.0002 | <0.0002 | <0.0002 | | | <0.0002 | <0.0002 |
| 11-Dec-18 | Magnesium (mg/l) | | 1.66 | 1.53 | | 1.32 | 1.17 | 1.24 | 1.21 | 1.25 | | | | | 0.53 | 0.748 | | |
| 12-Dec-18 | Magnesium (mg/l) | | | | | | | | | | 1.23 | 1.44 | 1.51 | 1.42 | | | 2.3 | 0.642 |
| 11-Dec-18 | Lead (mg/l) | <0.05 | <0.010 | <0.010 | | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | | | | | <0.01 | <0.010 | | |
| 12-Dec-18 | Lead (mg/l) | <0.05 | | | | | | | | | <0.010 | <0.010 | <0.010 | <0.010 | | | <0.01 | <0.010 |
| 11-Dec-18 | Potassium (mg/l) | | 0.677 | 0.749 | | 0.772 | 0.744 | 0.774 | 0.759 | 0.799 | | | | | 0.583 | 0.723 | | |
| 12-Dec-18 | Potassium (mg/l) | | | | | | | | | | 0.742 | 0.719 | 0.717 | 0.693 | | | 0.564 | 0.269 |

| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 | NCH 01 | NPH 01 | NXA 01 | NHS 01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Parameters (Unit)** | **Guideline** | | | | | | | | | | | | | | | | |
| 11-Dec-18 | Sodium (mg/l) | | 1.63 | 1.47 | | 1.35 | 1.26 | 1.33 | 1.23 | 1.32 | | | | | 1.11 | 1.59 | | |
| 12-Dec-18 | Sodium (mg/l) | | | | | | | | | | 1.18 | 1.52 | 2 | 1.92 | | | 2.94 | 1.43 |
| 11-Dec-18 | Total Iron (mg/l) | | 1.27 | 0.107 | | 0.055 | 0.058 | 0.058 | 0.422 | 0.406 | | | | | 0.394 | 0.227 | | |
| 12-Dec-18 | Total Iron (mg/l) | | | | | | | | | | 0.372 | 0.382 | 0.316 | 0.394 | | | 0.491 | 0.936 |
| 2-Oct-18 | Phytoplankton Biomass (g dry wt/m3) | | | 27.2 | 3.4 | 10.3 | 6.8 | 8.1 | 2.6 | 3.4 | | | | | | | | |
| 06-Nov | Phytoplankton Biomass (g dry wt/m3) | | | 8 | | 8.4 | 4.9 | 8.7 | | | | | | | | | | |
| 07-Nov | Phytoplankton Biomass (g dry wt/m3) | | | | | | | | 11.8 | 10.7 | | | | | | | | |
| 11-Dec-18 | Phytoplankton Biomass (g dry wt/m3) | | | 2.4 | | 1.9 | 1.7 | 2.5 | 4.4 | 8.4 | | | | | | | | |
| 2-Oct-18 | Total Phosphorus (mg/l) | | | 0.04 | 0.04 | 0.03 | 0.03 | 0.03 | 0.02 | 0.04 | | | | | | | | |
| 06-Nov | Total Phosphorus (mg/l) | | | 0.02 | | <0.01 | 0.02 | 0.02 | | | | | | | | | | |
| 07-Nov | Total Phosphorus (mg/l) | | | | | | | | 0.02 | 0.02 | | | | | | | | |
| 11-Dec-18 | Total Phosphorus (mg/l) | | | <0.01 | | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | | | | | | | | |
| 2-Oct-18 | Total Dissolved Phosphorus (mg/l) | | | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | <0.01 | 0.03 | | | | | | | | |
| 06-Nov | Total Dissolved Phosphorus (mg/l) | | | <0.01 | | <0.02 | <0.02 | <0.02 | | | | | | | | | | |
| 07-Nov | Total Dissolved Phosphorus (mg/l) | | | | | | | | 0.01 | <0.01 | | | | | | | | |
| 2-Oct-18 | TOC (mg/l) | | | 0.92 | 1.09 | 3.32 | 3.79 | 3.64 | 2.57 | 1.81 | | | | | | | | |
| 06-Nov | TOC (mg/l) | | | 1.8 | | 2.08 | 2.54 | 3 | | | | | | | | | | |
| 07-Nov | TOC (mg/l) | | | | | | | | 1.81 | 1.78 | | | | | | | | |
| 11-Dec | TOC (mg/l) | | | 1.46 | | 1.6 | 1.61 | 1.78 | 1.6 | 1.72 | | | | | | | | |
| 03-Oct | Hydrogen Sulfide (mg/l) | | | | | | | | | <0.02 | | | | | | | | |
| 04-Oct | Hydrogen Sulfide (mg/l) | | | | | | | 0.03 | | | <0.02 | | | | | | | |
| 10-Oct | Hydrogen Sulfide (mg/l) | | | | | | | <0.02 | | <0.02 | <0.02 | | | | | | | |

| | | Station Code | NNG01 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | NNG 05 | NNG 06 | NNG 07 | NNG 08 | NCH 01 | NPH 01 | NXA 01 | NHS 01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Parameters (Unit)** | **Guideline** | | | | | | | | | | | | | | | | |
| 17-Oct | Hydrogen Sulfide (mg/l) | | | | | | | <0.02 | | <0.02 | <0.02 | | | | | | | |
| 23-Oct | Hydrogen Sulfide (mg/l) | | | | | | | <0.02 | | <0.02 | <0.02 | | | | | | | |
| 31-Oct | Hydrogen Sulfide (mg/l) | | | | | | | <0.02 | | <0.02 | <0.02 | | | | | | | |
| 06-Nov | Hydrogen Sulfide (mg/l) | | | | | | | <0.02 | | | | | | | | | | |
| 07-Nov | Hydrogen Sulfide (mg/l) | | | | | | | | | <0.02 | <0.02 | | | | | | | |
| 13-Nov | Hydrogen Sulfide (mg/l) | | | | | | | <0.02 | | | | | | | | | | |
| 14-Nov | Hydrogen Sulfide (mg/l) | | | | | | | | | <0.02 | <0.02 | | | | | | | |
| 11-Dec | Hydrogen Sulfide (mg/l) | | | | | | | <0.02 | | <0.02 | | | | | | | | |
| 12-Dec | Hydrogen Sulfide (mg/l) | | | | | | | | | | <0.02 | | | | | | | |
| 06-Nov | Total nitrogen (mg/l) | | 0.53 | 0.34 | | 0.75 | 0.56 | 0.51 | | | | | | | 0.37 | | | |
| 07-Nov | Total nitrogen (mg/l) | | | | | | | | 0.38 | 0.41 | 0.27 | 0.28 | 0.5 | 0.3 | | | 0.51 | 0.35 |

## APPENDIX 5-2: EFFLUENT CAMP MONITORING RESULTS – Q4 2018

| | | Site Name | Owner's Site Office and Village | Obayashi Camp | Sino Hydro Camp | Song Da5 Camp No.1 | Song Da5 Camp No.2 | Zhefu Camp | V & K Camp | HM Main Camp | IHI Camp | Kenber Camp | Lilama10 Camp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Station Code | EF01 | EF02 | EF06 | EF07 | EF08 | EF09 | EF10 | EF13 | EF14 | EF16 | (EF17) |
| Date | Parameter (Unit) | Guideline in the CA | | | | | | | | | | | |
| 02-Jul-18 | pH | 6.0-9.0 | 7.21 | 7.57 | | 7.55 | 7.4 | 7.49 | 7.35 | 7.28 | 7.35 | 7.13 | 7.09 |
| 16-Jul-18 | pH | 6.0-9.0 | 7.53 | 7.58 | 7.57 | 7.51 | 7.52 | 7.7 | 7.57 | 7.35 | 7.12 | 7.55 | 7.05 |
| 13-Aug-18 | pH | 6.0-9.0 | 7.02 | 7.63 | 7.51 | 7.17 | 7.36 | 6.77 | 7.36 | 7.8 | 7.19 | 7.82 | 6.85 |
| 27-Aug-18 | pH | 6.0-9.0 | 6.87 | 7.6 | 7.51 | 7.27 | 7.5 | 7.29 | 7.56 | 7.29 | 6.91 | 7.3 | 7.68 |
| 03-Sep-18 | pH | 6.0-9.0 | 7.09 | 7.31 | 7.44 | 7.4 | 7.28 | 6.92 | 7.53 | 7.47 | 7.09 | 7.32 | 7.23 |

