Initial Environmental Examination

Project No.: 50099-003
June 2018

REG: Fourth Greater Mekong Subregion Corridor Towns Development

Pakxan Subproject

Prepared by the Ministry of Public Works and Transport for the Asian Development Bank.

CURRENCY EQUIVALENTS

(as of 18 June 2018)

Currency unit	–	Kip (LAK)
LAK1.00	=	$0.000119
$1.00	=	LAK 8,412

ABBREVIATIONS

ADB	–	Asian Development Bank
AP	–	affected person
CEMP	–	contractor environmental management plan
CSO	–	combined sewer overflow
DHUP	–	Department of Housing and Urban Planning
DONRE	–	Department of Natural Resources and Environment
DPWT	–	Department of Public Works and Transport
EIA	–	environmental impact assessment
EIAR	–	environmental impact assessment report
EHS	–	environmental, health, and safety guidelines
EMP	–	environmental management plan
EMR	–	environmental monitoring report
ERT	–	emergency response team
ESO	–	environmental safeguard officer (of executing agency)
ES	–	environmental specialist
GHG	–	greenhouse gas
GMS	–	Greater Mekong Subregion
GMS-CTDP-4	–	Fourth Greater Mekong Subregion Corridor Towns Development Project
GRM	–	grievance redress mechanism
HDPE	–	high-density polyethylene
IEC	–	information, education and communication
IEE	–	initial environmental examination
IEER	–	initial environmental examination report
Lao PDR	–	Lao People's Democratic Republic
MONRE	–	Ministry of Natural Resources and Environment
MPWT	–	Ministry of Public Works and Transport
PIU	–	project implementation unit
PIC	–	project implementation consultant
PMU	–	project management unit
PPE	–	personal protective equipment
PPTA	–	project preparatory technical assistance
SES	–	socio-economic survey
SPS	–	Safeguard Policy Statement
SWTP	–	small-scale wastewater treatment plant
UDAA	–	Urban Development Administrative Authority
USD	–	United States dollar
UXO	–	unexploded ordnance
WWTP	–	wastewater treatment plant

UNITS OF MEASURE

ha	–	hectare
km	–	kilometer
m	–	meter
m^3	–	cubic meter
tpy	–	tonne per year

NOTES

(i) The fiscal year (FY) 2018 of the Government of the Lao People's Democratic Republic and its agencies ends on 31 December 2018.

(ii) In this report, "$" refers to United States dollars.

This initial environmental examination is a document of the borrower. The views expressed herein do not necessarily represent those of ADB's Board of Directors, Management, or staff, and may be preliminary in nature.

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EXECUTIVE SUMMARY

A. Introduction

1. The Fourth Greater Mekong Subregion (GMS) Corridor Towns Development Project (GMS-CTDP-4, or Project) will support the governments of Cambodia and the Lao People's Democratic Republic (PDR) in enhancing the competitiveness of towns located along the Central Mekong Economic Corridor in the GMS. The Project will support at least three of the seven strategies of the ten-year Socio-economic Development Strategy (2016–2025),[1] and also contribute to one of the five key government directions of the 8th Five-Year National Socio-Economic Development Plan (2016–2010).[2]

2. In Lao PDR, the Project will cover the districts of Pakxan and Thakhek in the provinces of Borikhamxay and Khammouane, respectively (Figure 1). Both districts lie along National Road 13 (NR 13) and are located on the banks of the Mekong River. The districts have significant economic potential given the strategic road network that provides access to Thailand and Viet Nam. However, the districts suffer from perennial flooding due to lack of adequate drainage system. There are also problems on solid waste management, environmental sanitation, and wastewater disposal that need to be addressed to sustain socio-economic competitiveness.

3. This report is the draft initial environmental examination (IEE) and environmental management report (EMP) (Appendix A) for the proposed GMS CTDP-4 – Pakxan Subproject. The IEE and EMP were prepared following the Safeguard Policy Statement (SPS, June 2009) of the Asian Development Bank (ADB) and Environmental Protection Law 2012 (No. 29/NA) of Lao PDR and its implementing guidelines.

B. Description of the Subproject

4. The proposed infrastructure components in Pakxan are as follows:

Component	Description
Storm water drainage improvement	○ Four new trunk drains (lines A to D), length 7.23 km; catchment area of 465 ha ○ Road drains for 19 existing small roads, length 16.10 km, 800 mm size
Small-scale wastewater treatment system (SWTP) for treatment of black water only	Four SWTP units located at: ○ Pakxan 1[3] (Old Town) urban area in an existing wetland east of the urban center, capacity 300m^3/day; pipe network 7225 m of 150mm diameter ○ Pakxan 1 hospital compound, capacity 200m^3/day; pipe network 2009m of 150mm diameter ○ Pakxan 2[4] (north) on low point close to the riverbank to the east of the main new town to serve the urban area, main market and bus station, capacity 200m^3/day; pipe network 6839m of 150mm diameter
	○ Pakxan 2 (south) in Phonexay village on rice field south of NR-13S to serve Phonexay village with capacity of 200m^3/day; pipe network 4325m

[1] Namely (i) strategy on quality, inclusive, stable, sustainable and green economic growth, (ii) strategy on 'least developed country' graduation by 2020 and progress on the sustainable development goals, and (iii) strategy on sustainable and green environment with effective and efficient use of the natural resources.

[2] Ensuring sustainable development with harmonization between economic development, socio-cultural development and environmental protection.

[3] Pakxan 1 refers to the "old town" area with the main road running north-south along the east bank of the San River to the confluence of the San and Mekong rivers.

[4] Pakxan 2 refers to the new administrative center with the main road running north-south on the west side of the San River.

	of 150mm diameter o Free household connections (1,635 HHs in 2020)
Pakxan municipal solid waste controlled landfill	o Controlled landfill with volume capacity of about 226,100 m^3 compacted waste over 20 years o Six waste collection and compaction vehicles o One crane for handling recyclables o Septage treatment plant.
Riverbank protection along San River	Two sections: o From the confluence of the San and Mekong rivers up to the road bridge (950m) o Continue a further 890m upstream of the road bridge to where there are no houses.

5. The subproject will also enhance institutional capacities of the Executing Agency (EA) and Implementing Agency (IA) officials through the following interventions:

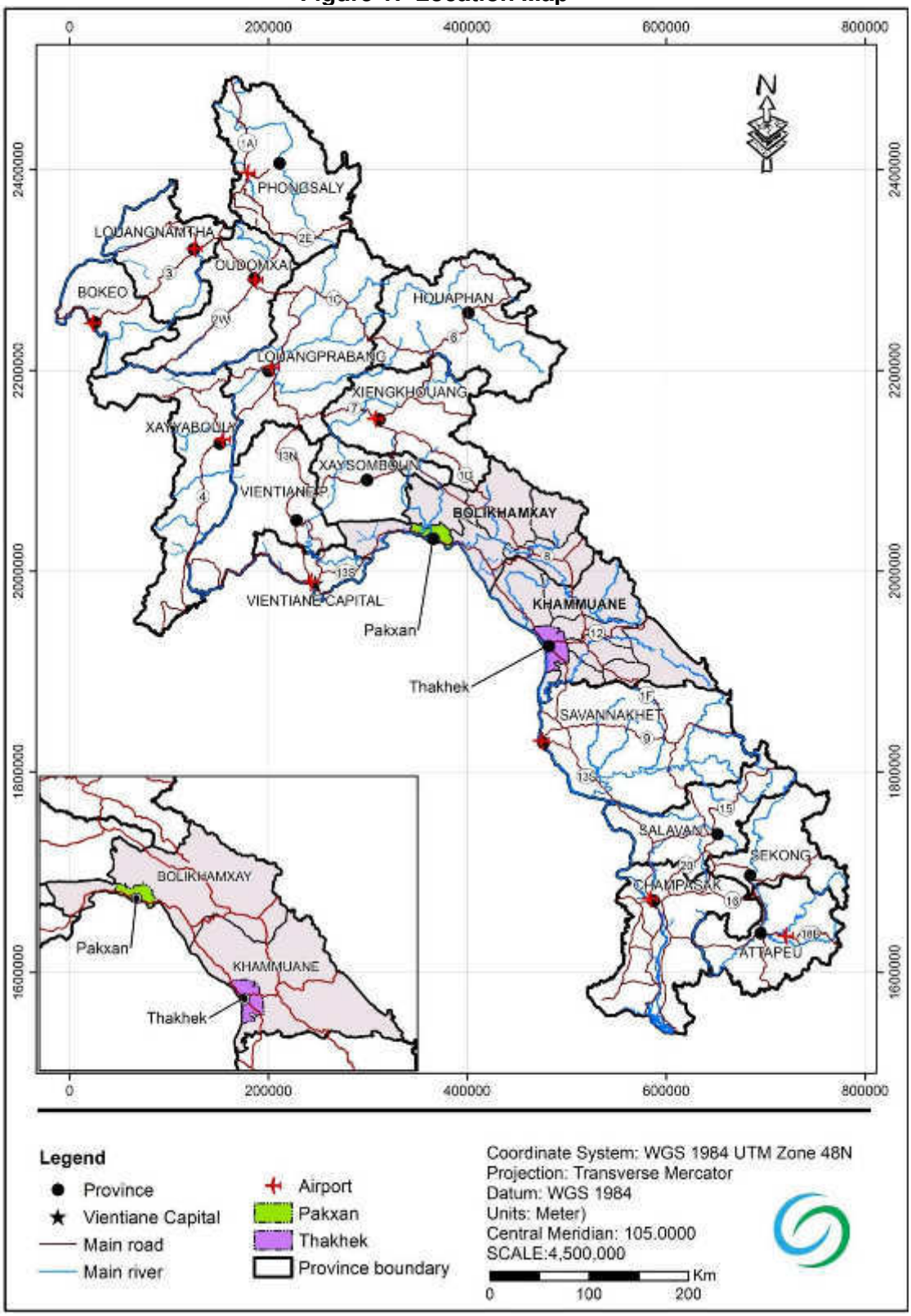
- Training on SWTP, solid waste management (SWM), and urban asset operation and maintenance (O&M)
- Support to project management, construction supervision, and social and environment safeguards monitoring
- Awareness raising campaign
- Formulating the provincial town master plan.

C. Key Findings

6. **Environmental benefits, positive impacts and results.** The Pakxan subproject will provide the town with improved stormwater, small-scale wastewater treatment plants and solid waste management services, enhance river flood protection, strengthen institutional capacities, and formulate a 5-year provincial development strategy. The positive impacts include: reduced flood risk; reduced health risks and incidence of diseases; reduced pollution to the Mekong and San River, improved water quality and improved environmental sanitation; controlled greenhouse gas (GHG) emissions from solid waste disposal; reduced air, water and land pollution; improved social equity from access by all to recreational amenity; and urban growth in a more sustainable direction. The subproject will lead to: (i) improved climate resilience; (ii) reduced vulnerability to climate risks; and (iii) enhanced quality of life and livability.

7. **Stormwater Drainage Improvement.** The proposed drainage improvement works will follow the natural drainage pattern to a natural flood retention basin so diversion of flow is not foreseen. The assimilative capacity of the receiving retention basin will be assessed further during detailed design to ensure that the flows from all four drains, along with the effluent from the SWTP for Pakxan 1 old town area amounting to 300 m^3/day, will not cause overflow and flooding in the surrounding areas where there is some agricultural land and community areas that may be affected. During the laying of the stormwater drainage, there may be structures and irrigation systems that may be temporarily affected, control measures are included in the EMP.

Figure 1: Location Map



8. **Small-scale Wastewater Treatment Plants (SWTPs).** The wastewater treatment

component will include the construction of the four SWTP units and the laying of sewer lines along road easements to channel and treat black water from the service area.

9. The sewer lines will be laid along road easements and will affect drainage lines, sidewalks, driveways, electric poles and water lines during pipe laying. Coordination with affected agencies, utility companies and stakeholders will be undertaken during detailed design. Restoration of damaged road easement, sidewalks, and driveways will be undertaken after the laying of the sewer lines.

10. The impacts of the SWTP will be generally positive because treatment of domestic sewage will avoid the pollution of waterbodies and reduce incidences of water-borne and water-related diseases caused by unsanitary practices and exposure of the people to untreated wastewater. The operation of the four SWTPs is expected to reduce the BOD concentration being discharged into receiving bodies of water by >300 mg/l to 29 mg/l or about a 90% reduction in BOD concentration.[5] By treating wastewater, the project will avoid water pollution and contribute to the clean-up of the receiving water bodies. Table 6 presents the effluent quality before and after treatment.

11. The SWTP units will be designed to conform to the national effluent discharge standards to avoid impacts on the users of the receiving stream and Mekong River. Regular monitoring of effluent quality should be part of routine operational monitoring parameters to ensure that discharges are complying with the prescribed standards as embodied in the Mekong River Commission Guidelines for the Protection of Aquatic Life and the National Environmental Standards No. 81/NA (21 February 2017).

12. The SWTP for Pakxan 1 old town area will be located in a grassland area that is adjacent to some residential houses along a narrow road and agricultural areas. The effluent from the SWTP is proposed to be discharged into the adjacent wetland or retention basin. The receiving basin is usually dry during the months of October to April with a section in the middle with water all throughout the year. The site of the SWTP for Pakxan 1 old town area has been selected at the elevated dry edge of the wetland. The wetland or retention basin will be further evaluated during detailed design to check the hydrological capacity of the receiving basin and to determine interventions needed to avoid flooding or overflows of the basin into adjacent areas.

13. The second SWTP that will serve Pakxan 1 is located at the corner section of the Borikhamxay provincial hospital compound that is adjacent to the main road. The toilet waste from the hospital and dormitory and the hospital's immediate surroundings (about 480 population) will be accommodated at the SWTP. The effluent from the SWTP at the hospital compound amounting to 200m^3/day will drain into the Mekong River and should comply with the National Environmental Standards (81/NA). There is no foreseen impact in terms of capacity of Mekong River to receive the effluent from the SWTP.

14. The SWTP for Pakxan 2 (south) will be located on private agricultural land with higher elevation than the proposed site of the sewer line. This would entail pumping of wastewater to bring the influent to the SWTP site. The SWTP for Pakxan 2 (south) will discharge into the San River and there is no foreseen impact on the capacity of the receiving stream since the river is large enough to accommodate the flow of 200 m^3/day. However, effluent quality should ensure compliance with the National Environmental Standards 81/NA to protect the uses of San River.

[5] Based on BOD concentration of inflow of 333 mg/l) and effluent concentration of 29. mg/l) after treatment.

15. The SWTP for Pakxan 2 (north) is located in a low-lying area in Phonexay village where storm water accumulates during a rain event for a maximum of one day according to the landowner of the site. The site will be evaluated further during the design phase to determine buffer against flooding and if backfilling will be needed.If backfilling will be undertaken, appropriate measures to avoid flooding of adjacent properties will be required such as provision of adequate drainage lines leading to Mekong River. In terms of capacity of the receiving stream, the discharge of effluent from the SWTP for Pakxan 2 (north) is not expected to cause an impact on the hydrology of Mekong River because the effluent flow is small and the river can accommodate the discharge from the SWTP.

16. The operation of the SWTP may result in changes to natural surface hydrology and drainage pathways and risk of pollution if facilities are flooded. The detailed design will include more detailed hydrological assessment and measures to reduce flood risk, such as incorporating bunds and raising the elevations of the SWTP units above potential flood levels.

17. **Controlled Landfill.** The controlled landfill will be located within the 9-hectare (ha) area of land that is currently utilized as the open dumpsite. The closure plan of the existing dumpsite involves the transfer of the existing wastes to the new lined waste cell of the proposed landfill that will be constructed within the existing dumpsite compound. The plan will also prioritize key mitigation features, including (i) surface grading and covering of exposed waste cell surfaces to improve controlled runoff and reduce erosion, and (ii) site perimeter drains to control surface water run-on and runoff. Access to the site is via a 1 km laterite road through Nasommo village. The laterite road will be improved and forms part of the primary impact area of the controlled landfill component.

18. The frequent movement of waste haulers along the access road will cause nuisance to villagers living along the access road to the landfill. On the average, there will be about 24 truck trips per day to the landfill site during the operational phase. The project includes surface improvement of this laterite road to the landfill site to prevent dust emission during frequent movement of waste haulers. During the landfill operation, access road maintenance will form part of DPWT's regular program. This will include typical road repairs, cleaning, adding or grading of soil and gravel, filling holes, and cleaning of drainage ditches. In addition, waste haulers will be properly trained and instructed to minimize vehicle speeds while passing through the settlement areas.

19. There are waste pickers at the dumpsite who earn a living by collecting recyclable plastics. Waste glass bottles and metals are not being sorted out because of the lack of buyers of these wastes in Pakxan. The nearest residential house to the landfill is located about 500-meter from the site, along the laterite access road in Nasommo village. There are no waste picker households living at the site, but there are only temporary sheds being used as resting area and for storage of sorted recyclables placed in sacks.

20. There are no nearby water bodies that may be affected in the immediate vicinity of the landfill but groundwater quality sampling from a village well indicated exceedances with the Lao PDR drinking water quality standards in terms of Pb, As, Cd, NO3, total coliform, E. coli, and fecal coliform. During the consultation meeting held in April 27, 2018, the results of the groundwater sampling were disclosed and the head of the Nasommo village agreed to inform the villagers and prohibit them from drinking water from the contaminated well. Groundwater monitoring will continue during project implementation with additional monitoring stations at the downgradient and upgradient of the landfill site.

21. The identified potential impacts of the controlled landfill include the clearing of vegetation, accidental discovery of mine/UXO, soil runoff, and odor during mining or transfer of existing wastes to the new waste cells due to ongoing decomposition of wastes. The concerns and potential impacts during controlled landfill operations include: (i) generated dust, gas, fumes and odor; (ii) greenhouse gas emissions; (iii) potential groundwater and soil contamination from leachate and landfill gas migration; (vi) pests/rodents/vermin, bird and stray animal attraction; (vii) wind-blown litter; (viii) fire/explosion; (ix) community health and safety; and (x) workers' health and safety hazards.

22. During the construction and operational phases, the impacts of the controlled landfill on groundwater, air quality and soil quality will be monitored by establishing monitoring stations at the landsite site and surrounding areas. Workers will also be trained on waste handling, recording, including wearing of personnel protective equipment while working at the site. Fire protection system to manage occasional landfill fires during the dry season will be provided and a materials recovery facility (MRF) at the landfill site will be established to temporarily store collected recyclables to be sold to buyers.

23. **Riverbank Protection.** The riverside embankment will be located in two sections at the eastern bank of the San River. These riverbank sections have experienced flooding and erosion of banks in the past, hence, require protection against potential future flooding. There are sections where roots of trees have been exposed due to bank scouring. The proposed riverbank protection will strengthen and raise the riverbank and save these large trees. Cutting of trees along the riverbank will be avoided by the project. During the construction of the riverbank embankment, possible blocking of one lane of adjacent roads may occur particularly during delivery of construction materials to the site. Vehicle movement is not heavy at the adjacent roads but a traffic management system will be implemented to guide motorists during temporary lane blocking. Construction activities may also cause bankside erosion and pollution of the San River, hence, erosion control and water quality protection measures are included in the EMP. There are two temples near the riverbank sections which may experience temporary noise disturbance and dust during the construction activities. The contractor will be required to coordinate with the temple authorities to avoid disruption of temple services and nuisance to the surrounding area.

24. The issues and concerns that need to be resolved or acted on during the pre-construction phase could be classified into those relating to: (i) design, i.e. ensuring components are climate-resilient and minimize environmental impacts; (ii) loss of private assets due to land and rights-of-way acquisition; and (iii) preparation and readiness of key subproject stakeholders and affected communities prior to implementation of the subproject components. To ensure there is adequate capacity to implement environmental mitigation and monitoring measures consulting services will include qualified environmental personnel who will provide environmental training and capacity building for EA/IA and Contractors.

25. Prior to construction, there will be a need to obtain UXO clearance, conduct baseline environmental studies that includes ecological survey and hydrological assessment of the receiving wetland at Pakxan 1 old town area, environmental sampling (ambient air, noise, groundwater quality, soil quality, as presented in the EMP), operationalize a grievance redress mechanism, update the IEE and EMP based on detailed engineering design, obtain relevant DONRE/MONRE approval of IEE/ESIA, and incorporate the EMP in bidding and contract documents. During detailed design, the environmental issues associated with the existing dumpsite such as groundwater pollution, will be reviewed and addressed in the design. The

update of the IEE/EMP for ADB will include supplementary baseline assessments[6] and public consultation.

26. **Air Quality.** The controlled landfill will generate landfill gas.[7] These gases are formed through organic decomposition processes within waste masses, with decomposition being accelerated through saturation due to the ingress of precipitation and surface waters. The transition from uncontrolled open dumping to controlled landfilling will however reduce the impacts of landfill gas generation and emission to some extent, due to (i) surface covering (capping) system, thus reducing surface water inundation, and (ii) through the controlled venting of landfill gas from the facility, which will reduce fire and explosion risks.[8]

27. Using the IGES tool, the estimated GHG emission from the controlled landfill operation, as designed, is 45,0336 kg of CO_2/monthly managed waste. A simulation was made to see how much emissions would be saved if the following measures would be implemented by the project:

- Waste to be collected is reduced by 15% due to active recycling at source.
- Waste collection frequency is every other day except for market waste.
- Composting of about 20% of the waste collected at the landfill site.

28. The simulation revealed a reduction of greenhouse gas by 62% as compared to the current open dumping of wastes.

29. **Odor.** The handling of organic wastes at the SWTPs and controlled landfill will generate odor. The SWTPs will be located away from major receptors and the sites will have berms and tree lines to act as buffer against odor. The controlled landfill in Pakxan is not located near community areas (houses are about 500 m away from the landfill site). Odor is expected to be minimized with the controlled landfill operation as compared to the current open dumping activities at the site. The odor control measures include the soil covering of wastes to significantly reduce odor and planting of trees around the landfill site to act as buffer against odor.

30. **Hydrology.** The consolidated flows from the stormwater drainage and sewer network would have an impact on the receiving water bodies in terms of assimilative capacity, uses and water quality. The runoff and stormwater flowing from the four road trunk drains and the effluent discharge from the SWTP for Pakxan 1 old town area will be assessed during detail design to check the assimilative capacity of the retention basin/wetland to receive the storm runoff from the road trunks and the SWTP to ensure that flooding will not be induced in the surrounding areas. Climate risk mitigation options will be considered during detailed design such as the detailed analysis of historical and projected future flood levels taking into account climate change, increasing rainfall intensities, and land use changes.

31. There is no anticipated problem in terms of the hydrological capacity of the San River and Mekong River to accommodate the effluent discharges from the SWTPs for Pakxan 2 and the SWTP located at the hospital compound in Pakxan 1 because these rivers are very large as compared to the minimal volume of effluent to be discharged from the SWTP units.

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[6] These include for example, the sampling and analysis of biodiversity, air quality, surface waters, groundwater, soils (vadose zone), noise.

[7] Landfill gas includes the primary greenhouse gases (GHGs) of carbon dioxide, methane and nitrous oxide.

[8] In the future, it may be feasible to install LFG flaring systems at the controlled landfill, however at the present time, such installation would be difficult due to the challenges in capture such small quantities of generated LFG, and the excessive cost of the system.

32. The locations of the SWTPs at Pakxan 1 old town and at Pakxan 2 (north) and the riverbank protection works are reportedly flooded in the rainy season. The SWTPs need to be protected against potential overflowing of the adjacent waterbodies which could cause damage to the SWTP units. The SWTP will be raised to an elevation that is above conventional flood levels of the wetland/retention basin, ensuring separation between the effluent and surrounding surface waters. Factor of safety will be incorporated based on detailed analysis of the flood situation to protect the SWTP from inundation. Bunds around SWTP units will be provided.

33. The SWTP facilities will also be designed to meet appropriate regulatory standards for effluent discharge. These include (i) specifying maintenance procedures in SWTP operations manuals, (ii) ensuring adequate budget and equipment for routine maintenance activities, (iii) removing flow obstructions in the sewer system, (iv) conducting operator training for SWTP operations and maintenance (O&M), and (v) monitoring water quality of the effluent to receiving water bodies following an overflow event.

34. **Water Quality.** The subproject components that will cause impacts on water quality are the SWTPs and the controlled landfill. The SWTP impacts on water quality are generally positive since it will avoid pollution of receiving water bodies. Regular maintenance of the SWTPs should be undertaken to ensure that effluents conform with the prescribed discharge standards.

35. Surface water quality impacts at the controlled landfill (during operations) include: (i) surface water run-on,[9] (ii) site water runoff, (iii) waste mass inundation, and (iv) discharge of leachate. Surface water run-on and runoff will be mitigated through the provision of perimeter drains. The potential for waste mass inundation from precipitation will be mitigated through the provision of cover materials over waste mass surfaces, and drainage of these areas through the contouring of surfaces and installation of surface drains to encourage flow. Completed waste mass surfaces can also be vegetated to reduce cover material erosion.

36. Leachate may impact surface waters by its migration through the sidewalls and bases of the landfill. This will be mitigated through provision of base liners to capture leachate which will be collected in a leachate pond for landfill reticulation.[10]

37. **Groundwater.** A failure of the integrity of the sewer systems, the SWTPs and the controlled landfill could result in leakage of untreated or partially treated wastewater effluents, which in turn could percolate into and contaminate soil and the underlying groundwater. These impacts will be mitigated however by ensuring system design and operation integrity through both the facility designs (that provide for system sustainability) and facility O&M procedures, which are supported by training, monitoring and evaluation.

38. **Disposal of sludge from SWTPs.** The SWTPs will be designed with anaerobic tanks to treat wastewater delivered from the sewer lines. Using this system and with the low volume of wastewater to be treated in each unit, sludge generation is expected to be minimal at about 5.04 m^3/year[11] (total) for all the four SWTPs. Based on the conceptual plan of the wastewater treatment plant, sludge will be removed annually or every two years. Sludge from anaerobic treatment is largely inert, can be dried and landfilled or applied to agricultural land. During the first two years of operation of the SWTPs, sludge that will be collected will be analyzed in terms of bacterial content before these are applied to agricultural land. If the results show consistent absence of

[9] Surface water run-on is the movement of surface water onto the site.
[10] Refers to leachate recirculation with trickle irrigation of used cells.
[11] Sludge generation rate is estimated at 0.0056 m^3 per m^3 of wastewater per year.

bacterial contamination, only then can this be applied to agricultural land, otherwise, sludge will be dried and sent to landfill.

39. **Health and Safety Aspects.** Operations and maintenance (O&M) activities of the SWTPs and controlled landfill pose risks to the health and safety of workers. These risks will be mitigated through preparation of an operations manual for the SWTP and controlled landfill, which shall include an occupational health and safety plan (OHSP) and capcity building program.[12]

D. Environmental Management Plan

40. The EMP will serve as the framework for the environmental management of the subproject, commencing from the detailed design phase through to operation and if applicable, decommissioning. The EMP addresses the potential impacts and risks identified in the IEE. It includes: (i) mitigation measures; (ii) monitoring measures; (iii) implementation arrangements and responsibilities; and (iv) preliminary costs for EMP implementation. The EMP will be updated by the Project Management Unit (PMU) based on the detailed design, with technical assistance from the Environmental Specialists of the Project Management and Construction Supervision (PMCS) Consultant.

41. The EA will ensure that the subproject complies with the environmental requirements and standards as stipulated in the Law on Environmental Protection No. 29/NA and other Ministerial Instructions and directives. An Environmental and Social Impact Assessment (ESIA) report for the controlled landfill component will be submitted to MONRE to secure the Environmental Compliance Certificate (ECC) prior to project implementation while IEE reports will be prepared for the components on drainage improvement, riverbank protection and SWTPs. The IEE reports are to be reviewed by the DONRE in securing approval of the ECC for the subproject components prior to implementation.

42. A Project Implementation Consultant (PIC) with Environment Specialists (1 international and 1 national) will be commissioned to provide support to MPWT and DPWT. Sufficient budget through the PIC will be allocated for the conduct of baseline studies and ECA, updating of the IEE, preparation of IEIA and EIA for DONRE/MONRE, implementation of the EMP and environmental monitoring plan and post-closure monitoring of existing dumpsite. The PIC will work in close coordination with the Public Works and Transport Research Institute (PTRI) of the MPWT in ensuring the project's compliance with environmental safeguards identified in the EMP. An Environment Safeguards Officer under the PTRI will be engaged and assigned to the project to sustain the environmental management and monitoring activities of MPWT. Capacity building program on environment safeguards will be undertaken by the PIC providing hand-on training for the PTRI, Project Coordinating Units (PCUs), Project Implementation Units (PIUs), and other relevant units and agencies.

E. Conclusion

43. The IEE concludes that the proposed subproject components in Pakxan will not some adverse impacts during construction and operation but they can be readily managed through effective implementation of mitigation, monitoring and maintenance measures. The classification of GMS-CTDP-4 Pakxan Subproject is confirmed as Category B for environment. Direct impacts during operation will for the most part be beneficial resulting in improvement of the urban

[12] Based on the Environmental, Health and Safety Guidelines for Water and Sanitation of the International Finance Corporation, dated 10 December 2007.

environment in Pakxan, reduction of pollution impacts, reduction of vulnerability to environmental and climate risks, improvement of health and support to a more sustainable development path for the future. The project will provide Pakxan with improved management services for stormwater, wastewater and solid wastes and enhance flood protection from river overflows.

44. Overall, the subprojects in Pakxan are not expected to have long-term permanent/irreversible adverse impacts. Any adverse impacts can be mitigated through design and engineering interventions. There are no significant adverse environmental impacts resulting from the subproject that cannot be mitigated if implemented effectively and efficiently. The proposed EMP will mitigate impacts on the natural environment and affected people to an acceptable level. The adverse impacts during construction will be temporary and short-term (i.e. most likely to occur only during peak construction period) and can be readily mitigated with effective implementation of mitigation and monitoring measures. The SWTPs and landfill operations will be guided by respective operations manuals. Institutional capacities will be strengthened through continued capacity development.

45. In terms of climate risk, given their nature, the proposed components will be vulnerable to climate change particularly the stormwater drainage and SWTPs. Hence, it is critical that the components are designed to ensure flood resilience, particularly the site of SWTP in Pakxan 1 old town and the four stormwater drains which all discharge to a natural drainage retention basin. The proposed components will be optimally engineered to avoid and/or minimize adverse impacts to surrounding communities and to ensure resilience to climate risks. Detailed analysis of historical and future flood levels, rainfall intensities taking into account climate change to determine appropriate factors of safety, will be considered in the design.

46. Mitigation measures that have been integrated in the preliminary design to address climate risks are: (i) raising of banks of trunk drains by 1 m above ground and enlargement of channel; (ii) adequate sizing of road drains for potential increase in runoff; (iii) concreting of roads and installation of larger drains at the controlled landfill; (iv) leachate recirculation; (v) raising of embankment by 1 m; and (vi) use of geotextile layers under gabion blankets for the river bank protection.

47. Additional measures to improve flood resilience will be considered during detailed engineering design, as set out in the Climate Risk and Vulnerability Assessment report and as presented in summary in this IEE.

I. INTRODUCTION

A. Background

1. The GMS-CTDP-4 or Project) will support the governments of Cambodia and the Lao People's Democratic Republic (PDR) in enhancing the competitiveness of towns located along the Central Mekong Economic Corridor in the GMS.

2. The Project will improve urban services and competitiveness in the participating towns, namely, Pakxan and Thakhek in Lao PDR. Both towns lie along National Road 13 (NR 13) and are located on the banks of the Mekong River. In Pakxan, the Project will include urban infrastructure improvements, particularly (i) storm water drainage, (ii) small-scale wastewater treatment systems, (iii) municipal solid waste-controlled landfill, and (iv) riverbank protection along the Mekong River and San River. It will also support the development of institutional capacities for enhanced regional economic connectivity, particularly through the formulation of the next provincial 5-year strategic development plans.

3. The Project will support at least three of the seven strategies in the Ten-Year Socio-economic Development Strategy (2016–2025) of Lao PDR, namely: (i) quality, inclusive, stable, sustainable and green economic growth; (ii) "least developed country" graduation by 2020 and progress on the sustainable development goals; and (iii) sustainable and green environment with effective and efficient use of the natural resources. The Project also contributes to one of the five key government directions of the 8th Five-Year National Socio-Economic Development Plan (2016-2010) to ensure sustainable development in harmony with economic development, sociocultural development and environmental protection.

4. The project environment classification is confirmed as Category B. This report is the IEE and EMP for the proposed GMS-CTDP4 – Pakxan Subproject.

B. Purpose of the Report

5. This IEE and EMP have been prepared according to the Safeguard Policy Statement (June 2009) of the Asian Development Bank (ADB), and the Environmental Protection Law 2012 (No. 29/NA) of Lao PDR and its implementing guidelines. This IEE and EMP: (i) identify and assess potential impacts and risks arising from the implementation of the proposed subproject on the physical, biological, physical cultural and socioeconomic environment; and (ii) recommend measures to avoid, mitigate, and compensate for adverse impacts, and enhance positive impacts.

6. The IEE is based on relevant reports/documents, site reconnaissance, consultations with communities, and meetings and discussions with the government agencies.

II. POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

A. Lao PDR Safeguard Systems

7. **Policy Framework.** The Government of Lao PDR has enacted policies and legislation that provide the framework to manage its natural and physical cultural resources; protect the environment for the health and well-being of its people; and achieve its international, regional and sub-regional commitments. This is contained in the following key policy documents:

(i) The 8th Five-Year National Socio-Economic Development Plan (2016-2020) is Lao PDR's guiding strategic document which ensures sustainable development in harmony with economic development, socio-cultural development and environmental protection.
(ii) National Vision 2030, which targets effective environmental protection and sustainable natural resources management by 2030, among others;
(iii) National Socio-Economic Development Strategy 2016-2025, comprising seven strategies including quality, inclusive, stable, sustainable and green economic growth, and sustainable and green environment with efficient use of the natural resources.
(iv) The 2030 Agenda for Sustainable Development which are mainstreamed into all three aforementioned policies.

8. The Strategy on Climate Change of the Lao PDR, March 2010 outlines the approach for mainstreaming climate change in the 7th Five-Year National Socio-Economic Development Plan (2011-2015). Furthermore, sector level policies that seek to preserve and expand cultural and national heritage resources; protect natural resources and biodiversity; and develop and promote environmental and social assessment are contained in the National Urban Sector Strategy (2012), and in the National Environment Strategy to the Year 2020.

9. **Legal Framework.** The principal legislation on environmental safeguards is the Environmental Protection Law 2012 (No. 29/NA). This law requires every private and public investment project to undergo either an initial environmental examination (IEE) or an environmental impact assessment (EIA) and prepare the corresponding report for MONRE clearance prior to the consideration and approval by the Government of Lao PDR. The law is supported by the:

(i) Ministerial Agreement on the Endorsement and Promulgation of List of Investment Projects and Activities Requiring the Conduct of Initial Environmental Examination or Environmental and Social Impact Assessment (No. 8056/MONRE), 2013, which categorized projects and activities into two groups based on type and scale.[13] Table 1 screens the proposed activities under the Project following the provisions of this Agreement.
(ii) Ministerial Instruction on the Process of Initial Environmental Examination of Investment Projects and Activities (No. 8029/MONRE), 2013, provides the guidelines on the preparation, review and approval process for IEEs.[14]
(iii) Ministerial Instruction on the Process of Environmental and Social Impact Assessment of Investment Projects and Activities (No. 8030/MONRE), 2013, provides the guidelines on the preparation, review and approval process for ESIAs.[15]

[13] Group 1 projects and activities are required IEEs; Group 2, ESIAs. The Agreement stipulates that investment projects involving compensation and resettlement of people as specified in the Decree on Compensation and Resettlement of People Affected by Development Projects (No. 192/PM), dated 07 July 2005, or in any superseding legislation, will require ESIA.
[14] An approved IEE is granted an environmental compliance certificate (ECC), a required document prior to construction.
[15] An approved ESIA is granted an environmental compliance certificate (ECC), a required document prior to construction.

Table 1: Screening of Proposed Activities Using Ministerial Agreement No. 8056/MONRE

TOWN/Proposed Activities[a]		Required Assessment	
		IEE	ESIA
PAKXAN			
Drainage improvement			
New trunk drains, 4 lines	7.23 km	√	
Road drains, 19 existing small roads	16.1 km		
Riverbank protection			
South of bridge, North of bridge	0.95 km 0.89 km	Not in the Agreement's list of activities. MONRE will assess based on the designs and PPTA's IEE to determine the appropriate EA requirement.	
Solid waste management			
Controlled solid waste disposal facility	Includes medical waste incinerator and separate cells for medical waste		Disposal of hazardous waste √
Wastewater management			
SWTP in Pakxan 1 (old town area)	300 m^3/d	Not in the Agreement's list of activities. MONRE will assess based on the designs and PPTA's IEE to determine the appropriate EA requirement.	
SWTP in Pakxan 1 (Hospital compound)	200 m^3/d		
SWTP in Pakxan 2 (north)	200 m^3/d		
SWTP in Pakxan 2 (south)	200 m^3/d		

[a] Proposed scopes/lengths/numbers were obtained from Final Report - Technical Annex v9. May 2018. PPTA Engineering Team.

10. Other laws, regulations and guidelines that will apply to the activities under the Project include: (i) the Law on Water and Water Resources 1996, (ii) Law on National Heritage 2005, (iii) Labor Law 2013, (iv) Law on Hygiene, Disease Prevention and Health Promotion 2011, (v) Land Law 2003, (vi) The revised Law on Public Roads 2016, (vii) Decree on the Compensation and Resettlement Management in Development Projects 2016, and (viii) Decree on Disposal Site Management 207. A summary description of these legal issuances and their relevance to the project activities is presented in Appendix B. The IEE applies the environmental quality standards presented in Table 2. Appendix B compares the limits set in the national standards against those of international standards featured in the Environmental, Health, and Safety Guidelines (EHSG).[16] The more stringent limit will apply.

Table 2: Key Standards to Apply in the IEE

Particular	National Environmental Standard (No. 81/NA) 21 February 2017		International Standard
Ambient air quality	Table 5	General Ambient Air Quality Standard	WHO Air Quality Guidelines, global update 2005
Noise	Table 15	General Noise Standard	WHO Guidelines for Community Noise, 1999

[16] Environmental, Health and Safety General Guidelines, 30 April 2007; Environmental, Health and Safety Guidelines for Water and Sanitation, 10 December 2007; and Environmental, Health and Safety Guidelines for Waste Management Facilities, 10 December 2007. IFC. WBG. These are currently being updated.

