



# INITIAL ENVIRONMENTAL EXAMINATION

## FOR THE HOUAY SOUP RESETTLEMENT AREA



November 2015

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## FOR THE HOUAY SOUP RESETTLEMENT AREA

**FINAL**

Prepared for



By



November 2015



**EARTH SYSTEMS**  
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## DOCUMENT REVISION LIST

Revision Status/Number	Revision Date	Description of Revision	Approved By
Rev0	August 2015	Working Draft	Nigel Murphy
Rev1	September 2015	Working Draft	Nigel Murphy
Rev2	18 <sup>th</sup> September 2015	Draft	Nigel Murphy
Rev3	22 <sup>nd</sup> September 2015	Draft (Revised)	Tom Callander
Rev4	20 <sup>th</sup> October 2015	Final	Nigel Murphy
Rev5	18 <sup>th</sup> November 2015	Final (Revised)	Nigel Murphy

For and on behalf of Earth Systems

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## ACRONYMS

ADB	Asian Development Bank
ARI	Average Recurrence Interval
BMPs	Best Management Practices
COD	Carbonaceous Oxygen Demand
COD	Commercial Operation of Dam
CA	Concession Agreement
CEC	Cation Exchange Capacity
DAFO	District Agriculture and Forestry Office
dBA	‘A’ weighted decibels
DBH	Diameter at Breast Height
DEM	Digital Elevation Model
DIP	Ductile Iron Pipe
DO	Dissolved Oxygen
EC	Electrical Conductivity
EMO	Environmental Management Office
EIA	Environmental Impact Assessment
EM	Effective Microorganisms
EMP	Environmental Management Plan
ESD	Environmental and Social Division
ESIA	Environmental and Social Impact Assessment
ESMMP- CP	Environmental and Social Monitoring and Management Plan for the Construction Phase.
ESMMP-OP	Environmental and Social Monitoring and Management Plan for the Operations Phase
FAO	Food and Agriculture Organization
GHG	Greenhouse gas
GOL	Government of Lao PDR
GPS	Global Positioning System
Ha	Hectares
HDPE	High Density Polyethylene
HSRA	Houay Soup Resettlement Area
IAP	Independent Advisory Panel
IEE	Initial Environmental Examination
IFC	International Finance Corporation
IFI	International Financial Institution

IHA	International Hydropower Association
INRMP	Integrated Natural Resource Management Plan
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
kV	Kilovolt
kW	Kilowatt
LFAP	Land and Forest Allocation Program
LKS	Local Knowledge Sharing
MAF	Ministry of Agriculture and Forestry
Masl	Metres above sea level
MONRE	Ministry of Natural Resources and environment
MSDS	Material Safety Data Sheet
MW	Megawatt
NAFRI	National Agriculture and Forestry Research Institute
NLMA	National Land Management Authority
NNP1	Nam Ngiep 1 Power Company
NN1HP	Nam Ngiep 1 Hydropower Project
NS	Lao PDR National UXO/MINE Action Standards
NTFP	Non-Timber Forest Products
NTU	Nephelometric Turbidity Unit
ORP	Oxidation Reduction Potential
PAFO	Provincial Agriculture and Forestry Office
PAPs	Project Affected Peoples
PCD	Public Consultation, Participation and Disclosure
PCDP	Public Consultation, Participation and Disclosure Plan
PFA	Protected Forest Area
pH	Potential Hydrogen
PLUP	Participatory Land Use Planning
PONRE	Provincial office of Natural Resources and Environment
PPE	Personal Protective Equipment
QC	Quality Control
RAP	Resettlement Action Plan
RDS	Resettlement Development Site
REDP	Resettlement and Ethnic Minority Development Plans
SDP	Social Development Plan
SIA	Social Impact Assessments
SMO	Social Management Office

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SP	Sub-Plan
SS-ESMMP	Site Specific Environmental and Social Management and Monitoring Plan
TD	Technical Department
TFP	Timber Forest Products
TL	Transmission Line
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
UMD	Upper Mixed Deciduous
UXO	Unexploded Ordnance
VFG	Village Forest Group
VLFA	Village Land and Forest Management Agreements
WMP	Watershed Management Plan
WQ	Water Quality

# EXECUTIVE SUMMARY

## ***Introduction***

This Initial Environmental Examination (IEE) has been prepared by Earth Systems on behalf of the Nam Ngiep 1 Power Company (NNP1) to identify and assess the potential environmental and social impacts of the proposed development of the Houay Soup Resettlement Area (HSRA).

This assessment covers the 6,108 ha HSRA including the development of a 2,393 ha resettlement development site (RDS) and the sustainable management of the 3,715 ha of Nam Ngiep Nam Mang Protected Forest Area (PFA) that overlaps the HSRA boundary.

## ***Context***

Nam Ngiep 1 Power Company has received a Concession Agreement (CA) (NNP1 2013a) from the Government of Lao PDR (GOL) to build and operate the Nam Ngiep 1 Hydropower Project (NN1HP) in Central Lao PDR. The NN1HP will generate power from a Main Dam (272 MW) and a Re-regulation Dam (18 MW) on the Nam Ngiep River in Bolikhan District, Bolikhamsay Province.

As many as 3,300 project affected people (PAPs) from 417 households in five (5) communities are expected to require relocation. Due to options to split households, up to 750 Resettlement houses may be required. Resettlement communities include:

- Ban Hatsaykham (a Hamlet of Ban Hat Gniun) located in the construction area (referred to as Zone 3); and
- Ban Houaypamom, Ban Sopphuane, Ban Sopyouak and Ban Namyouak located in the lower reservoir area (referred to as Zone 2LR).

The HSRA has been selected as the Project's designated resettlement site. This site was selected in consultation with PAPs after extensive analysis of a number of resettlement site options. The site's positive characteristics include its size, agricultural development potential, and access to forest resources, access to markets, and suitability for infrastructure (i.e. domestic and irrigation water supply) which will be provided. In addition, all of the greater majority of infrastructure development will occur on highly degraded habitat, with access to less disturbed areas for community resource requirements. Concerns have been raised regarding the suitability of the soil for agriculture in the area - with some PAPs not yet convinced by the viability of the soil improvement plan.

Part of the proposed HSRA is being used by a number of 'host communities' located downstream of the main Project (referred to as Zone 5). The NNP1 Concession Agreement identifies these communities as Ban Hat Gniun and Ban Thaheua. A Confirmation Survey conducted by NNP1 (2014) identified that villagers from Ban Hat Gniun, Ban Hatsaykham and Ban Somseun currently use land within the HSRA and villagers from Ban Thaheua do not.

The HSRA has previously been assessed in the Project's Environmental Impact Assessment (EIA) Social Impact Assessment (SIA) and Resettlement Action Plan (RAP) (KANSAL et al 2012a,b,c). These documents were approved by the Ministry of Environmental and Natural Resources (MONRE). The documents were then revised by NNP1 in 2014 to ensure compliance with ADB Safeguard Policies (ADB 2009). The revised EIA (ERM 2014), SIA (NNP1 2014a) and Resettlement and Ethnic Development Plan (REDP) (NNP1 2014b) provided further assessment and management measures for the development and operations of the HSRA.

A number of significant developments have occurred following the approval of these documents:



- The HSRA was found to be overlapping the Nam Ngiep Nam Mang Protected Forest Area (officially designated in 2012);
- The design of the HSRA has been revised to potentially accommodate the relocation of up to 750 households from the five (5) resettlement communities (up from 417 households); and
- Approximately 30 households from Ban Somseun have been identified as project affected people (NNP1 2014).

Consequently, the ADB and NNP1's Independent Advisory Panel requested a more comprehensive assessment for the revised design of the HSRA, with greater attention given to how resources in the PFA land will be managed.

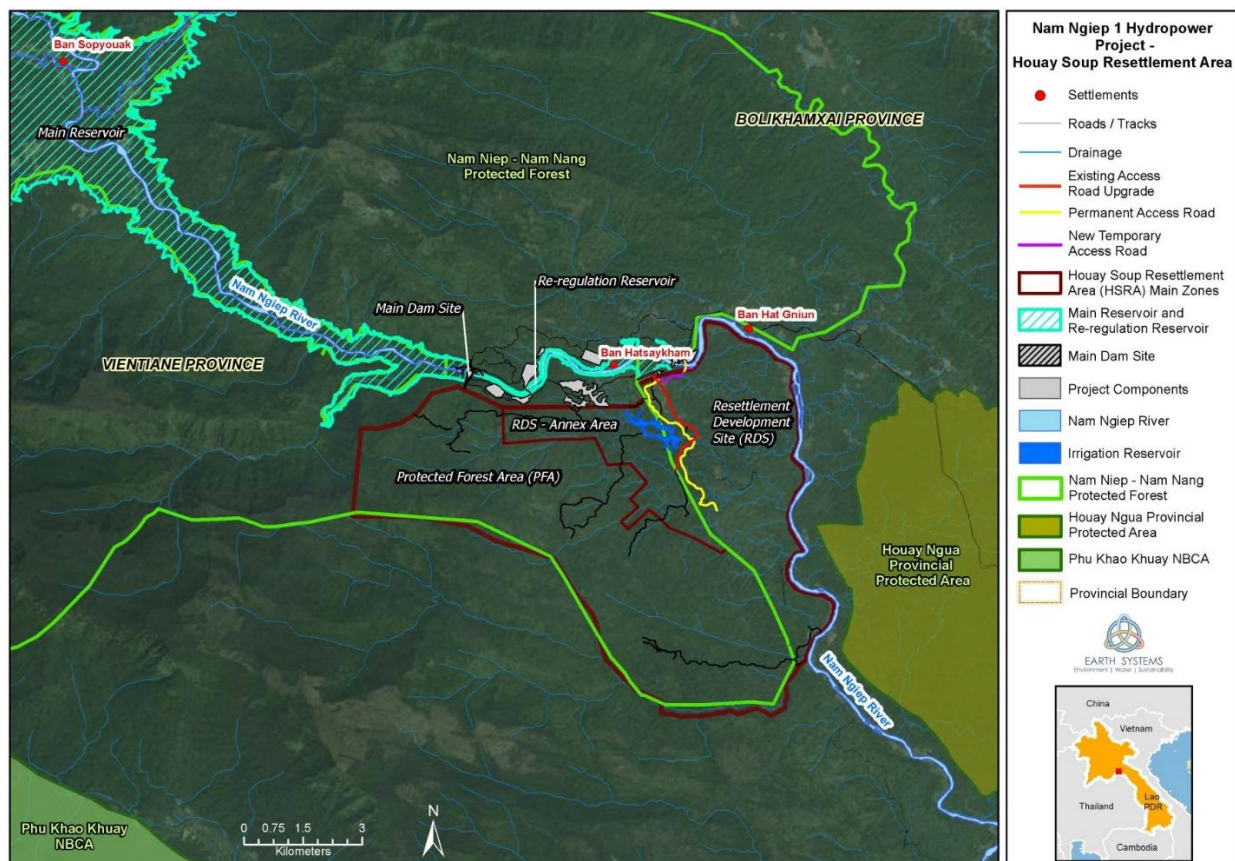
### ***Brief Project Description***

NNP1 will develop the HSRA for inclusion of up to 750 individual households, community assets (road/bridge, schools, health centre, market, bus stop, and community hall / village offices) and utilities (domestic water supply, irrigation water supply / irrigation pumps, solid waste disposal facility and electricity).

Construction and resettlement will occur in phases; (a) preliminary construction works (temporary roads, barges, workforce accommodation, etc.); (b) permanent road infrastructure, and residential / community infrastructure and agricultural lands implemented for some 40 households that will be relocated from Ban Hatsaykham in April, 2016; (c) the remainder of the primary infrastructure completed over the following 1 – 2 years; and (d) additional agricultural plots / plantation completed post – construction. Further detail on this infrastructure is outlined in the following sections.

As part of the construction / post-construction for the HSRA, NNP1 will work with residents of the HSRA to implement approximately 369 ha of rice paddy fields, 427 ha of upland agricultural area, and 262 ha of plantation area, including the development and implementation of a soil improvement program to ensure yields meet expectations and requirements for livelihoods and sustenance. NNP1 will develop an aquaculture pond in the Irrigation Reservoir which will support HSRA residents in its sustainable supply of fish for consumption.

The HSRA has adequate resources to provide timber forest products (TFP), non-timber forest products (NTFP), agricultural areas, and culturally significant sites (e.g. cemeteries and spirit forests), some of which will occur within the Nam Ngiep Nam Mang Protected Forest Area (PFA). An *Integrated Natural Resource Management Plan* (INRMP – Appendix A) has therefore been developed to ensure resources are sustainably managed and applicable GOL laws for PFA are adhered to within the PFA.



## Objectives

The objectives of this IEE are to:

- Characterise the physical, social and biological baseline conditions of the HSRA;
- Identify and assess the potential environmental and social impacts of the HSRA development to host communities and resettled communities during construction and post construction phases;
- Identify management and mitigation measures to avoid, minimise or mitigate potential impacts during construction and post construction phases;
- Describe maintenance requirements for the HSRA infrastructure and identify suitable mechanisms for handover of responsibility from NNP1 to the village and GOL;
- Assess the capability of natural resources within the HSRA to support the livelihoods of resettled communities and outline management measures, in the form of an Integrated Natural Resource Management Plan (INRMP), to protect and enhance the integrity and sustainability of these resources;
- Ensure the conduct of public consultation and dissemination activities in compliance with the EIA / SIA (ERM 2014; NNP1 2014a) and the ADB Safeguards Policy (ADB 2009) through the development and implementation of a standalone public consultation and dissemination plan for the HSRA development; and
- Identify any additional environmental and social impacts that may result from the HSRA development.

## Methodology

This IEE has been conducted in compliance with both Lao Standards and the ADB's Safeguard Policy Statement (ADB 2009) and has included:

- A literature review of available background information, including preliminary and final technical design specifications for HSRA Project components;
- Detailed desk-based analysis of the proposed HSRA footprint utilising high-resolution satellite imagery;
- Conduct of a series of site investigations including village consultations, soil sampling, hydrological observations, water quality sampling and terrestrial biodiversity assessments;
- Mapping and analysis of current land uses, water resources, and habitat values in the HSRA;
- Assessment of the environmental and social risks and potential impacts for host communities and resettlement communities;
- Consultations with Project stakeholders (GOL, host communities and resettlement communities) on the preliminary results of the assessment; and
- The preparation of the IEE Report including standalone INRMP and PCDP.

### ***Key Findings: Risks and Potential Benefits and Impacts***

Key risks concerning the establishment and development of the HSRA identified and considered in this assessment include:

- Potential social and cultural impacts for host communities resulting from the loss of land and access to natural resources;
- Potential impacts on the natural environment including land, water, forests, aquatic and terrestrial biodiversity;
- Potential social and cultural impacts for resettlement communities resulting from their relocation to the area; and
- Potential inadequacy of proposed management and mitigation measures outlined in the ESMMP-CP (NNP1 2014c) and REDP (NNP1 2014b).

The sections below provide a summary of key risks and potential benefits and impacts of the proposed HSRA and existing management and mitigation measures.

#### ***Benefits for Resettlers and Host Communities***

Residents of the resettlement communities which choose to relocate to the HSRA are expected to benefit from the establishment and development of the area (in addition to compensation and livelihood restoration measures). Direct benefits are likely to include: security of tenure through the provision of land titles; access to the Project community development program; raising of income and housing to national standards; improved in-village services and infrastructure (i.e. education, health, bridge/roads, electricity); and support for the management of natural resources through the INRMP. Indirect benefits are likely to include better access to district and provincial services; reduced UXO risk; and increased monitoring / oversight (from GOL and Project financiers) regarding the successful development of the area.

Residents of Ban Hatsaykham will be relocated to the HSRA and will benefit from the establishment and development of the HSRA. PAPs from Ban Hat Gniun and Ban Somseun will receive compensation and livelihood restoration support. Ban Hat Gniun is also expected to directly benefit from the development of infrastructure within the village and the HSRA. Residents from Ban Hat Gniun, and to a lesser extent Ban Somseun, may receive indirect benefits from further development of the surrounding area including improved infrastructure and services and development of the local economy.

#### ***Land, Assets, and Agricultural Livelihoods***

The allocation of lands for the HSRA will allow for the development of a settlement and productive lands that will facilitate compensation and livelihood restoration (NNP1, 2014b) for households directly affected by the inundation of the NN1HP reservoirs.

The establishment and development of the HSRA will result in the loss of land currently being used by villagers from Ban Hatsaykham, Ban Hat Gniun and Ban Somseun.

A substantial percentage of the total village lands of Ban Hatsaykham (63%) and Ban Hat Gniun (69%) will be lost to the HSRA development. The affected land area includes agricultural and cattle grazing zones for these communities. Households from Hatsaykham will be compensated through resettlement to the HSRA. Households from Hat Gniun and Ban Somseun who will not be resettled, will be compensated. Effective implementation of the REDP and additional management and mitigation measures outlined above are expected to result in fair and adequate compensation for all PAPs from these communities.

### **Forest Resources**

The key potential impact is the loss of access to agricultural landscapes and forests currently utilised by host communities for forest resource livelihoods. Villagers in Hatsaykham will be relocated and will benefit from the establishment of the HSRA. The forest resource based livelihoods of villagers from Ban Hat Gniun and Ban Somseun are expected to be restored or supplemented through effective implementation of livelihood restoration programs and the provision of community use rights to other areas within the PFA and support for the management of these areas.

### **Archaeology and Cultural Heritage**

Local Knowledge Surveys conducted in Ban Hat Gniun, Ban Hatsaykham, and Ban Somseun indicated there are no archaeological and culturally significant sites of national and regional importance within the HSRA and none of major significance.

One local culturally significant site was identified within the HSRA: a sacred rock near Houay Thamdin (at the confluence with the Nam Ngiep River). The site is respected by local villagers as it was believed a hermit monk meditated in a small cave called Thamdin (Din cave). The cave has collapsed long ago and only sacred rocks remain. No grave sites or cemeteries were identified in the HSRA during the surveys.

The protection of cultural heritage values within the HSRA will be achieved through avoidance of known sites, a duty of care under the Law on National Heritage (2013), and application of procedures for chance finds.

### **Noise, Vibration and Air Quality**

Due to the distance from local settlements, preliminary and early phase HSRA construction activities will not impact sensitive receptors. As Ban Hatsaykham will be relocated in approximately April 2016, while HSRA infrastructure development continues, relocated villagers may be exposed to nuisance level noise, vibration and dust stemming from earthworks and vehicular traffic on unsealed roads. Management and mitigation measures provided in the Project's ESMMP-CP and this IEE will minimise these impacts. However, nuisance level air quality impacts (dust) and noise during daylight hours is anticipated.

### **Flora**

The severity of impacts to terrestrial fauna will be limited as development of the HSRA in the Resettlement Development Site will primarily impact fallow habitat or agricultural plots. Approximately 88% (2,106 ha) of the 2,394 ha of land that will be disturbed during implementation of the residential area, water resource infrastructure, paddy fields, upland agricultural / plantation plots, and livestock grazing areas is comprised of Fallow forest, cleared land, or current agricultural areas. Approximately 8% of the HSRA footprint (200 ha) is comprised of moderately to highly disturbed and fragmented modified habitat types (Upper Mixed Deciduous Forest/ Mixed Deciduous / Bamboo mosaic, Bamboo Forest, and Riparian Forest). The impact of clearing this forest is tempered by the fact that the quality and ecological function of the forested areas in the PFA is considerably higher. During June 2015 surveys, no threatened flora species were identified within the RDS.



The flora of the PFA (within the HSRA) ranges from pristine to moderately disturbed. The introduction of up to 750 households to the HSRA is likely to increase timber and non-timber forest product resource extraction from the PFA. The PFA will be managed according to the *Integrated Natural Resource Management Plan* (Appendix A), which provides a sustainable approach to forest resource management and requires adherence to GOL law with respect to resource extraction in a PFA (e.g. Total Protection Zones, Conservation Zones, Utilisation Zones). Implementation of this plan is expected to minimise impacts, and should serve to protect the handful of threatened flora species identified during surveys of the PFA.

### **Terrestrial Fauna**

According to the results of Local Knowledge Surveys for this IEE, 14 threatened terrestrial fauna species have been observed by villagers in the PFA (ranging from Vulnerable to Endangered, according to IUCN Red List of Threatened Species, 2015), with none observed within the HSRA Resettlement Development Site. Construction, agricultural activity, and forest resource extraction will leave habitat for these species largely intact. However, the relocation of up to 750 households to the HSRA is likely to increase hunting activities, potentially impacting the fauna populations and species diversity.

### **Aquatic Biodiversity**

A host of resident and migratory fish, crustaceans, eel, frogs, snail, aquatic insects, and other aquatic biodiversity inhabit HSRA streams. According to the results of the Local Knowledge Surveys, a number of species of conservation significance may utilise the perennial streams. However, due to their similarity in appearance to other (non-threatened) species their occurrence cannot be confirmed without direct sampling from a qualified aquatic biologist.

Development of the HSRA will impact aquatic biology in one perennial stream (two tributaries), but is not expected to impact regional / global fish populations as many tributaries of similar morphology discharge to the Nam Ngiep River upstream and downstream of the NN1HP inundation area.

Potential impacts are expected to be minimised by: (i) inclusion of an environmental flow regime, with at least baseflow bypassing the Houay Soup Noi Dam and the Houay Soup Ngai domestic water intake to minimise impacts to aquatic habitat and fish migration; (ii) ensuring irrigation canal design provides for the ongoing existence of natural Houay Soup stream channels; (iii) prohibiting infrastructure development, diversion, or abstraction from Houay Khinguak and its tributaries; and (iv) potential inclusion of Houay Khinguak and its tributaries as a Conservation Zone (determined during Participatory Land Use Planning), prohibiting or limiting resource extraction. Given the application of these management and mitigation measures, it is anticipated that impacts to aquatic resources may be locally significant but are not expected to have regional significance for fish populations.

The development of the aquaculture pond in the Irrigation Reservoir is also expected to offset resource losses from increased fishing pressure of HSRA resulting from resettlement / increased population.

### **Hydrology**

Five (5) perennial streams flow through the HSRA. The hydrology of two (2) of these streams (Houay Soup Noi and Houay Soup Ngai) will be significantly altered and the hydrology of the remaining small perennial stream (Houay Dhakong) slightly altered. The impoundment of the primary Houay Soup Noi tributary for the paddy field Irrigation Reservoir / aquaculture pond will significantly reduce the flow in this stream, particularly during the dry season. Abstraction of Houay Soup Ngai surface water for domestic water supply will significantly reduce the downstream flow regime during the dry season. The implementation of a continuous environmental flow program (365 days / years, 24 hours / day) will minimise the severity of impacts to hydrology and aquatic biodiversity.

### **Flooding**

Preliminary flood modelling for this IEE indicates that flooding from peak storm events could impact HSRA infrastructure (e.g. a portion of the main access road / road network) and potentially a small portion of the

HSRA residential area. NNP1 should conduct more detailed flood modelling to ensure the impact from flooding on HSRA infrastructure / livelihoods will not be significant.

Construction of the settlement for the first phase of relocation (Ban Hatsaykham in April 2016) may easily avoid potential flood zones. Higher ground also exists within the RDS annex area to the north of the current residential alignment if further flood modelling indicates the need to realign any of the Project footprint. Road alignment will require careful consideration to avoid long-term impacts on the community from flooding.

### **Water Quality**

Water quality in HSRA steams is generally good, with the exception of total and faecal coliforms that are likely a result of fairly extensive utilisation of the area for livestock grazing. Implementation of roughing filters and chlorination for the domestic water supply and implementation of fencing to prohibit livestock from accessing water resource infrastructure and much of the catchment area will improve water quality for residents in the HSRA.

Downstream receiving waters may be impacted. In the absence of diligent application of erosion and sediment control measures, sediment loading in streams will be significant during construction and following regular site preparation for agricultural areas. Progressive rehabilitation and the rapid establishment of vegetation in the region will incrementally reduce potential impacts.

Fertiliser applications and feed application in the aquaculture pond may increase nutrient loading considerably. Careful evaluation of fertiliser application rates and aquaculture practices is required to minimise nutrient loading and potential indirect impacts (e.g. eutrophication).

### **Soil Quality**

Soils of the HSRA are moderately to highly acidic and low in available nutrients, organic matter, and cation exchange capacity. The soil improvement program will increase the quality of soils in the HSRA, with the capacity for higher crop yields and improved annual growth / productivity for plantations.

### **Hazardous and Non-Hazardous Waste**

A significant quantity of non-hazardous waste will be generated, stored and disposed of in the HSRA during construction and post-construction. A number of potentially hazardous materials and hazardous materials waste products will be stored and handled in the HSRA during construction and post-construction. Non-hazardous and hazardous wastes may impact soil, surface water, and groundwater quality if improperly managed or contained.

NNP1 has developed management and mitigation measures for non-hazardous and hazardous waste storage, handling, and disposal in its ESMMP-CP and measures are further elaborated in this report. Diligent application of these measures is expected to minimise potential impacts to negligible during construction.

Non-hazardous waste separation, storage, and disposal (recycling and landfill) have been preliminarily designed for HSRA operations. Hazardous waste storage facilities (e.g. for hydrocarbons, sewage, herbicides, etc.) will have to be properly designed and constructed to ensure that they cannot discharge to the environment. Applicable HSRA residents will have to be trained in handling procedures for hazardous and non-hazardous materials / waste and emergency preparedness and response planning to ensure sensitive receptors (people and the receiving environment) are not impacted during operations.

### **Conclusions**

The assessment of the IEE concludes that the establishment of the HSRA is important so as to enable the planned resettlement for the Nam Ngiep Hydropower Project.

The proposed HSRA is considered a viable site for the NNP1 resettlement program:

- The HSRA has ample forest resources and water resources. Communal land use rights will be required to take sustainably manage and provide adequate resources for the resettled communities;
- While HSRA soils have been confirmed to be poor for agriculture purposes across the HSRA, the physical and chemical deficiencies can be suitably ameliorated with the implementation of a robust soil improvement program;
- The siting of the RDS will primarily occur on highly disturbed land and habitat;
- Preliminary modelling indicates that road infrastructure and potentially a small part of the residential area may reside within the peak storm event flood inundation zone. With the annexure of the additional 648 ha, ample land exists for re-siting if required. Current road alignment and design should be considered in the context of the anticipated flood regime; and
- Implementation of an environmental flow is considered a key factor in sustaining aquatic habitat and aquatic fauna in the Ban Houay Soup and its tributaries.

Residents of Ban Hat Gniun and to a lesser extent Ban Somseun (~30 households) who are currently using land and natural resources inside the proposed HSRA have the potential to be significantly impacted by the establishment of the HSRA. These PAPs require compensation to be implemented in accordance with the REDP (NNP1 2014).

Monitoring and management of the HSRA during the construction and post construction phases will be required to ensure that Nam Ngiep environmental and social standards are implemented.

### **Key Recommendations**

It is recommended that NNP1:

- Consult with the GOL and ADB regarding HSRA host communities and the identification of approximately 30 households from Ban Somseun;
- Continue to work with the GOL and residents of Ban Hat Gniun and affected households in Ban Somseun to identify suitable compensation, livelihood restoration, and / or provision of additional village land to recompense for land / livelihood losses associated with HSRA development and decrease in agriculture / livestock land for these two communities;
- Support the implementation of *Integrated Natural Resource Management Plan* developed for the HSRA (RDS and PFA) including completion of participatory land use planning; conduct of environmental protection and improvement activities and monitoring and evaluation of the program;
- Conduct flood modelling (including survey channel bathymetry and Digital Elevation Models) to ensure HSRA infrastructure, including residential areas and road networks, are outside the flood zone for peak storm events;
- Engineer the Houay Soup Noi irrigation water supply dam and the Houay Soup Ngai domestic water intake facility to provide for ongoing (365 days per year) environmental flow that equals at least baseflow for these streams. Adequate water volume will be available, given sourcing from the Nam Ngiep River Re-regulation Reservoir;
- Ensure continuous hydrologic connectivity of the Houay Soup Noi and Houay Soup Ngai with the Nam Ngiep River to allow for continued fish residency and migration. Engineer the irrigation channels to allow continuous stream flow to bypass the irrigation system or merge them with discharge outlets at the river; and
- Rehabilitate and revegetate unused logging road network in the PFA to restrict vehicular access, minimising the likelihood of large-scale timber operations in the higher elevations of the PFA.

# 1 INTRODUCTION

This Initial Environmental Examination (IEE) has been prepared by Earth Systems on behalf of the Nam Ngiep 1 Power Company (NNP1) to identify and assess the potential environmental and social impacts of the proposed development of the Houay Soup Resettlement Area (HSRA).

## 1.1 Background

Nam Ngiep 1 Power Company (NNP1) has received a Concession Agreement (CA) from the Government of Lao PDR (GOL) to build and operate the Nam Ngiep 1 Hydropower Project (NN1HP) in Central Lao PDR. The NN1HP will generate power from a Main Dam (272 MW) and a Re-regulation Dam (18 MW) on the Nam Ngiep River in Bolikhan District, Bolikhamsay Province. As many as 3,300 project affected people (PAPs) from up to 750 households in five (5) communities are expected to require relocation.

The Houay Soup Resettlement Area (HSRA) is the Nam Ngiep 1 Hydropower Project's designated resettlement site (refer to the Project's Concession Agreement, Annex C). This site was selected in consultation with PAPs after extensive analysis of a number of resettlement site options. The HSRA totals 6,108 ha and is located on the right bank of the Nam Ngiep River, immediately south of NN1HP's Re-regulation Dam (refer to Figure 2-1).

The HSRA has previously been assessed for the Project's Environmental Impact Assessment (EIA Social Impact Assessment (SIA) and Resettlement Action Plan (RAP) (KANSAL et al. 2012a,b,c). These documents were approved by the Ministry of Environmental and Natural Resources (MONRE). The documents were then revised by NNP1 in 2014 to ensure compliance with ADB Safeguard Policies (ADB 2009). The revised EIA (ERM 2014), SIA (NNP1 2014a) and Resettlement and Ethnic Development Plan (REDP) (NNP1 2014b) provided further assessment and management measures for the development and operations of the HSRA.

A number of significant developments have occurred since these assessments were completed:

- *Preliminary Survey of the HSRA*

Following a joint (GOL and NNP1) field survey of the proposed 6,108 ha site in June 2014, MONRE approved 1,745 ha of unallocated government land for the purpose of resettlement and livelihood restoration for NN1HP Project Affected People (PAP) (MONRE Decision 6423, September 2014). The remaining 4,363 ha was identified as overlapping with the Nam Ngiep Nam Mang Protected Forest Area (PFA), a National Protected Forest (MAF Decree 333, 2010). The GOL has since approved the annexure of 648 ha from the PFA for resettlement site development (MONRE Decision 4466, July 2015) and has indicated that the remaining 3,715 ha area may be used by PAPs as long as it is managed in accordance with a sustainable management plan.

- *Revised design of the HSRA*

The design of the HSRA has been revised by NNP1 to accommodate the potential relocation of up to 750 households (up from an estimated 417 households as outlined in the REDP, (NNP1, 2014b)). More detailed design documents for key infrastructure are also now available.

- *Host Communities and Affected People*

The NNP1 Concession Agreement identifies host communities as Ban Hat Gniun and Ban Thaheua. A Confirmation Survey conducted by NNP1 (2014) confirmed that villagers from Ban Hat Gniun, Ban Hatsaykham and Ban Somseun currently use land within the HSRA and villagers from Ban Thaheua do not.



At the IAP and ADB Missions of December 2014, both parties requested a more comprehensive assessment be conducted based on the revised design of the HSRA; and greater attention be given to how the resources in the PFA land, particularly forests, were going to be managed.

This IEE has been conducted in compliance with the ADB's Safeguard Policy Statement (ADB 2009). It includes an Integrated Natural Resource Management Plan and a Public Consultation and Dissemination Plan for the construction and 'operation' of the HSRA.

## 1.2 Objectives and Scope of the IEE

The objectives of this investigation are to:

- Characterise the physical, social and biological baseline conditions of the HSRA;
- Identify and assess the potential environmental and social impacts of the HSRA development to host communities and resettled communities during construction and operations;
- Identify management and mitigation measures to avoid, minimise or mitigate potential impacts during construction and operations;
- Describe maintenance requirements for the HSRA infrastructure and identify suitable mechanisms for handover of responsibility from NNP1 to the village and GOL;
- Assess the capability of natural resources within the HSRA to support the livelihoods of resettled communities and outline management measures, in the form of an INRMP, to protect and enhance the integrity and sustainability of these resources; and
- Ensure the conduct of public consultation and dissemination activities in compliance with the EIA / SIA (ERM 2014; NNP1 2014a) and the ADB Safeguards Policy (ADB 2009) through the development and implementation of a standalone public consultation and dissemination plan for the HSRA development.

This assessment covers the 6,108 ha HSRA, including the main construction and operation of the 2,393 ha resettlement development site (RDS) and the sustainable management of the 3,715 ha protected forest area (PFA).

Preliminary works including the preliminary access road, bridge abutment and ferry crossing, and the 22 kV village transmission line are covered in separate IEE's completed by Earth Systems in July 2015 (Earth Systems, 2015a) and August 2014 (Earth Systems, 2014) respectively.

## 1.3 HSRA Developer and IEE Consultant

### 1.3.1 Nam Ngiep 1 Power Company

NNP1 is owned by KPIC, a subsidiary of Kansai Electric Power Co. Inc. (Kansai Electric); the Electricity Generating Authority of Thailand (EGAT-I) International Co. Ltd; and Lao Holding State Enterprise. The Company is headquartered in Vientiane, Lao PDR. The owners of NNP1 have extensive experience in the design, construction and operation of large-scale hydroelectric power projects.

The contact details for NNP1 are as follows:

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W: [www.namngiep1.com](http://www.namngiep1.com)

### 1.3.2 Earth Systems

The Earth Systems Group is a multidisciplinary environmental and social consulting firm. Earth Systems has been operating in Lao PDR for more than 15 years and is a registered EIA consultant with the Department of Environmental and Social Impact Assessment, MONRE.

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W: [www.earthsystems.com.au](http://www.earthsystems.com.au)

## 1.4 Methodology

Earth Systems undertook the following activities to complete its assessment:

- A literature review of available background information available for preliminary and final technical design specifications for HSRA Project components;
- Detailed desk-based analysis of the proposed HSRA footprint utilising high-resolution satellite imagery;
- The conduct of a series of site investigations including village consultations, soil sampling, hydrological observations, water quality sampling and terrestrial biodiversity assessments;
- Mapping and analysis of current land uses, water resources, and habitat values in the HSRA;
- Assessment of the environmental and social risks and potential impacts for host communities and resettlement communities;
- Consultations with Project stakeholders (GOL, host communities and resettlement communities) on the preliminary results of the assessment; and
- The preparation of the IEE Report including INRMP and PCDP.

## 2 DESCRIPTION OF THE HSRA

### 2.1 HSRA Location

The Nam Ngiep Hydropower Project Houay Soup Resettlement Area (HSRA), located in Bolikhan District, Bolikhamsay Province, abuts the Nam Ngiep River immediately south (river right) of the Project's Main Dam and Re-Regulation Dam (refer to Figure 2-1). The closest settlements to the HSRA are on the opposite bank of the river and include Ban Hatsaykham, Ban Hat Gniun and Ban Thaheua.

#### 2.1.1 Current Land Zoning

The total village area for the HSRA will include 6,108 ha which is comprised of 1,745 ha of land previously allocated to Ban Hat Gniun and Ban Somseun (Resettlement Development Site – RDS) and 4,363 ha within the Nam Ngiep Nam Mang Protected Forest Area (PFA) - a National Protection Forest established in 2012. NNP1 has recently gained approval to annex 648 ha of the 4,363 ha PFA for expansion of the RDS bringing the total area to 2,393 ha (MONRE Decision 4466, 2015).

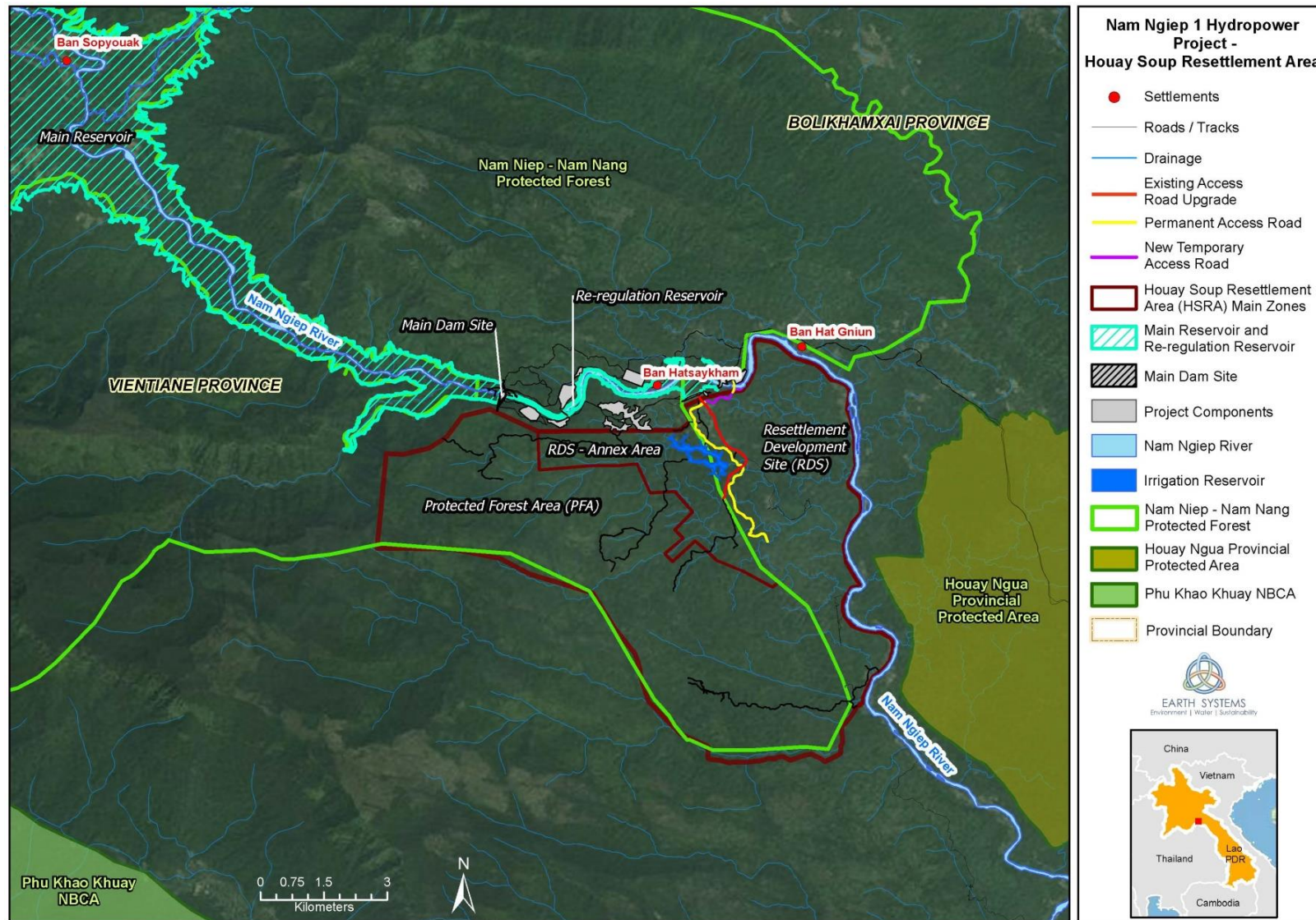
All major infrastructure will be developed within the 2,393 ha RDS. The remaining 3,715 ha PFA will be zoned for protection forest, conservation forest, and utilisation forest (refer to the Houay Soup Resettlement Area Integrated Natural Resources Management Plan, Appendix A).

A summary of the land zones designated within the HSRA is provided in Table 2-1.

**Table 2-1 Current Land Zoning within the HSRA**

Current Zoning	Brief description	Total area (ha)
Resettlement Development Site (RDS)	1,745 ha previously 'unallocated land' currently utilised by villagers of Ban Hat Gniun, Ban Hatsaykham, and Ban Somseun. Approved by GOL for HSRA resettlement development (MONRE Decision 6423/2014).  648 ha previously part of the PFA, now annexed for the RDS (MONRE Decision 4466/2015)	2,393
Protected Forest Area (PFA)	The remaining portion of the HSRA within the Nam Ngiep Nam Mang Protected Forest Area.	3,715
<b>Total</b>		<b>6,108</b>

Source: NNP1 2015





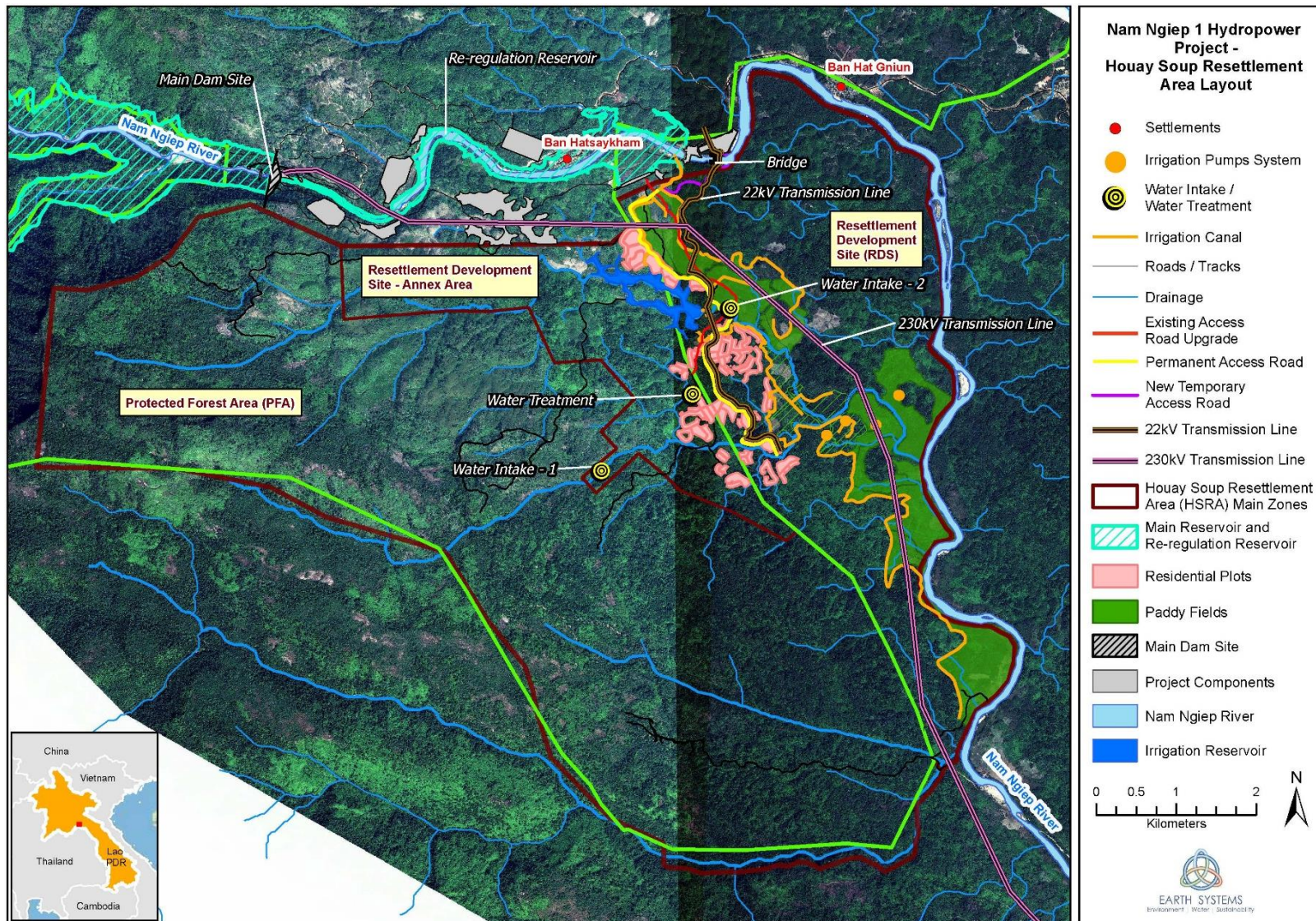


Figure 2-2 Proposed Resettlement Development Site Layout

Source: Earth Systems 2015

## 2.2 HSRA Description and Design

### 2.2.1 Infrastructure

The completed village infrastructure will include up to 750 individual households and additional community assets (refer to Table 2-2) and utilities. Construction and resettlement will occur in phases, with preliminary construction works (temporary roads, barges, etc.), permanent road infrastructure, and residential / community infrastructure implemented for some 40 households that will be relocated from Ban Hatsaykham in April, 2016. The remainder of the primary infrastructure will be completed over the following 1 – 2 years, with some agricultural plots / plantation established post-construction.

Further detail on this infrastructure is outlined in the following sections.

**Table 2-2 Primary HSRA Infrastructure**

Item	Description
House	750 houses: main building (75 m <sup>2</sup> for medium), toilet and kitchen in 800 m <sup>2</sup> plot with fence
Access Road	Main road (sealed) from Nam Ngiep River bridge to HSRA town centre and to southern portion of HSRA (20 km) and ancillary roads to each household. Secondary road (unsealed): access to irrigated paddy land (5 km).
Access Bridge	Reinforced concrete and pre-stressed concrete bridge, 132 m length and 6.7 m wide with 2 lane road way (2 x 3m) and 2 parapet pedestrian walkway (2 x 0.35m)
Health Centre	1 ha land, 2 rooms (4 x 4m each), 2 toilets, concrete and slate or tiled roof, adequate first-aid equipment.
Market	Market: 600 m <sup>2</sup> roof covered with 2 toilets, waste facilities, near bus stop and residential areas (1 ha total area).
Bus stop	100 m <sup>2</sup> bus stop building adjacent to market and east end of residential area for mini-buses and song theo; with 2 toilets, 1 ha total area.
Community hall	Village centre 760 m <sup>2</sup> community hall with 2 office rooms, 4 toilets
Village office	
School and related structures	1 nursery (664 m <sup>2</sup> ), 2 primary schools (828 m <sup>2</sup> ), 1 lower secondary school (486 m <sup>2</sup> ) with teachers' house
Community playground	1,600 m <sup>2</sup> playground with equipment
Domestic Water supply	Tap water (two taps) to each house by gravity fed and filter system
Irrigation Reservoir	Irrigation Reservoir on the Houay Soup Noi (67 ha surface area; maximum retention capacity 2.25 million m <sup>3</sup> ; live storage of 400,000 m <sup>3</sup> ; operational depth of 1.5 m).
Irrigation distribution network	Irrigated area 496 ha. Distribution canals totalling 9,143 m including a northern canal (3,850 m); central canal (1,093 m) and southern canal (4,200 m)
Solid waste disposal	1.5 ha disposal area with 6 pits, each W 35 m x L 15 m x D 3 m.
Power line	22 kV: 1 km from the connection point at Ban Hat Gniun and distribution line to each house with current meter
ESD & GOL office	Resettlement Centre at Pilot Plant

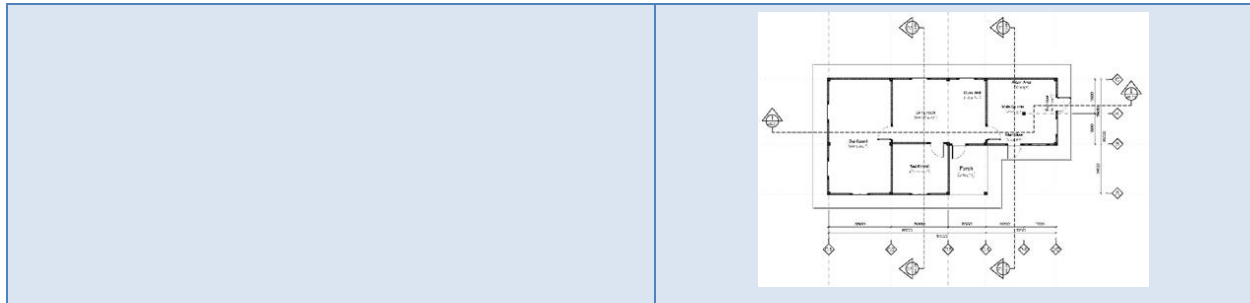
Source: Earth Systems 2015



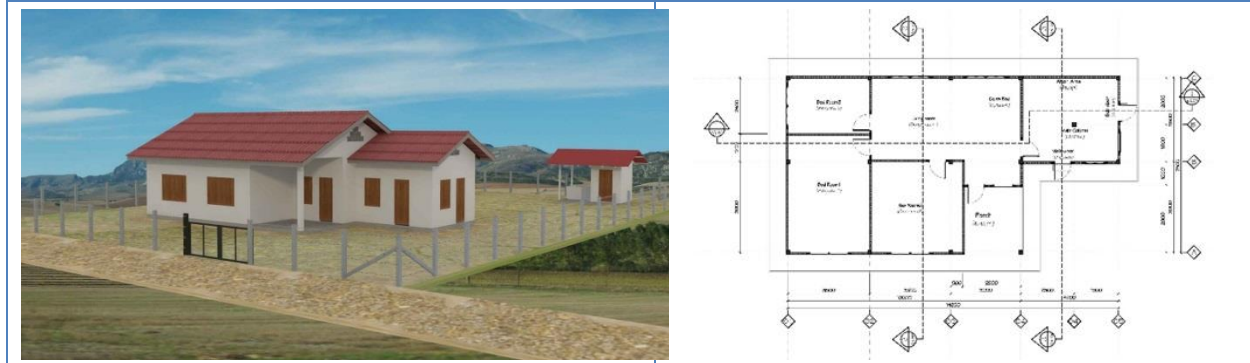
## Housing

Houses will be constructed with concrete floors and wall and corrugated roofing on 800 m<sup>2</sup> fenced plots, with two (2) water taps and toilet outfitted with a water meter per household. It is anticipated that each household will be provided with one of three models, with the select model pending the number of people in the household and preference according to ethnic tradition (refer to Plates 2-1 to 2-3). Housing standards will be applied independent of the quality of the previously occupied house for each household.

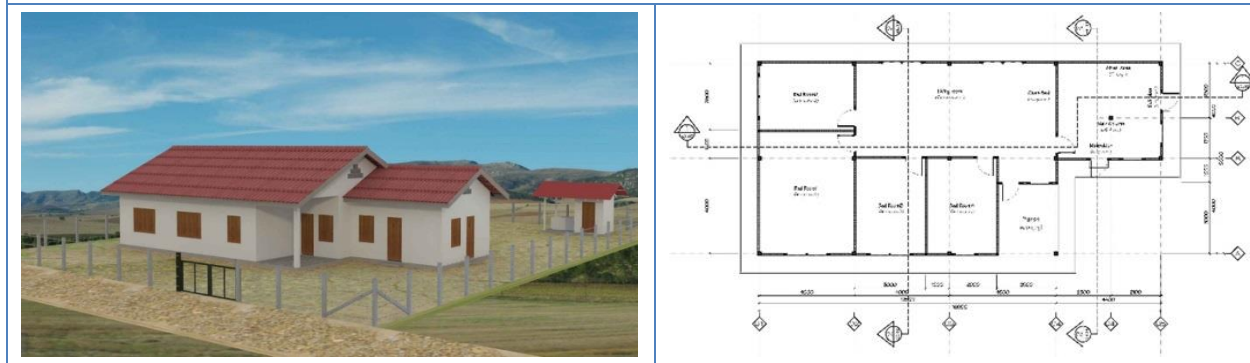
The size of house provided will be based on the number of household members. A minimum of 7.5 m<sup>2</sup> will be provided per person, but average space is expected to be more than 10 m<sup>2</sup> per person (NNP1 2014b). The final designs will be prepared in consultation with the PAPs and will take into account their customs and needs, house orientation, and preferred neighbours to the extent practicable.