| | | Site Name | Owner's Site Office and Village | Obayashi Camp | Sino Hydro Camp | Song Da5 Camp No.1 | Song Da5 Camp No.2 | Zhefu Camp | V & K Camp | HM Main Camp | IHI Camp | Kenber Camp | Lilama10 Camp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Station Code | EF01 | EF02 | EF06 | EF07 | EF08 | EF09 | EF10 | EF13 | EF14 | EF16 | (EF17) |
| Date | Parameter (Unit) | Guideline in the CA | | | | | | | | | | | |
| 17-Sep-18 | pH | 6.0-9.0 | 6.91 | 7.29 | | 7.5 | 7.25 | 6.98 | 7.18 | 7.29 | 7.69 | | 6.82 |
| 02-Jul-18 | Sat. DO (%) | | 55.3 | 90.6 | | 68.1 | 46.7 | 39.5 | 85.2 | 54 | 23.9 | 92.5 | 64.6 |
| 16-Jul-18 | Sat. DO (%) | | 59.8 | 77.4 | 74.5 | 66.6 | 44.4 | 30 | 53 | 59.1 | 11 | 98.7 | 33.4 |
| 13-Aug-18 | Sat. DO (%) | | 73.9 | 98.3 | 102.1 | 55.2 | 44.8 | 36.9 | 93.6 | 42.4 | 77.2 | 155.4 | 61.4 |
| 27-Aug-18 | Sat. DO (%) | | 55.4 | 95.1 | 56.8 | 59 | 26.8 | 44.7 | 95.8 | 68.9 | 55.5 | 123 | 68.3 |
| 03-Sep-18 | Sat. DO (%) | | 69.2 | 67.7 | 89.4 | 36.8 | 47.1 | 29.5 | 77.4 | 61.3 | 15.3 | 106.6 | 71.3 |
| 17-Sep-18 | Sat. DO (%) | | 59.2 | 53.7 | | 72.3 | 32.6 | 30.6 | 35.2 | 69.2 | 42.1 | | 77 |
| 08-Aug-18 | DO (mg/l) | | 4.16 | 5.63 | 3.87 | 4.71 | 5.05 | | 5.73 | 5.22 | 3.39 | 7.38 | |
| 02-Jul-18 | DO (mg/l) | | 4.08 | 6.48 | | 4.81 | 3.38 | 2.7 | 6.14 | 3.92 | 1.7 | 6.74 | 4.56 |
| 16-Jul-18 | DO (mg/l) | | 4.55 | 5.74 | 5.59 | 5.01 | 3.38 | 2.62 | 4.04 | 4.47 | 0.8 | 6.7 | 2.5 |
| 13-Aug-18 | DO (mg/l) | | 5.68 | 7.31 | 7.67 | 4.1 | 3.38 | 2.77 | 7.08 | 3.22 | 5.88 | 11.41 | 4.64 |
| 27-Aug-18 | DO (mg/l) | | 4.17 | 6.61 | 4.19 | 4.14 | 1.99 | 3.16 | 7.03 | 5.05 | 4.03 | 8.79 | 4.87 |
| 03-Sep-18 | DO (mg/l) | | 5.33 | 5.17 | 6.99 | 2.84 | 3.69 | 2.25 | 5.95 | 4.78 | 1.15 | 8.23 | 5.32 |
| 17-Sep-18 | DO (mg/l) | | 4.57 | 4.04 | | 5.5 | 2.46 | 2.29 | 2.67 | 5.19 | 3.14 | | 5.78 |
| 02-Jul-18 | Conductivity (µS/cm) | | 333 | 578 | | 1,164 | 674 | 523 | 185.1 | 936 | 657 | 154.1 | 333 |

| | | Site Name | Owner's Site Office and Village | Obayashi Camp | Sino Hydro Camp | Song Da5 Camp No.1 | Song Da5 Camp No.2 | Zhefu Camp | V & K Camp | HM Main Camp | IHI Camp | Kenber Camp | Lilama10 Camp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Station Code | EF01 | EF02 | EF06 | EF07 | EF08 | EF09 | EF10 | EF13 | EF14 | EF16 | (EF17) |
| Date | Parameter (Unit) | Guideline in the CA | | | | | | | | | | | |
| 16-Jul-18 | Conductivity (µS/cm) | | 322 | 549 | 289 | 843 | 568 | 475 | 350 | 866 | 476 | 195.5 | 328 |
| 13-Aug-18 | Conductivity (µS/cm) | | 385 | 483 | 294 | 919 | 651 | 394 | 382 | 1023 | 835 | 163.2 | 324 |
| 27-Aug-18 | Conductivity (µS/cm) | | 269 | 412 | 245 | 903 | 396 | 534 | 208.2 | 1.101 | 704 | 154 | 293 |
| 03-Sep-18 | Conductivity (µS/cm) | | 296 | 435 | 142.2 | 776 | 654 | 432 | 309 | 947 | 643 | 134.8 | 366 |
| 17-Sep-18 | Conductivity (µS/cm) | | 385 | 501 | | 940 | 506 | 736 | 338 | 1343 | 1,236 | | 439 |
| 02-Jul-18 | Temperature (°C) | | 29.1 | 31.1 | | 32 | 30.7 | 33.7 | 30.8 | 30.1 | 31.4 | 29.5 | 29.1 |
| 16-Jul-18 | Temperature (°C) | | 27.3 | 28.7 | 27.9 | 28.2 | 27.8 | 28.4 | 27.6 | 27.8 | 27.9 | 27.3 | 28.6 |
| 13-Aug-18 | Temperature (°C) | | 26.9 | 28.7 | 28.1 | 29.3 | 28.1 | 28.4 | 28 | 27.7 | 27.5 | 28.9 | 28 |
| 27-Aug-18 | Temperature (°C) | | 28.1 | 32.8 | 25.3 | 32.2 | 30.5 | 31.6 | 29.7 | 29.6 | 30.3 | 31 | 31.3 |
| 03-Sep-18 | Temperature (°C) | | 26.2 | 27.3 | 26.2 | 27.1 | 26.9 | 27.7 | 27.2 | 27.4 | 28.1 | 26.4 | 26.8 |
| 17-Sep-18 | Temperature (°C) | | 27 | 28.2 | | 27.9 | 28.2 | 28.2 | 27.9 | 28.5 | 28.6 | | 28.4 |
| 02-Jul-18 | Turbidity (NTU) | | 0.73 | 20.26 | | 54.82 | 62.1 | 26.38 | 4.68 | 58.09 | 25.04 | 6.18 | 32 |
| 16-Jul-18 | Turbidity (NTU) | | 2.01 | 33.28 | 25.52 | 29.6 | 65.17 | 20.72 | 8.1 | 37.88 | 35.85 | 15.42 | 35.4 |