Particular	National Environmental Standard (No. 81/NA) 21 February 2017		International Standard
Surface water quality	Table 10	Standard for Surface Water Quality	US EPA National Recommended Water Quality Criteria
			MRC Technical Guidelines for the Protection of Aquatic Life
			MRC Technical Guidelines for the Protection of Human Health
Groundwater quality	Table 11.1	Groundwater Standard for Domestic Consumption	WHO Guidelines for Drinking-water Quality, Fourth Edition, 2011
Soil quality	Table 8.2	Soil Quality Standard for Other Purposes	-
Wastewater discharge	Table 14.4	Standard of Pollution Control to River from Toilet	EHSG for Water and Sanitation, 2007
	Table 14.5	Standard of Pollution Control to River from Public Drainage	EHSG for Waste Management Facilities, 2007

11. Lao PDR is committed to the Sustainable Development Goals 2030 and has adopted the Sendai Framework for Disaster Risk Reduction 2015-2030. At the regional level, it is party to the ASEAN Agreement on Transboundary Haze Pollution, while at a sub-regional level, to the Mekong Agreement.[17] The country is also party to relevant international environmental agreements, namely:

(i) UNESCO World Heritage Convention;
(ii) UN Framework Convention on Climate Change and its associated Kyoto Protocol and Paris Agreement;
(iii) Basel Convention on the Control of Transboundary Movements of the Hazardous Wastes and Their Disposal; and
(iv) Vienna Convention for the Protection of the Ozone Layer and its Montreal Protocol on Substances that Deplete the Ozone Layer and all Amendments.

12. **Administrative Framework.** The Ministry of Natural Resources and Environment (MONRE) is the national environmental management agency. It reviews and approves Environmental and Social Impact Assessment (ESIA) reports which are handled and processed by its ESIA Department. The supporting agencies are as follows:

(i) Provincial or Capital DONRE, which reviews and approves IEE reports;
(ii) District or Municipality Offices of Natural Resources and Environment; and
(iii) Village Units of Natural Resources and Environment.

13. **MONRE Prescriptive Periods for IEE and ESIA Reports.** The MONRE has issued the following prescriptive periods for both reports:

(i) Ministerial Instructions No. 8029 prescribes: (a) 10 business days to review the accuracy and comprehensiveness of an IEE Report from the date of receipt, and (b) should revision not be required, another 40 business days from the date of receipt of 15 or more hard and electronic copies of the report for review, incorporation of

[17] Agreement for sustainable development, utilization, management and conservation of water and related resources of the Mekong River Basin, and to the minimization of harmful effects that might result from natural occurrences and man-made activities.

comments from relevant institutions, and decision making.

(ii) The Ministerial Instructions No. 8030 prescribes: (a) 10 business days to review the accuracy and comprehensiveness of an ESIA Report from the date of receipt; (b) should revision not be required, another 55 business days from receipt of 15 or more hard and electronic copies of the report for compiling reviews, forwarding comments to the Project Proponent for reference in finalizing the report, and (c) another 40 business days from receipt of Final ESIA Report for decision making.

B. ADB Safeguard Policy Statement (SPS)

14. All projects funded by ADB must comply with SPS 2009 to ensure that these are environmentally sound, are designed to operate in compliance with applicable regulatory requirements, and are not likely to cause significant environmental, health, or safety hazard. Depending on the type, location, scale and sensitivity and magnitude of its potential environmental impacts, projects are categorized as either, Category A, B, or C which dictates whether and IEE or EIA is required.

15. This Project is classified as environment Category B as impacts are site-specific, few, if any of them are irreversible, and in most cases mitigation measures can be readily designed. This requires an IEE and EMP. The IEE is based on primary and secondary information and data, including from published reports. Public consultations with government stakeholders, key stakeholders and affected persons was undertaken and site reconnaissance was conducted to determine community perceptions on the subproject and to obtain relevant information.

16. The report structure follows the format outlined in Appendix 1 of the SPS. In line with ADB's Public Communications Policy, ADB will post the IEE reports and environmental monitoring reports submitted by the borrowers/clients during project implementation on ADB website. Translations of the EMPs will be made available at PIU offices.

III. DESCRIPTION OF THE PROJECT

A. Rationale

17. The GMS-CTDP-4 focuses on the eastern branch of the Central GMS Corridor where Pakxan town, the capital of Borikhamxay Province is located. The town is located at the confluence of the San River and the Mekong River. From Pakxan, there is a road connection north to Xieng Khouang Province and its capital Phonsavanh. Pakxan is divided into two areas, the original "old town" or "Pakxan 1" area with the main road running north-south along the east bank of the San River to the confluence of the San and Mekong rivers, and the new administrative center or "Pakxan 2" with main road running north-south on the opposite (west) side of the San River.

18. The provincial government envisions Pakxan as a main logistics center in a cross-Lao PDR network of roads, linking to both Thailand and Vietnam. This vision is supported by the proposed Fifth Friendship Bridge between Lao PDR and Thailand which is expected to be constructed from 2019 onwards.

19. Pakxan's economic development is hampered by deficient urban infrastructure and its consequently adverse impacts on the environment, people's livelihood, and health. Flooding is the top perennial hazard in Pakxan; it is regarded as the most serious issue, from a menu of urban

environmental issues, by 28% of town's households and as the second-most serious issue by 22%, based on the household survey conducted under the PPTA. Contributory factors to flooding include: (i) inadequate drainage system; (ii) reclamation of an area of the town that has blocked the natural drainage courses; and (iii) elevated roads in some areas. The absence of riverbank protection has caused riverbank erosion when water level rises, and the water current becomes too strong. Only 13% of households surveyed have access to sewerage or drainage, and 14%, to open canal drains. Regarding wastewater disposal problems, 14% of HHs consider them very serious while 30% deem them somewhat serious.

20. In line with ADB's country partnership strategy (CPS) for the Lao PDR, 2017–2020 and its geographic focus along the GMS economic corridors, a project roadmap framework has been prepared which entailed analyses on the degree of competitiveness and connectivity of the towns and cities along the Central Mekong Economic Development Corridor (CMEDC). [18] This determines the scope and priorities of the subproject, which include the following:

(i) drainage and wastewater treatment, to mitigate against flooding and improve public health;
(ii) solid waste management, to improve collection coverage and treatment of waste in managed landfills, which will also mitigate against flooding and improve public health;
(iii) e-Government, to improve the efficiency of local government services and connectivity between the towns; and
(iv) assistance to the provincial governments for strategic planning, including addressing climate change and disaster risk management as well as identifying opportunities for the marketing of agricultural produce, and the improvement of tourism and research and knowledge-based facilities.

B. Description of Pakxan Subproject

21. The components of the Pakxan subproject under GMS-CTDP-4 are described as follows:

22. **Component 1: Stormwater drainage improvement.** The town drainage improvement will comprise of four new trunk drains (Lines A to D) with total length of 7.23 km and road drains for 19 existing small roads with total length of 16.10 km in the old town. The new main trunk drains will pass through farmland and allow water collected in the urban area to flow to a natural retention basin which is in a low-lying area to the south east. Most of these four drains will be open, with a short length near the market requiring concrete pipe.

[18] As part of the mission undertaken to prepare the concept paper for the GMS-CTDP-4 by ADB in September 2016, an evaluation was carried out to determine which towns should be selected for inclusion in the Project. One of the criteria for town selection was location along the Central Mekong Economic Development Corridor (CMEDC).

Table 3: Proposed Trunk Drainage Channels

Trunk Drains					Road Drains		
Line	Top width (m)	Base width (m)	Depth (m)	Length (m)	Road No.	Drain length (m)	Drain size (mm)
A	5.3	1.1	1.4	3,800	1	1,128	800
B	3.1	0.7	0.8	886	2	793	800
C	3.1	0.7	0.8	540	3	835	800
D	5.3	1.1	1.4	2,000	4	543	800
					5	833	800
					6	645	800
					7	226	800
					8	336	800
					9	287	800
					10	418	800
					11	645	800
					12	850	800
					13	774	800
					14	400	800
					15	5,150	800
					16	625	800
					17	287	800
					18	320	800
					19	1,009	800
Total length				7,226		16,104	

Source: Final Report - Technical Annex v9. May 2018. PPTA Engineering Team

23. In addition to the four main open channel drains, a network of road drains will be proposed to serve Pakxan 1 urban area to supplement the proposed new road drains along the main road that the province is undertaking. The road drains are proposed for 19 existing small roads in Pakxan 1 area with 800mm diameter reinforced concrete pipe. These are all roads that were constructed without drainage originally. The typical cross section of the roadside drain in shown in Figure 2. Figure 3 presents the location of the four trunk drains while the locations of the road drainage channels are shown in Figure 4.

Figure 2: Cross-section of proposed road drains

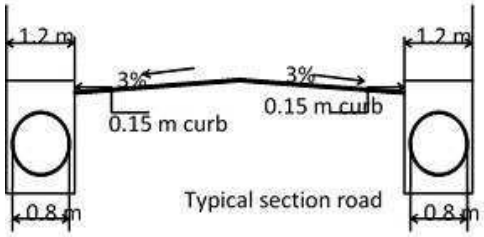


Figure 3: Proposed Location of Four Trunk Drains

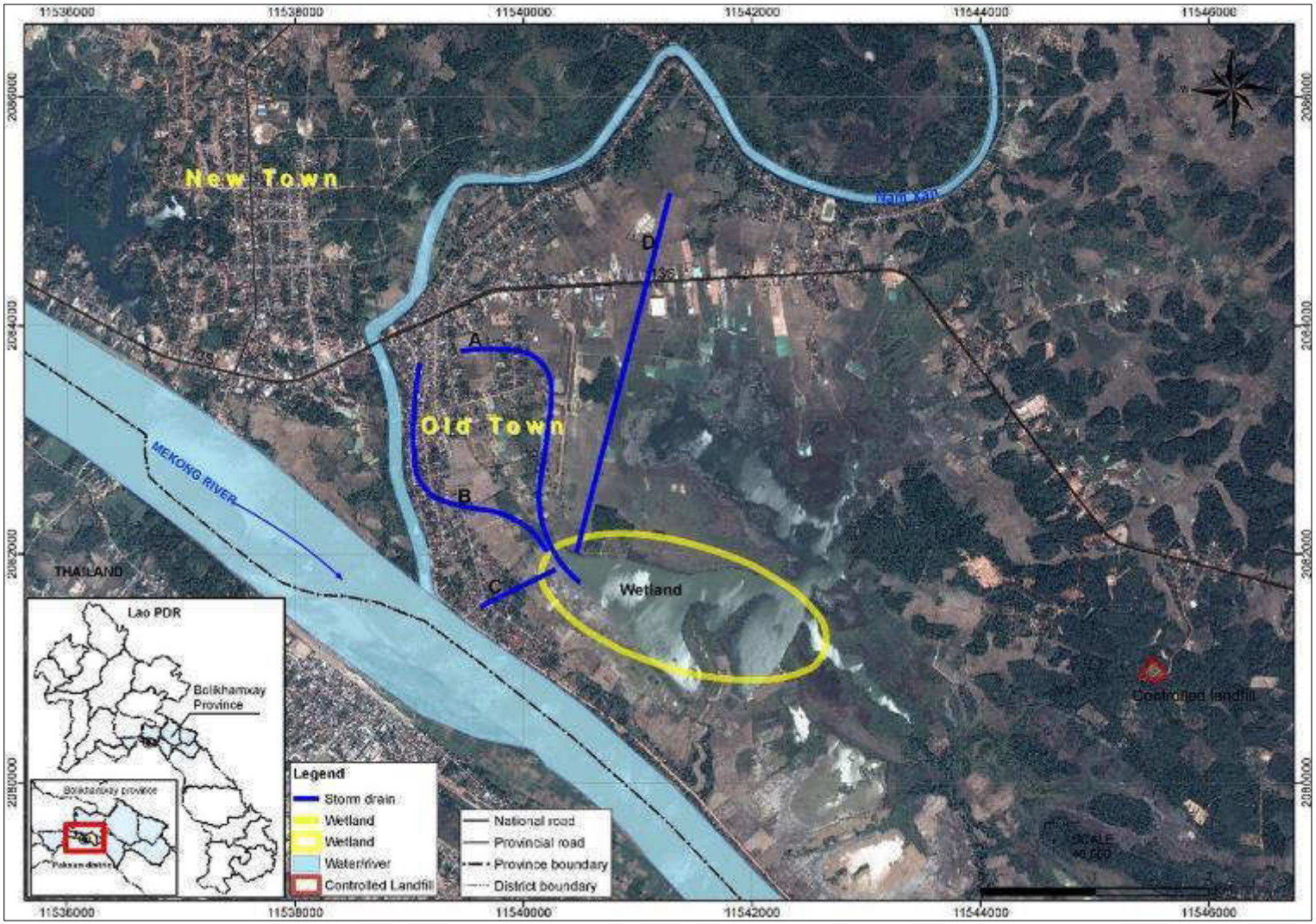
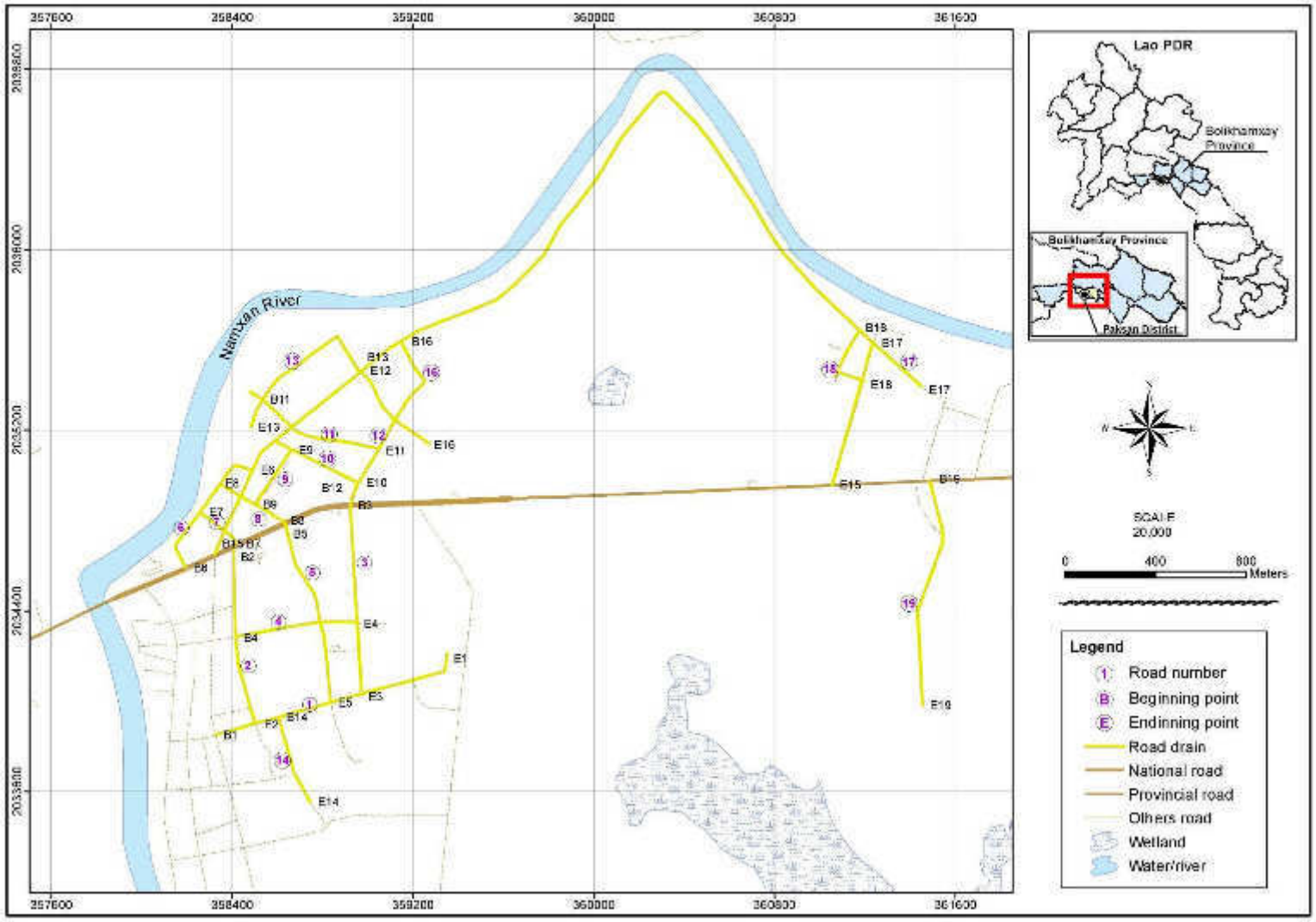


Figure 4: Location of Roadside Drains



24. **Component 2: Small-scale wastewater treatment plants (SWTPs).** Four units of SWTPs will be built. Two SWTPs will serve Pakxan 1: (i) a SWTP with a design capacity of 300 m^3/day to serve a projected population by 2040 in the old town urban area with a treatment plant on an existing natural drainage retention basin east of the urban center, and (ii) a SWTP to be located within the Borikhamxay provincial hospital compound with capacity of 200m^3/day to serve the hospital and immediate surrounding areas with 480 population by 2040.

25. There will be two SWTP units that will serve Pakxan 2: (i) a 200m^3/day capacity SWTP located at Pakxan 2 (north) to serve a projected 2,152 population by 2040 in the current urban area, the main market and the bus station and (ii) a 200m^3/day SWTP for Pakxan 2 (south) located on a former rice field in Phonexay village, south of NR13S to serve a projected 3,068 population by 2040 in Phonexay village. Figure 5 presents the coverage areas and the proposed locations of the SWTP units.

Table 4: Proposed SWTP Locations in Pakxan

SWTP	Design Capacity	Point of Discharge	Service Area
1 – Pakxan 1 (old town area)	300 m^3/day	Natural drainage retention basin/wetland	Pakxan 1 main urban area (Old town area)
2 – Pakxan 1 (hospital)	200 m^3/day	Mekong River	Hospital and portion of Pakxan 1 main urban area
3 – Pakxan 2 (north)	200 m^3/day	San River	Pakxan 2 (north) new town area, main market, bus station
4 – Pakxan 2 (south)	200 m^3/day	Mekong River	Pakxan 2 (south) in Phonexay Village

26. Based on the preliminary design, only black water will be accommodated at the SWTPs. The subproject will include the laying of 150mm diameter sewer pipes along road easements. It is proposed to install free connections to all existing properties in the proposed service areas (1,635 households in 2023).

27. Following the guidelines set by BORDA[19] and adopted by the Ministry of Public Works and Transport (MPWT), the SWTPs in Pakxan will comprise of the following units:

(i) Primary treatment module—sedimentation and flotation;
(ii) Secondary anaerobic treatment in fixed-bed reactors: baffled upstream reactors or anaerobic filters;
(iii) Tertiary aerobic treatment in sub-surface flow filters; and
(iv) Tertiary aerobic treatment in polishing ponds or gravel beds, or release to river or wetland.

[19] Stands for Bremen Overseas Research and Development Association. BORDA's Project Office is in the capital city of Vientiane since 2013. BORDA Laos aims to uplift the living situation of disadvantaged demographic groups by improving their sanitation. Their work also focuses on environmental protection by reducing pollution of ecosystems and clearing untreated wastewater.

Figure 5: Proposed Sewer Service Areas and SWTP at Pakxan 1 (Old town area)

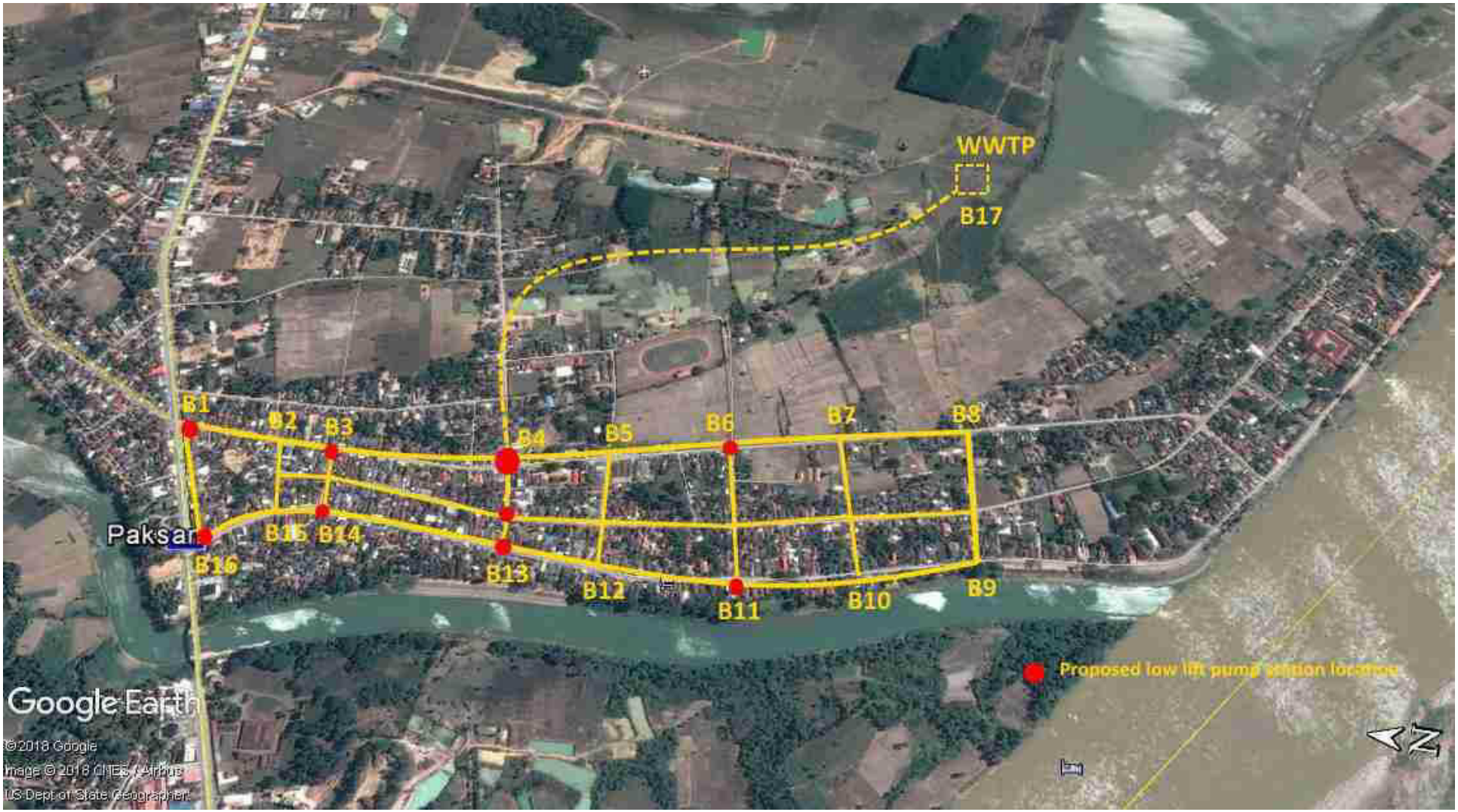


Figure 6: Proposed Sewer Service Areas and SWTP at Pakxan 1 (hospital compound)

Figure 7: Proposed Sewer Service Areas and SWTP at Pakxan 2 (north)

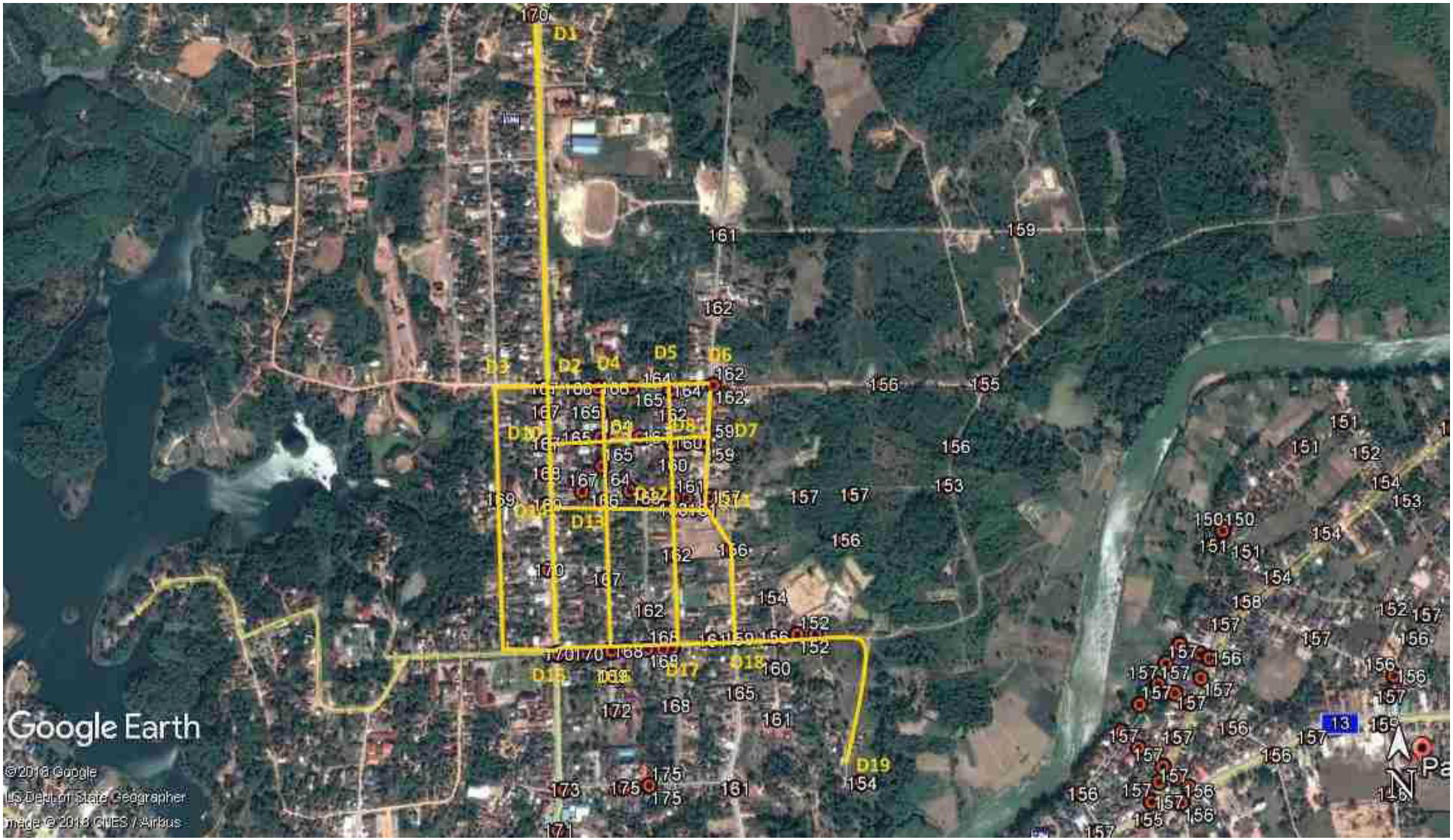


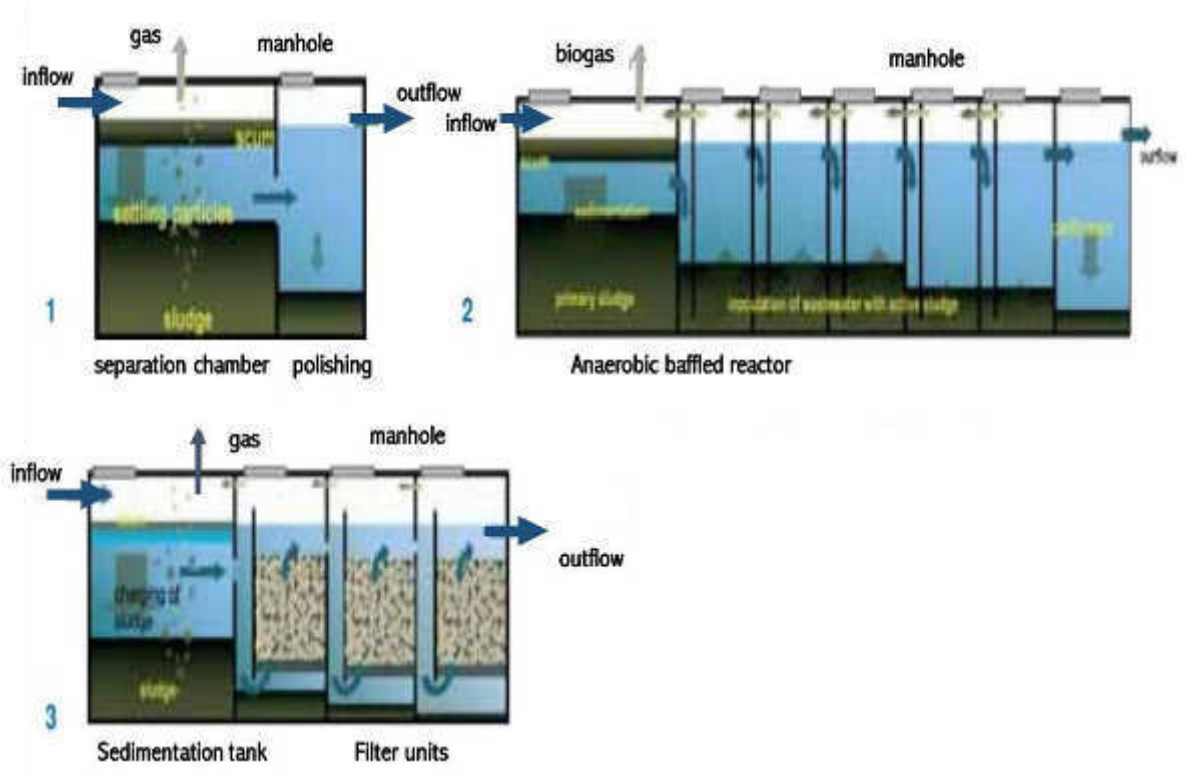
Figure 8: Proposed Sewer Service Areas and SWTP at Pakxan 2 (south)


C1
C2
C3
C4
C5
C6
C7
C8
Paksan
Google Earth
©2018 Google
Image © 2018 CNES / Airbus
US Dept of State Geographer
N

Table 5: SWTP Module Sizes for Pakxan

SWTP	Module	Capacity (in m^3/day)	Length (in meters)	Width (in meters)	WW depth (in meters)	Height (in meters)
1 - Pakxan 1	Settling/flotation tank	300	18	12	3	3.5
	ABR	300	18	8.5	2.9	3.5
	Aerobic Filter	300	19	10	2.9	3.5
2 – Pakxan 1 (Provincial Hospital)	Settling/flotation tank	200	18	8	3.	3.5
	ABR	200	9	6	2.9	3.5
	Aerobic Filter	200	13	6	2.9	3.5
3 – Pakxan 2 North	Settling/flotation tank	200	18	8	3.	3.5
	ABR	200	9	6	2.9	3.5
	Aerobic Filter	200	13	6	2.9	3.5
4 – Pakxan 2 South	Settling/flotation tank	200	18	8	3.	3.5
	ABR	200	9	6	2.9	3.5
	Aerobic Filter	200	13	6	2.9	3.5

Figure 9: SWTP Treatment Process



Source: Decentralized Wastewater Treatment Solutions, BORDA & BORDA BNS Network

28. The effluent from the SWTPs is expected to comply with the effluent quality standards as outlined in the National Environmental Standard No. 81/NA (21 February 2017). Table 6 presents the material balance of the SWTP.

Table 6: Summary of Material Balance of SWTP for Pakxan

	Unit	Inflow	After Settler/ Septic tank	After ABR	After AF	Lao PDR Effluent Standards
BOD5	mg/l	333	171	36	29	30
COD	mg/l	633	343	93	123	125
TSS	mg/l	350	300	250	20	50

29. **Component 3: Municipal solid waste controlled landfill**. A controlled solid waste landfill facility with volume capacity of 226,100 m^3 compacted waste is proposed on the 9-ha site of which around 1.8ha is currently being utilized as open dumpsite. Additional land up to 30 ha is available at the adajcent area as required as shown in Figure 7. The layout of the proposed Pakxan controlled landfill is presented in Figure 8.

30. The proposed new controlled landfill will allow collection from 100% of the 22 villages inside the urban area. The landfill will consist of the following components:

(i) a site office for full time operators
(ii) 4 lined cells, 75m x 75 m x 10m deep
(iii) a "retirement" cell for all existing waste to be buried, compacted and covered
(iv) all season access roads
(v) capping soil storage
(vi) site drainage
(vii) leachate collection, storage and recirculation
(viii) monitoring boreholes
(ix) a covered sorting and recycling area
(x) a separate medical/hazardous waste area
(xi) full site fencing
(xii) services – water and power to site
(xiii) 6 waste collection and compaction vehicles and a crane (for handling recyclables).

31. At this stage, a composite lining of geomembrane HDPE liner with clay/earth cover is recommended. The selection of the liner should be taken during the final design stage based on source and availability of clay and transport costs. Geotechnical investigations will also better inform the preferred liner type to ensure protection from leakage.

32. **Component 4: Riverbank protection.** The riverbank protection will be at two seprate sections: (i) from the confluence of the San and Mekong rivers up to the road bridge with a length of 950m and (ii) a further 890m upstream of the road bridge to where houses are no longer situated along the riverbank. The locations of the river bank protection are shown in Figure 9.

33. The riverbank protection has been designed in two sections, each with different amenity features. From the San/Mekong confluence, the cross section will include a 10-15m tiled walkway with planted shade trees, lighting, seating and exercise machines, with a lower level footpath and boat access path that will be accessible in all but flood periods. The section further upriver from the road bridge will not include the public amenity space but will have a 3m wide walkway. The cross sections are shown in Figures 10 and 11.