**Plate 2-1 House model small**



**Plate 2-2 House model medium**



**Plate 2-3 House model large**

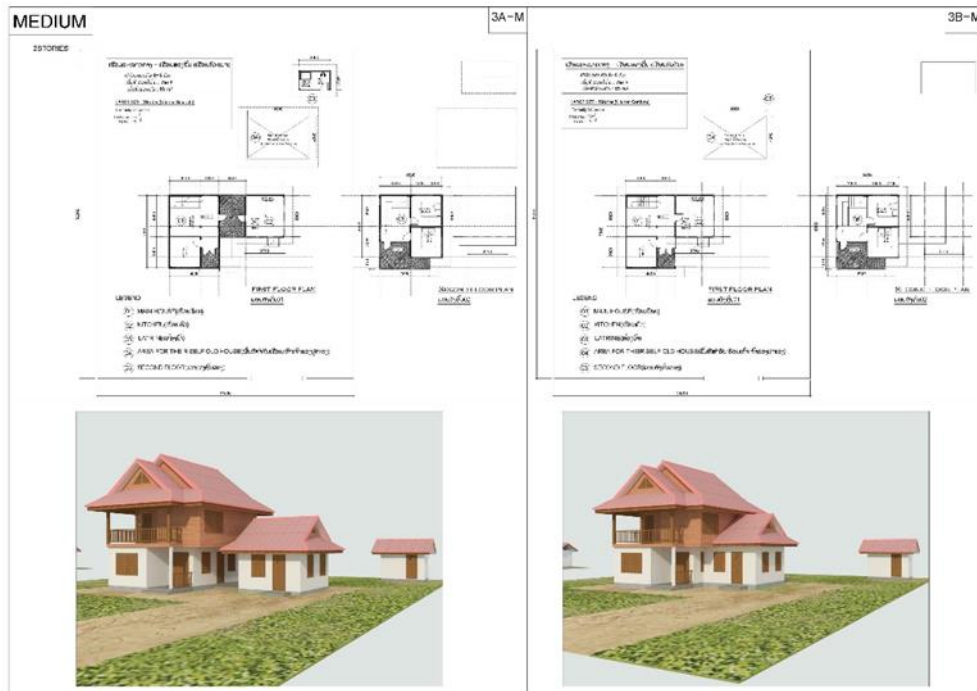


Plate 2-4 House model 2 story medium

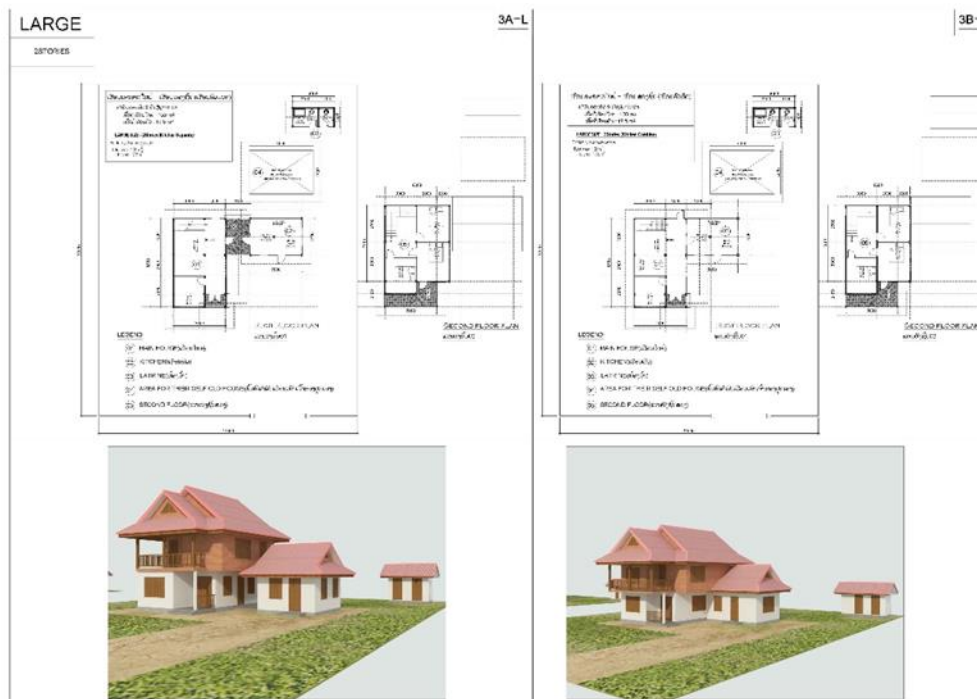


Plate 2-5 House model large

### Community Infrastructure

Community infrastructure will include a market; bus terminal; health centre; village office; nursery, primary (2), and lower secondary schools and playgrounds; and public office and hall (refer to Table 2-3 for component footprints).

**Table 2-3 HSRA schools and associated infrastructure**

Facility	Description
Nursery	Estimated 140 children (50% of 3-5 years old children from 5 PAP communities)
Elementary	Approximately 15 classrooms for 550 students
Lower secondary	Approximately 12 classrooms for 430 students
Teachers' offices	2 rooms
Teachers' housing	1 house
Playgrounds	2 (1.5 ha each)
Toilets	10, separate male and female

Source: NNP1 2015

Community structures are required to follow the regulations of GOL line agencies (Ministry of Education, Health, Public Works and Transport, Home Affairs, etc.) for respective public infrastructure. NNP1 has coordinated with these agencies during design of infrastructure development plans and therefore design considered requests from PAPs in addition to regulatory obligation. Preliminary design has been completed for community structures (refer to Plates 2-4 to 2-8). Final design is expected to include some variation from these concepts.



**Plate 2-6 Bus station**



**Plate 2-7 Health centre**



**Plate 2-8 Market place**



**Plate 2-9 Community hall with village offices**



**Plate 2-10 Kindergarten**

It is anticipated that small shops will be constructed around the central roofed market area. These shops will be leased to resettled peoples at reduced cost or at commercial rates for outsiders. The income generated from these leases will be used to maintain the market area, including garbage disposal, and may contribute to the village development fund for ongoing operational expenses of village authorities (e.g. teacher salaries), to be managed by the community directly.

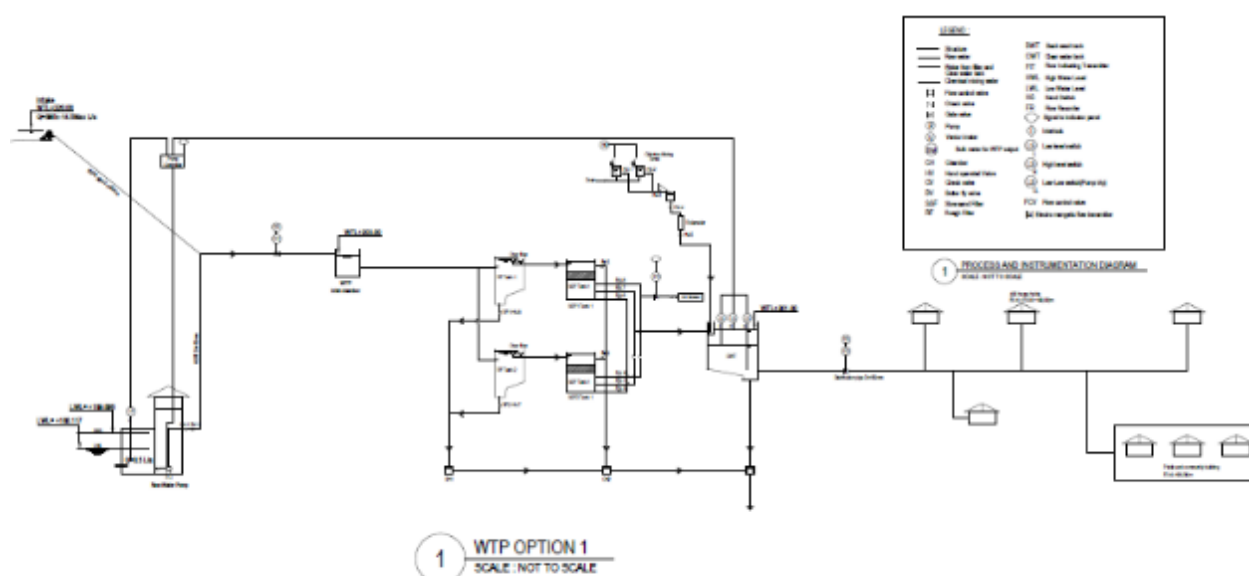
### ***Domestic Water Supply***

The domestic water supply system (intakes, conveyance, and treatment plant) has been designed to supply up to 6,500 people and will accommodate at least an annual population growth rate of 2% beyond 2015. The domestic water supply systems are intended to supply a minimum of 100 litres of water per capita per day (650 m<sup>3</sup> / day for 6500 people). At full capacity, the system will provide 14.5 L / s (1,250 m<sup>3</sup> / day).

- Intake 1:** Water for domestic uses will be primarily sourced from Houay Soup Ngai. A water intake structure will convey surface water via gravity from the intake at 220.583 metres above sea level (masl) to a water treatment plant at 205.719 masl and 2,380 m from the intake. The 150 mm ductile iron pipe (DIP) at the inlet and 150 mm diameter DIP pipe will convey 14.5 L / s at maximum capacity (anticipated for 8 – 9 months / yr.) and 6 L / s (minimum flow estimate for Houay Soup Ngai) for the remaining 3 - 4 months / yr.
- Intake 2:** The Irrigation Reservoir (refer to below) will supplement the Houay Soup Ngai domestic water supply during the dry season (approximately 3 - 4 months / yr.). The intake will include an open wet pit collection chamber with two horizontal centrifugal pumps (capacity of 8.5 L / s) and will be reinforced by with concrete. Raw water will be pumped via HDPE 150 mm pipe for 1,300 m to the treatment plant.

The Intake 2 system will only be constructed / operated if village water demand exceeds the supply capacity of Intake 1.

Raw water will enter an inlet chamber and pass through one of two roughing filter tanks (4 x 7.5 x 1.5 m) for pre-treatment. The water will then pass through a slow sand filter tank and will be disinfected using hypo-chlorine injected from separate mixing tanks at the ingress to the clear water tank. The Clear Water Tank will have a capacity to store 200 m<sup>3</sup> of water for distribution to households / public and community buildings. Two (2) taps will be installed at each household.



### Figure 2-3 Domestic Water Supply System

Source: NNP1 2015

### ***Irrigation Supply***

An irrigation system will be constructed to supply water as much as 420 ha of rice paddy area (North Paddy = 154 ha; South Paddy = 266 ha) for dry and wet season cultivation, though Earth Systems mapping indicated an availability of approximately 369 ha. Water will be primarily sourced from the Nam Ngiep River (Re-regulation Reservoir) with supplementary water from Houay Soup Noi. Water intake from the Re-regulation Reservoir will vary considerably during the wet season when Houay Soup Noi contribution to the Irrigation Reservoir increases.

A simple gate system at the intake will provide  $4.6 \text{ m}^3 / \text{s}$  ( $63,000 \text{ m}^3 / \text{day}$ ) of water which will be gravity fed via an 825 m concrete lined canal from the Re-regulation Dam reservoir to the Irrigation Reservoir (refer to Figure 2-4) for four (4) hours per day when the Re-regulation Dam generator is not operating and the Re-regulation Reservoir subsequently rises.

An Irrigation Reservoir will be developed. This reservoir will also be used for a) aquaculture and b) domestic water supply (see above). The Irrigation Reservoir will cover an area of approximately 67 ha, with a maximum water retention capacity of 2.25 million  $\text{m}^3$  (2,500 megalitres) and live storage of 400,000  $\text{m}^3$  (operational depth of 1.5 m). A 15 m high dam (to 181.2 masl) will be constructed across the Houay Soup Noi stream channel to create the reservoir (dam width 50 m at bottom of channel). Minimum water level in the reservoir will be 176.3 masl and maximum water level 178 masl. Water will be stored in the irrigation pond at night and released to the paddy fields during the day.

An 18 m wide spillway will be constructed (143.5 m long channel) at 177.8 masl (inlet) to 166.6 masl (outlet) to convey stormwater around the dam, protecting the structure (and supplying the Houay Soup Noi with rainy season environmental flow).

The Irrigation Reservoir will have three (3) outlets (gate systems) to canals that will convey water via gravity to three (3) paddy fields.

- Outlet 1 will feed a 3,850 m concrete lined irrigation canal to the northern section of the paddy area. This canal will branch into two sections to supply approximately 68 ha.
- Outlet 2 will feed a 1,093 m concrete lined canal to a 38 ha paddy field in the middle of the paddy area, primarily for relocated residents of Ban Hatsaykham (resettled first in early 2016).
- Outlet 3 will supply  $\sim 2.91 \text{ m}^3 / \text{s}$  to the southern section of the paddy field via a 4,200 m concrete lined canal to directly irrigate 124 ha of paddy field and will supply water to four (4) pumping stations that will pump water to four canals that feed 266 ha of paddy fields in the southeast of the HSRA.

The pumps / canals for the southeast area are as follows:

- Pump 1: 55 kW x 2 units,  $5.6 \text{ m}^3 / \text{s}$  concrete lined canal - 1,383 m;
- Pump 2: 22 kW x 2 units,  $2.1 \text{ m}^3 / \text{s}$  concrete lined canal – 722 m;
- Pump 3: 75 kW x 3 units,  $9.8 \text{ m}^3 / \text{s}$  concrete lined canal - 6,697 m; and
- Pump 4: 37 kW x 2 units,  $9.0 \text{ m}^3 / \text{s}$  concrete lined canal – 524 m.



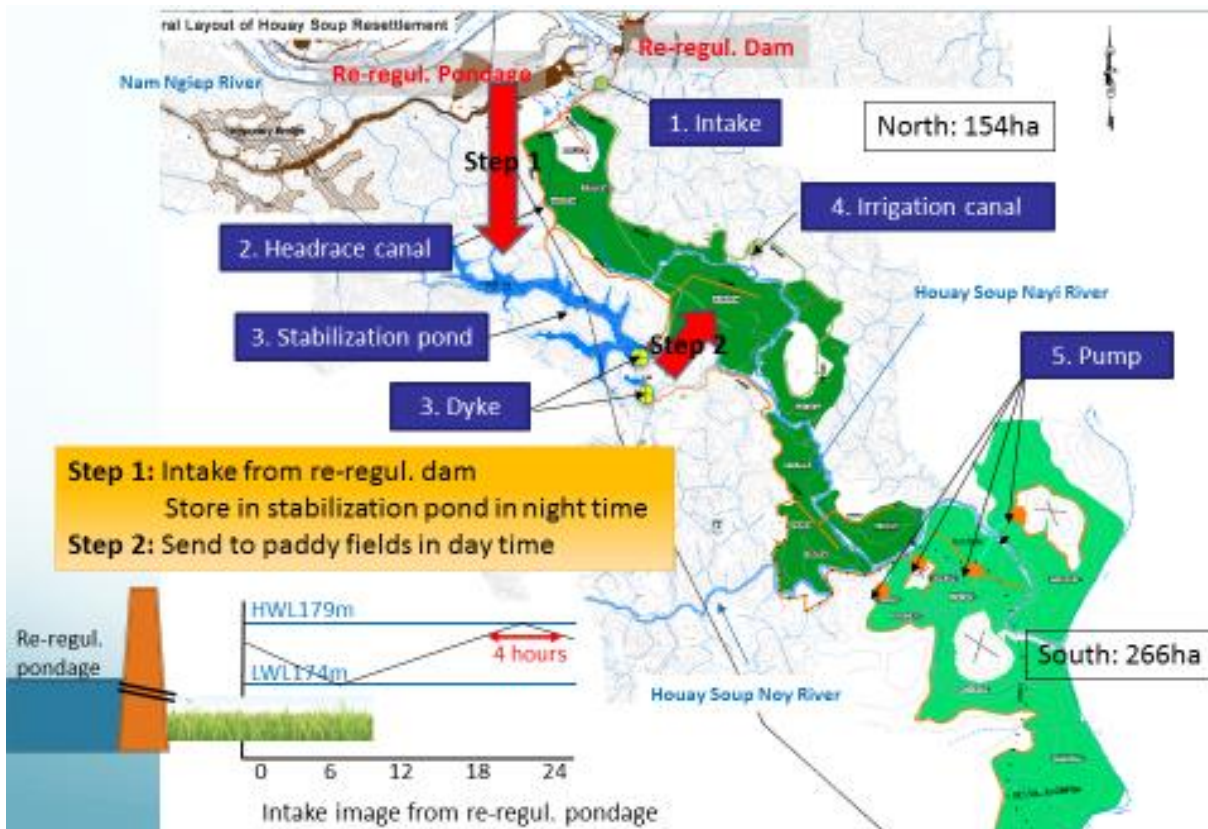


Figure 2-4 HSRA Irrigation System

Source: NNP1 2015

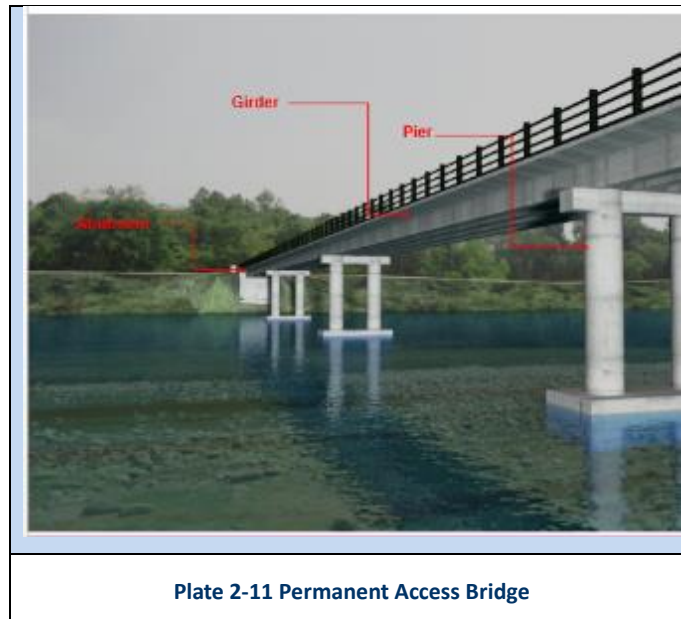
### **Permanent Access Road (and Bridge)**

A permanent, sealed road (Main Road) and bridge across the Nam Ngiep River will be developed to provide access to the HSRA. Construction for the Main Road will include maintenance for the temporary access road and extension of this road through the HSRA. A portion of this road was constructed during the Preliminary Works for the Houay Soup Resettlement Area and an IEE completed for this work (refer to *Initial Environmental Examination of Preliminary Works for the Houay Soup Resettlement Area* (Earth Systems, June 2015)).

Ancillary roads will be constructed that branch from this main road to the front of each house in the HSRA. An existing access road which was upgraded during Preliminary HSRA Construction works will remain in place to provide access to paddy fields and the border of the northern livestock areas.

A reinforced and pre-stressed concrete bridge will be constructed over the Nam Ngiep River. The bridge will have a total width of 6.70 m and length of 132.31 m supporting two (2) road lanes (2 x 3.0 m) and two (2) pedestrian walkways (2 x 0.35 m). The structure will consist of two (2) reinforced concrete abutments (currently being completed as preliminary works – refer to *IEE of Preliminary Works for the Houay Soup Resettlement Area*, Earth Systems, June 2015); three (3) reinforced concrete piers; and two (2) paved approach roads 50 m length and 7 m width. Detailed design is provided in *Design Drawing of the Nam Ngiep River Bridge* (ASA Power Engineering & Vietnam Japan Engineering Consultants 2014).





### Transmission Line

A 22kV transmission line will be constructed along the access road to supply electricity for HSRA construction and subsequently to supply households / applicable infrastructure for the resettlement area - refer to IEE of the 22kV TL (sections 2, 3 & 4) and Ban Houay Soup Distribution Line (Earth Systems, 2014). One (1) km of transmission line was constructed from the connection point at Ban Hat Gniun to the primary development area during Preliminary HSRA Construction Works. This line will be extended, with distribution lines providing power to each house (with a current meter).

The connection to the current EDL line will be changed. The line will connect at EDL pole 315 on the left bank of the Nam Ngiep River, extend along the current Obayashi contractor line to P09, and then will deviate from the line to cross the Nam Ngiep River parallel to and just downstream of the HSRA access bridge (refer to Figure 2-5). The compensation process has been completed for this proposed connection pathway.

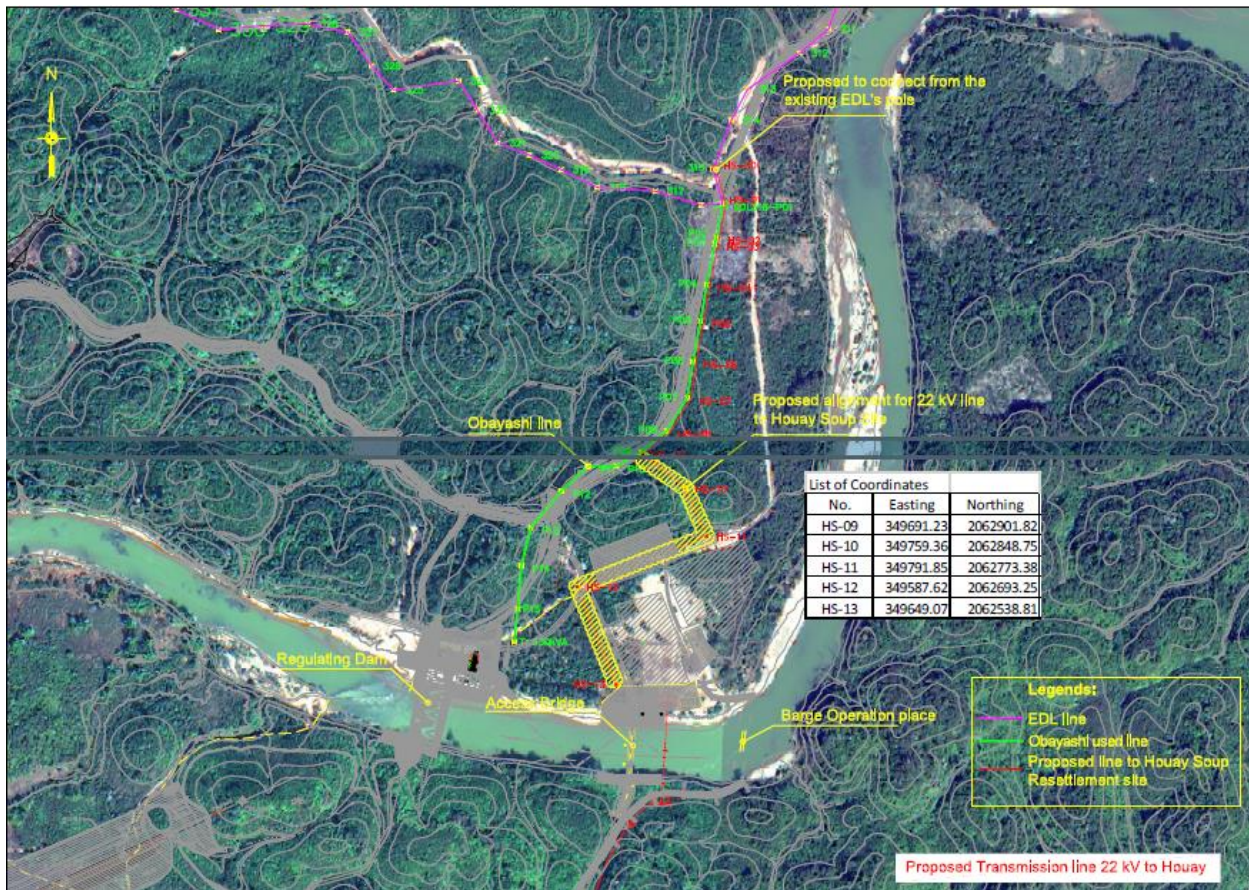


Figure 2-5 Proposed 22kV Transmission Line Connection to the EDL Line

Source NNP1

### Solid Waste Disposal

The solid waste disposal site will be situated in Disposal Area No.6 (refer to Figure 2-6 and Figure 2-7). Access to Disposal Area No.6 will be via the access road in Houay Soup which will connect to the existing access road on the right bank of the Nam Ngiep River. The waste pit will be appropriately lined to prevent seepage into the groundwater in accordance with applicable environmental regulations (NNP1, 2014b).

NNP1 has designed the facilities to accommodate anticipated disposal requirements for a ten year period. The design is based on per capita waste figures for Lao PDR. Lao urban residents produce about 0.75 kg of solid waste per capita each day. Using a global average rural to urban waste generation ratio of between 0.3 - 0.5, NNP1 expects HSRA residents to produce solid waste of approximately 0.5 kg / capita / day. Based on a population of 3,700, this would total 1,620 m<sup>3</sup>. The expected area of disposal area is 1.5 ha and will consist of 6 pits, each W 35 m x L 15 m x D 3 m. Pit design is shown in Figure 2-6. . One pit will be prepared by NNP1 with sufficient volume for the first 5 years.

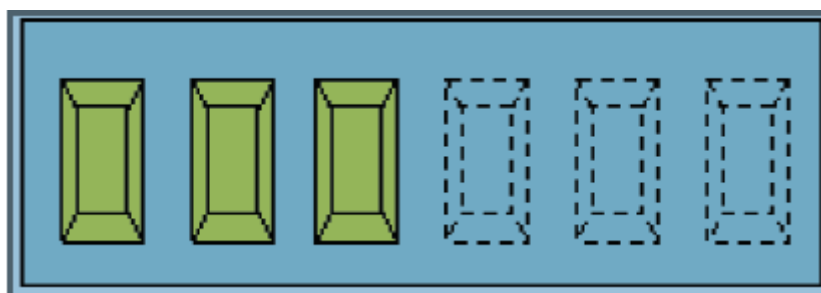


Figure 2-6 Preliminary waste disposal design

Source: NNP1 2015



## Landfill Location Plan

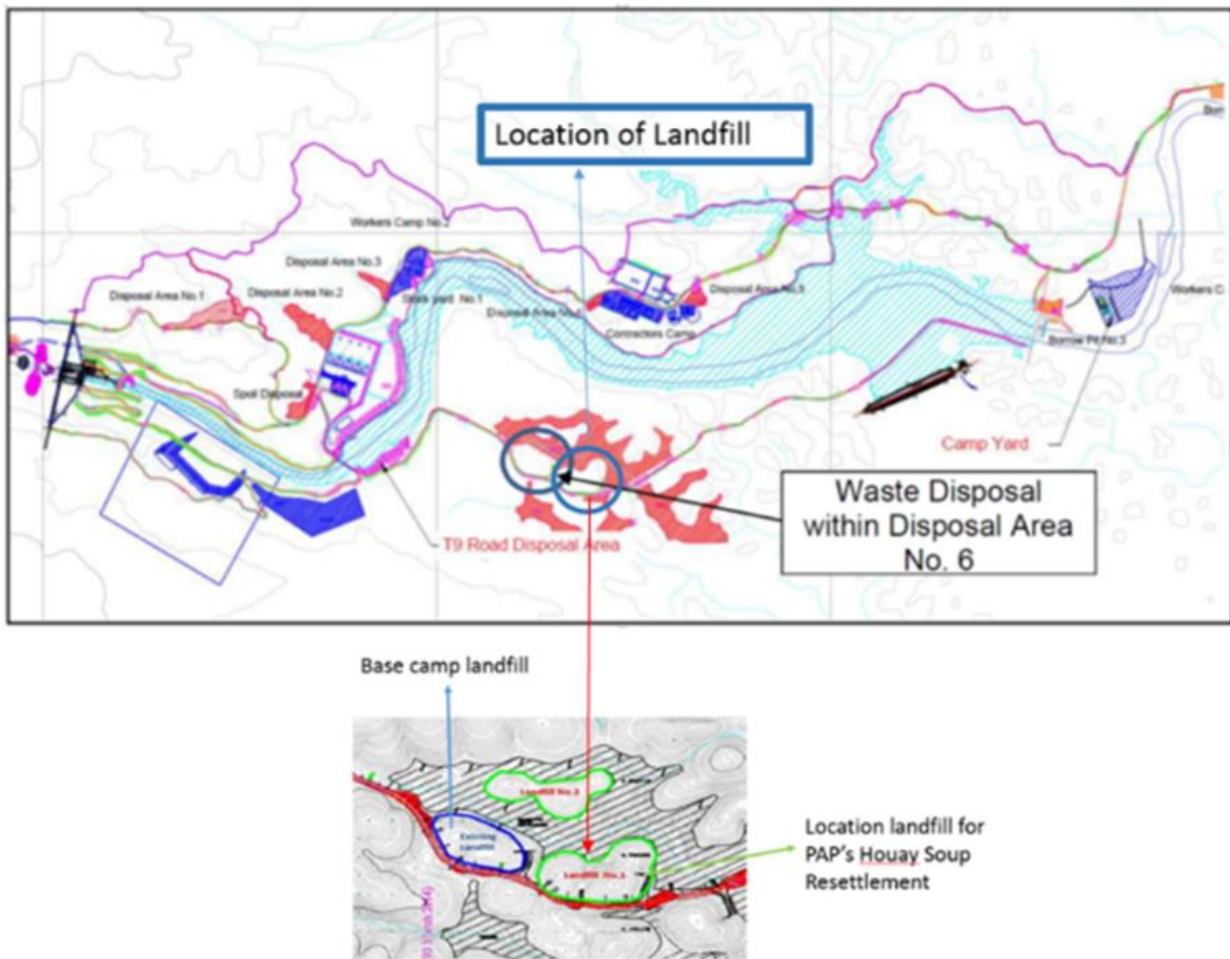


Figure 2-7 Proposed Waste disposal area for the HSRA

### 2.2.2 Temporary Construction Facilities

#### HSRA Preliminary Works Description

A separate IEE was developed for preliminary construction works for the HSRA (refer to *IEE of Preliminary Works for the Houay Soup Resettlement Area* (Earth Systems, 2015a). In summary, the following will be conducted in advance of infrastructure development described above:

- New Temporary Access Road (1.1 km) - Unpaved compacted road with surface shaping and drainage ditch. The road will be cut through a sloped area and will run in parallel with a small ephemeral stream (Houay Kee Hia) above. A pipe culvert will be installed where the stream crosses the road;
- Existing Access Road Upgrade (3.1 km) – An existing rural track which will be upgraded to an unpaved / paved compacted road (refer to Figure 2-8). The road passes through a lowland area and crosses one (1) perennial (Houay Soup Noi) and one (1) ephemeral stream (Houay Na). In a number of places the road will be backfilled and gravel pavement will be used. A v-shaped drainage system will be installed. Gabion boxes will be placed in sensitive areas. Pipe culverts will be installed in four locations;
- Barge landings (Left and Right banks) – The left bank landing will connect to the existing NN1HP road infrastructure. The right bank landing will connect to the proposed temporary access road. Stone / compacted gravel landings will be established on the left and right banks of the Nam Ngiep River.

The sites will be excavated and large stones will be used to construct the landing and for slope protection. A 10 cm gravel pavement will be used to surface the landing. Refer to Plates Plate 2-1 and Plate 2-2; and

- Bridge Abutment – An abutment for the permanent bridge will be constructed on the left bank. This will include an earth / rock frustum slope with stone masonry reinforcement.

A barge will be operated across the Nam Ngiep River, between the two Barge landings. The type of barge and its operation will be confirmed once tendering for this service has been completed.

### ***Ancillary Infrastructure***

Ancillary infrastructure will include:

- The development of work camp / stock yard, borrow area and batching facilities at the TCM / Song Da camp site on the left bank of the Nam Ngiep River. Existing quarries will also be utilised.<sup>1</sup>
- The development of a work camp and stockyard on the old UXO camp site within the HSRA; and
- The development of two (2) new borrow areas - Borrow pit #1 near the Re-regulating Dam and borrow pit #2 in the HSRA.

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<sup>1</sup> These facilities are included under the Main Project EIA and ESMMP-CP.



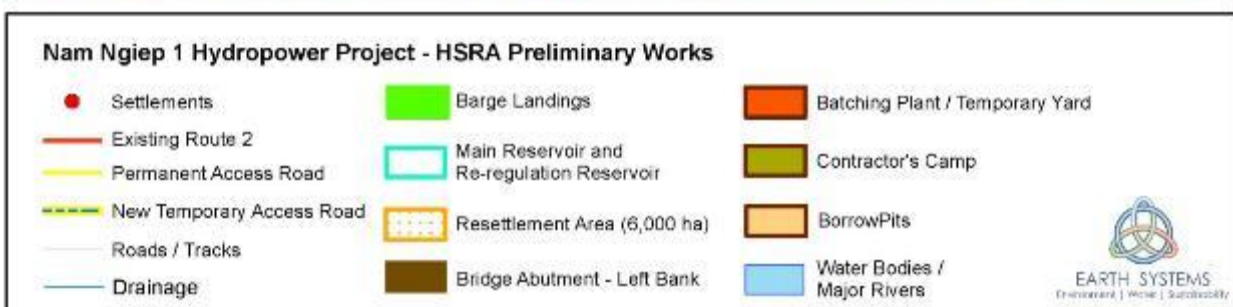


Figure 2-8 HSRA Preliminary Works Layout

Source: Earth Systems 2015

### 2.2.3 Primary Land Use Designations

The main components of the proposed land uses in the HSRA (Table 2-4) will include residential area and infrastructure; lowland rice fields; plantations and upland crop fields, grazing land, community NTFP forest, firewood collection forest, utilisation forest, conservation forest, protection forest and cemetery.

**Table 2-4 Land Uses and Livelihood Resotration Requirements**

Land use	Allocation for resettled household	Total Land Requirement for 750 HHs (Ha)*
Residential plots (including livestock pens and gardens)	Housing (no less than 800 m <sup>2</sup> for residential land for each household), community buildings and structures.	360
Lowland rice fields	Minimum of 0.1 ha per household member (value multiplied by the number of household members and combined into one land title). Household minimum of 0.3 ha and household maximum of 1.5 ha.	330
Cash crop and upland crop fields	minimum of 0.1 ha of plantation land per person (value multiplied by the number of household members and combined in one land title in the name of both heads of household)	330
Plantation	Minimum of 0.1 ha per household member (value multiplied by the number of household members and combined into one land title).	330
Grazing land	A limit of 5 cattle/buffaloes per household is assumed (for a total of 2,400 cattle and 1,200 of buffalo).	586
Firewood	Minimum of 0.08 ha of designated forest per person (multiplied by the number of household members and combined in one land title). Assumes 1 m <sup>3</sup> of firewood is required per person per year).	264
Utilisation forest	Various NTFP (refer to INRMP)	3,702
Conservation forest		
Protection forest		
Cemetery	One or more cemeteries and / or cemetery forests pending PLUP.	N/A
<b>Total area</b>		<b>5,902</b>

Source: NNP1 2014b

\*Assumes all 750 households with approximately 3,300 people relocate.

The INRMP (Appendix A) details the land use zoning for HSRA and provides information on resource utilisation and conservation requirements for these land uses. A summary is provided in Table 2-5 and Figure 2-9.



**Table 2-5 Proposed land use zoning in the HSRA**

Village Land use category	PFA		RDS		Total	
	Ha	%	Ha	%	Ha	%
Residential	-	-	241.19	10.08%	241.19	3.94%
Lowland agriculture	-	-	368.84	15.41%	368.84	6.03%
Grazing	-	-	586.76	24.51%	586.76	9.60%
Upland agriculture	-	-	427.16	17.85%	427.16	6.99%
Plantation	-	-	262.05	10.95%	262.05	4.29%
Utilisation forest	2047.44	55.03	-	-	2047.44	33.49%
Conservation forest	1103.25	29.65	-	-	1103.25	18.04%
Water source forest (and water supply)^	-	-	225.48	9.42%	225.48	3.69%
Protection Forest*	570.01	15.32	-	-	570.01	9.32%
Other	-	-	282.03	11.78%	282.03	4.61%
<b>Total</b>	<b>3720.7</b>	<b>100</b>	<b>2393.5</b>	<b>100</b>	<b>6114.2#</b>	<b>100</b>

Source: Earth Systems 2015b

^ Includes water source protection forests, water supply area and Irrigation Reservoir

# GIS files supplied by NNP1 cover 6,114.2 ha (while HSRA is 6,108 ha).

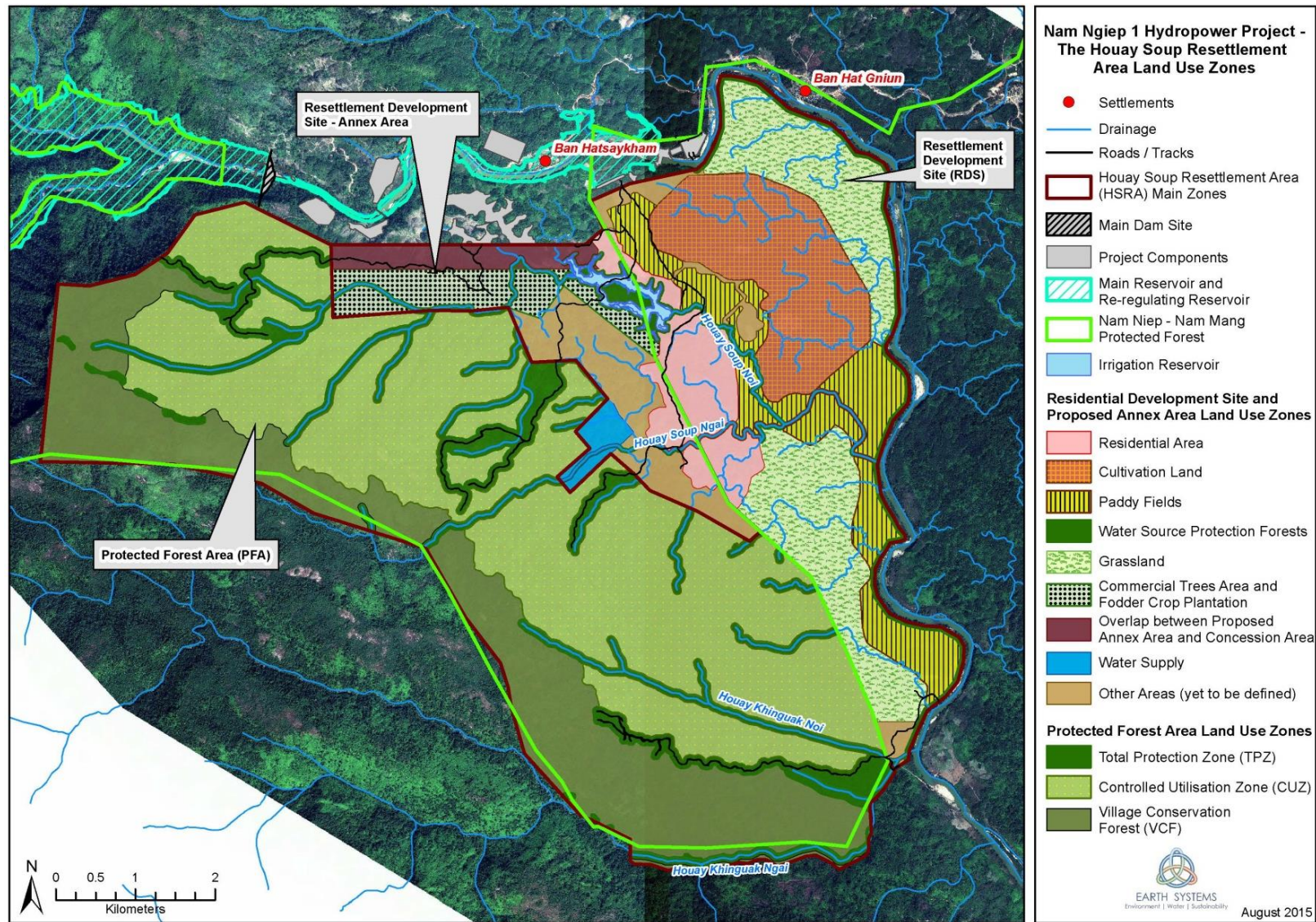


Figure 2-9 Preliminary HSRA Land Use Zoning

Source: Earth Systems 2015

## 2.3 HSRA Development Schedule

### 2.3.1 Construction Phase

Main construction for the resettlement village will commence in October, 2015. It is planned that the Ban Hatsaykham community (~40 households) will relocate in approximately April 2016, while the 2LR communities (~507 households) will relocate during the 2017-18 period following the rainy season. The number of households relocating is currently in the process of negotiation (up to 750).

Accordingly, the Construction Phase will be carried out in two stages. The first phase of construction (commencing in October 2015) will include the construction of a portion of the housing as well as community infrastructure and buildings, domestic and irrigation water systems, paddy rice fields, soil improvement, and pasture development.

The second stage, extending until late 2017-18, will involve the construction of remaining houses for villagers from 2LR (~507 households) and the finalisation of all resettlement infrastructure within the HSRA, including paddy rice fields, pastures, cash crop fields developed, and the southern irrigation system for the paddy rice fields.

### 2.3.2 Post Construction Phase

The Post Construction Phase for the HSRA is divided into two distinct phases: (a) HSRA Stabilization Period (as per the REDP, *Livelihood Restoration and Income Plan*); and (b) Operations and Maintenance.

It is understood that NNP1 involvement in livelihood restoration activities for PAPs (in accordance with the NNP1 REDP) will continue for 10 years following the pre-construction period of the Main Project (December 2013) and for up to five (5) years during a stabilisation phase after NN1HPP COD.

NNP1 involvement in post-construction maintenance and operation of the resettlement infrastructure is expected to commence in 2018 following the resettlement of 2LR households. Operational responsibility by the village and / or GOL for village infrastructure will commence following the official transfer of the HSRA to the village / GOL. Official transfer will occur after MONRE is satisfied that CA requirements have been met (e.g. training requirements for villagers, financial planning for operations and maintenance completed, land tenure certificates registered, etc.).

NNP1 involvement in HSRA post-construction management, mitigation, monitoring, maintenance, training, etc. will continue, at a minimum, until official transfer of the HSRA from NNP1 ownership to village / GOL ownership.

## 2.4 Models of financing for Operations and Maintenance of infrastructure

NNP1 will negotiate with new inhabitants of the HSRA and applicable GOL staff to develop models of financing operation and maintenance of infrastructure (post-transfer date). Current planning includes several options (NNP1 2014b):

- Operation and Maintenance by a commercial operator, financed by fees to be provided by the inhabitants of the resettlement site;
- Operation and Maintenance from a village fund, which would require determination of how this village fund would be financed. The Project will establish market booths, which the village can rent out to achieve income for village activities;
- Operation and Maintenance from the Project's Community Development Program, in the event that it can be implemented without creating dependencies and reduced ownership;



- Operation and Maintenance via neighbourhood groups; or
- Operation and Maintenance by self-funding measures, for example fees at the bus station for its maintenance.

## 2.5 HSRA Alternatives

A number of alternative sites for resettlement and / or options for resettled villagers have been considered throughout the resettlement planning process.

### 2.5.1 Alternative Sites

One of the most important concerns raised by PAPs has been the selection of the resettlement site – with PAPs affected by the main reservoir expressing a preference to be relocated near to their current location.

NNP1 along with PAPs and applicable GOL authorities investigated several potential resettlement sites throughout the ESIA process (refer to EIA (Kansai et al. 2012a); EIA (ERM 2014); SIA (NNP1 2014a)), including:

- Samtoey area, Vientiane Province (for 2LR);
- Phalavaek area, Vientiane Province (for 2LR);
- Phukatha area, Vientiane Province (for 2LR);
- Pha-Aen area, Vientiane Province (for 2LR);
- Nam Choi, Bolikhamxay Province (for 2LR);
- Hat Gniun, Bolikhamxay Province (for Z3); and
- Houay Soup, Bolikhamxay Province (for Z3 and 2LR together).

A detailed account of the site selection process is provided in the SIA and REDP (NNP1 2014a,b).

The Houay Soup area, located on the opposite bank of Ban Hat Gniun in Bolikhan district, Bolikhamxay Province, was selected as the most appropriate resettlement area. This area was extensively studied and enlarged in size to 6000 ha from the original allocation of 2000 ha, to have sufficient land available for livelihood activities.

### 2.5.2 Alternative Layouts

Consultation (initiated in 2007) in Project affected communities identified villagers' preferences regarding the configuration and composition of the prospective resettlement communities.

A number of prospective land use zoning configurations were considered pre-feasibility assessment for the HSRA, with the layout of housing and community infrastructure reconfigured a number of times to accommodate evolving numbers of prospective relocated peoples (refer to Kansai et al. 2012a,b; ERM 2014; NNP1 2014a,b; *Resettlement and Ethnic Minority Development Plan Report – Nam Ngiep 1 Hydropower Project*, etc.). The size and configuration of lowland and upland agricultural areas, plantations, community forests, etc. have similarly been progressed through a number of iterations to ensure appropriate land availability for food security and livelihoods for the HSRA population.

### 2.5.3 Resettlement Options

NNP1 has agreed to three (3) resettlement options for resettlers in consultation with PAPs and GOL:

- Resettlement to a site agreed by PAPs, the GOL and NNP1 (i.e. the HSRA);
- Self-resettlement within the Project area of influence with follow-up activities by the project; and

- Self-resettlement outside the Project area of influence with no follow-up by the Project.

It is understood that the resettlement of up to 750 households is based on the assumption that the majority of PAPs will select the option to resettle to the HSRA.

## **2.5.4 No HSRA Alternative**

As the NN1HP will inundate settlements and agricultural lands of communities in Zones 2LR and 3, village resettlement or financial settlement is required. As a number of PAPs have indicated a desire to be resettled, the 'No Project Alternative' has is not analysed in this IEE.

## 3 LEGAL CONTEXT

### 3.1 Project Obligations

NNP1 is committed to developing the NN1HP in accordance with GOL legislation and international standards / best practice.

Documents describing Project specific environmental and social obligations for developing and operating the NN1HP (including the HSRA) are outlined in Table 3-1.

**Table 3-1 Relevant Lao PDR Laws and Policies for the HSRA and PFA**

Author	Document	Year
KANSAI	Environmental Impact Assessment Report (approved by GOL)	2012
GOL	NN1HP Concession Agreement	2013
ERM	Environmental Impact Assessment (revised to meet ADB safeguard standards)	2014
NNP1	Social Impact Assessment (revised to meet ADB safeguard standards)	2014
ERM	NN1HP Environmental and Social Monitoring and Management Plan for the Construction Phase	2014
NNP1	NN1HP Resettlement and Ethnic Development Plan including: <ul style="list-style-type: none"> <li>• Livelihood and Income Restoration Plan</li> <li>• Ethnic Peoples Development Plan</li> <li>• Public Consultation, Participation and Disclosure Plan</li> </ul>	2014

Source: Earth Systems 2015

### 3.2 HSRA Development

The Houay Soup Resettlement Area (HSRA) has been selected as the Project's designated resettlement site. This site was selected in consultation with PAPs and the GOL after extensive analysis of a number of resettlement site options.

Detailed assessment of the environmental and social aspects of the proposed site, including a number of preliminary design concepts was conducted through the Project's EIA (KANSAI et al. 2012a) and later through the updated EIA (ERM 2014), SIA (NNP1 2014a), REDP (NNP1 2014b) and other social development plans in accordance with GOL legislation and the ADB's Safeguards Policy Statement (ADB 2009).

In May 2014 the Governor of Bolikhamxay Province officially proposed the HSRA to the Central Government and National Assembly. This proposal triggered the conduct of a joint GOL-NNP1 site survey of the HSRA lead by the MONRE which resulted in:

- Approval of 1,745 ha of land to for the purpose of resettlement and livelihood restoration for NNP1 PAPs (the Resettlement Development Site);
- Identification of the remaining 4,363 ha as overlapping with the Nam Ngiep Nam Mang Protected Forest Area, established in 2012 in accordance with PM Decree 333 on National Protected Forest Areas;
- GOL recognition of the importance of the PFA for resettlers' livelihoods and agreement that resettlers could use this area as long as it was managed according to a sustainability plan; and
- GOL agreement to consider the annexure of 648 ha of the PFA for further resettlement development. In July 2015, MONRE approved the annexure request.



Key approval documents relevant to the development and operation of the HSRA are summarised in Table 3-2.

**Table 3-2 Relevant HSRA Development Approval Documents**

Author	Document Name	Year
Governor	Proposal from the Governor of Bolikhamsay Province on the HSRA, No. 035 / BP	2014
PONRE	Report on the site survey for 6,108 ha of land (Houay Soup) for the purpose of resettlement and livelihood restoration for NN1HP PAPs	2014
PONRE	Minutes of the Provincial Meeting on the results of the site survey for 6,108 ha of land (Houay Soup) for the purpose of resettlement and livelihood restoration for NN1HP PAPs	2014
MONRE	Decision on the Approval of State's Land to be used as the Resettlement and Livelihood Restoration Area for NN1HP PAPs (1,745 ha)	2014
MONRE	Decision on the Approval of State's Land to be used as the Resettlement and Livelihood Restoration Area for NN1HP PAPs (648 ha PFA Annex)	2015

Source: Earth Systems 2015

### 3.3 Environmental and Social Impact Assessment and Natural Resource Management

The IEE has been prepared in accordance with Government of Lao (GOL) policies and legislation, and relevant requirements of the Asian Development Bank's (ADB) Safeguard Policy Statement (ADB 2009).

A detailed description of legal requirements and obligations is provided in the EIA (ERM 2014) and SIA (NNP1 2014a). Key documents are summarised in the following sections.

#### 3.3.1 National Environmental and Social Impact Assessment Framework

The policy and legal framework for environmental and social impact assessment and resettlement in Lao PDR is summarised in Table 3-3.

**Table 3-3 Lao PDR Environmental and Social Impact Assessment Framework**

Legislation	Year
Environment	
Regulations and Implementing Decree 192/PM on Compensation and Resettlement of People Affected by Development Projects	2006
Agreement on National Environmental Standards	2009
Prime Ministerial Decree on Environment Impact Assessment.	2010
Technical Guidelines on Compensation and Resettlement of People Affected by Development Projects	2010
Law on Environmental Protection	2013
The Ministerial Instruction on the Environmental and Social Impact Assessment for the Investment Projects and Activities	2013
Policy on Sustainable Hydropower Development in Lao PDR	2015

Source: Earth Systems 2015

### 3.3.2 ADB Safeguard Requirements

Relevant environmental and social safeguards for the HSRA and PFA are outlined in Table 3-4, according to the Project Concession Agreement.

**Table 3-4 Relevant environmental and social standards for the HSRA and PFA**

Institution	Policy and Standards	Year
ADB	ADB Safeguard Policy Statement (2009)	2009
ADB	Public Communications Policy	2011
IFC	IFC Sustainability Framework	2012

Source: Earth Systems 2015

### 3.3.3 Integrated Natural Resource Management

The legal and policy framework for the management of natural resources in Lao PDR is outlined in Table 3-5. More detailed analysis of this framework is provided in the INRMP (Appendix A).

Key documents for the development of the INRMP include:

- Prime Ministerial Decree 333 on Protected Forests which defines the principles, procedures and management measures regarding the protection, conservation, development and sustainable use of the Protection Forest and Protection Forestry lands. Protection forests are divided into two categories: the absolutely/total prohibited zones and the utilisation zones; and
- MAF / NLMA (2010) Manual on Participatory Agriculture and Forest Land Use Planning which outlines the formal process for village establishment and land and forest land use planning.