| | | Site Name | Owner's Site Office and Village | Obayashi Camp | Sino Hydro Camp | Song Da5 Camp No.1 | Song Da5 Camp No.2 | Zhefu Camp | V & K Camp | HM Main Camp | IHI Camp | Kenber Camp | Lilama10 Camp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Station Code | EF01 | EF02 | EF06 | EF07 | EF08 | EF09 | EF10 | EF13 | EF14 | EF16 | (EF17) |
| Date | Parameter (Unit) | Guideline in the CA | | | | | | | | | | | |
| 13-Aug-18 | Turbidity (NTU) | | 1.59 | 27.06 | 8.03 | 32.39 | 38.2 | 19.56 | 7.64 | 71.69 | 37.43 | 10.91 | 46.87 |
| 27-Aug-18 | Turbidity (NTU) | | 1.29 | 10.5 | 3.97 | 30.79 | 16.13 | 34.58 | 3.33 | 38.95 | 31.28 | 6.38 | 25.99 |
| 03-Sep-18 | Turbidity (NTU) | | 1.57 | 14.94 | 13.36 | 14.66 | 27.14 | 23.48 | 4.95 | 34.66 | 34 | 6.85 | 23.89 |
| 17-Sep-18 | Turbidity (NTU) | | 1.42 | 21.1 | | 22.48 | 8.8 | 28.33 | 4.34 | 49.83 | 16.11 | | 9.17 |
| 02-Jul-18 | TSS (mg/l) | <50 | <5 | 5.26 | | 20.54 | 15.24 | 18.77 | 11.49 | 26.07 | 18.41 | 6.31 | 52.68 |
| 16-Jul-18 | TSS (mg/l) | <50 | <5 | 6.46 | 0.19 | 25.7 | 17.75 | 28.79 | 8.94 | 33.58 | 136.73 | 19.33 | 20.83 |
| 13-Aug-18 | TSS (mg/l) | <50 | <5 | 5.38 | 8.92 | 18.49 | 12.6 | 30.08 | 9.21 | 47.49 | 36.03 | 16.9 | 17.92 |
| 27-Aug-18 | TSS (mg/l) | <50 | <5 | 8.81 | <5 | 20.83 | 12.12 | 41.05 | 13.64 | 42.42 | 42.86 | 10.1 | 15.46 |
| 03-Sep-18 | TSS (mg/l) | <50 | <5 | 8.03 | 12.53 | 25.68 | 13.26 | 32.65 | 13.57 | 40.54 | 28.62 | 6.84 | 10.34 |
| 17-Sep-18 | TSS (mg/l) | <50 | <5 | 10.58 | | 16.24 | 11.76 | 47.3 | 7.3 | 89.74 | 12.94 | | 7.52 |
| 02-Jul-18 | BOD5 (mg/l) | <30 | 18.66 | <6 | | <6 | <6 | <6 | 10.98 | 112.2 | 89.93 | <6 | <6 |
| 16-Jul-18 | BOD5 (mg/l) | <30 | 9.39 | <6 | 6.03 | <6 | <6 | <6 | <6 | 198.3 | <6 | <6 | 29.76 |
| 13-Aug-18 | BOD5 (mg/l) | <30 | 10.74 | <6 | <6 | 32.64 | <6 | 45 | <6 | 64.84 | <6 | <6 | 21.9 |
| 27-Aug-18 | BOD5 (mg/l) | <30 | <6 | <6 | <6 | <6 | <6 | <6 | <6 | 128.1 | 78.9 | <6 | <6 |
| 03-Sep-18 | BOD5 (mg/l) | <30 | 6.12 | <6 | <6 | <6 | <6 | 22.32 | <6 | <6 | <6 | <6 | <6 |
| 17-Sep-18 | BOD5 (mg/l) | <30 | 6.81 | 24.42 | | <6 | <6 | <6 | <6 | <6 | <6 | | <6 |

| | | Site Name | Owner's Site Office and Village | Obayashi Camp | Sino Hydro Camp | Song Da5 Camp No.1 | Song Da5 Camp No.2 | Zhefu Camp | V & K Camp | HM Main Camp | IHI Camp | Kenber Camp | Lilama10 Camp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Station Code | EF01 | EF02 | EF06 | EF07 | EF08 | EF09 | EF10 | EF13 | EF14 | EF16 | (EF17) |
| Date | Parameter (Unit) | Guideline in the CA | | | | | | | | | | | |
| 02-Jul-18 | COD (mg/l) | <125 | <25 | 37.6 | | 93.6 | 54.6 | 29.4 | <25 | 221 | 114 | <25 | 106 |
| 16-Jul-18 | COD (mg/l) | <125 | <25 | 43.1 | <25 | 53.8 | 61.6 | 67.5 | 32.8 | 316 | 374 | 39.1 | 26.6 |
| 13-Aug-18 | COD (mg/l) | <125 | <25 | 40 | 26.8 | 70.9 | 59.2 | 76 | 37.2 | 254 | 196 | 32.2 | <25 |
| 27-Aug-18 | COD (mg/l) | <125 | <25 | 32.9 | <25 | 55.4 | 47.2 | 91.9 | <25 | 224 | 187 | <25 | <25 |
| 03-Sep-18 | COD (mg/l) | <125 | <25 | 42.8 | <25 | 62.5 | 45.4 | 66.3 | 32.4 | 282 | 142 | <25 | <25 |
| 17-Sep-18 | COD (mg/l) | <125 | <25 | 46.6 | | 64.2 | 51 | 73 | 29.4 | 302 | 63.4 | | <25 |
| 02-Jul-18 | $NH_3$-N (mg/l) | <10 | 6.9 | 20.3 | | 24.8 | 24.4 | 10.3 | 3.7 | 28 | 16.8 | 4.9 | 34.2 |
| 16-Jul-18 | $NH_3$-N (mg/l) | <10 | 8.4 | 21.2 | 5.2 | 11.2 | 28.5 | 30.2 | 8.7 | 25.1 | 14.4 | 6.1 | 9.5 |
| 13-Aug-18 | $NH_3$-N (mg/l) | <10 | 11.7 | 16.8 | 6.3 | 21.1 | 19.7 | 25.2 | 7.8 | 18.2 | 12.8 | 2 | 7.6 |
| 27-Aug-18 | $NH_3$-N (mg/l) | <10 | 5.3 | 14.1 | 5.5 | 10.5 | 16.1 | 20 | 2.1 | 12.2 | 6.9 | <0.2 | 2.9 |
| 03-Sep-18 | $NH_3$-N (mg/l) | <10 | 3.9 | 12.7 | 2.3 | 15 | 10.4 | 21.3 | 3.9 | 18.1 | 6.8 | <0.2 | 2.3 |
| 17-Sep-18 | $NH_3$-N (mg/l) | <10 | 9.2 | 19.3 | | 19.7 | 23.7 | 26 | 8 | 11.8 | 25.4 | | 1.6 |
| 02-Jul-18 | Total Nitrogen (mg/l) | <10 | 10.4 | 20.6 | | 27.6 | 28.1 | 14.8 | 9.79 | 28.4 | 17 | 6.31 | 34.9 |
| 16-Jul-18 | Total Nitrogen (mg/l) | <10 | 9.36 | 21.8 | 19.7 | 25.7 | 29.1 | 30.8 | 17.3 | 25.3 | 15 | 6.25 | 9.87 |

| | | Site Name | Owner's Site Office and Village | Obayashi Camp | Sino Hydro Camp | Song Da5 Camp No.1 | Song Da5 Camp No.2 | Zhefu Camp | V & K Camp | HM Main Camp | IHI Camp | Kenber Camp | Lilama10 Camp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Station Code | EF01 | EF02 | EF06 | EF07 | EF08 | EF09 | EF10 | EF13 | EF14 | EF16 | (EF17) |
| Date | Parameter (Unit) | Guideline in the CA | | | | | | | | | | | |
| 13-Aug-18 | Total Nitrogen (mg/l) | <10 | 16.2 | 17.3 | 10.3 | 23.1 | 23.7 | 26.4 | 13.3 | 18.7 | 13.1 | 4.88 | 7.9 |
| 27-Aug-18 | Total Nitrogen (mg/l) | <10 | 11.1 | 17.3 | 25.4 | 14.2 | 19.9 | 20.2 | 39.4 | 16 | 28.2 | 8.7 | 42.2 |
| 03-Sep-18 | Total Nitrogen (mg/l) | <10 | 8.91 | 15.8 | 8.27 | 16.7 | 14.9 | 21.7 | 4.29 | 21.4 | 9.19 | 1.42 | 2.91 |
| 17-Sep-18 | Total Nitrogen (mg/l) | <10 | 13.8 | 20 | | 20.7 | 24.3 | 27.7 | 8.6 | 12.1 | 26.2 | | 2.6 |
| 02-Jul-18 | Total Phosphorus (mg/l) | <2.0 | 0.69 | 0.8 | | 0.68 | 0.83 | 0.23 | 0.34 | 0.95 | 0.61 | 0.39 | 0.48 |
| 16-Jul-18 | Total Phosphorus (mg/l) | <2.0 | 1.94 | 1.82 | 1.09 | 0.77 | 2.25 | 1.04 | 0.95 | 2.37 | 2.53 | 0.69 | 0.28 |
| 13-Aug-18 | Total Phosphorus (mg/l) | <2.0 | 1.19 | 1.07 | 0.84 | 0.91 | 1.15 | 1.36 | 0.73 | 1.26 | 1.1 | 0.3 | 0.12 |
| 27-Aug-18 | Total Phosphorus (mg/l) | <2.0 | 1.08 | 1.11 | 0.8 | 0.62 | 1.26 | 1.2 | 0.32 | 1.11 | 0.89 | 0.27 | 0.12 |
| 03-Sep-18 | Total Phosphorus (mg/l) | <2.0 | 0.97 | 0.98 | 0.31 | 0.68 | 1.13 | 1.07 | 0.53 | 1.31 | 0.76 | 0.16 | 0.04 |
| 17-Sep-18 | Total Phosphorus (mg/l) | <2.0 | 0.86 | 1.13 | | 1.07 | 1.19 | 1.09 | 0.73 | 1.15 | 1.17 | | 0.03 |