Figure 10: Location of the Existing Dumpsite and the Pakxan Controlled Landfill

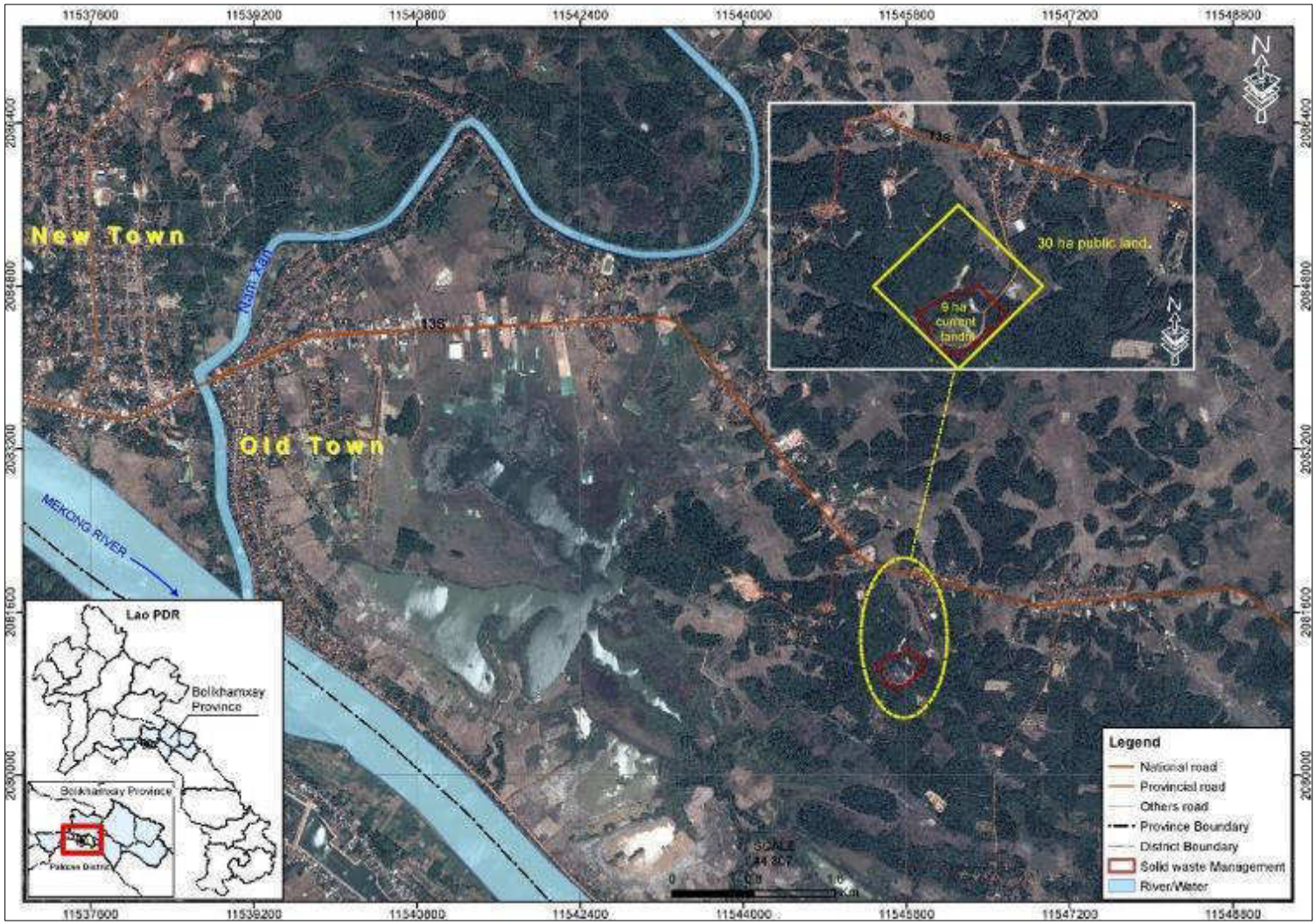


Figure 11: Layout of Proposed Pakxan Contolled Landfill

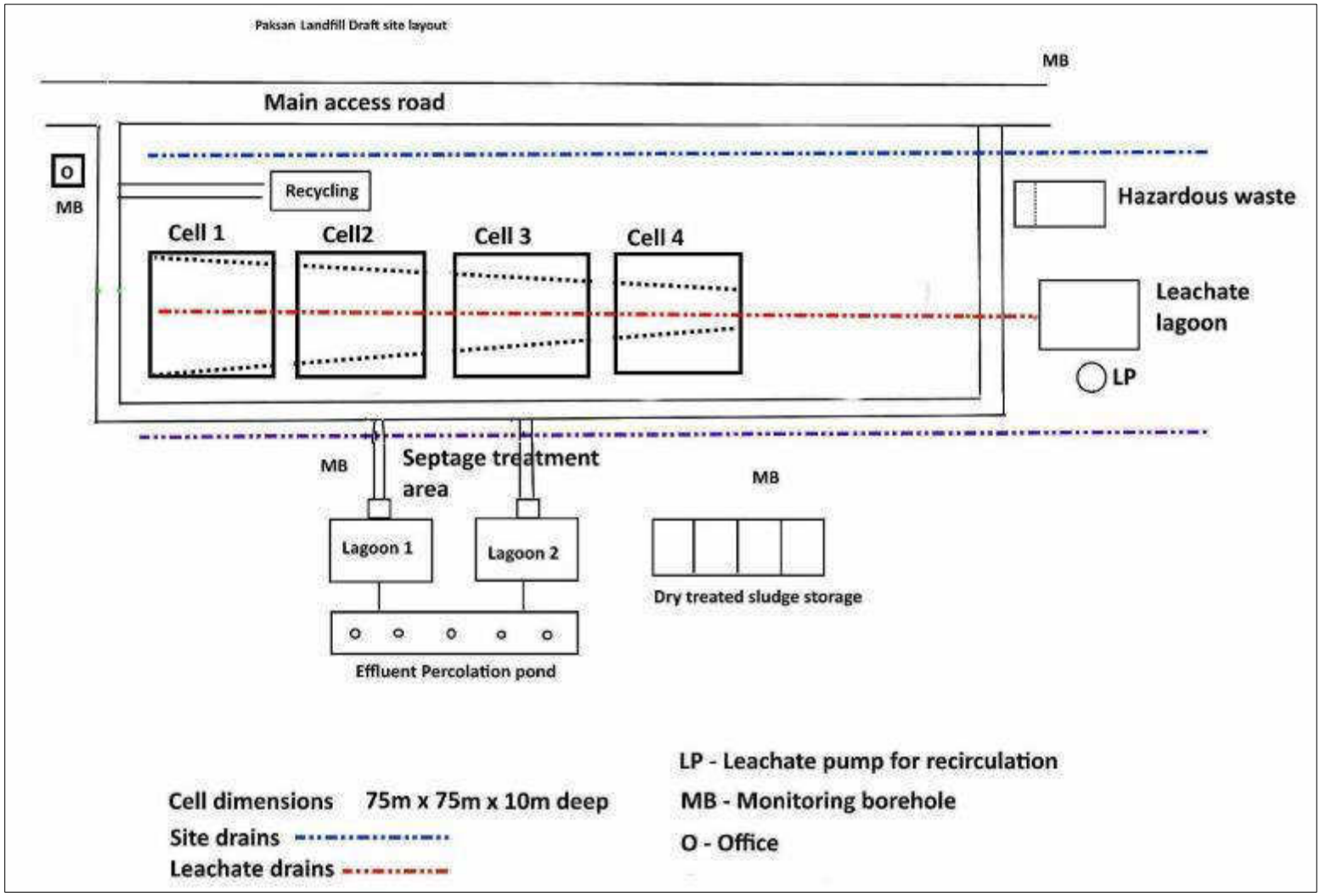


Figure 12: Location of proposed riverbank protection in Pakxan

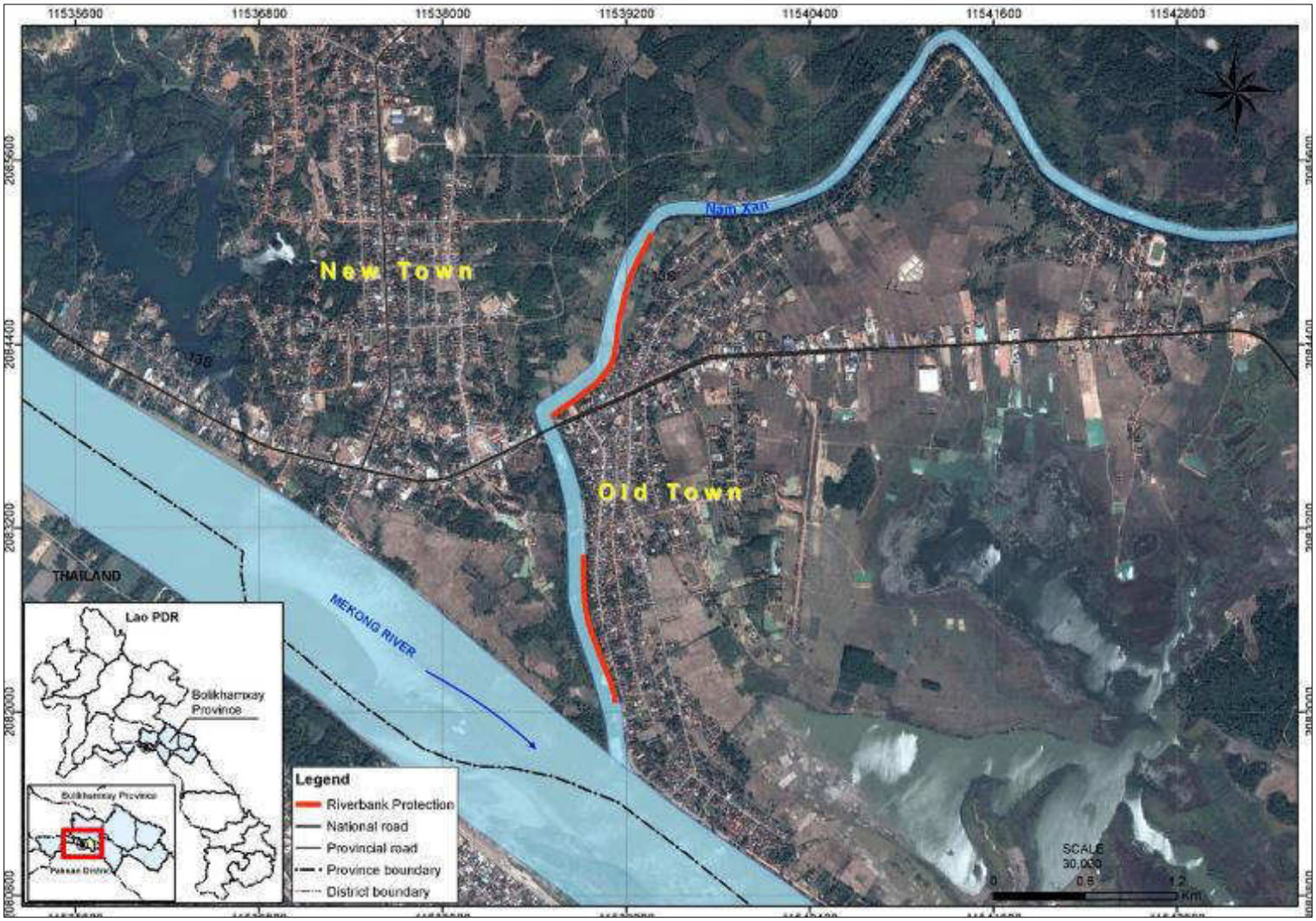


Figure 13: Cross section of the Pakxan riverbank protection (Mekong River to road bridge)

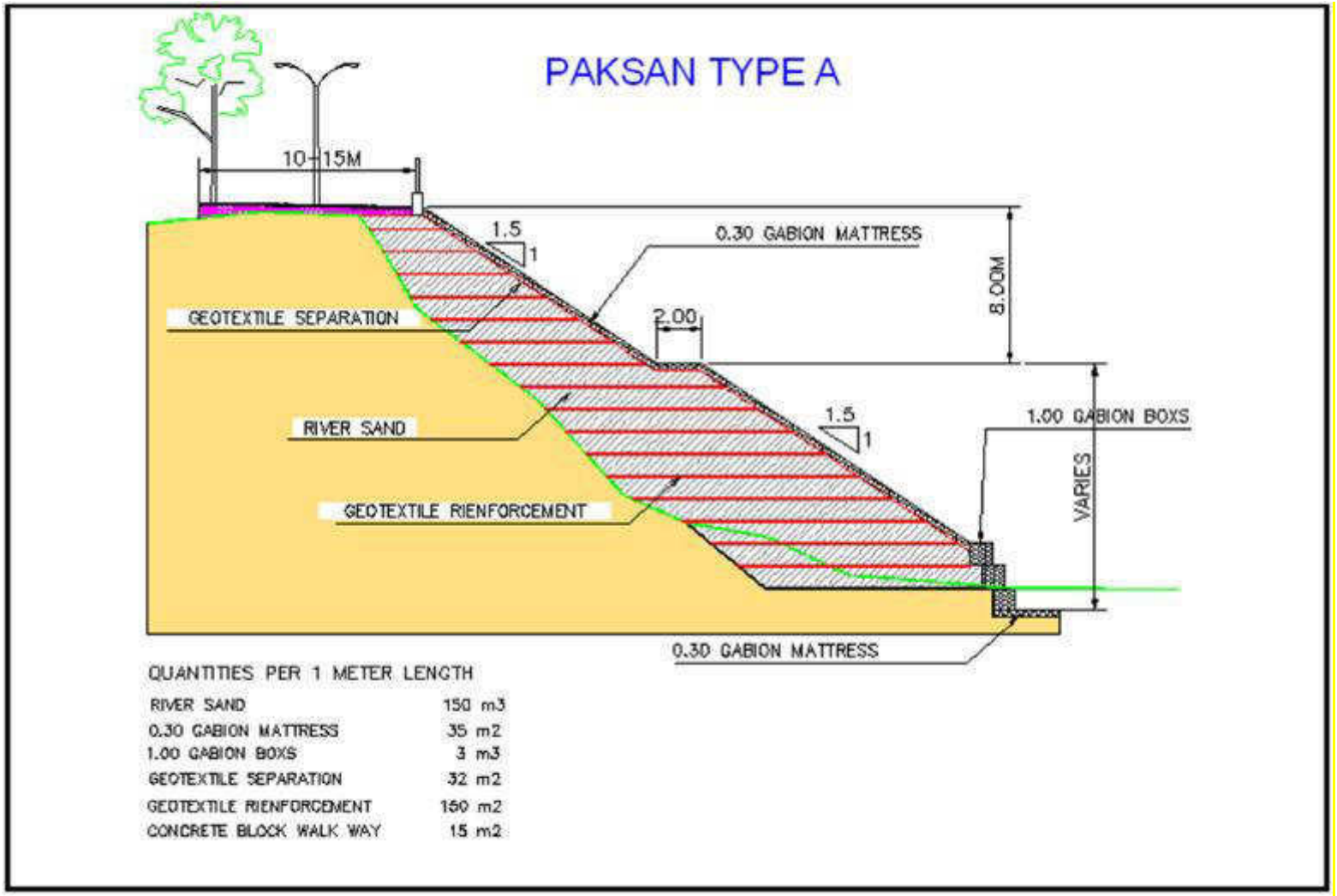
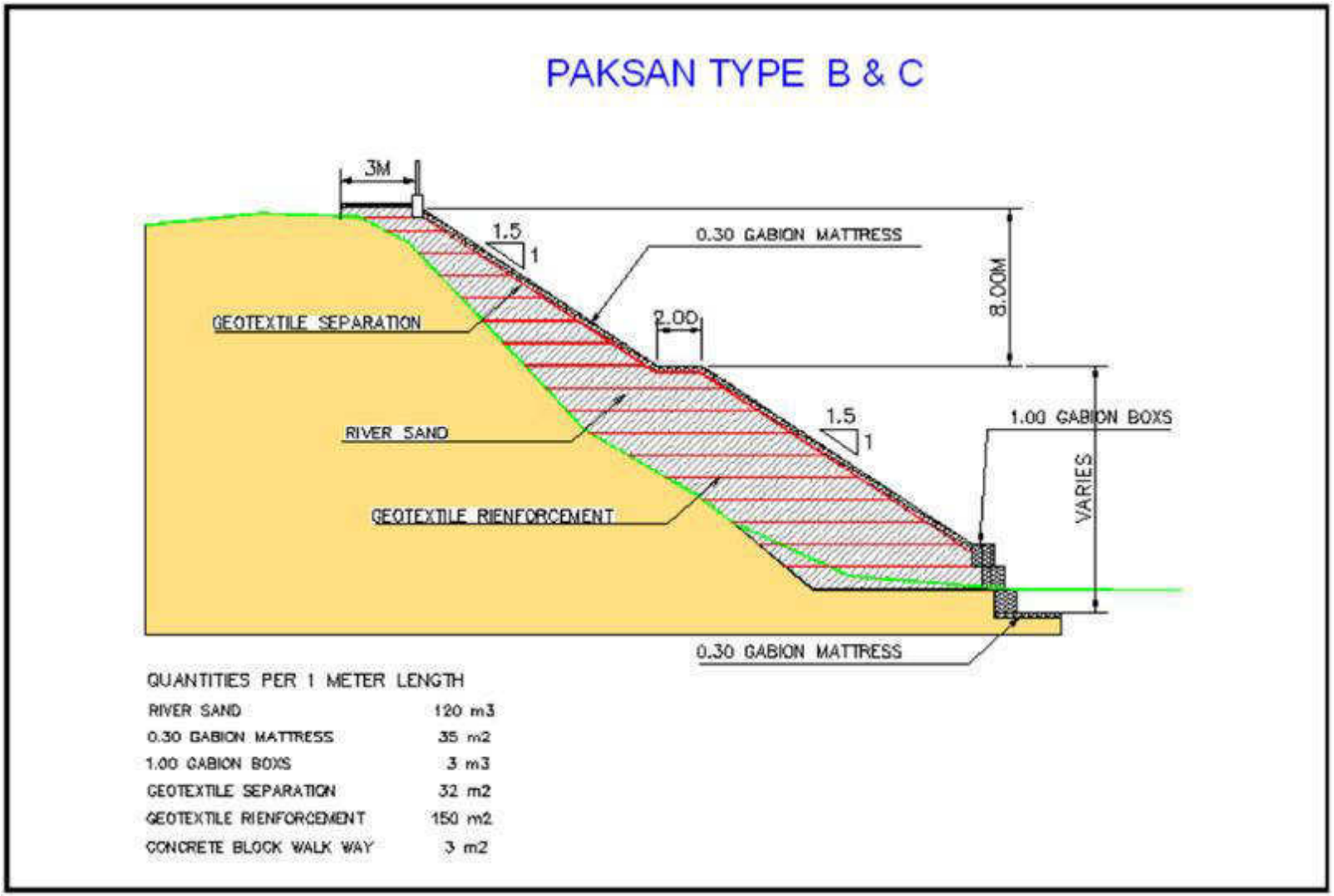


Figure 14: Cross section of Pakxan riverbank protection (upstream of road bridge)



34. **Component 5: Institutional capacity for regional economic connectivity enhanced**. This component will strengthen the institutional capacity of the provincial government by: (ii) supporting project management, construction supervision and social and safeguards monitoring; (ii) training on resilience town planning that incorporates economic, climate change and disaster risks; and (iii) formulating the next provincial 5-year strategic development plans through the regional economic corridor development analysis on commodity value-chains, tourism, and human resources.

C. Implementation Period

35. The physical components of the subproject will be implemented under either a design-build (DB) contract or standard (non-DB) contract. The controlled landfill will be implemented under a DB contract; while the drainage, SWTPs and riverbank protection will be implemented under a standard contract.

36. The DB contract is expected to commence in 2020, and executed within a period of at least three years, covering 6 months of preparation of detailed design, and 30 months of construction works. Operation of completed facility is estimated to start in 2023. The standard contracts are expected to involve: (i) 6 months of detailed design and preparation and approval of tender documents starting 2019; (ii) 6 months of procurement for construction works; and (iii) 24 months of construction activities, starting 2020. Completed works under standard contracts are expected to commence operation by beginning of 2022. The subproject implementation schedule is in Figure 12.

Figure 15: Implementation Schedule

No.	Activity	2018				2019				2020				2021				2022				2023			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
B. Output 1: Urban infrastructure services for enhancing regional economic connectivity in Paksan improved																									
B.1	Resettlement/livelihood compensation																								
B.2a	Design-build (DB) contracts: Preparation, approval of tender documents for solid waste management/landfill subproject components																								
B.2b	Tendering, evaluation of bids, negotiations, award of DB contracts																								
B.2c	Execution of DB contracts (detailed design, construction phases)																								
B.2d	Operation of controlled landfills																								
B.3a	Procurement of goods (SWM equipment, vehicles)																								
B.3b	For non-DB works (DEWATS, riverbank protection components): detailed engineering surveys, site investigations, designs (including public hearings and stakeholder consultations on design of each component)																								
B.3c	Preparation and approval of standard contract documents (including requirement under GAP for 30% women in contracted local work force)																								
B.3d	Tendering, evaluation of bids, negotiations, award of contracts																								
B.3d	Construction of physical works																								
D. Output 3: Institutional capacities and national infrastructure for economic connectivity enhanced																									
D.1	Recruitment of project implementation consultant (PIC) team																								
D.2	Mobilization of PIC team																								

IV. DESCRIPTION OF THE ENVIRONMENT

A. Geographic Location

37. Pakxan is situated along the National Road 13 (NR13) and the north bank of the Mekong River. It is about 146 km east of Vientiane. Based on altitude, Pakxan is in the central plains region of Lao PDR, which includes the alluvial basin of the Mekong River. The terrain of Pakxan is relatively flat, but changes quickly on its eastern urban fringes, where land rises from Mekong flood plain environments to form the initial foot slopes of the Annamite Range.

38. Pakxan lies in the Mekong Plain physiographic unit of Lao PDR. The Mekong Plain has flat upper levees with recent alluvial deposits that are acidic and shallow. The younger alluvial soils of the floodplain are fertile but are often subject to wet season inundation (ICEM 2003).[20]

B. Description of Subproject Areas of Influence

39. The subproject impact areas include: i) the directly impacted areas or main areas of influence, covering the subproject construction footprints and areas within 200m from their edges, considering the potential reach of noise, dust, impact or water quality, impact on biodiversity and socio-economic impacts; and (ii) indirect or extended areas of influence which include waste disposal site/s, sources of water for construction use, workers' campsites, and sources of labor. Potentially affected resources within the main areas of influence are presented in Table 8.

40. **Component 1: Stormwater drainage.** The new main trunk drains will pass through farmland and allow water collected in the urban area to flow to the retention basin in the low-lying area to the south east. The drainage improvement works will follow the natural drainage pattern. However, all four trunk mains will drain into a single natural drainage retention basin. The trunk mains will serve a drainage area of 4.65 km^2 and is expected to drain a storm water discharge of 5.792 m^3/s (Table 7).

Table 7: Calculated flood discharge from trunk mains

Canal	Drainage area, km^2	Channel Length, km	Discharge, Q, m^3/s	Start point	End point
Line A	2.1868	3.800	3.34	Ban Symongkhoun	drainage retention basin
Line B	0.315362	0.886	0.482	Ban Phosy	Join line A at B in Phoxay
Line C	0.316537	0.53742	0.29	Ban Pakxan Tai	Join line A near to the lake
Line D	1.835	2.0	1.68	Ban Nachik	drainage retention basin
Total	4.653699	7.23	5.792		

Source: Appendix F, Discharge and sizing calculations for Pakxan trunk drains. Final Report – Lao PDR (Volume 2: Annexes – Planning, Corridor, Engineering). PPTA. May 2018

[20] Profile on Environmental and Social Considerations in Lao P.D.R. December 2013 Japan International Cooperation Agency.

Table 8: Identified Sensitive Receptors in the Subproject Main Areas of Influence[a]

Component/ Sub-component	GPS	Surface Water Receptors	Socio-Economic & Cultural Receptors	Land Cover/ Ecological Receptors	Protected Area Status
○ Drainage (trunk drains and road drains)	18°24'36.53" N 103°40'34.79" E (north of NR13) 18°23'20.30" N 103°39'39.92" E (approx. center of works area) 18°22'40.15" N 103°40'12.84 E Elev. 150m (natural drainage retention basin)	drainage retention basin	• Residents, workers, business and/or other establishments - in the old town - north of NR 13. • Borikhamxay Hospital • At least 5 schools • At least 4 temples • Existing utility lines • Road users	• Main urban area • Agricultural lands • Few trees • drainage retention basin	None
○ SWTP for Pakxan 1 (old town area)		Natural drainage retention area/ wetland	• Residents, workers, business and/or other establishments - in the old town - north of NR 13 • At least 5 schools • At least 4 temples • Existing utility lines • Road users	• Main urban area • Agricultural lands • Few trees • drainage retention basin	None
○ SWTP for Pakxan 1 within hospital compound	18° 22'21.53" N 103 °39'54.09" E Elev 52m	Mekong River	• Residents, workers, business and/or other establishments • Hospital, patients and workers • Existing utility lines • Road users	• Main urban area • Mekong River	None
○ SWTP for Pakxan 2 (north)		San River	• Residents, workers, business and/or other establishments in Pakxan 2 • At least 1 temple • Existing utility lines • Road users • Farmers working in their farmlands	• New urban area • Agricultural lands • Secondary forest lands • San River	None
○ SWTP for Pakxan 2 (south) in Phonexay village	18°23'27.35"N 103°38'43.39"E	Mekong River	• Residents, workers, business and/or other establishments in Phonexay and Anousonexay villages • Existing utility lines • One temple • Road users (NR13S)	• Main urban area • Residential areas • Mekong River	None
○ Controlled landfill	18° 22'12.98" 103 °42'54.03" Elev 168m	According to UDAA, none.	• Residents of Nasommo Village • Trees and vegetation • Farmers and farmlands • Surrounded by secondary forest area and farmlands. • Nearest structure is a building of an enclosed rubber tree farm. • Nearest house in the village is about 500m away.	• Secondary forest and farmlands	None

Component/ Sub-component	GPS	Surface Water Receptors	Socio-Economic & Cultural Receptors	Land Cover/ Ecological Receptors	Protected Area Status
○ Riverbank protection	18º 23'02.04" N 103 º39'22.80" E Elev 155m	San River Mekong River	• Residents, workers, business and/or other establishments in the old town • 2 temples • Trees and vegetation along the banks • Potential domestic water line	• Riverine vegetation • 2 independent sections with riverbank protection • Main urban area (old town)	None
	18º 23'57.14" N 103 º39'27.59" E Elev 155m	San River	• Residents, workers, business and/or other establishments in the urban area north of NR13 • Agricultural lands	• Urban area • Farmlands	None

[a] 200 m from the edges of construction footprints.

41. Considering that the project will consolidate all stormwater runoff from the four drains aside from the 300m^3/day effluent from SWTP in Pakxan 1 (old town area), the carrying capacity of the natural drainage retention area will be evaluated during detailed engineering design to ensure that the proposed drainage improvement works will not cause flooding in the surrounding areas. Figure 13 shows photos of locations of proposed drain extensions.

Figure 16: Photos of proposed trunk drains

Trunk drain A. The surrounding agricultural land gets flooded in the rainy season.

Trunk drain B. The surrounding agricultural lands experience flooding in the rainy season.


Trunk drain C. The trunk drain will pass through primarily agricultural land with some residential areas.

42. **Component 2: Small-scale wastewater treatment plants (SWTPs).** Based on the preliminary design, only black water will be accommodated at the SWTPs. The project will include the laying of sewer lines along road easements to connect households to the sewer network.

43. The SWTP for the old town area in Pakxan 1 will be located in grassland area, on the dry edge of the wetland. The site is adjacent to some residential houses on the eastern section and some agricultural areas. The site is along a narrow, unpaved road. The effluent from this SWTP is proposed to be discharged into a natural drainage retention area or wetland referred to as Parkpheng wetland. The retention area/wetland is also the outfall of the four trunk drains.

44. The Parkpheng wetland covers an area of about 2351.48 ha. It traverses nine villages, namely, (i) B. Parkpheng, (ii) B. Parkxan, (iii) B. Phoxi, (iv) B. Mixay, (v) B. Sisaarth, (vi) B. Phonesavanh, (vii) B. Phasikhai, (viii) B. Nasommor, and (ix) B. Angnongpheng. This wetland is located in the lower area where all storm water flows before it discharges to the Mekong River in the southern part of Pakxan district. In the western and northern parts of the wetland are some houses by 9 villages. Agriculture, fishing, and livestock (cow farm) are community activities in the areas surrounding the wetland. The wetland is usually dry during the months of October to April, with a section in the middle with water all throughout the year.

Figure 17: Photos of SWTP for Pakxan 1 (Old town area)


Site of proposed SWTP at Houngxay village

Houses in the eastern part of the SWTP site.

View of Parkpheng wetland from the proposed site of the SWTP

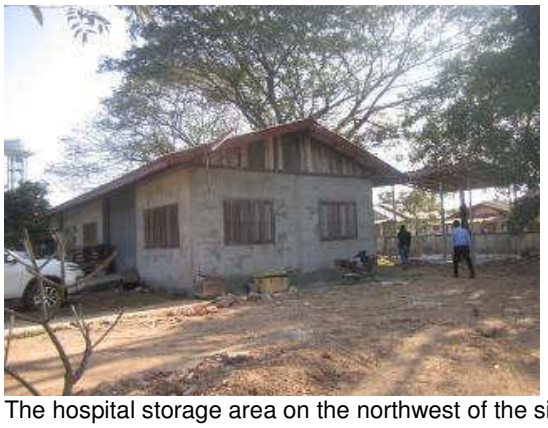
Direction of flow to Parkpheng wetland area

45. The planned location of the SWTP for Pakxan 1 located at the corner section of the Borikhamxay Hospital compound is adjacent to main road intersection. The SWTP will accept the toilet wastes from the hospital and dormitory and from immediate surrounding areas of the hospital in Pakxan 1. Access to SWTP site is not a concern since the main roads are well-paved. Likewise, there are no sensitive receptors in the immediate vicinity since the site is located at a distance from the main hospital building. Effluent from SWTP will drain into the nearby Mekong River.

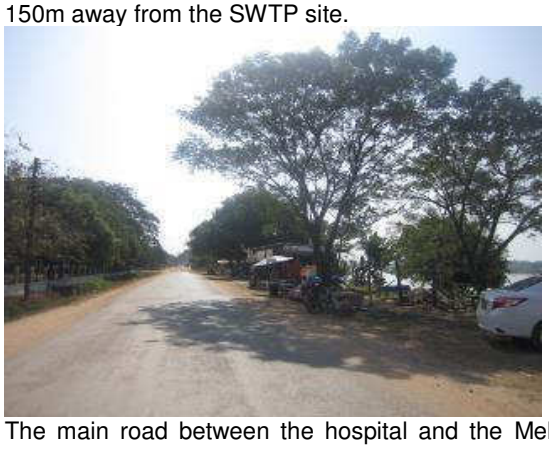
Figure 18: Location of SWTP at Borikhamxay Hospital compound

Location of SWTP at Borikhamxay Hospital Compound

The hospital building on the northeast, approximately 150m away from the SWTP site.



The hospital storage area on the northwest of the site.



The main road between the hospital and the Mekong River bank.

46. The proposed location of SWTP for Pakxan 2 (north) is on a private agricultural land. The site is about 100 – 200m away from houses. The site is on a permanently dry land. Access to the site is through an unpaved road which gets muddy during the rainy season. The SWTP will discharge into San River which is large and wide enough to accommodate the 200m^3/day effluent.

Figure 19: Location of SWTP for Pakxan 2 (north)

Proposed site of SWTP – Pakxan 2 (north). The surrounding area is sparsely populated.

Northwest section of SWTP site.

47. The proposed location of SWTP for Pakxan 2 (south), west of the river, will be in a privately-owned former riceland area in Phonexay village. The site of the SWTP accumulates storm water during a rain event for a maximum of one day according to the landowner of the site. The site is about 500m from the town center. Access to the site is through an unpaved road which connects to the NR13S. The nearest residential house to the site is about 10 – 20 m away. The will serve the villages of Phonexay and Anousonexay and treated effluent will drain into the Mekong River.

Figure 20: Location of SWTP in Pakxan 2 (south)

The proposed site of SWTP in Phonexay village.

Access road to SWTP in Phonexay village.

48. **Component 3: Municipal solid waste controlled landfill.** The existing dumpsite has been operating at the proposed site of the controlled landfill since 2008. The site is situated about 6km east of the town and can be accessed through NR13 and a 1 km laterite access road through Nasommo village. There are no houses at the landfill site but the nearest residential area in Nasommo village to the landfill is located about 500m away. Waste pickers from the nearby village come to the dumpsite to sort plastic wastes. They work at the site to supplement their income from farming. At the site are small makeshift sheds being used by the waste pickers as resting area and for storage of sorted recyclables placed in sacks. There is also a damaged leachate collection and treatment tank at the existing dumpsite.

49. The existing dumpsite has been allocated an area of 9ha, of which only 1.8ha is currently being utilized. This 9ha is part of a wider 30ha of available public land for the solid waste controlled landfill. The Urban Development Administration Authority (UDAA) manages the existing dumpsite and collects solid waste from all areas of Pakxan where roads are accessible using two trucks and one skip loader. The UDAA was granted this responsibility on solid waste collection and disposal by virtue of Prime Minister Decree No. 177/PM dated 22 December 1997.

50. Currently, 15 of the 22 villages within Pakxan District are serviced, with collection coverage within a village ranging from 15 – 65%. Only 44% of the 3,420 households in the current collection route have contracts with UDAA. Domestic solid waste collection is once per week and commercial/market waste on demand. Collection is hampered by the lack of collection vehicles, particularly the lack of small 5-tonne trucks that can access smaller residential earth roads.

Figure 21: Photos of existing dumpsite and proposed controlled landfill site

Laterite road, approximately 1 km long to the landfill site. The road passes through the Nasommo village.

The existing dumpsite.

Waste picking activities at the dumpsite.

Waste pickers bring along their children to the dumpsite.

The damaged leachate collection/treatment tank.

The secondary forest area adjacent to the dumpsite.

51. **Component 4: Riverbank protection.** The riverbank protection works will be at two separate sections near the San River and Mekong River. There are large trees at the bank of the San River with partially exposed roots due to bank scouring. There are two temples and some residential houses and commercial shops in the vicinity of the riverbank protection areas.

Figure 22: Unprotected bank of San River

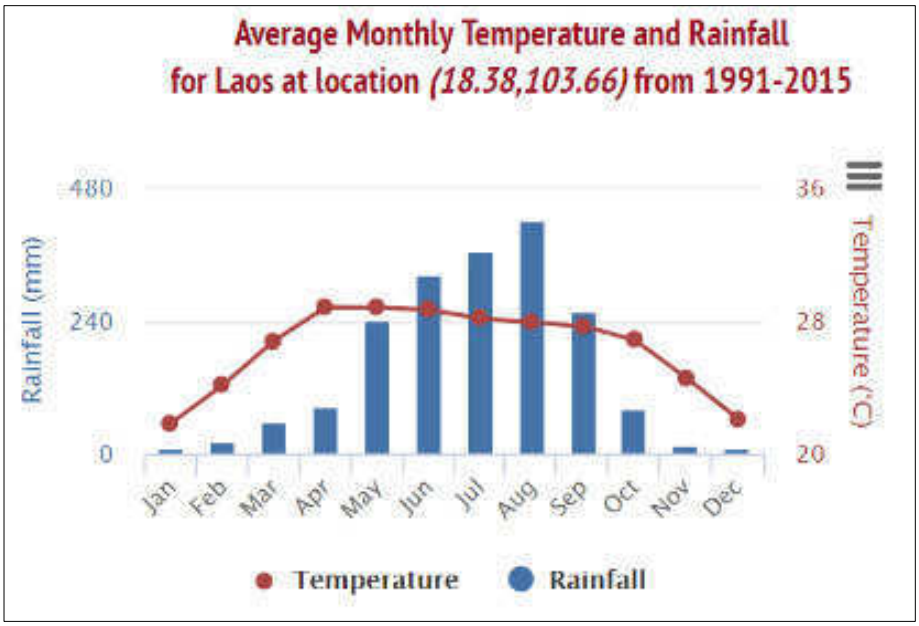
C. Climate

52. Lao PDR's tropical climate is influenced by the southeast monsoon which causes significant rainfall and high humidity. The climate is divided into two distinct seasons: rainy season, or monsoon, from May to mid-October, followed by a dry season from mid-October to April. Considering its altitude, Lao PDR is divided into three different climatic zones, and Pakxan belongs to the "tropical lowland plain and floodplains along the Mekong River", where more than 50% of the Lao population resides. Average temperatures in the plains are 25°C–27°C; average rainfall is 1,500 mm to 2,000 mm.[21]

[21] National Adaptation Programme of Action to Climate Change. WREA UNDP. GEF. April 2009.

53. Mean monthly temperature in Pakxan for the period 1991-2015 ranged from a minimum 21.85 ^{O}C in January to a maximum of 28.83 ^{O}C in April. Mean monthly rainfall was a minimum of 9.77 mm in January and a maximum 421.24 mm in August.

Figure 23: Average Monthly Temperature and Rainfall (1901-2015)[22] – Pakxan



Climate Change and Natural Disaster

54. The Project was screened using the AWARE for Projects tool, an online tool used by ADB to screen projects for climate risks. The result of the screening indicated that the Project is at "high" risk for flood, landslide and onshore category 1 storm; at medium risk for precipitation increase; and low risk for other variables, such as temperature increase, precipitation decrease, water availability and wind speed increase.

55. Initial findings of the Climate Risk and Vulnerability Assessment show that the probable range of mean annual temperature by 2050 for Pakxan would be 27.07°C to 28.28°C. The mean annual rainfall ranges from 1,985mm to 2,099mm. The flood hazards map in the Developing a National Risk Profile of Lao PDR 2010 (UNDP) reveal that Nam Ngiap River and San River could cause more than two meters deep of flooding in the Pakxan District.[23] The worst flooding events recalled by the villagers happened in 1966, 1995, 1996, 2001, and 2007. The villages are classified according to the level of flooding in their areas: (i) Zone A–flooding occurs about every 5 years along the San River; (ii) Zone B– flooding occurs once a year during the rainy season, but rain water stagnates because it could not flow for many days; and (iii) Zone C–flooding is caused by overflow of water from the Mekong River and San River due to improper drainage system.[24]

[22] Source: Climate Change Knowledge Portal. The World Bank Group. http://sdwebx.worldbank.org/climateportal/
[23] Developing a National Risk Profile of Lao PDR. Part 1 Hazard Assessment. 2010. National Disaster Management Committee Government of Lao PDR. United Nationals Development Programme (UNDP) Lao PDR.
[24] Integrated disaster risk management (IDRM) – Lao PDR. DFR. PPTA. March 2018

56. According to the Mekong River Commission (MRC) Working Paper 2011–2015:[25]

(i) Over the period 1985-2000 to 2042-2050, the mean annual high flow season discharge along the entire length of the Mekong River is projected to increase by 10%-15%. This would potentially increase the mean annual "flood days" in the project towns.[26]
(ii) In Vientiane, based on a mean high flow season discharge of 6,837 m^3/s, the mean annual number of flood days would increase to 105 days in 2042–2050 (from 89 days in 1985–2000).
(iii) In Nong Khai, based on a mean high flow season discharge of 6,947 m^3/s, the mean annual number of flood days would increase to 106 days in 2042–2050 (from 89 days in 1985–2000).
(iv) A comparison of the extent of flooding between that in the 2000 flood event and that of a large flood event in 2048 under a projected climate change state revealed an 8.8% increase in the extent of flooding (that is, flood depths above 0.0 m) in the 2048 event. This will increase with greater depths. For depths over 1.5 m, the projected increase would be 30%-60%.

57. Typhoon is another hazard that damages houses and agricultural areas in Pakxan. Landslide is flagged as high risk in AWARE. However, the terrain within the Pakxan district's main urban area is flat to moderately undulating and is not prone to landslides. Earthquakes of small to moderate magnitudes have been experienced in Lao PDR. Pakxan district is not among the areas vulnerable to earthquake hazards.

D. Air Quality

58. Data on ambient air quality in Pakxan are not available. Emissions from moving vehicles are considered as the major sources of air pollution in Pakxan although traffic volume is low when compared with major urban centers like Vientiane. Resuspended dust also occurs when vehicles pass over dry unpaved roads or from wind action on unpaved or exposed surfaces.

59. Air quality at the proposed landfill site and immediate vicinity is largely affected spontaneous landfill fires at the existing dumpsite which occur during the dry season[27] as well as by emissions from moving vehicles along the laterite road in Nasommo village going to the landfill site.

60. In general, air quality at the sites of the SWTP sites, stormwater drainage improvement and riverbank areas is good because of the low volume of vehicles plying roads adjacent to the project sites. There are ongoing road construction works in the areas for the small road drains which generate dust emission.

E. Noise

61. Ambient noise in the main urban area is brought about by vehicles, construction activities, small-scale industry involving metal forming and equipment maintenance and repairs. Drainage, riverbank protection and SWTP works will be implemented in the main urban area, where

[25] Working Paper 2011–2015. The Impact and Management of Floods and Drought in the Lower Mekong Basin and Implications of Possible Climate Change. Flood Management and Mitigation Programme. Mekong River Commission. March 2012.
[26] Flood days are days with discharges greater that mean annual high flow season discharge.
[27] Based on information provided by waste pickers at the existing dumpsite during the site visit on April 3, 2018.

population concentration is high and where there are sensitive receptors, such as hospitals, schools and temples.

F. Surface Water

62. Pakxan lies within the floodplain north and northeast of the confluence of the Mekong River and San River. These major river systems contribute to the seasonal flooding of the project area. The Mekong River will be within the areas of influence of the SWTP for the provincial hospital and the road drains. The San River will be within the areas of influence of the riverbank protection, SWTPs for Pakxan 1 and 2, road drains and trunk drains. The Parkpheng wetland which is a natural drainage retention area to the east will be the receiving water for discharges from the proposed trunk drains and the SWTP in Pakxan 1 old town area.

63. In the town centre, drains were constructed along the new main dual carriageway only. Based on the survey conducted by the PPTA team in November 2017 to identify drainage problem areas, the main flood points that were identified are in the old town, all along the bank of the San River from near the Mekong confluence to the north. The province is currently widening the main road through the old town and providing drains, footpaths and streetlights. This road ends at the southern end at the confluence of the San and Mekong rivers.

64. All natural drainage from Pakxan 2 area west of the San River collects in three natural low points in the southern and eastern sides of the built-up area. All natural drainage from the old town or Pakxan 1 area drains to a large natural drainage retention area due east of the town center. This area has a permanent pond which expands substantially in the wet season, hence, the capacity of this drainage retention basin will be further evaluated during detailed engineering design.