**Table 3-5 Relevant Lao PDR Laws and Policies for Natural Resource Management**

INRM Aspect	Key Policy and Legislation
Settlements (and socio-economic development)	<ul style="list-style-type: none"> <li>• Constitution of Lao PDR 1991 (amended 2003)</li> <li>• <i>Land Law 2003</i></li> <li>• National Socio-economic Development Strategy</li> </ul>
Agricultural Resources	<ul style="list-style-type: none"> <li>• <i>Law on Agriculture 1998</i></li> <li>• <i>Law on Irrigation 2012</i></li> <li>• Agricultural Development Strategy 2011-2020</li> <li>• MAF Instruction 0822 on Land and Forest Allocation for Management and Use</li> <li>• MAF / NLMA Participatory Agriculture and Forest Land Use Planning Manual 2010</li> </ul>
Forests and Terrestrial Resources	<ul style="list-style-type: none"> <li>• <i>Law on Forestry 2007</i></li> <li>• Forestry Strategy to the year 2020</li> <li>• Prime Ministerial Decree 333/2010 on Protected Forests</li> </ul>
Water and Aquatic Resources	<ul style="list-style-type: none"> <li>• <i>Law on Water and Water Resources 1996</i></li> <li>• Draft National Water Resources Strategy 2010</li> </ul>
Biodiversity	<ul style="list-style-type: none"> <li>• <i>Law on Wildlife and Aquatic Biodiversity</i></li> <li>• National Biodiversity Strategy and Action Plan to 2020</li> </ul>
Cultural Heritage Resources	<ul style="list-style-type: none"> <li>• <i>Law on National Heritage 2013</i></li> </ul>

## 4 PHYSICAL SETTING

### 4.1 Atmosphere and Climate

#### 4.1.1 Climate

The HSRA is situated within a tropical climate influenced by a south-western monsoon regime, which divides the year into a distinct dry season and a distinct rainy season. The wet season typically occurs between April and October (with the heaviest rains typically in June - August, while the dry season begins in November and extends until March (or later during drought years) (refer to Figure 4-1). The average annual rainfall at the nearest rainfall gauging stations along the Nam Ngiep near the HSRA is approximately 2,950 mm at Ban Hat Gniun (based on rainfall data collected since 2011), 3,700 mm Muong Main (R3), and 3,000 mm at Paksan (R2), respectively (Lao Consulting Group 2014).

The area generally experiences more moderate weather conditions than elsewhere in Lao PDR, with less extremes of temperature. Meteorological data collected from the nearest weather station at Ban Hat Gniun (since April 2011) indicates average ambient temperatures ranges from 12°C to 38°C. During the wet season from June to September, temperatures ranged from 22°C to 36°C; and during the dry season from December to February, temperatures ranged from 12°C to 38°C (NNP1 2014b).

Occasional tropical storms or typhoons move inland (westward) from the South China Sea bringing torrential rains (potentially) over a prolonged period, typically during the wet season or early in the dry season (when the official typhoon season starts from June to December each year). These storms are predicted to become both more intense and frequent in the coming decades due to climate change, leading to an increased likelihood of flooding in the area (ICEM 2015).

Further meteorological data of the HSRA is provided in the REDP (NNP1 2014b) and the NNP1 EIA (ERM 2014).

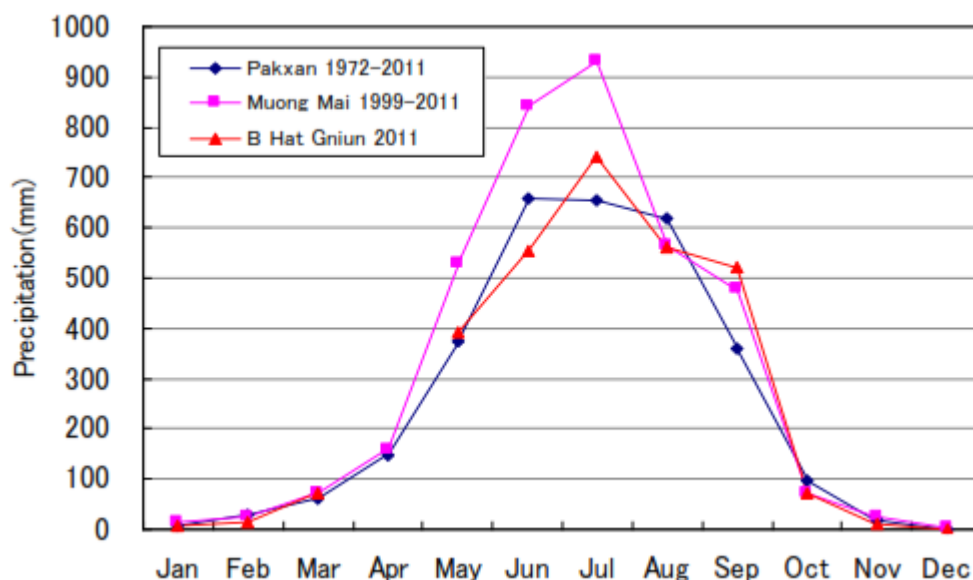


Figure 4-1 Monthly rainfall at Hat Gniun, Muong Mai, and Paksan (Bolikhamsay Province)

## 4.1.2 Atmosphere

The air quality in the HSRA is typical of a rural environment in Lao PDR, and is considered generally good. There are no major industrial pollution sources in the vicinity of the HSRA, and transportation density is still relatively low. The main sources of air pollutants are likely from frequent vegetation burns for preparatory work associated with shifting cultivation and other purposes (e.g. hunting), as well as burning associated with rubbish disposal. Transportation on unsealed roads, particularly during the dry season, contributes short term particulate matter to the atmosphere.

## 4.2 Topography

The HSRA is bounded by the Nam Ngiep to the north and east, the Houay Khinguak Ngai to the south, and mountains / plateau with elevations of up to 1,600 masl to the west / northwest. The HSRA is generally characterised by flat to hilly and undulating topography, with low-lying floodplains bordering the Nam Ngiep and its major tributaries, and steep escarpments and granite outcrops in higher areas to the south and west / northwest (refer to Figure 4-2).

According to topographical survey mapping conducted in 2011, the HSRA land generally slopes down towards the east from about 1,500 masl in the north and west to about 180 masl to the east. The lower areas along the Nam Ngiep River, Houay Soup Noi and Houay Soup Ngai include flat plains and rolling lands with gentle slopes between elevations of 174 and 177 masl, suitable for agriculture and grazing (Lao Consulting Group 2014).

The mountain range bordering the south of the HSRA includes Phu Kata (peak at 2,071 masl) and Phu Samsao (peak at 2,426 masl) (NNP1 2014b).

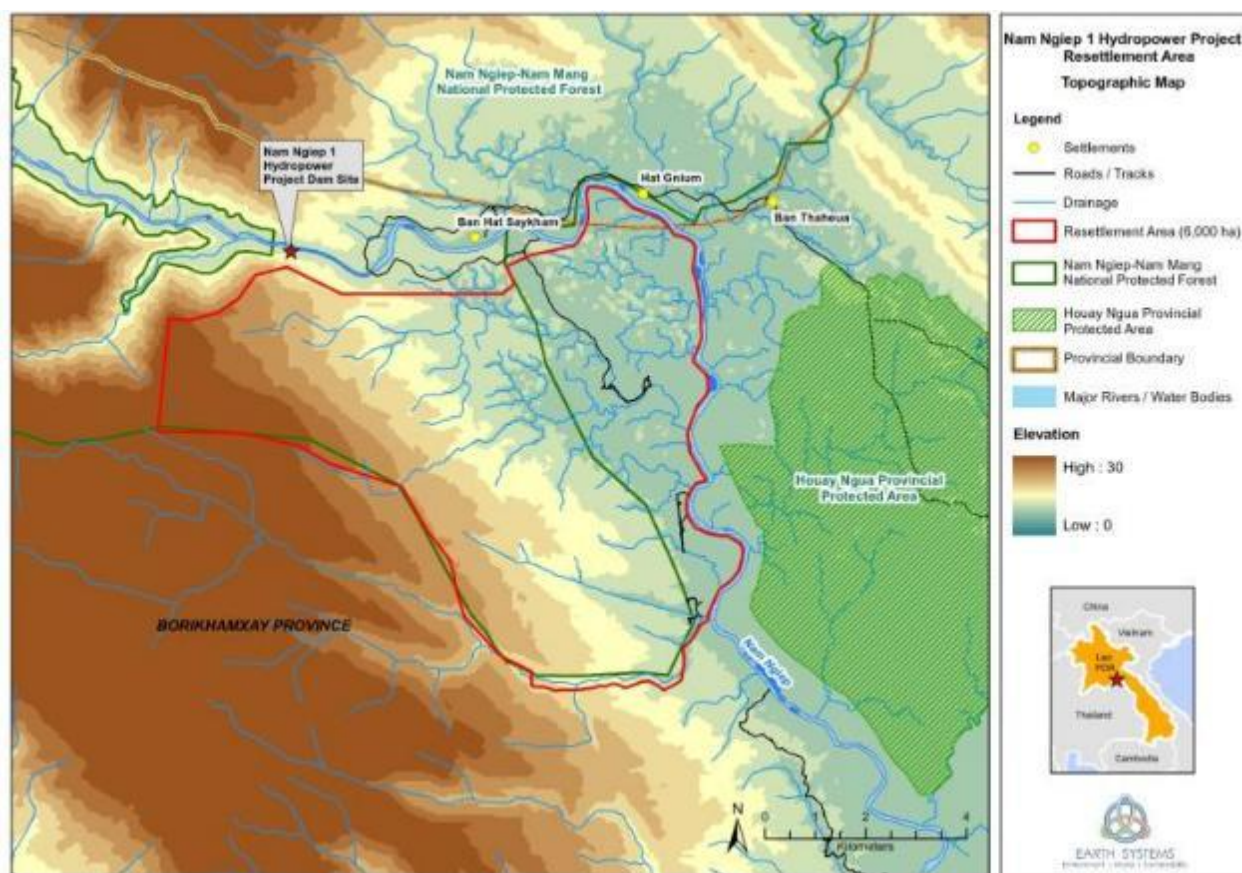


Figure 4-2 Topography of the Houay Soup Resettlement Area and surrounds

Source: Earth Systems 2015



## 4.3 Geology

The geology of the HSRA is mainly characterised by Quaternary sediments comprising alluvium deposits found along the river and riverside (NNP1 2014b). These overlie Palaeozoic sedimentary and igneous rocks. Further description of the geology of the region can be found in the EIA (ERM 2014).

The geological structure of the HSRA is considered stable and seismic activities in the Nam Ngiep River basin are rare (ERM 2014).

## 4.4 Soils

### 4.4.1 Soil types

The dominant soil types within the HSRA are Acrisols (FAO classification), including Ferric Acrisols found primarily in elevated areas across the HSRA (e.g. PFA), Haplic Acrisols in the majority of the HSRA development area and along the Nam Ngiep River, and Plinthic Acrisols in a small area bordering the Nam Ngiep River (refer to Figure 4-3).

Acrisols are characterised by an accumulation of low activity clays with low cation exchange capacity (CEC) in the subsurface and by typically low base saturation level. Acrisols generally have low fertility (likely a result of low CEC and nutrient leaching) and are often acidic, with corresponding elevated aluminium concentrations (potentially toxic levels for plants) and high proportions of fixed (unavailable) phosphorous. Acrisols generally form on upper ridge slopes of escarpments / plateaus and are derived from weathered weak sandstone. The soils are often characterised by a dark red loamy surface horizon overlying a bleached subsurface horizon.

The Acrisols in the HSRA are divided into subclasses based on the following criteria:

- Ferric Acrisols: characterised by coarse mottles / redoximorphic features indicating saturated conditions (poor drainage / aeration) for an extended period;
- Haplic Acrisols: uniform colour in the upper 0.5 m of the soil profile; and
- Plinthic Acrisols: presence of iron-rich, humus-poor material, which hardens upon repeated wetting and drying.

### 4.4.2 Soil properties

The results of physio-chemical assessment of soil samples collected during 2011 and 2015 surveys are provided in Appendix G (refer to Figure 4-4 for sampling locations). With few exceptions, the physical and chemical properties of the soil samples are very similar across the large geographic range sampled and for both sampling events.

The general properties of the HSRA soils are as follows:

- Soil texture is predominately sandy loam and loam, with localised areas of sandy clay loam, clay loam, loamy sand, clayey loam, and sand;
- Topsoils (A horizons) are shallow (ranging from 0 - 12 to 0 - 20 cm), and subsoil clay content is generally higher than in topsoils (a feature of Acrisols that lends to poor drainage);
- pH ranges from very acidic to acidic (pH = 3.8 – 4.7), with a median pH of 4.4;
- Soil fertility is poor, with nutrient content very low or low for phosphorous, potassium, calcium, magnesium, and sodium, with moderately low to moderate nitrogen availability;
- Phosphorous and potassium are likely growth limiting nutrients;
- Soil organic matter is low for each of the topsoil and subsoil samples; and

- CEC is moderately low for each of the samples.

2011 and 2015 laboratory analyses confirmed that the HSRA Acrisol soils are generally not suited to agriculture without implementation of a soil improvement program, primarily for soil pH and nutrient content, while additions of organic matter would also likely be beneficial with respect to elevating CEC and providing additional nutrient value.

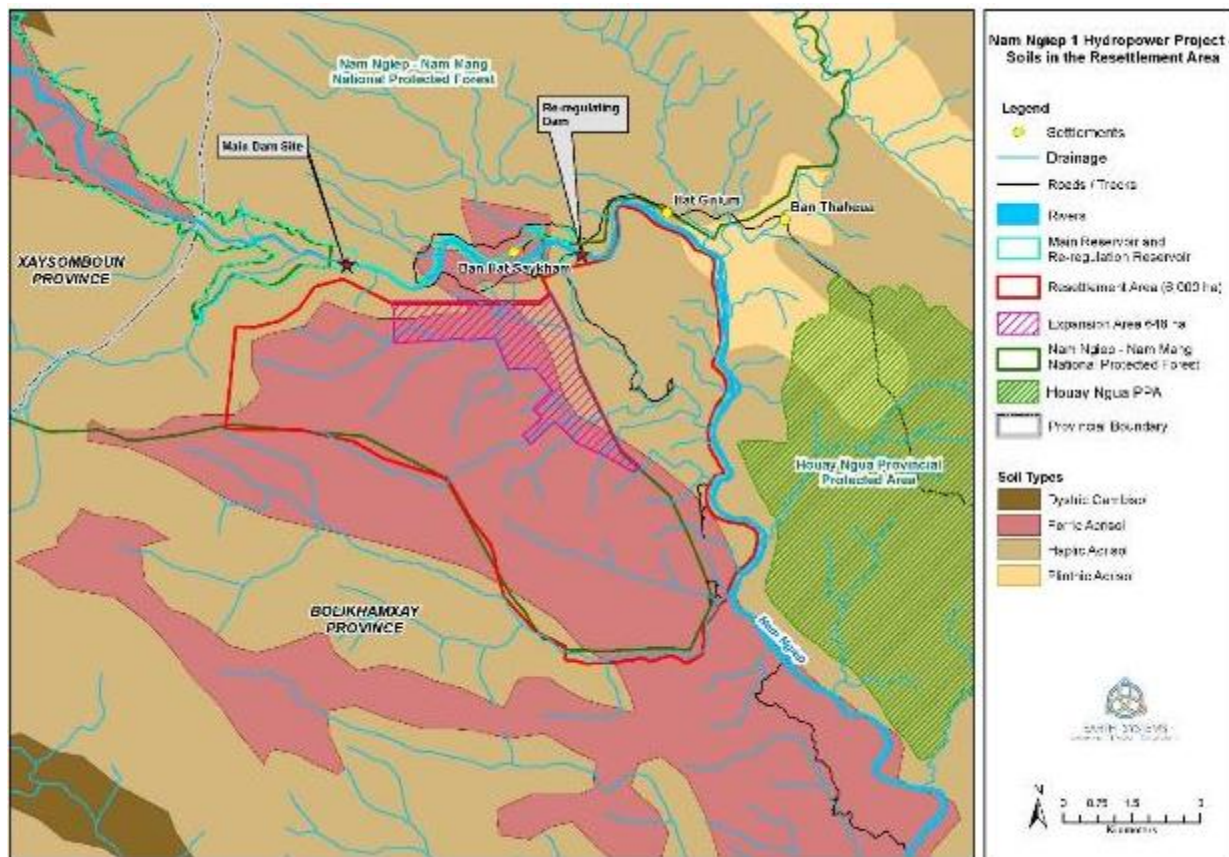
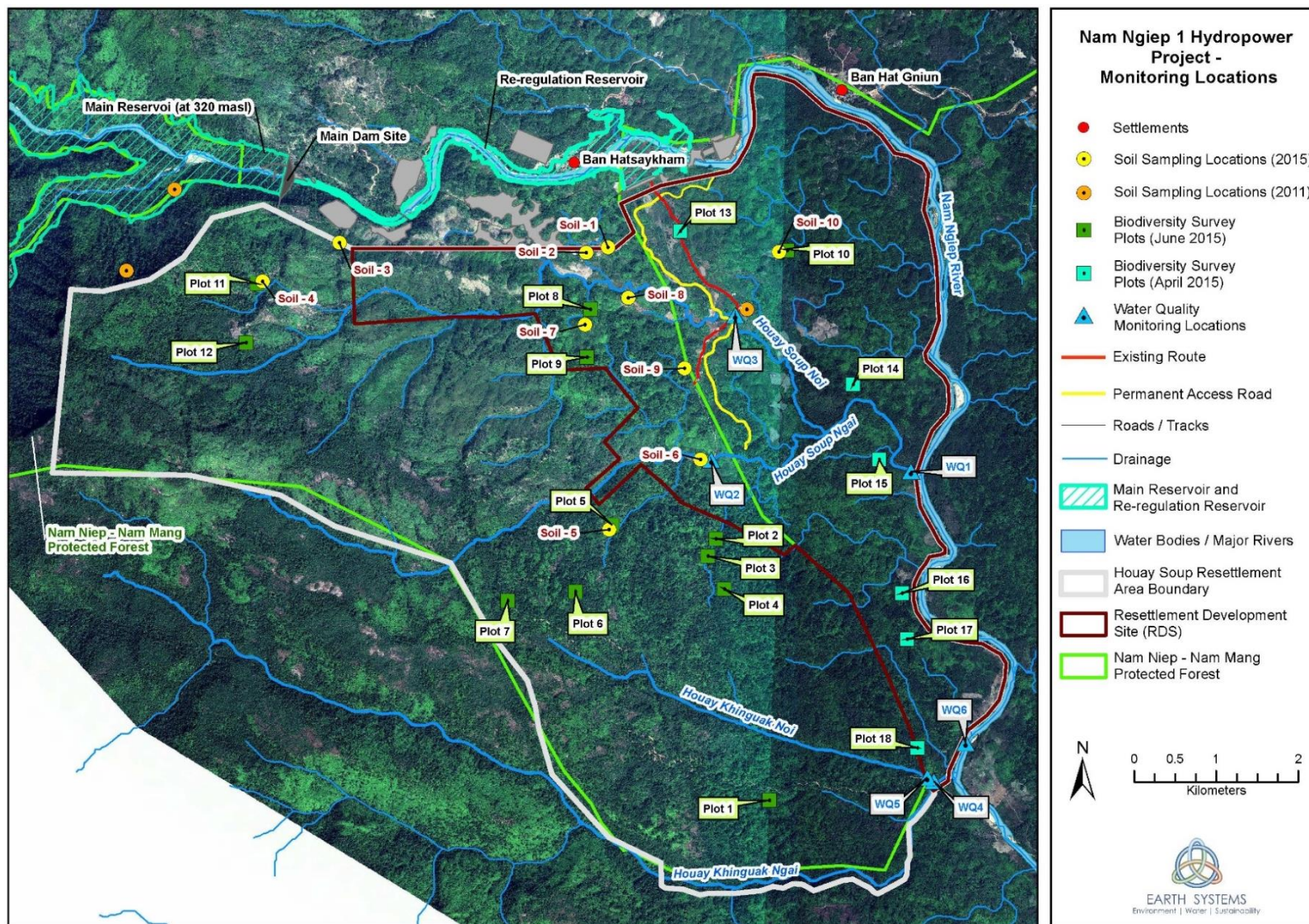


Figure 4-3 Soil Classification in the HSRA

Source: Earth Systems 2015

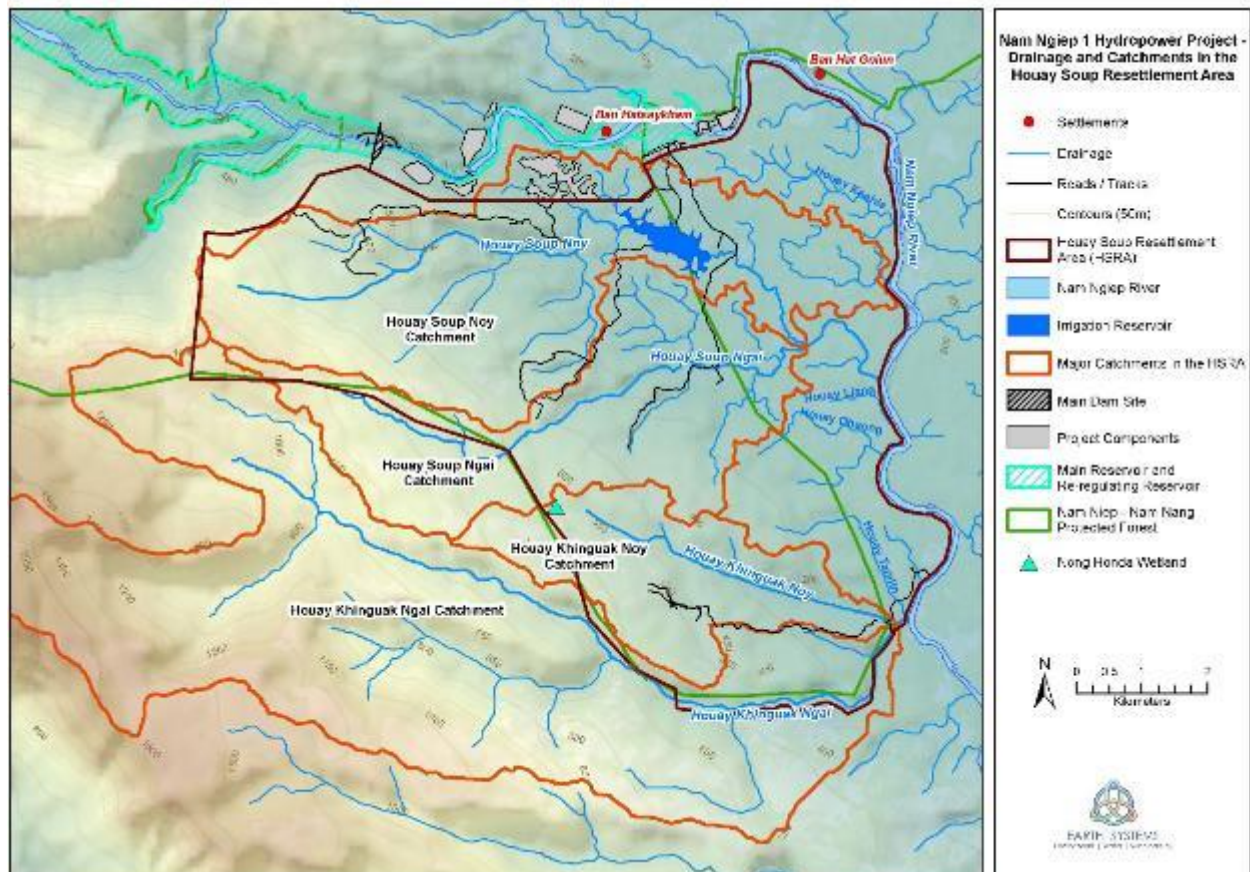






## 4.5 Hydrology

The HSRA is located in the mid to lower catchments of the Nam Ngiep River catchment, downstream of the NN1HP Main Dam and Re-regulation Dam (refer to Figure 4-5). The HSRA is comprised of two primary catchments: the Houay Soup and Houay Khinguak. All of the HSRA sub-catchments flow from those two streams or are direct tributaries to the Nam Ngiep River which flows to the north and east of the HSRA. The upper catchment ridgeline to the west of the HSRA (approximately 800 – 1200 m in elevation) forms the western most catchment boundary for the HSRA water catchments.



**Figure 4-5 Nam Ngiep 1 Hydropower Project - Drainage and Catchments in the Houay Soup Resettlement Area**

Source: Earth Systems 2015

Catchments in the project area are generally steeper around the western edges with average slopes at ridgelines (1000 - 1200 masl) at 18-30%, mid catchment areas (300 - 400 masl) at 16-20% and flattening to less than 10-14% towards lower catchment areas as streams enter the floodplain of the Nam Ngiep River at around 180-200 masl (refer to Figure 4-6 for a 3D model of the HSRA topography and catchment boundaries).

The most significant streams of the HSRA (with respect to surface water flow, aquatic habitat, and aquatic biodiversity) include the Houay Soup Noi, Houay Soup Ngai, Houay Khinguak Ngai and Houay Khinguak Noi (from north to south). Though water abstraction for the HSRA is planned only for Houay Soup Noi and Houay Soup Ngai, each of the perennial streams are described below as future expansion of the resettlement area may provide impetus for further water resource utilisation. The region was subjected to relative drought conditions leading up to the June site visit, therefore reported stream flow / depth (field reporting) was likely considerably lesser than average mid-June conditions. According to local guides present during surveys, the dry ephemeral streams would generally be flowing in June.



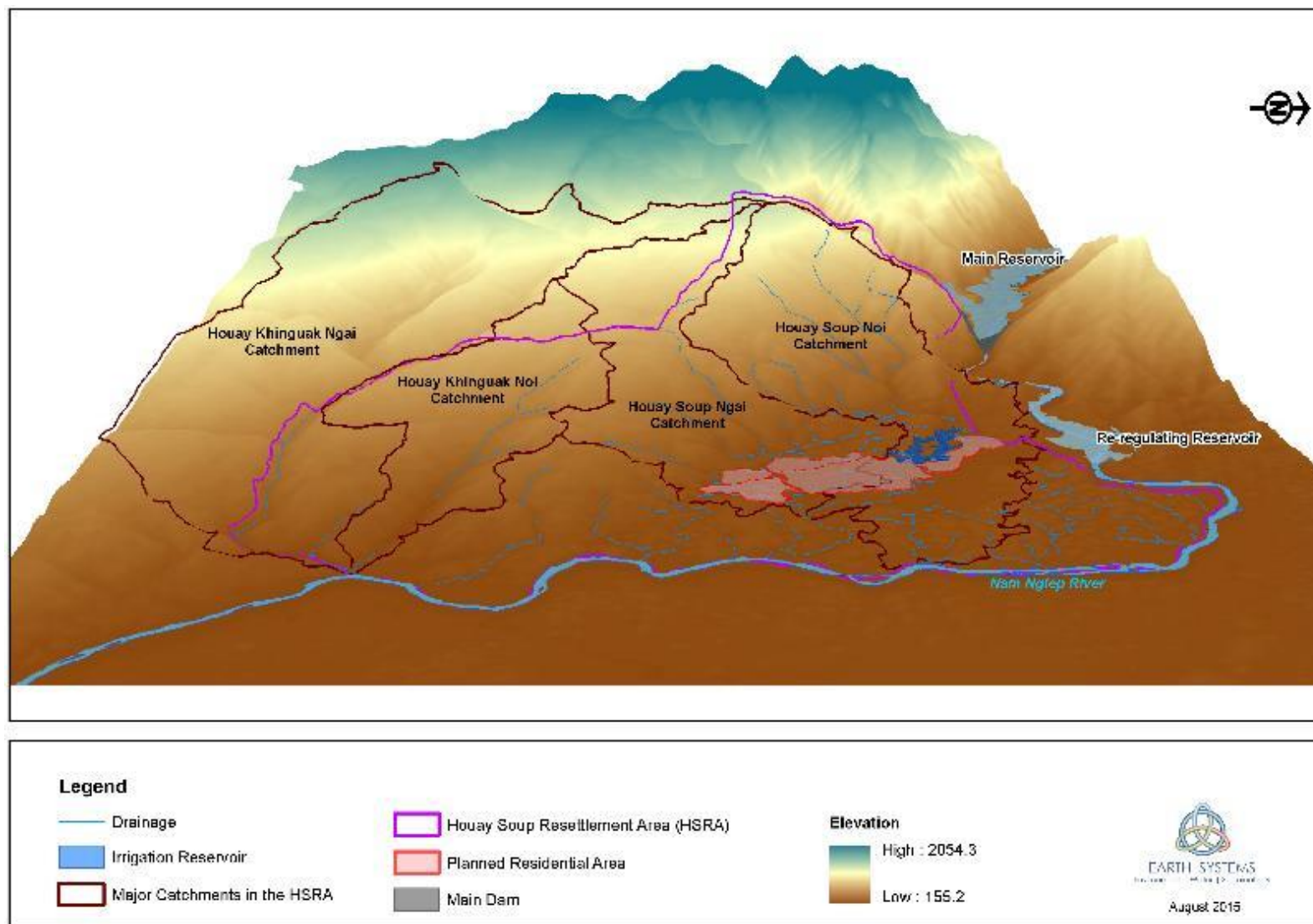


Figure 4-6 Topographic Digital Elevation Model projection - HSRA, Irrigation Reservoir and Catchment Boundaries

Source: Earth Systems 2015

Hydrology modelling has been conducted for the Houay Soup Noi, Houay Soup Ngai, Houay Khinguak Noi, and Houay Khinguak Ngai (refer to Table 4-1). The results display the expected high peak nature due to the small and steep catchments with some limited sustained flow after each storm event. The upper to mid catchment granite aquifers, highly forested land use percentage at greater than 95% of the catchment area, and relatively impermeable soils, interact to produce a small but sustained baseflow developing in the streams of the HSRA estimated at 0.006 - 0.25 m<sup>3</sup> / s when estimated during the dry season with no appreciable antecedent rainfall. The effects of small local springs are difficult to incorporate individually into the model as no hydrographic data exists to model spring behaviour, so this data has been included as a simple baseflow component based on field observations of flow in the dry season.

**Table 4-1 Modelled flow data for perennial HSRA streams**

	Houay Khinguak Ngai	Houay Khinguak Noi	Houay Soup Noi	Houay Soup Ngai
	m <sup>3</sup> / sec			
<b>Max. flow</b>	38.21	19.41	34.89	72.00
<b>95%</b>	9.75	1.80	4.78	8.31
<b>75%</b>	0.54	0.03	0.09	0.40
<b>Median (50%)</b>	0.25	0.01	0.01	0.21
<b>25%</b>	0.25	0.01	0.01	0.21
<b>Min. flow</b>	0.25	0.01	0.01	0.01

Source: Earth Systems 2015

**Houay Soup** – The Houay Soup is formed at the confluence of the Houay Soup Noi and Houay Soup Ngai, within the HSRA boundaries (east of the PFA), ~1.4 km from its confluence with the Nam Ngiep River. More than 99% of its catchment exists within the proposed 6,108 ha HSRA boundary. This stream meanders through a very low gradient plain. Flow was estimated to be < 0.25 m / s during June site visit, with very few pools or significant features in its morphology. The channel bottom is comprised of sediment, with no aquatic vegetation observed in the channel near the Nam Ngiep River and increasingly more aquatic vegetation near the Houay Soup Noi / Houay Soup Ngai confluence. With higher flows some of the riparian (hydrophytic) vegetation will be submerged within the channel, providing refugia and possibly spawning habitat for aquatic fauna.



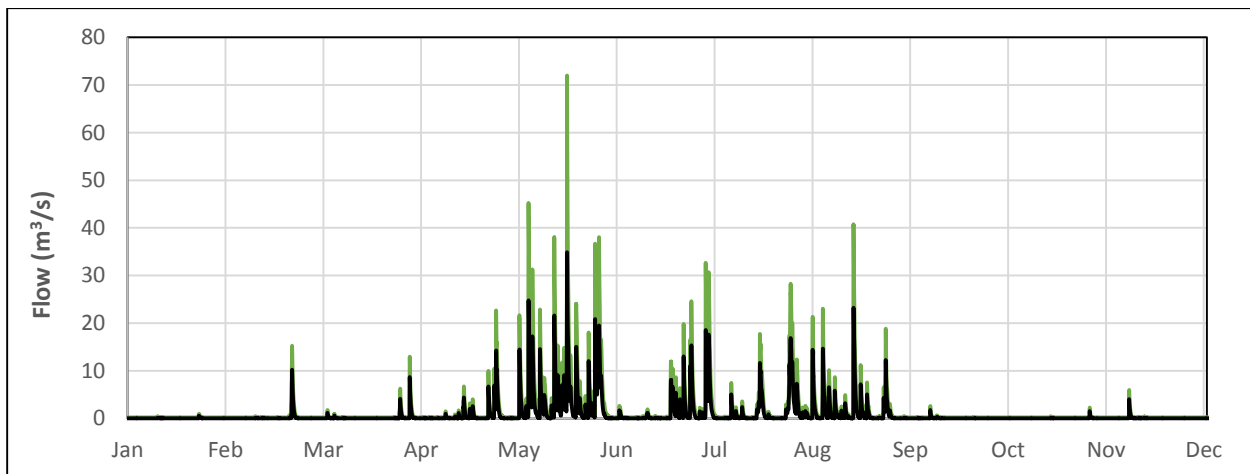
**Plate 4-1 Houay Soup, 20 m from confluence with Nam Ngiep River**



**Plate 4-2 Houay Soup, at WQ1 Monitoring Site (~300m from Nam Ngiep River)**

### **Houay Soup Noi**

Houay Soup Noi is a significant perennial tributary of the Nam Ngiep River (forms the Houay Soup at its convergence with Houay Soup Ngai), both for its current utility for five primary communities (fishing and other aquatic resources as well as drinking, bathing, clothes washing, etc. during agricultural work in the area – refer to Section 6.2.7) and for its provision of spawning grounds for migratory fish that venture up the Nam Ngiep River in approximately June of each year. The stream is the larger of the two primary Houay Soup tributaries during the dry season (wider channels, deeper pools, greater flow), but has less peak flow during the rainy season (refer to Figure 4-7). The stream has a very low gradient from its confluence with the Houay Soup Ngai (refer to Plate 4-3) for approximately 4 – 5 km upstream, with slow dry season flows, a meandering pattern, and a morphology comprised of deep pools (some > 2 m) and shallow runs (0.5 – 4 m wide). Dense aquatic vegetation lines the bottom of much of the lower reach of this stream.



**Figure 4-7 Predicted median year stream flow at Houay Soup Ngai (green) and Houay Soup Noi (black), 2012**

Source: Earth Systems 2015

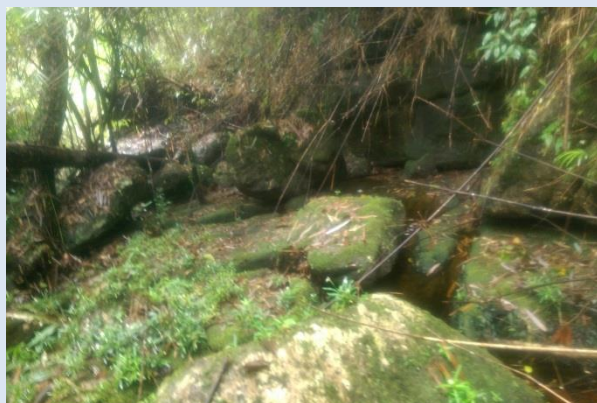
The gradient abruptly transitions to a high gradient stream in its upper reaches. Here the Houay Soup Noi (and its many unnamed tributaries) flows more swiftly through large boulders under a moderately dense canopy of mixed deciduous forest. The morphology is comprised of riffles, runs (< 1 m wide), and small pools (<0.5 m deep).

The Houay Soup Noi is spring-fed, presumably with the majority of its flow sourced from these springs during the later months of the dry season. The springs emerge from fissures in granite outcropping toward the higher elevations for the PFA.



**Plate 4-3 Houay Soup Noi and Houay Soup Ngai confluence – note two braids of Houay Soup Noi discharge to the right sight of the photograph and the Houay Soup Ngai at the upper left corner (forming the Houay Soup).**





**Plate 4-4 Upper reaches of the Houay Soup Noi  
(approximately 10 km from Nam Ngiep River).**



**Plate 4-5 Dry Houay Soup Noi channel – part of the  
braided channel network near confluence with Houay  
Soup Ngai.**

### ***Houay Soup Ngai***

Houay Soup Ngai is comprised of a series of tributaries (though the domestic water intake is upstream of its tributaries), some of which originate from small springs in the Nam Ngiep Nam Mang PFA. The tributaries combine to form the perennial stream and dissect a portion of the HSRA before its confluence with the Houay Soup Noi / formation of the Houay Soup. The upper reaches of the stream in the PFA are high gradient, with water flowing through large granite boulders with intermittent pools.

Houay Soup Ngai has a very low gradient at its confluence with the Houay Soup Noi. The channel meanders through the plain for approximately 1.2 km in its lower reach. The stream morphology is comprised of long runs with moderately deep pools (1 – 4 m wide; > 1.0 m deep) throughout the lower reach. The stream flow was low during June 2015 surveys (< 0.25 m<sup>3</sup> / s), though as noted, precipitation in May – June 2015 was well below average for the region. Aquatic vegetation lines the bottom of much of the lower reach of this stream.



**Plate 4-6 Houay Soup Ngai at WQ3 Monitoring  
Station**



**Plate 4-7 Houay Soup Ngai at WQ3 Monitoring Station**

### ***Houay Dhakong***

Houay Dhakong is a small perennial stream, originating from a spring in the HSRA (south of the PFA boundary) which provides surface water throughout the year. The spring was not found during surveys due to difficult access. The stream flow was less than 0.1 m<sup>3</sup> / s during the 24 / 6 / 15 site visit (approximately 8



cm deep x 0.3 m wide). The village guide from Ban Somseun indicated that the flow is usually greater at this time of year, due to the relative drought (or late arrival of 2015 rainy season). However this stream does not currently provide water resources (with the possible exception of drinking water for those working in proximity) and is not considered a viable fishery by those villagers interviewed (Ban Hatsaykham, Ban Hat Gniun, and Ban Somseun). This stream will not be managed for HSRA utilisation.

### ***Houay Thamdin and Houay Liang***

Houay Thamdin and Houay Liang are small ephemeral streams, with channel width of approximately 0.5 m near their confluence with the Nam Ngiep River. The streams were dry during June surveys though likely would have flowing during an average rainfall year. Neither stream is not spring fed, relying on rainfall input for seasonal flow. Neither are utilised for water resources or fishing and will not likely be managed for HSRA utilisation.

### ***Houay Khinguak Noi***

Houay Khinguak Noi is a relatively small perennial stream near the southern boundary of the proposed HSRA. It is presumed that the stream is spring-fed during the dry season as the catchment is fairly small and the stream originates at the steep incline in the PFA. The stream channel is primarily comprised of sand / silt, with pools intersecting long runs through the low to moderate gradient stream. Stream flow was less than 0.25 m<sup>3</sup> / s during the June site visit.



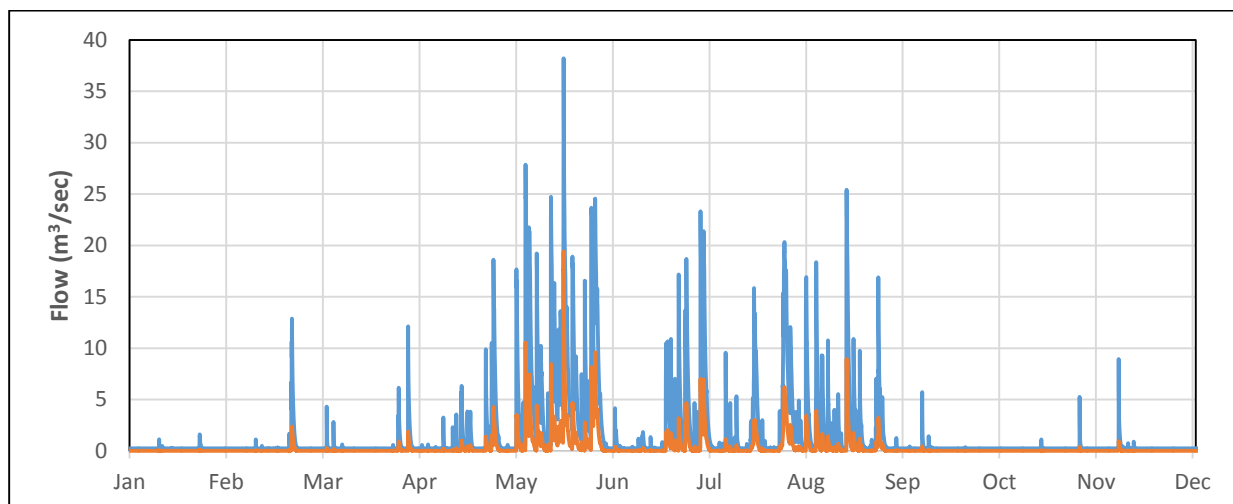
**Plate 4-8 Houay Khinguak Noi 20m from confluence with H. Khinguak Ngai**



**Plate 4-9 Houay Khinguak Noi 30m from confluence with H. Khinguak Ngai**

### **Houay Khinguak Ngai**

Houay Khinguak Ngai, which comprises the southern boundary of the HSRA, is the largest stream of the HSRA area. It is a perennial stream that reaches a width of > 20 m at its confluence with the Nam Ngiep River during the dry season. Houay Khinguak Ngai has a steep gradient in its headwaters in the higher elevations of the PFA, with riffles, runs and pools through granite boulders and rock-lined channels where a number of tributaries join to form the large stream. It emerges into flatter terrain for the lower ~1.8 km, and comprises a mix of long runs with intermittent deep channels.



**Figure 4-8 Predicted median year stream flow at Houay Khinguak Ngai (blue) and Houay Khinguak Noi (tan), 2012** Source: Earth Systems 2015



**Plate 4-10 Houay Khinguak immediately upstream of confluence with Nam Ngiep River**

A preliminary flood assessment was undertaken using the predicted peak flow values for the Nam Ngiep River and hydrologic modelling of design rainfall events for the 1:100 ARI and 1:1000 ARI flood (NNP1 2013b), and preliminary peak flow modelling of Houay Soup Ngai, Houay Soup Noi and their tributaries. The results of this assessment indicate there is potential that periodic peak storm events may inundate a portion of the main access road for a short duration. More robust modelling is required to determine whether some of the residential area footprint is at risk from flooding from major storm events (e.g. 1:100 ARI - 1:1000 ARI peak floods).

Flood modelling conducted for this IEE is considered indicative only. Data gaps were identified (e.g. the precision of channel bathymetry / HSRA Digital Elevation Model (DEM) and lack of stream discharge values) that prohibited the conduct of more robust flood modelling. Surveys should be conducted to refine understanding of channel bathymetry / HSRA DEM, and stream discharge measured to provide suitable data to assess risk for (a) temporary isolation of communities; (b) the need for ongoing maintenance of the access road; and (c) siting of residential areas / community safety.

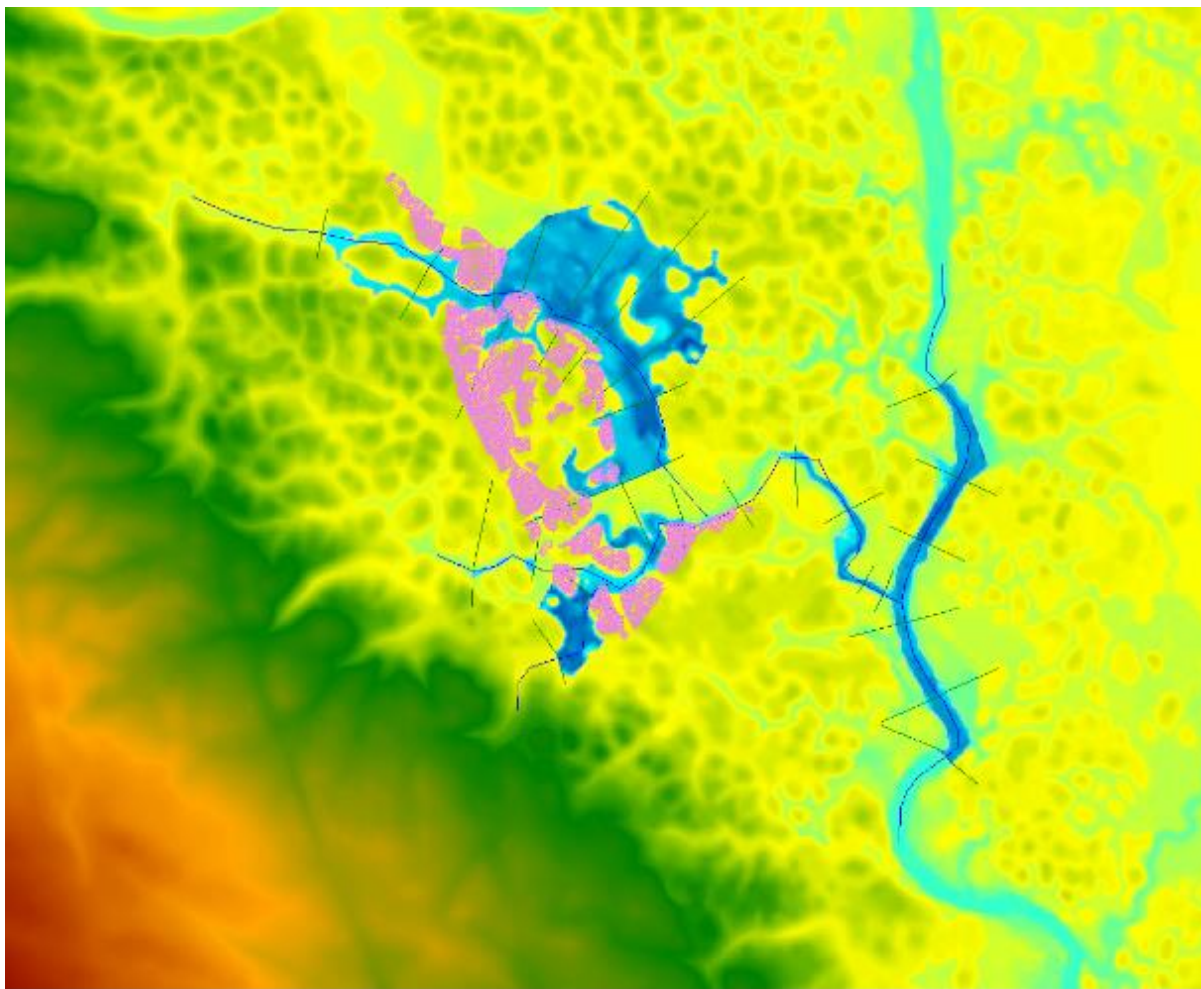


Figure 4-9 Predicted flooding extent and depth for 1:100 ARI in the HSRA

Source: Earth Systems 2015

The predicted depth of the Houay Soup Noi is shown below in Figure 4-10.

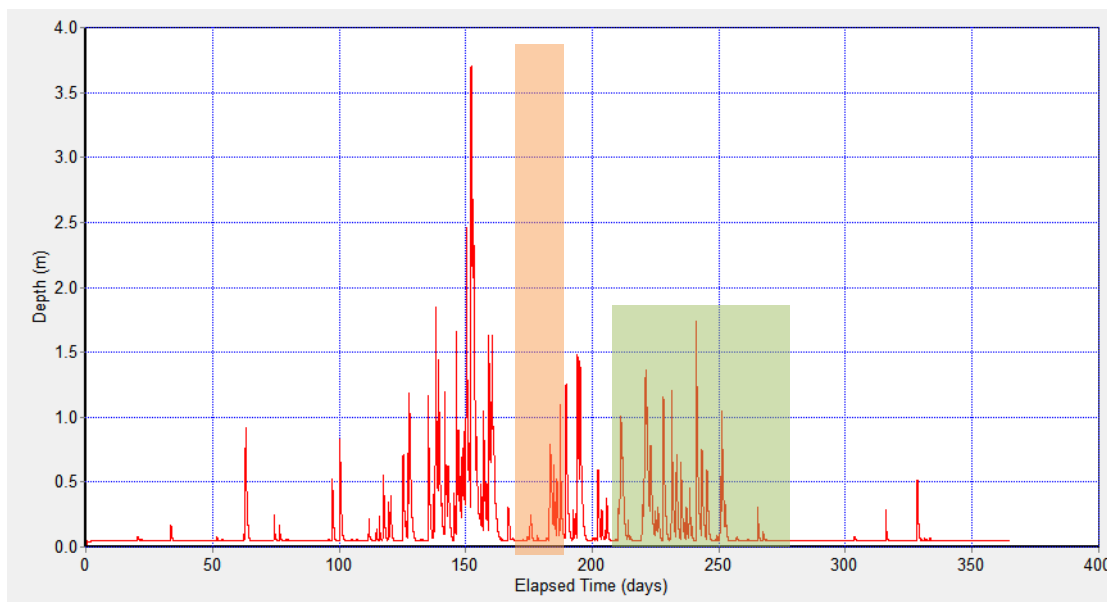
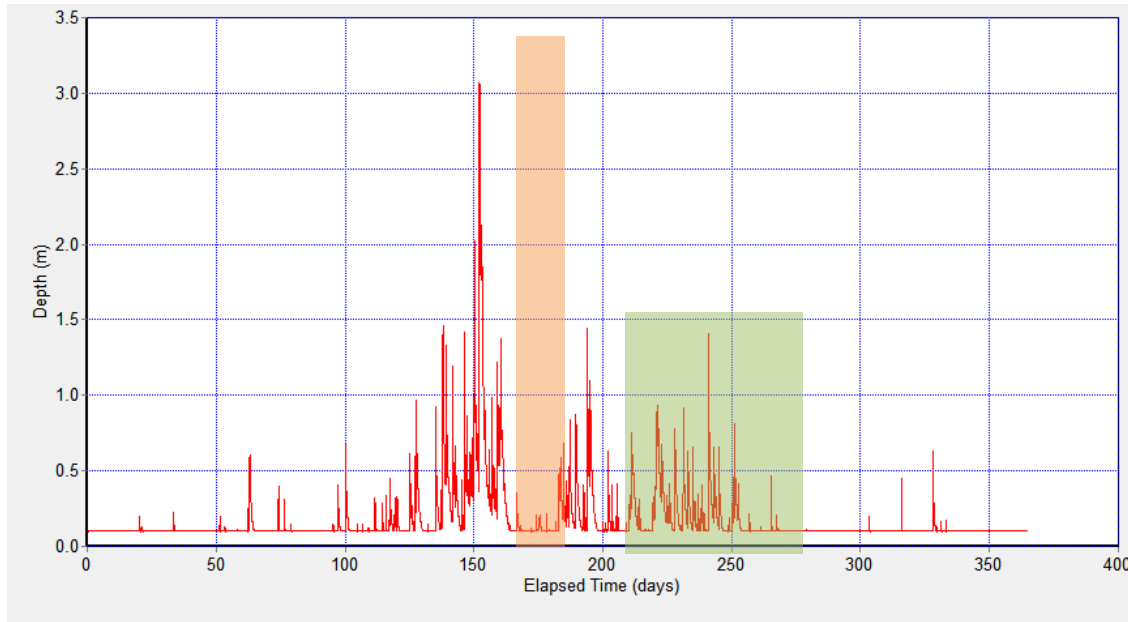


Figure 4-10 Predicted flooding depths for Houay Soup Noi median year with 1:100 ARI in the HSRA (Source: Earth Systems 2015)

Baseflow conditions create a flow depth of approximately 0.1 - 0.5 m with peak flows in the median year data (highlighted in green) reaching approximate depths of 1.5 m - 1.75 m. The 1:100 peak flow event at day 150 (highlighted in orange) shows a short 24 hour flow peak of 3.75 m in the depression area in the Houay Soup Noi. This data matches the results of the hydraulic model predictions and is considered to be of acceptable accuracy based on the available data.

The predicted depth of the Houay Soup Ngai is provided below in Figure 4-11.