| | | Site Name | Owner's Site Office and Village | Obayashi Camp | Sino Hydro Camp | Song Da5 Camp No.1 | Song Da5 Camp No.2 | Zhefu Camp | V & K Camp | HM Main Camp | IHI Camp | Kenber Camp | Lilama10 Camp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Station Code | EF01 | EF02 | EF06 | EF07 | EF08 | EF09 | EF10 | EF13 | EF14 | EF16 | (EF17) |
| Date | Parameter (Unit) | Guideline in the CA | | | | | | | | | | | |
| 02-Jul-18 | Faecal Coliform (MPN/100 ml) | <400 | 23 | 0 | | 0 | 0 | 920 | 23 | 540 | 170 | 0 | 0 |
| 16-Jul-18 | Faecal Coliform (MPN/100 ml) | <400 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 920 | 0 | 0 | 27 |
| 13-Aug-18 | Faecal Coliform (MPN/100 ml) | <400 | 170 | 0 | 0 | 1600 | 0 | 220 | 0 | 23 | 0 | 0 | 540 |
| 27-Aug-18 | Faecal Coliform (MPN/100 ml) | <400 | 22 | 0 | 0 | 0 | 2 | 2 | 2 | 1600 | 0 | 0 | 0 |
| 03-Sep-18 | Faecal Coliform (MPN/100 ml) | <400 | 23 | 0 | 79 | 0 | 0 | 240 | 0 | 0 | 0 | 0 | 2 |
| 17-Sep-18 | Faecal Coliform (MPN/100 ml) | <400 | 1600 | 1600 | | 0 | 0 | 0 | 0 | 0 | 0 | | 0 |
| 02-Jul-18 | Total Coliform (MPN/100 ml) | <400 | 920 | 540 | | 0 | 0 | 1600 | 240 | 16000 | 540 | 0 | 0 |
| 16-Jul-18 | Total Coliform (MPN/100 ml) | <400 | 1600 | 0 | 0 | 0 | 0 | 0 | 0 | 16000 | 0 | 0 | 920 |
| 13-Aug-18 | Total Coliform (MPN/100 ml) | <400 | 280 | 0 | 240 | 1600 | 0 | 220 | 0 | 23 | 0 | 0 | 1600 |
| 27-Aug-18 | Total Coliform (MPN/100 ml) | <400 | 140 | 0 | 17 | 0 | 2 | 2 | 7.8 | 3500 | 0 | 2 | 0 |

| | | Site Name | Owner's Site Office and Village | Obayashi Camp | Sino Hydro Camp | Song Da5 Camp No.1 | Song Da5 Camp No.2 | Zhefu Camp | V & K Camp | HM Main Camp | IHI Camp | Kenber Camp | Lilama10 Camp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Station Code | EF01 | EF02 | EF06 | EF07 | EF08 | EF09 | EF10 | EF13 | EF14 | EF16 | (EF17) |
| Date | Parameter (Unit) | Guideline in the CA | | | | | | | | | | | |
| 03-Sep-18 | Total Coliform (MPN/100 ml) | <400 | 130 | 0 | 170 | 0 | 0 | 240 | 0 | 0 | 2 | 0 | 4.5 |
| 17-Sep-18 | Total Coliform (MPN/100 ml) | <400 | 1600 | 1600 | | 0 | 0 | 0 | 0 | 0 | 0 | | 0 |
| 02-Jul-18 | Oil & Grease (mg/l) | <10 | <1 | <1 | | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 16-Jul-18 | Oil & Grease (mg/l) | <10 | | | | | | | | | | | |
| 13-Aug-18 | Oil & Grease (mg/l) | <10 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | 6 | 8 | <1 | <1 |
| 27-Aug-18 | Oil & Grease (mg/l) | <10 | | | | | | | | | | | |
| 03-Sep-18 | Oil & Grease (mg/l) | <10 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | 6 | <1 | <1 |
| 17-Sep-18 | Oil & Grease (mg/l) | <10 | | | | | | | | | | | |
| 02-Jul-18 | Residual Chlorine (mg/l) | <1.0 | | 0.48 | | 0.89 | 1.49 | 2.09 | 0.19 | 1.16 | 0.51 | 0.83 | 0.72 |
| 16-Jul-18 | Residual Chlorine (mg/l) | <1.0 | | 0.24 | 0.19 | 1.43 | 0.43 | 0.48 | 0.18 | 0.07 | 0.68 | 0.41 | 0.02 |

| | | Site Name | Owner's Site Office and Village | Obayashi Camp | Sino Hydro Camp | Song Da5 Camp No.1 | Song Da5 Camp No.2 | Zhefu Camp | V & K Camp | HM Main Camp | IHI Camp | Kenber Camp | Lilama10 Camp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Station Code | EF01 | EF02 | EF06 | EF07 | EF08 | EF09 | EF10 | EF13 | EF14 | EF16 | (EF17) |
| Date | Parameter (Unit) | Guideline in the CA | | | | | | | | | | | |
| 13-Aug-18 | Residual Chlorine (mg/l) | <1.0 | | 0.37 | 0.14 | 0.04 | 1.23 | 0.03 | 0.46 | 0.86 | 1.1 | 0.19 | 0.07 |
| 27-Aug-18 | Residual Chlorine (mg/l) | <1.0 | | 1.09 | 0.22 | 1.27 | 0.94 | 1.1 | 0.14 | 0.08 | 0.83 | 0.35 | 0.93 |
| 03-Sep-18 | Residual Chlorine (mg/l) | <1.0 | | 0.6 | 0.09 | 0.94 | 1.12 | 0.53 | 0.33 | 0.98 | 0.49 | 0.24 | 0.37 |
| 17-Sep-18 | Residual Chlorine (mg/l) | <1.0 | | 0.1 | | 0.54 | 0.61 | 0.77 | 0.22 | 1.48 | 1.93 | | 1 |
| 02-Jul-18 | Chlorination Dosing Rate (ml/mn) | | | 217 | | 47 | 240 | 3.1 | 20 | 3.1 | | 58 | 3.1 |
| 16-Jul-18 | Chlorination Dosing Rate (ml/mn) | | | 840 | 152 | 385 | 842 | 3.1 | 21 | 3.1 | | 16 | |
| 13-Aug-18 | Chlorination Dosing Rate (ml/mn) | | | 95 | 12 | 20 | 85 | 3.1 | 50 | 3.1 | 38 | 9 | 3.1 |
| 27-Aug-18 | Chlorination Dosing Rate (ml/mn) | | | 290 | 38 | 300 | | 3.1 | 148 | 3.1 | | 160 | 3.1 |