G. Water quality

65. Data on the water quality of Mekong River, San River and natural drainage retention areas are not available. According to the 2014 Lower Mekong Regional Water Quality Monitoring Report of the Mekong River Commission, water samples taken at the Vientiane station had rating scores of: (i) “B” or “good quality” for the protection of human health; (ii) “B” or “good quality” for the protection of aquatic life; and (iii) “A” for agricultural use. Water samples taken at Nakhon Phanom station had rating scores of: (i) “B” for the protection of human health; (ii) “A” for the protection of aquatic life; and “A” for agricultural use.[28]

66. Based on a report from the Water Division of DONRE Borikhamxay, the Parkpheng wetland in recent years has become degraded due to human activities, resulting in the pollution of the wetland. Water level in the wetland is shallow and water quality is now worse which affected the biodiversity of this wetland. There used to be a dense forest along the wetland which has been cut and removed by villagers living near the wetland. The Water Division of DONRE proposes to implement wetland improvement through planting of trees in the original forest area, provide nursery for fish propagation, and land use planning to control activities allowed in the vicinity of the wetland.

67. Baseline water quality of Mekong River, San River and the Parkpheng wetland will be established during detailed design, further assessment of the suitability of discharge to the

[28] “A” for “high quality” class indicates all measurements as within objectives virtually all of the time. “B” for “good quality” class indicates conditions rarely depart from desirable values.

wetland will be assessed and options for supporting DONRE with managing and restoring the wetland will also be considered during detailed engineering design.

H. Groundwater

68. Data on groundwater quality in Pakxan is not available. The PPTA team engaged the DONRE Borikhamxay Province to conduct a study of the groundwater quality in the vicinity of the dumpsite in December 2017. Groundwater tapped by a well in the Nasommo village close to the Pakxan dumpsite was sampled and subjected to laboratory tests. The study revealed exceedances in Pb, As, Cd, total coliform and E coli, Faecal coliform with the Lao PDR drinking water quality standards and with the Guidelines for Drinking Water Quality of the WHO. (Table 9 and Appendix D).

Table 9: Parameters That Exceeded Standard Limits – Groundwater Study – Pakxan[a]

Parameter	Unit	Results	Lao PDR [b]	WHO [c]
Pb	mg/L	0.49	0.01	0.01
Cd	mg/L	0.025	0.003	0.003
As	mg/L	0.063	0.01	0.01
Total Coliform	MPN/100ml	59	2.2	Must not be detectable in any 100 ml sample
E.Coli (Faecal Coliform)	-	7	None	

[a] Conducted by DONRE Pakxan for the PPTA of GMS-CTDP-4. December 2017. Samples were taken from a household well in Nasommo Village, about 600-700m from the Pakxan dumpsite.
[b] Table 11.1 Standard for Groundwater Quality for Domestic Consumption. National Environmental Standards (No. 81/NA), 21 February 2017. Lao PDR.
[c] Guidelines for Drinking Water Quality. Fourth Edition incorporating the first addendum. Geneva. WHO. 2017.

I. Biological Environment

69. Pakxan lies between two national protected areas: (i) Nam Kading in the east, and (ii) Phou Khao Khouay in the west. The western boundary of Pakxan is at least 2 km away from the eastern edge of Phou Khao Khouay. The distance of Pakxan to Nam Kading is much farther. There are no RAMSAR[29] site and international bird areas in Borikhamxay Province. The natural drainage retention areas are not considered as wetlands of ecological importance. These are functioning as areas where urban drainage and floodwaters accumulate during the rainy season, however, further assessment will be carried out during detailed engineering design.

J. Physical Cultural Environment

70. There is no UNESCO world heritage site in Borikhamxay Province or in adjacent province and close to Pakxan. At the local level, there could be temples or religious structures in the areas of influence of the trunk and road drains, SWTPs and riverbank protection works.

K. Socioeconomic Environment[30]

71. **Population.** Pakxan town had a population 25,805 in 2015.[31] In the 2005 census, Pakxan constituted 37.1% of the province's urban population but by 2015 this has decreased to 28%. Borikhamxay's urban population has grown at an average growth rate of 4.4% during these two

[29] Wetlands of international importance, especially those providing waterfowl habitat.
[30] Sources: (i) Commune Database 2009-2013. Ministry of Planning. (ii) PPTA SES of September 2017.
[31] The 4th Population and Housing Census (PHC) 2015. Urban population.

census years, but Pakxan's urban population has been growing at a much slower rate of at 1.6%. The trunk and road drains, SWTP units and the riverbank protection works will be implemented in the urban areas where population is highest and urban activities are concentrated. The controlled landfill site will be accessed through Nasommo Village. Residences in the village comprise permanent housing, made of concrete and with metal roofing. The closest residence from the entrance to the controlled landfill site is about 600 m away.

72. **Water Supply**. Of the 59 villages comprising Pakxan District, only 16 villages are served by the existing piped water supply. All households in the 16 villages are connected to the system. The villages close to the landfill site are not covered by the supply system and rely on their dug wells for water. From an interview with one of the households nearest to the dumpsite, they buy bottled water for drinking. The household survey indicates that 68% of the households had access to piped water.

73. **Sanitation.** There is no reticulated wastewater collection and treatment in Pakxan. There are no records of numbers, volumes or condition of septic tanks in the city. Private septage trucks and septage disposal are unregulated. There is no building code stipulating requirements for urban on-site sanitation. Wastewater treatment is limited to septic tanks in the more modern houses, hotels and restaurants. Many households use an unsealed soakaway pit formed with locally available concrete ring sections. Household survey results showed that 31% of the households made use of soak pits while 34% had their own septic tanks.

74. **Drainage.** According to the DPWT of Borikhamxay, only about 40% of the town is served with drainage, of which 10% are open channels and 30% is the underground drainage system. The household survey showed that only 13% of the town was served by the open canal drains. Of the 270 respondents to the household survey, 22% considered flooding and inadequate drainage for stormwater as their most serious problems.

75. **Solid Waste Management.** Of the 22 villages comprising the district, only 15 are reached by the solid waste collection service whose coverage ranged from 15%–65%. Of the 3,420 households in the current collection route, only 44% have a contract with the UDAA. Domestic collection is once per week, and commercial/market waste on demand. The UDAA would like to expand the collection area to all villages in the near future. Currently only the wastes from areas in the Pakxan district, where roads are accessible using 2 trucks and one skip loader, are collected. The collection fee is LAK25,000/month per household (about 4 bags) and LAK50,000/month–-LAK250,000/month for a hotel.

76. The existing method of final disposal is open dumping at a 9-ha site, 6 km east of Pakxan town. Open dumping started in 2011. The site is accessed from NR 13 through a 1-km road whose first 360-m stretch from NR 13 is lined with houses. There is no equipment at the site and dumped waste is not moved or compacted. The UDAA manages this disposal operation. There are eighteen waste pickers who have been informally allowed by the UDAA to pick waste on and off.[32] They are farmers from the adjacent village of Nasommo, through which the access road passes. The household survey indicated that 73% of the respondent households were covered by waste collection.

77. **Power Supply.** All households in Pakxan are connected to the power supply. This is validated by the household survey which showed that 98.9% of the respondent households were connected to the grid.

[32] Information obtained from the PPTA social and gender Team.

78. **Health**. Based on the data provided by the Provincial Department of Health on waterborne and water related diseases as well as most common diseases for the 2 years 2015-2016 (Table 10), there were 8,303 diarrhoeal cases from 2015-2016 and 1,367 cases of dysentery. The most common diseases in the province are upper and respiratory diseases with 22,179 cases and 5,356 cases, respectively in 2015–2016.

79. The Department of Health implements 8 programs, 57 projects and 154 activities in coordination with donors such as WHO, UNICEF, ASB, and HUMANA. There is an education team on health activities and each village has a health committee. Community campaigns are also undertaken through loudspeakers provided in each village to announce health activities, brochures, and volunteer groups.

80. The number of road traffic accidents is high in the province with 4,460 people injured and 30 traffic-related deaths in 2015–2016.

Table 10 Water-borne, Water Related and Most Common Diseases in Borikhamxay Province 2015-2016

Disease	**Cases 2015-2016 (2 years)**
Water borne diseases	Out-patients 280,417, in-patients 36,021 in the whole province
Diarrhoea	8,303
Dysentery	1,367
Typhoid	88
Most common diseases	
Upper Respiratory	22,179
Lower respiratory	5,356
Traffic accidents	4,460 people injured who came to hospital
Deaths from traffic accidents	About 30
Dengue	581 cases in the two years, 1 death. In first 6 months of 2017: 481 cases
Malaria	12
Parasites - worms etc	2,500 with stool check - 44% positive
HIV/AIDS	53 - all get treatment
Skin diseases	115 - 3 leprosy in 3 districts in the province

Source: Borikhamxay Department of Health

81. **Education**. The Pakxan district has 24 pre-schools, 58 primary schools, 13 high schools and three colleges. According to the household survey, the literacy rate of the 15–17 year-old population was 99.2%; that of the 18-45-year population was 96.3%. The household survey obtained data for the highest education attainment of any male and any female members in the household. For secondary, high school and vocational training/diploma there is almost gender balance in terms of the percentages of households with females and males with those educations. There are a few more households with females who have no education than households with males who have no education. Approximately 70% of those who graduated from primary school as their highest educational level are females; in this educational level, 15% were females, and 6%, males.

82. **UXO Contamination in Pakxan.** According to the National Regulatory Authority for UXO/Mine Action Sector in Lao PDR (UXO-NRA), "*Despite huge advancements in the human and institutional capacity within the UXO Sector, and much investment from the international*

community, Lao PDR still has a very significant UXO problem".[33] However, Borikhamxay Province is one of the provinces with lowest density of UXO existence.[34]

V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Environmental Benefits, Positive Impacts and Results

83. The subproject is expected to improve the urban environment in Pakxan, reduce the town's vulnerability to environmental and climate risks, and improve its climate resilience level and quality of life. It will provide Pakxan with improved stormwater, wastewater and solid waste management services, enhance flood protection from river overflows, formulate a provincial development strategy, and strengthen institutional capacities in resilience town planning. Cumulatively, the positive impacts of such benefits are, but not limited to: (i) reduced flood risk, (ii) reduced risk of human contact with raw sewage during flooding, (iii) reduced health risks from diseases caused by inadequate stormwater management, (iv) improved environmental sanitation, (v) controlled GHG emissions from solid waste disposal, (vi) reduced pollution discharges and improved water quality, (vii) reduced air and land pollution, and (viii) improved recreational amenity. Table 11 presents the positive impacts and expected results from each component of the subproject.

Table 11: Benefits, Positive Impacts and Outcomes

Subproject Component	Benefits, Positive Impacts and Outcomes	
Stormwater drainage	Benefit	Improved stormwater management
	Positive impacts	Reduced flood risks Reduced health risks and incidence of diseases
SWTP systems	Benefit	Improved wastewater management
	Positive impacts	Reduced pollution discharges Improved water quality Reduced health risks and incidence of diseases Improved environmental sanitation Reduced risks of human contact with sewage from drainage during flooding
Controlled landfill, equipment and septage facility	Benefit	Improved solid waste management
	Positive impacts	Improved environmental sanitation Protection of surface and groundwater quality Reduced air and land pollution Controlled and managed GHG emissions from solid waste disposal operations Improved working conditions for informal waste pickers currently at the disposal site
Riverbank protection	Benefit	Improved flood protection Provision of a public recreational amenity
	Positive impacts	Reduced flood risks Improved public safety Reduced health risks and incidence of diseases from flooding Improved public health

[33] National Regulatory Authority for UXO/Mine Action Sector in Lao PDR (UXO-NRA). http://www.nra.gov.la/uxoproblem.html

[34] Developing a National Risk Profile of Laos PDR. Part 1: Hazard Assessment. 2010. National Disaster Management Committee. Government of Lao PDR. United Nations Development Programme (UNDP) Lao PDR.

Subproject Component	Benefits, Positive Impacts and Outcomes	
		Improved social equity, ensuring access by all to recreational amenity
Institutional support	Benefit	Strengthened institutional capacities 5-year Provincial Development Strategy
	Positive impacts	Sustainable urban growth Reduced infilling of natural drainage retention basin

84. A significant, positive impact from the subproject will be the improvement in the working conditions of informal waste pickers currently operating at the existing dumpsite. Currently, these workers endure significant occupational health and safety risks,[35] working under difficult and often dangerous conditions in order to segregate out and sell higher value waste fractions from the dumpsite.[36] The waste pickers will be allowed to continue their livelihood activities at the site, however, they will be trained and will be required to abide by the guidelines set out by the management of the landfill to ensure their safety. A sorting area will be constructed to facilitate the recovery of recyclable materials brought to the landfill. All waste pickers should be required to wear protective gear such as rubber gloves, rubber boots and crush helmets. Waste picking will only be allowed during regular operating hours and persons below 18 years of age will be prevented from waste picking activity at the landfill.

B. Anticipated Impacts/Issues/Concerns of Each Subproject Component

85. The proposed location and conceptual design of each of the infrastructure components of the subproject was assessed to identify issues and concerns that need to be evaluated further during detailed design and to design mitigation measures to address adverse impacts that will affect the operation. The general pre-construction and construction impacts and mitigation measures that apply to all subproject components are discussed in sections C and D of this chapter.

1. Stormwater Drainage Improvement

86. **Impacts on hydrology.** The proposed drainage improvement works will follow the natural drainage pattern, hence, impacts on diversion of flow is not foreseen. The impacts of stormwater drainage improvement will be largely positive for communities since it will abate perennial flooding of ricefields.

87. The natural drainage retention area (Parkpheng wetland) which will receive the stormwater runoff from the four trunk drains and the effluent from SWTP from Pakxan 1 old town area will be evaluated further in terms of its capacity to accommodate the storm water flows and the effluent discharge and to ensure that flooding will not be induced in the surrounding areas. Further study will be undertaken during detailed design to evaluate the assimilative capacity and uses of the wetland area to take into consideration the ongoing land development and future land use plan of Pakxan. Climate risk mitigation options will be considered during detailed design that

[35] Waste picker health complaints include diarrhoea, fever, chronic coughs and phlegm, colds, shortness of breath, skin infections, skin ulcers, respiratory and gastrointestinal ailments and visual problems. Other afflictions include dysentery and bronchitis, asthma and pneumonia, as well as the prevalence of parasites and malnutrition.

[36] Particulate and dust levels can be high at dumpsites, and can include asbestos and other dangerous dusts. Decomposing wastes also produce gases, including methane, carbon monoxide, and volatile organics potentially containing toxic and carcinogenic compounds. Waste burning releases hazardous compounds into the atmosphere, including dioxins and polycyclic aromatic hydrocarbons, which are known mutagens and teratogens (causing fetal defects), and are suspected human carcinogens (causing cancer).

includes detailed analysis of historical and projected future flood levels, taking into account the increasing rainfall intensities and land use changes.

88. During the operational phase, an emergency response plan will be designed to ensure that the flood risk areas and location of designated evacuation sites and routes are identified. Community-based flood warning system, information dissemination campaign of the community evacuation plan, and drills will be identified through consultation with communities.

89. **Impact on structures and land.** The trunk mains will affect agricultural land while the roadside drains will affect some structures and shops that are beside these roads. Potential impacts on irrigation systems (if any) will be assessed during detailed design.

2. Small-scale Wastewater Treatment Plants

90. **Positive impacts.** The wastewater treatment component will include the construction of four SWTP units and the laying of sewer lines to channel and treat black water from the service area. The component will avoid the current practice of uncontrolled disposal of sewage by households into canals and rivers. This issue was raised during the household survey wherein 14.4% of respondents think that wastewater disposal is a serious problem of the town. With properly designed and effective wastewater treatment systems, microbial contamination of receiving water will be controlled and spread of disease, odors, and contamination of land and ground will be avoided. The operation of the four SWTPs is expected to reduce the BOD concentration being discharged into receiving bodies of water by >300mg/l or about 90% reduction in BOD concentration. By treating wastewater, the project will avoid water pollution and contribute to the clean-up of the receiving water bodies. Table 6 presents the effluent quality before and after SWTP treatment.

91. **Impact of sewer pipe laying.** The sewer lines will be laid along road easements and will affect drainage lines, sidewalks, driveways, electric poles and water lines during pipe laying. Coordination with affected agencies, utility companies and stakeholders will be undertaken during detailed design and prior to construction. Restoration of damaged road easement, sidewalks, and driveways should be undertaken after the laying of the sewer lines.

92. **Leaks from the sewer lines.** Once the sewer lines are operational, there may be instances when black water would leak and cause contamination of soil, groundwater and surface water. Overflow of blackwater may occur when the system cannot manage the volume of wastewater due to blockages. Overflow due to storm water runoff is not anticipated from the sewer lines since the pipes will accommodate black water only and the design will employ the closed pipe system using HDPE circular pipes. In order to prevent, minimize and control leaks, sufficient hydraulic capacity will be designed to accommodate peak flows with adequate slope in the main trunk to prevent buildup of solids. Routine maintenance and inspection program will be undertaken to identify areas needing repair, cracked or deteriorated pipes, leaking joints or seals, and any suspected infiltration or exfiltration.

93. **Waterlogging at SWTP sites.** Of the four SWTP locations, the proposed location of SWTP near the Parkpheng wetland which is natural drainage retention area east of the town center and the SWTP in Phonexay village have been reported to be waterlogged during the rainy season. The location of these SWTPs will be evaluated during detailed design to determine buffer against flooding and if backfilling will be necessary. If backfilling is to be undertaken, appropriate measures to avoid flooding of adjacent properties/land should be instituted such as provision of adequate drainage lines leading to the Mekong River. Factor of safety will be incorporated in the

design based on detailed analysis of the flood situation to protect the SWTP from inundation. Bunds around the SWTP units will be provided.

94. **Impact on receiving stream capacity and uses.** There is no anticipated problem in terms of the hydrological capacity of the San River and Mekong River to accommodate the effluent discharges from the SWTPS for Pakxan 2 and the SWTP located at the hospital compound in Pakxan 1 because these rivers are very large as compared to the minimal volume of effluent to be discharged from the SWTP units. The SWTP within the Borikhamxay Provincial Hospital compound also do not have an impact on the capacity of the receiving Mekong River since it can accommodate the flow of 200 m^3/day. The site is not prone to flooding. The SWTP in Pakxan 1 old town area will be assessed in terms of impacts on the hydrology and uses of the receiving Parkpheng wetland. The capacity and value of the wetland and impacts on other uses/users will be evaluated further during detailed design to confirm suitability as a receiving water.

95. The effluent quality from all the SWTPs should comply with the standards to avoid deterioration of the water quality of receiving water bodies.

96. Hydrologically, the potential environmental impacts to surface water resources from SWTP construction are: (i) changes to natural surface hydrology and drainage pathways and (ii) potential flooding of the facilities by elevated surface waters. These impacts will be addressed at final design phase through (i) detailed hydrological assessment to ensure that the final designs fully accommodate and mitigate impacts on natural hydrology, and (ii) incorporating bunds and raising the elevations of the SWTP units above potential flood levels.

97. **Impacts of effluent on surface water quality.** During the final design phase, the SWTP facilities will be designed and dimensioned to ensure that appropriate effluent discharge standards are adhered to (Appendix C). This is important, as the SWTP facilities are to discharge either directly, or through drainage facilities, into nearby surface waters. Measures will therefore be implemented to strengthen the operations and maintenance of these facilities to ensure that they continue to comply with the Effluent Standards as embodied in the National Environmental Standards 81/NA.[37] These measures include:

(i) Specifying specific maintenance procedures in the SWTP operations manuals.
(ii) Ensuring adequate budget and equipment for routine maintenance activities.
(iii) Conducting operator training for SWTP operations and maintenance.
(iv) Regularly monitoring effluent quality and implementing corrective actions for non-compliance.

98. **Air quality and Odor from SWTPs**. The SWTPs would be able to reduce the biodegradable organics in raw wastewater. The SWTP units are expected to generate biogas at each stage of the process units which could release odor to the surrounding area. Based on information provided by the PPTA engineering team, the septic tank or the first process unit will produce about 21.8m^3/day; the anaerobic baffled reactor will produce 40.5 m^3/day and the aerobic filter will produce 45 m^3/day. This is based on the SWTP capacity of 300m^3/day. For the 200m^3/day capacity SWTP, the total biogas to be produced at the septic tank is 14.5m^3/day; at the anaerobic baffled reactor is 27 m^3/day and at the aerobic filter is 29 m^3/day. The biogas is composed of 70% methane (CH_4) which has a global warning potential of 21. Using this

[37] Appendix C compares the Lao PDR and IFC EHS effluent discharge standards. The standards are the same for pH, BOD, COD, TSS and TKN. The Lao PDR standard is stricter in terms of oil/grease (5mg/l as compared to the EHS guideline of 10mg/l). The Lao PDR standard also includes more parameters including heavy metals.

information, the estimated GHG emission from all four units was computed as 516.05 tons CO_2 eq/year.

99. Based on the 2006 IPCC guidelines for national GHG inventories, direct emissions from nitrification and denitrification at wastewater treatment plants may be considered as minor sources. Typically, these emissions are much smaller than those from effluent and may only be of interest for advanced centralized wastewater treatment plants with significant volume and with nitrification and denitrification steps.

100. To mitigate odors from the operation of the SWTP facilities, berms and tree lines can be incorporated into the design of the SWTPs.

101. **Disposal of sludge from SWTP.** Based on the conceptual plan of the SWTPs, sludge will be removed annually or every two years. Sludge from anaerobic treatment is largely inert, can be dried and landfilled or applied to agricultural land. Using the anaerobic system and with the low volume of wastewater to be treated in each unit, sludge generation is expected to be minimal at about 5.04m^3/year (total) for all the four SWTPs.

102. **Health and Safety Aspects.** Damage of or failure to wastewater pipelines could result in leaks, and the outflow of untreated wastewater. This could potentially lead to both human contact with raw wastewater, and the contamination of the water supply system if nearby water supply pipelines are also damaged, both of which can endanger community health. Routine inspections for the early detection of leaks, together with close and ongoing collaboration with communities in leak monitoring and reporting will help to mitigate this impact.

103. Operation and maintenance activities pose risks to the health and safety of workers of SWTPs and the controlled landfill. These risks will be mitigated through the preparation of an operations manual for the controlled landfill and the SWTP facilities, which shall include an occupational health and safety plan (OHSP) and capacity building program. [38]

3. Controlled Landfill

104. The identified potential impacts of the controlled landfill include the clearing of vegetation, accidental discovery of mine/UXO, soil runoff, and odor during mining or transfer of existing wastes to the new waste cells due to ongoing decomposition of wastes. The concerns and potential impacts during controlled landfill operations include: (i) generated dust, gas, fumes and odor; (ii) greenhouse gas emissions; (iii) potential groundwater and soil contamination from leachate and landfill gas migration; (vi) pests/rodents/vermin, bird and stray animal attraction; (vii) wind-blown litter; (viii) fire/explosion; (ix) community health and safety; and (x) workers' health and safety hazards.

105. The closure plan of the existing dumpsite includes the transfer of the existing wastes into a new lined waste cell at the landfill. The plan will prioritize key mitigation features, including (i) surface grading and covering of exposed waste cell surfaces to improve controlled runoff and reduce erosion, and (ii) site perimeter drains to control surface water run-on and runoff.

106. During the construction and operational phases, the impacts of the controlled landfill on groundwater, air quality and soil quality will be monitored by establishing monitoring stations at

[38] Based on the Environmental, Health and Safety Guidelines for Water and Sanitation of the International Finance Corporation, dated 10 December 2007.

the landsite site and at the upgradient and downgradient of the site for groundwater and soil quality. Workers will also be trained on waste handling, recording, including wearing of personnel protective equipment while working at the site. Fire protection system to manage occasional landfill fires during the dry season will be provided and a materials recovery facility (MRF) at the landfill site will be established to temporarily store collected recyclables.

107. **Impact on communities.** There are no residential communities within the immediate vicinity of the landfill site but residential communities along the laterite road will be affected by the movement of waste haulers. This laterite road should be improved to prevent dust emission during frequent movement of haulers. In addition, waste haulers should be properly trained and instructed to minimize vehicle speeds while passing through the settlement areas.

108. **Impact of landfill on air quality.** During its operation, the controlled landfill will generate landfill gas which includes the primary greenhouse gases (GHGs) of carbon dioxide, methane and nitrous oxide. These gases are formed through organic waste decomposition process, with decomposition being accelerated through the saturation of waste due to the ingress of precipitation and surface waters into the waste. The subproject transition from uncontrolled open dumping to controlled landfilling will however reduce the impacts of landfill gas generation and emission to some extent. This is due to a reduction of landfill gas generation within the waste as a result of reducing precipitation and surface water inundation due to its surface cover (capping) system.

109. As indicated in a recent ADB preliminary report,[39] as the landfill will receive only a relatively small waste volume (less than 100 tons per day), the facility will only generate limited amounts of landfill gas. Given the technical complexity and excessive cost in capturing and treating such small amounts of landfill gas, available capture and treatment systems, such as a flaring system or energy conversion system, are not considered to be appropriate or affordable at this time by the technical team, as indeed, it would likely take a number of years anyway for landfill gas generation to reach a point of viable capture. It is therefore considered that the landfill gas be vented over the medium term, with the potential to evaluate more sophisticated landfill gas management systems at a later date, once the landfill reaches critical mass.

110. A simulation to estimate GHG emissions of the dumpsite was made using IGES tool and using information provided by the UDAA. The simulation revealed net GHG emission of 456,033 kg of CO2-eq/monthly managed waste or 5,472 tonnes CO_2-eq/yearly managed waste. This was compared with the GHG emission from the current open dumping of wastes. The simulation revealed that with the proposed controlled landfill, GHG emission will be reduced by 62% as compared to open dumping of wastes. The reduction in GHG emission is due to the expected increase of recycling at source by 15%; collection of market waste every other day, and the composting of about 20% of wastes collected at the landfill site. (See Appendix F)**.**

111. **Odor.** Odor will be produced during waste dumping as well as during waste mining or transfer of existing wastes at the open dumpsite to the new waste cell. Odor can be mitigated through structural design and non-structural measures. This includes (i) enforcing waste encapsulation in waste trucks while in transit, (ii) constructing perimeter fences and berms around the facility, (iii) minimizing exposed tipping areas, (iv) covering all exposed waste, and (v) washing vehicles on facility exit.

[39] Preliminary Report on GMS and CTDP Projects – Solid Waste, March 2018, prepared by an independent SWM expert assigned by the ADB.

112. The impacts of the controlled landfill on air quality will be monitored by establishing monitoring stations at the existing dumpsite and at the new landfill site. Ambient air quality sampling will be undertaken during detailed design (as part of baseline), during the construction phase, and will be continue throughout the operational phase. Post-closure monitoring of the existing dumpsite will also continue one year after the existing dumpsite has been decommissioned.

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114. **Impact on surface water quality.** Surface water impacts relating to controlled landfill operations include: (i) surface water run-on,[40] (ii) site water runoff, (iii) waste mass inundation, and (iv) leachate emissions. Surface water run-on and runoff will be mitigated through the provision of perimeter drains and additional collector drains within the site area. As discussed earlier, the potential for waste mass inundation from precipitation will be mitigated through the provision of cover materials over waste mass surfaces, coupled with the drainage of these covered areas through the contouring of surfaces and installation of surface drains. Completed waste mass surfaces can also be vegetated to reduce cover material erosion.

115. A leachate collection pond will be constructed as part of the features of the controlled landfill. Leachate will not be disposed to a body of water but will be recirculated into the landfill mass.

116. **Impact on groundwater.** Leachate generated within the waste mass of the landfill can migrate through the sidewalls and base and cause contamination of groundwater. Monitoring of a household well at Nasommo village reveals that the groundwater quality is contaminated with Pb, As, Cd, NO_3, total coliform and E coli, Faecal coliform with concentration above the allowable standards for drinking water. The contamination of the groundwater was discussed during the public consultation held in April 27, 2018. The head of the Nasommo Village agreed to inform the villagers not to drink the water from the well. Follow-up on this will be carried out during ongoing public consultation.

117. During the implementation of the controlled landfill, groundwater contamination will be mitigated to some extent through (i) a reduction in leachate generation, (ii) the provision of a base liner to capture leachate, and (iii) a rudimentary leachate collection and disposal system that will allow leachate to be collected and stored, for disposal back onto and into the controlled landfill.

118. During the operational phase, damage to the liner could result to failure in the integrity of the leachate collection system of the controlled landfill resulting in subsurface contamination. These impacts will be mitigated through measures to strengthen facility O&M procedures to ensure that the facilities operate as intended over the long term, coupled with continuous monitoring of groundwater quality to detect and mitigate any future subsurface emissions should they occur. The impacts of the controlled landfill on groundwater quality will be monitored by establishing monitoring stations at the upgradient and downgradient of the site.

[40] Surface water run-on is the movement of surface water onto the site.

119. **Impacts on Access Roads due to Waste Transportation.** During the operational phase of the controlled landfill, the collection and transport of solid wastes will become regular activities that will use existing roads and infrastructure. On average, there will be about 24 truck trips per day to the landfill site during the operational phase. Frequent movement of waste haulers will cause nuisance to villagers living along the access road to the landfill. The lack of proper maintenance of roads being traversed by waste collection vehicles may lead to damage, unnecessary delays in solid waste collection and disposal, and community hazards. The existing laterite road will be utilized as the direct haul route to the landfill. Traffic along this road is light but its unpaved condition generates dust during movement of vehicles. The project will include the improvement of this road. In addition, on a continuous basis, the DPWT should ensure a program and budget for the maintenance of access roads to be used as haul route of waste collectors in community areas. Typical repairs include cleaning, adding or grading of soil and gravel, filling holes, and cleaning of drainage ditches.

4. Riverbank Protection

120. The adverse impacts of the riverbank protection will generally occur during the construction phase. These impacts are on removal of trees, soil erosion and sedimentation of adjacent river, possible blocking of one lane of adjacent roads during delivery of construction materials to the site, noise, dust, and nuisance to two temples and some residents living across the road near the riverbank. Vehicle movement is not heavy at the adjacent roads but a traffic management system will be implemented to guide motorists during temporary lane blocking. Construction activities may also cause erosion to the river, hence, erosion control measures will be necessary. Coordination with the temples will be necessary to avoid nuisance of construction to temple activities.

C. Anticipated Impacts/Issues/Concerns – Pre-Construction Phase

121. Pre-construction issues and concerns primarily relate to (i) ensuring that subproject component designs fully incorporate environmental protection, sustainability and climate resilience measures, and (ii) promoting the preparation and readiness of key subproject stakeholders and affected communities. Mitigation of impacts from these issues includes the following:

(i) **Engaging Qualified Environmental Specialists.** These include the engagement of (i) an international Environmental Specialist (4 months,) and national Environmental Specialist (20 months), based in the PIC, (ii) an Environmental Safeguard Officer in the PCU, and (iii) an environmental focal point in the PIU.

(ii) **Environmental Training and Capacity Building:** The PIC will provide training for environmental personnel of the PCU, PIU, contractors and the DOE. Training modules will include environmental management and technical strengthening in EMP implementation, grievance redress mechanism (GRM) implementation, climate adaptation, disaster risk resilience, public consultation, and monitoring and reporting. Funds for environmental seminars, workshops and training are also allocated.

(iii) **Mine and Unexploded Ordnance Clearances.** Working closely with relevant agencies, these impacts will be mitigated as follows: (i) all subproject sites and their areas of influence will have been cleared by the National Regulatory Authority for UXO/Mine Action Sector in Lao PDR (UXO-NRA) at least two weeks prior to

construction mobilization,[41] (ii) In collaboration with the UXO-NRA, PCU and PIU, a workers' preconstruction workshop will be held to orientate workers on health and safety requirements, and particularly the procedures to follow when mines or unexploded ordnances are encountered during construction, and (iii) information and key contacts will be incorporated in an emergency response plan.

(iv) **Preparing the National IEE/ESIA and Obtaining Clearances.** The MPWT will engage a registered environmental assessment entity to prepare the national IEE/ESIA and secure clearances prior to contract awards.

(v) **Grievance Redress Mechanism:** Established by the MPWT and with oversight from the PCU, the PIU will ensure implementation of the GRM at the subproject level. The GRM provides the mechanism to receive and facilitate the resolution of affected peoples' environmental and other concerns and grievances at the subproject level, accommodating informally and formally lodged grievances. The PCU and PIU will ensure that information about the GRM is posted at the offices of the PIU, town and affected villages prior to construction mobilization. Section VIII describes the GRM.

(vi) **IEE and EMP Updates.** Mitigation measures defined in this IEE and associated EMP will be modified and updated as necessary, based on the final design of subproject components. The detailed design of the subproject components on stormwater drainage, SWTP, and road drains and the updated IEE will consider the assimilative capacity of receiving water bodies, intended use of receiving water bodies, presence of sensitive receptors, and impacts on ecology. Further site assessment, ecological surveys, environmental sampling (surface and groundwater quality noise and leachate quality), geological survey, hydrological and hydrogeological assessment and environmental compliance audit of existing dumpsite will be conducted. These activities will be conducted during detailed engineering design as part of the domestic IEE/ESIAs and in the updating of the IEE and EMP. In accordance with ADB and government protocol, the revised IEE and EMP will be submitted to ADB and government for review and approval, for subsequent disclosure on the ADB's website.

(vii) **Inclusion of the EMP in Bidding Documents.** The updated EMP will be included in the respective bidding and contract documents. Civil works contracts will include provisions to ensure that contractors prepare site-specific contractor EMPs (CEMPs) that fully respond to the EMPs.

(viii) **Consultations and Disclosures.** Consultations and disclosure activities will be maintained with affected people and other involved stakeholders to ensure continued communication, including for example, overall subproject implementation schedule, details of construction activities and particularly activities that result in nuisances and disturbances, the status of claims and compensation, and other aspects.

(ix) **Environmental Site Parameter Evaluation.** Supplementary baseline assessments will be conducted during the final design phase to further refine component designs and inform any necessary IEE and EMP modifications. Further baseline studies will also be required as part of national IEE/ESIA preparation; hence, will be carried out as part of that work and then also used to inform the detailed engineering design and updates to this IEE/EMP. These include for example, the sampling and analysis of air quality, surface waters, groundwater, soils, noise, wastewater influents, and existing dumpsite effluent and leachate quality. The PCU will ensure the results of

[41] According to the UXO-NRA: "*Despite huge advancements in the human and institutional capacity within the UXO Sector, and much investment from the international community, Laos still has a very significant UXO problem*". http://www.nra.gov.la/uxoproblem.html

these baseline studies are provided to the design team.

(x) **Environmental Compliance of existing dumpsite.** The closure of the existing dumpsite will form part of the implementation of the controlled landfill. Post-closure monitoring plan will be designed to ensure effectiveness of the dumpsite closure. The monitoring plan will include monitoring of surface and groundwater, landfill gas, erosion control, and leachate collection. The post-closure monitoring plan will be included in the updated IEE.

D. Anticipated Impacts/Issues/Concerns – Construction Phase

122. **Air Quality.** Temporary, moderate air quality impacts are anticipated during the construction phase, due to both fugitive dust generation associated with earthworks and construction works, and to the movement and disturbance of solid wastes at the existing dumpsite.[42] The receptors of these air quality impacts are residents, businesses, and other affected persons residing nearby, and particularly downwind of construction activities, as well as formal and informal waste workers at the dumpsite. Dust will also be generated during the construction of the riverbank protection works, and also the pipeline network installation excavations in urban areas which are by their nature, densely populated. Sources of air quality impacts during construction therefore include the following:

(i) Construction machinery and equipment leading to minor increases in levels of nitrogen oxides (NOx) and sulfur oxides (SOx).
(ii) Asphalt for any road pavement reinstatement for pipelines and other excavations that will generate emissions containing small quantities of toxic and hazardous chemicals such as volatile organic compounds (VOC) and poly-aromatic hydrocarbons (PAH).
(iii) Fugitive dust from (i) the loading, unloading and haulage of construction materials. (ii) borrow pits and other excavations, (iii) batching plants and (iv) movements of construction trucks over unpaved access roads.
(iv) Fugitive dust, bioaerosols and potentially hazardous chemicals from the movement or disturbance of waste within the existing dumpsite.
(v) Fugitive dust from wind action on stockpiles of cement, fine natural aggregates and dry residual wastes.

123. The following mitigation measures are proposed to protect sensitive receptors from air quality issues:

(i) The spraying of water at borrow pits, construction sites, material handling areas and access roads where fugitive dust is generated.
(ii) Ensuring dust suppression systems are included in asphalt and concrete batching facilities, and that they are located at least 500 m downwind from the nearest receptors.
(iii) Covering trucks to encapsulate dry construction materials.
(iv) Ensuring that vehicles and machinery are maintained to a high standard to minimize emissions.
(v) Ensuring suitable advance notice is provided for pipeline and other excavation works.
(vi) Ensuring that formal and informal waste workers at the dumpsites, and receptors within 500 m of these facilities, are suitably informed in advance of when these activities are planned.

[42] The existing dumped wastes at the Pakxan dumpsite will be carefully transferred to one of the cells of the controlled landfill.

(vii) Ensuring that appropriate environmental protection and occupational health and safety provisions are followed during the disturbances and movement of solid wastes at the dumpsite, as to be defined in the controlled landfill final design.

124. **Noise.** Noise impacts will be caused by the operation and movement of construction vehicles as well as works involving the use of excavators, electric saws, pumps, generators, drilling rigs, and other equipment. These noise impacts will however be temporary and localized, as the machinery and vehicles only generate noise as they operate. It is anticipated that construction machinery may generate noise levels of up 90 dB(A), and also, that receptors within an approximate 250 m influence area could be affected temporarily by intermittent noise impacts above the WHO limit of One Hour LAeq 55 dBA. Although noise will therefore be periodically endured by nearby receptors, particularly during pipeline laying activities, it is anticipated that only construction site workers will be subjected to noise impacts for an extended period of time.

125. Potential noise impacts will be mitigated through the following measures:

(i) Utilizing low-noise, well maintained vehicles and equipment, and ensuring that exhaust systems are in good working order.
(ii) Establishing noise barriers such as temporary fences around active work areas, and barriers to be as close to the source or to the receptor location as possible.
(iii) Installing sound-absorbing enclosures around generators and other equipment.
(iv) Restricting heavy and noisy machinery operations to between 8am-5pm.
(v) Providing construction workers with and enforcing the use of personnel protective equipment (PPE).
(vi) Enforcing the non-use of vehicle horns unless absolutely necessary.
(vii) Maintaining close coordination with affected persons and communities, to ensure that advanced warning is provided, considerations are given, and the GRM is widely understood so that grievances and complaints are handled expeditiously.
(viii) Monitoring noise levels, particularly of nearby sensitive receptors.