**Figure 4-11 Predicted flooding depths for Houay Soup Ngai median year with 1:100 ARI in the southern HSRA (Source: Earth Systems 2015)**

Baseflow conditions in the Houay Soup Ngai creates a slightly higher flow depth of approximately 0.2 - 0.5 m with peak flows in the median year data (highlighted in green) reaching approximate depths of 1.0 - 1.5 m. The 1:100 peak flow event at day 150 (highlighted in orange) shows a short sub - 24 hour flow peak of 3.1 m in the southern flood zone. This data also matches the results of the hydraulic model predictions and is considered to be of acceptable accuracy based on the available data.

## 4.6 Surface and Ground Water Quality

Earth Systems conducted field water quality analyses and sampled for laboratory analysis on 24-25 June, 2015 (refer to Table 4-2) on Houay Soup (below the confluence of Houay Soup Ngai and Houay Soup Noi), Houay Soup Noi, Houay Soup Ngai, Houay Khinguak Noi, Houay Khinguak Ngai, and the Nam Ngiep River (for comparison). More extensive analyses were conducted for Houay Soup Noi and Houay Soup Ngai as these waters will be used for irrigation and domestic water supply, respectively. Surface water samples indicated the water quality is generally good, with the exception of pathogens and pathogenic indicators (e.g. COD).

**Table 4-2 Water quality of the HSRA streams**

Parameter	Houay Soup (WQ1)	Houay Soup Ngai (WQ2)	Houay Soup Noi (WQ3)	Houay Khinguak Ngai (WQ4)	Houay Khinguak Noi (WQ5)	Nam Ngiep River (WQ6)	Project Drinking Water Guidelines	Ambient Water Quality Guidelines
Sampling Date	24/6/15	25/6/15	25/6/15	24/6/15	24/6/15	24/6/15		
<b>Field Parameters</b>								



Parameter	Houay Soup (WQ1)	Houay Soup Ngai (WQ2)	Houay Soup Noi (WQ3)	Houay Khinguak Ngai (WQ4)	Houay Khinguak Noi (WQ5)	Nam Ngiep River (WQ6)	Project Drinking Water Guidelines	Ambient Water Quality Guidelines
Sampling Date	24/6/15	25/6/15	25/6/15	24/6/15	24/6/15	24/6/15		
pH (units)	6.04	6.13	5.72	4.71	4.65	6.00	6.5 - 8.5	5-9
Temp (°C)	26.2	24.5	27.3	23.4	23.7	27.6	35	-
EC (mg/L)	25.3	18.9	28.1	12.8	8.6	85.4	1,000	-
Turbidity (NTU)	55.3	0.2	1.6	5.0	4.6	129.9	10	-
DO (mg/L)	6.75	6.05	5.02	6.43	5.76	6.19	-	>6.0
ORP	+125	+145	+147	+184	+165	+79	-	-
<b>Laboratory Parameters</b>								
pH	-	6.64	6.80	6.83	-	-	6.5-8.5	5-9
Total Coliform	-	680	2300	-	-	-	<2.2 MPN / 100ml	5,000
Faecal Coliform	-	200	180	-	-	-	0 MPN / 100ml	1,000
E. Coli	-	<0.25	<0.25	-	-	-	0 MPN / 100ml	-
TSS	-	<0.25	<0.25	11	-	-	-	-
TDS	-	9	8	11	-	-	600	-
Sulphate	-	7	3	6	-	-	250	-
NO <sub>3</sub> <sup>-</sup>	-	<0.01	0.07	<0.01	-	-	50	-
NO <sub>2</sub>	-	<0.1	<0.1	<0.1	-	-	3	-
NO <sub>3</sub> -N	-	<0.01	0.07	<0.01	-	-	-	5.0
COD	-	27	19	21	-	-	-	5.0
<b>Total Metal Concentrations (Mg/L)</b>								
Aluminium	-	0.31	0.07	-	-	-	0.2	-
Antimony	-	<0.001	<0.001	-	-	-	0.0005	-
Arsenic	-	<0.001	<0.001	-	-	-	0.01	0.1
Beryllium	-	<0.001	<0.001	-	-	-	-	-
Barium	-	0.012	0.015	-	-	-	0.7	-
Bismuth	-	<0.001	<0.001	-	-	-	-	-
Cadmium	-	<0.0001	<0.0001	-	-	-	0.003	0.005
Cerium	-	<0.001	<0.001	-	-	-	-	-
Cesium	-	<0.001	<0.001	-	-	-	-	-
Chromium	-	<0.001	0.002	-	-	-	-	0.05
Cobalt	-	<0.001	<0.001	-	-	-	-	-
Copper	-	0.002	<0.001	-	-	-	1.0	0.1
Dysprosium	-	<0.001	<0.001	-	-	-	-	-
Erbium	-	<0.001	<0.001	-	-	-	-	-
Europium	-	<0.001	<0.001	-	-	-	-	-
Gadolinium	-	<0.001	<0.001	-	-	-	-	-
Gallium	-	<0.001	<0.001	-	-	-	-	-
Hafnium	-	<0.01	<0.01	-	-	-	-	-
Holmium	-	<0.001	<0.001	-	-	-	-	-
Indium	-	<0.001	<0.001	-	-	-	-	-
Lanthanum	-	<0.001	<0.001	-	-	-	-	-
Lead	-	<0.001	<0.001	-	-	-	0.01	0.05

Lithium	-	<0.001	<0.001	-	-	-	-	-
Lutetium	-	<0.001	<0.001	-	-	-	-	-
Manganese	-	0.024	0.045	-	-	-	0.5	1.0
Molybdenum	-	<0.001	<0.001	-	-	-	-	-
Neodymium	-	<0.001	<0.001	-	-	-	-	-
Nickel	-	<0.001	<0.001	-	-	-	-	-
Praseodymium	-	<0.001	<0.001	-	-	-	-	-
Rubidium	-	<0.001	<0.001	-	-	-	-	-
Samarium	-	<0.001	<0.001	-	-	-	-	-
Selenium	-	<0.01	<0.01	-	-	-	0.01	-
Silver	-	<0.001	<0.001	-	-	-	-	-
Strontium	-	0.007	0.009	-	-	-	-	-
Tellurium	-	<0.005	<0.005	-	-	-	-	-
Terbium	-	<0.001	<0.001	-	-	-	-	-
Thallium	-	<0.001	<0.001	-	-	-	-	-
Thorium	-	<0.001	<0.001	-	-	-	-	-
Thulium	-	<0.001	<0.001	-	-	-	-	-
Tin	-	<0.001	<0.001	-	-	-	-	-
Titanium	-	<0.01	<0.01	-	-	-	-	-
Uranium	-	<0.001	<0.001	-	-	-	-	-
Vanadium	-	<0.01	<0.01	-	-	-	-	-
Ytterbium	-	<0.001	<0.001	-	-	-	-	-
Yttrium	-	<0.001	<0.001	-	-	-	-	-
Zinc	-	0.009	0.008	-	-	-	5.0	1.0
Zirconium	-	<0.005	<0.005	-	-	-	-	-
Boron	-	<0.05	<0.05	-	-	-	-	-
Iron	-	0.52	0.88	-	-	-	1.0	-

Source: Earth Systems 2015

Earth Systems' sampling indicated the following:

- Total coliform in Houay Soup Noi and Houay Soup Ngai surface water exceeded Project drinking water guidelines but were below ambient water quality guidelines;
- Faecal coliform concentrations in Houay Soup Noi and Houay Soup Ngai exceeded Project drinking water guidelines, but were below ambient water quality guidelines;
- E. Coli was not detected in Houay Soup Noi or Houay Soup Ngai water, but the laboratory detection limit (2.5 MPN / 100mL) is above the drinking water guideline (0 MPN / 100 mL);
- COD is elevated in Houay Soup Noi, Houay Soup Ngai, and Khinguak Noi (27,19, and 21 mg / L, respectively), above the Project ambient water quality guideline of 5 mg/L;
- pH in Houay Soup and its tributaries was recorded below Project drinking water guidelines during field assessment (ranged from pH 5.72 – 6.13) but was within Project guidelines for laboratory assessment (6.64 – 6.83);
- HSRA steams were significantly less turbid than the Nam Ngiep River. The Houay Soup, measured near the confluence with the Nam Ngiep River was more turbid than for upstream monitoring locations (55 NTU), likely a result of intensive shifting cultivation and the unsealed road network as the stream approaches in river. However, this value is considered slightly higher than it would have otherwise been due to the boat disturbing the fine silt on the channel bottom;

- Total metal concentrations were low, with the majority below detection limit and only aluminium exceeding Project drinking water guidelines or Project ambient water quality guidelines (refer to Appendix C, Concession Agreement for comprehensive guidelines); and
- Total aluminium in Houay Soup Ngai was measured at 0.31 mg/L, above the Project drinking water guideline of 0.2 mg/L.

**Table 4-3 Houay Soup water quality data (NNP1 sampling)**

Parameter*	Sampling Date	Value
Temperature	15/06/15	26.1 °C
	06/07/15	24.8 °C
	21/07/15	24.5 °C
pH	15/06/15	7.23
	06/07/15	6.34
	21/07/15	6.26
Dissolved Oxygen	15/06/15	7.5 mg / L
	06/07/15	9.1 mg / L
	21/07/15	6.8 mg / L
Turbidity	15/06/15	10.8 NTU
	06/07/15	6.9 NTU
	21/07/15	4.5 NTU
BOD <sub>5</sub>	01/06/15	2.0
	15/06/15	1.0
COD	01/06/15	30.5
	15/06/15	34.8
Faecal Coliform	01/06/15	>240 MPN/100 ML
	01/07/15	2,400 MPN/100 ML
Total Coliform	01/06/15	>240 MPN/100 ML
	01/07/15	3,500 MPN/100 ML
Arsenic	01/06/15	0.0462

Source: Earth Systems 2015

\*Additional parameter were assessed, but not included in the Table (metals and nutrients and were found to be well below guidelines)

NNP1 sampling for June and July 2015 indicated similar results, with the following key issues identified:

- BOD, COD, faecal coliform, and total coliform levels were elevated, above Project drinking water guidelines and in some cases (BOD and COD) above ambient water quality guidelines;
- Total and faecal coliform levels are likely a result of livestock utilising the area, with unrestricted access to surface waters, as there are no upstream communities;
- The reasons for elevated COD cannot be conclusively determined. The pathogens play a role in the elevated BOD and COD, while suspended solids are likely rich in organic material and additional oxidising agents; and
- Arsenic was measured at 0.0462 mg / L, above the Project drinking water guideline of 0.01 mg / L. While it is considered likely that detection is a result of laboratory error (arsenic was not found in either Houay Soup tributaries during Earth Systems sampling), the potential health effects of arsenic in drinking water are significant, therefore further test work is required to verify seasonal arsenic levels in Houay Soup.

As baseflow for Houay Soup is spring-fed, arsenic contamination may be sourced from local aquifers. Test work conducted for groundwater sampled in 10 July 2014 from the HSRA found arsenic at 2.21

µg / L, (following initial test work that indicated higher concentrations). Further test work is required to verify arsenic levels in groundwater.

#### **4.6.1 Groundwater**

NNP1 drilled a well in the HSRA (20 m depth). An initial test of the groundwater found the water table at 16 m depth of generally acceptable quality. Initial test work found elevated levels of mercury and arsenic, both of which exceeded Project drinking water guidelines. Due to doubts regarding the accuracy of initial test work, bore water from the HSRA was re-tested and arsenic concentrations (2.21 µg / L) and mercury concentrations (0.25 µg / L) were detected at far lower concentrations and below Project drinking water guidelines (LCG, 2014).

Groundwater should be periodically tested, as the streams in the HSRA are spring fed, and the village may at some point require bores to supplement domestic water supply in the event that option 2 (irrigation pond water supply for domestic water) is not constructed.

### **4.7 UXO**

The NNP1 EIA (ERM 2014) and SIA (NNP1 2014a) report that there is a relatively low level of UXO contamination in the greater Nam Ngiep Hydropower Project area. Figure 4-12 provides a map of aerial bombing data from the US government. This indicates a low UXO risk in the HSRA. The access road, village development area and paddy rice field area for Hatsaykham have been cleared. No live UXO were identified during the UXO clearance. However, the absence of UXO cannot be assumed. Areas cleared to date are shown in Figure 4-13. Further analysis of UXO risk is provided in Section 7.3.10.



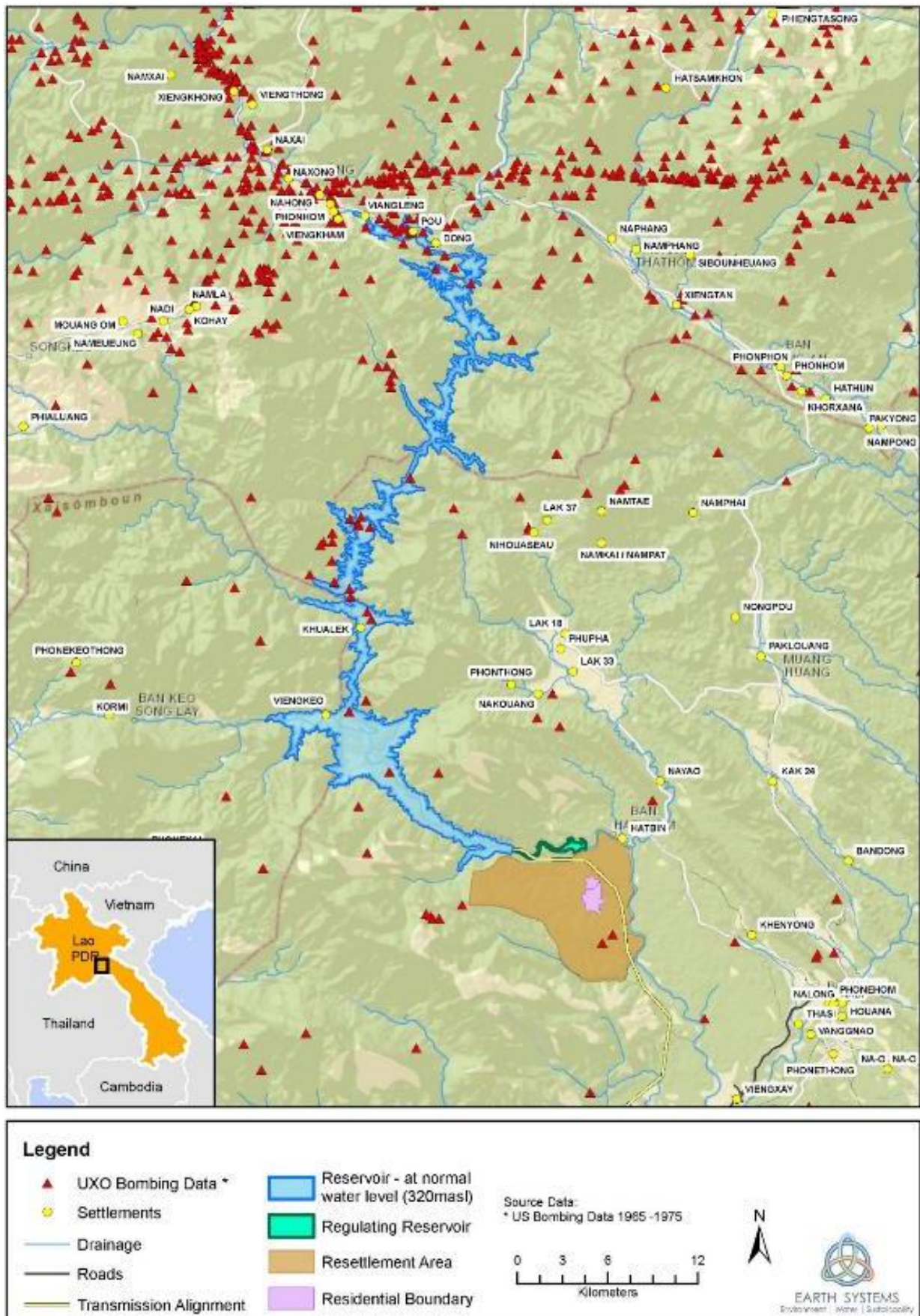


Figure 4-12 US Aerial bombing Data

Source: US Embassy 2006

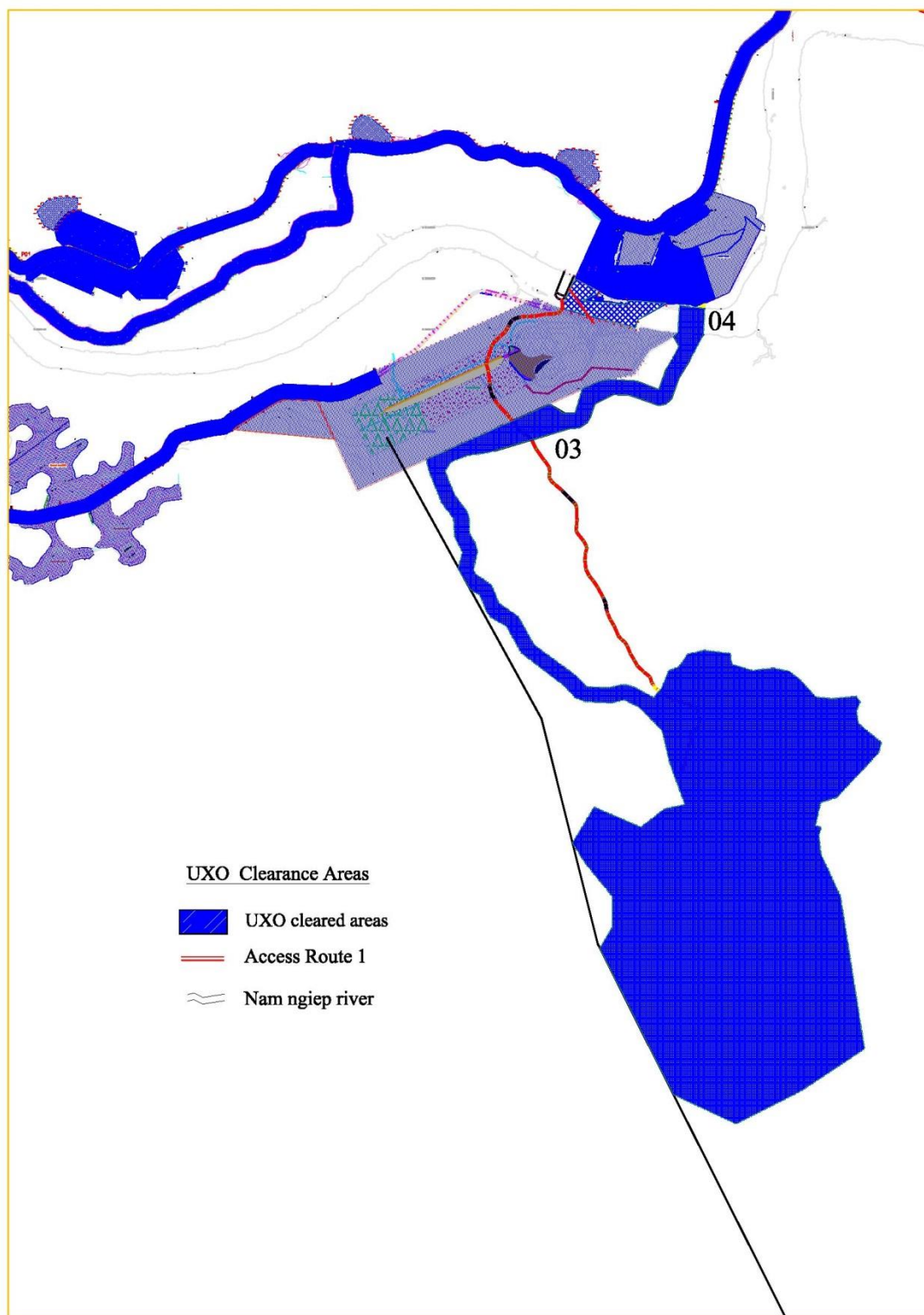


Figure 4-13 UXO Clearance Areas

Source: NNP1 2015



## 5 BIOLOGICAL SETTING

### 5.1 Protected Areas and Forests

The HSRA footprint overlaps the Nam Ngiep Nam Mang PFA. PFA's are primarily managed to protect water resources, reduce soil erosion, and conserve forest ecology / habitat. Utilisation of timber forest products (TFP) and non-timber forest products (NTFP) is not prohibited, however these activities must be conducted according to an accepted sustainable development plan (refer to the INRMP, Appendix A) and all utilisation of resources must be conducted outside of Total Protection Zones, which include areas of steep slopes, buffers near watercourses, and other sensitive areas.

The Project Development Site (HSRA infrastructure) will be located outside the PFA, however according to livelihood requirements and the INRMP, HSRA villagers may utilise designated areas within the 3,715 ha PFA / HSRA overlap for TFP and NTFP as long as these activities are conducted according to the sustainability planning (Appendix A).

The Houay Ngua Provincial Protection Area (PPA) is located approximately 8 km downstream and the Phou Ngou PPA is located approximately 11 km downstream from the NNP1 HPP.

### 5.2 Land Use, Habitat Distribution and Quality

The HSRA is primarily comprised of Upper Mixed Deciduous Forest, Mixed Deciduous Forest / Bamboo mosaic, Bamboo Forest, Old Fallow, and Young Fallow, with smaller areas of Riparian Forest, granite outcrops, and watercourses (refer to Figure 5-1 and Section 5.3 for a detailed description of vegetative communities established in the HSRA).

HSRA forest communities / land use designations differ considerably for the 2,393 ha Project Development Site and the 3,715 ha Protected Forest Area,

The Project Development Site (not including the recently annexed area) is primarily comprised of Young Fallow (594 ha) and Old Fallow (919 ha), with pockets of Upper Mixed Deciduous Forest (58 ha) and Mixed Deciduous / Bamboo mosaic (77 ha) predominantly in the south of the HSRA PDS. A recent history of commercial logging, slash and burn agriculture, and livestock grazing has altered the landscape in a manner that it currently provides very little of its natural ecological function. Small areas of recent upland agriculture (81 ha) have not yet developed into Young Fallow. A very small eucalyptus plantation occurs within the PDS, which is likely nearing the end of its rotation (within the next 2 - 4 years). More than 91% of the 1,745 ha original RDS area is not classified as 'natural forest' (i.e. is Fallow or Agricultural land).

The 648 ha PDS annex area is similarly very disturbed, but has a higher proportion of 'natural habitat' (as defined by ADB, 2009 – refer to Section 5.3.1) than the remainder of the PDS. The annexed area is primarily comprised of Old and Young Fallow (~492 ha equals 76% of the PDS annex), but a relatively large area (117 ha) of moderately to highly disturbed Mixed Deciduous / Bamboo mosaic occurs adjacent the Houay Soup Noi tributaries. Overall, the vegetative structure and the quality of habitat in the PDS annex is largely defined by degradation from historic logging and clearing for swidden agriculture. Approximately 19% is covered by disturbed 'natural habitat'.

In contrast, the majority of the 3,715 ha PFA is comprised of Upper Mixed Deciduous Forest, Mixed Deciduous Forest / Bamboo Mosaic, or Bamboo Forest (approximately 83% is natural habitat as defined by ADB, 2009). Much of the PFA has been disturbed by historic logging, however timber harvest appears to have been largely selective logging and clearing for agriculture has not occurred. At the higher elevations of the PFA (northern section) some pristine forest remains as massive granite boulders / outcrops that preclude vehicular access / road construction and the forests are far enough from settlements that other means of timber hauling have not occurred. The more accessible portions of the PFA (refer to logging

roads in Figure 2-2) have been degraded by logging activity, but forest canopy, mid-level canopies and shrub / herbaceous vegetation is contiguous to the extent that the ecological function of PFA forests remains largely intact.

**Table 5-1 Vegetative communities in the HSRA Project Development Site and HSRA Protected Forest Area**

Vegetative Community / Land Use	Project Development Site (ha)		HSRA PFA Land (ha)
	Original 1,745 ha	Annexed 648 ha	
Mixed Deciduous Forest	57.96	1.68	163.05
Mixed Deciduous / Bamboo Mosaic	76.80	117.27	2325.63
Bamboo Forest	-	7.13	284.05
Riparian Forest	13.10	1.98	-
Old Fallow	918.54	185.55	307.36
Young Fallow	593.65	306.62	469.58
Agricultural Land	80.08	22.07	1.10
Grassland	-	2.99	81.83
Rock Outcrops	-	-	69.98
Watercourses	0.90	-	7.19
Roads / Tracks	2.84	3.47	10.92
Nam Ngiep Demonstration Farm	0.89	-	-
<b>Total</b>	<b>1744.76</b>	<b>648.75</b>	<b>3720.70</b>

Source: Earth Systems 2015



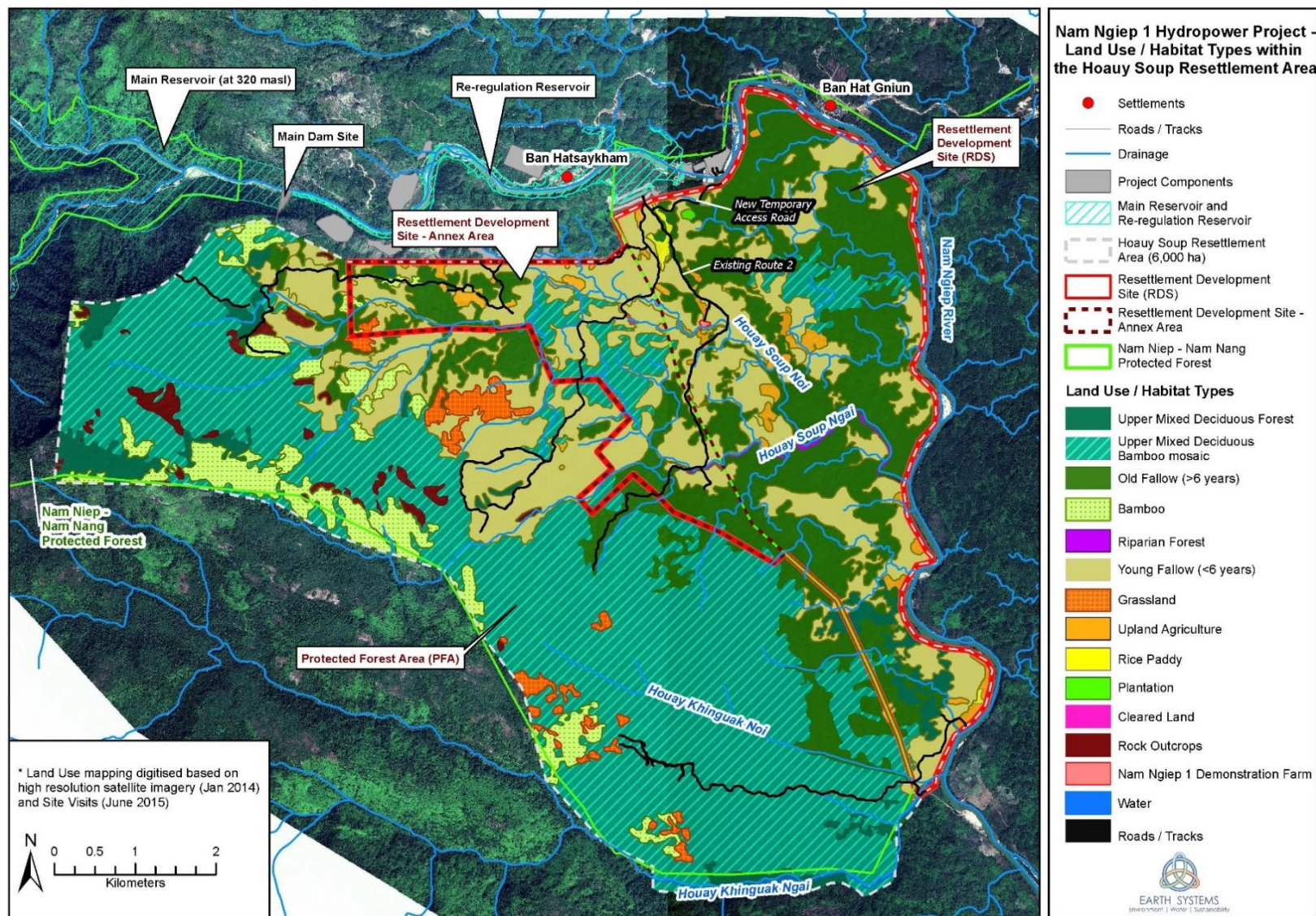


Figure 5-1 Current (Pre-HSRA) Habitat Types / Vegetative Communities and Land Use in the HSRA

Source: Earth Systems 2015

## 5.3 Vegetation / Habitat Types

### 5.3.1 Land Cover Types

Vegetation identified during June 2015 surveys included a mix of 'natural habitat' and modified habitat (refer to below). Natural Habitat, as defined by the ADB Safeguard Policy Statement (ADB 2009) refers to "Land and water areas where the biological communities are formed largely by native plant and animal species, and where human activity has not essentially modified the area's primary ecological functions."

#### *Natural Habitat*

- Upper Mixed Deciduous Forest;
- Mixed Deciduous Forest / Bamboo mosaic;
- Bamboo Forest;
- Riparian Forest.

#### *Modified Habitat*

- Old Fallow – left to regenerate > 8 years;
- Young Fallow – left to regenerate < 8 years;
- Agricultural Plantation; and
- Rice Paddy

Descriptions of each land cover type identified in the field are provided below.

#### ***Upper Mixed Deciduous Forest***

Upper mixed deciduous (UMD) forest in the HSRA (primarily PFA) is characterised by a dominance of deciduous tree species representing more than 50% of the stand. Most areas of UMD had a continuous canopy. Lower structural layers were less dense as the canopy prevents light from reaching these lower layers and cover was typically less than 20%.

Upper mixed deciduous forest was the most species rich habitat surveyed (73% of species identified), in particular all conservation significant species identified in the HSRA were found in UMD (refer to Appendix D). Common canopy species were *Anisoptera costata*, *Hopea ferrea* and *Ormosia pinnata*. *Gonocaryum lobbianum* and *Mallotus thorelii* were the most common species within the mid-storey, both being small trees or shrubs. Bamboo species were also common in the mid-storey, such as *Oxytenanthera albociliata* and *O. parvifolia*. Herbaceous plants and climbers were dominant within the understorey, particularly species within the ginger family (*Zingiberaceae*) and euphorb family (*Euphorbiaceae*), some with spectacular florescence's.

A few native species have become dominant in the habitat type, particularly *Scleria terrestris* as it establishes quickly following disturbance.

Much of the UMD within the HSRA PFA appears to be minimally disturbed (refer to Table 5-3) as access to logging vehicles is restricted at some of the higher elevations. The remainder of UMD in the PFA has been disturbed by historic logging / fire but has retained a relatively continuous canopy, very few or no introduced species, large trees and little evidence of human disturbance. Patches of moderately to highly disturbed UMD exist in close proximity to human activity, such as roads and settlements. The level of disturbance to UMD was correlated with distance to human activity and accessibility for historic logging operations.



**Table 5-2 Most common species found within each of the three structural components of upper mixed deciduous forest in the Project Area**

Structural Component	Scientific Name	
Canopy 5 – 50% cover Tree height 4 - 30 m	<i>Anisoptera costata</i>	<i>Ormosia pinnata</i>
	<i>Crypteronia paniculata</i>	<i>Schima wallichii</i>
	<i>Hopea ferrea</i>	<i>Syzygium cumini</i>
	<i>Irvingia malayana</i>	
Mid-storey 5 – 30% cover Plant height ≥ 1 - 4 m	<i>Alangium kurzii</i>	<i>Mallotus thorelii</i>
	<i>Cinnamomum iners</i>	<i>Oxytenanthera albociliata</i>
	<i>Gonocaryum lobbianum</i>	<i>Oxytenanthera parvifolia</i>
	<i>Mallotus paniculatus</i>	<i>Trema orientalis</i>
Understorey or ground cover 5 – 45% cover Plant height < 1	<i>Alpinia galanga</i>	<i>Dracaena angustifolia</i>
	<i>Ancistrocladus tectorius</i>	<i>Embelia libers</i>
	<i>Catimbum bracteatum</i>	<i>Globba reflexa</i>
	<i>Cissus assamica</i>	<i>Scleria terrestris</i>

Source: Earth Systems 2015

**Table 5-3 Definition of low and moderate/high quality mixed deciduous forest (includes upper and lower forest)**

Condition	Definition
Low disturbance	<p>Deciduous forest occurs when deciduous tree species represent more than 50% of the stand. The forest storeys are not as dense as those of evergreen type. Most often bamboo occurs in this type of forest. Mixed Deciduous forest includes both Upper and Lower types and this definition is based on relative altitude, forest occurring above 200 m is classified as Upper Mixed Deciduous forest and deciduous forest occurring at an altitude 200 m and below is classified as Lower Mixed Deciduous forest.</p> <p>This forest type is considered 'low disturbance' when the majority of the following criteria are met:</p> <ul style="list-style-type: none"> <li>• Tree canopy dominated by trees with greater than 30 cm DBH.</li> <li>• Tree canopy cover greater than 50%;</li> <li>• Alien species rare (e.g. represent less than 5% of the stand);</li> <li>• Level of disturbance from factors such as selective logging and fire is relatively low.</li> </ul>
Moderate / high disturbance	<p>Deciduous forest occurs when deciduous tree species represent more than 50% of the stand. The forest storeys are not as dense as those of evergreen type. Most often bamboo occurs in this type of forest. Deciduous Forest includes both Upper and Lower deciduous forest types and this definition is based on relative altitude, forest occurring above 200 m is classified as Upper Mixed deciduous Forest and deciduous forest occurring at an altitude 200 m and below is classified as Lower Deciduous Forest.</p> <p>This forest type is considered 'moderate/high disturbance' when:</p> <ul style="list-style-type: none"> <li>• Tree canopy dominated by trees with less than 30 cm DBH.</li> <li>• Tree canopy cover greater than 10% but less than 50%;</li> <li>• Alien species can be widespread (e.g. represent &gt; 10% of the stand);</li> <li>• Level of disturbance from factors such as selective logging and fire is high.</li> </ul>

Source: Earth Systems 2015

### Bamboo Forest

Bamboo forest typically occurred on low-quality soil or granite outcropping and was dominated (in biomass) by species of the sub-tribe *Bambusoideae*. This forest type is defined as having over 80% of the biomass being made up of bamboo species. The most common bamboo species were *Cephalostachyum virgatum* and *Oxytenanthera parvifolia*. Bamboo generally occurred in dense stands or clumps, predominantly in the mid-storey.

A tree canopy was almost absent, with a few scattered trees (refer to Table 5-4). Ground cover was also relatively sparse because of the dense mid-storey canopy of bamboo. Bamboo forests are native to many regions and are a common natural habitat type in Lao PDR. Due to the rapid establishment and growth of bamboo it often becomes dominant in areas that have been cleared. The composition and density of the bamboo forest surveyed in the Project Area indicated that some areas are likely the natural habitat type (on fractured granite with very little soil), while other areas had dominant bamboo stands that likely established following tree harvest operations.

**Table 5-4 Common species found within the structural components of bamboo forest in the Project Area**

Structural Component	Scientific Name	
Canopy 0 – 2% cover Tree height 4 - 15 m	<i>Cratogeomys formosus</i> var. <i>pruniflorum</i>	<i>Pterocymbium dussaudii</i>
	<i>Glochidion sphaerogynum</i>	<i>Schima wallichii</i>
	<i>Macaranga denticulata</i>	<i>Vitex tripinnata</i>
	<i>Ormosia pinnata</i>	<i>Wrightia arborea</i>
Mid-storey 50 – 60% cover Plant height ≥ 1 - 4 m	<i>Alangium kurzii</i>	<i>Mallotus paniculatus</i>
	<i>Aporosa ficifolia</i>	<i>Mallotus thorelii</i>
	<i>Cephalostachyum virgatum</i>	<i>Oxytenanthera parvifolia</i>
	<i>Cinnamomum iners</i>	<i>Rinorea boissieu</i>
	<i>Gonocaryum lobbianum</i>	<i>Trema orientalis</i>
Understorey or ground cover 10 – 15% cover Plant height < 1 m	<i>Ancistrocladus tectorius</i>	<i>Embelia libers</i>
	<i>Caryota mitis</i>	<i>Globba reflexa</i>
	<i>Catimbum bracteatum</i>	<i>Lygodium flexuosum</i>
	<i>Cyclea barbata</i>	<i>Scleria terrestris</i>
	<i>Dracaena angustifolia</i>	

Source: Earth Systems 2015

### Old Fallow

Old fallow is where secondary regrowth dominates; where native and non-native species have regenerated for at least 8 years after disturbance or clearing. The forest may retain structural and floristic similarities to the natural habitats (e.g. canopy, understorey), but is not readily classified as a particular recognised natural forest type. Although old fallow forest has been highly modified and is considered as modified habitat, it retains many native species and provides habitat for wildlife. Old fallow was particularly species rich, but most species are common and widespread, with no conservation species present (refer to Table 5-5).

**Table 5-5 Most common species found within Old Fallow in the Project Area**

Structural Component	Scientific Name	
Canopy 10 – 30% cover	<i>Cratogeomys formosus</i> var. <i>pruniflorum</i>	<i>Peltophorum dasyrrhachis</i>



Structural Component	Scientific Name	
Tree height > 4 m	<i>Crypteronia paniculata</i>	<i>Sapium discolor</i>
	<i>Glochidion sphaerogynum</i>	<i>Schima wallichii</i>
	<i>Irvingia malayana</i>	<i>Vitex tripinnata</i>
	<i>Ormosia pinnata</i>	
Mid-storey 10 – 20% cover Plant height ≥ 1 - 4 m	<i>Aporosa ficifolia</i>	<i>Grewia paniculata</i>
	<i>Cephalostachyum virgatum</i>	<i>Oxytenanthera albociliata</i>
	<i>Croton cascarillodes</i>	<i>Oxytenanthera parvifolia</i>
	<i>Gonocaryum lobbianum</i>	<i>Peltophorum dasyrrhachis</i>
Understorey or ground cover 1 – 5% cover Plant height < 1 m	<i>Ardisia helferiana</i>	<i>Lygodium flexuosum</i>
	<i>Curculigo orchiodes</i>	<i>Scleria terrestris</i>
	<i>Dracaena angustifolia</i>	<i>Thysanolaena maxima</i>
	<i>Forrestia griffithii</i>	<i>Uvaria macrophylla</i>

Source: Earth Systems 2015

### Young fallow

Young fallow was where the land has been cleared recently (< 8 years), and native and non-native species have begun to regenerate. As with old fallow, the forest may retain similarities to natural habitat, but cannot be considered as natural. Bamboo could be quite common within the mid-storey, forming large stands or clumps (Table 5-6).

*Chromolaena odorata*, a non-native plant and considered as one of the world's worst invasive species, was common within the mid-storey of young fallow (ISSG 2015). The fast growing perennial shrub is an aggressive competitor and forms dense stands that prevent other species from establishing.

**Table 5-6 Dominant and common species within young fallow in the Project Area**

Structural Component	Scientific Name	
Canopy 0 – 5% cover Tree height > 4 m	<i>Cratoxylum formosum</i> var. <i>pruniflorum</i>	<i>Ormosia pinnata</i>
	<i>Crypteronia paniculata</i>	<i>Schima wallichii</i>
	<i>Glochidion sphaerogynum</i>	
Mid-storey 30 – 70% cover Plant height ≥ 1 - 4 m	<i>Alangium kurzii</i>	<i>Mallotus paniculatus</i>
	<i>Aporosa ficifolia</i>	<i>Mallotus thorelii</i>
	<i>Cinnamomum iners</i>	<i>Oxytenanthera albociliata</i>
	<i>Gonocaryum lobbianum</i>	<i>Peltophorum dasyrrhachis</i>
	<i>Macaranga denticulata</i>	<i>Trema orientalis</i>
	<i>Maesa ramentacea</i>	
Understorey or ground cover 5 – 20% cover Plant height < 1 m	<i>Alpinia galanga</i>	<i>Cyclea barbata</i>
	<i>Ancistrocladus tectorius</i>	<i>Dracaena angustifolia</i>
	<i>Caryota mitis</i>	<i>Embelia libers</i>
	<i>Catimbium bracteatum</i>	<i>Globba reflexa</i>

	<i>Chromolaena odorata</i>	<i>Scleria terrestris</i>
	<i>Cissus assamica</i>	<i>Thysanolaena maxima</i>

Source: Earth Systems 2015

## 5.4 Terrestrial Flora

Ninety-three species of flora were recorded within the HSRA (Appendix D). These 93 species belong to 53 families with all except one species being from *Tracheophyta* (vascular plants). The only non-vascular plant identified was a fern. Many non-vascular plants are difficult to detect (e.g. mushrooms, lichen) and thus more targeted studies would be required for a comprehensive data set. Interviews with local villagers indicated that several species of mushrooms and ferns are found within the region. Hence, it can be assumed that there are many more species in the HSRA.

The majority of species (73%) were found within UMD and 51 species were exclusive to UMD. Only eight (8) species were found in all habitat types. Based on other studies within Lao PDR and the greater South-east Asian region most species are common, widespread or secure within the region surrounding the HSRA and/or Lao PDR. However, the majority of these species have not been assessed for their global conservation significance (i.e. IUCN Red List).

Nine ecologically important species were identified in the surveyed areas and six of these are considered globally threatened (i.e. IUCN status of Vulnerable, Endangered or Critically Endangered). Most of these species are also economically important, many as important timber species. The most threatened species identified, two Critically Endangered (CR) species, *Aquilaria crassna* and *Dipterocarpus turbinatus*, are commercially important. The importance and overexploitation of these trees for their wood or other products has generally led to their rarity, as well as deforestation of UMD and other forest types in the greater region (e.g. evergreen forest). The other four threatened species *Anisoptera costata*, *Dipterocarpus costatus*, *Hopea ferrea* and *Vatica cinerea* are globally Endangered as they occur on fertile, arable land, are subject to deforestation and are overexploited for their timber (IUCN 2015).

All except the mango tree (*Mangifera indica*) of these globally threatened and conservation significant species are also considered priority species for the conservation of Lao PDR forest genetic resources (refer to Table 5-7). A list of priority species was compiled by the Ministry of Agriculture and Forestry (MAF) in coalition with the Asia Pacific Forest Genetic Resources Programme (APFORGEN) (Phongoudome et al 2004). A priority species was defined by a) indigenous to Lao PDR, b) economically important now or in the near future and c) threatened as a result of over-use or destruction of natural habitats.

Twenty-one of these priority forest genetic resource species were identified in the Project Area, including the six globally threatened trees. In general, the distribution of these species has not been mapped across the globe, or the region, as has been done for other globally threatened species. However, the APFORGEN led by international and Lao specialists assessed many of these species for their security and local conservation status. The assessment considered each species geographical range and rarity, habitat specificity, protection of their habitat and the human impact on the habitat and species. Species were assigned conservation statuses similar to the IUCN Red List of Threatened Species, however there was no Critically Endangered category. Some of the species lacked sufficient information to make an assessment of their local conservation significance (i.e. Data Deficient).

A few of the threatened species could not be assessed due to a lack of information, while others retained a local threatened status. However, *Anisoptera costata* was considered as lower risk, conservation dependent and nearly threatened, predominantly due to its ability to grow in different ecoregions and habitats. The species is found across several ecological zones, has low habitat specificity, and its habitat is moderately common; however humans have had a high impact on the species (Phongoudome et al 2004).

**Table 5-7 Species of global conservation significance and threatened flora species identified in the HSRA**

Scientific Name	English Common Name	IUCN Red List Status	Major Threats
<i>Anisoptera costata</i>		EN	Occurs on fertile, arable land
<i>Aquilaria crassna</i>	Agarwood / Eagle wood	CR	Wood used in perfume, other parts used for incense, medicine, cosmetics
<i>Dalbergia cultrata</i>	Burma blackwood	NT	Deforestation and overexploitation of timber
<i>Dialium cochinchinense</i>	Velvet tamarind	LR/NT	Overexploitation of timber
<i>Dipterocarpus costatus</i>		EN	Timber and resin used for construction, e.g. boat building
<i>Dipterocarpus turbinatus</i>		CR	Deforestation and overexploitation of timber
<i>Hopea ferrea</i>		EN	Commercially important tree, deforestation and overexploitation of timber
<i>Mangifera indica</i>	Mango	DD	Locally and commercially important fruit tree
<i>Vatica cinerea</i>		EN	Deforestation and overexploitation of timber

Source: Earth Systems 2015

Key: CR – Critically Endangered; EN – Endangered; DD – Data Deficient; NT – Near Threatened; LR – Lower Risk

**Table 5-8 Flora species identified within the HSRA that are considered priority forest resource species\***

Scientific Name	English Common Name	Family	IUCN Red List Status	Lao PDR APFORGEN Status
<i>Alstonia scholaris</i>	White cheesewood	Apocynaceae	LR/LC	LR/LC
<i>Anisoptera costata</i>		Dipterocarpaceae	EN	LR/CD/NT
<i>Aquilaria crassna</i>	Agarwood / Eagle wood	Thymeleaceae	CR	EN
<i>Cinnamomum iners</i>		Lauraceae	N/A	LR/LC
<i>Dalbergia cultrata</i>	Burma blackwood	Leguminosae	NT	VU
<i>Dialium cochinchinense</i>	Velvet tamarind	Leguminosae	LR/NT	LR/CD/NT
<i>Dipterocarpus costatus</i>		Dipterocarpaceae	EN	VU
<i>Dipterocarpus turbinatus</i>		Dipterocarpaceae	CR	DD
<i>Elaeocarpus stipularis</i>		Elaeocarpaceae	N/A	LR/CD/NT
<i>Fagraea fragrans</i>	Tembusu	Gentianaceae	N/A	VU
<i>Garcinia frangeoides</i>		Clusiaceae	N/A	VU
<i>Gmelina arborea</i>	Malay beechwood	Lamiaceae	N/A	LR/CD/NT
<i>Hopea ferrea</i>		Dipterocarpaceae	EN	VU
<i>Irvingia malayana</i>		Irvingiaceae	LR/LC	LR/CD/NT
<i>Mesua ferrea</i>		Calophyllaceae	N/A	VU
<i>Peltophorum dasyrrhachis</i>		Fabaceae	N/A	LR/LC
<i>Schima wallichii</i>		Theaceae	N/A	LR/CD/NT

Scientific Name	English Common Name	Family	IUCN Red List Status	Lao PDR APFORGEN Status
<i>Sindora siamensis</i> var. <i>siamensis</i>		Leguminosae	LC	VU
<i>Syzygium chloranthum</i>		Myrtaceae	N/A	VU
<i>Vatica cinerea</i>		Dipterocarpaceae	EN	DD
<i>Wrightia arborea</i>		Apocynaceae	N/A	LR/CD/NT

Source: Earth Systems 2015

\*Species given priority designation for Lao PDR Ministry of Agriculture and Forestry (MAF) and research centre coalition Asia Pacific Forest Genetic Resources Programme (APFORGEN) (Phongoudome et al 2004)

Key: CR – Critically Endangered; EN – Endangered; VU – Vulnerable; DD – Data Deficient; NT – Near Threatened; LR – Lower Risk; LC – Least Concern; CD – Conservation Dependent; N/A – Not Assessed

## 5.5 Terrestrial Fauna

### 5.5.1 Field Surveys

Twelve terrestrial fauna species were observed via indirect and direct methods (e.g. prints, sight) during June, 2015 field surveys (refer to Table 5-9). The majority of species identified were mammals and birds common to the local area and throughout Lao PDR and South-east Asia. Surveys for this IEE have not produced a comprehensive list of species within the Project Area. Targeted field survey methods would be required to detect a mostly cryptic and nocturnal species assemblage (e.g. small cats, rodents, owls).

Two globally significant species were identified during field surveys, the Vulnerable Asiatic black bear (*Ursus thibetanus*) and the Near Threatened Large Indian civet (*Viverra zibetha*).

**Table 5-9 Fauna identified as occurring in the HSRA during field surveys**

English Common Name	Scientific Name	Local name	IUCN Red List Status	Lao PDR Status
Tree squirrel	<i>Callociurus</i> sp.	Ka hok	N/A	
Greater coucal	<i>Centropus sinensis</i>	Nok kod	LC	
Feral/domestic chicken*	<i>Gallus</i>	Kai pah	LC	LKL
Silver pheasant	<i>Lophura nycthemera</i>	Kai khua louang	LC	
Southern red muntjac	<i>Muntiacus muntjak</i>	Fan	LC	
Common palm civet	<i>Paradoxurus hermaphroditus</i>	Ngen dug/om	LC	
Red-necked keelback	<i>Rhabdophis subminiatus</i>	Ngou dang hae	LC	
Asiatic black bear	<i>Ursus thibetanus</i>	Mee	VU	ARL
Common/feral bore*	<i>Sus scrofa</i>	Mou pah	LC	
Common tree shrew	<i>Tupaia glis</i>	Ka nai	LC	
Large Indian civet	<i>Viverra zibetha</i>	Ngen hang kan	NT	
Ratsnake	<i>Zamenis</i> sp.	Ngou sing dong	N/A	

Source: Earth Systems 2015



Key: \* - Introduced, not native; VU – Vulnerable; NT – Near Threatened; LR – Lower Risk; LC – Least Concern; N/A – Not Assessed; LKL – Little Known in Lao PDR; ARL – At Risk in Lao PDR

### 5.5.2 Local Knowledge Surveys

Eighty-six species of fauna were identified by villagers as being seen in the HSRA / PFA (Appendix E). Most species are common and widespread in Lao PDR, Southeast Asia and/or globally. Similarly, many of the species are disturbance-tolerant and a few are non-native, non-indigenous or introduced.

Of the 86 species, 17 species of global conservation significant species were identified, while 11 species are considered globally threatened (i.e. Vulnerable, Endangered IUCN status). The majority of these species are also considered “At Risk” within Lao PDR. Three Endangered mammals, Dhole (*Cuon alpinus*), Hairy-nosed otter (*Lutra sumatrana*) and Sunda pangolin (*Manis javanica*) are very rarely seen by local villagers and only the Sunda pangolin was reported by representatives from all three communities interviewed. Similarly the other threatened mammals are rarely seen, including the Asiatic black bear.

Five globally threatened herpetofauna were identified by local villagers. The king cobra (*Ophiophagus hannah*) is reportedly common to the region, but is globally Vulnerable and considered Potentially At Risk in Lao PDR. This snake is commonly hunted for its skin, meat and for the Chinese medicine trade (IUCN 2015). Three of the five threatened herpetofauna were turtles. There is limited information regarding these species, but it appears that their spread across Southeast Asia may be influenced by the historic and current food and medicine trade.

#### **Species Assemblage**

All species identified during field surveys were identified by local villagers. Overall there were 86 species of terrestrial fauna reportedly inhabiting the HSRA and surrounds. This includes 27 mammals, 33 birds, 9 amphibians and 17 reptiles. It is assumed that there are more species undetected, targeted surveys for more cryptic and nocturnal species would need to be undertaken.

### 5.5.3 Invasive Species

Several invasive and non-indigenous flora species were identified in the habitats of the Project Area (refer Table 5-10). The majority of species were identified growing in fallow land and other modified habitats, while only a few were found in natural habitats. The number of invasive species and the dominance of these species increased with decreasing distance from human activity (e.g. roads).

Six of the species identified are considered as globally significant weed species, with three on the list of the Top 100 World's Worst Invaders. *Chromolaena odorata* was more widespread than the other significant weed species, being found in fallow land and disturbed upper mixed deciduous forest. *Imperata cylindrica* is native to Asia and it has become a particularly invasive weed in areas where it historically did not occur, such as Lao PDR (ISSG 2015). The other two species are native to South and Central America. These three species are especially efficient at colonising areas that have been disturbed by fire, clearing, selective harvesting and other anthropogenic sources of disturbance.