| | | Site Name | Owner's Site Office and Village | Obayashi Camp | Sino Hydro Camp | Song Da5 Camp No.1 | Song Da5 Camp No.2 | Zhefu Camp | V & K Camp | HM Main Camp | IHI Camp | Kenber Camp | Lilama10 Camp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Station Code | EF01 | EF02 | EF06 | EF07 | EF08 | EF09 | EF10 | EF13 | EF14 | EF16 | (EF17) |
| Date | Parameter (Unit) | Guideline in the CA | | | | | | | | | | | |
| 03-Sep-18 | Chlorination Dosing Rate (ml/mn) | | | 615 | 38 | 152 | 503 | 3.1 | 70 | 3.1 | 3.1 | 43 | 3.1 |
| 17-Sep-18 | Chlorination Dosing Rate (ml/mn) | | | 500 | | 256 | 880 | 3.1 | 170 | 3.1 | 3.1 | | 3.1 |
| 02-Jul-18 | Effluent Discharge Volume (L/mn) | | 12 | 6 | | 12 | 20 | 4.2 | 3.33 | 4.2 | 2.4 | 3 | 4.2 |
| 16-Jul-18 | Effluent Discharge Volume (L/mn) | | 20 | 12 | 6 | 60 | 12 | 4.2 | 3.15 | 4.2 | 6 | 3 | |
| 13-Aug-18 | Effluent Discharge Volume (L/mn) | | 20 | 6 | 3 | 60 | 30 | 4.2 | 6 | 4.2 | 3 | 3 | 4.2 |
| 27-Aug-18 | Effluent Discharge Volume (L/mn) | | | 20 | | 60 | | 4.2 | 12 | 4.2 | | | 4.2 |
| 03-Sep-18 | Effluent Discharge Volume (L/mn) | | 6 | 30 | 8.5 | 60 | 30 | 4.2 | 6 | 4.2 | 4.2 | 0 | 4.2 |
| 17-Sep-18 | Effluent Discharge Volume (L/mn) | | | 20 | | 4 | 30 | 4.2 | 6 | 4.2 | 4.2 | | 4.2 |

**APPENDIX 5-3: EFFLUENT CONSTRUCTION AREA DISCHARGED MONITORING RESULTS – Q4 2018**

| Date | Site Name | Parameter (Unit) | pH | Sat. DO (%) | DO (mg/L) | Conductivity (µS/cm) | TDS (mg/L) | Temperature (°C) | Turbidity (NTU) | TSS (mg/L) | Oil & Grease (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Standard | 6.0 - 9.0 | | | | | | | <50 | <10 |
| 05-Jul-18 | RCC Plant Discharged at lower ponds | DS09 | | | | | | | | | |
| 12-Jul-18 | RCC Plant Discharged at lower ponds | DS09 | | | | | | | | | |
| 18-Jul-18 | RCC Plant Discharged at lower ponds | DS09 | | | | | | | | | |
| 26-Jul-18 | RCC Plant Discharged at lower ponds | DS09 | | | | | | | | | |
| 02-Aug-18 | RCC Plant Discharged at lower ponds | DS09 | | | | | | | | | |
| 09-Aug-18 | RCC Plant Discharged at lower ponds | DS09 | | | | | | | | | |
| 16-Aug-18 | RCC Plant Discharged at lower ponds | DS09 | | | | | | | | | |
| 23-Aug-18 | RCC Plant Discharged at lower ponds | DS09 | 6.86 | 98.3 | 7.46 | 233 | 116.5 | 27.9 | 10.97 | 10 | |
| 30-Aug-18 | RCC Plant Discharged at lower ponds | DS09 | 7.97 | 99.4 | 7.73 | 202.3 | 101 | 26.2 | 17.8 | 7.89 | |
| 06-Sep-18 | RCC Plant Discharged at lower ponds | DS09 | | | | | | | | | |
| 13-Sep-18 | RCC Plant Discharged at lower ponds | DS09 | | | | | | | | | |

| Date | Site Name | Parameter (Unit) | pH | Sat. DO (%) | DO (mg/L) | Conductivity (µS/cm) | TDS (mg/L) | Temperature (°C) | Turbidity (NTU) | TSS (mg/L) | Oil & Grease (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Standard | 6.0 - 9.0 | | | | | | | <50 | <10 |
| 20-Sep-18 | RCC Plant Discharged at lower ponds | DS09 | | | | | | | | | |
| 27-Sep-18 | RCC Plant Discharged at lower ponds | DS09 | | | | | | | | | |
| 05-Jul-18 | CVC Plant | DS03 | | | | | | | | | |
| 12-Jul-18 | CVC Plant | DS03 | | | | | | | | | |
| 18-Jul-18 | CVC Plant | DS03 | | | | | | | | | |
| 26-Jul-18 | CVC Plant | DS03 | | | | | | | | | |
| 02-Aug-18 | CVC Plant | DS03 | | | | | | | | | |
| 09-Aug-18 | CVC Plant | DS03 | | | | | | | | | |
| 16-Aug-18 | CVC Plant | DS03 | | | | | | | | | |
| 23-Aug-18 | CVC Plant | DS03 | | | | | | | | | |
| 30-Aug-18 | CVC Plant | DS03 | | | | | | | | | |
| 06-Sep-18 | CVC Plant | DS03 | | | | | | | | | |
| 13-Sep-18 | CVC Plant | DS03 | | | | | | | | | |
| 20-Sep-18 | CVC Plant | DS03 | | | | | | | | | |
| 27-Sep-18 | CVC Plant | DS03 | | | | | | | | | |
| 05-Jul-18 | Aggregate Crushing Plant | DS02 | | | | | | | | | |
| 12-Jul-18 | Aggregate Crushing Plant | DS02 | | | | | | | | | |
| 18-Jul-18 | Aggregate Crushing Plant | DS02 | | | | | | | | | |
| 26-Jul-18 | Aggregate Crushing Plant | DS02 | | | | | | | | | |

| Date | Site Name | Parameter (Unit) | pH | Sat. DO (%) | DO (mg/L) | Conductivity (µS/cm) | TDS (mg/L) | Temperature (°C) | Turbidity (NTU) | TSS (mg/L) | Oil & Grease (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Standard | 6.0 - 9.0 | | | | | | | <50 | <10 |
| 02-Aug-18 | Aggregate Crushing Plant | DS02 | | | | | | | | | |
| 09-Aug-18 | Aggregate Crushing Plant | DS02 | | | | | | | | | |
| 16-Aug-18 | Aggregate Crushing Plant | DS02 | | | | | | | | | |
| 23-Aug-18 | Aggregate Crushing Plant | DS02 | 7.81 | 101.1 | 8.21 | 46.4 | 23.2 | 25.7 | 17.36 | 16.25 | |
| 30-Aug-18 | Aggregate Crushing Plant | DS02 | 7.98 | 98.6 | 7.81 | 43.4 | 21.5 | 25.3 | 7.59 | 1.76 | |
| 06-Sep-18 | Aggregate Crushing Plant | DS02 | 6.27 | 98.8 | 7.48 | 32.1 | 16 | 28 | 3.28 | 1.29 | |
| 13-Sep-18 | Aggregate Crushing Plant | DS02 | 7.36 | 96.8 | 7.35 | 34.8 | 17.4 | 27.8 | 4.94 | 1.64 | <1 |
| 20-Sep-18 | Aggregate Crushing Plant | DS02 | 6.28 | 94.1 | 7.52 | 29.4 | 14.5 | 25.6 | 2.29 | 0.5 | |
| 27-Sep-18 | Aggregate Crushing Plant | DS02 | 7.46 | 108.5 | 8.25 | 34 | 17 | 27.6 | 2 | 0.66 | |
| 05-Jul-18 | Spoil Disposal No.2 | DS04 | 6.9 | 69.9 | 5.29 | 22.7 | 11 | 27.8 | 147.68 | 136.61 | <1 |
| 12-Jul-18 | Spoil Disposal No.2 | DS04 | 7.73 | 78.6 | 6.11 | 20.4 | 10 | 26.1 | 90 | 58.72 | |
| 18-Jul-18 | Spoil Disposal No.2 | DS04 | 6.42 | 97.4 | 7.71 | 23.3 | 11.5 | 25.5 | 183 | 151.69 | |
| 26-Jul-18 | Spoil Disposal No.2 | DS04 | 6.35 | 88.8 | 7.08 | 55.4 | 27.5 | 25 | 2,765 | 2,833 | |
| 02-Aug-18 | Spoil Disposal No.2 | DS04 | 6.45 | 81.8 | 6.55 | 15.6 | 7.8 | 25.4 | 51.34 | 39.04 | |
| 09-Aug-18 | Spoil Disposal No.2 | DS04 | 7.86 | 67.7 | 6.17 | 17.62 | 8.8 | 24.6 | 19.73 | 13.15 | <1 |
| 16-Aug-18 | Spoil Disposal No.2 | DS04 | 7.05 | 74.2 | 5.82 | 15.25 | 7 | 25.8 | 13.71 | 7.4 | |
| 23-Aug-18 | Spoil Disposal No.2 | DS04 | 7.52 | 79.8 | 6.3 | 16.02 | 8 | 25.5 | 20.76 | 14.6 | |
| 30-Aug-18 | Spoil Disposal No.2 | DS04 | 6.68 | 89.3 | 6.91 | 12.64 | 6.3 | 25.4 | 19.45 | 8.82 | |
| 06-Sep-18 | Spoil Disposal No.2 | DS04 | 7.32 | 78.8 | 6.12 | 12.26 | 6 | 28.6 | 12.22 | 9.79 | |
| 13-Sep-18 | Spoil Disposal No.2 | DS04 | 7.33 | 79.9 | 5.93 | 16.55 | 8.27 | 29.1 | 22.33 | 14.87 | <1 |