126. **Surface Water**. Regarding controlled landfill development, the final design of this facility will incorporate surface drainage features, including perimeter drains, to mitigate any adverse run-on or runoff drainage impacts during construction.

127. The proposed sites of the SWTP facilities are, by their very nature, at low elevations to allow gravity flow (with minimal or no pumping) of wastewater to the units. Due to their relatively low elevations, two of the SWTP sites have been recognized as subject to flooding. Any potential flooding impact will therefore be evaluated and mitigated at the final design phase by for example, incorporating bunds or other protection features, elevating the facilities, and/or through the actual design of the SWTP facilities, which can be sealed, partly underground units. The hydrology of receiving waters from each SWTP facility will also be re-evaluated and verified during detailed engineering design.

128. Other mitigation measures to be adopted that are common to the construction of the SWTP facilities, controlled landfill and riverbank improvements include the following:

(i) Adequate management of sediments, soils, stockpiles and aggregate materials utilized in facility construction.
(ii) Monitoring of upgradient and downgradient surface water quality.
(iii) Monitoring of river water quality in relation to riverbank protection works.

(iv) Management of solid and hazardous wastes.[43]
(v) Siltation and sedimentation runoff control by (i) minimizing excavation exposure, (ii) stockpiling soils away from water bodies and flood-prone areas, (iii) utilizing sediment detention basins and other control features, and (iv) avoiding rainy season excavation where possible.
(vi) Avoidance of vegetation removal or damage beyond site boundaries.

129. For works that will be close to the river such as the riverbank protection works, these works will need to ensure that aquatic and riverine habitats are not impacted. Measures to mitigate these impacts include the following:

(i) Minimizing riparian vegetation removals.
(ii) For riverbank protection, installation of temporary berms between component footprints and the San River and Mekong River, prior to the start of construction.
(iii) Installation of erosion and sediment controls prior to construction commencement to complement the berm.[44]
(iv) Limiting soil stripping to the dry season.
(v) Ensuring workers observe proper sanitation and good hygiene.
(vi) Ensuring where possible works close to the river are conducted in the dry season.
(vii) Ensuring the management of hazardous materials, and the containment of spills.
(viii) Ensuring that sites close to waterbodies are stabilized prior to the removal of erosion and sediment control measures following construction.
(ix) Monitoring water quality during and after construction.

130. **Wastewater**. During the construction works, wastewater will be generated by (i) on site sanitation facilities, campsites and other facilities, (ii) equipment maintenance and repairs, (ii) vehicle and equipment washing, (iii) construction site surface runoff, and (iv) borings and excavation works. Inadequate wastewater management will impact on the health and safety of construction workers and communities. It will pollute surface water resources, groundwater and soils within the areas of influence. These impacts will be mitigated by:

(i) Maintaining sanitation facilities onsite and at workers' campsites.
(ii) Strictly enforcing hygiene and sanitation practices.
(iii) Incorporating sediment controls, silt traps and wastewater collection.
(iv) Maintaining equipment washdown areas, complete with sediment control devices.
(v) Providing retention control for material stockpile areas.
(vi) Designating specific areas for repair and maintenance.
(vii) Ensuring regular wastewater collection by a recognized service provider.
(viii) Ensuring wastewater from boring and excavation works is properly managed and disposed of.

131. **Groundwater.** There is a potential that boreholes drilled during the controlled landfill design and construction phases are not properly sealed after completion, creating a direct contaminant pathway from the surface to the groundwater table. This will be mitigated through the inclusion of detailed borehole construction specifications in the contractor's overall method statements for the drilling works to assure correct borehole construction. Other than this, potentially significant groundwater impacts during construction are not anticipated.

[43] Including (i) provision of adequate waste storage facilities; (ii) enforced sorting and disposal; (iii) separate storage for hazardous and non-hazardous wastes; and (iv) prompt disposal.
[44] For example, sediment control fences supplemented with sandbag barriers.

132. **Fauna, Flora and Potential Habitat Loss.** Although initial baseline assessment has not revealed specific impacts to fauna and flora at the proposed sites, it is recommended that further site assessment, potentially including site specific ecological surveys, be conducted at the riverbank protection sites during the final design stage in order to further evaluate, and where necessary mitigate any ecological impacts caused by the riverbank protection works.

133. **Physical Cultural Environment.** Although component sites are not within the close vicinity of historical and archaeological sites, the pipelines to be constructed for the SWTP network could be located close to pagodas, other religious monuments and other facilities. In adherence with the Law on National Heritage 2005, measures to mitigate any associated impacts are as follows:

(i) Ensure pre-construction coordination with authorities.
(ii) Cease construction works on discovery.
(iii) Declare to the local administration and local information, culture and tourism sector.
(iv) Prohibit exploration of the item/s found without the approval of the information, culture and tourism sector.

134. Chance finds procedures are set out in the EMP and will be followed.

135. **Community Health and Safety.** Communities will be exposed to health and safety hazards from dust, noise, access restrictions, local flooding, utility service disruptions, construction vehicle and equipment movements, and potential social conflicts and diseases (communicable and transmittable) from outside workers. Mitigation measures include:[45]

(i) Access restrictions:
    a. Manage material stockpiles to prevent blockages.
    b. Provide access restriction information in advance.
    c. Ensure vehicles park at previously agreed locations.
    d. Provide temporary, alternative access where possible.
(ii) Localized flooding:
    a. Divert main surface drainage routes when obstructions are unavoidable.
    b. Dispose of spoils and debris promptly.
(iii) Utility service disruptions:
    a. Repair service disruptions expeditiously.
    b. Provide alternative power and water supplies.
(iv) Worker social conflicts:
    a. Prioritize local employment.
    b. Provide health and safety training.

136. **Traffic.** Traffic impacts caused by the subproject relate primarily to the implementation of the riverbank protection, drainage and SWTP works in the main urban area in the same period. Traffic impacts are anticipated during peak hours. Contractors will be required to mitigate traffic impacts by:

(i) Developing traffic management schemes in conjunction with local traffic authorities and affected community leaders.
(ii) Scheduling materials delivery and other traffic-causing activities outside of peak

[45] Air quality, dust and noise mitigation is provided earlier in this section.

hours.
(iii) Assigning traffic staff during periods of peak disruption and peak hours.
(iv) Ensuring construction equipment and vehicles least impede traffic flow.
(v) Providing prior information on road and lane closures, and traffic diversions.
(vi) Providing safe access to pedestrians, motorbikes and bicycles.
(vii) Ensuring affected persons are aware of the GRM.
(viii) Ensuring contractors repair damages at their expense.

137. **Construction workers' health and safety.** Construction workers will be exposed to air emissions, noise, vibration, construction-generated wastes and wastewater, hazardous substances, social conflicts with communities, communicable and transmittable diseases in the community, chance finds of unexploded ordnances (UXO), large moving and operating construction vehicles and equipment, and pits and excavations. These impacts will be mitigated through:

(i) Contractor compliance with environmental and occupational health and safety guidelines.
(ii) Contractor's CEMPs will include health and safety plans.
(iii) Provision of personal protective equipment (PPE) for workers.
(iv) Adequate work site lighting, water supply, sanitation facilities and safe access
(v) Establishment of a first-response team comprising of trained staff, equipment, tools, supplies, and an adequate office/clinic. The first response team will be linked to ultimate responders.
(vi) Appointment of an Environmental, Health and Safety Officer.[46]

E. Anticipated Impacts/Issues/Concerns – Operation Phase

138. It is estimated that the largest environmental risks caused by the subprojects occur in the operation phase, and that these primarily relate to the operation of the controlled landfill and SWTP facilities. This is largely due to the risks of uncontrolled atmospheric, surface and subsurface emissions arising from (i) leachate, landfill gas and odor emissions from the controlled landfill and (ii) substandard effluents and odor that could be generated from the SWTP facilities. The identified impacts of the subproject components have been discussed in Section B of this chapter.

VI. ANALYSIS OF ALTERNATIVES

139. This section summarizes the alternatives considered in the selection of the design and locations of the proposed drainage, wastewater management, solid waste management and river embankment improvement components. Following initial component identification in April 2017, additional technical, environmental and other analyses were performed, leading to confirmation of priority subproject lists at the inception workshop in June 2017. These priorities were then adjusted and consolidated during the interim workshops in October 2017, and again during the joint Cambodia-Lao DPR Strategic Local Economic Development Plan workshop in November 2017.

[46] To maintain worker's health records, and ensure compliance regarding the recommended minimum vaccinations and physical examinations for construction workers.

A. Stormwater Drainage

140. **Without project.** Downstream areas of the town experiences annual flooding. Without the project, flooding in the lower areas of the town will continue and could worsen with climate change.

141. **With project.** The following three technical solutions have been considered regarding the drainage options for Pakxan:

(i) Provision of key trunk drains as identified by the Municipality and the Departments of Housing and Urban Planning (DHUP). This would improve existing channel drainage in the town by allowing stormwater to flow out of the populated areas. This option also includes the provision of road drains in the urban centers for existing roads that currently lack drains.

(ii) Introduction of a comprehensive combined drainage system for the urban area, utilizing large and small diameter reinforced concrete pipes, channels where appropriate, combined sewer overflows (CSO) and individual household connections.[47] This drainage methodology is new to Lao PDR, there being no comprehensive urban wastewater schemes developed yet.[48]

(iii) Introduction of a separated sewer system for the urban area, utilizing (i) large and small diameter reinforced concrete pipes and channels where appropriate for stormwater, and (ii) a network of smaller diameter high-density polyethylene (HDPE) pipes and domestic connections for wastewater.[49] Separated sewer systems often require pumping from different sub-catchments to a centralized wastewater treatment plant (WWTP) and therefore there must be confidence in the ability to collect sufficient revenues for the pumps to be sustainable if this option is selected. There are no separated systems currently in use in Lao PDR.

142. The option taken forward for development under the subproject is the option on the combined sewer which ranks more favorably than the two other options.

Table 12: Multi-Criteria Analysis of Drainage Options

Criteria	Option 1 Addressing immediate drainage and flooding issues only	Option 2 Combined sewer	Option 3 Separated sewer
Technical			
Service coverage	A minimal option. May solve localized drainage problems.	Aims to resolve drainage concerns of main urban area and residential areas of significance in the periphery.	Aims to resolve drainage concerns of main urban area and residential areas of significance in the periphery.
Managed waters	Stormwater only.	Stormwater and wastewater.	Stormwater and wastewater.
Economic			

[47] Pumps may also be required for this option, considering the flat topography of the town and the need to attain minimum self-cleaning velocities, and for the CSOs, to be confirmed following full topographical survey during the detailed design stage.
[48] A lagoon system was developed in the late 1980's for Vientiane but it was not maintained and failed.
[49] Pumps may be required to attain self-cleaning velocities for the separated wastewater pipe network.

Criteria	Option 1 Addressing immediate drainage and flooding issues only	Option 2 Combined sewer	Option 3 Separated sewer
Construction cost	Least construction cost.	Lower construction cost	Higher construction cost.
Pumping cost	Least pumping cost.	Lower pumping costs	Higher pumping costs
O&M costs	Least O&M costs	Low O&M costs	High O&M costs
Environmental and social			
Will reduce vulnerability of town to climate change	No replacement of existing systems. Lesser new pipes will be installed. If to interface new with old pipes, stormwater management in covered areas may not be effective. Old system deemed no longer adequate to cope with increasing runoffs.	Install new, upgrade or replace existing systems, taking into account the effects of climate change.	Install new, upgrade or replace existing systems, taking into account the effects of climate change.
Land (surface area) disturbed or converted	Least new land disturbed and least surface area required.	Higher new land disturbed and higher surface area required.	Less land disturbed, less surface area required than that Option 2.
Pollution to environment	Lower pollutant load (from relatively little polluted surface runoff). Surface runoffs over un-serviced larger part of town and wastewater of town not managed.	Higher pollutant loads due to mixed stormwater and wastewater. CSOs during heavy rains are untreated wastewater.	No mixing of storm- and wastewater. Lower pollutant load, only from surface runoff, discharged without treatment.
GHG emissions	Negligable (if using all underground pipes, since wastewater in underground pipes is not believed to be a significant source of CH4).	With few open channels in areas needing pipes >1500mm. Mixed stormwater and wastewater in open channels will be subject to heating from the sun and may be stagnant, allowing anaerobic conditions, emitting CH4.	Wastewater in closed underground sewers is not believed to be a significant source of CH4.
Access by households to wastewater collection	None	Includes individual household connections.	Domestic connections for wastewater.
Impacts on health and safety	Risk of contact with contaminated stormwater during flooding.	The few open channels pose risk of human contact with raw sewage; open to pest/mosquito breeding; and risk of people falling into them.	Risk of contact with contaminated stormwater during flooding.

Most favorable, 1
2
3
4
Least favorable, 5

143. Regarding pipe size, the following three alternatives have been considered:

(i) Option 1 is the current way of providing drainage, one that is not calculated and not part of a larger and studied system. This option faces the risk of not being able to cope with the pressures of climate change.
(ii) Option 2, uses a rain event of once every two years to calculate the pipe sizes. This is the option adopted by the PPTA Team, which led to the finding that the largest pipe size available in the local market is still large enough to handle the extreme rain event that would occur every two years.
(iii) Option 3 uses a higher return period, which will result in much larger pipes. In most cases, pipes that are much larger than needed will have lower flow velocities. This will allow sediment to remain in the pipes and in effect, will not work well. Moreover, this option will be more expensive. Larger sized pipes need to be imported and transport by land.

B. Wastewater Treatment

144. **Without project.** As there is currently no reticulated wastewater collection and treatment system or septage treatment facility in Pakxan, wastewater treatment is therefore limited to septic tanks in the more modern houses, hotels and restaurants.[50] These however do not allow for any significant treatment; liquid waste soaks into the ground if the groundwater table is low enough, and solids remain in the pit.[51] There is currently only one septage truck operating in Pakxan, with septage typically being sold as fertilizer and discharged directly to agricultural land without treatment. Without the project, untreated wastewater will therefore continue to contaminate surface and groundwater resources in the area, impacting negatively on public health and the environment.

145. **With project.** There are several technologically appropriate options to consider in identifying the most appropriate solution for treating wastewater in Pakxan to the year 2040, a 20-year design capacity having been selected by DHUP for wastewater treatment. The principle options presented are standard lagoon systems, aerated lagoon systems, trickling filters preceded by settlement, and SWTP. Technologies that are widely seen as inappropriate for countries at the beginning of their wastewater treatment capacity development have not been considered, and case studies of technologies that have succeeded or failed across the region have been reviewed in identifying these technologies. For this reason, activated sludge oxidation ditch technology, up-flow anaerobic sludge blanket (UASB) and sequencing batch reactors (SBR) for example, have not been considered further.

(i) **Option 1: Lagoon Systems.** Lagoons are shallow, artificial basins into which wastewater flows and from which, after a retention time of several days (rather than several hours in conventional treatment process), a well-treated effluent is discharged. Lagoon systems comprise a series of ponds in series including anaerobic, facultative, and several maturation ponds. The advantage of lagoon systems are their simplicity, low cost, and high efficiency. If a suitable amount of low value land is available, it is generally acknowledged that they should always be the first choice of technology in developing countries.
(ii) **Option 2: Aerated Lagoons.** With the ambient temperatures experienced in Lao PDR, aeration by mixing the upper layers of the lagoons has the potential to increase

[50] The majority of households use an unsealed soakaway pit formed with locally available concrete ring sections.
[51] Detailed septic tank surveys as part of the socio-economic survey in 2017 showed the average incidence of true septic tanks to be between 3-20%. A greater percentage is often reported as most people (the public and DHUP/Municipal staff) do not differentiate between a septic tank and an unsealed soakaway “ring” tank.

the capacity of a WWTP by two to two and a half times. If insufficient land is available for an unaerated lagoon system, this represents the most technically simple option for ease of operation and maintenance from a staff base of limited capacity and experience.

(iii) **Option 3: Trickling Filters.** Where sufficient land for a lagoon system is not available, an option is also to utilize trickling filters preceded by a settling pond, to avoid the filter becoming easily blocked. The key advantage of using trickling filters is that they require a smaller footprint than lagoon systems and can have very small footprints if more modern "high rate" trickling filters are used. However, these are more suited to fully developed countries as they require skilled operators and an established institutional framework. Trickling filters are designed primarily to reduce biological oxygen demand (BOD) concentration. They are basically a form of biological filter as opposed to a physical filter in that solids are not removed. An underdrain system collects treated wastewater, which then usually requires further treatment and settlement in an oxidation pond prior to release into receiving waters. A standard low-rate trickling filter can reduce BOD concentration by 80-85% when operated correctly.

(iv) **Option 4:** Small-scale wastewater treatment plant. This is a separated sewer system suitable for pockets of the main urban area, feeding to decentralized SWTP. It is the favored option of DHUP and MPWT and has been heavily promoted over the last few years.

146. A multi-criteria assessment of the four wastewater treatment options was prepared for the IEE (Table 13). The results showed Option 4, the SWTP option, to rank more favorably than the other three options. This option is also the strong preference of the MPWT and DHUP in order to avoid a single combined system with lagoon-based treatment for the full urban area, or any technology of equal or greater complexity.[52]

Table 13: Multi-Criteria Analysis of Wastewater Treatment Options

Criteria	Option 1 Standard lagoon	Option 2 Aerated lagoon	Option 3 Trickling filter	Option 4 SWTP
Technical				
Efficiency in wet season treatment	Less effective wet season treatment.	Less effective wet season treatment.	Better wet season treatment	Separated system. Collects only wastewater. Uses HDPE, not rigid but flexible.
Availability of important parts	Low requirement	Replacement parts are available to prevent extended downtimes.	Not all parts and materials are available locally	Materials and inputs used are locally available
Suitability to developing countries	Most appropriate technology for countries with limited financial or trained operational staff resource.	Most technically simple O&M. Can be handled by staff with limited capacity and experience.	More suited to fully developed countries. Requires skilled staff for construction and operation.	Suitable. Low operation and maintenance requirement.
Economic				

[52] In the late 1980s a lagoon based treatment plant was constructed in the That Luang area but quickly deteriorated due to lack of funds to run pumps, and was abandoned to use as a fishpond. This historical experience has swayed favor away from lagoon based systems within MPWT.

Criteria	Option 1 Standard lagoon	Option 2 Aerated lagoon	Option 3 Trickling filter	Option 4 SWTP
Capital cost	Low capital cost where land prices are low.	Moderate to high	High capital cost.	Low capital cost
Operation and maintenance costs	Least operation cost	Low operation costs	High operation cost	Least operation cost
Environmental and social				
Land disturbed or converted	Higher land disturbance and higher surface area requirement	Less land requirement than the standard lagoon system	Requires far less land than standard lagoon system.	Less land requirement than standard lagoons (if to serve all of the town)
Energy consumption	Low	High.	High.	Low
Pollution to environment	May be used for unrestricted irrigation or for direct recharge in surface waters, if sized adequately to meet effluent standard.	Effluents of completely mixed ponds require post-treatment in a sedimentation pond.	Additional treatment may be needed to meet more stringent discharge standards	Effluent designed to meet standard will be dispersed into a planted gravel filter.
Waste to manage (sludge, etc.)	Sludge requires proper removal and treatment. Anaerobic ponds need to be desludged once every 2-5 years,	Settled sludge needs to be dug out regularly and requires further treatment or correct disposal.	The sludge that accumulates on the filter must be periodically washed away once in 5-7 years or more.	Long desludging intervals.
Flies/mosquitoes and odors	No real problems with flies or odors if designed and maintained correctly. Mosquito control required.	No real problems with insects or odors if designed and maintained correctly.	Odor and fly problems require that trickling filters be built away from homes	Sealed (per design for the subproject)
Reuse of effluent	Effluent contains nutrients (e.g. N and P) and is therefore appropriate for reuse in agriculture. But may not be for direct recharge in surface waters.	The treated water can be reused or discharged if a secondary maturation/ settling pond follows the aerated lagoon/completely mixed aerated pond	Should be clarified prior to discharge	Can be reused.

Most favorable, 1
2
3
4
Least favorable, 5

C. Solid Waste Disposal

147. **Without Project.** Currently, Pakxan is served by a 9-hectare sized open dumpsite, located to the east of the town, which currently has an open tipping area of about 1.8-hectares. There is no equipment operated at the site, and as a result, the dumped waste is not moved or compacted. The site and immediate vicinity is potentially exposed to waste litter, leachate discharges into surface and groundwater, the emission of landfill gas and foul odors, and to the potential spread of disease vectors. The UDAA manages the open disposal operations and collects waste from accessible areas of Pakxan, using two trucks and one skip loader. Currently only 15 of the 22 villages within the district are serviced, with the collection coverage within villages varying between only 15-65%. Without the Project, these conditions would therefore persist, resulting in increased difficulty in providing adequate collection services, and the continuation of the open dumping practices that significantly impact negatively on the environment and public health.

148. **With Project.** The options that were considered for solid waste disposal for Pakxan generally relate to the level of advancement possible for a proposed landfill. This ranges from the current practice of open dumping at one end of the scale, to a controlled landfill that includes certain basic engineered systems, through to full sanitary landfill development. A multi-criteria assessment of these three waste disposal options was completed for the IEE, the results of which is shown on Table 14. The results indicate that Option 2 (controlled landfill) ranked more favorably than the other two options, given the size and relative development level of the town, funding level, and overall planning and implementation capacity of involved institutions.

Table 14: Multi-Criteria Analysis of Solid Waste Disposal Options

Criteria	Option 1 Open dump	Option 2 Controlled landfill	Option 3 Sanitary landfill
Technical	.		
Management of waste at the site	Waste dumped as collected	Waste dumped into lined cells	Waste dumped into lined cells
Materials recovery	Some sorting and recycling by informal pickers at dumpsite, often operating in dangerous conditions	Organized sorting and recycling at landfill	Sorting and recycling prior to collection and potentially also at landfill
Final disposal method	Limited compaction, no cover	Compaction and soil cover in layers (daily or periodic)	Compaction and soil cover daily and periodic
Hazardous waste management	No separate hazardous waste treatment	Incinerator or separate cell for hazardous waste	Incinerator or separate cell for hazardous waste
Onsite energy generation	None	None	Possible landfill gas recovery
Appropriateness for improving solid waste disposal in developing countries	Will not improve solid waste disposal.	Staged improvement and often more appropriate where there are operational capacity limitations	Improvements meet international standards, and require a high level of operational capacity
Economic			
Capital cost	Least	Moderate	High
Operation and maintenance costs	Least	Moderate	High

Criteria	Option 1 Open dump	Option 2 Controlled landfill	Option 3 Sanitary landfill
Environmental and social			
Risks to biodiversity	High	Low	Least
Waste burning	High	None	None
GHG emissions	Uncontrolled	Controlled, and possibly collected and flared	Controlled, collected and flared or converted to energy
Odor	High	Low	Least
Leachate	High, as exposed to rainfall	Lower, collected and reduced risk	Low, collected and least risk
Groundwater and soil pollution risks	High risk	Lower risk	Lowest risk
Risk of surface water pollution	High risk	Reduced risk	Least risk
Flies, mosquitoes, other disease vectors	High	Low	Low
Vulnerability to climate change effects	High	Low	Least
Health and safety hazards	High	Low	Low
Reuse of landfill gas	None	Potential flaring	Flaring or energy recovery

Most favorable, 1
2
3
4
Least favorable, 5

149. An analysis of landfill liner design has also been completed, which compared (i) a standard clay (soils with a low hydraulic conductivity) liner, with (ii) a composite liner of HDPE geomembrane with clay protection layers. Although the liner design will be confirmed during final design, at this stage a composite liner has been recommended by the PPTA engineering team.[53]

150. Options were also considered regarding the collection, storage and treatment of leachate generated within the facility. Although treatment options vary considerably, from rudimentary gravity draining, storage and reticulation, through to the capture and full treatment of leachate through relatively complex treatment processes, typically, leachate is collected through a system of underdrains to a lined and bunded leachate pond. From there, it is typically treated on site, or either pumped or transported to a SWTP.

151. The most basic means of leachate treatment is recirculation. This is the action of collecting leachate from the base of the cell and pumping it back over the top of the waste layers, where it can evaporate or be absorbed by the waste. A second approach that is appropriate for Lao PDR at this time is onsite lagoons, which operate in a similar way to municipal wastewater lagoons but are sized using different BOD loading requirements. However, given the current reluctance of MPWT to utilize lagoons for domestic wastewater treatment, these have not been included in the scope.

D. Riverbank Protection

[53] Due to its resilience, lower hydraulic conductivity, and relative assurance of quality.

152. **Without Project**. Pakxan is at the confluence of the Mekong and San rivers. When the Mekong River water level is high, the San River water level rises up and can spill onto surrounding land that is at a lower elevation than the Mekong riverbank. Erosion is also an issue along the unprotected banks of the San River. This has damaged domestic structures along the river and caused the loss of agricultural lands. Without the project, this seasonal flooding and erosion will persist to damage establishments and farmlands.

153. **With Project.** Supplementing previous and ongoing riverbank protection initiatives, the proposed component will add to the riverbank protection works from the confluence of the San and Mekong rivers up to the road bridge, and then continue a further 890 m upstream of the road bridge to where houses are no longer situated along the riverbank. This will protect houses, farms and other facilities and plots along the east bank of the river, and protect the river itself from sedimentation caused by bank erosion. The Project will also develop a recreational amenity along the San River from the confluence with the Mekong River to the road bridge.

VII. INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION

154. Stakeholder consultation and participation were considered essential throughout the project preparation. These included: (i) an inception workshop held in Vientiane on 27 June 2017 with representatives from MPWT, other central government agencies, provincial officials from the project towns, ADB project staff and PPTA Team to present the overall work plan and obtain feedback and comments on key issues; (ii) consultations at the interim stage to hold key informant interviews, meetings, discussions and random interviews; (iii) a socio-economic survey in September 2017; and (iv) a joint Laos-Cambodia workshop, attended by the officials and representatives of the Project provinces in November 2017, which included disaster risk reduction as one of the topics. The socioeconomic survey, which covered 270 households, included key questions on environmental issues and concerns. Relevant findings from the survey are presented in Section IV(K).

155. Public consultation meetings in Pakxan were held from December 25, 2017 to January 29, 2018 with affected communities. The meetings were arranged by the MPWT through the assistance of the provincial authorities. The purpose of the meeting was to provide the community and the affected persons with the general information of the proposed subproject components, its benefits and potential impacts, anticipated land requirements, compensation policy and entitlement, cut-off date on eligibility and the grievance redress mechanism. The summary of these meetings is presented in Table 15.

Table 15: Summary of stakeholder consultation meetings in Pakxan

	Activities	Date	Location	Attendants	Key Agenda/Issue
1	Consultation meetings with DPWT, UDAA, Departments concerned and Heads of villages in the subproject area	25 Dec-2017	DPWT-Meeting room	21, F=3	Discussed activities to be carried out in relation to resettlement for GMS 4-Pakxan subproject. Discussed Decree 084/GOV, dated 5 Apr,2016, and ADB SPS 2009, the announcement of the cut-off-date, unit rates for compensation, the need to organize consultation meeting in project and conduct of IOL and SES.
2	Consultation meeting in Nasommor village	25 Dec-2017	At the temple of Nasommor's village	15, F=5	Informed the participants and village authorities about the Project and subproject, discussed the project

	Activities	Date	Location	Attendants	Key Agenda/Issue
					resettlement policy, including the cut-off-date for eligibility, and the activities to be carried in connection with resettlement works (such as the IOL and SES) for GMS4-Pakxan subproject.
3	Consultation meeting in Sivilay village	26 Dec-2017	Sivilay village meeting room	19,F=3	Informed the participants and village authorities about the Project and subproject, discussed the project resettlement policy, including the cut-off-date for eligibility, and the activities to be carried in connection with resettlement works (such as the IOL and SES) for GMS4-Pakxan subproject.
4	Consultation meeting in Souansavanh and Nachick villages	26 Dec-2017	The temple of Souansavanh village	59,F=34	Informed the participants and village authorities about the Project and subproject, discussed the project resettlement policy, including the cut-off-date for eligibility, and the activities to be carried in connection with resettlement works (such as the IOL and SES) for GMS4-Pakxan subproject.
5	Consultation meeting in Phosy village	27 Dec-2017	The Phosy village meeting room	24,F=4	Informed the participants and village authorities about the Project and subproject, discussed the project resettlement policy, including the cut-off-date for eligibility, and the activities to be carried in connection with resettlement works (such as the IOL and SES) for GMS4-Pakxan subproject.
6	Consultation meeting in Phoxay and Pakxan villages	27Dec-2017	The Phoxay village meeting room	14,F=8	Informed the participants and village authorities about the Project and subproject, discussed the project resettlement policy, including the cut-off-date for eligibility, and the activities to be carried in connection with resettlement works (such as the IOL and SES) for GMS4-Pakxan subproject.
7	Consultation meeting with Pakxan Vice District Governor	27 Dec-2017	The District ‘s Governor office	5,F=2	Informed the participants and village authorities about the Project and subproject, discussed the project resettlement policy, including the cut-off-date for eligibility, and the activities to be carried in connection with resettlement works (such as the IOL and SES) for GMS4-Pakxan subproject.
8	Meeting with Waste pickers at the Landfill with UDAA	28 Dec2017	Landfill, Nasommor village	6, F=6	Discussed and interview the waste pickers about their daily activities, basic information, income from waste picking, and the problems and opinion when landfill will be rehabilitated.

	Activities	Date	Location	Attendants	Key Agenda/Issue
9	Meeting on briefing the overview of the survey on IOL, and SESAH, and the unit rate for Pakxan town to the PIU-Head, DDG of DPWT-Borikhamxay	29 Jan 2018	DPWT Office	3, F=1	Discussed the IOL survey for Pakxan town, the unit rates for compensation of affected assets, and resettlement activities for AHs along the river banks.

156. During the consultation meetings and survey, the three main problems in 13 villages in Pakxan were identified. Drug issues and poor physical access to villages due to bad roads are the problems identified by village leaders. This is followed by solid waste and drainage problems. Other environmental problems that were identified were air pollution and odor from markets and throwing of garbage elsewhere. Riverbank erosion was also mentioned by one village as one of the main problems.

157. A consultation meeting was held on 17 April 2018 at the meeting room of the DPWT in Borikhamxay Province to present the initial results of the IEE and resettlement plan and to solicit feedback from the stakeholders. The meeting was attended by representatives from the District Government, DPWT, UDAA, DONRE, and affected villages and households at the riverbank improvement works. The documentation of the environmental safeguard-specific consultations held on 27 April 2018 is presented in Appendix G. Table 16 presents a summary of issues raised and how the project will respond to the issues raised.

158. During the consultation meeting, the following issues were raised by the stakeholders:

(i) The compensation of affected persons shall follow the procedure through the committee to be formed for each section. This will be proposed to the National Assembly for approval.
(ii) The waste pickers at the existing dumpsite can continue to recover recyclables during construction. The waste pickers requested the project to provide safeguards measures for them during landfill construction.
(iii) After construction, the waste pickers will be priority to be considered for formal employment in the recycling activity at the controlled landfill.
(iv) The DPWT will endorse to DONRE the summary plan of the IEE and the Resettlement Plan, Policy Framework and Entitlement Matrix.
(v) In case a SWTP network will affect household assets, a detailed survey and consultation with stakeholders will be conducted during design to conclude if the case would require compensation or not.
(vi) Regarding groundwater in the area surrounding the landfill site, it was agreed that the head of the Nasommo Village will inform the villagers not to drink the water from the well since the groundwater analysis conducted by DONRE Pakxan for the IEE showed contamination.

Table 16: Issues raised during the public consultation on the IEE

Stakeholder	Issue/Concern/Suggestion	MPWT/DPWT Response
Somchit Phomsavath Deputy District Governor	The compensation of affected persons shall follow the procedure through the committee to be formed for each section. This will be proposed to the National Assembly for approval.	A compensation plan will be developed that is fair and acceptable to affected persons.
Somchit	The waste pickers at the existing dumpsite can	Waste pickers can continue

Stakeholder	Issue/Concern/Suggestion	MPWT/DPWT Response
Phomsavath Deputy District Governor	continue to recover recyclables during construction. The waste pickers requested the project to provide safeguards measures for them during landfill construction.	their livelihood activities at the site. They will be trained and will be required to abide by the safety guidelines.
Somchit Phomsavath Deputy District Governor	After construction, the waste pickers will be priority to be considered for formal employment in the recycling activity at the controlled landfill.	The waste pickers will be given priority during employment at the landfill.
Mr. Bounpheng Mahavong Deputy, DONRE Borikhamxay Province	The DPWT will endorse to DONRE the summary plan of the IEE and the Resettlement Plan, Policy Framework and Entitlement Matrix.	This will be undertaken prior to implementation of the project.
Mr. Somchit Phomasavth Deputy District Governor	In case a SWTP network will affect household assets, a detailed survey and consultation with stakeholders will be conducted during design to conclude if the case would require compensation or not.	Survey of affected households will be undertaken based detailed engineering design.
Mr. Somchit Phomasavth Deputy District Governor	Regarding groundwater in the area surrounding the landfill site, it was agreed that the head of the Nasommo Village will inform the villagers not to drink the water from the well since the groundwater analysis conducted by DONRE Pakxan for the IEE showed contamination.	Noted on the initial of Nasommo village head to inform the villagers about the contaminated well water. Further groundwater quality tests will be undertaken during the detailed engineering design stage.

159. Stakeholder consultations will continue through subproject implementation and operation, following the Project Stakeholder Participation Plan. To facilitate the engagement of stakeholders, the PCU and PIU will maintain good communication and collaboration with the district and village leaders. The PCU, PIU, Contractors and/or Operators will be open to contact by the public on matters concerning the progress of the subproject, adverse impacts, mitigation measures and environmental monitoring and grievances. Future stakeholder consultations will include the following:

(i) During detailed design, if update of the IEE is warranted, it would be appropriate to disclose the updated IEE to the affected communities and solicit feedback.
(ii) Prior to construction, the PCU will conduct an intensive information, education and communication campaign to ensure sufficient level of awareness/ information among the affected communities regarding the upcoming construction, its anticipated impacts, the grievance redress mechanism, contact details and location of the PCU, and status of compliance with Government's environmental safeguard requirements, among others.
(iii) Billboards about the subproject, implementation schedule and contact details of the executing agency, PCU, PIU and Contractors will be set up at strategic locations within the main areas of influence. The grievance redress procedure and details will have been posted at the offices of the PCU, PIU and District and at the residences of concerned village leaders.

160. The IEE (in English) and the EMP (in English and Lao), as well as the MONRE/DONRE-approved IEE/EIA Reports (in Lao), will be available at the offices of the PCU and PIU for

interested parties. Copies may be made available upon formal request. The IEE and EMP and semi-annual environmental monitoring reports will be disclosed on the ADB's website.

VIII. GRIEVANCE REDRESS MECHANISM

A. Purpose of the Mechanism

161. ADB requires that the borrower/client establish and maintain a grievance redress mechanism (GRM) to receive and facilitate resolution of affected peoples' concerns and grievances about the borrower's/client's social and environmental performance at project level.

B. Proposed Set-Up

162. The MPWT, as executing agency of the GMS-CTDP-4 will establish the GRM. The PCU's environmental safeguards officer (ESO) will oversee the implementation/observance of the GRM for the Project, in coordination with the Public Works and Transport Research Institute (PTRI) of MPWT. The ESO's counterparts in the PIUs (environmental focal points) will ensure the implementation of the GRM at the subproject level and will be responsible for keeping the PMU informed as prescribed in the GRM. Access points will be set up with the Village and District. Contractors and Operators will be required to designate their respective counterpart GRM staff.

163. The GRM will accommodate both informally and formally lodged, but eligible, grievances. Informally lodged grievances are those received by the Contractor during construction or Operator during operation. Formally lodged grievances are those received at the offices of the PIU, District and Village Leader. The PIU evaluates complaints for eligibility. The PIU and PCU maintains record of all grievances, informally and formally lodged, eligible and ineligible. The PCU will inform the ADB, as necessary, and report on the observance/implementation of the GRM in the quarterly progress and in the semi-annual Environmental Monitoring Report that will be submitted to ADB.

164. Sufficient support system, including well GRM-oriented staff in the access points of the Village Leader and District, communication facilities, documentation/recording, and reporting system, funds, posters declaring contact details and displayed at strategic locations, among others, will be in place to sustain the effective implementation of the mechanism.

C. Access to the Mechanism

165. Any person who has environmental concerns/issues pertaining to the subprojects during detailed design, construction and operation phases will have access to the mechanism free of charge. The PCU, through its ESO and his/her counterparts in the PIUs, will ensure that:

(i) the mechanism is understandable, transparent, gender-responsive, culturally appropriate, and readily accessible to all segments of the affected people at no cost and without retribution;
(ii) the GRM is displayed in the offices of the PCU, PIU, District and Village Leader and at strategic places.

D. GRM Steps and Timeframe

166. Grievances raised on environmental impacts are critical to the health, wellness and safety of affected persons (APs). Hence, the proposed mechanism intends to be easily accessible and promptly responsive to APs' complaints.

1. Informal Approach

167. Informally, APs can lodge complaints directly to the Contractor during construction or Operator during operation. Contractor/Operator shall document and assess the complaint immediately. If assessment shows the complaint as valid, the Contractor/Operator shall act on the complaint within 3 days from receipt of complaint. If assessment invalidates the complaint (i.e., reveals the complaint as ineligible or not associated with the subproject's environmental performance), the Contractor/Operator shall direct the AP to the District. The Contractor/Operator shall report to the PIU the complaints received, eligible or ineligible, actions to be taken, ineligible complaints directed to the District within 2 days from receipt of complaint. The PIU shall obtain a written confirmation of satisfaction from the AP after 7 days from completion of resolution by Contractor/Operator.

2. Formal Approach

168. If complaint is eligible but is not acted on within three days from receipt of complaint, or if AP is not satisfied with the resolution undertaken by the Contractor/Operator, he/she can access the formal mechanism, as follows:

Step 1 Lodging a Complaint (Day 1)
AP lodges complaint, by him/herself or with assistance from the Village Leader, at the access points of the PIU, District or Village Leader.