**Table 5-10 Invasive and non-indigenous flora species identified in the Project Area**

Scientific Name	ISSG status	Description
<i>Chromolaena odorata</i>	Top 100 worst invaders	Fast-growing perennial shrub, native to South America and Central America. It has been introduced into the tropical regions of Asia, Africa and the Pacific, where it is an invasive weed. It forms dense stands that prevent the establishment of other plant species. It is an aggressive competitor and a nuisance weed in agricultural land and commercial plantations
<i>Curculigo orchoides</i>		Flowering plant that may also be used in traditional medicine
<i>Dracaena angustifolia</i>		Species often used as an ornamental house-plant, but can grow large when unrestrained
<i>Globba reflexa</i>		Rhizomatous, perennial herb, found in various shaded to open, wet to seasonally dry habitats
<i>Imperata cylindrica</i>	Top 100 worst invaders	Native to Asia, common in the humid tropics and has spread to the warmer temperate zones worldwide. Its extensive rhizome system, adaptation to poor soils, drought tolerance, genetic plasticity and fire adaptability make it a formidable invasive grass. Species displaces native plant and animal species and alters fire regimes.
<i>Mimosa pigra</i>	Top 100 worst invaders	It reproduces via buoyant seed pods that can be spread long distances in flood waters and has the potential to spread through natural grassland floodplain ecosystems and pastures, converting them into unproductive scrubland which are only able to sustain lower levels of biodiversity.
<i>Mimosa pudica</i>	Listed	Native to South America, but has become a pan-tropical weed. It was introduced to many countries as an ornamental plant and is still widely available for sale. <i>Mimosa pudica</i> has become a pest in forest plantations, cropland, orchards and pasture, but is used as a medicinal plant in many regions
<i>Oxytenanthera parvifolia</i>		Medium to large bamboo species that forms clumps
<i>Ricinus communis</i>	Listed	Perennial shrub that can assume tree-like status if it establishes in a suitable climate, especially riparian areas. The seed are toxic to variety of species including humans. Consuming only a few seeds can be fatal.

Scientific Name	ISSG status	Description
<i>Solanum torvum</i>	Listed	Often found in disturbed areas, it can form dense impenetrable stands. <i>Solanum torvum</i> is considered to be a serious threat to the productivity and sustainability of pasture and competes with native species.
<i>Thysanolaena maxima</i>		Perennial grass plant found in hilly regions, flowers can be used as cleaning tool or broom
<i>Uvaria macrophylla</i>		Large climbing shrub with large leaves and striking flowers, and is harvested from the wild and used locally for food, medicines and fibre.

Source: Earth Systems 2015

## 5.6 Aquatic Biodiversity

### 5.6.1 Aquatic Habitat

The Nam Ngiep River is a major tributary of the Mekong River, flowing in a southerly direction for approximately 160 km and joining the Mekong River near township of Paksan. The Nam Ngiep River and its tributaries provide habitat for resident aquatic biodiversity and migratory species adapted to the significant seasonal variability in flow.

Streams in the HSRA are a mix of perennial (spring-fed) and ephemeral streams and are predominantly lined by fallow, bamboo, or highly disturbed Upper Mixed Deciduous Forest near their confluence with the Nam Ngiep River. At higher elevations (in the PFA) the perennial streams are lined by contiguous canopies, including some areas of pristine forest or high value intact forest. The lower reaches of the perennial streams have a very high proportion of their channel bottoms covered in aquatic vegetation, providing habitat spawning, juvenile fish, and a host of aquatic biodiversity. During Local Knowledge Surveys (Earth Systems, June 2015), villagers indicated that the lower to middle reaches of Houay Soup Noi and Houay Khinguak Ngai are the most productive fisheries in the HSRA, though fish are caught in Houay Soup Ngai and Houay Khinguak Noi.

According to the results of Local Knowledge Surveys with villagers from Ban Hatsaykham, Ban Hat Gniun, and Bat Somseun, the HSRA streams host a number of migratory fish from approximately May / June when they make their way up the Nam Ngiep River to October when the last of the migratory fish reportedly leave the tributaries and migrate downstream to the Nam Ngiep River and the Mekong. The HSRA is a spawning ground for migratory and resident populations. Fish likely utilise the areas of aquatic vegetation and the flooded fields (adjacent streams) during the rainy season spawn, in addition to the variety of stream channel substrates (pending individual species' requirements). The HSRA streams are similar in morphology to a number of perennial and ephemeral tributaries to the Nam Ngiep River for the ~47 km stretch of river downstream of the HSRA.

One perennial wetland (Nong Pa) and two seasonal wetlands (Nong Da and Houay Na) exist within the HSRA. The Houay Na seasonal wetland results from overbank flooding of the stream, whereas the Nong Pa and Nong Da (also referred to as Nong Honda) are spring fed wetlands with no hydrologic connectivity to streams. The wetlands provide habitat for a host of aquatic biodiversity, including hydrophytic vegetation, frogs, crustaceans, aquatic insects, etc. Overbank flooding / annual creation of Houay Na presumably provides spawning habitat (in addition to paddy rice production area utilised by villagers of Ban Somseun).

### 5.6.2 Aquatic Biology

Several fish surveys have been undertaken within the Nam Ngiep River and in many of its tributaries during the last 20 years, upstream and downstream of the greater NN1HP area - refer to NNP1 EIA (ERM 2014). More than 100 species had previously been identified during direct and indirect surveys for the NN1HP.

For the streams of the HSRA, Earth Systems conducted Local Knowledge Surveys / focus group discussions in June 2015 with villagers from Ban Hatsaykham, Ban Hat Gniun, and Ban Somseun (men and women that fish the HSRA streams at least occasionally). Results are limited to those fish identified by villagers from a comprehensive set of photographs provided. Direct sampling of the streams was not conducted, therefore results are considered indicative only.

106 fish species were identified that may inhabit HSRA streams for at least some portion of the year. However, it is believed that a number of these species are likely found only in the Nam Ngiep River. Villagers indicated that many of the Nam Ngiep River fish populate or migrate into HSRA streams with the notable exception of “fish without scales”, presumably referring to the various catfish species that inhabit the Nam Ngiep River. The fish species listed in Appendix F is therefore considered an over-representation of fish populating or migrating to and from HSRA streams. Lao Consulting Group (LCG) identified 22 fish species during May 2014 sampling of the HSRA. It should be noted that fish migration into HSRA streams occurs in June / July – October, so this sampling event under-represents species richness in perennial HSRA streams.

The HSRA perennial streams are known to support a host of resident and migratory fish species as they are viable fisheries for villagers of Ban Hatsaykham, Ban Hat Gniun, and Ban Somseun, amongst others. Representative from each community indicated that the fisheries are in decline over the past 5 years, and indicated that increased fishing pressure (more people fishing) and new fishing techniques (electro-fishing and spear fishing) are the primary reasons for this decline (refer to Section 6.1.6 for community fish resource extraction from HSRA streams).

Of the 106 fish identified during LKS, five (5) are listed as threatened (refer to Table 5-11) according to the IUCN Red List of Threatened Species (Critically Endangered, Endangered, or Vulnerable). An additional eight (8) species were identified in the NN1HP EIA *Biodiversity Baseline Assessment Report* (ERM 2014) as potentially new to science and / or endemic to the Nam Ngiep River Basin (refer to Kottelat 2014, Appendix A to BBAP). However, due to their similarity in appearance to other non-threatened species, their occurrence cannot be confirmed without direct sampling by a qualified aquatic biologist. While it cannot be determined with certainty that each of these species occur in HSRA waters, their known habitat and ecology and geologic range is generally consistent with the Nam Ngiep River tributaries.

The five (5) IUCN listed species were not assessed for the NN1HP. The additional eight (8) species of conservation significance have been evaluated during NN1HP assessment, and the populations of these species are not considered at risk from NN1HP development (Kottelat, 2014). HSRA development is not expected to impact the populations of fish of conservation significance, as only one (1) perennial stream (Houay Soup) and its tributaries will be impacted by development. The streams passing through the HSRA are relatively small and do not constitute a significant portion of the habitat for any of the fish species identified during focus group discussions.

The Nam Ngiep River continues downstream for approximately 47 km from the Houay Soup, with many perennial and ephemeral tributaries of similar morphology to the Houay Soup. While increased fishing may occur throughout the HSRA (pending Conservation status of streams determined during PLUP), impacts may be locally significant but are not expected to have regional significance.

**Table 5-11 Fish species identified during Focus Group Discussions for HSRA streams and IUCN status**

Scientific Name	Lao Name	Comments	IUCN Red List Status
<i>Datnioides pulcher</i>	Pa seux	This species inhabits mainstreams and tributaries, preferring submerged woods and rocky crevices. Known throughout Indochina, with rare reported sightings in Lao PDR.	CR
<i>Datnioides undecimradiatus</i>	Pa seux	Found throughout the middle to lower Mekong basin in Thailand, Lao PDR, Cambodia and Vietnam. Found primarily in rivers and large tributaries.	VU
<i>Epalzeorhynchus munense</i>	Pa pan dang	Distributed throughout Thailand, Lao PDR and Cambodia. The species is found among boulders and rocks. During the flood season,	VU



Scientific Name	Lao Name	Comments	IUCN Red List Status
		it moves into inundated tributaries / forests / grasslands and returns to the rivers as water levels receded.	
<i>Hemimyzon confluens</i>	Pa korhin	This species is currently known only to the Nam Ngum basin, found under stones in fast flowing streams and rivers.	VU
<i>Oreoglanis delacouri</i>	Pa kor	Currently known only to the Nam Ngiep basin. Found in the Nam Ngiep and a number of tributaries during Project surveys of fast-water habitat.	NE
<i>Poropuntius aff. carinatus</i>	Pa kang	Currently known only to the Nam Ngiep basin. Found in the Nam Ngiep River and a number of tributaries during Project surveys of fast-water habitat.	NE
<i>Poropuntius sp. n</i>	Pa pok	Found in the Nam Ngiep and a number of tributaries during Project surveys of fast-water habitat.	NE
<i>Rhinogobius albimaculatus</i>	Pa kang	This species is currently known only to the Nam Ngum basin.	VU
<i>Schistura aff. defectiva</i>	Pa muman	Currently known only to tributaries of the Nam Ngiep River	NE
<i>Schistura aff. ephelis</i>	Pamuman	Currently known only to the Nam Ngiep basin. Found throughout the Nam Ngiep River and tributaries during Project surveys of fast-water habitat.	NE
<i>Schistura sp. 'compact'</i>	Pamuman	Currently known only to the Nam Ngiep basin. Found in the Nam Ngiep and a number of tributaries during Project surveys of fast-water habitat.	NE
<i>Schistura sp. N. 'Nam Youak'</i>	Pa khanglai	This species is currently known only to tributaries of the Nam Ngiep River, generally in fast flowing water.	NE
<i>Schistura sp. N. 'slender'</i>	Pamuman	Currently known only to the Nam Ngiep basin. Found in the Nam Ngiep River and a number of tributaries during Project surveys of fast-water habitat.	NE

Source: Earth Systems 2015

\*Introduced or species beyond their normal range; IUCN Status Red List Categories: EN – Endangered, VU – Vulnerable, NT – Near Threatened, DD – Data Deficient, LC – Least Concern; NE – Not Evaluated

Additional aquatic species identified in vicinity of the Project included crustaceans, eel, snail, aquatic insects and reptiles. Of particular interest, is the globally Vulnerable Asiatic softshell turtle (*Amyda cartilaginea*) which was identified in the HSRA during previous surveys. The turtle's population is relatively secure and widespread in protected areas, but the consumption trade of tonnes per day is counteracting gains achieved in protected areas. The habitat of the HSRA streams is similar to that of many of the Nam Ngiep River tributaries. The species' population is not expected to be impacted by HSRA development.

## 6 SOCIO-ECONOMIC SETTING

The scope of the socio-economic baseline of this IEE includes:

- *Host Communities:* Ban Hat Gniun (including Ban Hatsaykham sub-village) and a number of households from Ban Somseun located downstream of the main dam and currently using the proposed HSRA area; and
- *Proposed Resettlement Communities:* Ban Hatsaykham settlement located in the regulation reservoir area and Ban Houaypamom, Ban Sopphuane, Ban Sopyouak and Ban Namyouak located in the main reservoir area (also referred to as 2LR or lower reservoir communities).

This section provides an overview of the socio-economic context of host communities and resettlement communities drawing on information presented in the EIA (Kansai et al. 2012a; ERM 2014), SIA (Kansai et al 2012b; NNP1 2014a) and REDP (NNP1 2014b) and additional surveying completed by Earth Systems in May and July 2015 (Earth Systems 2015a; Earth Systems 2015b). An emphasis is placed on host communities who are expected to be primarily impacted by the establishment of the HSRA.

Key distinctions between the information provided in previous assessments and this IEE include:

- Ban Somseun has been included in this assessment and is referred to by the authors as a 'host community';
- Ban Thaheua, has been excluded from this assessment as no households from this village have been identified as using land within the HSRA; and
- Ban Hatsaykham has been identified as both a host community and a resettlement community. Due to its location and use of the proposed HSRA, socio-economic information for Hatsaykham is outlined in the section on 'host communities'.

### 6.1 Host Communities

#### 6.1.1 Location

The location and village boundaries of Ban Hat Gniun (including Ban Hatsaykham) and Ban Somseun in relation to the proposed HSRA are outlined in Figure 6-1.

- **Ban Hat Gniun** is located approximately 25 km from the district centre of Bolikhan. It comprises of two settlements: a) Hat Gniun settlement located on the left bank of the Nam Ngiep River about 7 km downstream of the main Project dam and about 3 km downstream of the re-regulation dam; and b) Hatsaykham settlement, also located on the left bank about 2.5 km downstream from the main dam site and before the regulation dam. The village land boundary extends across the Nam Ngiep River (refer to Figure 6-1) into the proposed HSRA.
- **Ban Somseun** is located about 11 km from the district centre of Bolikhan. The village consists of one (1) main settlement, located on the left bank of the Nam Ngiep about 31 km downstream of the main dam and 25 km downstream of the re-regulating dam. The village land boundary extends north from the settlement on both sides of the Nam Ngiep River into the proposed HSRA and approximately 30 households from Somseun have land within the HSRA.

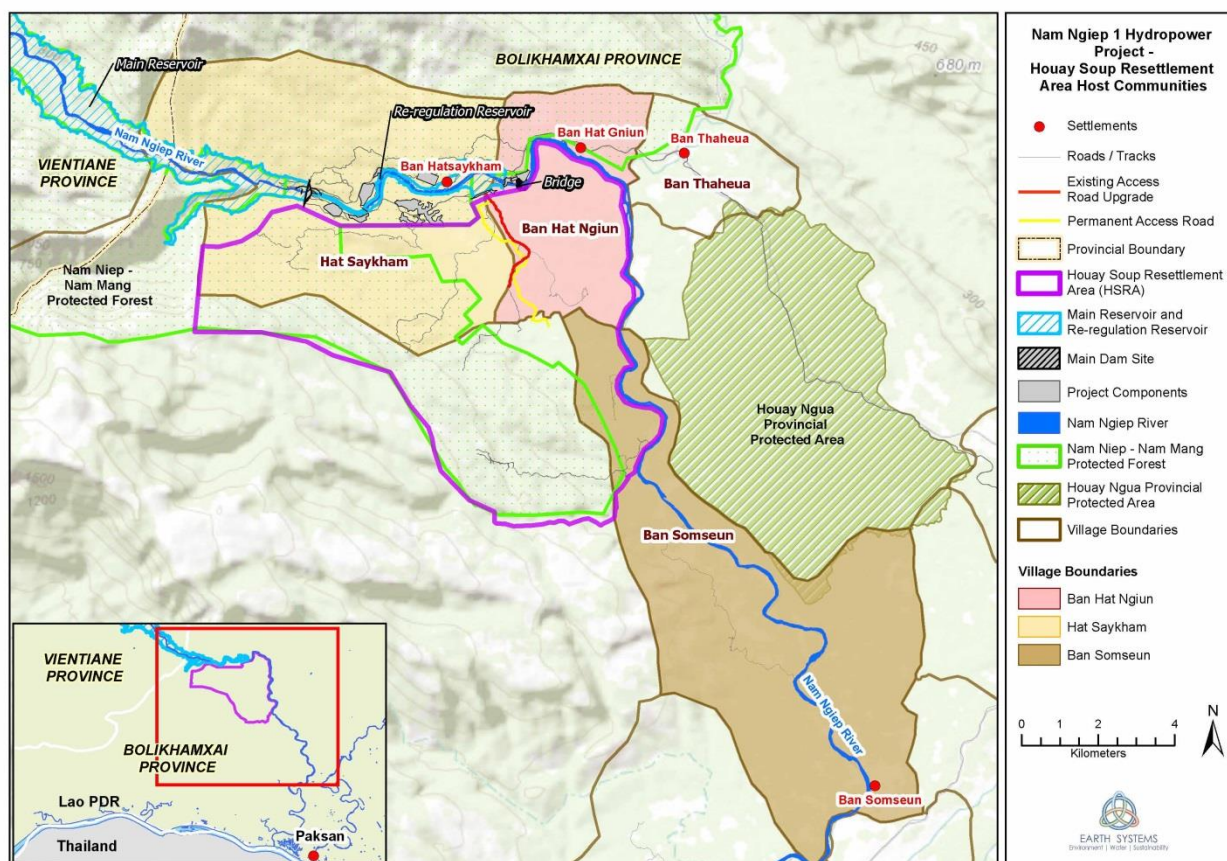


Figure 6-1 Location and Village Boundaries of Host Communities

Source: Earth Systems 2015

## 6.1.2 Demography and Population Changes

According to recent surveying (Earth Systems 2015b), the host communities have a total population of 1,927 living in 345 households with an average of 5.6 people per household. The gender ratio of men to women in these communities is 1.04. The official population in Ban Hat Gniun and Ban Hatsaykham has increased by 15% since 2011 when the surveying for the EIA (Kansai et al 2012a) was conducted (refer to Table 6-1).

Table 6-1 Host Community Demographics

Village / Community	No. HHs	No. Families	No. People			HH Size	Gender Ratio (male to female)	Population change (%) since 2011
			Female	Male	Total			
Ban Hatsaykham (sub-village)	39	45	147	140	287	7.36	0.95	+24%
Ban Hat Gniun	74	86	177	224	401	5.42	1.27	+7%
Ban Somseun	232	225	620	619	1239	5.34	1.00	-
<b>Total</b>	<b>345</b>	<b>356</b>	<b>944</b>	<b>983</b>	<b>1927</b>	<b>5.59</b>	<b>1.04</b>	

Source: Earth Systems 2015b; Kansai et al. 2012a

### 6.1.3 Ethnicity, Religion and History

Ban Hat Gniun consists of two distinct settlements. The Ban Gniun settlement is predominately comprised of people from the Lao-Tai language family (Tai Phouan ethnicity). These people mainly practice Theravada Buddhism. The majority of people living in Ban Hatsaykham are from the Mon-Khmer language family (Hmong-Lu Mien ethnicity) and practice animism. People in Ban Hatsaykham are reportedly related to upstream Hmong including the 'resettlement communities' in the lower reservoir area and moved to the current settlement in the early 1990s. The two settlements were administratively consolidated into one (1) village in the early 2000s.

The majority of people living in the Ban Somseun are from the Lao-Tai family (Tai Phouan ethnicity) and practice Theravada Buddhism. In the mid-1970s Ban Somseun and two former villages located in the proposed HSRA (Ban Hat Soup and Ban Thamdin) were merged to form the present day Ban Somseun.

### 6.1.4 Land Allocation and Ownership

All land in Lao PDR is ultimately owned by the State. The State, however, recognises both private and collective long term land tenure. The Government has a range of instruments with which it can allocate land rights and ownership of land and forests such as *Land Titles*, *Temporary Land Use Certificates*, *Land Lease Contracts*, *Village Land Map Sheet* and *Village Land and Forest Management Agreements*.

#### ***Village Land and Forest Allocation***

Since 1996 the GOL has implemented the Land and Forest Allocation Program (LFAP) with the aim of devolving most decisions about land use and land allocation to the village level. Government authorities liaise with villagers to decide on the allocation of land use for village land and they jointly develop a set of rules for the use of the land – outlined in Village Land and Forest Management Agreements.

Village land allocation exercises were reportedly last conducted in the Project area by the Land and Forest Allocation Program in the late 1990s and early 2000s. Original maps for Ban Hat Gniun and Ban Somseun are provided in Figure 6-2 and Figure 6-3. The information on village land allocation is summarised in Table 6-2, indicating total land areas for Ban Hat Gniun (16,848 ha) and Ban Somseun (13,000 ha). The maps also outline village land allocation and use rights within the HSRA. For Ban Hat Gniun (and Hatsaykham) (Figure 6-2) this includes protected forest, conservation forest, rehabilitation forest and agricultural land. For Ban Somseun map (Figure 6-3) this includes protected forest, conservation forest and rehabilitation forest.



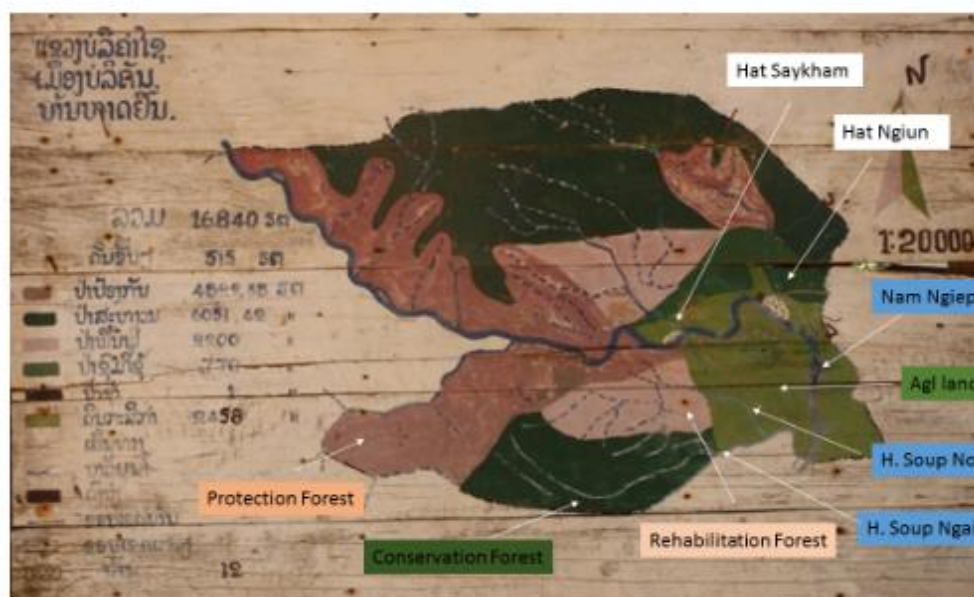


Figure 6-2 Ban Hat Gniun VLFA Map

Source: Earth Systems 2015

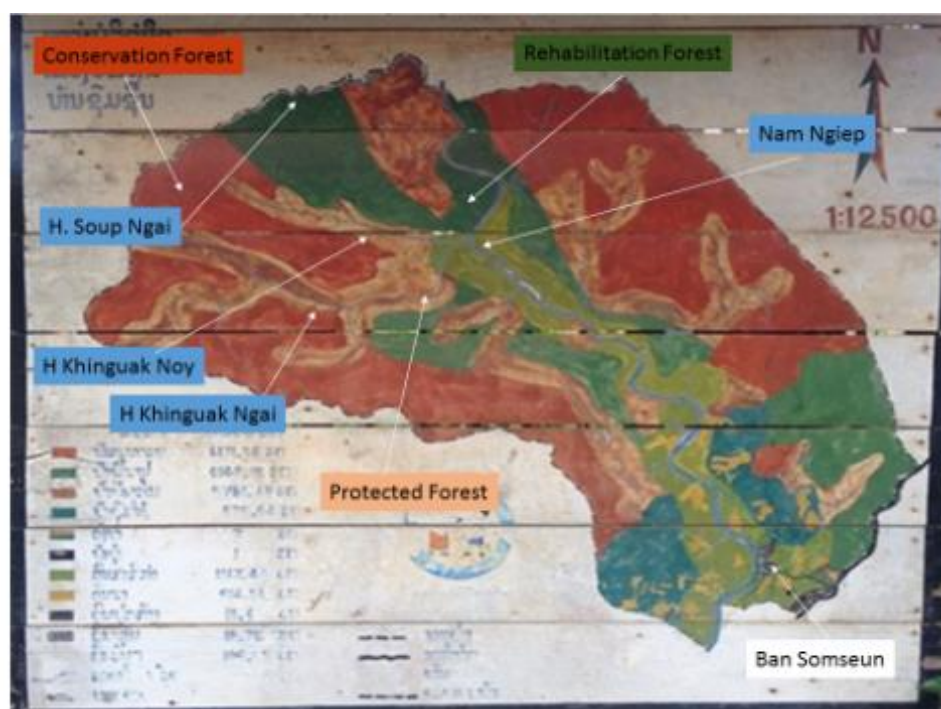


Figure 6-3 Ban Somseun VLFA Map

Source: Earth Systems 2015

Table 6-2 Village land allocation

Land Allocation Category	Ban Hat Gniun / Hatsaykham (Ha)	Ban Somseun (Ha)
Residential	12	34.3
Lowland agriculture	1167*	215.6
Upland agriculture		2,458

Land Allocation Category	Ban Hat Gniun / Hatsaykham (Ha)	Ban Somseun (Ha)
Production forest	770	873.9
Regeneration forest	2,200	2,148.1
Conservation forest	6,051.4	6,172.5
Protection forest	4,829.6	2,781.4
Cemetery / spirit forest	4	8
Concession land	-	-
Other	103	-
<b>TOTAL</b>	<b>16,840</b>	<b>13,000</b>

Source: VLFA maps (MAF 1999-2000)

GIS data on village land boundaries sourced from the Division of Land Management (PONRE – Bolikhamsay 2015) (refer to Table 6-3) provide a distinction between Ban Hat Gniun and Ban Hatsaykham and indicate a substantial reduction in total village land areas. It is understood that the reduction of village land is due to the establishment of the PFA in 2012 – essentially annexing land from these communities.

**Table 6-3 Village land allocation**

Village / Community	Village Land Area (ha)		
	Outside HSRA	Inside HSRA	Total
Ban Hatsaykham	3121.82	1852.08	4973.89
Ban Hat Gniun	817.72	1196.67	2014.40
Ban Somseun	4759.25	513.25	5272.50
<b>TOTAL</b>	<b>8698.78</b>	<b>3562.00</b>	<b>12260.79</b>

Source: GIS data (PONRE 2015)

### **Land Allocation and Ownership in the HSRA**

A number of surveying exercises have been completed in the proposed HSRA to identify existing land use. Each new survey has revealed more claimed use of the area than the last.

The REDP (NNP1 2014b) presents the results of land use surveying conducted in October 2012 – concluding that villagers from Ban Hat Gniun and Ban Hatsaykham currently use land within the HSRA.

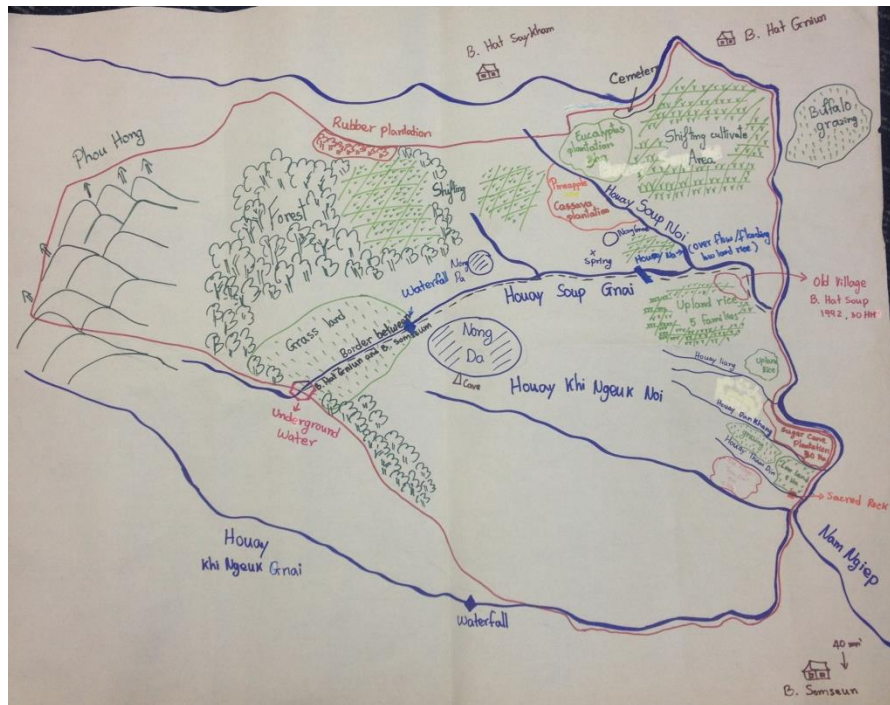
Participatory village mapping of the proposed HSRA was conducted by Earth Systems (July 2015) (refer to Figure 6-4). This exercise confirmed that three (3) host communities – Ban Hat Gniun, Ban Hatsaykham and Ban Somseun currently conduct agricultural activities in the proposed HSRA – consistent with VLFA maps and GIS data presented above.

Most villagers (80-90% of households) from Ban Hatsaykham reportedly utilise the north east and central area of the HSRA (above the Houay Soup Ngai) for upland / swidden agriculture. Each household prepares between three (3) to five (5) hectares each year. A small number of households have established commercial tree plantations<sup>2</sup>.

Similarly, all households from Ban Hat Gniun reportedly utilise the central and North West area of the HSRA (above the Houay Soup Ngai) for upland / swidden agriculture. Approximately five (5) households have established rain-fed lowland rice paddy fields and one (1) household has established a eucalypt plantation.

<sup>2</sup> The communities of Ban Hatsaykham, Ban Hat Gniun, and Ban Somseun will be consulted further during finalisation of the Resettlement Action Plan.

Approximately 45 households from Ban Somseun (the decedents of the previous occupants of Ban Thamdin and Ban Hatsoup) reportedly utilise a strip of land between the Houay Soup Ngai and Houay Khinguak and within 1-2 km of the Nam Ngiep river for upland / swidden agriculture. Five (5) of these households have also established rain-fed rice paddy fields.

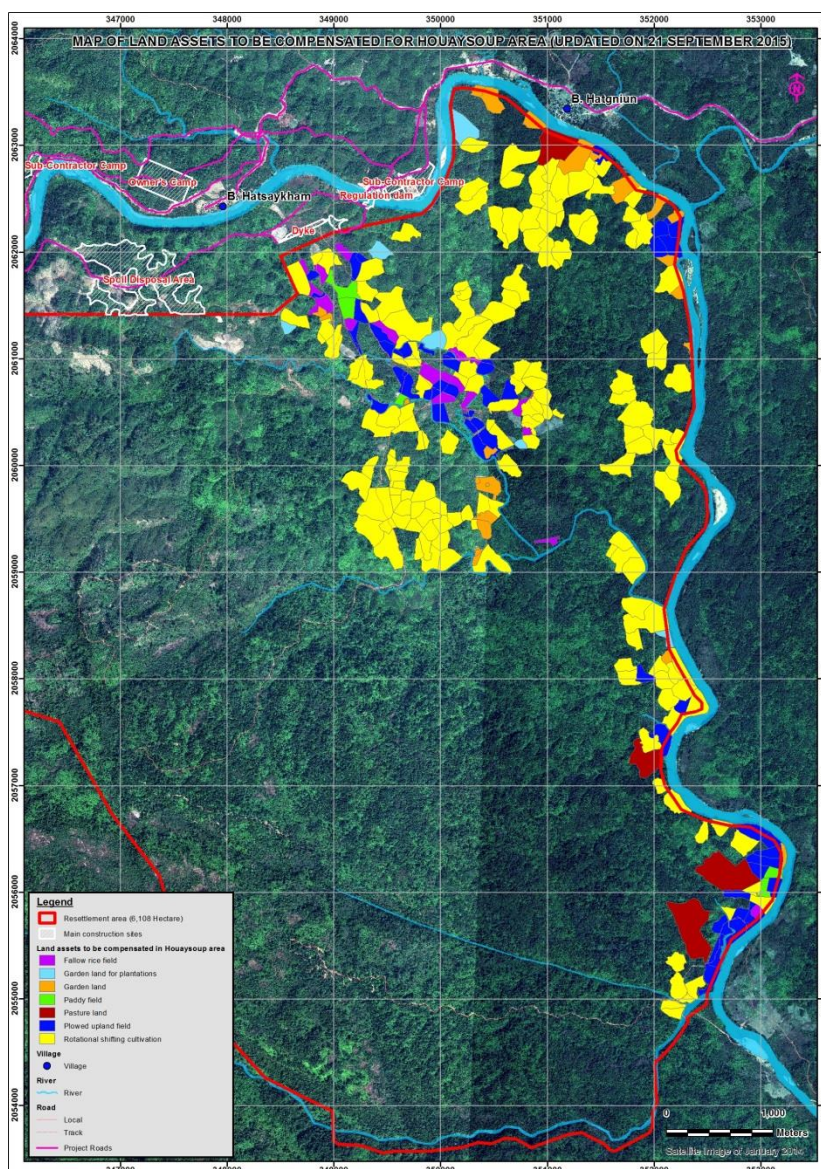


**Figure 6-4 Consolidated Participatory Map, Proposed HSRA (Ban Hatsaykham, Ban Hat Gniun and Ban Somseun)**

Source: Earth Systems 2015

The findings of the participatory mapping exercise are supported by the preliminary results of detailed land and asset surveying of the area conducted by NNP1's Social Management Office in late 2014 (refer to Figure 6-5 below). In addition to privately and commonly held land used by villagers in the three (3) host communities, a number of plots have been identified as concession areas owned by the GOL.





**Figure 6-5 Individual land use within the HSRA from 2012 survey**

**Source: NNP1 2015**

### ***Proof of ownership***

Individual ownership of permanent lowland and upland fields is most commonly verified by tax receipts and the village land log.

Individual ownership of upland agricultural areas is currently based on an informal system whereby each household recognises the general areas of each farm, and temporary borrowing and sharing of areas between households is common. Permanent land ownership is recorded in the village land log and verified with tax receipts. Some swidden cultivation plots are reported to the village chief annually for tax purposes, however the majority is not reported and therefore little documented proof of ownership of this land exists.

In recent years NNP1 SMO has defined individual land and allocation per household size for compensation purposes. District officials have also conducted 'productive land' assessments and issued letters to individuals outlining land under production and tax obligations.



## 6.1.5 Wealth and Poverty

### *Perceptions of Wealth and Poverty*

During village level surveying (Earth Systems 2015b) respondents were asked to group village households into four (4) categories: very well-off, sufficiently well-off, poor with land and poor with no land. The results of this exercise, provided in Table 6-4, indicate that Somseun is perceived as a wealthy village, while Ban Hat Gniun and Hatsaykham are perceived as fairly poor communities.

**Table 6-4 Perceptions of Wealth and Poverty in Host Communities**

	Ban Hat Gniun	Ban Hatsaykham	Ban Somseun
Very well off	-	26%	30%
Sufficiently well off	60%	51%	60%
Poor with some land	37%	23%	10%
Poor with no land	3%	-	0%

Source: Earth Systems 2015b

### *Income Sources and Expenditure*

According to previous assessments (SIA, NNP1 2014a) the main sources of cash income for villagers in Khum Hatsaykham comes from the sale of livestock and fish. Income from hunting and trade & service are secondary income sources. For Ban Hat Gniun the sale of livestock and agricultural products are reported as the primary sources of income. Secondary cash income sources are derived from the sale of surplus fish, NTFPs and handicrafts. Primary income for the residents in Ban Somseun derives from sales of livestock and agriculture products (i.e. sugarcane and cassava) while their secondary incomes are salaries for working with local Governments and local factories.

A recent income survey conducted by SMO in 2014 shows that people in Ban Hat Gniun and Ban Hatsaykham generate an average of 1.1 million kip per household per month. Earth Systems conducted village survey in June 2015 indicated that households in Ban Somseun earn an average income of 2.9 million kip per month.

Information on household expenditure is provided in the SIA (NNP1 2014a). The main expenditures for villagers in Hat Gniun and Hatsaykham are for clothing and contributions to social events such as marriages, funerals and celebrations for new-borns. Other important expenditures are on agricultural tools and supplies and costs for education and health. Villagers in Ban Somseun spend the majority of their money on food, social events (i.e. donations for temple and weddings) and utilities.

### *Vulnerability*

Information on vulnerable households in the three (3) host communities is outlined in Table 6-5. A total of 39 disadvantaged households were identified. Elderly and the disabled account for most of the vulnerable households in Ban Hat Gniun while in Ban Hatsaykham and Ban Somseun, widows are the chief reason for vulnerability, making up 57% and 74% of the vulnerable households respectively.

**Table 6-5 Vulnerable Households in the Host Communities**

Vulnerability Category	Ban Hat Gniun (HHs) <sup>^</sup>	Ban Hatsaykham (HHs) <sup>^</sup>	Ban Somseun (HHs) <sup>**</sup>
Female headed (Widow)	1	4	20
Elderly / Infirmed with no support	2	1	2
Disabled	2	0	1

Vulnerability Category	Ban Hat Gniun (HHs) <sup>^</sup>	Ban Hatsaykham (HHs) <sup>^</sup>	Ban Somseun (HHs) <sup>**</sup>
Absolutely poor	0	3	0
<b>Total</b>	<b>5</b>	<b>7</b>	<b>27</b>

Source: <sup>^</sup>NNP1 2014a (Vulnerability Report Access Road); <sup>\*</sup>Earth Systems 2014; <sup>\*\*</sup>Earth Systems 2015b

### ***Rice Security***

Rice security through self-production is a key indicator of household vulnerability in rural areas of Lao PDR. The SIA (NNP1, 2014a) reports that all households in Hat Gniun have enough rice to eat for 12 months round. In Ban Hatsaykham, 64 per cent of the villagers grow enough rice themselves to consume for more than 10 months a year. The remaining 36 per cent suffer from rice shortages for 1 to 8 months a year and mainly rely on food purchases or exchange in kin to address this deficit. All households in Ban Somseun have sufficient rice year round.

## **6.1.6 Local Economies and Livelihoods**

Local economies and livelihoods of the three (3) host communities are fairly typical of rural communities located in the transitional zone between mountainous and lowland areas in Lao PDR. The majority of villagers are still dependent on rice cultivation, animal husbandry, fishing in nearby streams, collection of non-timber forest products (NTFPs) and harvesting of timber forest products (TFPs). While the three (3) host communities share these commonalities, a number of clear differences are also present – influenced by the village size, settlement location, ethnicity of villagers and the history and connection to the local area. These aspects are discussed in the sections below.

### ***Lowland rice cultivation***

Lowland rice cultivation is fairly limited in Ban Hat Gniun and Hatsaykham and more widespread in Ban Somseun.

Villagers in Ban Hatsaykham prefer the upland rice cultivation, a traditional staple livelihood for Hmong communities. They have reportedly established only a limited lowland rice cultivation area (10 ha planted every year and 7 ha planted biennially).

Villagers in Ban Hat Gniun reported having 20 ha of rain-fed lowland rice paddy fields on the right bank of the Nam Ngiep River and 17 ha within the HSRA. According to NNP1's SMO, these field were established with the support of the Luxemburg government in 2004 and abandoned a few years later due to poor harvests. However villagers reported that these fields are still used and produce average annual yields of 4.6 tonnes / ha.

Villagers in Ban Somseun have developed approximately 96 ha of lowland rice paddy fields across the village lands. These fields are reportedly owned and used by approximately 40% of households. Approximately 2.9 ha of paddy fields held by five (5) households have been identified in the HSRA near the old Ban Tam Din settlement area (NNP1 SMO 2014) – considerably less than the 8 ha reported during village surveying (Earth Systems 2015b). Annual yield of these fields reportedly ranges from 2.8 to 5.4 tonnes / ha.

Common issues with lowland rice cultivation in the HSRA include drought (water availability), floods (destroying crops) and pests such as rats, beetle and termites that eat the roots of the rice after planting and as the rice grows.



**Plate 6-1 Lowland rice cultivation in Ban Hong in the HSRA**



**Plate 6-2 upland rice cultivation in the HSRA**

### ***Upland agriculture***

Upland agriculture, both permanent and shifting, is practiced by the majority of households in the three (3) host communities. In addition to upland rice, other crops such as maize, corn, sugar cane, cassava, pineapple and banana are grown. Mak keng (a small fruit) also grows naturally in upland fields.

Upland agriculture fields in Ban Hatsaykham and Hat Gniun are located on the right and left banks of the Nam Ngiep River - a large proportion within the proposed HSRA. According to ES village surveying (July 2015), 100% of households from both communities claim to practice upland agriculture within the HSRA – tending to between three (3) to (5) ha each per year. Villagers' reported yields of upland rice in these areas varied considerably – ranging from 1 ton/ha up to 4 ton/ha. A number of factors reportedly affect rice yields including:

- Fallow cycles: Cycles range from 2 - 8 years with longer cycles producing greater yields. There is reportedly ample land for longer cycles, however limited access, transport and distance from settlements is a limiting factor;
- Intercropping: Villagers in Hat Gniun practice inter-cropping (rice with chili, cassava, eggplant and corn) while villagers in Hatsaykham reportedly separate rice from other crops; and
- Agricultural issues: Drought and pests (i.e. rats, beetles and termites) can cause significant damage to upland crops.

Upland agriculture fields in Ban Somseun are located on the right and left banks of the Nam Ngiep River. Original VLFA maps indicate this area (2,458 ha) extending from Houay Khinguak Noy down past the village settlement area, however recent village surveying has also confirmed upland agriculture cultivation (56 ha) on the old Tam Din village lands within the HSRA (refer to Figure 6-4). A total of 27 households reportedly practice both shifting (average of 2 ha per year per family) and permanent upland agriculture (average of 3 ha per year per family) in this area. Permanent agriculture fields are generally located in the most productive areas (i.e. good soils and near watercourses). Reported annual yields of upland rice in these areas range between 2.8 to 4.0 tonnes / ha. Shifting agriculture fields are generally located further away from the Nam Ngiep River. Annual yields reportedly range between 1.4 and 2.8 tonnes / ha. Drought and pest issues outlined above, can significantly affect yields.

### ***Gardens***

A number of households in Ban Hat Gniun and Somseun have established vegetable gardens around the homestead and along riverbanks particularly during dry season. Vegetables grown in these gardens include spring onion, eggplants, mint, chili, lemon, beans, legumes, and vegetables.

Villagers surround the vegetable plots with woven bamboo fences to demarcate use boundaries and to keep out animals. A number of these gardens have been identified in the proposed HSRA, located along the Nam Ngiep River and near the confluence of the Houay Soup Noi and Houay Soup Ngai (refer to Figure 6-4).

### **Tree Plantations**

The main household tree plantations in the three (3) host communities are fruit plantations, including mango, longan, coconut, and tamarind. The fruit trees are planted around village settlements and in upland agricultural areas and are mostly for domestic consumption. Over recent years a small number of households (~3) have planted commercial trees, such as eucalyptus and rubber. These plantations are in their initial stages of development. A small number of these commercial tree plantations have been identified in the HSRA area including 3 ha of eucalyptus plantation in Ban Hat Gniun, 1 ha of rubber plantation in Ban Somseun, and 5 ha of rubber owned by 4 households in Ban Hatsaykham.

### **Livestock**

Households from all three (3) host communities raise a variety of animals for domestic consumption and for sale. Chickens, ducks and pigs roam around the houses. Some larger pigs are kept in pens. Other large animals such as water buffaloes, cows and goats are usually left to roam or are herded during the day before being brought back to stay near the house at night. Livestock holdings for host communities are presented in Table 6-6.

**Table 6-6 Livestock Holdings in Host Communities**

Village / Community	Households (2015)	2013*					2015^				
		Buffalo	Cow	Goat	Pig	Poultry	Buffalo	Cow	Goat	Pig	Poultry
Ban Hat Gniun	39	184	289	6	84	1,200	250	200	0	50	1,500
Ban Hatsaykham	74	166	155	20	248	755	75	150	14	120	800
Ban Somseun	232	100	350	100	350	4,500	150	400	150	400	5,000

Source: \*NNP1 2014b; ^Earth Systems 2015b

The HSRA is commonly used by all three (3) host communities for cattle rearing (ES July 2015):

- Approximately 25 households from Hatsaykham raise between 4-5 head of cattle in the HSRA. Key grazing areas include grasslands in the upper Houay Soup Ngai catchment (near Nong Da) and lower Houay Soup Noi catchment. Streams throughout these areas are used as a water source;
- Typically, the residents of Ban Hat Gniun do not raise cattle in the HSRA during the rainy season as this area is used for cultivation activities. Nonetheless, there are about 7 households that graze their animals in the HSRA during the dry season; and
- Approximately nine (9) households from Ban Somseun raise an average of 5-6 head of cattle in the HSRA. Cattle reportedly graze in young fallow areas and source drinking water from nearby waterways.





**Plate 6-3 Pigs at Ban Hatsaykham**



**Plate 6-4 Cattle grazing in the HSRA**

### **Forest Resource Use**

Most villagers in the Ban Hat Gniun, Ban Hatsaykham and (to a lesser extent) Ban Somseun still rely on forest resources including Non-Timber Forest Products (NTFPs), Timber Forest Products (TFP) and wildlife for subsistence and as a source of livelihood. These resources are mainly sourced from allocated village forests (production, conservation and regeneration). The HSRA was identified as a key source of forest resources in all three (3) communities. The HSRA is characterised by a mosaic of upland agriculture / fallow forest and upper mixed deciduous areas. While resources in fallow areas are utilised (mainly for NTFPs) other more intact forest areas (i.e. within the PFA) are the main sources of TFPs and wildlife.

Earth Systems surveying for this study indicates that villagers collect and use 12 timber forest product (TFP) plant species and 21 non-timber forest product (NTFP) plant species (Appendix D). A few species were used for both timber and non-timber products, totalling 30 species used by villagers for subsistence and trade. Nearly all NTFPs are reportedly collected from fallow forest/land. Since most of the larger trees usually occur within upper mixed deciduous (UMD) forest, the most common habitat for collection of TFPs from these species was in UMD. According to the LKS, the villagers reported that there are 28 mammal species, 33 bird species and 33 reptile species in fallow and UMD forest areas of the HSRA. Most of these wild animals were reported as being seen only. However, the ES survey team witnessed hunting activities and wildlife captured including wild pigs (*Sus scrofa*), black Crested Bulbul (*Pycnonotus melanocyterus*) and squirrels (*Callociurus* sp.) that were captured by villagers from Ban Somseun and Ban Hat Gniun.

Men and women typically shared the collection duties of TFPs and NTFPs. However, it appears that timber from some of the larger trees (e.g. Dipterocarpaceae) were only collected by men from Hat Gniun and Somseun. Wildlife hunting was mostly reported as the men's activity in the three host communities as they are more skilful at making and using artisan hunting tools such as traps and homemade guns.

Use of plants included food, medicine and sale for income. Timber products were normally used within the village, with the exception of some Dipterocarps from Somseun that were also sold. Similarly most NTFPs and wild animals were consumed within the village for food, as well as being used within traditional medicine. Wildlife meat is a supplementary source of animal protein for the villagers.



**Plate 6-5 Hunting Equipment, HSRA**



**Plate 6-6 Squirrels, HSRA**



**Plate 6-7 Edible mushroom Gathering, HSRA**



**Plate 6-8 Small-scale logging, HSRA**

### ***Fishing and Aquatic Resource Use***

Fish and other aquatic resources are an important source of protein for people in rural Lao PDR and villagers of Ban Hat Gniun, Ban Hatsaykham and Ban Somseun are no exception. During focus group discussions / Local Knowledge surveys, villagers estimated that 100%, 80%, and 95% (for Ban Hat Gniun, Ban Hatsaykham and Ban Somseun, respectively) of households include a family member that fishes regularly. Most of the resources are consumed locally (85 – 90%, including 10% that is fermented or dried for later consumption). Fish are considered an essential element of nutrition for local people, who even in low fishing season consume fish several days per week (NNP1 2014a). Approximately 10 – 15% of fish caught are sold at markets, to restaurants, or to individuals in Ban Houay Khoun, Ban Somseun, Ban Hat Gniun, and Paksan. The money earned from fish sales depends on the size of the fish and species (refer to Table 6-7).

**Table 6-7 Prices earned for fish sales**

	> 3 kg	<3 kg
Catfish species	50,000 – 80,000 Kip / kg	30,000 – 40,000 Kip / kg
All other species	30,000 – 50,000 Kip / kg	20,000 – 30,000 Kip / kg

Source: Earth Systems 2015b

Households that fish generally have at least one member of the household fishing for 6-7 days per week during the dry and rainy seasons. Representatives from all three communities indicated that of the regional

fisheries, the Nam Ngiep River is the best (particularly during the dry season), both for the number of fish caught and the average size of the fish. All three communities are increasingly fishing tributaries of the river (most often HSRA streams) for 10 – 30% of their fishing. The primary reason for this is the increased number of people that fish the Nam Ngiep consistently, including a significant rise in the number of people that fish commercially (whereas fishing was traditionally for consumption only).

The HSRA is fished somewhat regularly by villagers from Ban Hatsaykham, Ban Hat Gniun, Ban Songkhone, Ban Nampa, and Ban Houay Khoun, primarily during the rainy season. HSRA streams are more commonly fished during the rainy season to coincide with the fish migration pattern (fish move up the Nam Ngiep in ~June and back out in ~October) and because their boats can reach further upstream with higher flows. Each community indicated that the best fisheries (in the HSRA) are Houay Soup Noy / Ngai near their confluence (lower to middle reaches) and the lower reach of Houay Khinguak Ngai, though each of the perennial streams are fished at least occasionally. In addition, aquatic biota are collected from seasonal and perennial wetlands in the HSRA (Nong Pa, Nong Da (also referred to as Honda)), with frogs and crustaceans comprising the majority of harvest.

Villagers from Hatsaykham, Hat Gniun, and Somseun reported catching an average of 20-30 kg, 5-6 kg, and 2 - 3 kg per day in general, and approximately half this much in HSRA streams (villagers of Ban Hatsaykham were asked numerous times to confirm this high number and insisted that this is accurate). During LKS, representatives from each community reported that the fisheries are in decline for the Nam Ngiep River and its tributaries. Reportedly, 40 – 80% less fish are caught on the Nam Ngiep when compared to five (5) years ago and 50 – 70% less fish (weight) are caught in HSRA streams when compared to five (5) years ago. The primary reasons cited for declining fisheries included:

- Number of people fishing;
- Turbidity in the Nam Ngiep River;
- Increase in commercial fishing / transition from consumption to consumption and commercial; and
- Change in fishing methods (each community indicated knowledge of people using electrofishing and spearfishing).

Men and women from each community fish, with approximately 70 – 80% of fishing dominated by men. Villagers indicated that men practice traditional fishing for large fish in the rivers and streams, while women usually use scoop nets and other techniques to collect smaller fish as well as frogs, crab, shrimp, eel, snails, and aquatic insects.

The most common fishing techniques include:

- Mong (gill net);
- Hae (cast net);
- Hook and lines;
- Handle scoop nets; and
- Sai (horizontal cylinder traps).

Each community also occasionally use Toun (upright basket traps), life nets, bamboo trap, scoop baskets, and filtering traps. As above, representatives from each community reported knowing of others who are using electrofishing gear and spearfishing.





**Plate 6-9 Fishing, Nam Ngiep River**



**Plate 6-10 Frog, HSRA**

### ***Aquaculture***

NNP1 has supported the development of household aquaculture ponds in Ban Hat Gniun and Ban Hatsaykham.

In Ban Somseun thirty (30) families share an aquaculture pond and fish resources. A small stream enters the pond, capturing native fish. The villagers also capture smaller live fish from the Nam Ngiep River and transplant them to the pond for raising to an adequate size for consumption.