| Date | Site Name | Parameter (Unit) | pH | Sat. DO (%) | DO (mg/L) | Conductivity (µS/cm) | TDS (mg/L) | Temperature (°C) | Turbidity (NTU) | TSS (mg/L) | Oil & Grease (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Standard | 6.0 - 9.0 | | | | | | | <50 | <10 |
| 20-Sep-18 | Spoil Disposal No.2 | DS04 | 6.82 | 83.2 | 6.18 | 14.42 | 7.2 | 25.9 | 14.34 | 9.79 | |
| 27-Sep-18 | Spoil Disposal No.2 | DS04 | 7.61 | 88.8 | 6.78 | 16.98 | 8.49 | 27.4 | 6.53 | 8.38 | |
| 05-Jul-18 | Main Dam's Treatment Plant No.3 | DS14 | 7.16 | 107.8 | 7.29 | 295 | 147.5 | 30.7 | 3.8 | 6.77 | <1 |
| 12-Jul-18 | Main Dam's Treatment Plant No.3 | DS14 | 7.9 | 101.3 | 7.03 | 128.7 | 64.3 | 32.8 | 7.88 | 7.39 | |
| 18-Jul-18 | Main Dam's Treatment Plant No.3 | DS14 | 8.3 | 98.7 | 7.78 | 75.2 | 37.5 | 25.5 | 58.41 | 154.14 | |
| 26-Jul-18 | Main Dam's Treatment Plant No.3 | DS14 | 7.72 | 97.1 | 7.5 | 787 | 393 | 26.8 | 25.93 | 29.75 | |
| 02-Aug-18 | Main Dam's Treatment Plant No.3 | DS14 | 7.81 | 98.3 | 7.78 | 121.9 | 60.5 | 25.8 | 49.87 | 50.78 | |
| 09-Aug-18 | Main Dam's Treatment Plant No.3 | DS14 | 6.68 | 119.1 | 8.69 | 142.8 | 71.4 | 29.8 | 4.64 | 3.55 | <1 |
| 16-Aug-18 | Main Dam's Treatment Plant No.3 | DS14 | | | | | | | | | |
| 23-Aug-18 | Main Dam's Treatment Plant No.3 | DS14 | | | | | | | | | |
| 30-Aug-18 | Main Dam's Treatment Plant No.3 | DS14 | | | | | | | | | |
| 06-Sep-18 | Main Dam's Treatment Plant No.3 | DS14 | | | | | | | | | |
| 13-Sep-18 | Main Dam's Treatment Plant No.3 | DS14 | | | | | | | | | |

| Date | Site Name | Parameter (Unit) | pH | Sat. DO (%) | DO (mg/L) | Conductivity (µS/cm) | TDS (mg/L) | Temperature (°C) | Turbidity (NTU) | TSS (mg/L) | Oil & Grease (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Standard | 6.0 - 9.0 | | | | | | | <50 | <10 |
| 20-Sep-18 | Main Dam's Treatment Plant No.3 | DS14 | | | | | | | | | |
| 27-Sep-18 | Main Dam's Treatment Plant No.3 | DS14 | | | | | | | | | |

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**APPENDIX 5-4: GROUNDWATER QUALITY MONITORING RESULTS – QUARTER -Q4 2018**

| | | Site Name | Somseun Village | | NamPa Village | ThongNoy Village | Pou Village |
|---|---|---|---|---|---|---|---|
| | | Station | GSXN01 | GSXN02 | GNPA01 | GTHN01 | GPOU01 |
| Month Year | Parameter (Unit) | Guideline | | | | | |
| 11-Jul-18 | pH | 6.5 - 9.2 | 6.94 | | 7.02 | 6.91 | |
| 17-Jul-18 | pH | 6.5 - 9.2 | | | | | 6.31 |
| 01-Aug-18 | pH | 6.5 - 9.2 | 7.6 | | 7.54 | 7.45 | |
| 07-Aug-18 | pH | 6.5 - 9.2 | | | | | 6.37 |
| 04-Sep-18 | pH | 6.5 - 9.2 | | | | | 7.02 |
| 11-Sep-18 | pH | 6.5 - 9.2 | 7.48 | | 7.43 | 7.51 | |
| 11-Jul-18 | Sat. DO (%) | | 80.9 | | 82.2 | 77.2 | |
| 17-Jul-18 | Sat. DO (%) | | | | | | 78.2 |
| 01-Aug-18 | Sat. DO (%) | | 95.8 | | 90.5 | 81.4 | |
| 07-Aug-18 | Sat. DO (%) | | | | | | 80.3 |
| 04-Sep-18 | Sat. DO (%) | | | | | | 84.9 |
| 11-Sep-18 | Sat. DO (%) | | 82.6 | | 91.5 | 94.9 | |
| 11-Jul-18 | DO (mg/l) | | 6.15 | | 6.28 | 5.81 | |
| 17-Jul-18 | DO (mg/l) | | | | | | 6.07 |
| 01-Aug-18 | DO (mg/l) | | 7.24 | | 6.87 | 6.08 | |
| 07-Aug-18 | DO (mg/l) | | | | | | 6.16 |
| 04-Sep-18 | DO (mg/l) | | | | | | 6.76 |
| 11-Sep-18 | DO (mg/l) | | 6.07 | | 6.76 | 6.94 | |
| 11-Jul-18 | Conductivity (µS/cm) | | 344 | | 292 | 308 | |
| 17-Jul-18 | Conductivity (µS/cm) | | | | | | 15.78 |
| 01-Aug-18 | Conductivity (µS/cm) | | 347 | | 331 | 288 | |
| 07-Aug-18 | Conductivity (µS/cm) | | | | | | 14.72 |
| 04-Sep-18 | Conductivity (µS/cm) | | | | | | 18.72 |
| 11-Sep-18 | Conductivity (µS/cm) | | 301 | | 347 | 299 | |
| 11-Jul-18 | TDS (mg/l) | | 172 | | 146 | 154 | |
| 17-Jul-18 | TDS (mg/l) | | | | | | 7.5 |
| 01-Aug-18 | TDS (mg/l) | | 173 | | 165 | 144 | |
| 07-Aug-18 | TDS (mg/l) | | | | | | 7.3 |
| 04-Sep-18 | TDS (mg/l) | | | | | | 9.3 |
| 11-Sep-18 | TDS (mg/l) | | 150.5 | | 173.5 | 149.5 | |
| 11-Jul-18 | Temperature (°C) | | 28 | | 27.7 | 28.5 | |
| 17-Jul-18 | Temperature (°C) | | | | | | 25.7 |