Step 2 Documentation & Registration of Complaint (Day 1)
PCU/PIU/District/Village Leader documents/registers lodged complaint, makes sure these are duly referenced and provides AP with a copy of referenced complaint. The District forwards documented complaint to the PIU; the Village Leader, through the District.

Step 3 Assessment and Discussion (Day1/Day 2/Day 3)
AP shall be informed if the grievance is eligible or ineligible. If it is ineligible, AP shall be directed to the District. If complaint is eligible, AP shall be informed of the expected action timelines as set out in the established mechanism.

If both of the AP and Contractor/Operator are available, the complaint shall be immediately reviewed, investigated and discussed. If not, both parties should agree to undertake the review, investigation and discussion within 3 days. The discussion will be on the cause and action/measure to implement based on the review and investigation. Agreement on actions and measures and time involved shall be made with the AP. Agreement shall be properly documented and filed; PIU, District, Village Leader and AP shall have copies of the agreement.

Step 4 Implementing the Agreed-on Resolution
(Day 3/Day 4) If complaint is minor, i.e., not requiring further investigation and would be easy to resolve, the Contractor/Operator shall immediately implement agreed on action/resolution.

(Day 3/Day 4 to Day 7/Day 8) If further investigation and/or procurement of supplies/parts would be necessary, the Contractor/Operator shall: (i) immediately provide the most suitable interim measure to reduce the magnitude of the impact;

and (ii) start work on the final measure within 5 days from the day discussion meeting is held.

Step 5 Acceptance of Resolution (1 week after completion of action/measure taken)
If, according to the AP, the impact has been resolved satisfactorily, PIU shall obtain a written confirmation of satisfaction from the AP. This confirmation will signify closure of grievance and will form part of the grievance documentation. The District, Village Leader and AP shall retain their copies of the confirmation.

Step 6 Monitoring and Evaluation (for 1 week after closure of grievance)
The PCU shall monitor the effectiveness of the resolution for at least a week after closure of grievance (that is, when action implemented has been satisfactorily confirmed in writing by the complainant). Monitoring and evaluation shall be properly documented and included in the Environmental Monitoring Report (EMR).

Step 7 Appeal for Dissatisfied AP
When dissatisfied (or, in the event the issue/impact persists despite actions undertaken), AP can appeal for assistance from the District in the elevation of his/her complaint to the Province. The Province shall call all parties concerned to review the history of the grievance and resolution process taken and assess the validity of the appeal.

If appeal is found not valid, the Province shall write the AP and declare the grievance closed.

If appeal is assessed to be valid, Province and the parties discuss and agree on the quick resolution of the issue. PCU requires Contractor and Operator to implement the agreed resolution. Should the issue continue to persist despite the second action, dissatisfied AP can raise an appeal to the Provincial Court.
In the event of an appeal, the PIU shall immediately report to the PCU. The PCU shall ensure that the ADB is immediately informed.

169. The PCU will be the overall manager of GRM and should document and report on all complaints that have been raised in respect of the Project. All grievances and their resolution should be reported to ADB in quarterly project progress reports and semi-annual environmental monitoring reports.

170. The mechanism prescribes that the PIU shall inform the PCU (at least) whenever: (i) an ineligible complaint is directed to the District; (ii) a complaint is evaluated as a major issue; and (iii) a dissatisfied AP raises an appeal.

171. Adversely affected persons can also raise their grievances to the Accountability Mechanism of the ADB. Alleged noncompliance of ADB projects may also be reported to this Accountability Mechanism.

Environmental Management Plan

172. A detailed EMP has been prepared for the subproject. The EMP will serve as the framework for the environmental management of the subproject, commencing from the detailed design phase through to operation and decommissioning. The EMP addresses the potential impacts and risks identified in the IEE. It includes: (i) mitigation measures; (ii) monitoring

measures; (iii) implementation arrangements and responsibilities, (iv) capacity development, (v) public consultations; and (vi) preliminary costs for EMP implementation. The EMP will be updated by the PCU based on the detailed designs, with technical assistance from the Environmental Specialists of the Project Implementation Consultants (PIC). (Appendix H)

173. Environmental management of the subproject during implementation will be the joint responsibility of the: (i) Ministry of Public Works and Transport (MPWT) through its Project Coordination Unit (PCU); (ii) Department of Public Works and Transport through its Project Implementation Unit (PIU); (iii) Central Project Steering Committee (CPSC); (iv) Design Consultant; (v) Civil Works Contractors; (vi) Operators of completed components; (vii) Project Implementation Consultants; and (viii) Asian Development Bank (ADB). As executing agency, the MPWT will be responsible for overseeing the EMP implementation through its PCU. As implementing agency, the DPWT will supervise component activities carried out prior to construction, during construction and during operation through its PIU. The PIUs will be responsible for providing assistance to the PCU in environmental management at the subproject level. Table 16 presents the overall responsibilities of these key institutions in environmental management.

Table 17: Responsibilities of Key Institutions in Environmental Management

Entity	Overall Responsibility
Central Project Steering Committee (CPSC)	Strategic guidance and support to the MPWT and PCU and facilitate inter-agency coordination.
Project Coordination Unit (PCU)	Management of the day-to-day activities of the Subproject.
PCU Environmental Safeguard Officer (PCU-ESO)	Supervision of EMP implementation/compliance.
Project Implementation Unit (PIU)	Overseeing subproject implementation.
PIU environmental focal point	Responsible for subproject environmental monitoring.
Design Consultant	Ensuring detailed designs incorporate environmental and climate considerations.
Standard Contractor	Preparation of Contractor EMP (CEMP) that fully responds to the ADB-cleared EMP. Implement the CEMP.
Operators of completed components	Responsible for EMP implementation during operation.
Project Implementation Consultants (PIC)	Technical support and capacity building to the PCU and PIU.
International and national Environmental Specialists (ESs)	Technical support in environmental safeguard management during design and implementation.
Asian Development Bank (ADB)	Review of project performance against the commitments in the covenants, review of relevant documents and advise on corrective actions.

174. The MPWT has the Public Works and Transport Institute (PTRI) that conducts environmental monitoring of various projects of the agency. Two safeguards staff, i.e. one for environment and one for social/resettlement/gender, will be hired by the MPWT to work with the PTRI as part of the PCU to institutionalize the monitoring of safeguards compliance of subprojects in Thakhek and Pakxan. The two safeguards staff of PTRI will be assigned to work under the PCU on safeguards monitoring of the GMS CTPDP4 project and concurrently on other ADB projects for a period of five years as full time PTRI staff.

175. The Environment Safeguards staff will have the following responsibilities:

a) Work with the PCU and PIUs in evaluating the environmental soundness of the design of the subproject components by ensuring that mitigation measures to address adverse environmental impacts are incorporated in the detailed design and that climate change resilient and adaptation measures are considered.
b) Provide support to the PCU and PIUs in ensuring compliance with the (i) Environmental Protection Law 2012 (No. 29/NA) and relevant associated ministerial agreements and guidelines; (ii) Safeguard Policy Statement (SPS) 2009 of the Asian Development Bank (ADB); and (iii) ADB-cleared EMP.
c) Review the Terms of Reference (TOR) prepared by the construction supervision consultants for the preparation of the Environmental and Social Impact Assessment (ESIA) / Initial Environmental Examination (IEE) reports to be submitted to MONRE/DONRE in securing the Environmental Compliance Certificate (ECC) of the subprojects.
d) Ensure that the firm to be engaged in the preparation of the ESIA/IEE is nationally certified/registered to provide ESIA/IEE services.
e) Review the ESIA/IEE prepared by the MONRE-registered firm and check the completeness documents prior to submission to MONRE/DONRE.
f) Monitor the status of the ECC approval process and ensure that the ECC of each subproject is secured by MPWT prior to start of construction.
g) Coordinate with the PCU and PIUs in organizing public consultations and information disclosure and activating the grievance redress mechanism (GRM) at the subproject, town and village levels.
h) Work with the PMU, PIUs, and consultants during the Environmental Compliance Audit (ECA) of the existing dumpsite; provide recommendations/suggestions to improve environmental compliance.
i) Conduct monitoring and inspection of the subproject components and check compliance with the ESIA/IEE/ESMP.
j) Review the status reports for environmental compliance with the conditions set out in the approved ESIA/IEE reports.
k) Review the semi-annual environmental monitoring report to be submitted to ADB.

IX. CONCLUSION AND RECOMMENDATION

176. This IEE was prepared to determine the environmental issues and concerns associated with the proposed subproject. The assessment confirms that the subproject is classified as Category B for environment. The IEE concludes that the proposed subproject components in Pakxan are not environmentally critical and not located in an environmentally sensitive area. In terms of climate risk, given their nature, the proposed components will be vulnerable to climate change particularly the stormwater drainage and SWTP. Hence, it is critical that the components are designed to ensure flood resilience, particularly the site of SWTP in Pakxan 1 (old town area) and the four stormwater drains which all discharge to a natural drainage retention area.

177. There are no significant adverse environmental impacts resulting from the subproject that cannot be mitigated if implemented effectively and efficiently. The proposed EMP will mitigate impacts on the natural environment and affected people to an acceptable level. The key parties involved in implementing the proposed mitigation measures are the construction contractors and operators. They will be supported by national and international environmental consultants within the Project Management and Construction Supervision Consultant team. Training in operation and maintenance of wastewater treatment and solid waste management facilities and urban asset

will be provided. The subproject stakeholders will closely monitor, and report on, the implementation of the EMP.

178. Overall, the Subproject is expected to improve the urban environment in Pakxan, reduce the town's vulnerability to environmental and climate risks, and improve its climate resilience level and quality of life. It will provide improved stormwater, wastewater and solid waste management services, and formulate a provincial development strategy and strengthen institutional capacities in resilient town planning. Cumulatively, the positive impacts of such benefits are, but not limited to: (i) reduced flood risk, (ii) reduced risk of human contact with raw sewage during flooding, (iii) reduced health risks from and incidence of diseases caused by inadequate stormwater, (iv) improved environmental sanitation, (v) controlled GHG emissions from solid waste disposal, (vi) reduced pollution discharges and improved water quality, (vii) reduced air and land pollution, and(viii) improved social equity from access by all to recreational amenity.

179. The design of the stormwater drainage, SWTP, and sewer network will take into consideration the assimilative capacity of the receiving water bodies, their intended uses, and the presence of sensitive receptors. Further to hydrological assessments, flood mitigation and emergency response measures will be developed and incorporated into the subproject component operations and maintenance manual. Additional baseline surveys (ecology, air, surface water and groundwater quality and noise) will be carried out during detailed engineering design as part of the domestic IEE/ESIA and in the updating of the IEE/EMP to be submitted to ADB.

180. The proposed subproject will be designed to ensure climate risks are mitigated, particularly the receiving drainage detention area of the proposed stormwater trunk drains and SWTP. Additional measures will be considered during detailed engineering design, as set out in the Project Climate Risk Management Report and as presented in summary in this IEE.

181. The key parties involved in implementing the proposed mitigation measures are the construction contractors and operators. They will be supported by national and international environmental consultants within the Project Management and Construction Supervision Consultant team and the loan will finance a full-time Environment Safeguards Officer under the PTRI to support the PCU with implementation and monitoring of environmental compliance and EMP.

REFERENCES

Agreement on the rule of construction activities on water bodies in Lao PDR, No.7736/MPWT, 08 June 2010 at Vientiane capital.

Chu Thai HOANH, Kittipong JIRAYOOT, Guillaume LACOMBE, Vithet SRINETR, 2010. Impacts of climate change and development on Mekong flow regime. First assessment – 2009. MRC Technical Paper No. 29. Mekong River Commission, Vientiane, Lao PDR.

Developing a National Risk Profile of Lao PDR. Part 1 Hazard Assessment. 2010. National Disaster Management Committee Government of Lao PDR. United Nationals Development Programme (UNDP) Lao PDR.

Environmental, Health and Safety General Guidelines. 30 April 2007. IFC.

Environmental, Health and Safety Guidelines for Waste Management Facilities. 10 December 2007. IFC.

Environmental, Health and Safety Guidelines for Water and Sanitation. 10 December 2007. IFC.

Estimation Tool for Greenhouse Gas (GHG) Emissions from Municipal Solid Waste (MSW) Management ia Life Cycle Perspective". Nirmala Menikpura. Janya Sang-Arun. Institute for Global Environmental Strategies (IGES).

Integrated disaster risk management (IDRM) – Lao PDR. DFR. PPTA. March 2018

Lao People's Democratic Republic. The First National Communication on Climate Change. Submitted to the United Nations Framework Convention on Climate Change. October 2000.

Lao PDR National Assessment Report on Disaster Risk Reduction (2012). Linkages between Poverty and Disaster Risk. National Disaster Management Office. Ministry of Labor and Social Welfare. Lao PDR. 2012.

MRC (2009) Adaptation to climate change in the countries of the Lower Mekong Basin: regional synthesis report. MRC Technical Paper No. 24. Mekong River Commission, Vientiane. 89 pp.

MRC Technical Paper No. 60. 2014 Lower Mekong Regional Water Quality Monitoring Report. June 2016. Mekong River Commission.

National Adaptation Programme of Action to Climate Change. WREA UNDP. GEF. April 2009.

National Regulatory Authority for UXO/Mine Action Sector in Lao PDR (UXO-NRA). http://www.nra.gov.la/uxoproblem.html

Preliminary (Interim) results of the PPTA Socio-economic Survey (SES). September 2017. PPTA. Fourth Greater Mekong Subregion Corridor Towns Development Project.

Profile on Environmental and Social Considerations in Lao P.D.R. December 2013 Japan

International Cooperation Agency.

Relevant policies, laws and guidelines of the Government of Lao PDR, among others:
8th Five-Year National Socio-Economic Development Plan 2016-2020. Ministry of Planning and Investment. June 2016.

Environmental Protection Law 2012 (No. 29/NA) and its implementing guidelines
National Environmental Standard (No. 81/NA). 21 February 2017.

All other laws, policies and guidelines mentioned in Section II and Annex A of this IEE.
Second National Communication on Climate Change of Lao PDR. Ministry of Natural Resources and Environment. Vientiane. March 2013.

Solid Waste Management in Laos. A PPt presentation. Mr Thevarack Phonekeo. Director of Socio- Environment Division. National Secretariat for GMS. Water Resources and Environment Administration. Mr. Phouthasom Inthavong. Deputy Head of Urban Development Division. Department of Housing and Urban Planning, Ministry of Public Works and Transport.

Strategy on Climate Change of the Lao PDR. Lao People's Democratic Republic. March 2010.

The 4th Population and Housing Census (PHC) 2015. Urban population.

The Mekong: Biophysical Environment of an International River Basin. Edited by Ian Charles Campbell.

The World Bank Group. Climate Change Knowledge Portal. http://sdwebx.worldbank.org/climateportal/

Working Paper 2011-2015. The Impact and Management of Floods and Drought in the Lower Mekong Basin and Implications of Possible Climate Change. Flood Management and Mitigation Programme. Mekong River Commission. March 2012.

Appendix A

Environmental Management Plan

Project No. 50099-003
June 2018

Lao PDR: Fourth Greater Mekong Subregion Corridor Towns Development – Pakxan Subproject

Prepared by the Ministry of Public Works and Transport for the Asian Development Bank.

I. INTRODUCTION

1. This draft environmental management plan (EMP) is for the Pakxan Subproject of the Greater Mekong Subregion Corridor Towns Development Project (GMS-CTDP4). The EMP summarizes the potential impacts of the subproject, as identified in the initial environmental examination (IEE) and defines mitigation measures and monitoring requirements to reduce these impacts to acceptable levels.

2. The EMP also defines the institutional arrangements, procedures and budgets for implementation of the EMP. It seeks to ensure effective implementation of environmental protection activities during preconstruction, construction, and operation to prevent, reduce, and/or mitigate adverse impacts and risks.

3. This draft EMP is based on the proposed subproject design as of May 2018. It will be finalized by the Project Coordination Unit (PCU), based on the detailed design and results of the baseline environmental quality surveys, with technical support from the Environmental Specialist of the Project Implementation Consultant (PIC-ES). The final IEE/EMP will be disclosed on the ADB website in accordance with ADB's Public Communications Policy. The final EMP will be included in all bidding and contract documents.

4. Environmental monitoring results will be used to evaluate (i) the extent and severity of actual environmental impacts against the predicted impacts, (ii) the performance of the environmental protection measures and compliance with regulations, (iii) overall effectiveness of the project EMP, and (iv) the need for adjustment of the project EMP.

II. INSTITUTIONAL ARRANGEMENTS AND RESPONSIBILITIES FOR EMP IMPLEMENTATION

5. The environmental management of the project during implementation will be the joint responsibility of:

a) Ministry of Public Works and Transport (MPWT) through its PCU;
b) Public Works and Transport Institute (PTRI);
c) Department of Public Works and Transport (DPWT) through its Project Implementation Unit (PIU);
d) Central Project Steering Committee (CPSC);
e) Design consultant;
f) Civil works contractors;
g) Operators of completed components;
h) Project Implementation Consultant (PIC); and
i) Asian Development Bank (ADB).

6. Primary responsibilities are defined below and detailed in Table 1.

7. **Executing Agency.** The MPWT, the executing agency for the Project, through the Department of Housing and Urban Planning, will be responsible for overseeing the implementation of and compliance with loan assurances and the EMP. It will ensure the subproject's compliance with environmental safeguard requirements identified in the EMP, and

that environmental approvals are obtained from the Ministry of Natural Resources and Environment (MONRE) prior to contract awards.

8. **Project Coordination Unit.** The PCU, established by the MPWT, will be responsible for managing the day-to-day activities of the Subproject. Prior to the commencement of the detailed engineering design (DED). The PCU will appoint an Environmental Safeguard Officer assigned under the PTRI.

9. **Implementing Agency.** The provincial DPWT will be the implementing agency for the project. It will supervise component activities carried out prior to construction, during construction and during operation. The DPWT will coordinate with the provincial Department of Environment for collaborative environmental impact monitoring.

10. A **PIU** for the subproject will be established within the provincial DPWT. Prior to the commencement of the DED, the PIU will appoint an environmental focal point for environmental safeguard matters at the provincial level. The PIU will provide assistance to the PCU in environmental management at the subproject level.

11. A **CPSC** will be established to provide strategic guidance and support to the MPWT and PCU and facilitate inter-agency coordination. MONRE is among the proposed members of the CPSC.

12. **Civil works contractors** will be responsible for implementing the mitigation measures during construction. Design-build contractors will engage environmental management specialists during the design stage (and retain the same specialist or set up an environmental management unit/team during construction) to ensure compliance with environmental requirements and obligations in designs and during construction. Each contractor will appoint an environmental, health and safety officer.

13. **Design consultants** for components under standard construction contracts will incorporate environmental and climate considerations in designs, and key EMP clauses in tender and contact documents.

14. **Operators** will comprise the DPWT for the riverbank protection, and the Urban Development Administrative Authority for the controlled landfill, drainage and small-scale wastewater treatment plants (SWTPs). Operators will engage their respective environmental officers as the focal persons on EMP implementation during operation. Through their respective environmental officers, operators will: (i) ensure effective implementation of the EMP and the environmental management sections of operations manuals, (ii) submit the required environmental monitoring reports to the PIU until the project completion report is issued, and (iii) observe the grievance redress mechanism (GRM) in addressing pertinent complaints during operation.

15. The **PIC Consultant** will engage environmental specialists (1 international and 1 national), who will provide training for the PCU, PIU and contractors, and technical support during the updating of the IEE and EMP, implementation of EMP, monitoring and reporting.

16. **ADB** will: (i) review and supervise project performance against the commitments of the executing agency and implementing agencies as described in legal agreements, (ii) review relevant documents, such as the updated IEE and EMP, for clearance purposes, and (iii) carry out periodic review missions to review, among others, the implementation of the EMP.

Table 1. Environmental Responsibility

Responsible Entity	Project Stage and Environmental Responsibility					
	Project Preparation	**Post-Loan Approval & Prior to DED**	**Detailed Engineering Design**	**Tendering and/or Pre-Construction**	**Construction**	**Operation**
MPWT	As the EA for the project, MPWT will be responsible for overseeing the implementation of and compliances with loan assurances and the EMP.					
		- Ensure environment approvals from MONRE are obtained prior to contract awards. - Establish the necessary collaboration with the MONRE for environmental impact monitoring. - Ensure the PCU is staffed with a qualified environmental safeguard officer. - Ensure PIUs have appointed their environmental focal points.		Clear CEMP.		
PCU	Established by the EA, the PCU is responsible for managing the day-to-day activities of the project. It has an overall responsibility, delegated by the EA, for supervising the implementation of environmental mitigation measures, coordinating the project level GRM and reporting to ADB.					
		<u>For works under DB contracts</u>. - Incorporate the mitigation measures and EMP clauses (environmental conditions) in the bidding documents and contracts for DB works. - Incorporate environmental criteria in the evaluation of bids for DB works.	- Obtain the results of baseline survey from the national initial environmental impact assessment/environmental and social impact assessment consultant to inform design and update of IEE/EMP. - Update the IEE and EMP based on the detailed designs and results of the baseline environmental surveys. - Provide updated EMP to the Design Consultant. - Conduct follow up consultations and information, education & communication activities to prepare the affected communities. - Ensure readiness of the subproject for construction, especially with respect to environmental approvals/clearances and	<u>For works under standard contracts</u> - Ensure mitigation measures and EMP clauses (environmental conditions) are incorporated in the bidding documents and civil works contracts and environmental criteria are incorporated in bid evaluation. <u>For works under DB and standard contracts</u> - Review CEMP. - Clear CEMP.	- Coordinate GRM; supervise EMP implementation; conduct regular site inspections; prepare monthly (periodic) progress reports; collaborate with the PIC-ES in the preparation of annual EMP monitoring & progress reports. - Engage a licensed institute to conduct environmental effects monitoring.	- Conduct compliance review; instruct PIUs on environmental management requirements; prepare semi-annual environmental monitoring reports and summary for quarterly project progress reports until PCR is issued. - Engage a licensed institute to conduct environmental effects monitoring for an agreed period.

Responsible Entity	Project Stage and Environmental Responsibility					
	Project Preparation	**Post-Loan Approval & Prior to DED**	**Detailed Engineering Design**	**Tendering and/or Pre-Construction**	**Construction**	**Operation**
			mine and unexploded ordnances clearances.			
DPWT	As the IA of the subproject, the DPWT will supervise component activities carried out prior to construction, during construction and during operation. It will ensure that the EMP is implemented proactively and will respond to any adverse impact beyond those foreseen in the IEE and ensure that if there are any changes in scope, inform the PCU for the IEE/EMP to be updated, as needed.					
		- Tie up with the Department of Natural Resources and Environment for collaborative environmental impact monitoring. - Ensure PIU has appointed with an environmental focal point.				
PIU	Established by the IA, the PIU will be responsible for providing assistance to the PCU on environmental management at the subproject level.					
		- Support the PCU in ensuring the incorporation of the mitigation measures and EMP clauses (environmental conditions) in the bidding documents and contracts for DB works.	- Support the PCU in carrying out its responsibilities during DED phase.	- Support the PCU in ensuring that mitigation measures and EMP clauses (environmental conditions) are incorporated in the bidding documents and civil works contracts and environmental criteria are incorporated in bid evaluation.	- Monitor EMP implementation at component level and report to PCU.	- Support the PCU in the environmental management of the subproject.
PPTA Team	- Provide technical assistance in project preparation. - Prepare FSR, IEE/EMP, RP/CP. - Conduct public consultations.					
CPSC	The CPSC will be established to provide strategic guidance and support to the MPWT and PCU and facilitate inter-agency coordination. MONRE is among the proposed members of the CPSC.					
DB Contractor			- Engage an EMS to: (i) ensure compliance with environmental requirements and obligations in designs; (ii) prior construction prepare the CEMP based on the ADB cleared updated IEE/EMP and reviewed and cleared by the PCU; and (iii) during construction, to monitor adherence to CEMP and	(Phase not applicable to works under DB Contracts)	- Implement mitigation measures and conduct internal monitoring and supervision of environmental management during construction.	

Responsible Entity	Project Stage and Environmental Responsibility					
	Project Preparation	**Post-Loan Approval & Prior to DED**	**Detailed Engineering Design**	**Tendering and/or Pre-Construction**	**Construction**	**Operation**
			need for any corrective actions. - Engage the EMS or an environmental officer and health and safety officer for construction phase, and conduct workers' orientation on health and safety and CEMP requirements. - Ensure its design team incorporates: (i) mitigation measures in detailed designs and bidding documents; (ii) climate change adaptation measures in detailed designs; (iii) the results of baseline groundwater and soil quality surveys in the detailed designs of controlled landfills and wastewater treatment plant; & (iv) environmental management and climate change adaptation measures during operation in Operations Manuals.			
Design Consultant for standard civil works contracts			- Incorporate key EMP clauses (or updated EMP or simplified matrix of mitigation measures for major impacts) in the tender documents and environmental conditions in standard civil works contracts. - Incorporate environmental criteria in bid evaluation			
Standard Contractor				- Prepare and submit Contractor's CEMP that is fully responsive to the ADB-cleared updated EMP. - Engage an environmental officer and health and safety officer.	- Implement mitigation measures and conduct internal monitoring and supervision of environmental management during construction.	

Responsible Entity	Project Stage and Environmental Responsibility					
	Project Preparation	**Post-Loan Approval & Prior to DED**	**Detailed Engineering Design**	**Tendering and/or Pre-Construction**	**Construction**	**Operation**
				- Conduct workers' orientation on health & safety & pertinent EMP matters.		
Licensed Institute					- Conduct quarterly environmental quality monitoring & prepare monitoring report.	- Conduct environmental quality monitoring following approved monitoring plan and prepare corresponding reports.
Operator						- Implement mitigation measures as defined in the EMP
PIC			- Provide TA and support to PCU in carrying out its responsibilities during DED phase.	- Provide TA and support to PCU in ensuring that the mitigation measures and EMP clauses (environmental conditions) are incorporated in the bidding documents and civil works contracts and environmental criteria are incorporated in bid evaluation. - Review tender documents and assess subproject's readiness. - Review bid evaluation (environmental safeguards aspect) - Review CEMP.	- Advise on the mitigation measures; provide comprehensive TA and support to the PCU and PIUs in environmental management, conduct or facilitate lectures/training; conduct annual EMP compliance review; prepare annual EMP monitoring & progress reports.	- If PCU-ES is engaged to provide TA & support in the first year/or first few years of operation, advise on mitigation measures during operation. - Support the PCU in its task in environmental management in operation.
ADB	- Engaged a PPTA Team. - Review and clear the draft IEEs/EMPs.		- Review and clear the updated IEEs/EMPs. - Disclose the updated IEEs/EMPs on ADB project website.	- Review and clear tender documents. - Review and concur on bid evaluation.	- Conduct review missions; review an approved semiannual monitoring reports and disclose on ADB project website.	- Review and approve EMP monitoring ad progress reports, disclose on ADB project website.

ADB = Asian Development Bank, CEMP = construction environmental management plan, CPSC = central project steering committee, DB = design-build, DED = detailed engineering design, DPWT = Department of Public Works and Transport, EA = executing agency, EMP = environmental management plan, IA = implementing agency, IEE = initial environmental examination, MONRE = Ministry of Natural Resources and Environment, MPWT = Ministry of Public Works and Transport, PCU = project coordination unit, PIC-ES = project implementation consultant-environmental specialist, PIU = project implementation unit, PPTA = project preparatory technical assistance, TA = technical assistance.

III. SUMMARY OF POTENTIAL IMPACTS AND MITIGATION

17. Table 2 summarizes potential environmental impacts and mitigation measures designed to avoid and/or minimize identified impacts to acceptable levels. Mitigation measures that will become part of the permanent infrastructure (such as landscaping) and temporary construction mitigation measures (such as dust suppression) should be included within the bills of quantities for the civil works.

18. The mitigation measures defined in the EMP will be (i) reviewed and where necessary updated by the Environmental Safeguard Officer (ESO) working under the PTRI and assigned to the PCU and with technical support from the PIC-ES during detailed design, (ii) incorporated into tender documents, construction contracts, and operation and maintenance (O&M) manuals, and (iii) implemented by contractors under supervision of the PCU/PIU and PIC. The effectiveness of these measures will be evaluated based on the results of the environmental quality monitoring conducted by the licensed institute, and through EMP compliance verification monitoring conducted by the PIU environmental focal person, PCU-ESO and PIC-ES.

Table 2. Environmental Mitigation Plan

Item	Impact Factor	Potential impact, concerns and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
A. PRE-CONSTRUCTION PHASE						
Design	Existing environmental conditions	Lack of baseline data on environmental quality	• Conduct supplementary baseline assessments to further refine component designs and inform any necessary IEE and EMP modifications, e.g., re-evaluation and verification of the hydrology and suitability of receiving waters for each SWTP facility and stormwater trunk drains and road drains, and air quality and groundwater quality assessment at controlled landfill • Obtain results of baseline studies carried out as part of the national IEE/ESIA to inform the detailed engineering design • Use the baseline studies and monitoring data and results of national IEE/ESIA to update the ADB IEE/EMP.	PCU	PIC-ES	Included in PIC sot
		Waste picker health and safety	• Implement waste picker employment transition initiatives. • Provide training for waste pickers and require them to abide by guidelines set out by management of the landfill to ensure their safety. • Ensure budget for protective gear for waste pickers such as rubber gloves, rubber boots, and crush helmets. • Develop an operational manual that includes occupational health and safety provisions including regulations on waste picking during regular operating hours and prohbitions on persons below 18 years of age from entering the landfill or conducting waste picking activities.	UDAA	PCU, PIC-ES	Government budget
	Stormwater drainage	Impact of consolidated flows from trunk drains into the wetland	• Undertake hydrological studies, determine assimilative capacity, intended uses, and presence of sensitive receptors along the stormwater drains and surrounding the receiving Parkpheng wetland/retention basin. • Raise the banks by 1 m above ground and enlarge the channel. • Design adequately sized road drains that takes into account potential increase in runoff. • Design an emergency response plan based on the results of the hydrological studies in coordination with stakeholders. • Identify flood risk areas, location of evacuation sites and routes and community-based flood warning system, information dissemination campaign programs.	PCU	PIC-ES	Included in the PIC cost
	SWTP	Impact of the SWTP on hydrology, water logging, receiving water bodies and sensitive receptors	• Undertake hydrological studies, determine assimilative capacity, intended uses, and presence of sensitive receptors associated with receiving water bodies of the SWTP • Undertake baseline water quality tests on Mekong River, San River, and Parkpheng wetland and further assessment of the suitability of discharge to the wetland and options for supporting the Department of Natural Resources and Environment with managing and restoring the wetland • Ensure that the final effluent of the SWTPs conforms to the prescribed National Environment Standards and the Mekong River Commission target values • Undertake ecology baseline survey of retention basin/wetland associated with the SWTP of Pakxan 1 old town area to assess impacts on biodiversity (if any) and water users	PCU	PIC-ES	Included in the PIC cost
	Controlled landfill	Impact on trees, leachate, sensitive receptors at collection	• Design concrete roads and larger drains at the controlled landfill • Provide leachate treatment and recirculation system	PCU	PIC-ES	Included in the PIC cost

Item	Impact Factor	Potential impact, concerns and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
		service area, groundwater, and surface water	• Provide a sorting area to facilitate recovery of recyclable materials brought to the landfill. • Conduct an inventory of trees and other vegetation that will be affected prior to site clearing at the riverbank improvement works and coordinate with the Department of Agriculture and Forestry • Design a tree replacement plan • Conduct consultation with Nasommo village regarding the results of the groundwater quality monitoring to inform the communities about the contamination in the sampled village well; present planned leachate collection and treatment measures and monitoring activities to be integrated in the implementation of the future controlled landfill. • Undertake further assessment of geological condition, groundwater levels and surface water bodies that will be affected by possible leaching based on detailed design • Design a leachate collection and treatment system to avoid percolation into groundwater or discharge into streams • Design measures to control air and odor pollution • Provide buffer/fence surrounding the controlled landfill • Design measures to enhance occupational health and safety and livelihood security of existing waste pickers through formalized employment contracts with UDAA, toilet and washing facilities, covered rest area, and PPE for workers. • Prepare a Landfill Operations Manual to includes specifications for the cover material, procedures for periodic and final cover, operational measures to safeguard liner during waste dumping, and proper operation and maintenance of the septage treatment plant.			
	Closure of existing dumpsite	Impacts of leachate, landfill gas, and erosion to surface water, groundwater and sensitive receptors	• Design a post-closure monitoring plan for the existing dumpsite that includes monitoring of surface and groundwater quality, landfill gas, erosion control, and leachate.	PCU	PIC-ES	Included in the PIC cost
Environmentally responsible readiness	Preparation & readiness of key subproject stakeholders and affected communities	Engaging qualified environmental specialists	• Engage an international Environmental Specialist and a national Environmental Specialist based in the PIC	ADB		Included in the PIC cost
			• Engage a full-time national Environmental Safeguards Officer under the PTRI in the PCU over the subproject's five-year implementation period	PCU	PIC-ES	Recurrent cost
			• Appoint an environmental focal point in the PIU.	PIU	PIC-ES	Government budget
		Environmental training and capacity building	• Train environmental personnel of the PCU, PIU, contractors and the DOE in environmental management and technical strengthening in EMP implementation, GRM implementation, climate adaptation, disaster risk resilience, public consultation, and monitoring and reporting.	PIC	ADB	Included in PIC cost
		Mine and Unexploded Ordnance Clearances	• Have all subproject sites and their areas of influence cleared by the National Regulatory Authority for UXO/Mine Action Sector in Lao PDR at least two weeks prior to construction mobilization	PCU	PIC-ES	Government budget

Item	Impact Factor	Potential impact, concerns and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
			• In collaboration with the National Regulatory Authority for UXO, PCU and PIU, o hold a preconstruction workshop to orientate workers on health and safety requirements, and particularly the procedures to follow when mines or unexploded ordnances are encountered during construction o incorporate information and key contacts in an emergency response plan.	Contractor	PCU, PIC-ES	Included in the Contractor's contract
		Preparing the National IEE/ESIA and Obtaining Clearances	• The Ministry of Public Works and Transport will engage a registered environmental assessment entity to prepare the national IEE/ESIA and secure clearances prior to contract awards.	PCU	PIC-ES	Government budget
		Grievance redress mechanism	• Ensure establishment of the GRM at the subproject level. • Ensure information about the GRM is posted at the offices of the PIU, town and affected villages prior to construction mobilization.	PCU, PIU	PIC-ES	Government budget
		IEE and EMP updates	• Update IEE/EMP based on the final design of subproject components. Have this reviewed and cleared by ADB.	PIC-ES, PCU	ADB	Included in PIC cost
		Inclusion of EMPs in bidding documents	• Include the ADB-cleared updated EMP in bidding and contract documents. • Ensure contracts require Contractors to prepare site-specific CEMPs that fully respond to the ADB-cleared EMPs.	PCU PIC-ES	ADB	Included in PIC cost
		Consultations and disclosures	• Maintain consultation and disclosure activities with affected people and other involved stakeholders to ensure continued communication regarding for example, overall subproject implementation schedule, details of construction activities and particularly activities that result in nuisances and disturbances, the status of claims and compensation, and other aspects.	PCU, PIU	PIC-ES	Included in PIC cost
Estimated cost for Pre-construction phase: Included in the Government budget, PIC cost, Contractor's contract						
B. CONSTRUCTION PHASE						
Construction site good practice	Air quality	Dust & suspended particles in air, and gas emissions/fumes	• The spraying of water at borrow pits, construction sites, access roads, and material handling areas where fugitive dust is generated. • Ensuring dust suppression systems are included in asphalt and concrete batching facilities, and that they are located at least 500 m downwind from the nearest receptors. • Covering trucks to encapsulate dry construction materials. • Ensuring that vehicles and machinery are maintained to a high standard to minimize emissions. • Ensuring suitable advanced notice is provided for pipeline and other excavation works. • Ensuring that formal and informal waste workers at the dumpsites, and receptors within 500 m of these facilities, are suitably informed in advance when these activities are planned. • Ensuring that appropriate environmental and occupational health and safety provisions are followed during the disturbance and movement of solid waste at the dumpsites, to be defined in the controlled landfill final design.	Contractor	PIU, PCU, PIC-ES	Included in Contractor's Contract
	Noise	Noise impact caused by the operation/movement of construction vehicles, drilling, excavations	• Utilizing low-noise, well maintained vehicles and equipment, and ensuring that exhaust systems are in good working order. • Establishing noise barriers such as temporary fences around active work areas, and barriers to be as close to the source or to the receptor location as possible.	Contractor	PIU, PCU, PIC-ES	Included in Contractor's Contract

Item	Impact Factor	Potential impact, concerns and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
			• Installing sound-absorbing enclosures around generators and other equipment. • Restricting heavy and noisy machinery operations to between 8am-5pm, particularly at sites near temples and residential areas. • Providing construction workers with and enforcing the use of PPE. • Enforcing the non-use of vehicle horns unless absolutely necessary. • Maintaining close coordination with affected persons and communities, to ensure that advanced warning is provided, considerations are given, and the GRM widely understood so that grievances and complaints are handled expeditiously. • Monitoring noise levels, particularly nearby sensitive receptors.			
	Surface Water		• Adequate management of sediments, soils, stockpiles and aggregate materials utilized in facility construction. • Use of sediment detention basins, silt fences, sediment sandbag barriers, along main surface drainage routes and around stockpiles of excavated soils and natural aggregates. • Prohibit stockpiling of excavated materials, spoils and natural aggregates on the riverside (where water body is in the area of influence). Stockpiles/storage of construction materials should be located sufficiently away from water bodies (not less than 50 m away) and main surface drainage routes; and installed with effective diversion drains • Avoid excavation in the rainy season, as practicable. • Stockpile natural construction aggregates only in amounts necessary for the short-term. • Dispose of residual soils/spoils promptly and properly if no longer reusable. • Monitoring of upgradient and downgradient surface water quality during and after construction. • Monitor river quality in relation to riverbank protection embankments. • Have adequate sanitation facilities at active work site and ensure workers observe proper sanitation and good hygiene. • Ensuring the management of hazardous materials, and the containment of spills • Management of solid and hazardous wastes: o Provide adequate storage facilities for solid wastes. o Enforce proper sorting and disposal of solid wastes. o Separate storage for hazardous and non-hazardous wastes o Ensure hazardous substances and wastes have safe storage that can contain spillage, raised at least 1 foot (or higher as may be advised during detailed design) above ground & sited at areas not vulnerable to water impoundment. o Manage the amount of hazardous substances brought on site, ensuring not more than what would be needed in two weeks are brought to or stored on site. o Protect storage areas for solid wastes and hazardous materials and wastes from stormwater, placed under a shed as much as possible, with peripheral channels to lead runoffs away from the storage area. o Dispose of wastes regularly. o Link with junkshops and itinerant buyers of recyclables for reusable and recyclable materials.	Contractor	PIU, PCU, PIC-ES	Included in Contractor's Contract

Item	Impact Factor	Potential impact, concerns and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
			• For works close to river/stream/wetland (riverbank protection, SWTPs) o Minimize riparian and lagoon/wetland vegetation removals. o Installation of temporary berms between the component footprints and river/stream, prior to construction commencement. o Install effective erosion and sediment controls, prior to construction commencement to complement the berm. e.g., sediment fence supplemented with sandbag barriers. o Limit soil stripping to the dry season o Ensure site and all areas to waterbody are stabilized prior to removal of erosion and sediment control measures following construction. o Reporting of wildlife and rare animal species sightings, and prohibition of poaching. o Avoid damage and removal of vegetation beyond component footprints. Physically mark the limits of construction footprints, including work easements, and ensuring limits ae observed. Replant and reinstate disturbed areas, as possible. o Ensure, where possible, works close to the river are conducted in the dry season.			
			For sewer works: • Minimize riparian vegetation removals. • Installation of erosion and sediment controls prior to construction commencement.[1] • Limit soil stripping to the dry season. • Ensure workers observe proper sanitation and good hygiene. • Ensure where possible works close to the river are conducted in the dry season. • Ensure the management of hazardous materials, and the containment of spills. • Ensure that sites close to waterbodies are stabilized prior to the removal of erosion and sediment control measures following construction. • Monitor water quality during and after construction.	Contractor	PIU, PCU, PIC-ES	Included in Contractor's contract
	Wastewater		• Maintain sanitation facilities onsite and at workers' campsites. • Strictly enforcing hygiene and sanitation practices. • Incorporate sediment controls, silt traps and wastewater collection. • Maintain equipment washdown areas, complete with sediment control devices. • Provide retention control for material stockpile areas. • Designate specific areas for repair and maintenance. • Ensure regular wastewater collection by a recognized service provider. • Ensure wastewater from boring and excavation works is properly managed and disposed of.	Contractor	PIU, PCU, PIC-ES	Included in Contractor's Contract
	Groundwater.	Improper sealing of boreholes after completion of construction	• Include of detailed borehole construction specifications in the contractor's overall method statements for the drilling works to assure correct borehole construction.	Contractor	PIU, PCU, PIC-ES	Included in Contractor's Contract
	Biodiversity	Fauna, flora and potential habitat loss	• Further site assessment, including site specific ecological surveys, be conducted at the final design stage in order to identify, evaluate and where necessary mitigate ecological impacts caused by the siting of these facilities.	Contractor	PIU, PCU, PIC-ES	Included in Contractor's Contract

[1] For example, sediment control fences supplemented with sandbag barriers.