### ***Non-Agriculture livelihood activities***

A few households in Ban Hat Gniun run small-scale trading including groceries and restaurants. This activity is their primary household income. In addition, few people are working for the Government in Bolikhan district. A number of villagers are also casually employed by NNP1's sub-contractors such as cleaning and construction works. About one-third of total households in Ban Somseun casually work for nearby sawmills. The village authorities also reported that there are 60 - 70 people who work for the government as teachers, soldiers and Forestry Department staff. A few villagers provide local transport services from the village to Paksan and school transport services.

It was reported that about 20% of total households in Ban Hatsaykham make handicraft products both for sale and domestic use. The villagers have been employed casually by sub-contractors to work in the NNP1's related construction and UXO clearance activities. One villager was recently recruited as full-time staff of NNP1.

## **6.1.7 Water Resource Use**

The three (3) host communities are situated within the Nam Ngiep River Basin. Each settlement is located on the left bank of the Nam Ngiep River. The river and left bank tributaries supply domestic water to these settlements and agriculture water to left bank agriculture fields.

Information on key water resources on the right bank of the Nam Ngiep River and in the proposed HSRA is provided in Section 4.5. The most significant streams in the HSRA include the Houay Soup Noi, Houay Soup Ngai, Houay Khinguak Noi and Houay Khinguak Ngai (from north to south). All these streams are perennial – the former two (2) spring-fed. A number of smaller ephemeral streams located in the East of the proposed HSRA drain directly into the Nam Ngiep river and include (from north to south), the Houay Liang, Houay Dhakong and Houay Thamdin. A number of grassy wetlands including the Nong Hong Da and Nong Pa were identified in the upper areas of the Houay Soup Noi and Ngai catchments.



These water resources are used by villagers from the three (3) host communities primarily for fishing (refer to Section 7.3) and to a lesser extent agriculture (i.e. livestock drinking water and rain-fed paddy fields). Streams in the area are also used by villagers as a source of drinking water and bathing whilst they are working in the area. Water is reportedly not boiled before drinking. According to villagers in Ban Hat Gniun and Ban Hatsaykham, grassy wetlands Nong Hong Da and Nong Pa are used for small-scale aquaculture (i.e. frog breeding) and as a source of drinking water for livestock. In addition to the water use described above, Ban Hatsaykham utilises three (3) boreholes with hand pumps installed by NNP1. Ban Hat Gniun has a gravity fed system (GFS) and they have a larger water supply system under construction. Ban Somseun has a town water supply system fitted with water meters which is currently struggling to meet demand. NNP1 is working with Ban Somseun to upgrade this system. All communities capture and store rainwater for use during the rainy season.

### **6.1.8 Local Infrastructure and Services**

This section provides a summary of local infrastructure and services in the three (3) host communities. More detailed information is provided in the SIA (NNP1 2014a). The majority of village infrastructure is located in and around the settlement areas of the three (3) host communities and not within the proposed HSRA – with the exception of agricultural and logging access tracks (see below).

#### ***Proximity and access to district / provincial services***

All three (3) host communities have relatively good access to district and provincial services (i.e. health, education and economic etc.). Ban Hatsaykham and Ban Hat Gniun are located approximately 21 km from the district capital of Bolikhan and 36 km from the provincial capital of Paksan. Access to these communities was improved substantially in 2014 after the completion of the main NN1HP access road. Ban Somseun is located within 3km of the provincial capital of Paksan via a sealed road.

#### ***Electricity and Energy***

All three (3) host communities have access to the national electricity grid. Most households in Ban Somseun utilise this electricity for lighting, operation of small appliances and cooking. Ban Hat Gniun and Hatsaykham were only recently connected in 2014 (with the support from NNP1). Most households still use firewood as their primary source of cooking fuel although some households have started to use electricity. A small number of households from these communities used small river-powered generators prior to the connection to the grid (NNP1 2014a).

#### ***Health***

All three (3) host communities have a village medicine box and an appointed village health representative. All three (3) communities have relatively good access to district and provincial health services and receive regular visits from district health programs (i.e. immunization and other health support services).

#### ***Water and Sanitation***

Domestic water in the three (3) host communities is sourced from nearby waterways or wells. Villagers in Ban Hatsaykham source their domestic water from three (3) bore holes and supplement this supply with water from the Nam Ngiep – only 60% of households boil this water prior to drinking. Villagers in Ban Hat Gniun use a gravity fed system (GFS) and Ban Somseun source drinking water from town supplies as well as village wells (all boiling before use) and bottled water. Households in these communities also use water from the Nam Ngiep, and rainwater harvesting during the rainy season, for domestic use. All households in Ban Somseun and Ban Hat Gniun and 26% of households in Ban Hatsaykham reportedly have access to private sanitation infrastructure, including latrines and closed septic tanks in each household.

## **Education**

Each of the host communities have primary schools – although the school in Hatsaykham only provides grades one (1) to three (3). NNP1 currently provides support for a school bus to take students from Hatsaykham to Hat Gniun. Villagers in Ban Hat Gniun and Ban Hatsaykham do not commonly go to secondary school as there are no secondary schools located within close proximity of the settlements. Villagers in Ban Somseun go to upper and lower secondary school that is available in Ban Houay Khoun, 3 km from Ban Somseun. The College of Forestry is also located in in Houay Khoun.

## **Irrigation**

There are currently no irrigation systems present in the three (3) host communities.

### **6.1.9 Village Access to the HSRA**

Villagers from the three (3) host communities mainly access the HSRA via boat. A rope pull barge (provided by NNP1) has also recently been installed at Ban Hatsaykham. Villagers from Hatsaykham and Ban Hat Gniun use the barge. There are a number of agricultural and logging access tracks throughout the HSRA providing villagers from all three (3) of the host communities with access to most areas via foot or small vehicle (i.e. toktok and motorbike).

Proposed resettlement communities include Ban Hatsaykham settlement located in the regulation reservoir area (see above) and Ban Houaypamom, Ban Sopphuane, Ban Sopyouak and Ban Namyouak located in the main reservoir area (2LR villages).

Baseline information for these communities is documented in the main Project's SIA (NNP1 2014a) and REDP (NNP1 2014b). The following sections provide a summary of key information on 2LR villages from these reports.

## **6.2 Resettlement Communities**

Proposed resettlement communities include Ban Hatsaykham settlement located in the regulation reservoir area (see above) and Ban Houaypamom, Ban Sopphuane, Ban Sopyouak and Ban Namyouak located in the main reservoir area (2LR villages).

Baseline information for these villages is documented in the main Project's SIA (NNP1 2014a) and REDP (NNP1 2014b). The following sections provide a summary of key information on 2LR villages from these reports.

### **6.2.1 Location**

The 2LR villages are located in Hom District of Xaysomboune Province about 12 to 25 km upstream from the dam site, which is located in Bolikhan District of Bolikhamxay Province. Through the inundation of the reservoir, all four (4) villages will require resettlement and lose productive land, and will require relocation to the selected resettlement sites.

### **6.2.2 Demography and Population Changes**

The 2LR villages have a total 481 households with 3,231 people (Earth Systems 2015b). The average household has 6.7 people. The ratio of males to females is 1.1. The total population in these villages has increased 4% over the last four (4) years.

### 6.2.3 Ethnicity, Religion and History

Almost 100% of the population in these villages are Hmong with the exception of a few Lao Loum households in Ban Sopyouak. The main religion is Animism. All four (4) villages have a long history with the local area. Present village locations were established between 1984 and 1996.

### 6.2.4 Land Allocation and Ownership

Average village land for these villages is 1900 ha, ranging from 850 ha (Ban Houaypamom) to 2880 ha (Ban Sopyouak). Land use in all villages includes a mixture of lowland agriculture, upland agriculture, commercial plantations, and grazing land and village forests. Privately held lands account for 36.4 % of the total land area of the communities. Over half of the total village forest land across the four communities is classified as community managed production forest.

### 6.2.5 Local Economies and Livelihoods

All four (4) 2LR villages have agricultural based economies. The residents of these communities have traditionally had a mixed economy of cultivating rice and food crops, fishing, raising livestock, hunting for meat and gathering NTFPs – all primarily for household use. Households in these villages practice lowland rice cultivation and upland rice cultivation. Livestock raising and collection of NTFP's are both important sources of cash income within 2LR villages.

### 6.2.6 Wealth and Poverty

The average annual cash income of households in 2LR villages is 7.6 million ranging from 3.8 million in Ban Sopphouane to 10.6 million in Ban Sopyouak. Rice sufficiency was used to assess poverty in these villages. The majority of households in 2LR villages (90%) were found to be rice sufficient year round with the remainder experiencing shortfalls of rice for up to 2 to 4 months of the year. Those households either buy or exchange goods and services in kind to obtain the additional rice they need.

### 6.2.7 Water Resource Use

All villages use the Nam Ngiep as a key water resource for domestic use, as well as other activities such as fishing and generation of electricity through pico hydro-electric systems. Drinking water comes from simple gravity flow water systems from mountain streams or from wells. Water for other domestic uses is from the Nam Ngiep or its tributaries (with associated water quality issues), or from wells. Sufficient water is not available throughout the year.

### 6.2.8 Local Infrastructure and Services

Access to 2LR villages is via a road from Hom District via Ban Phalavaek which is not always passable during the rainy season. Villages are accessible by boat on the Nam Ngiep River, though parts of the river are difficult to travel due to rapids and rock outcrops. None are served by the national electricity grid, but individual electricity production via pico-hydro or solar power is present; the latter supported by the Project.

Three of the four villages (excluding Ban Houaypamom) have primary schools and Ban Namyouak also has a lower secondary school. Ban Sopyouak has a health centre which is fairly easily accessed by the people of Ban Namyouak as well. None of the communities have temples or pharmacies.

All four communities have small grocery shops which are small rooms or add-ons at people's houses where they sell soaps, shampoos and detergents, toothpaste, and a variety of packaged and canned goods.

## 6.3 Cultural Components

### 6.3.1 Cultural Practices

The majority of people in the host communities of Ban Hat Gniun and Ban Somseun are Lao Loum. These populations are well integrated into the wider Lao society and economy and have a history of good relations with other ethnic groups in the area (NNP1 2014b).

The majority of people in the resettlement communities are Hmong. Although Hmong are traditionally highland residents, these communities live in the river valley and have adopted livelihood activities more typically associated with sedentary agriculture of the Lao. Their settlements are quite recent, with the oldest of the four communities established about 30 years ago. The lands were given to these villagers after the civil war, in gratitude for their support for the Pathet Lao. Many of the villagers moved from higher, mountainous areas, the traditional area where Hmong live, with some having moved from the Phu Katha region (NNP1 2014b).

The Project has assessed these Hmong communities as fulfilling the ADB's criteria for classification as indigenous people (NNP1 2014b).

### 6.3.2 Cultural Heritage

Village surveys (Earth Systems 2015) conducted in Ban Hat Gniun, Ban Hatsaykham, and Ban Somseun indicated there are no archaeological and culturally significant sites of national and regional importance within the HSRA (Kansai et al 2012b; Earth Systems, 2015b).

One local culturally significant site was identified within the HSRA: a sacred rock near Houay Thamdin. Anecdotal evidence indicates that the site is considered an important place respected by local villagers as it was believed a hermit monk meditated in a small cave called Thamdin (Din cave). The cave has collapsed long ago and only sacred rocks remain.

One cemetery in Ban Hat Gniun was identified in the north east corner of the HSRA, however, this cemetery is located outside the HSRA.

Other cultural sites and artefacts identified in the vicinity of the HSRA include (Kansai et al 2012b; Earth Systems, 2015b):

- A polished shouldered axe/adze in stone found in the Nam Ngiep River during fishing in 2006, which provides evidence of Neolithic human occupation during the late stone age; and
- An ancient Buddhist temple cave located approximately 6 km from Ban Hatsaykham, upstream and on the right bank of the Nam Ngiep. The cave is approximately 200 m further inland, at the foothill of Phu Hong, a mount that belongs to the Phu Kata range. Three bronze statues survived looting and have been moved to the Buddhist temple in Ban Gniun (10 km away) for improved security

In addition, other physical resources of archaeological and cultural significance have been identified in Thaheua village, including a bronze Buddha image found in the ruins of an ancient Buddhist temple located on the opposite bank of the Ban Thaheua village (dated from Late Lane Xang Period, c. 19 AD, and now kept at the Buddhist temple in the village) and Neolithic remains at a tributary downstream of the Main Dam. The findings of Neolithic remains by villagers are currently under investigation by NNP1's Environmental Management Office to assess the sources and the significance of these findings (NNP1 2014b). The presence of numerous locally collected polished stone tools found in the wider area indicates that human occupation occurred between 4,000 and 12,000 years ago (Kansai et al. 2012a).

Intangible cultural heritage values found within the local area include traditional practices by local villagers, such as hunting, gathering, fishing, collection and use of medicinal plants and TFPs (e.g. firewood, bamboo used by both Lao and Hmong people to make animist symbols to ward off evil spirits).



### 6.3.3 Natural Heritage

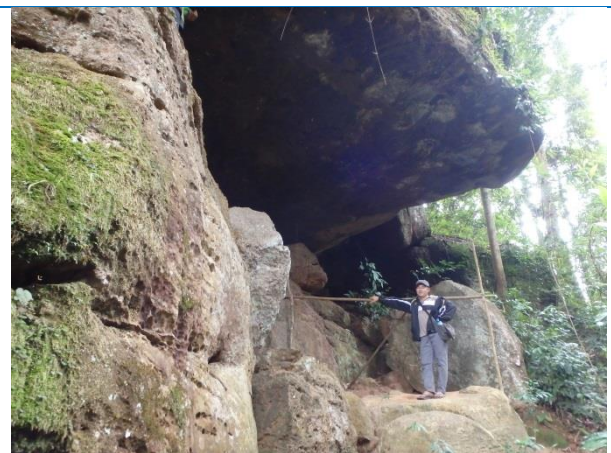
Natural heritage is strongly linked to physical and biological features of the natural environment which are of significance from a scenic, aesthetic, scientific or ecological perspective, such as conservation forests and biodiversity protected areas, mountains, waterfalls, caves, waterbodies, and wetlands.

There are no natural sites of international or national significance in the HSRA. However, during field and village surveys (Earth Systems 2015b), the following natural sites of local significance or aesthetic value were identified:

- Major streams including Houay Soup Noi, Houay Soup Ngai, Houay Khinguak Noi, and Houay Khinguak Ngai (which all occur within the HSRA);
- A number of lakes and wetlands, including Nong Da (seasonal wetland) in the south west of the HSRA (refer to Plate 6-1), and Nong Pa / Nong Gnae (with natural perennial spring) located in between Houay Soup Ngai and Houay Soup Noi in the western part of the HSRA. The perennial spring provides a good source of drinking water;
- A historical Tham Nong Da (Nong Da Cave) or Mr. Xeng's Cave (refer to Plate 6-2), located on the south-west border of the HSRA. Mr. Xeng, who was a local revolutionary movement leader, used this cave as a stronghold site during the Vietnam War. Currently, local residents still use the cave as a sleeping camp during hunting and collection of NTFPs;
- A seasonal waterfall on Houay Khinguak Ngai along the border of the HSRA. The waterfall is located about 3 km upstream from its confluence to Nam Ngiep River. The waterfall is 8 - 10 m in height with water flowing from July to October;
- An important mountain peak, which has natural caves and waterfalls located along the HSRA western boundary, approximately 1 km towards the boundary; and
- Pu Hong (referred locally as the 'Palace Mountain') and Phu Kata (referred locally as the 'Pan Shaped Mountain') near Ban Hatsaykham, which have been named after the famous 'Sinxay Epic', a masterpiece of Lao classic literature because they were believed to be the real places from that story.



**Plate 6-11 Nong Da (seasonal wetland) in the south west of the HSRA**



**Plate 6-12 Tham Nong Da (Nong Da Cave) located on the south-west border of the HSRA**

## 7 IMPACT ASSESSMENT AND MITIGATION MEASURES

Section 7 of this *Initial Environmental Examination* provides a more detailed assessment of the potential impacts and management / mitigation measures specific to the HSRA construction and post-construction phases. These phases are defined as follows:

- The construction phase will be initiated in approximately November 2015 and will extend to late 2018. Residents from Ban Hatsaykham will be relocated to the HSRA in approximately April 2016, bringing potentially sensitive receptors to within close proximity of construction activities. Therefore the potential for impacts and / or the severity of impacts will change at this time for certain aspects (e.g. dust and noise). The rigour of management / mitigation will vary according.
- The post construction phase for the HSRA is divided into two distinct stages:
  - » HSRA Stabilization Period (as per the REDP, Livelihood Restoration and Income Plan) - NNP1 involvement in livelihood restoration activities for PAPs will continue for 10 years following the pre-construction period of the Main Project (December 2013) and for up to five (5) years during a stabilisation phase after NN1HPP COD.
  - » Operations and Maintenance - NNP1 involvement in post-construction maintenance and operation of the resettlement infrastructure will commence in 2018 (or when infrastructure is completed). Operational responsibility for village infrastructure will be allocated to the village and / or GOL following the official transfer of the HSRA to the village / GOL after MONRE is satisfied that CA requirements have been met.

The management and mitigation measures specified in this Section (and monitoring framework in Section 8.3) will be incorporated into contractor' *Site Specific Environmental and Social Management and Monitoring Plans* (SS-ESMMP) to clearly demonstrate contractor requirements (and contractual obligations) and best management practices across the infrastructure development area. The Nam Ngiep Hydropower Project *Environmental and Social Management and Monitoring Plan* (ESMMP-CP) (ERM, 2012) specifies overarching Project requirements for management, mitigation, monitoring and reporting during the Project construction phase, which includes construction of the HSRA. Additional measures from applicable sub-plans of the ESMMP-CP (Appendix H to this report) should be considered for inclusion in SS-ESMMP, where appropriate.

It is anticipated that post construction management, mitigation, and monitoring measures identified in this IEE will be incorporated into the NN1HPP ESMMP – Operations Phase (ESMMP-OP).

### 7.1 Physical Impacts and Mitigation Measures

#### 7.1.1 Project Footprint

##### ***Issues and Findings***

Development of the HSRA will impact approximately 2,394 ha of landform morphology and soil / subsoil during construction of the RDS infrastructure (i.e. housing, community infrastructure, utilities, roads, etc. – permanently impacted areas) and during operations (paddy fields, upland agricultural areas, etc.). The construction of Project infrastructure, agricultural plots, and livestock grazing will not require extensive earthmoving operations and the morphology of the area will not be significantly altered. Development of the paddy fields will require some reshaping of the landscape, though the Nam Ngiep floodplains are relatively flat and thus earthworks will be moderate in scope.

The HSRA has also largely been positioned in heavily disturbed vegetation / habitat, minimising potential impacts to terrestrial biodiversity (refer to Section 7.2.1).

### Construction

The majority of development will occur during Project construction. The first phase of facilities' construction (site preparation) will include vegetation clearing and grubbing, earthworks, and topsoil compaction. Table 7-1 summarises the general impacts of site preparation, which are discussed in detail in applicable Sections of this chapter.

Primary earthworks / physical impacts will occur for housing / community infrastructure (levelling and compaction) and for rice paddy fields (levelling, creating Irrigation Reservoir and canals, etc.).

**Table 7-1 Summary of potential physical impacts related to site preparation during construction**

Impacts	Assessment	Reference Section
Erosion and Sedimentation	Clearing and grubbing of vegetation, major earthworks, soil stockpiling, soil compaction will increase the likelihood of soil erosion from water and wind with subsequent sediment transport	Section 7.1.4
Soil Compaction	Heavy earthmoving equipment and pad / road preparation will compact surface soils	Section 7.1.5
Water Quality	Diesel powered vehicles / equipment provide potential sources of hydrocarbons to surface and groundwater and accommodation camps a potential source of nutrients and pathogens	Section 7.1.3
Hydrology	Surface water from seasonal drainages will be diverted around disturbance areas.  The flow regime of Houay Soup Noi and Houay Soup Ngai will be permanently altered with the construction of domestic and irrigation water supply intake and storage reservoirs.	Section 7.1.2
Air Quality	Particulate matter (dust) will be generated from clearing and grubbing, topsoil stockpiling, vehicle transit on unsealed road networks, etc.  Exhaust emissions (e.g. CO, NO <sub>x</sub> , SO <sub>2</sub> , VOCs) will be generated from diesel powered vehicles / equipment	Section 7.3.9
Noise	Vehicles / Equipment will be a source of noise emissions during site preparation.	Section 7.3.8
Vibration	Vehicle / equipment utilisation will be a minor source of vibration during site preparation.	Section 7.3.8

Source: Earth Systems 2015

### Post-construction

Landforms that will support upland agriculture / cash crops and tree plantations will primarily be developed following construction of primary HSRA infrastructure. The HSRA footprint will expand during site preparation (e.g. clearing of vegetation and earthworks) and the majority of potential impacts will be indirect (e.g. water quality, air quality, erosion and sediment transport, etc.), as per the construction phase. Management and mitigation measures for associated indirect impacts are specified in applicable sections below.

Site preparation activities for upland and lowland cultivation sites will occur annually and periodically for tree plantation areas (pending rotation cycle). Annual and periodic site preparation of these areas may lead to additional physical disturbance to landforms (primarily surface soils) that will subsequently require annual / periodic management for indirect impacts listed in Table 7-1.

## **Management and Mitigation**

### **Construction**

The Project has been designed to minimise the physical impacts to the natural landscape by siting the majority of the Project footprint in highly degraded vegetative communities (i.e. old and young fallow). To ensure potential impacts on landforms are managed and mitigated for the Project, the following measures will be implemented by NNP1 / contractors for the construction phase:

- Areas requiring earthworks will be surveyed and delineated, with the maximum extent (area) of earthworks demarcated for each Project component. Vegetation clearance will be restricted to the minimum area required;
- Where feasible, landforms will be progressively rehabilitated throughout construction or immediately following construction for temporarily impacted areas that will not be required during operations. Buffer areas required for construction equipment (e.g. road embankments, access for construction equipment, vehicle laydown areas, etc.), temporary access roads, etc. will be ripped, graded to contour and planted with native vegetation;
- Areas disturbed by construction will be contoured to restore suitable drainage paths. Disturbed areas surrounding infrastructure will be rehabilitated and revegetated with native plants; and
- Management and mitigation measures provided in Section 7.2.1 will be applied for vegetation clearance.

### **Post-Construction**

Landform disturbance post construction will be limited to site preparation of agricultural areas / plantations. Management and mitigation measures are provided in applicable sections below (and in the INRMP, Appendix A) for the indirect impacts anticipated.

### **Assessment of Impacts**

The HSRA footprint is commensurate with the infrastructure, agricultural / livestock grazing area requirements of the resettled people. By minimising the footprint (and associated site preparation) to that needed for development of the HSRA, the impacts to the morphology of the area will be minimised.

Vegetation clearance and site preparation will lead to indirect impacts (e.g. erosion and sedimentation, noise, dust) that will require management measures identified in the Sections below.

## **7.1.2 Hydrology**

### **Issues and Findings**

**Flooding:** Preliminary modelling indicates that peak storm events may flood some of the proposed HSRA road network. Further modelling (including field measurement of flow for calibration) is required to clearly identify whether HSRA infrastructure (e.g. portions of the residential area) are above potential flood waters from major events (e.g. 1:100 – 1:1000 ARI).

It is anticipated that Phase 1 of relocation may easily be constructed above potential flood zones (with the potential exception of a portion of the access road). The phased approach to resettlement, with Ban Hatsaykham residents relocated in April 2016 and the remainder of resettlement occurring in the following 1 – 2 years, will allow for realignment of the residential infrastructure (e.g. to higher ground in the RDS Annex) to avoid potential flood zones, if further flood modelling indicates a risk to any of the remainder of the HSRA infrastructure.

**Stream flow reduction:** Construction of the Irrigation Reservoir on the Houay Soup Noi and abstraction of water from Houay Soup Ngai will significantly reduce surface water flow in these streams, particularly during the dry season. During the filling phase of the reservoir, the natural flow will cease below the dam wall as



it is captured in the reservoir. Temporary elimination of flow to the Houay Soup Noi may have serious long-term consequences for downstream aquatic biology.

According to preliminary design for the irrigation dam and domestic water supply intake, downstream dry season flow will be eliminated (if unmitigated) for these perennial streams during operations as well (given tributaries are ephemeral), with significant impacts for aquatic biota in the Houay Soup Noi and Houay Soup Ngai below the infrastructure.

Flow will also be decreased during the rainy season. Some aquatic biota likely require elevated rainy season flows during the rainy season. For example, migratory aquatic species likely require elevated rainy season flows to move upstream to suitable spawning areas and some macro-invertebrate species require flood waters to stimulate life cycle and reproductive processes. Thus, impacted rainy season hydrology may also indirectly denigrate aquatic habitat.

An environmental flow regime is required (continuous release of water) through the Irrigation Reservoir Dam and past the domestic water supply intake to preserve aquatic species habitat throughout the dry season.

### ***Management and Mitigation***

**Flooding:** Robust flood modelling should be conducted for the HSRA settlement area to determine reliable flood zone estimates. It cannot yet be determined whether the current siting of HSRA infrastructure avoids the flood zone for the 1:100 – 1:1000 year ARI peak storm events, whether current design constitutes a safety risk or temporary isolation risk for the resettled community, and whether flooding will necessitate ongoing maintenance of site infrastructure following flood events.

The following are recommended to manage / mitigate for potential flooding following significant storm events:

- Refine the flood model to accurately capture the extent of Houay Soup Noi and Houay Soup Ngai flood zones for annual, 1:100 and 1:1000 ARI peak storm events; and
- Identify suitable alternatives for housing and roads (in the Resettlement Development Site annex) that sit well above the flood zone.

**Flow reduction:** The following are recommended to ensure sustained populations of aquatic biology / habitat downstream of the irrigation dam and domestic water intake on the Houay Soup Noi and Houay Soup Ngai, respectively:

- A continuous environmental flow (i.e. 365 days / year and 24 hours / day) should be released to maintain a minimum of baseflow during the dry season and some retention of peak flow behaviour in the Houay Soup Noi below the Irrigation Dam; and
- Baseflow (currently estimated at 0.25 and 0.006 m<sup>3</sup> / s for Houay Soup Noi and Houay Soup Ngai, respectively) should be accurately determined via stream flow gauging.

### ***Irrigation Dam***

During the filling phase of the Irrigation Reservoir it is recommended that:

- Flow from the Re-regulation Dam should be diverted to the Irrigation Supply Reservoir until it is full. The environmental flow mechanism (e.g. culvert through the dam wall) should be in-place upon reservoir filling.

Once the Irrigation Reservoir is full it is recommended that:

- The water conveyance regime from the Re-regulation Reservoir should continue during the rainy season (excluding peak flow events that may lead to flooding) to provide an adequate volume of water to preserve the natural hydrology of the rainy season (to the extent practicable); and
- The environmental flow conduit should be suitable for fish passage.

### *Domestic Water Supply*

NNP1 is considering Option 2 for supplementary domestic water supply infrastructure (i.e. pumping from the Irrigation Reservoir during the dry season to supplement water supply from Houay Soup Ngai). The following is recommended to maintain and environmental flow in the stream, protecting aquatic habitat and species downstream of the domestic water supply intake:

- Construct and operate Option 2 to allow for an environmental flow release. Baseflow (~6 L / s) should bypass the intake to provide adequate water for fish in this perennial stream; and
- Consider constructing a larger holding tank for domestic water supply to provide adequate flow for domestic water supply during the rainy season, allowing for continuous discharge of 6 L / s throughout the year.

### **Assessment of Impact**

Preliminary flood modelling indicates that some infrastructure may reside within the flood zone for the 1:100 - 1:1000 ARI peak storm event. Some of the HSRA infrastructure may be flooded following large storm events. Only a fraction of the settlement area may occur within the flood zone. Therefore Phase 1 of relocation (Ban Hatsaykham) may commence without risk to settlement infrastructure. Further flood modelling will allow for either (a) construction of the remainder of the residential area if modelling indicates no flood risk, or (b) realignment of the remainder of the residential area and road network to avoid flood zones (likely into higher ground in the RDS annex).

With implementation of management measures, specifically (a) environmental flow regimes for the Houay Soup Ngai and Houay Soup Noy; (b) development of Option 2 for domestic water supply (pumping from the Irrigation Reservoir; and (c) provision of upstream / downstream migration conduits passed Project infrastructure, the habitat and ongoing existence of aquatic biology in the streams will not be significantly impacted by altered hydrology.

## **7.1.3 Water Quality**

### **Issues and Findings**

With the implementation of water treatment facilities, and isolation of domestic water facilities and catchments from livestock, water quality for HSRA residents should improve considerably.

There is potential for construction / post-construction impacts to downstream surface water quality and groundwater, including erosion and sediment transport (assessed independently in Section 7.1.4), hazardous and non-hazardous wastes, nutrients, and pathogens.

### **Construction**

Impacts to surface water from HSRA construction will likely be similar to that anticipated for NN1HP Construction during construction, potentially including:

- **Hazardous materials / waste:** Diesel fuel (and other hazardous materials and waste) for vehicles and equipment will be transported and stored / handled on-site providing potential for spillage and subsequent impacts to surface and groundwater;
- **Non-hazardous waste:** General refuse will be generated during construction (e.g. food packaging, plastic water bottles, construction packaging) and excess construction materials may pollute surface water during storm events (refer to Section 7.1.6); and
- **Nutrients and Pathogens:** A small workforce accommodation will be constructed in the HSRA (refer to HSRA Preliminary Construction IEE). Waste water from the accommodation / construction facilities will comprise a potential source of nutrients and pathogens that may be released into receiving waters via grey-water or septic systems.

Temporary toilet facilities may be required in construction areas as well, providing an additional potential source of nutrients and pathogens.

### **Post-Construction**

- **Hydrocarbons:** The irrigation pumps for the southern paddy fields will require diesel fuel storage and handling providing potential for spillage and subsequent impacts to surface and groundwater;
- **Non-hazardous waste:** General refuse (rubbish) derived from up to 750 households inhabiting the HSRA (e.g. food / resource packaging) may pollute surface waters if improperly disposed of or improperly handled following collection. Waste disposed of at the landfill poses a potential threat to groundwater quality;
- **Arsenic:** Two data points indicated the presence of arsenic in HSRA groundwater and 0.046 mg / L of arsenic was detected in a single July 2015 sample from Houay Soup (NNP1 water quality sampling team and associated laboratory). It is considered likely that this reading resulted from laboratory error. However, because dry season surface water in Houay Soup Ngai is spring fed (and groundwater contamination with arsenic a remote possibility), the possible existence of arsenic in HSRA streams should be investigated further;
- **Pathogens:** The HSRA may accommodate up to 750 households (4,500 individuals if 6 people per household is assumed). Waste water (grey water or septic system discharge) will comprise a potential source of pathogens to receiving surface or groundwater.

Solid waste landfills may provide an additional source of pathogens to surface or groundwater if they are not effectively isolated.

Baseline total and faecal coliform levels are elevated above Project drinking water guidelines in the Houay Soup, including the Houay Soup Ngai above the Project intake for drinking water. Added populations of domestic livestock in the HSRA may contribute to increasingly higher concentrations of pathogens;

- **Nutrients:** Nutrient input to the Houay Soup Noi, Houay Soup Ngai, Houay Soup and downstream receiving waters (Nam Ngiep River) may increase significantly as a result of Project operations. The most significant nutrient inputs would likely be derived from over-fertilisation of agricultural plots, livestock in the HSRA, and from aquaculture in the Houay Soup Noi Irrigation Reservoir.

Additional nutrient input may occur from septic facilities that are not suitably designed and / or maintained, from grey water discharge from kitchen facilities, and from solid waste disposal areas if not effectively isolated.

Nutrient input to Houay Soup and downstream receiving waters may increase as a result of food application to the reservoir to increase productivity of the aquaculture that will be undertaken in the Project irrigation pond. Studies have found that less than 30% of the nitrogen and phosphorous added in feed is recovered with fish harvest (SRAC 1999). Monitoring of effluent from catfish farming in the south-eastern United States found water quality was poorest (highest concentrations of solids, organic matter, total phosphorous, and total nitrogen) in the warm season when fish feeding rates and water temperatures are highest (SRAC 1999).

Nutrient concentrations in the Houay Soup Noi, Houay Soup Ngai, and small first order ephemeral tributaries of the Nam Ngiep River may increase as a result of livestock rearing adjacent to these streams; and

- **Dissolved Oxygen:** As the Irrigation Reservoir will be supplied with water from the Nam Ngiep HPP Re-regulation Dam, the dissolved oxygen (DO) concentration may be low (as a result of oxygen consumption during the breakdown process of organic matter in the Project's Main Reservoir), particularly during the initial years following impoundment.

The predicted range of DO in the main reservoir outflow discharge varies from 3.5 mg / L to 7.9 mg / L through the year (ERM 2014). Due to oxygenation and dilution in the Re-regulation Dam reservoir, the DO concentration is expected to increase as the water flows downstream to the Re-regulation Dam. DO concentration of discharge water from the re-regulating dam is expected to be greater than 6 mg/L for most of the year.

## ***Management and Mitigation***

### ***Construction***

Management and mitigation measures to minimise impacts to downstream surface water and down-hydraulic gradient groundwater from significant impacts during construction include the following:

- Provide drinking water of suitable quality to HSRA residents and construction workers and contractors working in the HSRA (according to applicable Project water quality standards);
- Implement erosion and sediment control measures (as per Section 7.1.4);
- Identify the volume of spoil and location of spoil disposal sites prior to construction commencing, and account for site capacity, surface drainage, stabilisation, and erosion and sediment control requirements;
- Place and secure construction materials and chemicals above flood levels during rainy season;
- Effectively isolate the solid waste disposal facilities, septic systems, and grey water discharge from surface and groundwater by ensuring design of facilities suitable for the anticipated population of the HSRA and estimate solid waste / grey water / black water generation;
- Implement hazardous and non-hazardous management measures (refer to Section 7.1.6). Ensure all hazardous and non-hazardous waste facilities have primary containment (bundling, are covered to prohibit rain infiltration) and secondary containment. Provide hazardous materials spill kits (e.g. Sorbex) in readily accessible locations). Train staff (and ensure contractors are adequately trained) in hazardous and non-hazardous storage, handling, and emergency and preparedness planning;
- Service vehicles in the NN1HP laydown areas to the extent feasible. Minimise potential for effluent in the HSRA;
- Implement an auditing and reporting system to ensure that management and mitigation measures are effectively implemented (i.e. water quality monitoring, construction monitoring);
- Develop adaptive management strategies, where required, if management and mitigation measures are proven inadequate in protecting surface and groundwater quality;
- Monitor water quality during construction (upstream / downstream) to ensure ambient water quality and effluent discharge standards are maintained (refer to Section 8.3); and
- Ensure the SS-ESMMP for the HSRA provides detailed specifications for greywater treatment and sewage containment (and treatment / removal). Treatment and disposal should ensure effluent meets Project discharge guidelines and receiving waters meet ambient water quality guidelines for nutrients and pathogens. Septic systems shall be designed to account for or prohibit overflow.

The Project ESMMP-CP provides further detail regarding the measures above (e.g. SP01: Erosion and Sediment Control, SP02: Water Availability and Pollution Control; SP05: Waste Management, SP06: Hazardous Material Management, SP10: Spoil Disposal; and SP15 Training and Awareness. ESMMP-CP sub-plans (Appendix H) should be reviewed for incorporation into SS-ESSMPs, where applicable. These sub-plans are provided in Appendix H.

Contractors will be contractually obligated to the management, mitigation, monitoring and reporting requirements of the SS-ESMMP.



## **Post-Construction**

### *Hydrocarbons*

All hydrocarbons (fuels and lubricants, etc.) for irrigation pumps and additional requirements will be stored in fully bunded areas. Bunded areas will be covered to prohibit rain infiltration. Bunds will have sufficient capacity to contain at least 120% of the tanks' maximum capacity.

### *Nutrients and Pathogens*

- Effectively isolate the solid waste disposal facilities, septic systems, and grey water discharge from surface and groundwater by ensuring design of facilities and treatment measures are suitable for the anticipated population of the HSRA and estimate solid waste / grey water / black water generation. Septic system design and treatment methodology will have to prohibit the chance for overflow;
- Use high quality feeds and efficient feeding practices for aquaculture in the irrigation pond;
- Ensure adequate aeration and circulation of irrigation water to maintaining high DO, enhancing the appetite of fish encouraging feed conversion; and
- Consider diverting the Houay Soup Noi around the irrigation pond (relying on Re-regulation Reservoir water entirely for the Irrigation Reservoir / aquaculture facility). This would allow discharge of water from the reservoir that may have high concentrations of nitrogen and phosphorous for paddy field irrigation, enhancing fertilisation of paddy fields while avoiding discharge of nutrients to the Houay Soup Noi. This option would simultaneously benefit the environmental flow regime (refer to Section 7.1.2).

### *Drinking water infrastructure*

The implementation of roughing filters for pre-treatment of water for domestic supply will require development of a maintenance program that should be implemented by NNP1 while the HSRA villagers and the Company collaborate on the resettlement area maintenance program.

Organic matter build-up in the media will require periodic replacement or treatment of the media to ensure its ongoing effectiveness in removing suspended solids and associated parameters of interest.

- To protect water quality (pathogens) in the Irrigation Reservoir / water supply ponds, livestock will be prohibited by fencing (final design yet to be completed). NNP1 will install fences, which will be maintained by the community; and
- According to The NNP1 REDP, livestock will be prohibited from entering the watershed areas for water supply ponds as well (with Project installed fencing). This will require erection of a long fence and considerable maintenance. Detailed design has not yet been provided.

The domestic water supply should be regularly monitored for comparison with Project drinking water and ambient water quality guidelines (refer to Section 8.3).

## **Assessment of Impact**

The quality of domestic water supply is expected to be improved, both in comparison to pre-resettlement domestic water supply and in comparison to current HSRA stream water due to water treatment and isolation of water supply facilities from livestock. The domestic water supply treatment plant will require ongoing maintenance to remain effective.

Nutrients and pathogens in downstream receiving waters are expected to increase post-construction. Management of the Irrigation Pond effluent and application of appropriate volumes of fertilisers (and correct timing of application) should minimise impacts to less than significant for receiving waters.

Design, construction, and maintenance of key HSRA facilities, including septic systems, landfills, temporary waste holding facilities, etc. is expected to reduce post-construction water quality impacts to less than

significant. Erosion and sediment transport is expected to be the most significant water quality impact during construction (refer to below).

#### **7.1.4 Erosion and Sediment Transport**

The Acrisol soil groups that dominate the Project Development Site are highly dispersible, and will be prone to erosion and sediment transport during the rainy season. Erosion may lead to degradation of topsoil quality (soil character and fertility) and sediment transport impairs downstream surface water quality with associated impacts for aquatic species, aquatic habitat, and downstream water users.

The potential for erosion and sediment transport issue will be particularly significant during the first 1 – 2 rainy seasons during and following construction, prior to establishment of vegetation via natural regeneration and Project planting.

#### ***Issues and Findings***

##### ***Construction***

The majority of erosion and sediment transport will result from water erosion of disturbed areas during the rainy season. The primary impacts will include:

- Impaired surface water quality during construction due to suspended sediments generated from land clearing / earthworks, instream construction, sand / gravel extraction from borrow areas, and road construction / unsealed road surfaces; and
- Loss of topsoil and subsequent impacts to soil quality due to erosion of cleared landforms following site preparation for upland agricultural areas / plantation areas.

The design and construction of access road / road infrastructure will be particularly important in controlling sediment-laden runoff from the Project site. Roads intercept, concentrate and direct water on compacted surfaces to receiving waters.

Land clearance associated with site preparation will provide the following respective areas of disturbance that will be susceptible to erosion and sediment transport:

- Housing, roads, and community infrastructure (255 ha);
- Upland cultivation areas (427 ha);
- Plantation areas (191 ha); and
- Riparian areas adjacent domestic and irrigation water infrastructure (38 ha).

##### ***Post-Construction***

Following HSRA construction, it is anticipated that erosion sediment transport will be less extensive than during constructions as natural revegetation / planting of temporarily disturbed areas will stabilise topsoil.

However, annual or periodic clearing of vegetation in upland cropping areas and plantation areas will provide significant areas of disturbed areas prone to erosion and sediment transport. In addition, the ongoing existence of an unsealed road network will provide further area susceptible to erosion and pathways for sediment transport to watercourses.

#### ***Management and Mitigation***

##### ***Construction***

Application of suitable stormwater management measures and erosion / sediment control will be required during construction to avoid and minimise erosion and sediment transport. The following measures will be implemented:

- Where feasible, major earthworks and grading operations will be scheduled for early in the dry season;
- Surface water management infrastructure (e.g. cut-off / diversion drains, velocity dissipation devices, culverts) will be installed in appropriate locations to minimise and control surface water flow over disturbed areas and water will be diverted to appropriately size sediment basins for settling of suspended sediment prior to water discharge. All designed drainage works will be surveyed, pegged, and approved by NNP1 Site Manager prior to implementation. Site drainage will be implemented prior to vegetation clearance / earthworks;
- Major control measures such as sediment basins will be installed prior to vegetation clearance / earthworks. Major control measures will be surveyed and pegged. The contractor will require approval from the NNP1 Site Manager prior to constructing each measure;
- Appropriate sediment controls will be implemented (e.g. sediment traps and basins, silt fences, riprap, etc.) depending on the size of the disturbed area and the upslope catchment area. Discharged water from excavation / earthworks areas will not be allowed to discharge directly to natural water bodies. Sediment basins will be designed, installed and maintained to efficiently remove suspended solids from water and will be routinely inspected by the contractor and NNP1 EMO.
- Vegetation on steep slopes and riparian corridors will be preserved where possible. A minimum of 25 m of riparian vegetation will be left intact on each side of perennial streams and 10 m on each side of ephemeral streams, with the exception of in-stream works areas (e.g. water intakes and Irrigation Reservoir). A vegetative buffer of 25 m width will be left intact on the border of the Nam Ngiep River (e.g. between rice paddy and river);
- Vegetation clearing will be restricted to the minimum area possible and vegetation will be preserved in areas where construction will occur at a later date. Areas scheduled for vegetation clearance will be clearly demarcated and personnel will be informed of the maximum extent of clearance and the requirement to prohibit heavy equipment from straying beyond demarcated zones;
- Erodible construction material will be stockpiled on relatively flat areas, at least 20m from drainage lines and steep slopes, and in locations approved by the NNP1 Site Manager;
- Disturbed land areas will be progressively rehabilitated where feasible, with priority rehabilitation and revegetation undertaken in high risk areas such as steep slopes and sites close to rivers and creeks; and
- As earthworks are expected to extend into the wet season, sediment control dams, drainage structures, and additional erosion and sediment control facilities should be completed prior to the onset of the wet season.

The following management and mitigation measures should be implemented to minimise erosion and suspended sediment input to receiving waters from road infrastructure:

- Roads will be constructed during the dry season to the extent possible. Erosion and sediment control facilities for unsealed roads will be completed before the onset of the wet season;
- The road design will include a drainage system to channel water from the road surfaces to outlets with erosion and sediment control facilities, including rip-rap at inlets and outlets of culverts and channels and sediment control basins constructed for larger catchment areas;
- Roads will be constructed with cross-fall slopes of (maximum 3%) to promote rapid drainage from unsealed road surfaces to avoid scouring. Where cross-fall is insufficient, water bars will be constructed to direct water to road discharge channels that will be outfitted with velocity dissipaters and sediment control (e.g. rip-rap, sumps and/or silt fencing);
- Drainage from upslope of road surfaces will be diverted via roadside drainage channels to culverts with velocity dissipaters and sediment control at outlets;

- Culverts will be installed at drainage crossings, perpendicular to the road alignment and implemented with appropriate slopes to facilitate water and sediment movement with deposition and consequent culvert blockages;
- Permanent structures should be designed using an average peak storm recurrence interval of 50 years, and temporary structures should be designed using an average recurrence interval of two years (24 hour storm events);
- Batter slope angles will be minimised to the extent feasible;
- Soil will not be side-cast (pushed) over the crest of the low side of the road. Excess soil will be transported to the topsoil stockpile or temporary stockpiles, with stockpile locations identified prior to the onset of construction; and
- Where feasible, vegetation will be left intact on road verges and roadside batters to reduce surface flow velocity and erosive potential.

Erosion and sediment control facilities will require routine inspection and maintenance, as well as adaptive management if facilities are deemed inadequate or ineffective during monitoring.

Refer to Appendix H for a comprehensive list erosion and sediment control requirements for the Project as well as monitoring requirements (methods, location, and frequency) that should be considered for incorporation into the SS-ESMMP for HSRA Construction.

### **Post-Construction**

Management and mitigation post-construction should focus on completion and maintenance of erosion and sediment control facilities implemented or initiated during construction. The following maintenance activities should be prioritised:

- Monitoring of road-side drainage channels and additional water conveyance facilities (e.g. irrigation ditches) for erosion. Eroding channels should have additional measures implemented (i.e. velocity dissipation, rock armouring, or similar);
- Monitoring of unsealed road network, and corrective actions as applies (i.e. additional water bars on steep slopes, facilities to move water from road surfaces where erosion is evident, etc.); and
- Conduct ongoing monitoring of road network, stormwater conveyance channels, erosion and sediment control devices, and additional areas prone to erosion to identify maintenance requirements and determine where more robust facilities should be implemented.

Annual and periodic clearing of vegetation for agricultural plots / plantations will provide disturbed areas prone to erosion. This will require ongoing stormwater management, erosion and sediment control similar to construction phase management. The following are specific to agricultural areas / plantations operations:

- Consider planting rows to parallel to topographic contours, which minimises erosion and allows rows to act as surface water filters (sediment control);
- Restrict vegetation clearance / timber harvest to the dry season and ensure that erosion and sediment control facilities have been implemented prior to the onset of the rainy season;
- Maintain vegetated buffer strips at the downslope side of agricultural plots, and enforce 5 m riparian buffer zones either side of ephemeral and seasonal streams;
- Consider agroforestry models for plantation with wide spacing between rows (e.g. 10 m) to provide adequate space and light for intercropping (and thus establishing plants throughout clearance area); and
- Implement erosion and sediment control provided in the ESMMP-CP SP01 and those listed above for construction (e.g. vegetative buffers along stream channels, diversion of water around disturbance areas, etc.).



## **Assessment of Impacts**

Vegetation clearance and land disturbing activity during construction and site preparation for agricultural plots will promote erosion and contribute suspended sediment to the HSRA streams and Nam Ngiep River. Impacts will be below domestic water intakes / irrigation water supply infrastructure, thus impacts to HSRA villagers should be limited to the need for maintenance of unsealed roads and additional cleared areas.

Diligent application of management and mitigation measures identified above will minimise the impacts of sediment loading in receiving waters to moderate.

### **7.1.5 Soil Quality**

According to ISRIC World Soil Information database (2015), agricultural productivity on Acrisol soil types is limited by acidity (and corresponding aluminium toxicity and phosphorous sorption), and often poor fertility. Assessment of soil samples from 16 sampling sites in the HSRA (2011 and 2015) confirmed that the physio-chemical makeup of the soils in the HSRA will not be very productive without implementation of a soil improvement program. HSRA soils were uniformly (across all sampling sites) acidic (e.g. pH 4.0 – 4.7); low in plant available nutrients (particularly phosphorous, potassium, magnesium, and calcium); with moderately low cation exchange capacity (CEC) and organic matter. Some areas exhibit signs of poor drainage and aeration, though soil texture is generally conducive to crop production with soil improvement.

Project construction and operations will not impair soil fertility and the capacity of the soil to produce crops (outside of permanent infrastructure areas). Rather, HSRA implementation provides an opportunity to enhance soil fertility to facilitate greater crop / plantation yields during operations. The assessment below therefore considers potential negative impacts during construction and site preparation during operations but focuses on potential soil improvement techniques that will promote more viable agricultural production / livestock grazing areas.

## **Issues and Findings**

### **Construction**

Site preparation may impact soil physical properties in the following respects:

- Implementation of housing, community infrastructure, road networks, etc. will compact soil surfaces. However, by minimising vehicular access to the permanent infrastructure areas to the extent possible, compaction will be primarily limited to areas not intended for future plant growth; and
- Construction of lowland paddy fields and upland agriculture areas will provide opportunity for physio-chemical enhancement of soil properties in the HSRA.

### **Post-Construction**

- Annual and periodic site preparation for agricultural plots and plantations will provide opportunity for soil enhancement throughout inhabitation of the HSRA, as per livelihood restoration requirements of the REDP.

## **Management and Mitigation**

A pilot demonstration farm and soil improvement program has been established within the HSRA since 2014, and experiments have indicated that harvests can be improved through a soil improvement program. The soil improvement program was specifically developed to be implemented in rice paddy field areas prior to resettlement, and included some of the recommendations provided below.

### **Construction**

- Excessive soil compaction will be ameliorated by surveying, delineating, and marking construction area boundaries and limiting vehicular access to within construction area boundaries. Temporary

access roads and additional temporarily disturbed areas will be ripped to reduce soil compaction and revegetated with native plant species. Topsoils will be protected from erosion and sedimentation according to Section 7.1.4 of this report.

The following should be considered during HSRA construction:

- Demarcating the area identified for the irrigated paddy fields in consultation with current land users as all well as PAPs from the five resettlement communities;
- Levelling of the land to form fields that can be easily irrigated. Careful topsoil management will be required during this process to ensure topsoils are not lost and the upper fertile soil layers are maintained;
- Application of dolomitic limestone to raise pH levels in paddy field topsoil to target levels (refer to Table 7-2), minimising aluminium toxicity (< pH 4.5) and providing substrate more amenable to nutrient uptake. Dolomite is recommended as it provides magnesium and calcium fertilisation along with raising pH (as opposed to calcium carbonate which will not provide  $Mg^{2+}$ ). Annual or bi-annual soil sampling and laboratory test work should be undertaken to determine the frequency of dolomite application requirements;
- Planting of a nitrogen fixing crops (e.g. legumes) during construction will increase plant available nitrogen with minimal cost, effort, and readily accessible inputs (NNP1 2014b);
- Trialling of different crop rotation methods, including a double crop cycle whereby an initial nitrogen fixing crop is planted and subsequently ploughed back into the soil, and then a second crop is planted and left standing until first rice planting for the wet season;
- Fencing of the areas via a standard agricultural electric wire fence to prevent livestock from feeding on the crops. When the crop has reached an optimum level of nitrogen fixation, cattle may be allowed to graze depending on the crop selected, to actively attract livestock to forage and additionally fertilise the land; and
- Nutrient analysis of paddy field soils prior to planting the first rotation to determine inorganic fertiliser requirements (likely NPK, with micro-nutrients as required).

### Post-Construction

Soil improvement will be required (as per the REDP) to ensure adequate and sustainable upland agriculture / plantation yields as well has paddy fields (as above). The chemical properties of the soil should be considered during crop selection. Crops / trees more tolerant of acidity will reduce the required application rates of dolomite / lime, and potentially fertilisation rates. For example, rice, rubber trees, and certain fruiting trees / plants (e.g. pineapple, cashew, and palm) may be productive in more acidic soils, however the desired crops of villagers is expected to largely dictate crop selection.

NAFRI (2011) identified target values for key chemical properties paddy rice, upland farming, and fruit tree plantations (refer to Table 7-2).