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| | | Site Name | Somseun Village | | NamPa Village | ThongNoy Village | Pou Village |
|---|---|---|---|---|---|---|---|
| | | Station | GSXN01 | GSXN02 | GNPA01 | GTHN01 | GPOU01 |
| Month Year | Parameter (Unit) | Guideline | | | | | |
| 01-Aug-18 | Temperature (°C) | | 28.4 | | 28 | 28.8 | |
| 07-Aug-18 | Temperature (°C) | | | | | | 25.6 |
| 04-Sep-18 | Temperature (°C) | | | | | | 24.7 |
| 11-Sep-18 | Temperature (°C) | | 30.1 | | 29.8 | 30.4 | |
| 11-Jul-18 | Turbidity (NTU) | <20 | 0.66 | | 1.61 | 1.79 | |
| 17-Jul-18 | Turbidity (NTU) | <20 | | | | | 14.14 |
| 01-Aug-18 | Turbidity (NTU) | <20 | 3.29 | | 0.65 | 2.2 | |
| 07-Aug-18 | Turbidity (NTU) | <20 | | | | | 3.8 |
| 04-Sep-18 | Turbidity (NTU) | <20 | | | | | 2.98 |
| 11-Sep-18 | Turbidity (NTU) | <20 | 1.57 | | 1.42 | 1.22 | |
| 11-Jul-18 | Fecal coliform (MPN/100 ml) | 0 | 2 | | 0 | 0 | |
| 17-Jul-18 | Fecal coliform (MPN/100 ml) | 0 | | | | | 9.3 |
| 01-Aug-18 | Fecal coliform (MPN/100 ml) | 0 | 0 | | 0 | 0 | |
| 07-Aug-18 | Fecal coliform (MPN/100 ml) | 0 | | | | | 0 |
| 04-Sep-18 | Fecal coliform (MPN/100 ml) | 0 | | | | | 4.5 |
| 11-Sep-18 | Fecal coliform (MPN/100 ml) | 0 | 0 | | 0 | 0 | |
| 11-Jul-18 | E.coli Bacteria (MPN/100 ml) | 0 | 2 | | 0 | 0 | |
| 17-Jul-18 | E.coli Bacteria (MPN/100 ml) | 0 | | | | | 9.3 |
| 01-Aug-18 | E.coli Bacteria (MPN/100 ml) | 0 | 0 | | 0 | 0 | |
| 07-Aug-18 | E.coli Bacteria (MPN/100 ml) | 0 | | | | | 0 |
| 04-Sep-18 | E.coli Bacteria (MPN/100 ml) | 0 | | | | | 4.5 |
| 11-Sep-18 | E.coli Bacteria (MPN/100 ml) | 0 | 0 | | 0 | 0 | |
| 11-Jul-18 | Arsenic (mg/) | <0.05 | 0.0005 | | <0.0003 | <0.0003 | |
| 17-Jul-18 | Arsenic (mg/) | <0.05 | | | | | <0.0003 |
| 11-Jul-18 | Total Iron (mg/l) | <1 | <0.010 | | <0.010 | 0.98 | |
| 17-Jul-18 | Total Iron (mg/l) | <1 | | | | | 0.308 |
| 11-Jul-18 | Magnesium (mg/l) | | 4.26 | | 2.47 | 4.35 | |
| 17-Jul-18 | Magnesium (mg/l) | | | | | | 0.242 |
| 11-Jul-18 | Manganese (mg/l) | <0.5 | <0.005 | | <0.005 | <0.005 | |
| 17-Jul-18 | Manganese (mg/l) | <0.5 | | | | | <0.005 |
| 11-Jul-18 | Fluoride (mg/l) | <1 | | | | | |

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| | | Site Name | Somseun Village | | NamPa Village | ThongNoy Village | Pou Village |
|---|---|---|---|---|---|---|---|
| | | Station | GSXN01 | GSXN02 | GNPA01 | GTHN01 | GPOU01 |
| Month Year | Parameter (Unit) | Guideline | | | | | |
| 17-Jul-18 | Fluoride (mg/l) | <1 | | | | | 0.65 |
| 11-Jul-18 | Total hardness (mg/l) | <500 | 203 | | 152 | 171 | |
| 17-Jul-18 | Total hardness (mg/l) | <500 | | | | | 14.6 |
| 11-Jul-18 | Nitrate (mg/l) | <45 | 0.66 | | 1.64 | 1.68 | |
| 17-Jul-18 | Nitrate (mg/l) | <45 | | | | | 0.66 |
| 11-Jul-18 | Nitrite (mg/l) | <3 | <0.02 | | <0.02 | <0.02 | |
| 17-Jul-18 | Nitrite (mg/l) | <3 | | | | | |
| 11-Jul-18 | Lead (mg/l) | <0.05 | <0.008 | | <0.008 | <0.008 | |
| 17-Jul-18 | Lead (mg/l) | <0.05 | | | | | <0.008 |

## APPENDIX 5-5: GRAVITY FED WATER SUPPLY MONITORING RESULTS – Q4 2018

| | | Site Name | Thaheau Village | Hat Gnuin Village | Phouhomxay Village | | |
|---|---|---|---|---|---|---|---|
| | | Station | WTHH02 | WHGN02 | WPHX01 | WPHX02 | WPHX03 |
| Date | Parameter (Unit) | Guideline | | | | | |
| 11-Jul-18 | pH | 6.5 - 8.6 | 6.69 | 6.93 | 8.43 | 7.59 | 6.85 |
| 01-Aug-18 | pH | 6.5 - 8.6 | 7.88 | 7.72 | 7.75 | 7.74 | 7.52 |
| 11-Sep-18 | pH | 6.5 - 8.6 | 7.88 | 7.96 | 7.92 | 7.63 | 7.52 |
| 11-Jul-18 | Sat. DO (%) | | 95.3 | 96.1 | 98.3 | 95.5 | 91.7 |
| 01-Aug-18 | Sat. DO (%) | | 98.5 | 76.6 | 100.2 | 92.4 | 85.8 |
| 11-Sep-18 | Sat. DO (%) | | 94.5 | 96.9 | 100 | 99.2 | 98.8 |
| 11-Jul-18 | DO (mg/l) | | 7.11 | 7.3 | 7.61 | 7.3 | 6.93 |
| 01-Aug-18 | DO (mg/l) | | 7.41 | 5.53 | 8.04 | 7.08 | 6.54 |
| 11-Sep-18 | DO (mg/l) | | 6.86 | 7.22 | 7.72 | 7.7 | 7.4 |
| 11-Jul-18 | Conductivity (µS/cm) | <1,000 | 43.2 | 65.2 | 14.94 | 8.66 | 8.34 |
| 01-Aug-18 | Conductivity (µS/cm) | <1,000 | 24 | 36.6 | 14.81 | 10.87 | 10 |
| 11-Sep-18 | Conductivity (µS/cm) | <1,000 | 26.6 | 38.3 | 6.55 | 6.24 | 5.49 |
| 11-Jul-18 | TDS (mg/l) | <600 | 21.5 | 32.5 | 7.4 | 4.33 | 4.1 |
| 01-Aug-18 | TDS (mg/l) | <600 | 12 | 18 | 7.4 | 5.43 | 5 |
| 11-Sep-18 | TDS (mg/l) | <600 | 13.3 | 19.15 | 3.27 | 3.12 | 2.74 |
| 11-Jul-18 | Temperature (°C) | <35 | 28 | 27.9 | 26.7 | 27.5 | 27.9 |
| 01-Aug-18 | Temperature (°C) | <35 | 28.7 | 28.8 | 24.9 | 27.7 | 27.8 |
| 11-Sep-18 | Temperature (°C) | <35 | 30 | 29.7 | 27.5 | 27.2 | 28.9 |
| 11-Jul-18 | Turbidity (NTU) | <10 | 2.46 | 2.6 | 0.62 | 1.89 | 2.01 |
| 01-Aug-18 | Turbidity (NTU) | <10 | 5.56 | 6.06 | 0.71 | 2.75 | 2.58 |
| 11-Sep-18 | Turbidity (NTU) | <10 | 19.91 | 6.2 | 1.96 | 1.98 | 1.81 |
| 11-Jul-18 | Faecal Coliform (MPN/100ml) | 0 | 49 | 240 | 140 | 49 | 6.8 |
| 01-Aug-18 | Faecal Coliform (MPN/100ml) | 0 | 33 | 23 | 7.8 | 0 | 0 |
| 11-Sep-18 | Faecal Coliform (MPN/100ml) | 0 | 920 | 220 | 79 | 6.8 | 0 |
| 11-Jul-18 | E.coli Bacteria (MPN/100ml) | 0 | 49 | 240 | 33 | 17 | 6.8 |
| 01-Aug-18 | E.coli Bacteria (MPN/100ml) | 0 | 23 | 23 | 7.8 | 0 | 0 |
| 11-Sep-18 | E.coli Bacteria (MPN/100ml) | 0 | 920 | 220 | 79 | 6.8 | 0 |