Item	Impact Factor	Potential impact, concerns and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
	Damage to items of cultural/ historical / archaeological significance	Potential chance find of items of cultural/historical/ archaeological significance	• In case of chance find, stop construction work and make a declaration to the local police, who shall transmit the declaration to the Provincial Governor. o Ensure pre-construction coordination with authorities. o Cease construction works on discovery. o Declare to the local administration and local information, culture and tourism sector. o Prohibit exploration of the item/s found without the approval of the information, culture and tourism sector.	Contractor	PIU, PCU, PIC-ES	Included in Contractor's Contract
		Religious structures within the area of influence	For SWTP network and trunk drain works: • Coordinate with concerned village leader and temple/church authorities for the measures to protect temple/church structure and parts along the road.			
	Community health and safety	Communities exposed to health and safety hazards	• Access restrictions: o Manage material stockpiles to prevent blockages. o Provide access restriction information in advance. o Ensure vehicles park at previously agreed locations. o Provide temporary, alternative access where possible. • Localized flooding: o Divert main surface drainage routes when obstructions are unavoidable. o Dispose of spoils and debris promptly. • Utility service disruptions: o Repair service disruptions expeditiously. o Provide alternative power and water supplies. • Worker social conflicts: o Prioritize local employment. o Provide health and safety training.	Contractor	PIU, PCU, PIC-ES	Included in Contractor's Contract
	Traffic	Traffic impacts	• Implement road surface improvement on the laterite road to be used as access to the landfill. • Develop traffic management schemes in conjunction with local traffic authorities and affected community leaders. • Schedule materials delivery and other traffic-causing activities outside of peak hours. • Assign traffic aide during periods of peak disruption and peak hours. • Ensure stockpiles and construction equipment and vehicles least impede traffic flow. • Provide adequate prior information on road and lane closures, and traffic diversions. • Provide safe access to pedestrians, motorbikes and bicycles. • Ensure affected persons are aware of the GRM. • Ensure contractors repair damages at their expense.	Contractor	PIU, PCU, PIC-ES	Included in Contractor's Contract
	Construction workers' health and safety – risks	air emissions, noise and vibration, construction wastes and wastewater, hazardous substances, potential social conflicts with surrounding communities,	• Contractor compliance with environmental and occupational health and safety guidelines. • Contractor's CEMPs will include health and safety plans. • Provision of PPE for workers. • Adequate work site lighting, water supply, sanitation facilities and safe access • Establishment of a first-response team comprising of trained staff, equipment, tools, supplies, and an adequate office/clinic. The first response team will be linked to	Contractor	PIU, PCU, PIC-ES	Included in Contractor's Contract

Item	Impact Factor	Potential impact, concerns and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
		potential communicable and transmittable diseases in the community, chance finds of UXO, large moving and operating construction vehicles and equipment pits and excavations	ultimate responders. • Appointment of an Environmental, Health and Safety Officer.			
Estimated cost for Construction phase: Included in Contractor's Contract						
C. OPERATION PHASE						
Standard operational practices	Air quality	Landfill gas, odor	• The proposed solid waste volume is low and is therefore not expected to generate large landfill gas. In the medium term, more sophisticated landfill gas management systems will be evaluated once the landfill reaches critical mass. • Mitigate odor from controlled landfill through: o enforcing waste encapsulation in waste trucks while in transit o constructing perimeter fences and berms around the facility o minimizing exposed tipping areas o covering all exposed waste on a regular basis o washing vehicles on facility exit. • Mitigate odor from operation of SWTP facilities through perimeter berms and tree line.	Operator	PCU, PIU PIC-ES	Included in the Operator's budget
	Surface water quality	Water contamination from effluent discharge	• For SWTPs: o Specify maintenance procedures in the SWTP operations manual. o Ensure adequate budget and equipment for routine maintenance activities. o Conduct operator training for SWTP operations and maintenance o Monitor water quality and implement corrective actions for non-compliance. • For controlled landfill, o mitigate the potential for waste mass inundation from precipitation through: (i) the provision of cover materials over waste mass surfaces and ensuring contoured surfaces to encourage flow to drains; and (ii) vegetation of completed waste mass surfaces to reduce cover material erosion. • implementation of the rudimentary leachate collection and disposal system that will allow leachate to be collected and stored, for disposal back onto and into the controlled landfill, as prescribed in the operations manual.	Operator	PCU, PIU PIC-ES	Included in the Operator's budget
	Vadose zone & groundwater	Leachate contamination due to failure in the integrity of septage treatment plant liner, controlled landfill liner	• Provision of surface cover systems for controlled landfills and closed dumpsites. • Provision of liner and leachate collection system for controlled landfills. • Provision of liners for the tanks of the septage treatment plant . • Strengthen operations and maintenance procedures through training, monitoring and evaluation	Operator	PCU, PIU PIC-ES	Included in the Operator's budget
	Water logging at downstream of SWTP sites and	Flooding of downstream communities	• Conduct regular inspection of pump stations to ensure operation during flood events • Identify flood risk areas along with evacuation sites and routes • Implement the emergency response plan in case of flooding that includes a community-based flood warning system and information dissemination	PIU Operator	PCU, PIU PIC-ES	Included in the Operator's budget

Item	Impact Factor	Potential impact, concerns and/or Issues	Mitigation Measures	Implementing Entity	Supervising Entity	Source of funds
	stormwater drainage					
	Effluent quality	Discharge of effluent above the prescribed standards	• Monitor the quality of resulting effluent on a monthly basis to check compliance with the prescribed discharge standards. • Report the results of monitoring to the PCU	Operator	PCU, PIU PIC-ES	Included in the Operator's budget
	Sludge from SWTP	Disposal of sludge	• Implement sludge management through sludge drying and landfilling.	Operator	PCU, PIU PIC-ES	Included in the Operator's budget
	Health and safety	Operational hazards to community and workers' health and safety	• Routine inspections for the early detection of leaks of sewer network and SWTP, together with close and ongoing collaboration with communities in leak monitoring and reporting. • Implement the occupational health and safety plan which forms part of the operations manual of the SWTP. For controlled landfill: • Implement the occupational health and safety plan which forms part of the operations manual of the controlled landfill. • Conduct training on, and enforce the observance of, proper occupational health and safety practices. • Provide PPE, adequate sanitation facilities, water supply (potable & non-potable but safe for washing), lighting & safe accesses. • Provide workers with a shaded/roofed, clean rest & eating area, with seats and tables and first aid kits.	Operator	PCU, PIU PIC-ES	Included in the Operator's budget
			Estimated cost for Operation phase: Included in Operator's budget			

ADB = Asian Development Bank, CEMP = construction environmental management plan, EMP = environmental management plan, EMS = environmental management specialist, ESIA = environment and social impact assessment, GRM = grievance redress mechanism, IA = implementing agency, IEE = initial environmental examination, MONRE = Ministry of Natural Resources and Environment, OHSP = occupational health and safety plan, PCR = project completion report, PCU = project coordination unit, PIC-ES = project implementation consultant-environmental specialist, PIU = project implementation unit, PPE = personal protective equipment, SWTP = small-scale wastewater treatment plant, UDAA = Urban Development Administrative Authority, UXO = unexploded ordnances.

IV. ENVIRONMENTAL MONITORING AND REPORTING

A. Environmental Monitoring

19. Environmental monitoring will consist of:

1. Subproject readiness monitoring, to be undertaken by the PCU, with technical assistance from the PIC-ES.
2. Environmental effects monitoring, to be undertaken by a licensed institute engaged by the PCU.
3. EMP compliance monitoring or verification, to be undertaken by the PCU and PIU, with technical assistance from the PIC-ES.

20. The ADB will oversee project compliance on the basis of the annual environmental monitoring reports provided by the PCU, and site visits conducted generally once or twice a year. Monitoring and reporting arrangements for this project are described below.

21. **Project readiness monitoring.** Before construction, the PIC will assess the project's readiness on environmental management based on the set of indicators presented in Table 3, and report to the ADB and the PCU. This assessment will demonstrate that environmental commitments are being carried out and environmental management systems are in place before construction starts, or suggest corrective actions to ensure that all requirements are met.

Table 3. Project Readiness Assessment Indicators

Indicator	Criteria	Assessment	
Compliance with loan covenants	• Borrower has complied with loan covenants relative to detailed design and environmental	Yes	No
EMP update	• EMP updated after approval by the Asian Development Bank of detailed designs and environmental management.	Yes	No
Households affected by land or right-of-way acquisition	• Affected households compensated at the latest one month prior to construction mobilization.	Yes	No
Ministry of Natural Resources and Environment/Department of Natural Resources and Environment approvals	• Secured at the latest one month prior to contract award.	Yes	No
Mine/UXO clearance	• Secured at the latest one month prior to contract award.	Yes	No
CEMP cleared	• PCU-cleared CEMP obtained at prior to construction mobilization.	Yes	No
Contractors' needed pre-construction coordination	• Contractor has made coordination with proper authorities on: - Waste and wastewater disposal - Steps to take in case of discovery of items of cultural/historical significance - Steps to take in case of discovery of UXO/mine - Religious items of temples exposed to risk of accidental damaged during construction - Traffic management.	 Yes Yes Yes Yes Yes	 No No No No No
PCU/PIU prepared	• PCU-environment safeguard officer appointed • PIU environmental focal point appointed • PCU and PIU oriented on the initial environmental examination/environmental management plan • Monitoring and reporting systems in place	Yes	No

Indicator	Criteria	Assessment	
Relevant communities preparation	• Meaningful consultations completed • GRM established with entry points formally at commune, Town, PIU, PCU and informally, contractor and operator • Posters on health and safety strategically assigned • Posters on GRM assigned at PCU, PIU, commune and Town offices) • Posters and billboards with subproject details and contact numbers assigned/installed	Yes	No
Informal waste picker initiatives	• Waste picker employment transition initiatives implemented	Yes	No
Construction workers prepared	• Orientation of workers on health and safety and CEMP completed. • Contractor has appointed an environmental management officer to oversee CEMP implementation and reporting.	Yes	No
Bidding documents and contracts with environmental safeguards	• Bidding documents and contracts has incorporated the environmental activities and safeguards listed as loan assurances. • Bidding documents and contracts has incorporated the environmental contract clauses.	Yes	No
EMP financial support	• Funds for EMP implementation has been set aside.	Yes	No

CEMP = construction environmental management plan, EMP = environmental management plan, GRM = grievance redress mechanism, PCU = project coordination unit, PIU = project implementation unit, UXO = unexploded ordnances.

22. Environmental effects monitoring will be undertaken by a licensed institute engaged by the PCU. It includes the following:

<u>For the stormwater drainage and riverbank protection:</u>

a) Baseline: ambient air quality, noise, ecological survey and hydrological assessment of receiving wetland at Pakxan 1 old town area during pre-construction
b) Semi-annually: ambient air quality and noise during construction

<u>For the controlled landfill and closure of existing dumpsite:</u>

a) Baseline: ambient air quality, noise, surface water quality, groundwater quality, soil quality during pre-construction
b) Semi-annually: ambient air quality, noise, groundwater quality and soil quality during construction
c) Semi-annually: ambient air quality, noise, groundwater quality, and leachate/effluent quality during operation.
d) Annually: ambient air quality, groundwater quality, soil quality and leachate during operation.
e) Post-closure of dumpsite: ambient air quality, groundwater quality, leachate and soil quality

<u>For the SWTPs:</u>

a) Baseline: surface water quality, hydrology[2] during pre-construction
b) Semi-annual: ambient air quality, noise and surface water quality during construction.
c) Monthly: Effluent quality during operation.
d) Annually: effluent quality, surface water quality and hydrology[3] during operation.

[2] Evaluate hydrological flow regimes at receiving waterbodies, intended water uses and presence of sensitive receptors relying on the water bodies
[3] Evaluate changes in hydrological flow regimes at receiving waterbodies, flood/water logging instances and conditions

23. Environmental effects/quality monitoring results will be evaluated against both national and international standards, as shown in Table 4. The more stringent limit will apply. Refer to Appendix C of the IEE. In the event pre-construction or pre-operation levels of some parameters have exceeded standard levels, the target results should be not exceeding pre-construction or pre-operation levels. Performance will be assessed on the exceedance over the stringent standard level or the pre-construction/pre-operation levels if these have exceeded standard levels.

24. On the discharge of treated effluents from the SWTPs, baseline water quality studies will be undertaken during detailed design at the receiving waterbodies (Mekong River, San River, and Parkpheng wetland). Further assessment on the suitability of discharge to the wetland and options for supporting DONRE with the management and rehabilitation of the wetland will be considered during detailed design.

Table 4. Key Standards to Apply in the EMP

Particular	National Environmental Standard (No. 81/NA) 21 February 2017	International Standard
Ambient air quality	Table 5 General Ambient Air Quality Standard	WHO Air Quality Guidelines, global update 2005
Noise	Table 15 General Noise Standard	WHO Guidelines for Community Noise, 1999
Surface water quality	Table 10 Standard for Surface Water Quality	US Environmental Protection Agency National Recommended Water Quality Criteria
		MRC Technical Guidelines for the Protection of Aquatic Life
		MRC Technical Guidelines for the Protection of Human Health
Groundwater quality	Table 11.1 Groundwater Standard for Domestic Consumption	WHO Guidelines for Drinking-water Quality, Fourth Edition, 2011
Soil quality	Table 8.2 Soil Quality Standard for Other Purposes	-
Wastewater discharge	Table 14.4 Standard of Pollution Control to River from Toilet	EHSG for Water and Sanitation, 2007
	Table 14.5 Standard of Pollution Control to River from Public Drainage	EHSG for Waste Management Facilities, 2007

EHSG = Environment, Health and Safety Guidelines, MRC = Mekong Region Commission, WHO = World Health Organization.

25. EMP compliance during construction will be verified by the PCU-ESO, with the support of the PIU and the PIC-ESs. The PCU will report on environmental safeguard performance of the contractors and their environmental compliance through the quarterly project progress reports and the semi-annual environmental monitoring reports. The PCU will monitor environmental compliance during operations until loan closure or as agreed.

26. The environmental monitoring plan is presented as Table 5.

B. Reporting

27. Environmental monitoring activities and findings shall be documented for purposes of reporting, recording, verifying, referring on and evaluating the environmental performance of the Subproject. The documentation shall also be used as a basis in correcting and enhancing further environmental mitigation and monitoring. A suggested outline for the environmental monitoring report is presented as Annex B.

28. Environmental monitoring reports will be prepared as follows:

a) Monthly, by contractors during construction, and submitted to the PCU.
b) Quarterly, a progress report, prepared by the PCU for submission to the ADB, which will cover safeguard matters.
c) Semi-annually, a safeguards report prepared by the PCU for submission to the ADB.
d) Semi-annually, by the PCU during operation until loan closure or as agreed, to be submitted to the ADB.

Table 5. Environmental Effects Monitoring

Monitoring Location	Item	Monitoring Parameter	Monitoring Frequency & Duration	Implementing Entity	Supervising Entity
STORMWATER DRAINAGE					
Pre-Construction Phase o One at each of four trunk drains	Air quality	See F below	Once	Licensed Lab (for PCU)	2,400
o One at each of four trunk drains	Noise	L_{Aeq}	Once		200
○ Baseline ecological and hydrological surveys at receiving wetland at Pakxan 1 old town area	Biodiversity and assimilative capacity		Once	Consultant	75,000
Construction Phase o One at each of four trunk drains	Air quality	See F below	Semi-annual	Licensed Lab	4,800
o One at each of four trunk drains	Noise	L_{Aeq}	Semi-annual	(for PCU)	400
				Sub-total – stormwater drainage	**82,800**
SWTP					
Pre-Construction Phase Two stations each (upstream and downstream) o Pakxan 1 old town area at Parkpheng wetland o Pakxan 1 hospital at Mekong River o Pakxan 2 (north) at San River o Pakxan 2 (south) at Mekong River	Surface water quality	See E below	Once	Licensed Lab (for PCU)	9,600
Construction Phase Two stations each (upstream and downstream) o Pakxan 1 old town area at Parkpheng wetland o Pakxan 1 hospital at Mekong River o Pakxan 2 (north) at San River o Pakxan 2 (south) at Mekong River	Surface water quality	See E below	Semi-annual	Licensed Lab (for PCU)	19,200

Monitoring Location	Item	Monitoring Parameter	Monitoring Frequency & Duration	Implementing Entity	Supervising Entity
o 1 location for sewer network of each of the four SWTP	Air quality	See F below	Semi-annual		4,800
Two stations in each of the 4 SWTP o Center of SWTP sites o Nearest receptor	Noise	L_{Aeq}	Semi-annual		3200
				Sub-total – SWTPs	**36,800**
Operation Phase					
o At discharge points of SWTP	Effluent	See B below.	Semi-annual	Licensed Lab (for PCU)	9,600
Two stations each (upstream and downstream) o Pakxan 1 old town area at Parkpheng wetland o Pakxan 1 hospital at Mekong River o Pakxan 2 (north) at San River o Pakxan 2 (south) at Mekong River	Surface water quality	See E below	Semi-annual		9,600
				Total Operation SWTP (annually)	**19,200**
CONTROLLED LANDFILL and CLOSURE of EXISTING DUMPSITE					
Pre-Construction Phase o At two locations, one close to the entrance of existing dumpsite and one at proposed controlled landfill site	Air quality	See F below	Once	Licensed Lab (for PCU)	1,200
o At two locations, one close to the entrance of existing dumpsite and one at proposed controlled landfill site	Noise	L_{Aeq}	Once		100
o Three stations: One at site; 1 at household well in Ban Nasommo; and 1 downgradient	Groundwater quality	See A below.	Once		3,600
o One at site, one at downgradient	Soil quality	See C below.	Once		2,000
Construction Phase o At two locations, one close to the entrance of existing dumpsite and one at proposed controlled landfill site	Air quality	See F below	Semi-annual	Licensed Lab (for PCU)	2,400
o At two locations, one close to the entrance of existing dumpsite and one at proposed controlled landfill site	Noise	L_{Aeq}	Semi-annual		200
o Three stations: One at site; 1 at household well in Ban Nasommo; and 1 downgradient	Groundwater quality	See A below.	Semi-annual		7,200

Monitoring Location	Item	Monitoring Parameter	Monitoring Frequency & Duration	Implementing Entity	Supervising Entity
o One at site, one at downgradient	Soil quality	See C below.	Semi-annually		4,000
Sub-Total Controlled landfill/closure of existing dumpsite					**20,700**
Operation Phase					
o At two locations, one close to the active waste cell, one close to the entrance of the site	Air quality	See F below	Semi-annually		2,400
o Three stations: One at site; 1 at household well in Ban Nasommo; and 1 downgradient	Groundwater quality	See A below.	Semi-annually		7,200
o One upgradient, 1 downgradient	Soil quality	See C below.	Semi-annually		4,000
o At sump at lower end of the waste cell (where leachate gathers at pump area)	Leachate	See D below	Semi-annually		2,400
Total Operation (annually)					**16,000**
Post-Closure of Existing Dumpsite					
o At two locations, one close to the active waste cell, one close to the entrance of the site	Air quality	See F below	Annual	Licensed Lab	1,200
o Three stations: One at site; 1 at household well in Ban Nasommo; and 1 downgradient	Groundwater quality	See A below.	Annual	(for PCU)	3,600
o At sump at lower end of the waste cell (where leachate gathers at pump area)	Leachate	See D below	Annual		1,200
o One upgradient, 1 downgradient	Soil quality	See C below.	Annual		2,000
Total Post-Closure of Dumpsite					**8,000**
RIVERBANK PROTECTION					
Pre-Construction Phase					
o At three locations (1 in each of 2 riverbank segments and 1 in at the temple area)	Air quality	See F below	Once	Licensed Lab	1,800
o At three locations (1 in each of 2 riverbank segments and 1 in temple area)	Noise	L_{Aeq}	Once	(for PCU)	150
Construction Phase					
o At three locations (1 in each of 2 riverbank segments and 1 in at the temple area)	Air quality	See F below	Semi-annual	Licensed Lab	3,600

Monitoring Location	Item	Monitoring Parameter	Monitoring Frequency & Duration	Implementing Entity	Supervising Entity
o At three locations (1 in each of 2 riverbank segments and 1 in at the temple area)	Noise	L_{Aeq}	Semi-annual	(for PCU)	300
o At two locations, one upstream and downstream of San River	Surface water quality	See E below.	Semi-annually		4,800
				Total	**10,650**

PCU = project coordination unit.

Suggested parameters to monitor:

A. Groundwater quality – Faecal coliform, e-coli, total coliform, As, Cd, Cr+6, Cr-3, CN, F Pb, Hg, Ni, NO2, NO3, odor, color, turbidity, conductivity, pH, temperature, TDS, hardness, Cu, Cl, Fe, Mn, SO4, Zn, Al, H2S. Selected from the National Drinking Water Quality Standards 2004.
B. Effluent (SWTP) –color, COD, BOD, TSS, pH, PO4, phosphates, NO3, Ammonia, Faecal coliform, E Coli.
C. Soil quality – pH, As, Cu, Zn, Cr, Pb, Hg, Fe, Cd, electrical conductivity, WHC, soil moisture, Cl, alkalinity, K, Na, Organic C, organic matter, Ca, Ng, NO3, soil salinity.
D. Recirculated leachate – Temperature, color, odor, turbidity, pH, conductivity, COD, BOD, TSS, Total organic carbon, TVS, TDS, ammonia-N, PO4, Chloride, faecal coliform, phenols, SO4, NO3, Ca, Mg As, CN, Pb, Cu, Ni, Cr, Zn, Cd, Mn, Hg, grease oil, Fe, DO.
E. Surface water quality – pH, BOD, SS, DO, Faecal Coliform, Total Coliform, Temperature, Total NO2+NO3, Total P, COD, NH3 as N, As, Cd, Pb, CN, Total Hg, Se, Cr+6, oil & grease, phenol, total organochlorine pesticide. These includes all the parameters for the protection of human health and aquatic life in the MRC Technical Guidelines for the Implementation of Water Quality, approved in the Meeting of the MRC Council on 22 November 2016, in Pakse, Lao PDR.
F. Ambient air quality and Landfill gas – CO, NO_2, SO_2, $PM_{2.5}$, Pb, Ch_4

V. CAPACITY DEVELOPMENT

29. The PPTA environment team conducted an interview with the Deputy Director of DPWT of Borikhamxay Province in November 2017, in order to assess the capacity of the PIU in project environmental management. Meeting was also held with the Director of PTRI's Environment and Social Division to assess the responsibilities and capacity of the institute to provide support on environmental management.

30. The PIU had not been established (and up to this reporting). The DPWT does not have an environmental management unit or section that is responsible for environmental matters or requirements. There is no one staff specifically assigned to deal with environmental matters unless there is a project that would require one. The Deputy Director expressed the lack of capacity and experience in project environmental management as a key issue. Also emphasized was the need for capacity building and technical support during subproject implementation. Primary areas of needed capacity strengthening are (i) knowledge of O&M procedures for controlled landfills and wastewater treatment facilities, (ii) knowledge of the country safeguard system and ADB's Safeguard Policy Statement, (ii) to be familiar with the IEE and EMP of the subproject, (iii) monitoring and reporting, (iv) implementing the GRM, and (iv) climate change matters.

31. The PTRI is a unit under the MPWT with about 45 staff. It has 5 divisions of which one division is in-charge of environmental monitoring. The Environment and Social Division of PTRI conducts monitoring and prepares monthly environmental monitoring reports of project funded by foreign donors. It has an Environmental and Social Manual that was developed in 2003 that guides the PTRI in screening environmental concerns of projects. However, this manual needs to be updated to meet the recent MONRE requirements. Considering the experience of PTRI in conducting environmental monitoring of projects, the an environment safeguards staff will be hired on a full time basis to work at the PTRI during the duration of the project. The aim is to institutionalize the monitoring of safeguards compliance of the subprojects in Thakhek and Pakxan. The PTRI staff will be assigned to work with the PCU as ESO of the project and to coordinate with the PIC-ES.

32. The PIC-ES will provide 'hands-on' training for the PCU-ESO and PIU environmental focal point. Among the responsibilities specified in the outline terms of reference for the Environmental Specialists of the PIC (Appendix I), the following relate to capacity development:

a) Provide close technical supervision and guidance to the PCU ESO and PIU environmental focal points.
b) At the onset of DED, in collaboration with the MONRE/DONRE, conduct an orientation on the: (i) Environmental Protection Law 2012 (No. 29/NA), (ii) Safeguard Policy Statement (SP) 2009, and (iii) ADB-cleared draft EMP to the PCU, PIUs and, if any, Environment Specialist of the design consultant.
c) Finalize training needs based on the preliminary consultations. In collaboration with the PCU and PIUs, develop a training plan for incorporation in the overall capacity building program of the Project. Develop an evaluation sheet on the usefulness of the training/capacity building design and performance of the trainers.

33. The capacity building program will (i) prepare the PIU to assume their responsibilities and to support the PCU, and (ii) provide other relevant agencies an understanding of basic principles of project management, including social and environmental safeguards.[4] Target participants include the PCU, PIU, nominated staff from the provincial and municipal Governors offices, provincial and municipal procurement committee members, other relevant staff of the DPWT and DONREs, and other provincial government agencies.

34. Topics recommended to be covered through training sessions, lectures and/or workshops are: (i) those that are relevant to the environmental management responsibilities of the PCU and PIUs under the Project,[5] and (ii) those that interviewed officers have expressed interest in, and others that may be agreed on during subproject implementation. Funds for seminars, workshops and training are allocated under the PIC cost.

Table 6. Capacity Building – LAO PDR

Training	Attendees	Contents	Time	Days	Persons	Unit Cost/ person	Total Cost
Orientation Training	PCU, PIUs, PTRI, contractors, DONRE,	Lao PDR's environmental safeguard system, ADB Safeguard Policy Statement	Pre-construction	1	25	LS	* 1,500 (held in 1 town)

[4] Through 'on-the-job' training, tutorials, e-manual tutorials and local workshops.
[5] Such as the EMP requirements, monitoring and reporting, carrying out consultations, and the GRM.

Training	Attendees	Contents	Time	Days	Persons	Unit Cost/ person	Total Cost
	DPWT, Town, Province	environmental management plan (mitigation measures, monitoring measures, roles and responsibilities, reporting, grievance redress mechanism, carrying out consultations) Overseeing & monitoring construction environmental management plan compliance.					
Project environmental management	PCU, PIUs, PTRI, contractors, DONRE, DPWT, Town, Province	Environmental management practices in improvement and maintenance of basic urban services (drainage, small-scale wastewater treatment plants, solid waste management) Bes practices other countries on the same	1st year of construction period	1	25	LS	1,500 (held in 1 town)
Assessment after one year	PCU, PIUs, PTRI, contractors, DONRE, DPWT, Town, Province	An evaluation of the 1st year of environmental management – sharing of the two towns. Sharing experiences with other GMS projects	After 1st year of construction period	1	25	LS	1,500 (held in 1 town)
Climate change and risks, adaptation and disaster management	PCU, PIUs, PTRI, contractors, DONRE, DPWT, Town, Province	Relative to the infrastructure components under the project. And other topics that may be suggested by the PCU/PIU	2nd year of construction period	1	25	LS	1,500 (held in 1 town)
1 other seminar	PCU, PIUs, contractors, DONRE, DPWT, Town, Province	Environmental management during operation Suggested topic/s by PCU and PIUs later.	After construction but before start of operation	1	25	LS	4,000 (held in VTE)
						Engagement of a total of 6 invited lecturers, all national	**10,000**
						TOTAL	**1,800**
							11,800

DONRE = Department of Natural Environment and Environment, DPWT = Department of Public Works and transport, PCU = project coordination unit, PIU = project implementation unit, PTRI = Public Works and Transport Institute.
Notes: Lump sum (LS) cost provided by the PPTA Team Leader: (i) USD1,500 for a workshop/seminar held in the town, 25 participants, and (ii) USD4,000 for a workshop in the capital city, 25 persons.

VI. PUBLIC CONSULTATIONS

35. As discussed in Section VII of the IEE, public participation and consultation has been essential in project preparation, and this will continue through to subproject implementation and operation. As indicated in Table 7, this will include:

a) Pre-construction phase: discussions on: (i) subproject environmental benefits, positive impacts and results, (ii) anticipated impacts and health and safety hazards during construction, (iii) the GRM, (iv) opportunities for participating in monitoring, and (v) subproject contact details.

b) Construction and operation phases: to solicit feedback on: (i) environmental impacts and the effectiveness of mitigation measures implemented by contractors and operators, and (ii) efficiency of the GRM.

Table 7. Public Consultation Plan – Pakxan

Organizer	Format	No. of Times	Subject	Attendees	Budget
Prior construction					
PCU	Public consultation	1 time, prior to mobilization	Environmental impacts during construction, health and safety risks, grievance redress mechanism, persons to contact in case of concerns, among others	Residents in the immediate influence areas of components	$188
During construction					
PCU	Public consultation	1st and 2nd years of construction	Solicit feedback on environmental impacts and mitigation measures implemented by contractors	Residents in the immediate influence areas of components	$375
During operation					
PCU	Public consultation	Once each in the 1st, 3rd and 5th year	Solicit feedback on environmental impacts and mitigation measures implemented by operators	Residents in the immediate influence areas of components	$563
				Sub-Total	**$1,125**
				10% contingency	**$113**
				Total	**$1,238**

PCU = project coordination unit.
Notes: unit cost for snack is estimated at $1.88/participant, 100 estimated participants in Pakxan, and consultations are estimated at: prior construction – 1, during construction – 2, and during operation – 3.

VII. PRELIMINARY COSTS

36. The preliminary costs for EMP implementation are presented on Table 8.

Table 8. Preliminary Cost for EMP Implementation

EMP Item	Estimated Cost (USD)		
	Fixed Cost	Annual Cost	Fund source

Environmental mitigation			Included in Contractor's contract
Environmental effects monitoring Pre-construction (baseline) During construction During operation Post-closure monitoring of dumpsite	 96,050 54,900 8,000	 35,200	 PIC cost PIC cost Operator's annual budget
PIC Environmental Specialists (fees only) Fee for international and national Travel and out-of-pocket expenses	 99,500		 PIC cost
Project Coordination Unit Environmental Safeguard Officer (5 years)	144,000		Recurrent cost
Preparation of Borrower's initial environmental examination/environment and social impact assessment and obtaining MONRE/DONRE clearance	100,000		PIC cost
MONRE/DONRE monitoring (quarterly for 5 years)[a]	14,000		PIC cost (5 years) Recurrent cost after 5 years c/o Government cost
Consultations	1,362		PIC cost
Training (inclusive 2 towns)	11,800		PIC cost

DONRE = Department of Natural Resources and Environment, MONRE = Ministry of Environment and Natural Resources and Environment, PIC = project implementation consultant.
Costs above exclude taxes and inflation.
[a] covers the per diem, transportation, and report writing of 3 MONRE staff and 2 DONRE staff during project construction

VIII. MECHANISM FOR FEEDBACK

37. The EMP will be reviewed when there are changes in the design, construction methods and program, unfavorable environmental monitoring results or inappropriate monitoring locations, or ineffective or inadequate mitigation measures. Based on the environmental monitoring and reporting systems in place, the PCU, with the technical guidance and support of the PIC-ES, shall assess whether further mitigation measures are required as corrective action, or improvement in environmental management practices. The PCU will inform the ADB promptly of any changes to the project and necessary adjustments to the EMP. The updated EMP will be submitted to the ADB for review and approval and will be disclosed on the ADB website.

RELEVANCE OF OTHER ENVIRONMENTAL LAWS, REGULATIONS AND GUIDELINES TO THE PROJECT

Protecting water resources. The Law on Water and Water Resources 1996 requires government approval for the following activities: (i) building dams or raising embankments to divert water flow for navigation or for building small reservoirs to produce electrical power, or for irrigation, livestock, fishing, and others; (ii) extracting stones, gravel, sand, soil, mud, minerals, trees, and others, in or around a water source having a minor impact on nature and the environment; and (iii) installing small mechanical water pumps to undertake production or services. In another article of the Law, the following activities are prohibited unless granted approval: (i) constructing by a water resource, on shore or in a water resource; (iii) digging drainage canals; or filling, modifying or changing the area of rivers, lakes, ponds, swamps so as to damage the interests of the public or other persons; (iv) constructing things that obstruct the flow of water; and (v) modifying water flows, building sluice gates, digging or excavating medium or small-scale drainage ditches.
Chance find of cultural heritage items. The Law on National Heritage 2005 provides that, in case of chance find of cultural heritage item/s during the conduct of activities: (i) the find must be reported immediately to the local administration and local information, culture and tourism sector; (ii) the activity must be suspended until approval for continuation of activity is granted; and (iii) finder shall be prohibited from exploring the item/s without the approval of the information, culture and tourism sector.
Labor health and safety. The Labor Law 2013 requires: (i) work conditions (workplace, machinery, equipment and procedures) to be safe and well-maintained; (ii) working hours of those in sectors that involved working directly with constantly vibrating equipment as not to exceed 6 hours per day or 36 hours per week; and (iii) employers to enforce appropriate measures to ensure the health and safety of workers at workplaces. The Law on Hygiene, Disease Prevention and Health Promotion 2011 requires employers to provide safe equipment to workers and ensure hygiene at workplaces, such as among others, to ensure generated vibration, noise, odor and dust do not exceed regulations.
Labor and community health and safety. The Law on Hygiene, Disease Prevention and Health Promotion 2011 requires construction sites to be safe, clean and accessible, installed with warning signs, fences, among others, to prevent health hazards to workers, neighboring people and passers-by. The revised Law on Public Roads 2016 requires a public road contractor to ensure safety and environmental protection during construction. The contractor shall be responsible of the safety procedure for the workers and neighboring communities locate close to the construction sites.
Establishment of public parks. The Law on Hygiene, Disease Prevention and Health Promotion 2011 provides for the necessity of establishing public parks planted with substantial number of trees to ensure clean and fresh air for widespread health promotion.
Use of "water area land". The Land Law 2003 defines "water area land" as submerged land, land surrounding water bodies, riverbanks, islands, land formed when water recedes, or land formed by a change or diversion of waterways. The Law requires that the use of water area land shall not, among others: (i) cause erosion, obstruction to waterways, water levels to recede or flood; (ii) pollute or poison water bodies; (iii) cut trees; and/or (iv) dig or take away soil from swamps and wetlands, except in case of necessity with prior authorization from concerned organization.

Damage of community facilities and infrastructure during project execution. The Decree on the Compensation and Resettlement of the Development Project 2005 provides that Project Proponent shall: (i) restore or repair community facilities and infrastructure damaged by the project, at no cost to the community; and (ii) in case of impacted/restricted access to resources managed by affected community, ensure arrangements are made for safe access to the managed resources or to at least equivalent resources, on a continuing basis.
Solid waste management (SWM). Decree on Disposal site management (No 520 / TCPC, dated 23 Feb 2007), regulates site selection and design of disposal sites.
Quarrying/extraction of construction aggregates. The Revised Law on Public Roads 2016 requires the extraction of natural construction aggregates, such soil, gravel, stone to be approved by the government authorities.
Cutting of trees. If there are trees in the list of protected trees by the Department of Agriculture and Forestry (DAF), a project proponent needs to provide the DAF with the detailed survey and then DAF will report to the Provincial Governor's office. If the affected trees are in a national protected area or national biodiversity conservation area (NPA/NBCA), the DONRE will inform (i) the DAF for site survey and (ii) get the list of trees to be cut including details on protected tree, other trees and quantity of trees to be cut in the protected area. The DAF will inform the Provincial Governor's office for consideration. The Provincial Governor will convene a meeting of the provincial national assembly to deliberate the project or stop the project activities in the NPA/NCBA.