**Table 7-2 Target value of soil improvement**

Item	Paddy field	Upland Agriculture	Fruit farm
pH (H <sub>2</sub> O)	5.5-6.0	6.0-6.5	5.5-6.0
pH (KCl)	5.0-5.5	5.5-6.0	5.0-5.5
Effective phosphoric acid (mg/100 g)	More than 10	More than 20	More than 20
CaO (mg/100 g)	More than 200	200-300	100-200
MgO (mg/100 g)	More than 25	20-40	25

Item	Paddy field	Upland Agriculture	Fruit farm
K <sub>2</sub> O (mg/100 g)	More than 15	15-30	15-25
CEC (me / 100 g)	More than 20	More than 20	More than 20
CaO / MgO	Less than 6	Less than 6	Less than 6
MgO / K <sub>2</sub> O	More than 2	More than 2	More than 2
Base saturation (%)	60-80	80	40-60

Source: NNP1 2014

The following should be considered to enhance soil productivity in lowland and upland agricultural areas and plantation areas (though management will differ in some respects per activity):

- Dolomite application to raise pH to target levels (as above) and annual or periodic soil sampling and laboratory test work undertaken to determine the application rate frequency of dolomite application requirements for paddy / upland agriculture / plantations, respectively;
- Annual or periodic analysis of soil fertility will be required (pending duration of crop cycling) to determine effective inorganic fertiliser application rates / frequency of application. Broad-scale applications of manure and other types of organic fertilisers should be avoided to prevent potential surface water pollution in the nearby Nam Ngiep River and its tributaries;
- Incorporation of further soil improvement techniques should be considered for the soil improvement program, including the application of either:
  - » Biochar produced from agricultural and food wastes as well as thinned wood after charring. Soil mixed with biochar becomes soft, porous, permeable and then suitable for plants to grow well. Moreover, it improves biological activity (i.e. microbes) due to its porous medium, which then supply plant nutrients such as nitrogen, potassium, phosphorus. The Project is exploring the option of biochar development with a research institute based in Chiang Mai, Thailand (NNP1 2014b); and / or
  - » Effective microorganisms (EM), which are predominantly anaerobic organisms such as lactic acid and fermenting bacteria. Research at the Houay Soup pilot farm has shown environmental destruction caused by symptomatic treatment, e.g. agrichemicals for plants damaged by blight, insects, and antibiotics for farm animals, in which microbes so called 'good bacteria' participate and decay organic matter. When EM is applied into the above conditions, various anti-oxidation materials and nutrients are produced, moreover it will stop organic matter from decaying, which creates suitable conditions for plants and animals (NNP12014b).
- Villagers will be informed of appropriate application rates for nutrients / dolomite through the NNP1 Livelihoods Support Program training. This training should be conducted annually for the initial years following agricultural plot establishment, as soil fertility will change over time and it is expected that ongoing monitoring of crop yield vs. nutrient application rates will refine the soil improvement program.

### Assessment of Impacts

The soil improvement programs is expected to enhance crop yields / plantation growth to levels currently not achievable in the HSRA. A robust program should provide yields that are greater than proposed resettled villagers currently achieve and may preclude the need for swidden agriculture in the area.

Nutrient loading in receiving waters should be avoided with diligent application of fertilisers during appropriate seasons and avoiding excessive fertiliser application via annual soil analysis for maximum soil enhancement requirements.

## 7.1.6 Hazardous and Non-hazardous Waste

### *Issues and Findings*

The following assessment of potential impacts from hazardous and non-hazardous waste considers construction and operations collectively, as the potential impacts are expected to be similar throughout. Management regimes consider construction and operations separately, as temporary vs. long-term management regimes will be implemented, respectively.

#### *Non-hazardous waste*

General waste materials generated from HSRA construction and operations, workforce accommodation, and administrative facilities may physically impact the environment (with potential biological / social implications), including contamination of receiving surface and groundwater and soil substrate for improperly stored or untreated wastes (refer to Section 7.1.3); increased populations of wildlife due to food wastes, including rates and other potential vectors for disease; and impaired visual amenity.

Soil amendments may impact the receiving environment if not properly stored, handled, or applied.

Detailed design for long-term (post-construction) waste facilities have not yet been completed. Non-hazardous waste disposal (landfill) and temporary waste storage and separation facilities near the market (separation of recycling, waste for landfill, and storage areas) are expected to minimise the risk for potential impacts from non-hazardous waste.

#### *Hazardous Waste*

Hydrocarbons and hydrocarbon waste may contaminate soils, groundwater, or surface water if improperly stored or handled. Hydrocarbons will be required during construction for vehicles / equipment and to run irrigation pumps and the water treatment plant during operations.

While pesticides / herbicides applications are not considered for HSRA construction, there is potential that either may be utilised by residents of the HSRA during agricultural site preparation and / or following an outbreak of a pest that threatens crops / plantations. Pesticides / herbicides vary considerably with respect to potential environmental and health risks.

The following hazardous substances may be used in construction activities:

- Paint and solvents;
- Petroleum products such as oils, fuels, and grease;
- Herbicides, Pesticides;
- Acids for cleaning masonry;
- Concrete curing and repair compounds;
- Contaminate waste materials;
- Concrete admixture;
- Flocculants;
- Adhesive;
- Release agent;
- Medical waste; and
- Effluent from work camps.



## ***Management and Mitigation***

NNP1 shall design facilities to ensure residents of the HSRA are able to properly store, handle and dispose of hazardous and non-hazardous wastes. NNP1 will train applicable HSRA residents in hazardous and non-hazardous waste containment, clean-up, disposal, and emergency preparedness and response. NNP1 will regularly audit contractors to ensure that contractor SS-ESMMP requirements for hazardous and non-hazardous waste are met during construction.

## ***Construction***

Waste management during construction will require several facilities (e.g. storage and separation area for recyclables, residue waste landfill for non-recyclables and non-hazardous materials, and / or a method of waste removal for disposal at primary NNP1 HPP landfill facilities. The management measures listed below and applicable measures from SP05 and SP06 (Appendix H) will be incorporated into SS-ESMMPs for HSRA construction.

### ***Non-Hazardous Waste***

Waste management should be based on the following hierarchy (in decreasing order of preference):

1. Minimise the production of waste.
2. Maximise waste recycling and reuse.
3. Treatment of waste.
4. Ensure safe waste disposal.

The first priority for the management of non-hazardous wastes generated by the Project will be to reduce the volume of waste generated, which will be achieved by:

- Procuring supplies that produce less waste by virtue of the way they are produced, packaged or consumed;
- Procuring supplies that have been produced from recycled materials, if possible; and
- Maximising the efficiency of all on site production processes.

To maximise recycling and reuse, waste should be segregated accordingly at the location where they are generated:

- Biodegradable materials – vegetation and food scraps;
- Recyclable materials – processed timber; hard plastic; glass; metal; paper and cardboard; and tyres. Waste will be further segregated within this category, depending on the requirements of recycling contractors; and
- Non-hazardous residue waste.

Any non-hazardous residue waste that cannot be reused or recycled will be deposited in clearly marked, general litter bins located around the Project site. The Company will implement an education campaign for staff and contractors to minimise the generation of litter associated with Project activities. The following management measures will be incorporated into SS-ESMMPs for HSRA construction:

- Appropriate facilities and procedures for collecting, separating, storing and disposing of wastes will be provided prior to the commencement of site preparation and waste generation. Waste facilities will be inspected in advance of construction by the nominated Owner Environment Officer to ensure they are in accordance with Project requirements;
- Dedicated waste bins will be provided around the Project site in different colours according to waste/recycling type for separation and sorting of waste at source. Containers for hazardous waste and non-hazardous waste will be clearly marked to avoid confusion. Bins will be clearly visible, impervious to rain, and regularly checked to ensure waste removal is frequent enough. Regular

collection and disposal of wastes (by approved waste contractors) will be carried out to avoid overflowing of waste containers and storage facilities;

- Bins containing food waste will be secured with lids to prevent scavenging by birds and animals;
- The dumping of wastes into the natural environment will be strictly prohibited;
- NNP1 will ban burning of waste during construction;
- NNP1 will ensure designated waste disposal areas are regularly covered by soil to reduce potential for pollution and animal encroachment; and
- The landfill will be utilised for non-hazardous waste only.

#### *Hazardous Waste*

Project requirements for management, mitigation, monitoring and reporting (refer to Appendix H) will be implemented by NNP1 and its contractors, including:

- All chemicals and waste considered potentially hazardous materials will be registered (type, quantities stored, quantities used or generated, quantities moved from storage and to waste disposal) and the information logged in a register;
- Containers of hazardous materials or waste must be labelled accordingly, with date of storage / waste accumulation; the name of the material and its physical state (solid or liquid); the hazard characteristics of the waste (ignitable, corrosive, toxic, reactive); main danger for user (poison, burning, dangerous for eyes, skin, lungs, etc.), with MSDS posted on-site;
- Safety procedures applicable to the handling and use of hazardous materials will be established and become a part of the training program. Safety rules will be translated in Lao languages and printed on posters to be posted on the walls of the dedicated buildings where hazardous materials are to be used. Personal protective equipment (PPE) will be provided to concerned workers and the use of such equipment will be enforced;
- All refuelling of heavy equipment and machinery will be undertaken by a service vehicle, with appropriate safeguards and protection measures to prevent any spillage or contamination by chemical wastes or maintenance oils, lubricants etc. Safety procedures regarding fire and accidental spill management will be posted;
- Pesticides for vector control (mosquitoes) and for vegetation control will be utilized in accordance with: authorized pesticides, in accordance with the list approved by EMO (and Lao PDR decree); labelling and storage of pesticides will satisfy measures listed above; the translation of all information related to toxicity of pesticides, including user instructions, to commonly used Lao language(s); safe handling of pesticides will rely on training users; specific training programs and supporting communication materials will be supplied for this purpose;
- All the fuel and hazardous material storage will be adequately banded to prevent any spillage problem (refer to below). Maintenance shops, fuel and oil depot will be provided with impermeable flooring or sheets with sump where wash water and sludge can be collected for proper disposal;
- Only minimal chemicals, hazardous substances and fuel will be stored on site works, within an enclosed and covered secure area that has an impervious floor and impervious bund around it (with capacity at least 120% of the total capacity of the tanks). The storage area will be located away from watercourses, flood prone areas, offices and barracks/accommodation. Equipment maintenance areas and fuel storage areas shall be provided with drainage leading to an oil-water separator that will be regularly maintained to ensure efficiency;
- Oil stained refuse such as oily rags, spent oil filters and used oil shall be collected and disposed of through recyclers/authorized waste handlers and disposal in authorized waste facilities;

- Waste oil, used lubricant and other hazardous wastes will be stored in tightly sealed containers. Transport and off-site disposal of such wastes shall comply with applicable laws and regulations;
- Spill clean-up materials (e.g. absorbent pads, etc.) specifically designed for petroleum products and other hazardous substances will be available where such materials are being stored and used. If spills or leaks do occur, clean-up operations will commence immediately. Spill response kits will be located at the workshop(s) where the servicing will take place and also at the refuelling point(s);
- All personnel involved with refuelling and with the servicing of equipment will be familiar with the use of the spill response kits and will be trained in the emergency procedures as described in the Emergency Response for Hazardous Materials Sub Plan (ESMMP-CP and SS-ESMMP);
- Discharge of oil contaminated water into the environment shall be prohibited; and
- Restoration of temporary work sites shall include removal and treatment or proper disposal of oil contaminated soils.

Appendix H provides comprehensive management, mitigation and monitoring requirements for the NN1HPP for hazardous waste (SP06) and general waste management (SP05). Applicable measures from these ESMMP-CP sub-plans should be incorporated into SS-ESMMP to ensure contractual obligation for implementation.

### **Post-Construction**

#### *Non-hazardous waste*

Short-term non-hazardous waste storage and handling areas will comprise:

- A sorting area to separate material to be recycled, biodegradable materials, and non-recyclable residue. Clearly marked bins will be provided at the market, school, community hall, and at strategically located locations near residential areas;
- NNP1 will facilitate the designation of a licensed waste recycling / removal company and will work with the HSRA to identify funding mechanism post-NNP1 involvement;
- The landfill will be utilised for non-hazardous waste only - The facility will:
  - » Have the capacity for at least 5 years of waste disposal in the prepared landfill and space for a development of additional pits for a second 5 years. The landfill area should be selected based on suitability for expansion indefinitely.
  - » The landfills will be designed to ensure waste does not leach to groundwater, including consideration of groundwater elevations, lining of pits that will not allow seepage, and additional information.
  - » Will be covered with soil on a weekly basis to prevent scavenging and wind-blown rubbish.
- Rubbish bins will be clearly visible, impervious to rain, and regularly checked to ensure waste removal is frequent enough; and
- HSRA resident training will include waste management (recycling, rubbish bins, etc.), and implications of improper waste management (pests, disease, impacted water quality, etc.).

#### *Hazardous waste*

- Septic and greywater facilities must be designed to contain the anticipated volumes of wastewater produced in households, kitchen, and additional facilities and must include provision for managing potential septic tank overflows. Septic systems should either treat wastewater in-situ or should be open systems for periodic wastewater removal by a licensed operator;
- A designated facility should be designed for hydrocarbon storage in the HSRA, with minimum design criteria as per Construction phase, above (bundling, rain cover, concrete flooring);

- The hydrocarbon storage facility should be equipped with spill clean-up material (e.g. Sorbex or similar), with villagers' trained in spill prevention and clean-up;
- MSDS should be provided for all hazardous materials stored in the HSRA (in Lao and English), with storage, handling, and disposal of materials conducted as per MSDS or product labelling;
- Hazardous materials (including hydrocarbons) will not be disposed of in landfill facilities or receiving waters. A licensed service provider should be contracted to remove wastes from the site for transport to a designated facility;
- Fertilisers, dolomite, and other soil amendments should be stored in a designated facility, that is covered from rain, with flooring to prevent storage on soil surfaces;
- The soil amendment storage area should be located at least 50 m from any natural watercourses, with upstream sheet flow diverted around the facility;
- If pesticides / herbicides are utilised, only those certified for use in Lao PDR may be utilised. Pesticides / herbicides must be stored off the ground, in designated facilities covered from rain. The storage facility should be located at least 50 m from surface water; and
- HSRA residents will be trained in the proper storage, handling, and disposal of hazardous materials and hazardous wastes.

### ***Assessment of Impacts***

Construction phase impacts are expected to be limited to small volumes of construction excess and rubbish that are improperly disposed of. NNP1 will have to diligently audit contractors to ensure proper disposal of non-hazardous wastes. If storage facilities are properly designed and implemented, and the mitigation measures in SP06 and above applied, hazardous wastes should not provide significant impacts to the receiving environment during construction.

Post construction impacts will be largely depended on the suitability of storage and handling facilities, and the efficacy of training and awareness campaigns. It is anticipated that NNP1 will assist residents of the HSRA in protecting themselves and their environmental (refer to Appendix A).

## **7.2 Environmental Impacts and Mitigation Measures**

### **7.2.1 Terrestrial Biodiversity**

Impacts to terrestrial biodiversity will occur during construction and operations. However, high value biodiversity areas exist almost exclusively within the Nam Ngiep Nam Mang PFA portion of the HSRA. The primary physical disturbance to vegetative communities and habitat for terrestrial biodiversity, conducted within the Resettlement Development Site, will occur in heavily disturbed areas that have been recently subjected to slash and burn agriculture and livestock grazing.

Impacts within the PFA will be minimised by the prohibition of infrastructure development in the PFA and the sustainable management practices that will be prescribed for the area (refer to Appendix A).

Some indirect impacts to terrestrial biodiversity are unavoidable, as the fallow land in the RDS provides habitat for a number of terrestrial species. Additionally, resource extraction (TFP, NTFP, terrestrial species from hunting) will increase post-construction with the resettlement of up to 750 households to the HSRA.

### ***Issues and Findings***

#### ***Construction***

Construction phase impacts to terrestrial biodiversity will include:



- Permanent conversion of vegetated areas in the RDS to infrastructure (residential and agricultural), including 56 ha of disturbed Mixed Deciduous Forest, 112 ha of Upper Mixed Deciduous Forest / Bamboo mosaic, 7 ha of Bamboo Forest, 558 ha of Old Fallow, and 602 ha of Young Fallow (refer to Table 7-3);
- Impacts to terrestrial fauna are expected to be restricted to loss of marginal habitat; and
- Potential introduction or spread of invasive plant species during site preparations.

The majority of remnant patches of degraded UMD and UMDB forest in the RDS will be avoided during construction (refer to Figure 2-2). These 'islands' of natural forest will remain adjacent the paddy fields and housing development areas during construction. Future land use determination for these areas will be determined during PLUP. It is anticipated that they will be zoned for Conservation Forest, Utilisation Forest, or Spirit Forest.

Riparian forest along watercourses in the HSRA RDS will be protected with an exclusion zone (25 m on each side of perennial streams / 10 m on each side of ephemeral streams). Irrigation canals and water resource infrastructure will impact small areas of riparian vegetation, which will be revegetated following construction.

No HSRA infrastructure will be developed in the Nam Ngiep-Nam Mang National Protected Forest (PFA).

**Table 7-3 Permanent forest conversion area as a result of HSRA construction and operations<sup>a</sup>**

Land Use	Upper Mixed Deciduous Forest	Upper Mixed / Bamboo Mosaic	Bamboo Forest	Old Fallow	Young Fallow	Total
HSRA infrastructure (residential and water infrastructure)	-	6.65	-	104.46	172.52	<b>283.63</b>
Paddy fields	21.03	0.63	-	137.60	167.64	<b>326.90</b>
Upland agriculture	-	61.13	-	244.20	108.37	<b>413.70</b>
Plantations	-	31.97	2.52	45.28	97.22	<b>176.99</b>
Livestock grazing	35.27	11.93	4.43	26.35	55.77	<b>133.68</b>
<b>Total</b>	<b>56.30</b>	<b>112.31</b>	<b>6.95</b>	<b>557.89</b>	<b>601.55</b>	<b>1335.10</b>

Source: Earth Systems 2015

<sup>a</sup>Note – footprints of HSRA components do not equal actual size, only size vegetated areas impacted

### Post-Construction

Potential operations phase impacts to terrestrial biodiversity are expected to include:

- Conversion of 724 ha of primarily fallow / disturbed mixed deciduous forest resulting from upland agricultural activity, plantation establishment, and livestock grazing area implementation in the HSRA resettlement development area (refer to Table 7-3);
- Settlement adjacent the Nam Ngiep-Nam Mang National Protected Forest will lead to an increase in hunting and forest resource collection (i.e. TFP and NTFP) by villagers, potentially including threatened flora or fauna that are known to occur or may occur in the region; and
- Tree harvesting for firewood / construction material in the HSRA RDS may lead to losses of high value species, though this is considered unlikely to occur as the development area is primarily fallow.

## **Management and Mitigation**

### **Construction**

NNP1 will implement the following measures to minimise impacts to terrestrial biodiversity during construction:

- HSRA infrastructure, agricultural plots, and livestock areas will primarily be implemented on highly disturbed vegetation / habitat (primarily fallow);
- The area of vegetation clearance will be minimised during construction to that required for Project components (i.e. clearly delineating boundaries and ensuring personnel clear accordingly);
- The Project footprint will be surveyed by a qualified botanist during detailed design to identify threatened flora. Threatened plants / trees will be flagged, with GPS coordinates recorded. Plants / trees small enough for transplant will be relocated to a location at least 100 m from disturbance areas. Larger individuals will be avoided to the extent practicable;
- An inspection by a nominated NNP1 monitor will be conducted for each site prior to the commencement of vegetation clearance to ensure Project requirements for biodiversity management have been met. Official approval will be required by NNP1 before vegetation clearance works proceed;
- Road construction into the PFA will be prohibited;
- Hunting and NTFP gathering by NNP1 personnel and construction workers will be prohibited;
- The introduction and spread of invasive species will be minimised (refer to Section 7.2.2);
- Biodiversity management requirements for the Project will be included in the environmental training and awareness program for construction workers and contractors, including the ban on hunting/fishing/harvesting of NTFPs, vegetation clearance requirements, and the importance of protecting threatened species; and
- Vegetation clearance will be monitored by NNP1 to ensure it is conducted within approved areas and according to specifications identified in the SS-ESMMP.

It is recommended that NNP1 consider rehabilitating the remnant logging access roads in the PFA to limit potential future harvesting activities.

### **Post-Construction**

Terrestrial biodiversity will be sustainably managed through implementation of Total Protection Zones, Conservation Forests, and Utilisation Forests in the PFA and through sustainable management practices in the Resettlement Development Site (refer to INRMP, Appendix A).

NNP1 will conduct the following management and mitigation measures, post construction:

- NNP1 will educate villagers on priority threatened flora and fauna species in the region through an environmental awareness and training program. The program should include identification keys / photographs of threatened species and posters in the local language. The awareness program should focus on providing an understanding of the value of sustaining biodiversity in the region;
- Land use designations will be clearly defined following PLUP (during the training program), including sustainable resource collection practices for the PFA (including GOL statutory requirements for Conservation Forests and Total Protection Zones);
- NNP1 will rehabilitate and revegetate riparian buffer zones that were disturbed during construction of the HSRA infrastructure (e.g. river crossings, water intake conduits, environmental release conduits);

- Reforestation activities will be supported by NNP1 in collaboration with the Village Forest Group (VFG);
- NNP1 will monitor the implementation of management measures identified in Appendix A, and assess the effectiveness of the program. Where ineffective, adaptive management strategies will be implemented to successfully mitigate impacts; and
- NNP1 will conduct a comprehensive survey of Utilisation Forests to identify threatened species. Threatened species will not be harvested (refer to Appendix A).

### ***Assessment of Impacts***

Impacts to terrestrial biodiversity from construction of the HSRA will primarily be limited to removal of fallow vegetation and low to moderate level habitat for terrestrial fauna. Application of the management and mitigation measures prescribed above are expected to minimise construction phase impacts to less than significant.

The extent of post-construction impacts to terrestrial biodiversity will be contingent on the successful application of land zoning and prescription of management measures in the INRMP. High value biodiversity is in relatively difficult areas to access. By rehabilitating remnant logging roads in the PFA and implementing an awareness campaign, it is anticipated that impacts to threatened species and high value habitat will be minimised. The resettlement of up to 750 household in the HSRA will increase hunting and TFP / NTFP gathering in the PFA, which may impact species' populations / diversity over time.

## **7.2.2 Weeds and Pest Management**

### ***Issues and Findings***

Construction of the HSRA and resettlement of households is not expected to promote pests and diseases. However, vegetation clearance / earthworks will provide disturbed area for the spread of invasive plants, which already occur in the Resettlement Development Site. Plantations may be affected by various pests that damage common plantation species in Lao PDR.

Without careful management of invasive plants and animal / plant pests and diseases, the primary impacts to the HSRA, including the resettled villagers, may include:

- Spread of invasive vegetation into the PFA;
- Reduced yield and losses in crops and plantations;
- Losses in livestock, poultry and fish farm production;
- Cross-species transmission to local native fauna and flora; and
- Potential impacts on the livelihoods of local households;

### ***Invasive Plants / Weeds***

A number of non-native invasive plant species occur in the HSRA, primarily within the more highly disturbed areas of the Resettlement Development Site. These plants are pioneer species, able to establish and dominate disturbed areas that would otherwise be colonised by native pioneer species, typically providing lesser habitat value and often lesser nutrient value (as many pioneer species are nitrogen fixers). As these species are fairly widespread in the lower topography of the HSRA, they pose a threat of further establishment following vegetation clearance in the HSRA for construction and annual / periodic clearance for crop production as well as encroachment on more pristine habitat following timber harvest. The introduction of construction vehicles provides the potential for introduction of new weed species.

### ***Crop Pests***

A number of pests occur in Lao PDR that are widely known to damage crops and plantation trees potentially relevant to the HSRA. These include pests / pathogens that damage Teak, Acacia, Eucalyptus, and a number of fruiting trees including Mango and citrus trees.

Rodent pests such as rats and mice have been reported to pose a significant problem for crop production as agricultural pests (particularly for rice cultivation) by eating newly planted crops as well as pre- and post-harvest grains. This can result in significant economic and livelihood losses for cultivators if rodent populations are not adequately controlled (ACIAR 2015a; Earth Systems 2015b).

#### *Livestock Pests and Diseases*

Frequent outbreaks of disease and pests in buffalo, cattle, chickens, pigs and fish have been documented in the Bolikhamxay province and Bolikhan district, including instances of foot-and-mouth disease virus in ruminants and pigs, classical swine fever virus, and avian influenza virus in bird populations (including poultry) (ACIAR 2015b). These contagious diseases spread readily if not adequately managed, and pose a threat to farmers in the region as well as to the local biodiversity (via cross-species transmission). Outbreaks are generally found to be the result of the introduction of infected stock, the localised movement and trade of infected animals and plants, and possibly through the importation of contaminated products (ACIAR 2015c).

### **Management and Mitigation**

#### **Construction**

##### *Invasive Plants*

The following management measures are recommended to minimise the introduction or spread of invasive plants during construction:

- Topsoil and vegetation (for mulching) removed from an area during site-clearance activities will be reused only in that area and landscaping / re-vegetation will utilise locally native species;
- Cleaning area for tools, equipment, and vehicles that will be transported to the HSRA for construction will be designated and utilised. Cleaning areas should be located away from waterways, sensitive habitats, and should be near areas already infested with invasive plants; and
- Plantation species must be non-invasive. For example, utilise known sterile stock of otherwise potentially invasive tree species (e.g. eucalyptus clones currently used in Lao PDR).

#### **Post-Construction**

##### *Invasive Plants*

An invasive species management plan should be developed for agricultural plots in the HSRA. This may include ploughing or herbicide applications. Herbicide can be applied in an environmentally and socially responsible manner given selection of appropriate herbicides (e.g. those that do not impair aquatic biota or habitat), application at the appropriate time of year (generally with respect to rain), and strict adherence to product labels and MSDS (i.e. PPE and disposal of containers) as well as GOL legislation for banned chemicals.

##### *Pests and Diseases*

Pest and disease management within the HSRA will be achieved through the application of an *Integrated Pest and Disease Management Program* targeting village animal production and agricultural systems. The program will include surveillance, diagnosis, and preventative and control measures, which are further described in the INRMP (Appendix A). NNP1 will work with PAFO / DAFO, the Department of Livestock and Fisheries, and resettled villagers to implement the Program.



## **Assessment of Impacts**

### *Invasive Plants*

The introduction and spread of invasive plants can be effectively managed. Weed species that already occur in the HSRA will not be eradicated, but implementation of measures to avoid the introduction and spread of weeds and application of eradication measures in upland farming plots and plantations will minimise impacts for terrestrial habitat and limit potential losses to crop yields.

### *Pests and Diseases*

Avoidance and minimisation of pests and diseases will rely on the development and effective implementation of the *Integrated Pest and Disease Management Plan*, community awareness and education campaigns, and reporting systems. These issues will be the primary responsibility of the Village Forestry Group, in coordination with PAFO, DAFO, DLF and NNP1. If management measures are widely promoted, the potential for impacts to livelihoods will likely be reduced in comparison to pre-resettlement conditions.

## **7.2.3 Aquatic Habitat and Biology**

### **Issues and Findings**

Aquatic habitat, aquatic species, and fish migration in the HSRA will be moderately to highly impacted, with the severity of impacts relative to the stream location and the section of stream. Impacts to habitat and aquatic biology will occur throughout construction and operations, with the greatest potential for impacts during operations.

Impacts to fish populations, species diversity (potentially including a number of threatened species), and fish migration may be particularly significant (for the Houay Soup), if design / management regimes do not provide for environmental flow regimes (Section 7.1.2) and fish passage on Houay Soup Noi and Ngai. However, on a regional / global scale, impacts to fish population from HSRA development and inhabitation will be minor (i.e. primarily for the Houay Soup and its tributaries) and from increased fishing pressure in HSRA streams.

### **Construction**

Impoundment of the Houay Soup Noi for irrigation and domestic water supply intake from the Houay Soup Ngai may dry the lower reaches of these streams during the dry season (eliminating aquatic flora and fauna) and may block upstream migration for spawning fish during the rainy season. In addition, the irrigation canals for rice paddies will cross the Houay Soup channel. Final design of irrigation canals has not yet been completed with respect to their intersection with the Houay Soup and the effect on downstream flow.

Implementation of the Environmental Flow regime described in Section 7.1.2 would provide baseflow throughout the year with additional flow added to the system when water levels in the Irrigation Reservoir activate the spillway. Additional water will flow into the Houay Soup Noi and Houay Soup Ngai from tributaries downstream of the reservoir dam / domestic water supply intake during the rainy season.

### **Post Construction**

Impacts to aquatic biodiversity may be significant post-construction, as follows:

- Migratory fish may be unable to reach upper reaches of Houay Soup tributaries and ephemeral streams of the HSRA, potentially cutting off spawning grounds (pending final design);
- Decreased flow in the Houay Soup Noi and Houay Soup Ngai will impact habitat, likely providing water for lesser fish populations and possibly impacting the diversity of aquatic biota. Decreased flow may also impact aquatic vegetation, indirectly impacting aquatic organisms' breeding, hiding from prey, etc. These impacts will be significant without implementation of an environmental flow;

- Fishing / aquatic resource collection in each of the HSRA streams (primarily Houay Khinguak Ngai, Houay Soup Noi, Houay Soup Ngai and Houay Khinguak Noi) and wetlands (Nong Pa and Nong Da) is expected to increase, with corresponding impacts to aquatic species' populations and species composition;
- Water from the Nam Ngiep Re-regulation Reservoir will be used to fill the irrigation reservoir. Water from the Re-regulation Reservoir, released to Houay Soup Noi via environmental flow or via the spillway, may have low dissolved oxygen concentration, potentially impacting the health of aquatic organisms in the Houay Soup Noi; and
- Use of the Irrigation Reservoir for aquaculture will allow for fish escape into the wild. If non-native species are used, this may impact native fish populations and species composition.

### **Management and Mitigation**

#### **Construction**

The following are recommended to minimise impacts to HSRA aquatic habitat and aquatic biology during design / construction:

- Prohibit NNP1 personnel and contractors from fishing / aquatic resource collection in the HSRA;
- Provision of an environmental flow regime for the Houay Soup Noi and Houay Soup Ngai that allows at least baseflow conditions to bypass the Irrigation Dam / domestic water intake. This may be achieved by:
  - » Providing adequate water volume to the Irrigation Reservoir from the Re-regulation Reservoir throughout the year to allow baseflow during the dry season (while maintaining at least minimum operating level in the Irrigation Reservoir) to activate the Irrigation Dam spillway during the rainy season to provide greater flow for fish migration;
  - » Construction Option 2 for domestic water supply (refer to Section 2) to replace Houay Soup Ngai intake with water from the Houay Soup Noi Irrigation Reservoir; and
  - » Consider constructing a larger water holding tank for domestic water supply to allow intake only during the rainy season to provide for annual domestic water requirements.
- Design irrigation canals to allow natural Houay Soup Noi and Houay Soup Ngai flow to pass beneath the canals (e.g. piped across channels);
- Prohibit construction, diversion, etc. on Houay Khinguak Ngai, Houay Khinguak Noi, and ephemeral streams of the HSRA (to the extent practicable for ephemeral streams intersected by irrigation canals);
- Implement the aquaculture pond in the Irrigation Reservoir to provide fish for HSRA villagers. It is anticipated that this will offset some of the fishing pressure on HSRA streams; and
- Design aeration structures (rip-rap in channels / drop-offs, etc.) in the channel that conveys water from the Re-regulation Reservoir to the Irrigation Reservoir to increase dissolved oxygen concentrations.

#### **Post-Construction**

The following are recommended to minimise impacts during post construction:

- Support the GOL and the HSRA community through implementation of the INRMP;
- Ensure management measures identified for design / construction phase continue throughout operations;

- Train village members in sustainable aquaculture to ensure the pond maximises yield per resident, minimising the need for fishing HSRA streams; and
- Utilise fish species native to the Nam Ngiep River for stocking the aquaculture pond / Irrigation Reservoir. Stress the importance of raising only native fish to HSRA residents during training and convey the potential impacts of non-native fish escape.

### ***Assessment of Impacts***

The potential for impacts to aquatic habitat downstream of the Houay Soup Noi Irrigation Dam and the Houay Soup Ngai domestic water intake are significant. The implementation of a continuous environmental release (minimum of baseflow), and provision of a bypass conduit for migratory fish should minimise impacts to aquatic biology to low – moderate. Designing irrigation canals that pipe water past the natural stream channels will allow for the ongoing existence of aquatic habitat and migratory stream channels.

Implementation of the aquaculture pond will reduce fishing / other aquatic resource collection from HSRA streams. However, fishing pressure will increase with resettlement into the area, and moderate to significant impacts are anticipated.

## **7.3 Social Impacts and Mitigation Measures**

### **7.3.1 Land, Assets and Agricultural Livelihoods**

#### ***Issues and Findings***

- The establishment and development of the HSRA will result in the allocation of 6,108 ha including 2,393 ha of land for resettlement development for up to 750 households from the five (5) resettlement communities that will lose land and assets due to the creation of the NN1HP main and regulation reservoirs;
- A section of the HSRA will be established on land currently allocated to the three (3) host communities of Ban Hatsaykham, Ban Hat Gniun and Ban Somseun. This will result in the loss of 2191.09 ha of productive land for these host communities (refer to Table 7-4);
- No settlement areas or permanent structures (with the exception of the NNP1 demonstration farm) have been identified within the proposed HSRA however a number of temporary agricultural huts exist;
- A substantial percentage of the current village lands (PONRE Bolikhamsay 2012) of Ban Hatsaykham (63%) and Ban Hat Gniun (69%) will be lost to the HSRA development. Approximately 2,171 ha in the proposed HSRA is currently an agricultural zone for villagers in Ban Hatsaykham and Ban Hat Gniun. Agricultural livelihoods of up to 113 households and 688 people will be impacted. According to village surveys, land use analysis (Earth Systems 2015b) and initial land and asset surveying (NNP1 2014d) this is estimated to include:
  - » Three (3) households who will lose 8.46 ha of rice paddy fields which produce on average 4.6 tonnes / ha of rice annually;
  - » 110 households who will lose 2161 ha of land currently used for permanent and shifting cultivation. Currently each household cultivates an average of 3-5 ha per year, with annual rice yields ranging from 1-4 tonnes / ha and a production of other crops (yields not calculated);
  - » Three (3) household who will lose 1.81 ha of young plantations (planted 2012); and
  - » 25 households who rear approximately 250 head of cattle on agricultural fields and on grasslands within the HSRA.

- A small percentage (8%) of Ban Somseun's village land will be lost due to the HSRA development. Approximately 345 ha of the affected land area is currently used for agricultural activities. Approximately 27 households and 135 people derive livelihoods from these activities. According to village surveys, land use analysis (Earth Systems 2015b) and initial land and asset surveying (NNP1 2014d) this is estimated to include:
  - » Between two (2) and five (5) households who will lose a total of 1.28 ha of rice paddy fields (note village surveying indicates a larger area of up to 8 ha) which produce between 2.8 to 5.4 tonnes / ha of rice annually.
  - » 27 households who will lose 343.51 ha of land currently used for permanent and shifting cultivation. Currently each household cultivates an average of 5 ha per year, with annual rice yields ranging from 2.8 to 5.4 tonnes/ha and a production of other crops (yields not calculated).
  - » Nine (9) households who will lose will lose access to agricultural fields and grasslands within the HSRA used to rear approximately 50 head of cattle.
- Proof of ownership of individual land parcels is limited. Some information is held in village land logs and to a lesser extent tax receipts, however the majority of land has been allocated through informal systems without clear documentation;
- The potential loss of land in Ban Hatsaykham, Ban Hat Gniun and Ban Somseun is compounded by reductions in the total village land areas completed in 2012 after the establishment of the PFA and other land impacts caused by the Main Project;
- The village boundaries of Ban Thaheua, previously identified in the REDP (NNP1 2014b) as an HSRA host community, are not affected by the proposed HSRA and no households from this village use the area for agriculture cultivation;
- Hatsaykham has agreed to relocate to the proposed HSRA and therefore will benefit from the proposed resettlement development and livelihood development program. Ban Hat Gniun and Ban Somseun will not be relocated and require other forms of compensation and livelihood restoration; and
- NNP1's REDP outlines compensation and livelihood restoration commitments for host and resettlement communities. However the identification of significant land loss for Ban Hat Gniun and PAPs from Ban Somseun will require re-evaluation of mitigation measures.

### **Management and Mitigation**

#### **Construction**

NNP1 will implement relevant management and mitigation measures outlined in the REDP (NNP1 2014b). Key measures will include:

- Completion of land (and asset) compensation activities before commencement of construction activities in accordance with the REDP (NNP1 2014b);
- Implementation of livelihood restoration activities for PAPs ensuring that:
  - » PAPs remain at the same or better level than before the Project;
  - » Impacted households are elevated above the National Poverty Line; and
  - » Significantly impacted communities increase the average community income to 200% of their baseline income ten years after COD.

NNP1 will implement the following additional management and mitigation measures:

- Recognise the significant loss of productive land in Hat Gniun and PAPs from Ban Somseun and implement measures outlined in the REDP (and livelihood restoration plan) accordingly.



Consideration should be given to replacement land and / or development of alternative livelihoods in line with the Project's policy on 'significantly impacted households' (NNP1 2014b).

#### ***Post Construction Period***

- NNP1 will implement livelihood restoration activities for PAPs in accordance with the REDP (NNP1 2014b) for 10 years following the pre-construction period of the Main Project (December 2013) or five (5) years of a stabilisation phase after COD.

#### ***Assessment of Impacts***

The allocation of lands for the HSRA will allow for the development of a settlement and productive lands that will facilitate compensation and livelihood restoration (NNP1 2014b) for households directly affected by the inundation of the NN1HP reservoirs.

The establishment and development of the HSRA will result in the loss of land currently allocated to Ban Hatsaykham, Ban Hat Gniun and Ban Somseun. A substantial percentage of the total village lands of Ban Hatsaykham (63%) and Ban Hat Gniun (69%) will be lost to the HSRA development. The affected land area includes agricultural and cattle grazing zones for these communities. Households from Hatsaykham will be compensated through resettlement to the HSRA. Households from Hat Gniun and Ban Somseun who will not be resettled will be provided with compensation. Effective implementation of the REDP and additional management and mitigation measures outlined above are expected to result in fair and adequate compensation for all PAPs from these communities.

**Table 7-4 Summary of Impacted Lands**

Village / Community	PFA							RDS and PAA							% of Total Village Land
	Rice Paddy	Other Ag Areas*	Plantations	Grassland	Forest Areas^	Other	TOTAL	Rice Paddy	Other Ag Areas*	Plantations	Grassland	Forest Areas^	Other	TOTAL	
Ban Hatsaykham		553.67		46.17	628.58	45.06	1273.47	1.43	453.45		2.99	117.70	3.04	578.60	63%
Ban Hat Gniun		45.29			50.80	1.35	97.44	7.03	1108.88	1.81		75.91	3.05	1196.67	69%
Ban Somseun								1.28	343.51			69.38	1.64	415.81	8%
<b>TOTAL</b>		<b>598.96</b>		<b>46.17</b>	<b>679.38</b>	<b>46.41</b>	<b>1370.91</b>	<b>9.74</b>	<b>1905.84</b>	<b>1.81</b>	<b>2.99</b>	<b>262.99</b>	<b>7.73</b>	<b>2191.09</b>	<b>40%</b>

Source: Earth Systems 2015b

\*includes cleared land, permanent fields, shifting cultivation and fallow areas

^ includes UMD Forest, UMD/Bamboo Mosaic, Bamboo, Riparian Forest

## 7.3.2 Forest Resource Use

### Issues and Findings

- The HSRA will include 3,715 ha of PFA which will be zoned in accordance with PM Decree 333 on National Protected Forests (2010) and managed sustainably through the implementation of the *Integrated Natural Resource Management Plan* (Appendix A). This has the potential to protect and enhance the forest and forest resources within the HSRA, benefiting resettled communities;
- The establishment of the HSRA (RDS and PFA) will result in the loss of or loss of access to forest habitats and agricultural landscapes currently used by villagers in Ban Hatsaykham, Ban Hat Gniun, Ban Somseun and surrounding communities as sources for NTFPs, TFPs and wildlife. Forest resources are important in the daily life of these villagers as an important food source and for construction. NTFPs and wildlife are an important food source for villagers, although due to improved access over the last year (for Ban Hatsaykham and Ban Hat Gniun) more income is expected to be derived from these products. Timber products are reportedly mostly used in the communities however it is also likely that these are sold to outsiders;
- The loss of areas currently used for TFP/NTFP harvesting and hunting within the HSRA is compounded by the loss of access to forest resources resulting from the establishment of the PFA in 2012. Potential impacts to forest resource use as a result of the HSRA are also compounded by the potential impacts of the Main Project (i.e. habitat loss and workforce; see SIA (NNP1 2014a);
- The presence of the workforce (construction) and new resettled community (post-construction period) has the potential to result in increased hunting and collection of forest resources. In the absence of effective management, this would result in a reduced availability of forest resources in the wider area;
- NNP1's REDP outlines compensation and livelihood restoration commitments for host and resettlement communities (with the exception of Ban Somseun). These include intensive rice and crop cultivation, intensive livestock rearing, commercial plantations and NTFP domestication activities. These activities, restricted to the RDS are expected to eliminate agriculture activities occurring within the PFA, which will allow disturbed forest to generate and enhance the availability of forest resources, also benefiting resettled communities; and
- NNP1's INRMP and WMP are currently being drafted. A key factor for the sustainable management of the HSRA (PFA) is community forest management. NNP1 is currently negotiating with the GOL for community use rights for resettled villagers in this area and the inclusion of the HSRA under the Project's Watershed Management Plan.

### Management and Mitigation

#### Construction

NNP1 will implement relevant management and mitigation measures outlined in Sections 7.1 and 7.2 and the REDP (NNP1 2014b). Key measures will include:

- Management of terrestrial biology resources as outlined in Section 7.2.1; and
- Implementation of resettlement and livelihood restoration activities for PAPs from host communities and resettlement communities in accordance with REDP (NNP1 2014b) including:
  - » Intensive rice and crop cultivation, intensive livestock rearing, commercial plantations and NTFP domestication activities; and
  - » Conduct of participatory land use planning in the HSRA and surrounding host communities identify, zone and plan for remaining forest resources in these communities.

NNP1 will implement the following additional management and mitigation measures:

- Recognise the loss of forest resources and potential for significant loss of forest resource based livelihoods for the residents of Hat Gniun, Ban Somseun, and surrounding communities and update the REDP giving further consideration to the type and adequacy of compensation measures. In addition to livelihood restoration activities outlined in the current REDP, NNP1 will work with GOL authorities to secure community use rights to PFA areas previously within these village boundaries (pre 2012) and not within the HSRA; and
- Coordinate the GOL and resettled communities to finalise the INRMP for the HSRA (RDS and PFA) and ensure that:
  - » Community use rights for the HSRA (PFA) are formally secured through engagement with GOL authorities and the implementation of the participatory land use planning process
  - » the HSRA is included within the NN1HP watershed; and
  - » Measures outlined in the INRMP are considered in the drafting of the Watershed Management Plan.

### **Post Construction**

- NNP1 will implement forest resource livelihood restoration activities for PAPs in accordance with the NNP1 REDP for 10 years following the pre-construction period of the Main Project (December 2013) and for up to five (5) years during a stabilisation phase after COD; and
- NNP1 will support the implementation of the INRMP for the HSRA until the end of the concession (27<sup>th</sup> year of operation).

### **Assessment of Impacts**

The establishment of the HSRA (and within this the PFA) and successful implementation of the management and mitigation measures in this IEE, REDP (NNP1 2014b), INRMP (Earth Systems 2015b) and draft Watershed Management Plan (NNP1 2015) is expected to provide resettled villagers with a sustainable supply of forest resources.

The key potential impact is the loss of access to agricultural landscapes and forests currently utilised by host communities for forest resource based livelihoods. Villagers in Hatsaykham will be relocated and will benefit from the establishment of the HSRA and sustainable management of forest resources. The forest resource based livelihoods of villagers from Ban Hat Gniun and Ban Somseun are expected to be restored or supplemented through effective implementation of livelihood restoration programs in these respective communities and the provision of community use rights to other areas within the PFA, and support for the management of these areas.

## **7.3.3 Fisheries and Aquatic Resource Use**

### **Issues and Findings**

- The development of the RDS (including irrigation and domestic water infrastructure) has the potential to impact natural fisheries and aquatic resources in the HSRA (refer to Section 7.2.3);
- Resettled villagers are expected to benefit from community use rights to and sustainable management of the remaining natural waterways (and fish and aquatic resources), however, the increase in fishing pressure may reduce fish populations. Resettled communities are also expected to benefit from the establishment of aquaculture schemes (i.e. stocking of the Irrigation Reservoir);
- Fisheries and aquatic resources sourced from within the HSRA and the Nam Ngiep River are an important livelihood for host villagers in Ban Hatsaykham, Ban Hat Gniun and Ban Somseun (and other surrounding communities) both for consumption and sale. The establishment of the HSRA has



the potential to impact these livelihoods, both through the impact of the RDS on waterways and aquatic resources and the assigning of common use rights to resettled villagers which restrict access for host communities (and surrounding communities); and

- Impacts to fisheries and fish / aquatic resource based livelihoods are likely to be compounded by the potential long-term impacts resulting from the main NN1HP including the damming of the Nam Ngiep River. There may be a short term 'windfall' for host communities and resettled communities who benefit from increased availability of fish who are prevented from migrating upstream.

### ***Management and Mitigation***

#### ***Construction***

NNP1 will implement relevant management and mitigation measures outlined above and in the REDP (NNP1 2014b). Key measures will include:

- Protection of aquatic habitat via implementation of the environmental flow regime on Houay Soup Noi and Houay Soup Ngai (refer to Section 7.1.2); retention and / or revegetation of riparian vegetation (refer to Section 7.2.1); and management of water quality (refer to Section 7.1.3);
- Prohibition of NNP1 / contractors from fishing HSRA streams during construction;
- Implementation of resettlement and livelihood restoration activities for PAPs from host communities and resettlement communities in accordance with REDP (NNP1 2014b) including:
  - » Aquaculture programs including the provision of fingerlings, ponds/cages and feeds and training;
  - » Fisheries co-management; and
  - » Substitute livelihood activities (i.e. livestock development).

NNP1 will implement the following additional management and mitigation measures:

- Development aquaculture specifically within the HSRA Irrigation Reservoir and support resettlers in managing it effectively.

#### ***Post Construction***

- NNP1 will implement fisheries and aquatic resource livelihood restoration activities for PAPs in accordance with the NNP1 REDP for 10 years following the pre-construction period of the Main Project (December 2013) and up to five (5) years of a stabilisation phase after COD.

### ***Assessment of Impacts***

Long term demining of the Nam Ngiep River and development of infrastructure in the RDS and fishing pressure in the HSRA will significantly reduce the availability of natural aquatic species. The effective implementation of aquaculture schemes is expected to partially offset this loss. Other substitute livelihood restoration activities are expected to reduce dependency on fisheries for consumption and sale.

## **7.3.4 Vulnerable People**

### ***Issues and Findings***

- A number of vulnerable households have been identified in each of the host and resettlement communities. These includes households with a widowed/female head; elderly / infirmed with no support; disabled members; and households deemed 'absolutely poor'. Other vulnerable groups identified include ethnic minorities (i.e. predominately Hmong resettlement communities), women and PAPs without legal title to land and or property; and

- Due to their vulnerability, there is potential for these households and groups to experience greater impacts or receive less benefits as a result of the establishment and development of the HSRA.

#### ***Management and Mitigation***

- NNP1 will implement specific measures for vulnerable people accordance with REDP (NNP1 2014b) and other social development plans including the Project's Livelihood Restoration Plan and Cultural Awareness / Heritage Preservation Action Plan.

#### ***Assessment of Impacts***

A number of vulnerable households and groups have been identified in host and resettlement communities. The successful implementation of specific measures for vulnerable people outlined in the REDP (NNP1 2014b) and other social development plans are expected to mitigate potential impacts and enhance benefits for vulnerable people, resulting in improved conditions.

### **7.3.5 Benefits to Host Communities**

#### ***Issues and Findings***

- Residents of Ban Hatsaykham will be relocated to the HSRA and will benefit from the establishment and development of the HSRA (refer to Section 7.3.6). Residents from Ban Hat Gniun will benefit from the development of infrastructure in the HSRA and also from a specific program to upgrade in-village infrastructure;
- While PAPs from Ban Somseun will receive compensation and livelihood restoration support, they are not expected to directly benefit from the development of the HSRA;
- Residents from Ban Hat Gniun, and to a lesser extent Ban Somseun may receive indirect benefits from further development of the surrounding area including improved infrastructure and services and development of the local economy; and
- The REDP (NNP1 2014b) while noting the potential indirect benefits does not outline measures to ensure these indirect benefits are maximised.

#### ***Management and Mitigation***

NNP1 will update the REDP to include measures for ensuring indirect benefits from the HSRA development are maximised including:

- Support the GOL to update socio-economic development plans (and cluster plans) for the local area including the HSRA and surrounding communities.

#### ***Assessment of Impacts***

With the effective implementation of the contractor SS-ESMMP, REDP (NNP1 2014b), INRMP (Earth Systems 2015b) and additional measures outlined above, host communities are expected to experience minimal indirect benefits from the development infrastructure and services in the HSRA and the surrounding area.

### **7.3.6 Benefits to Resettlement Communities**

#### ***Issues and Findings***

- Residents of the resettlement communities which choose to relocate to the HSRA are expected to benefit from the establishment and development of the area (in addition to compensation and livelihood restoration measures);

- Direct benefits are likely to include access to the Project community development program; raising income and housing to national standards; improved in-village services and infrastructure (i.e. education, health, roads, electricity); and support for the management of natural resources through the INRMP and the potential use of the NNP1 watershed management fund; and
- Indirect benefits are likely to include better access to district and provincial services; reduced UXO risk; and increased monitoring / oversight (from GOL and Project financiers) regarding the successful development of the area.

### ***Management and Mitigation***

- NNP1 will implement culturally appropriate benefits for resettlers in accordance with REDP (NNP1 2014b); and
- NNP1 will update the REDP to include measures for ensuring indirect benefits are maximised including support to the GOL to update socio-economic development plans (and cluster plants) for the local area including the HSRA and surrounding communities.

### ***Assessment of Impacts***

With the effective implementation of the REDP (NNP1 2014b), INRMP (Earth Systems 2015b), and additional measures outlined above, resettlers are expected to experience moderate direct and indirect benefits from the development infrastructure and services in the HSRA and the surrounding area.

## **7.3.7 Cultural Heritage and Archaeology**

### ***Issues and Findings***

- No archaeological and culturally significant sites of national and regional importance have been identified within the HSRA;
- One local culturally significant site was identified within the HSRA: a sacred rock near Houay Thamdin. Anecdotal evidence indicates that the site is considered an important place respected by local villagers. One cemetery was identified in the north east corner of the HSRA, however, this cemetery is located outside the HSRA;
- There is potential for proposed construction activities to cause adverse impacts to yet to be identified sites or places of cultural heritage value within the HSRA during the Construction phase; and
- There are no natural sites of international or national significance in the HSRA. However a number of natural sites of local significance or aesthetic value exist in the area (i.e. caves and waterfalls).

### ***Management and Mitigation***

#### ***Construction***

NNP1 will implement management and mitigation measures outlined in the REDP (NNP1 2014b) and other social development plans. The following measures will be implemented during construction:

- Construction activities will avoid impacts on known sites of cultural or religious significance;
- NNP1 will implement a Chance Find Procedure, adhering to the following steps:
  - » The contractor will cease operations where artefacts / archaeological finds are discovered;
  - » NNP1 will consult with the Head of Village and Culture and Tourism Administration Office for advice regarding next steps; and
  - » The contractor will resume work only after provision of official notification by the Culture and Tourism Administration Office.

- Contractors will be trained to identify potential sites or artefacts of cultural significance. Personnel will be trained in the reporting protocol and communication procedures stipulated in the Chance Find Procedure;

### ***Post Construction Period***

NNP1 will ensure the protection and management of identified cultural and natural heritage during the post construction period through the implementation of the INRMP (Earth Systems 2015).