## APPENDIX 5-6: LANDFILL LEACHATE MONITORING RESULTS – Q4 2018

| | | Site Name | NNP1 Landfill Leachate | | | | | Houay Soup Landfill | |
|---|---|---|---|---|---|---|---|---|---|
| | | Location | Pond No.01 | Pond No.02 | Pond No.03 | Pond No.04 | Discharge Point | Last pond | Discharged Point |
| | | Station | LL1 | LL2 | LL3 | LL4 | LL5 | LL6 | LL7 |
| Date | Parameter (Unit) | Guideline | | | | | | | |
| 16-Jul-18 | pH | 6.0-9.0 | | | | 8.39 | | | 7.48 |
| 13-Aug-18 | pH | 6.0-9.0 | | | | 8.9 | | 8.26 | |
| 3-Sep-18 | pH | 6.0-9.0 | | | | 8.87 | | | 7.77 |
| 16-Jul-18 | Sat. DO (%) | | | | | 120.1 | | | 70.7 |
| 13-Aug-18 | Sat. DO (%) | | | | | 103 | | 103.5 | |
| 3-Sep-18 | Sat. DO (%) | | | | | 133.2 | | | 51.3 |
| 16-Jul-18 | DO (mg/l) | | | | | 8.82 | | | 5.23 |
| 13-Aug-18 | DO (mg/l) | | | | | 7.79 | | 7.91 | |
| 3-Sep-18 | DO (mg/l) | | | | | 10.41 | | | 3.9 |
| 16-Jul-18 | Conductivity (µS/cm) | | | | | 169.7 | | | 154.8 |
| 13-Aug-18 | Conductivity (µS/cm) | | | | | 152.9 | | 171 | |
| 3-Sep-18 | Conductivity (µS/cm) | | | | | 93.8 | | | 191.2 |
| 16-Jul-18 | TDS (mg/l) | | | | | 84.3 | | | 77.4 |
| 13-Aug-18 | TDS (mg/l) | | | | | 76.45 | | 85.8 | |
| 3-Sep-18 | TDS (mg/l) | | | | | 46.5 | | | 99.5 |
| 16-Jul-18 | Temperature (°C) | | | | | 29.2 | | | 28.9 |
| 13-Aug-18 | Temperature (°C) | | | | | 27.8 | | 27.4 | |
| 3-Sep-18 | Temperature (°C) | | | | | 28.2 | | | 27.7 |
| 16-Jul-18 | Turbidity (NTU) | | | | | 83.86 | | | 2.22 |
| 13-Aug-18 | Turbidity (NTU) | | | | | 13.65 | | 4.38 | |
| 3-Sep-18 | Turbidity (NTU) | | | | | 12.46 | | | 3.77 |
| 16-Jul-18 | BOD (mg/l) | <30 | | | | 17.4 | | | 1.58 |
| 13-Aug-18 | BOD (mg/l) | <30 | | | | 5.74 | | 2.18 | |
| 3-Sep-18 | BOD (mg/l) | <30 | | | | 6.87 | | | <6 |
| 16-Jul-18 | COD (mg/l) | <125 | | | | 91.9 | | | <25 |
| 13-Aug-18 | COD (mg/l) | <125 | | | | 46.4 | | 33.4 | |
| 3-Sep-18 | COD (mg/l) | | | | | 35.7 | | | <25 |
| 16-Jul-18 | Faecal Coliform (MPN/100 ml) | | | | | 79 | | | 7.8 |
| 13-Aug-18 | Faecal Coliform (MPN/100 ml) | | | | | 4 | | 0 | |
| 3-Sep-18 | Faecal Coliform (MPN/100 ml) | | | | | 7.8 | | | 0 |
| 16-Jul-18 | Total Coliform (MPN/100 ml) | <400 | | | | 1,600 | | | 1,600 |
| 13-Aug-18 | Total Coliform (MPN/100 ml) | <400 | | | | 350 | | 39 | |
| 3-Sep-18 | Total Coliform (MPN/100 ml) | <400 | | | | 79 | | | 8 |
| 3-Sep-18 | Mercury (mg/l) | | | | | <0.0005 | | | <0.0005 |

| | | Site Name | NNP1 Landfill Leachate | | | | | Houay Soup Landfill | |
|---|---|---|---|---|---|---|---|---|---|
| | | Location | Pond No.01 | Pond No.02 | Pond No.03 | Pond No.04 | Discharge Point | Last pond | Discharged Point |
| | | Station | LL1 | LL2 | LL3 | LL4 | LL5 | LL6 | LL7 |
| Date | Parameter (Unit) | Guideline | | | | | | | |
| 3-Sep-18 | Total nitrogen (mg/l) | <10 | | | | 1 | | | 1 |
| 3-Sep-18 | Arsenic (mg/l) | | | | | 0.0006 | | | 0.001 |
| 3-Sep-18 | Manganese (mg/l) | | | | | 0.116 | | | 0.35 |
| 3-Sep-18 | Lead (mg/l) | <0.2 | | | | <0.010 | | | <0.010 |
| 3-Sep-18 | Iron (mg/l) | | | | | 0.666 | | | |
| 3-Sep-18 | Total Petroleum Hydrocarbons (mg/l) | | | | | <1 | | | <1 |

## APPENDIX 5-7: LANDFILL GROUNDWATER QUALITY MONITORING RESULTS – Q4 2018

| | Site Name | NNP1 Project Landfill | | | | Houay Soup Landfill |
|---|---|---|---|---|---|---|
| | Station | MW1 | MW2 | MW3 | MW4 | MW5 |
| | Date | 10-Sep-18 | 10-Sep-18 | 10-Sep-18 | 10-Sep-18 | 10-Sep-18 |
| Parameter (Unit) | National Guideline | | | | | |
| pH | | 6.34 | 7.06 | 6.34 | 6.07 | 6.69 |
| *Sat.* DO (%) | | 63.5 | 72.3 | 66.7 | 67.4 | 64.7 |
| DO (mg/l) | | 4.89 | 5.38 | 5.02 | 5.04 | 4.76 |
| Conductivity (µS/cm) | | 199 | 20.39 | 230 | 139 | 98.1 |
| TDS (mg/l) | | 99.5 | 10.19 | 115 | 69.5 | 49.05 |
| Temperature (°C) | | 27.1 | 29.0 | 28.5 | 28.7 | 29.7 |
| Turbidity (NTU) | | 3.03 | 1.61 | 1.95 | 1.8 | 4.69 |
| Total Nitrogen (mg/l) | | 0.77 | 0.64 | 0.88 | 0.51 | 0.52 |
| Lead (mg/l) | <0.01 | 0.213 | <0.01 | 0.108 | 0.108 | 0.241 |
| Total Phosphorus (mg/l) | | 0.02 | 0.01 | 0.04 | 0.02 | 0.02 |
| Faecal Coliform (MPN/100 ml) | | 0 | 0 | 0 | 0 | 0 |
| Total Coliform (MPN/100 ml) | | 0 | 0 | 0 | 0 | 0 |
| $NH_3$-N (mg/l) | | 0.5 | 0.4 | 0.8 | 0.4 | 0.4 |
| Copper (mg/l) | | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| Total Petroleum (mg/l) | | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| Water level (m) | | 21.2 | 31.2 | 18.97 | 16.67 | 6.8 |