NNP1 will monitor for instances where identified cultural and natural heritage sites within the HSRA have been encroached on, destroyed or damaged by human or natural causes, for which immediate protective measures shall be implemented to maintain the identified natural heritage values in coordination with the local cultural heritage administration via official notification.

### ***Assessment of Impacts***

No globally or regionally significant cultural or archaeological sites have been identified in the area. A number of locally important cultural sites / natural assets have been identified. The implementation of management and mitigation measures outlined above and in the REDP (NNP1 2014b) and INRMP (Earth Systems 2015b) are expected to effectively manage these sites and any chance finds during the construction and post construction periods.

## **7.3.8 Noise and Vibration**

### ***Issues and Findings***

#### ***Construction***

The existing acoustic environment of the HSRA is typical of a rural setting in Lao PDR, which is dominated by natural sounds (e.g. birds, insects, wind, etc.) and noises from farming and forestry activities, with low levels of transportation throughout the area. Construction works will generate noise and vibration during site preparation, earthworks, installation of facilities, road construction, etc.

No settlements are located within the HSRA and the surrounds are sparsely populated. At the onset of construction, sensitive receptors are expected to be limited to the construction workforce as the nearest settlements - Ban Hatsaykham and Ban Hat Gniun are ~1.0 and 2.6 km from the HSRA construction footprint, respectively. Upon resettlement of Ban Hatsaykham in approximately April, 2016, noise and vibration may provide nuisance level impacts to resettled villagers, as infrastructure construction will continue for 1-2 years.

Noise levels are not expected to exceed the Project guideline (i.e. National Environmental Standards of Lao PDR, 2009) for Maximum Sound Level (115 dB(A)), but will likely exceed ambient noise standards (55 dB(A) during daylight hours for residential areas), which will provide nuisance level disturbance for resettled Ban Hatsaykham villagers. Construction workers may also experience short-term nuisance levels of noise when construction activity occurs in the vicinity of the temporary work camp.

Due to the specified works being conducted (i.e. no blasting), vibration impacts are expected to be negligible.

#### ***Post-Construction***

Post-construction phase impacts from noise and vibration will be limited to villagers' activities, and are therefore considered negligible with respect to NNP1 operations.



## **Management and Mitigation**

### **Construction**

Key noise management and mitigation measures during the construction phase include the following:

- As much as possible, noisy construction activities will be limited to daytime when within 200 m of a community settlement (i.e. resettled Hatsaykham village). Otherwise, potentially affected people will be notified and suitable noise attenuation measures shall be implemented. Potentially affected residents near construction activities will be informed of scheduled commencement and completion dates, hours of activities and noise reduction measures to be implemented prior to the commencement of noisy activities;
- The siting of noisy activities and equipment shall consider natural buffers (e.g. hills) and / or the potential to install barriers around the source to reduce noise levels at nearby receptor sites where siting options exist;
- The proposed siting of noise sources that can be located at the discretion of the Project (i.e. not site-dependant) will be reviewed by the NNP1 Site Manager. This officer shall either approve the proposed sites of noisy activities or request the Contractor to consider alternative sites;
- Stationary noise sources (e.g. generators) that generate noise levels well above background levels (i.e. 45 dB(A) and above) shall be set back as far as possible from dwellings, workforce camps, schools, offices, businesses and other receptor sites;
- During school examination periods (following relocation of Ban Hatsaykham), noisy construction activities will be avoided near schools. The contractor will closely coordinate with the school administration on construction schedules to ensure that noise level from site works will be adequately mitigated so as not to be disruptive during school hours;
- Extended idling of construction vehicles will be avoided near sensitive receptors;
- Vehicles will be restricted to designated routes / areas and speed limits will be enforced, particularly near settlements and other sensitive receptors;
- Appropriate personal protection equipment (PPE) will be provided to construction workers for noise protection; and
- The Project Grievance Redress Mechanism (GRM) will be implemented for the community to submit noise / vibration related complaints. If complaints are received about excessive noise levels in the vicinity of communities, the Owner will consult with the complainant to identify appropriate additional mitigation measures (e.g. additional shielding, change of equipment type, restriction of construction hours in particular area) to be implemented.

### **Post-Construction**

Where appropriate, NNP1 may continue to implement relevant noise measures during the operations phase through the GRM. Additional noise measures may be developed in accordance with the IFC Noise Management Guidelines (IFC 2007).

### **Assessment of Impacts**

Noise and vibration during early construction works will not impact sensitive receptors on the left bank (opposite side) of the Nam Ngiep River. With the resettlement of Ban Hatsaykham in April 2016, during HSRA construction, it is anticipated that these villagers will be exposed to nuisance level noise impacts and negligible impacts from vibration.

These impacts will be minimised through application of the prescribed management and mitigation measures (primarily restricting work to daylight hours) and expected to be low to moderate at times for noise and low for vibration.

### 7.3.9 Air Quality

#### **Issues and Findings**

##### **Construction**

Prior to the first phase of relocation (April 2016) air quality impacts are expected to be isolated to construction personnel.

Following relocation of Ban Hatsaykham residents, particulate matter (dust) emissions from transportation on unsealed roads, site preparation for paddy fields, and site preparation for residential infrastructure may be a nuisance for residents, particularly during the dry season.

Air quality impacts from vehicle and additional exhaust emissions are not expected to be significant with adequate measures in place.

##### **Post-Construction**

Post-construction, increased traffic on unsealed roads and intensive soil cultivation in the HSRA are expected to result in dust impacts to sensitive receptors (i.e. the relocated community). Moreover, further nuisance may occur from fires in the HSRA (although burning of waste and shifting cultivation are intended to be eliminated).

The main road will be sealed, preventing what would otherwise be the most likely contributor to airborne particulate matter during operations.

#### **Management and Mitigation**

##### **Construction**

NNP1 and the Construction Contractor will implement a comprehensive emission and dust control plan to protect the local air quality. Implementation of these measures will be particularly important following resettlement of Ban Hatsaykham (April 2016) while construction of the remainder of the HSRA continues. Key measures include:

- Contractors will be supplied with appropriate PPE (i.e. masks) during the dry season;
- Dust suppression and control methods (e.g. regular water sprays) will be employed for dust-generating activities (e.g. quarry sites, earthworks, road construction, etc.) near sensitive receptors (i.e. relocated Ban Hatsaykham residents);
- Major earthworks and excavation in dry, windy conditions will be avoided following relocation of Ban Hatsaykham residents;
- Construction vehicles will be restricted to designated access routes (e.g. avoid passage through settlements where practical) and will adhere to speed limits;
- Construction haul vehicles transporting fill or other dusty materials will have covered loads;
- The construction fleet will be regularly maintained to ensure plant and vehicles are compliant with local air quality standards for exhaust emissions;
- Burning or incineration of wastes (e.g. cleared vegetative waste, construction materials) will be prohibited;
- Topsoil stockpiles to be retained during the rainy season will be treated to minimise dust generation (e.g. seeding with a cover crop or compaction with a backhoe bucket);
- Exposed surfaces will be progressively rehabilitated within one month following the completion of use to reduce dust and erosion generation (with planting conducted at the onset of the first rainy season);

- The GRM will be implemented for relocated villagers to allow air quality or dust related complaints; and
- Sensitive receptor areas will be monitored for excessive dust daily through visual inspections during high dust-generating activities near sensitive receptors.

### **Post-Construction**

The emission and dust control plan will be reviewed and updated during the operations phase to ensure potential dust and smoke impacts from proposed village activities within the HSRA are adequately minimised. This includes the continued implementation of dust suppression and control methods, and the establishment of a community fire management plan for villagers to minimise the risk of bushfires. Details of the bushfire management plan are further specified in the INRMP developed for the HSRA and PFA (Appendix A).

### **Assessment of Impacts**

Early construction works will not impact sensitive receptors on the left bank (opposite side) of the Nam Ngiep River. With the resettlement of Ban Hatsaykham in April 2016, during HSRA construction, it is anticipated that these villagers will be exposed to nuisance level air quality impacts from dust generated during the dry season.

These impacts will be minimised through application of the prescribed management and mitigation measures and should and are expected to be low. The development and application of adaptive management measures may be required to further minimise dust generation if complaints are lodged through the grievance redress mechanism.

## **7.3.10 UXO**

### **Issues and Findings**

- The Bolikhamxay Province is considered one of the 10 heaviest UXO contaminated provinces according to the Statement by the Delegation of Lao PDR on Victim Assistance (Intercessional Meeting of States Parties to the Convention on Cluster Munitions, Geneva, 2013), however the HSRA Preliminary Works Area was not as heavily bombed as neighbouring Districts;
- UXO clearance was completed for the HSRA Preliminary Access Road, village development area and paddy rice field area for Ban Hatsaykham in early 2015. No live UXO were identified during the UXO clearance. Residual UXO risk, although unlikely, for this area; and
- UXO clearance has not been completed for all HSRA Resettlement Development Site and agricultural / plantation areas. Development of each will provide risk for contractors during construction and resettled peoples during site preparation for agricultural activities.

### **Management and Mitigation**

#### **Construction**

NNP1 will ensure that construction workers are trained in the potential risks associated with disturbance of UXO. During construction, the following will be required:

- An appropriately qualified organisation will be engaged to undertake survey and disposal of UXO in areas where Project activity will occur, prior to the commencement of any construction works on-site;
- The priority method of UXO disposal shall be in-situ explosion. Where this is not possible alternative proven methods of disposal may be implemented;
- All cleared areas will be semi-permanently marked. Within 30 days of completion of clearing work at a site, a clearance report will be prepared, which describes (via GPS) and maps boundaries of

cleared areas as well as the survey methodology, disposal and QC processes implemented, description of UXO and disposal (as applies) and certification that the area has been cleared of UXO and is suitable for its intended purpose;

- As part of the construction worker training program, personnel will be trained in potential risks associated with UXO disturbance and procedures to be followed if potential UXO are identified during construction; and
- A UXO notification will be implemented in communities that are located in the vicinity of survey and disposal works at the time of undertaking.

### ***Post-Construction***

UXO clearance for paddy fields (likely during construction and post-construction), upland agriculture / tree plantations (during operations) shall be conducted by a qualified organisation (as per construction phase).

As per the contracted workforce, HSRA residents shall be trained in potential risks associated with UXO disturbance and procedures to be followed if potential UXO are identified during agricultural / plantation works.

Signs shall be posted (in appropriate languages) that instruct HSRA residents (particularly children) regarding UXO identification and appropriate procedures following identification of potential UXO.

### ***Assessment of Impacts***

With implementation of UXO clearance and the associated management, mitigation, reporting, and consultation (including awareness campaign) requirements specified in the ESMMP-CP (SP12) and above, it is anticipated that UXO will not pose a risk to construction contractors and resettled villagers in the HSRA.



## 8 INSTITUTIONAL REQUIREMENTS AND ENVIRONMENTAL MONITORING PLAN

### 8.1 Institutional Arrangements

Senior Management at NNP1 is responsible for the ongoing implementation of management and monitoring activities throughout the life of the NN1HP.

#### 8.1.1 Environmental and Social Department (ESD)

NNP1 has established an Environmental and Social Department which is responsible for implementing the monitoring and reporting program in compliance with the NN1HP Concession Agreement and the ESMMP-CP.

The ESD NNP1 consists of two divisions:

1. Social Management Office (SMO NNP1) which is (in part) responsible for land acquisition compensation works and social monitoring; and
2. Environmental Management Office (NNP1 EMO) which is responsible for all other environmental monitoring aspects.

#### 8.1.2 NNP1 Technical Department

The Technical Department (NNP1 TD) plays an important role in ensuring NN1HP compliance with its environmental and social obligations. The Department liaises with statutory bodies and head contractors to perform in accordance with all the applicable technical standards and regulations. The Technical Department also strives to enhance the performance of the contractors by following the construction plans and implementing routine inspections.

#### 8.1.3 Contractors

Contractors employed by NNP1 are required to plan, implement and monitor environmental and social management and mitigation measures in compliance with the Project's environmental and social management plans (refer to Section 8.2). Implementation is primarily undertaken by the Contractor's Environmental Inspector, and supervised, reviewed, and verified by the NNP1's ESD.

#### 8.1.4 Other Monitoring Institutions

Other institutions involved in environment and social monitoring of the road construction works include:

- Ministry of Natural Resources and Environment (MONRE);
- MONRE's Environmental Monitoring Unit;
- Resettlement Management Unit;
- Independent Monitoring Agency; and
- Asian Development Bank Monitoring Team.

## 8.2 Environmental and Social Management Plans

### 8.2.1 Environmental and Social and Management Plan for Construction Phase

An Environmental and Social Management and Monitoring Plan-Construction Phase (ESMMP-CP) was prepared for the NN1HP by ERM in 2014. The ESMMP-CP was prepared to address environmental and social compliance of NNP1 during the construction phase.

Under the ESMMP-CP, a number of sub-plans were developed to provide management and mitigation strategies for potential environmental and social impacts (refer to Appendix H of this report). Those most relevant to HSRA construction include:

- SP1: Erosion and Sediment Control;
- SP2: Water Availability and Pollution Control;
- SP3: Emissions and Dust Control;
- SP4: Noise and Vibration;
- SP5: Waste Management;
- SP6: Vegetation Clearing;
- SP7: Landscaping and Re-Vegetation;
- SP8: Protected Area Management;
- SP9: Biodiversity Management;
- SP12: Unexploded Ordinance (UXO) Survey and Disposal;
- SP17: Emergency Preparedness; and
- SP18: Cultural Resources.

Applicable management and mitigation measures detailed in these sub plans are expected to be incorporated into the Contractors EMP and SS-ESMMPs for review and approval by NNP1 and implementation during the construction.

Prior to hydropower operations commencing, NNP1 will develop a detailed ESMMP for the Operation Phase (ESMMP-OP). The management, mitigation and monitoring measures identified in this document may be included in the ESMMP-OP to ensure NNP1 commitment to integration of site-specific measures (including a maintenance program) during the phase of joint management of the HSRA following resettlement.

### 8.2.2 Resettlement and Ethnic Peoples Development Plan

A Resettlement and Ethnic Peoples Development Plan (REDP) was prepared by NN1HP in 2014. The REDP was prepared to address social compliance of NNP1 during the construction and operation phases of the Project.

The REDP includes:

- Entitlement Policy and Eligibility Matrix;
- Livelihood and Income Restoration Plan;
- Ethnic Peoples' Development Plan; and
- Public Consultation, Participation and Disclosure Plan

NNP1 will maintain the Grievance Redress Mechanism established Project-wide for community residents in the HSRA to submit any complaints (e.g. noise, dust, etc.) or grievances during the construction and operation phases.

### 8.2.3 Social Development Plan

A Social Development Plan was prepared by NN1P in 2014. This plan includes:

- Public Health Action Plan;
- Labour Management Plan;
- Community Development Plan;
- Gender Action Plan;
- Youth and Children Action Plan; and
- Cultural Awareness / Heritage Preservation Action Plan.

## 8.3 Management and Monitoring Program

### 8.3.1 Construction

Sections 7.2 and 7.3 contain site-specific environmental and social management and mitigation measures for NNP1 to implement during construction. Contractor EMPs and SS-ESMMPs will include monitoring requirements to ensure implementation of environmental and social management measures identified in this IEE. The management, mitigation, and monitoring measures identified above and prescribed in EMPs and SS-ESMMPs will be incorporated into construction contracts.

Key environmental and social requirements to be incorporated into this program for the construction phase are provided in Table 8-1 below.

**Table 8-1 Environmental and Social Monitoring Plan for the HSRA – Construction Phase**

Impact aspect	Management and mitigation measures	Monitoring method	Location	Frequency	Responsibility
Hydrology	Implement measures detailed in Section 7.1.2 for the environmental release regime and potential flood risks.	Visual observation of implementation and effectiveness.	Upstream and downstream of Houay Soup Noi and Ngai irrigation supply dam and domestic water supply intake.	Pre-construction flood modelling, Monthly hydrology monitoring	NNP1 and Construction Contractor
Water Quality	Implement surface water quality management measures as per Section 7.1.3 and 7.1.4.	Field sampling for: pH, DO, Temperature, TSS / turbidity. Sampling for laboratory analyses: pH, DO, BOD, COD, total coliform, faecal coliform, N-NO <sub>3</sub> , N-NH <sub>4</sub> , sulphate, arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc, manganese. (refer to CA, Annex C, Appendix 2).	Upstream and downstream of Houay Soup Noi and Ngai irrigation supply dam and domestic water supply intake Upstream and downstream drainage and storm water discharge outlets at construction sites in the HSRA, access roads, and ancillary components (e.g. waste dump, waste collection facilities at work camps, etc.).	Monthly	NNP1 and Construction Contractor
	Manage effluent as per Section 7.1.3 and 7.1.6	Sampling for following laboratory analyses: pH, BOD, COD, TSS, Oils and grease, Ammonia-N, Total N, Total P, Total coliforms, arsenic, cadmium, chromium, copper, fluoride, iron, lead, mercury, nickel, selenium, silver, sulphides, zinc. (refer to CA, Annex C, Appendix 2)		Bi-annually (rainy season / dry season)	
Drinking water and water supply	Provide adequate drinking water for construction work camps.	Drinking water quality monitoring in accordance with Appendix I (or provision of bottled water).	Potable water supply at construction worker camp.	Monthly	NNP1 and Construction Contractor
Erosion and sediment transport	Implement measures detailed in Section 7.1.4.	Verification of implementation and efficacy of erosion and sediment control facilities, including visual observation of design, capacity, maintenance requirements, etc. and measurement of turbidity and / or total suspended solids (refer to water quality).	Upstream and downstream of storm water discharge outlets at construction sites, roads / disturbed sites.	Monthly	NNP1 and Construction Contractor
Hazardous and non-hazardous waste	Implement relevant measures detailed in Section 7.1.3 and 7.1.6 to manage non-hazardous waste generated by Project construction.	Verification of implementation including visual inspection of waste facilities, and storage areas; and maintenance of a waste inventory	All general waste storage areas and facilities.	Weekly	NNP1 and Construction Contractor



Impact aspect	Management and mitigation measures	Monitoring method	Location	Frequency	Responsibility
	Implement relevant measures detailed in Sections 7.1.3 and 7.1.6 to manage hazardous waste generated by Project construction.	Verification of implementation, including hazardous waste inventory; visual inspection of facilities, storage areas, and spill response kits; and reporting and response to hazardous spills and leaks.	All areas where hazardous materials are handled and stored.	Weekly	NNP1 and Construction Contractor
Terrestrial biodiversity	Survey proposed footprint during Project design to avoid threatened fauna to the extent practicable.	A qualified botanist will survey the Project footprint for threatened flora species. Individuals will be flagged with GPS coordinates recorded.	Construction areas earmarked for clearing (e.g. RDS, access roads, and ancillary components).	Pre-construction	NNP1
	Transplant threatened flora (if small enough) and avoid larger individuals in the Project footprint to the extent practicable.			Weekly	NNP1 and Construction Contractor
	Implement relevant measures detailed in Section 7.2.1 to manage potential terrestrial biodiversity impacts. Monitor vegetation clearing throughout the HSRA.	Visual observation - extent of disturbance / vegetation clearing for construction, condition of surrounding habitat and level of disturbance, presence of local weeds.			
	Implement a wildlife incident reporting system for contractors and villagers to report wildlife encounters and illegal activities involving poaching or harvesting of TFPs/NTFPs.	Record incidents involving wildlife (e.g. road incidents, poaching or illegal harvesting of TFPs/NTFPs)	Project-wide	Ongoing	NNP1 and Construction Contractor
Aquatic habitat and biology	Implement relevant measures detailed in Sections 7.1.2 and 7.2.3 to manage potential aquatic biodiversity impacts.	Verification of implementation and efficacy.	Upstream and downstream of Houay Soup Noi and Ngai irrigation supply dam and domestic water supply intake.	Weekly	NNP1 and Construction Contractor
	Conduct aquatic habitat and biology monitoring.	Monitor environmental flow regime, condition of habitat and water quality, and presence of local aquatic flora and fauna.	Houay Soup Noi and Gnai.	Monthly	NNP1
	Implement a Project-wide incident reporting system allowing contractors and villagers to report illegal activities involving fishing or collection of aquatic resources.	Reportable incident records involving aquatic wildlife.	Project-wide.	Ongoing	NNP1 and Construction Contractor
Invasive vegetation	Implement relevant measures detailed in Section 7.2.2 to prevent introduction and spread of invasive species. Monitoring for the spread of invasive species.	Weed monitoring, including presence and extent of priority weed species.	Vegetation surrounding and in disturbed areas of HSRA, access roads, and ancillary components.	Biannually	NNP1 and Construction Contractor
Loss of land, assets and livelihoods	Implement relevant measures specified in Section 7.3.1 and in the REDP regarding steps to be taken for loss of land, assets and livelihoods.	Grievance Redress Mechanism (GRM).	Project affected communities.	Pre-construction	NNP1 in consultation with Project affected People
Site access	Implement measures specified in Section 7.3.2 to manage site access issues to the right bank and HSRA.	Verification of implementation.	Within and near the HSRA.	Monthly	NNP1 and Construction Contractor

Impact aspect	Management and mitigation measures	Monitoring method	Location	Frequency	Responsibility
Archaeology and cultural heritage	Implement relevant measures detailed in Section 7.3.7 to manage potential cultural heritage impacts, including a 'Chance Finds Procedure'.	Verification of implementation, including records of chance finds.	Within and near the HSRA.	Monthly	NNP1 and Construction Contractor
UXO	Implement relevant measures specified in Section 7.3.10 to manage potential impacts from UXOs.	UXO clearance surveys (Appendix H).	In planned construction areas not previously surveyed for UXOs.	Pre-construction	NNP1 and Construction Contractor
Noise and vibration	Implement relevant measures specified in Section 7.3.8 to ensure noise emissions and ambient noise levels comply with the Lao National Environmental Standard for noise.	Noise monitoring for dB(A) following relocation of Ban Hatsaykham.	At sensitive receptors (i.e. Ban Hatsaykham relocation area).	Biannually	NNP1 and Construction Contractor
	Implement the Project Grievance Redress Mechanism for community residents in and near the HSRA to submit noise and vibration complaints or grievances during construction.	Verification of GRM implementation	Project-wide.	Ongoing	NNP1 and Construction Contractor
Air quality	Baseline air quality (particulate matter)	Measurement of particulate matter (PM <sub>10</sub> and PM <sub>2.5</sub> )	HSRA Settlement Area.	Pre-construction	NNP1
	Implement relevant measures specified in Section 7.3.9 to ensure air / dust emissions and ambient air levels comply with the Lao National Environmental Standard for ambient air quality.	Measurement of particulate matter (PM <sub>10</sub> and PM <sub>2.5</sub> ).	At Ban Hatsaykham relocation site and HSRA work camps.	Biannually	NNP1 and Construction Contractor
	Implement the Project Grievance Redress Mechanism for community residents in and near the HSRA to submit air quality complaints or grievances during the construction phase.	Verification of GRM implementation.	Project-wide.	Ongoing	NNP1 and Construction Contractor
Workforce training and awareness	Implement relevant awareness and training measures specified in Section 8.3.2 for the construction workforce.	Monitor and record implementation of workforce awareness training and review training register.	HSRA construction workforce.	Routine	NNP1 and Construction Contractor
Community training and awareness	Implement relevant awareness and training measures specified in Section 8.3.2 for the local community.	Monitor and record community awareness training and review community training register.	HSRA residents and other users of the HSRA.	Annual and ongoing	NNP1 in collaboration with GOL and Village Committees
Temporary infrastructure	Provide buffer areas at construction worksites. Decommission temporary infrastructure and sites including landscaping and visual characteristics in consultation with the resettled communities.	Verification of implementation.	HSRA, access roads, and ancillary components (e.g. quarries and borrow areas).	Pre-construction and post-construction	NNP1 and Construction Contractors)

Source: Earth Systems 2015

### 8.3.2 Post-Construction

Where relevant, the environmental and social management measures implemented during the construction phase should be reviewed and adapted into the ESMMP-OP (for operations / post-construction). NNP1 will ensure the ESMMP-OP and relevant sub-plans (if applicable) are periodically reviewed and updated to ensure they remain relevant and effective (e.g. for changed HSRA conditions, unexpected environmental impact identified, etc.).

The suite of environmental and social management measures expected to be implemented in the HSRA post construction are summarised in Table 8-2 below and include a focus on regular maintenance to ensure facilities are operating effectively upon formal HSRA handover to the village and the GOL.

NNP1 involvement in HSRA post-construction management, mitigation, monitoring, maintenance, training, etc. will continue, at a minimum, until official transfer of the HSRA from NNP1 ownership to village / GOL ownership. Official transfer will occur after MONRE is satisfied that CA requirements have been met (e.g. training requirements for villagers, financial planning for operations and maintenance completed, land tenure certificates registered, etc.).

**Table 8-2 Environmental and Social Monitoring Plan for the HSRA – Post-Construction Phase**

Impact aspect	Management and mitigation measures	Monitoring method	Location	Frequency	Responsibility
UXO	Conduct and document UXO clearance surveys for areas where activities involving ground disturbance will be undertaken (that have not previously been surveyed for UXOs). Inform HSRA villagers to avoid disturbing areas where UXO surveys have not been conducted.	UXO clearance surveys, refer to sub-plan SP12 (Appendix H).	In any new areas previously not surveyed for UXOs for upland agriculture or plantations.	Before any activities are undertaken in the affected area.	NNP1 in collaboration with the Resettled Community
Soil fertility	Develop a detailed monitoring program that measures soil fertility and the effectiveness of soil improvement and cultivation methods used by villagers.	Soil fertility monitoring to consider: <ul style="list-style-type: none"> <li>• Soil quality and suitability for identified crops, including regular analysis of physio-chemical properties against the target values of soil improvement (refer to Table 7-2 – Section 7.1.5);</li> <li>• Type and quantities of organic and chemical inputs used for agriculture; and</li> <li>• Any organic and chemical inputs contaminating surface water further downstream (e.g. Nam Ngiep and tributaries).</li> </ul>	Upland and lowland agricultural areas and plantation lands.	At least 2 months in advance of planting seasons.	NNP1 in collaboration with the Resettled Community
Aquaculture and fish farming	Develop a detailed monitoring program that measures the effectiveness of fish farming methods used by villagers and quality of effluent.	Ongoing collaboration with villagers to ensure aquaculture scheme is effective. Monitor for any organic and chemical inputs entering the Houay Soup.	HSRA / Houay Soup.	Periodic (e.g. biannually).	NNP1 in collaboration with the Resettled Community
Compensation and livelihood restoration	Review and update the social management and monitoring requirements for the implementation of the livelihood restoration program.	Monitor socio-economic indicators as set out in the REDP. External reviews and audit to verify implementation of livelihood restoration program.	HSRA.	Annually.	NNP1



Impact aspect	Management and mitigation measures	Monitoring method	Location	Frequency	Responsibility
Access roads	Perform road maintenance and repairs as necessary for safety purposes and to reduce maintenance requirements upon formal handover of the HSRA.	Routine checks on the condition of road (e.g. for potholes). Reported grievances or road incidents.	Access roads for the HSRA.	Quarterly until HSRA transfer	NNP1 in collaboration with the Resettled Community
Domestic water supply	Perform scheduled maintenance, upgrades and repairs for operational effectiveness and safety purposes.	Routine checks on the condition of facilities (e.g. for leakage in domestic piping system, failure in water treatment facility, etc.).	Domestic water piping system, water intakes, and residence taps.	Monthly until transfer of facility	NNP1 in collaboration with the Resettled Community
	Drinking water quality.	Bacteriological parameters (total coliform, faecal coliform, entero virus).	Domestic water piping system and sub-sample of residence taps.	Monthly until transfer of facility	
		Physical-Chemical Parameters, Health Significant Parameters, and Priority Parameters (Appendix I and Concession Agreement – Annex C, Appendix 2) E.g.: pH, DO, BOD, COD, total coliform, faecal coliform, N-NO <sub>3</sub> , N-NH <sub>4</sub> , sulphate, arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc, manganese.	Domestic water piping system and sub-sample of residence taps.	Annually until transfer of facility	
Irrigation water supply	Perform scheduled maintenance, upgrades and repairs for operational effectiveness and safety purposes.	Routine checks on the condition of facilities.	Irrigation water reticulation system, reservoir, and intakes.	Monthly until HSRA transfer	NNP1 in collaboration with the Resettled Community
		Monitor water levels in the irrigation water reservoir via regular visual inspections to ensure sufficient freeboard is maintained for safety.	Irrigation water reservoir.	Weekly until HSRA transfer	
		Independent audit of dam structural integrity by a suitably qualified specialist for operational safety.	Irrigation water reservoir.	Once-off (prior to relinquishment to the GOL)	
Other community facilities and infrastructure	Monitor the condition of community facilities and infrastructure to determine if upgrades, repairs or maintenance are required.	Routine visual observation; Grievance Redress Mechanism.	Throughout the HSRA.	Monthly until HSRA transfer	NNP1 in collaboration with the Resettled Community

Impact aspect	Management and mitigation measures	Monitoring method	Location	Frequency	Responsibility
Rehabilitation	Continue to regularly monitor rehabilitation areas to assess the success of restoration activities as necessary.	Routine monitoring records to consider area revegetated/rehabilitated; survival rate of planted seedlings; and invasive weed presence.	Rehabilitation areas throughout the HSRA and PFA.	Ongoing until HSRA transfer	NNP1
Reportable incidents	Maintain the established Project incident reporting systems for villagers to report incidents such as chance finds, wildlife encounters, and observation of illegal activities involving poaching or harvesting of TFPs/NTFPs, etc.	Verification of implementation.	Project-wide.	Ongoing throughout Stabilisation Phase	NNP1
Community health and safety	Coordinate and implement relevant emergency notification and evacuation procedures with the GOL and relevant Village Committees to ensure community safety within the HSRA, e.g. NN1 HPP Emergency Preparedness and Response Plan, Bushfire Management Plan applicable for the HSRA and PFA, etc.	Verification of implementation.	HSRA.	Ongoing throughout Stabilisation Phase	NNP1
Community relations and Project grievances	Maintain the Project grievance redress mechanism for community residents in and near the HSRA to submit relevant complaints or grievances (e.g. dust complaint).	Verification of implementation. Logged grievances and complaints Informal discussion.	Project-wide.	Ongoing throughout Stabilisation Phase	NNP1
Community capacity training and awareness	Implement relevant capacity training and awareness measures specified in Section 8.3.2 for the local community, including: <ul style="list-style-type: none"> <li>Specific training to nominated villagers to perform maintenance and repairs on community facilities and infrastructure; and</li> <li>Awareness of the INRMP and associated bans, rules and restrictions which applies to the HSRA and PFA.</li> </ul>	Review of community training register.	HSRA residents and other users of the HSRA.	Ongoing throughout Stabilisation Phase	NNP1 in collaboration with GOL and Village Committees
Invasive species	Monitor for invasive species introduction and spread.	Reporting and checks for invasive species.	HSRA and PFA.	Ongoing until HSRA transfer	NNP1 in collaboration with Village Committees

Source: Earth Systems 2015

### ***Maintenance of community facilities and infrastructure***

As outlined in Section 7, NNP1 involvement in HSRA post-construction management, mitigation, monitoring, maintenance, training, etc. will continue, at a minimum, until official transfer of the HSRA from NNP1 ownership to village / GOL ownership. Official transfer will occur after MONRE is satisfied that CA requirements have been met (e.g. training requirements for villagers, financial planning for operations and maintenance completed, land tenure certificates registered, etc.).

NNP1 will facilitate regular monitoring for infrastructure and facilities essential to the community, such as access roads, livestock fencing, and facilities for irrigation and aquaculture. Appropriate repairs, maintenance, and upgrades will be performed as necessary by the relevant concerned parties, and specific training will be provided to nominated HSRA residents to ensure there is capacity for ongoing maintenance of community infrastructure and facilities after NNP1 relinquishes the HSRA prior to official transfer of the HSRA to the villagers / GOL.

NNP1 will negotiate with residents of the HSRA and applicable GOL staff to finalise an acceptable model for financing ongoing operations and maintenance of infrastructure. Several financing options under consideration are briefly described in Section 2.4 and further detailed in the REDP (NNP1 2014b).

NNP1 will facilitate community health and safety within the HSRA post-construction by supporting the implementation of scheduled maintenance programs involving community sanitation and hygiene infrastructure and facilities (e.g. drinking water supply, waste management facilities), as well as ongoing coordination and implementation of emergency notification and evacuation procedures with the GOL and relevant Village Committees (e.g. NN1 HPP Emergency Preparedness and Response Plan, Bushfire Management Plan applicable for the HSRA and PFA, etc.).

### ***Integrated Natural Resource Management***

The INRMP (see Appendix A) will be incorporated as a sub-plan of the WMP and implemented under the oversight of the Watershed Management Committee over the 27 year concession period.

A number of environmental and social management measures will need to be continued to ensure potential impacts from ongoing activities within the HSRA are effectively minimised. As such, the responsibilities and implementation of relevant environmental and social requirements to be continued should be adequately described and negotiated between GOL, affected communities and NNP1 prior to the transition.

## **8.3.3 Training and maintenance requirements**

### ***Workforce training and awareness***

NNP1 and the Construction Contractor will ensure all workers complete mandatory induction and training programs educating them on the requirements of relevant environmental plans (i.e. IEE contractor EMP and SS-ESMMP, REDP, etc.), raising awareness on the following aspects:

- Project ban and penalties for firearm possession, illegal logging, poaching, fishing, and collection of forestry products;
- UXO;
- Adherence to local traffic regulations and rules;
- Non-disturbance and cultural awareness of resettlement communities;
- Erosion and sediment control;
- Health, safety and hygiene;
- Waste management; and
- Other aspects, as required.

### ***Community training and awareness***

Post HSRA construction, HSRA residents will participate in training programs organised / facilitated by NNP1 and the GOL educating them on statutory obligations applicable to the HSRA and raising awareness on the following aspects:

- HSRA bans and penalties for illegal logging, poaching, fishing, grazing, and collection of forestry products (i.e. TFPs/NTFPs), particularly in Total Protection Zones and Controlled Use Zones within community forests;
- Environmental issues, including soil fertility improvement, erosion and sediment control, water quality, biodiversity conservation, and waste management;
- Social issues, including general health, safety, hygiene, and cultural heritage protection;
- UXO; and
- Other aspects, as required.

NNP1 will also provide specific training to nominated village representatives to ensure adequate maintenance of facilities and infrastructure essential to the community can be carried out, including for local access roads, irrigation and drinking water systems, waste management facilities, aquaculture farms, plantations, etc.

### ***Grievance Redress Mechanism***

NNP1 had developed and implemented a Grievance Redress Mechanism (GRM) during Project construction. This procedure will be implemented during HSRA construction and post-construction until formal handover of the HSRA to the community and the GOL. Success of the GRM will require that stakeholders are aware of the GRM process.

The Grievance Redress Mechanism will include:

- Promoting productive relationships with local communities and identifying concerns through consultation, disclosures, participatory planning and decision making with Project Affected Peoples to prevent grievances wherever possible;
- Ongoing engagement with stakeholders throughout the Project (particularly PAPs), with appropriately documented discussions and agreements signed (voluntarily) by all parties involved in negotiation;
- Address and resolve differences or grievances associated with the Project through the established GRM procedures, including the following five (5) stages of Project GRM, further elaborated in the Project ESMMP-CP:
  - » Stage 1: PAPs will register grievances with the Village Grievance Committee (VGC). The committee will organise a meeting within 15 days from the date of formal grievance receipt. The VG will generate and sign a report and will submit the grievance to NNP1;
  - » Stage 2: If either the PAPs or NNP1 is not satisfied with the decision of the VGC, or if NNP1 / contractors do not abide with the decision, and appeal can be made directly by NNP1 or by the PAP or by the VGC on behalf of the PAP. The appeals are forwarded to the District Grievance Committee (DGC). The DGC will meet in a public place within 20 days from the date of formal receipt of the grievance. Representatives from NNP1 must be available to provide relevant information. The DGC provides a written / signed report;
  - » Stage 3: If the PAP is not satisfied with the decision of the DGC or if NNP1 / contractors do not abide by the decision, and appeal can be made to the Provincial Grievance Redress Committee (PGRC). The PGRC will consider the grievance in consultation with representatives of MONRE and NNP1 within 20 days of complaint filing;



- » Stage 4: If the PAP is not satisfied with the decision of the PGRC, or in the absence of response within the stipulated time, the grievance can be submitted to the Court of Law by the PAPs, a representative of an NGO, the VGC on behalf of the PAPs, or at the request of NNP1. The Court of Law will follow up with representative authorities to make the final and binding decision; and
- » Stage 5: If NNP1 / contractors are found responsible for negligence, the Project will cover in full all administrative and legal fees incurred by the PAPs in the GRM process at the district, provincial and MONRE levels and in the Court of Law. Complaints and grievances concerning impacts during construction will be considered for up to and for no more than one year after the official date of construction completion.

### 8.3.4 Budget

#### **Contractors**

Contractors are obligated to provide suitably qualified staff and an appropriate budget to implement management and mitigation measures identified in Section 7 and to monitor the implementation and efficacy of these measures (refer to Table 8.1). Staff and budgeting for environmental / social management, mitigation, monitoring and reporting will be included in contracts as contractor obligations. Site-specific management obligations (i.e. design of environmental / social management and mitigation measures) will be included in contractor' Site-Specific Environmental and Social Management Plans (SS-ESMMP) for the HSRA. Implementation of the measures identified in the HSRA SS-ESMMP will be contractually binding.

#### **NNP1**

NNP1 costs associated with environmental and social management, mitigation, monitoring and reporting during construction (and post construction) will be included in the existing ESD operational budget, with adequate provision of resources to monitor construction and maintenance requirements and analyse parameters for ensuring the efficacy of controls implemented.

## 9 PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

NNP1's overall approach and commitment to public consultation and information dissemination is outlined in the Project's *Public Consultation and Information Disclosure Plan* (ERM 2014; NNP1 2014a). This Plan is compliant with GOL legislation (and the ADB's Safeguard Policy Statement (ADB 2009)).

An updated PCDP has been developed to guide activities during the construction and post construction phases of the HSRA development (refer to Appendix B). This Plan documents all PCD activities that have been conducted to date in relation to the HSRA and outlines a strategy and management plan for continued stakeholder engagement and information dissemination of environmental, social and other Project related matters during the development and operation of the HSRA.

The PCDP for the HSRA:

- Adopts the objectives and approach outlined in the Project's existing PCDP (ERM 2014);
- Recognizes and builds off the significant PCD activities conducted by NNP1 to-date;
- Promotes close collaboration with NNP1 SMO/EMO and GOL partners during PCD activity implementation;
- Improves (where possible), engagement and involvement of key stakeholders in the planning for the HSRA development; and
- Ensures compliance with GOL legislation and ADB safeguards requirements.

### 9.1 PCD Objectives

The goal of NNP1's PCD activities are to ensure opportunities exist for stakeholders to be involved in Project design, including potentially affected people.

Key objectives are to:

- Ensure that stakeholders concerns are incorporated in the Project design and implementation;
- Increase stakeholder awareness and familiarity with the Project;
- Ensure transparency in the decision-making process;
- Enhance the potential benefits by directly involving relevant stakeholders;
- Support a robust mechanism for recording and resolving project related issues and grievances; and
- Monitor the effectiveness of environmental and social impact mitigation, resettlement, compensation and livelihood restoration.

### 9.2 Summary of Consultation Activities

#### 9.2.1 Previous Consultations

PCD activities for the Project began early in the Project preparation stage (2007) and have been carried out on an ongoing basis throughout the Project cycle. Activities have included meetings, focus groups discussions, and participatory engagements with affected communities; meetings and consultation with GOL agencies; and a number of stakeholder forums with a wide range of Project stakeholders.

### **Resettlement Communities**

Earlier PCD activities (2007 onwards) regarding resettlement and the HSRA were focused on PAPs in 'resettlement communities' who will be impacted by reservoir inundation including:

- Three (3) communities in Zone 2: Upper Reservoir Area (2UR);
- Four (4) communities in Zone 2: Lower Reservoir Area (2LR); and
- One (1) village in Zone 3: Construction Area (Z3).

Consultations with resettlement communities resulted in a number of key milestones:

- Agreement of resettlement options;
- Site selection; and
- Confirmed project design.

### **Host Communities**

More recent PCD activities (2014 onwards) have also included PAP's in 'host communities' who are currently using the proposed HSRA including:

- One (1) village in the Construction Zone (Z3);
- Two (2) communities in the Downstream Area (Zone 4).

Consultations with host communities have included:

- EIA / SIA consultations;
- Land and asset registration;
- Engagement with external monitoring agencies.

A summary of these activities and results is provided in Appendix B.

## **9.2.2 IEE HSRA Update Consultations**

PCD activities to support development of the IEE and INRMP have been designed and conducted in accordance with GOL and ADB safeguard standards. The first round of consultations focussed on data collection, general feedback and inputs into initial INRMP design while the second round of consultations involved a presentation of new information and discussion on the proposed detailed design of the HSRA.

Key topics for each element of the presentations were as follows:

- INRMP – Outline and discussion of preliminary land and forest zoning allocations that were developed and Protected Forest Area management in the proposed HSRA. Discussion of next steps in the PLUP process; and
- IEE – Discussion of the potential environmental and social impacts of the design and proposed mitigation and management measures during the construction and post construction phase.

Consultations with host communities have included:

- Provincial exhibition with GOL stakeholders;
- Provincial and district meetings with the GOL;
- Information gathering and Consultations with Host Communities; and
- Consultations with Resettlement Communities.

A summary of the results of these activities is provided in Appendix B.

## 9.3 PCD Activities: Resettlement Implementation

The following section outlines planned PCD activities during the construction and post construction phases of the HSRA. These activities will be implemented in accordance with NNP1's existing PCD principles and approaches outlined in the REDP (NNP1 2014) and summarised in Section 2.5.

### 9.3.1 On-ground PCD Activities

On-ground PCD activities relating to the development of the HSRA will be conducted in three (3) phase as outlined below.

#### ***Preparation***

Preparatory PCD activities commenced during the feasibility phase of the project and will continue during the construction phase until the majority of PAPs have been resettled to the HSRA. These activities will be led by NNP1 and include:

- Consultation and use of existing grievance mechanisms with host communities and later resettled villagers from Ban Hatsaykham concerning potential impacts related to the construction of the HSRA facilities;
- Further consultation with GOL and host communities regarding compensation and livelihood restoration activities and the conduct of participatory land use planning activities to ensure adequate allocation of village land and land use zones;
- Conduct of indicative Choice Survey on Resettlement/Self-Resettlement including consultations on Resettlement Plan for 2LR and resettlement options for women, youth and vulnerable people;
- Further consultations with GOL and resettlement villages regarding the INRMP and proposed land use planning and process for the HSRA;
- Construction of facilities within the HSRA for the conduct of effective PCD activities (i.e. village meeting building and village notice board); and
- Preliminary participatory land use planning activities with villagers from Ban Hatsaykham from April 2018 (planned resettlement date).

#### ***Participatory Land Use Planning***

Formal PLUP activities will commence in 2018 when the PAPs from 2LR villages have resettled to the HSRA. These activities will be led by relevant government provincial and district authorities with the support of NNP1. Activities are outlined in detail in the INRMP and include:

- Establishment of the village committee and natural resource management groups;
- Consultation activities to finalise village land and forest zoning;
- Consultation activities to finalise village natural resource management plans and agreements for GOL endorsement;
- Conduct of land registration and titling for individual land and community land;
- Provision of relevant land and forest data to village, district and provincial authorities; and
- On-going NNP1 engagement and support during the implementation of natural resource management plans and agreements.

During the PLUP process NNP1 will also:

- Establish a formal grievance mechanism for the newly established Houay Soup village; and

- Conduct Livelihood Restoration and Community Development Activities including programs for agricultural extension, health, education and vulnerable households.

### Monitoring

NNP1 will work closely with GOL authorities and Project lenders to ensure that the following monitoring activities are undertaken:

- Implementation of an ongoing social monitoring and management program including regular consultations with village and GOL authorities and monthly, quarterly, annual government reporting; and
- A participatory review of PLUP implementation by relevant GOL authorities with the support of NNP1, two (2) years after the completion of Phase 2 PLUP activities.

### Other monitoring

- EMU monitoring; and
- External monitoring reports from LTA, IAP missions.

## 9.4 Other PCD Activities

Other PCD activities will include:

- Provincial and central government engagements such as meetings, workshops, exhibitions, site visits etc.; and
- Wider stakeholder PCD activities including public reporting, public information dissemination (i.e. website) and the conduct of broader stakeholder forums.

**Table 9-1 PCD Management Plan - Targets and Actions, Schedule, Responsibilities**

Action	Schedule/ Frequency	Responsibility	Monitoring
<b>On-Ground PCD Activities</b>			
<b>Preparation Activities</b>			
Consultation and use of existing grievance mechanisms with host communities and later resettled villagers from Ban Hatsaykham concerning potential impacts related to the construction of the HSRA facilities.	October 2015 / weekly	NNP1 SMO	EMU/LTA/IAP
Further consultation with GOL and host communities regarding compensation and livelihood restoration activities and the conduct of participatory land use planning activities to ensure adequate allocation of village land and land use zones.	October / as required	NNP1 SMO	EMU/LTA/IAP
Conduct of indicative Choice Survey on Resettlement/Self-Resettlement including consultations on Resettlement Plan for 2LR and resettlement options for women, youth and vulnerable people.	September until December 2015	NNP1 SMO	EMU/LTA/IAP



Further consultations with GOL and resettlement villages regarding the INRMP and proposed land use planning and process for the HSRA.	October 2015 / as required	NNP1 SMO	EMU/LTA/IAP
Construction of facilities within the HSRA for the conduct of effective PCD activities (i.e. village meeting building and village notice board).	April 2016 / once	NNP1 SMO	EMU/LTA/IAP
Preliminary participatory land use planning activities with villagers from Ban Hatsaykham from April 2016 (planned resettlement date).	April 2016 / as required	NNP1 SMO	EMU/LTA/IAP
<b>Participatory Land Use Planning</b>			
Establishment of the village committee and natural resource management groups.	2018 / as required	PONRE/DONRE/P AFO/DAFO, NNP1 / RMU	WMC/PCLRC and LTA/IAP
Consultation activities to finalise village land and forest zoning.	2018 / as required	PONRE/DONRE/P AFO/DAFO, NNP1 / RMU	WMC/PCLRC and LTA/IAP
Consultation activities to finalise village natural resource management plans and agreements for GOL endorsement.	2018 / as required	PONRE/DONRE/P AFO/DAFO, NNP1 / RMU	WMC/PCLRC and LTA/IAP
Provision of relevant land and forest data to village, district and provincial authorities.	2018 / as required	PONRE/DONRE/P AFO/DAFO, NNP1 / RMU	WMC/PCLRC and LTA/IAP
On-going NNP1 engagement and support during the implementation of natural resource management plans and agreements.	2018 / as required	PONRE/DONRE/P AFO/DAFO, NNP1 / RMU	WMC/PCLRC and LTA/IAP
Establish and implement a formal grievance mechanism for the newly established Houay Soup village.	2018 / as required	NNP1 / RMU	PCLRC and LTA/IAP
Conduct Livelihood Restoration and Community Development Activities including programs for agricultural extension, health, education and vulnerable households.	April 2016 / Ongoing until the end of 2023, five years after COD	NNP1 / RMU	WMC/PCLRC and LTA/IAP
<b>Monitoring</b>			
Implementation of an ongoing social monitoring and management program including regular consultations with village and GOL authorities and monthly, quarterly, annual government reporting.	Monthly, Quarterly, Semi-annual	NNP1 SMO, LTA and IAP Missions	PCLRC and LTA/IAP
A participatory review of PLUP implementation two (2) years after the completion of Phase 2 PLUP activities.	two (2) years after the completion of Phase 2 PLUP activities	PONRE/DONRE/P AFO/DAFO, NNP1 / RMU	PCLRC and LTA/IAP
EMU Monitoring.	Ongoing / As required	NNP1/EMU	EMU and LTA/IAP
External monitoring reports from LTA, IAP missions.	Semi-annual	LTA/IAP	LTA/IAP
<b>Other PCD Activities</b>			

Provincial and central government engagements such as meetings, workshops, exhibitions, site visits etc.	Quarterly / As required	NNP1 SMO	GOL/LTA/IAP
Wider stakeholder PCD activities including public reporting, public information dissemination (i.e. website) and the conduct of broader stakeholder forums.	As required	NNP1 SMO	GOL/LTA/IAP

Source: REDP 2014, Earth Systems 2015

## 10 CONCLUSION

The assessment of the IEE concludes that the establishment of the HSRA is important so as to enable the planned resettlement for the Nam Ngiep Hydropower Project.

The proposed HSRA is considered a viable site for the NNP1 resettlement program:

- The HSRA has ample forest resources and water resources. Communal land use rights will be required to sustainably manage and provide adequate resources for the resettled communities;
- While HSRA soils have been confirmed to be poor for agriculture purposes across the HSRA, the physical and chemical deficiencies can be suitably ameliorated with the implementation of a robust soil improvement program;
- The siting of the RDS will primarily occur on highly disturbed land and habitat;
- Preliminary modelling indicates that a small part of the residential area may reside in the peak storm event flood zone. With the annexure of the additional 648 ha, ample land exists for re-siting if required. Current road alignment and design should be considered in the context of the anticipated flood regime; and
- Implementation of an environmental flow is considered a key factor in sustaining aquatic habitat and aquatic fauna in the Ban Houay Soup and its tributaries.

Residents of Ban Hat Gniun and to a lesser extent Ban Somseun who are currently allocated and using land and natural resources inside the proposed HSRA have the potential to be significantly impacted by the establishment of the HSRA. These PAPs require compensation to be implemented in accordance with the REDP (NNP1 2014).

Monitoring and management of the HSRA during the construction and post construction phases will be required to ensure that Nam Ngiep environmental and social standards are implemented.

### **Key Recommendations**

It is recommended that NNP1:

- Consult with the GOL and ADB regarding HSRA host communities and the identification of approximately 30 households from Ban Somseun, prior to the commencement of construction;
- Continue to work with the GOL and residents of Ban Hat Gniun and Ban Somseun to identify suitable compensation, livelihood restoration, and / or provision of additional village land to recompense for land / livelihood losses associated with HSRA development and the decrease in agriculture / livestock land for these two communities, before completion of HSRA construction;
- Conduct flood modelling to ensure HSRA infrastructure, including residential areas and road networks, are outside the flood zone for peak annual storm events;
- Engineer the Houay Soup Noi irrigation water supply dam and the Houay Soup Ngai domestic water intake facility to provide for ongoing (365 days per year) environmental flows equivalent to at least baseflow for these streams. Adequate water volume will be available, given sourcing from the Nam Ngiep River Re-regulation Reservoir;
- Ensure continuous hydrologic connectivity of the Houay Soup Noi and Houay Soup Ngai with the Nam Ngiep River to allow for continued fish residency and migration. Engineer the irrigation channels to allow continuous stream flow to bypass the irrigation system or merge them with discharge outlets at the river; and
- Rehabilitate and revegetate unused logging road network in the PFA to restrict vehicular access, minimising the likelihood of large-scale timber operations in the higher elevations of the PFA.

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## 12 APPENDICES

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## **Appendix A: Integrated Natural Resource Management Plan**

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## **Appendix B: Public Consultation, Participation and Information Dissemination Plan for HSRA development**

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## Appendix C: Infrastructure Schedule

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## Appendix D: Terrestrial Flora, NTFP and TFP

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## Appendix E: Terrestrial Fauna

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## Appendix F: Fish and Aquatic Resources

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## Appendix G: Soils Analysis

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## Appendix H: ESMMP-CP Sub-Plans (ERM, 2014)

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## **Appendix I: Applicable Project Standards (ERM, 2014)**

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## **Appendix J: Requests and Approvals for PFA Land Category Transformation for PFA to HSRA Settlement Area**

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