ENVIRONMENTAL QUALITY STANDARDS APPLICABLE IN THE IEE

B.1 Ambient Air Quality Standards

Parameter	Averaging Period	LPDR's General Ambient Air Quality Standard *		WHO Air Quality Guidelines (mg/m^3)	
				Global Update 2005 **	1999 ***
		(ppm)	(mg/m^3)	(mg/m^3)	(mg/m^3)
CO	1-hour	30	^ 37.0	-	30
	8-hour	9	^ 11.1	-	10
NO_2	1-hour	0.11	^ 0.223	0.20	-
	1-year	0.02	^ 0.0405	0.04	-
SO_2	1-hour	0.13	^ 0.367	-	
	24-hour	0.05	^ 0.141	0.02	-
TSP	24-hour	-	0.33	-	-
	1-year	-	0.10	-	-
PM_{10}	24-hour	-	0.12	0.05	-
	1-year	-	0.05	0.02	-
$PM_{2.5}$	24-hour	-	0.05	0.025	-
	1-year	-	0.015	0.01	-
O_3	1-hour	-	0.20	-	-
	8-hour	-	0.14	0.10	-
Pb	1-year	-	0.00015	-	0.0005

WHO guideline value more stringent. To appy in the 4th GMS Corridor Towns Development Project.

* Article 5: General Air Quality Standard. National Environmental Standard (No. 81/NA). 21 February 2017.

** Source: Environmental, Health, and Safety General Guidelines. IFC. April 30, 2007.

*** Air Quality Guidelines for Europe. Second Edition. WHO Regional Publication, European Series, No. 91. 2000.

^ Converted ppm to mg/m3 via https://www.lenntech.com/.

B.2 Noise Level Standards

LPDR General Noise Standard (dBA) *		WHO Guidelines for Community Noise 1999 (dBA) **		
		Receptor	One-Hour L_{eq} (dBA)	
			Daytime 07:00 - 22:00	Nighttime 22:00 - 07:00
Maximum Sound Level (Lmax)	115	Residential, institutional, educational	55	45
Leq 24 hour	70	Industrial, commercial	70	70

WHO guideline value more stringent. To apply in the 4th GMS Corridor Towns Development Project.

* Table 15: General Noise Standard. National Environmental Standard (No. 81/NA). 21 February 2017.

** Environmental, Health, and Safety General Guidelines. IFC. April 30, 2007.

B.3 Surface Water Quality Standard

Parameter	Unit	LPDR Surface Water Quality Standard [1] Standard Values for Each Type of Surface Water					MRC Target Values [2] For the protection of	
		1	2	3	4	5	human health [2]	aquatic life [2]
Color, odor and taste	-	n	n'	n'	n'	-	-	-
Temperature	^{0}C	n	n'	n'	n'	-	Natural	Natural
pH	-	6 - 8	6 - 8	5 - 9	5 - 9	-	6 - 9	6 - 9
DO	mg/l	> 7	6	4	2	< 2	≥ 6 *	> 5
EC	µS/cm	< 500	≤ 1000	≤ 2000	≤ 4000	> 4000	700 - 1500	-
COD	mg/l	< 5	5 - 7	7 - 10	10 - 12	> 12	5	-
Total coliform bacteria	MPN/100 ml	n	5,000	20,000	-	-	5,000	-
Fecal coliform bacteria	MPN/100 ml	n	1,000	4,000	-	-	1000 *	-
TSS	mg/l	< 10	≤ 25	≤ 40	≤ 60	> 60	-	-
PO_4	mg/l	< 0.1	0.5	1	2	> 2	-	-
NH_4	mg/l	< 0.5	≤ 1.5	≤ 3	≤ 4	> 4	-	-
NO_3 - N	mg/l	n		5.0		-	-	5
NH_3 - N	mg/l	n		0.5		-	0.5 **	0.2 *
Phenol	mg/l	n		0.005		-	0.005	0.005
Cu	mg/l	n		1.5		-	-	0.1
Ni	mg/l	n		0.1		-	-	-
Mn	mg/l	n		1.0		-	-	-
Zn	mg/l	n		1.0		-	-	-
Cd	mg/l	n		0.003		-	0.005 **	0.005 **
Cr^{+6}	mg/l	n		0.05		-	0.05	0.05 *
Pb	mg/l	n		0.01		-	0.05	0.05 *
Hg	mg/l	n		0.001		-	0.002 ***	0.001 ***
As	mg/l	n		0.01		-	0.01 ***	0.01
CN	mg/l	n		0.07		-	0.01	0.005
Radioactive alpha	Becqurel/l	n		0.1		-	-	-
Radioactive beta	µg/l	n		1.0		-	-	-
Organochlorine pesticide	mg/l	n		0.05		-	0.05 ***	0.05 ***
Dichlorodiphenyltrichloroethane	µg/l	n		1.0		-	-	-
Alpha-Benzene hexachloride	µg/l	n		0.02		-	-	-
Dieldrin	µg/l	n		0.1		-	-	-
Aldrin	µg/l	n		0.1		-	-	-
Heptachlor & heptachlorepoxide	µg/l	n		0.2		-	-	-
Endrin	µg/l	n		none		-	-	-

Mekong River Commission (MRC) guideline value more stringent. To apply in the 4th GMS Corridor Towns Development Project.

1 Table 10: Standard for Surface Water Quality. National Environmental Standard (No. 81/NA). 21 February 2017.

2 Technical Guidelines on the Implementation of the Procedures for Water Quality. Mekong River Commission. Approved in the 23rd Meeting of the MRC Council on 22 November 2016.

* An interim target value requiring further review by the MRC Technical Body on Water Quality.

** When the water hardness is <100 mg/l as Ca CO_3

*** Total

Remarks: (Unofficial translation)

Type 1 This is a natural water resource or ambient river, the raw water does not pass any treatment process and the water quality is not mixed with any chemical from industrial factories or other activities

Type 2 This is a water source that will be used for consumption, but requires treatment. This water source is suitable for aquatic life conservation, fish farm and others.

Type 3 This is a water source that will be used for consumption; but requires treatment. This water source is suitable for agriculture, livestock farming and others.

Type 4 This is a water source that will be used for consumption; but requires trteatment. This water source is suitable for industrial activities, as receiving water body of wastewater discharge from the town or communities and others.

Type 5 The water source is useful for the communication, transportation and as receiving water body of wastewater discharge from the town and others.

n A natural water resource

n' A natural water resource but is disturbed by other factors, such as "temperature + 3"

B.4 Groundwater Quality Standard

Parameter	LPDR's Standard for the Quality of Groudwater for domestic Consumption *		WHO Guidelines for Drinking-water Quality **	
	Unit	Standard	Unit	Guideline Value
Color	-	15	-	None established
Turbidity	NTU	20	-	None established
pH	-	6.5 - 9.0	-	None established
Fe	mg/l	1.0	-	None established
Mn	mg/l	0.5	-	None established
Cu	mg/l	1.5	mg/l	2
Cr^{+6}	mg/l	0.05	mg/l	0.05
Zn	mg/l	15.0	-	None established
SO_4	mg/l	250	-	None established
Chloride	mg/l	600	-	None established
F		1.0		1.5
NO_3	mg/l	45	mg/l	50
Total Hardness ($CaCO_3$)	mg/l	500	-	None established
Hardness (non-carbonate as $CaCO_3$)	mg/l	250	-	None established
TSS		1,200		None established
As	mg/l	0.01	mg/l	0.01
CN	mg/l	0.07	-	None established
Pb	mg/l	0.01	mg/l	0.01
Hg	mg/l	0.001	mg/l	0.006
Cd	mg/l	0.003	mg/l	0.003
Se	mg/l	0.01	mg/l	0.04
Bacteria (SPC Method)	Colonies/cm3	500	-	None established
Coliform Bacteria	MPN/100 cm3	2.2	MPN/100 ml	Must not be detectable in any 100 ml sample.
E. coli Bacteria	-	None	MPN/100 ml	Must not be detectable in any 100 ml sample.

* Table 11.1: Standard for Groundwater Quality for Domestic Consumption National Environmental Standard (No. 81/NA) 21 February 2017

** Guidelines for drinking-water quality. fourth edition incorporating the first addendum. Geneva. World Health Organization, 2017.

B.5 B.5 Effluent/Discharge Quality Standard

A. Controlling Pollution of Rivers from Toilet

Parameter	Lao PDR Standard for Controlling Pollution of Rivers from Toilets		IFC EHS Guideline Value (Treated Sanitary Sewage Discharges)
	Unit	Standard Value	
pH	-	6-9	6 – 9
BOD_5	mg/l	30	30
COD	mg/l	125	125
TSS	mg/l	50	50
TKN	mg/l	10	10
Phenol	mg/l	2	-
Fats, oil, grease	mg/l	5	10
E.coli	mg/l	400	-
Total coliform	MPN/100ml	-	400

B. Controlling Pollution of Rivers from Public Drainage

Parameter	Lao PDR Standard for Controlling Pollution of Rivers from Toilets		IFC EHS Guideline Value (Treated Sanitary Sewage Discharges)
	Unit	Standard Value	
pH	-	5.5 - 8.5	6- 9
EC	µS/cm	2,000	-
TDS	mg/l	1,300	-
BOD_5	mg/l	30	30
TSS	mg/l	30	50
MnO_4	mg/l	6.0	-
H_2S	mg/l	1.0	-
CN	mg/l	0.2	-
Fats, oil, grease	mg/l	5.0	10
CH_2O	mg/l	1.0	-
Phenol & cresol	mg/l	1.0	-
Residual Cl	mg/l	1.0	-
Radioactive	mg/l	None	-
Color & odor	mg/l	Not visible	-
Tar	mg/l	None	-
Heavy metals/elements			
Zn	mg/l	5.0	-
Cr^{+6}	mg/l	0.3	-
As	mg/l	0.25	-
Cu	mg/l	1.0	-
Hg	mg/l	0.005	-
Cd	mg/l	0.03	-
Ba	mg/l	1.0	-

Parameter	Lao PDR Standard for Controlling Pollution of Rivers from Toilets		IFC EHS Guideline Value (Treated Sanitary Sewage Discharges)
	Unit	Standard Value	
Se	mg/l	0.02	-
Pb	mg/l	0.1	-
Ni	mg/l	0.2	-
Mn	mg/l	0.5	-

B.6 Soil Quality Standard

Parameter	Unit	Standard Value *
Volatile organic compound		
Benzene	mg/kg	15
Carbon Tetrachloride	mg/kg	5.3
1.2 Dichloroethane	mg/kg	7.6
1.1 Dichloroethylene	mg/kg	1.2
Cis-1.2 Dichloroethylene	mg/kg	150
Trans-1.2 Dichloroethylene	mg/kg	210
Dichloromethane	mg/kg	210
Ethylbenzene	mg/kg	230
Styrene	mg/kg	1,700
Tetrachloroethylene	mg/kg	190
Toluene	mg/kg	520
Trichloroethylene	mg/kg	61
1.1.1 Trichloroethane	mg/kg	1,400
1.1.2 Trichloroethane	mg/kg	19
Xylene	mg/kg	210
Heavy metals		
As	mg/kg	27
Cd	mg/kg	810
Cr+6	mg/kg	640
Pb	mg/kg	750
Mn	mg/kg	32,000
Hg	mg/kg	610
Ni	mg/kg	41,000
Se	mg/kg	10,000
Pesticides		
Atrazine	mg/kg	110
Chlordane	mg/kg	110
2.4 Dichlorophenoxyacetic	mg/kg	12,000
Dichlorodiphenyltrichloroethane	mg/kg	120
Dieldrin	mg/kg	1.5
Heptachlor	mg/kg	55
Heptachlor epoxide	mg/kg	2.7
Lindane	mg/kg	29
Pentachlorophenol	mg/kg	110
Others		
Benzo (A) pyrene	mg/kg	2.9
CN	mg/kg	35
Polychlorobiphenyls	mg/kg	10
Vinyl Chloride	mg/kg	8.3

* Table 8.2: Soil Quality Standard for Other Purposes. National Environmental Standard (No. 81/NA). 21 February 2017.

RESULTS OF THE GROUNDWATER QUALITY STUDY – PAKXAN AND THAKHEK DUMPSITES

Lao People's Democratic Republic
Peace Independence Democracy Unity Prosperity
======00000======

Department of Natural Resource and
Environments of Borikhamxay Province
Water Resource Division No...../ຂຊນ.DONRE
Borikhamxay, Date.....……

Report about the field ground water sampling and analysis of existing dumpsite at Pakxan and Thakhek districts

To: Representative of the ADB TA 9192 REG: Fourth Greater Mekong Subregion Corridor Towns Development Project.
Subject: To report of the results of Ground Water Sampling results for Pakxan and Thakhek District

I. Introduction

1. The history of laboratory and team of water quality analysis

1.1. The history of laboratory

This laboratory service is under the Department of Natural Resources and Environment, supervised by the Water Resource Division of Borikhamxay Province. The equipment for laboratory analysis are involved the Spectrom ® prove300, this equipment is supported by Environmental Protection Fund in year 2016 and the water quality equipment for analysis in the field is used the WTW 330i, this supported by water quality analysis project from Finland in year 2013. The Water Quality testing of the existing ambient rivers which locates in Pakxan District, Borikhamxay province are including Nam Theun- Kadding river, Nam Xan and Nam Niep.The Total sampling location are 12 points. The frequency of sampling is every quarterly of a year.

The Capacity building for the staff at the Laboratory including are:

- Provide training how to use the water quality testing equipment onsite for three times already.
- Participant the training of how to use the water quality equipment such the Spectroquant ® prove 300 during testing the water quality in the laboratory for 2 times.
- Participant the training how to monitor the water quality by using the insect in the ambient river as the indicator of the water quality, how to evaluate surrounding environment of the water quality by visual inspection for 2 times.
- Participant the technical seminar about how to use the technology as appropriate way for waste management and pollution control of the wastewater treatment, small and medium of enterprise business.

1.2. Team of water quality analysis

- Mr. Khamdi Phimmasone , deputy of DONRE, acting as the general director of the Laboratory
- Mr. Viengkeo Saipakdee , head of division of Water resource division, acting as the deputy director of the Laboratory
- Mr. Khampasert Keomany, deputy of head division
- Mrs. Yenpapha Vilavong, a laboratory technician
- Mr. Phonesavanh Phommavong, a laboratory technician
- Ms. Toy Keobundith, a laboratory technician
- Ms. Phimmasone Keovilay, a laboratory technician

1.3. Onsite water quality parameters analysis by team

- temperature of ambient water
- temperature
- humidity
- Dissolved oxygen (DO)
- Conductivity (EC)
- pH
- color, odor and test

1.4. Water quality parameters analysis in the Laboratory

- Cadmium (Cd)
- Asenic (As)
- Lead (Pb)
- Zinc (Zn)
- Copper (Cu)
- Ferrous (Fe)
- Hardness ($CaCO_3$)
- Cyanide (CN)
- Alkalinity
- Sulfide (S_2)
- Sulfate (SO_4)
- Phosphate (PO_4)
- T.Phosphate (P)
- Nitrite (NO_2)
- Nitrate (NO_3)
- Magnesum (Mg)
- COD
- BOD
- Ammonium (NH_4)
- Coliform
- Chlorine (Cl)

1.5. The process results and time spending of each analysis

Each time of water quality testing or analysis will be spent time in the maximum is 15 days (according to the proposed parameters of the analysis period), Department of Natural Resource will be issued the water quality certificate.

2. The Ground Water Sampling of Thakhek and Pakxan District

The existing dumpsite locates at Pakxan district was established in year 2007, of Thasommor village, Pakxan district, Borikhamxay Province. This existing dumpsite is managed by Urban Development Authorities Agency which it locates far from the Town around 9 kilometers. The total dumpsite area is around 9.6 hectars and it has used for waste dumped area around 1.8 hectares, every day the dumped waste's quantity is around 5 kg/per person (or approximately 47 tons/per day) which it provided a service for the households in the town up to 1,495 households. This dumpsite area also has a separate waste for recycling process which it has different waste's types are plastic bottles, steel, iron and for the other waste that couldn't recycled then it will be dump into the pit and cover by soil.

The existing dumpsite locates at Thakhek district was established in year 1997, of Nadonh village, Thakhek district, Khammoun Province. This existing dumpsite is managed by Urban Development Authorities Agency (UDAA) and Sinnawat Company which it locates far from the Town around 9 kilometers. The total dumpsite area is around 95 hectars and it has used for waste dumped area around 2 hectares. This dumpsite area also has a separate waste for recycling process which it has different waste's types are plastic bottles, steel, iron and for the other waste that couldn't recycled then it will be dump into the pit and cover by soil.

On the date 18 Dec 2017, the water quality analysis team from DONRE has conducted the field visit in dumpsites of Pakxan and Thakhek Districts. This objective of the field visit was to conduct onsite ground water analysis and took the samples to the Laboratory analysis, in order to conduct some existing contaminated hazardous parameters that could results to the people's health by using this ground water for daily consumption or drinking, the process of taking samples will be done as followed below:

2.1. Field visit and taking the samples in the dumpsites

- Field survey and taking Ground water samples
- To observed the physical reaction such as the color, odors and taste of ground water quality
- To measure the ground water quality at the dumpsites by WTW 330i for pH, DO, EC, and temperature

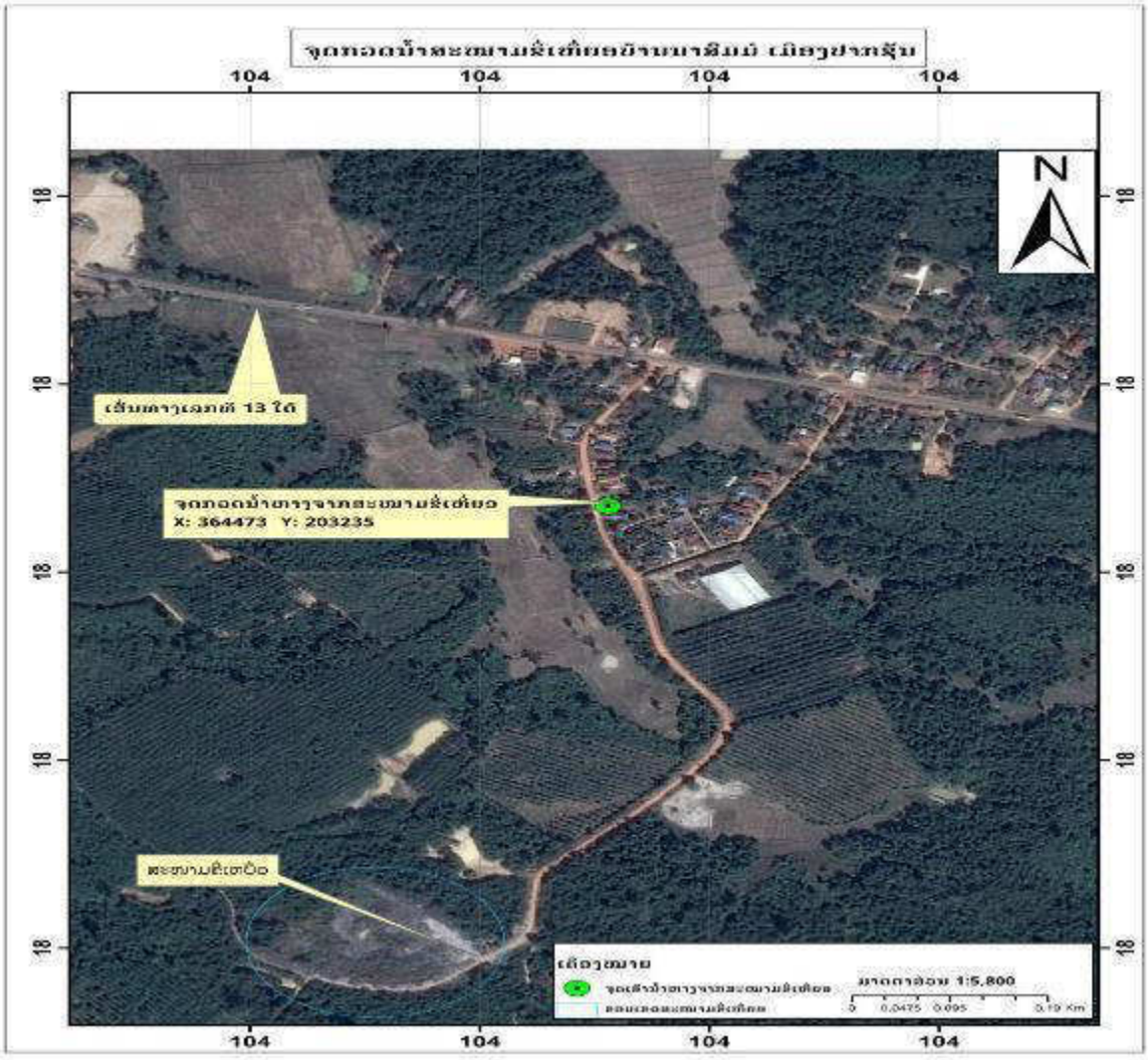
2.2. Ground water analysis in the Laboratory

The ground water samples divides to analysis into two Laboratories are included the laboratory of the Ministry of Natural Resource and Environments in Vientiane Capital and laboratory of the Department of Natural Resource and Environments in Borikhamxay Province. The ground water samples has analysis some parameters in the Laboratory of MONRE are include the TSS, Turbility, Mn, F, Total Coliform, E.Coli. For the Laboratory of DONRE in Borikhamxay has analysis some parameters which are included the Cu, Fe, Pb, Zn, Cd, As, Hardness ($CaCO_3$), Cl, NO_3, CN, COD, SO_4 which are analysis by the equipment of the Spectroquat ® prove 300.

II. Location of the Ground Water Sampling

- Dumpsite at Pakxan district, Borikhamxay Province
- Depth of ground water is around 7 meters
- Location marked by the GPS X: 364473
  Y: 203235

Figure 1: Location of the Ground Water Sampling



- Dumpsite at Thakhek district, Khammoun Province
- Depth of ground water is around 40 meters
- Location marked by the GPS X: 488173
  Y: 1918512

Figure 2: Dumpsite at Thakhek district, Khammoun Province

III. Results of Ground water analysis

Table 1: Parameters of Dumpsite at Pakxan

No	Parameters	Unit	Results	Standard values*
1	ກົດ ແລະ ດ່າງ (pH)	-	6.23	6.5 - 9
2	ອອກຊີເຈນລະລາຍໃນນ້ຳ (DO)	mg/l	0.01	6
3	ການຊັກນຳໄຟຟ້າ (Cond.)	µS/cm	27	<1000
4	ສີ (Color)	-	ໃສ or no color	-
5	ອຸນຫະພູມນ້ຳ (Water)	T^{oC}	25	-
6	ອຸນຫະພູມອາກາດ (Air)	T^{oC}	25.7	-
7	ທອງ (Cu)	mg/l	<0.1	1.5
8	ເຫຼັກ (Fe)	mg/l	0.13	1
9	ຊີນ (Pb)	mg/l	**0.5**	**0.01**
10	ສັງກະສີ) Zn)	mg/l	<0.20	5
11	ແຄັດເມຽມ (Cd)	mg/l	**<0.025**	**0.003**
12	ອາເຊນິກ (As)	mg/l	**0.073**	**0.01**
13	ຄວາມກະດ້າງຂອງນ້ຳ (Hardness)	mg/l	<5	500
14	ຄຼໍໄຣ (Cl_2)	mg/l	0.09	600

15	ไນເຕຣດ (NO_3)	mg/l	21.4	45
16	ໄຊຢາໄນທ໌ (CN^-)	mg/l	<0.05	0.07
17	COD	mg/l	45	150
18	ຊັນເຟດ (SO_4)	mg/l	50	250
19	ແອມໂມເນຍ (NH_3)	mg/l	<0.05	1.5
20	TSS	mg/l	0.83	1,200
21	ຄວາມຂຸ່ນ (Turbidity)	NTU	-	20
22	ມັງການີສ (Mn)	mg/l	0.002	0.5
23	ຟຼູອໍໄຣ (F)	mg/l	0.07	1
24	Total Coliform	MPN/100 ml	>100	**2.2**
25	E.Coli (Faecal Coliform – T44)	-	7	**None**

Note * :National Environmental Standard value according to the National standard Number 81/GOL, date 21 Feb 2017.

Table 2: Parameters of Dumpsite at Thakhek

No	Parameters	Unit	Results	Standard values*
1	ກົດ ແລະ ດ່າງ (pH)	-	8.26	6.5 - 9
2	ອອກຊີເຈນລະລາຍໃນນ້ຳ)DO)	mg/l	0.21	6
3	ການຊັກນຳໄຟຟ້າ (Cond.)	µS/cm	751	<1000
4	ສີ (Color)	-	ໃສ	-
5	ອຸນຫະພູມນ້ຳ (Water)	T^{oC}	25.6	-
6	ອຸນຫະພູມອາກາດ (Air)	T^{oC}	12	-
7	ທອງ (Cu)	mg/l	<0.1	1.5
8	ເຫຼັກ (Fe)	mg/l	<0.1	1
9	ຊີນ (Pb)	mg/l	**0.49**	**0.01**
10	ສັງກະສີ) Zn)	mg/l	<0.20	5
11	ແຄັດເມຽມ (Cd)	mg/l	**<0.025**	**0.003**
12	ອາເຊນິກ (As)	mg/l	**0.063**	**0.01**
13	ຄວາມກະດ້າງຂອງນ້ຳ (Hardness)	mg/l	<5	500
14	ຄຼໍໄຣ (Cl_2)	mg/l	0.03	600
15	ໄນເຕຣດ (NO_3)	mg/l	**66**	**45**
16	ໄຊຢາໄນທ໌ (CN^-)	mg/l	<0.05	0.07
17	COD	mg/l	114	150
18	ຊັນເຟດ (SO_4)	mg/l	80	250
19	ແອມໂມເນຍ (NH_3)	mg/l	<0.05	1.5
20	TSS	mg/l	0.5	1,200
21	ຄວາມຂຸ່ນ (Turbidity)	NTU	-	20
22	ມັງການີສ (Mn)	mg/l	0.002	0.5
23	ຟຼູອໍໄຣ (F)	mg/l	0.07	1
24	Total Coliform	MPN/100 ml	**59**	**2.2**
25	E.Coli (Faecal Coliform – T44)	-	**6**	**None**

Note * :National Environmental Standard value according to the National standard Number 81/GOL, date 21 Feb 2017.

IV. Results and Conclusion

The results of ground water analysis from two dumpsites of Pakxan and Thakhek districts which conducted the contaminated of hard heavy metals in the ground water quality, which is identified as the hard heavy metals parameters are exceeded the limitation of National Environmental Standard Value, 2017:

The dumpsite of Pakxan District, Borikhamxay Province, the ground water quality analysis results could conduct that the Dissolve Oxygen is lower than the standard value due to during the taking sample for onsite analysis by the small tube therefore, there is limited of oxygen of the ground water sample. The Cd, Pb , As, Coliform and E.Coli values are exceed the National Environmental Standard Value, 2017*.

The dumpsite of Thakhek District, Kammoun Province, the ground water quality analysis results could conduct that the Dissolve Oxygen is lower than the standard value due to during the taking sample for onsite analysis by the small tube- sampling therefore, there is limitation of oxygen of the ground water sample. These parameters including the $\mathrm{Nitrate\ (NO_3)}$, Lead (Pb), Arsenic (As), Cadmium (Cd), Coliform and (E.Coli) values are exceed the National Environmental Standard Value, 2017.the accumulated the exceeded parameters ($\mathrm{Nitrate\ (NO_3)}$, lead (Pb), As, Cadmium (Cd) ,Coliform and E.Coli values) will be raised the health impacts such a diarrhea, problem with their breath issue, vomits, impact to the brain, their health will be weak, there will have a cancer of lungs and skin, having spots of their skin, dangerous of baby in pregnancy.

The conclusion, for the two groundwater quality of dump site areas are contaminated with the heavy metal parameters in ground water quality. Therefore, if the community or village who lives close to these dump sites area of Pakxan and Thakhek districts consumes those ground water quality will have a potential the heath issues. The clean ground water or treated ground water (ground water quality is acceptable from the standard's value) for their consumed is necessary and to avoid their health issues may raised in the futures. The accumulated the heavy metal parameters to their health and raised the health issues problems.

I. Weak and good point of the field works

1. Good points

- Good cooperate with the related government sectors.
- Good Access to the ground water site

2. Weak points

- Time of site visit and sampling is limited

Photos during the field survey work

Location of sampling GWQ at Dumpsite at Thakhek District, Khammoun Province

Location of sampling GWQ at Dumpsite at Pakxan District, Borikhamxay Province

Note: during taking samples do not wear gloves because the GW sample goes straight inside the bottle sample directly by tube of pumping.

Photos of Laboratory's equipment for GW analysis

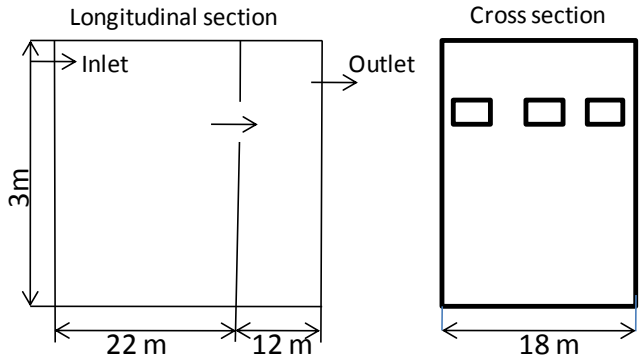
Photos during analysis samples

CALCULATING DIMENSION OF THE DEWATS FOR PAKXAN SUBPROJECT

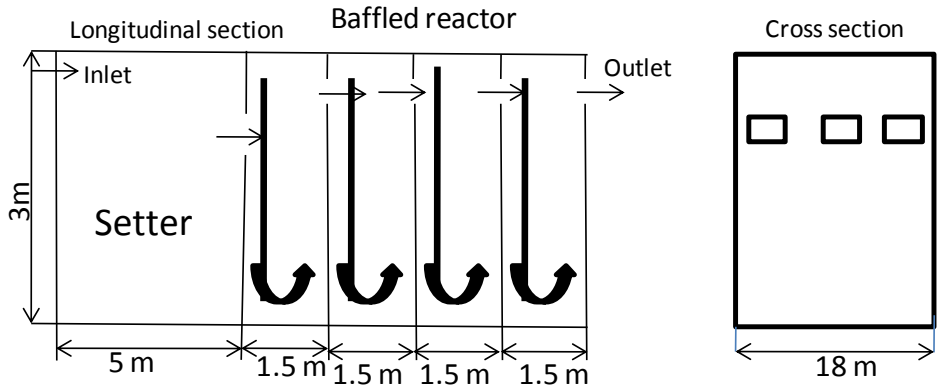
Source: Appendices E and F – Technical Annex_v9. Updated 4 May 2018. PPTA Engineering Team

1) DEWATS: 1000m^3/d

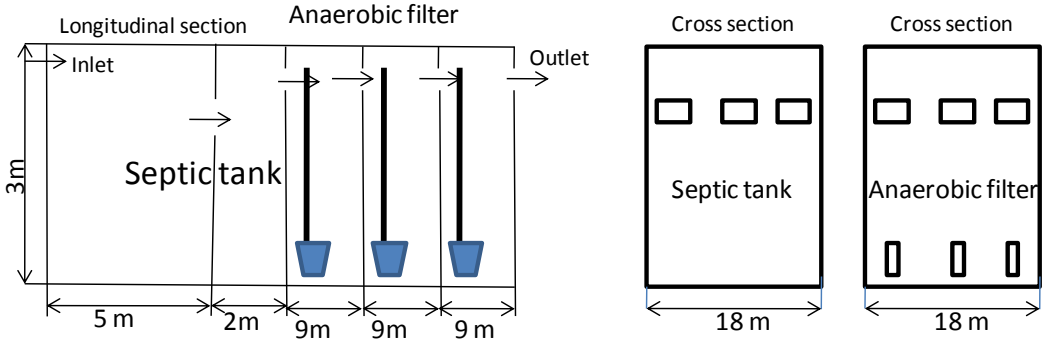
a) Septic tank



b) Anaerobic baffled reactor dimensions

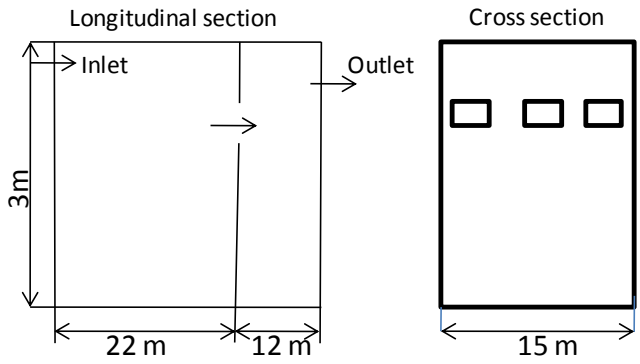


c) Anaerobic filter dimension

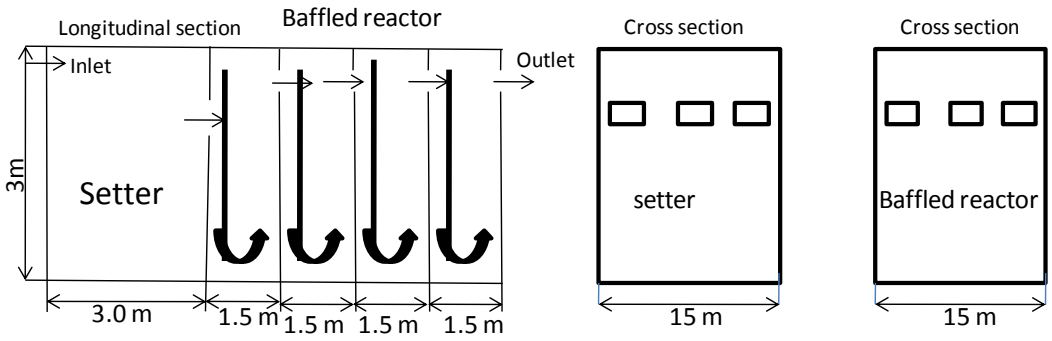


2) DEWATS : 500 m3/d

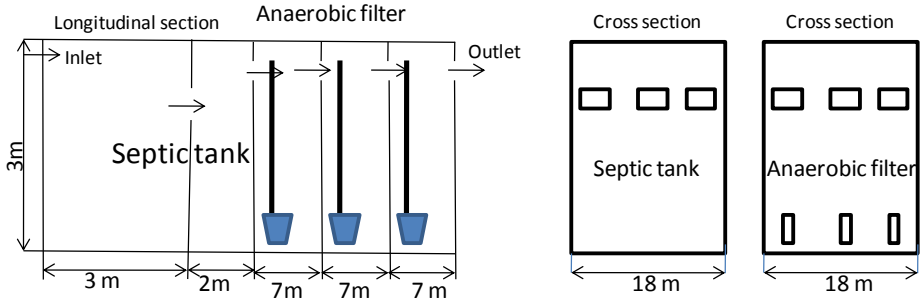
a) Septic tank



b) Anaerobic baffled reactor dimensions

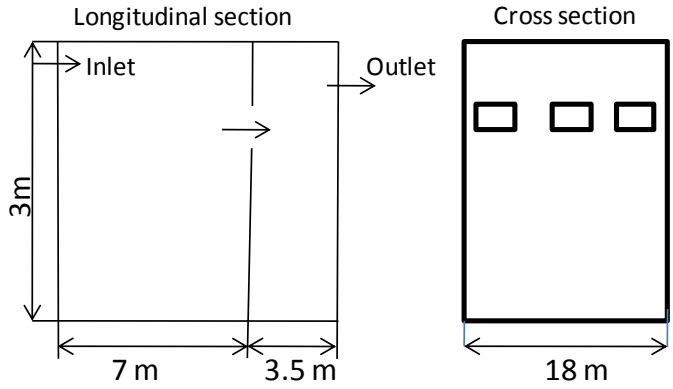


c) Anaerobic filter dimension

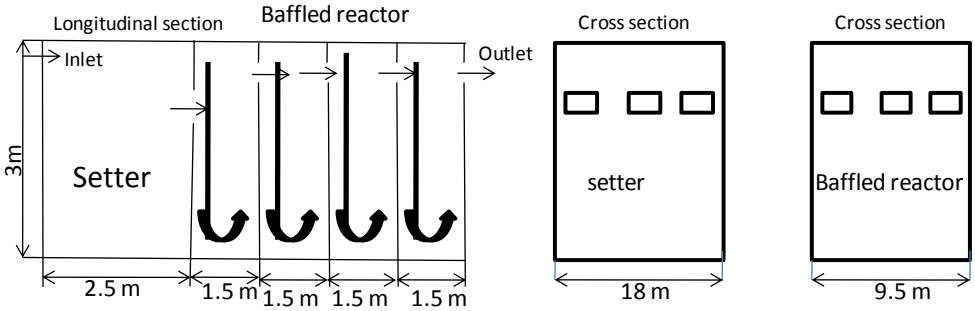


3) DEWATS: 300 m3/d

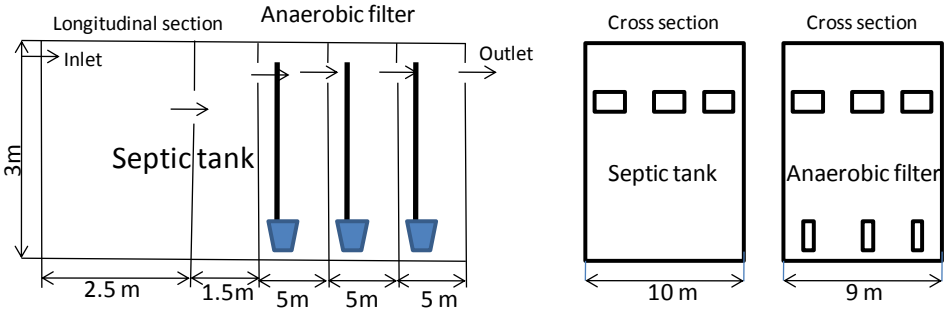
a) Septic tank



b) Anaerobic baffled reactor dimensions

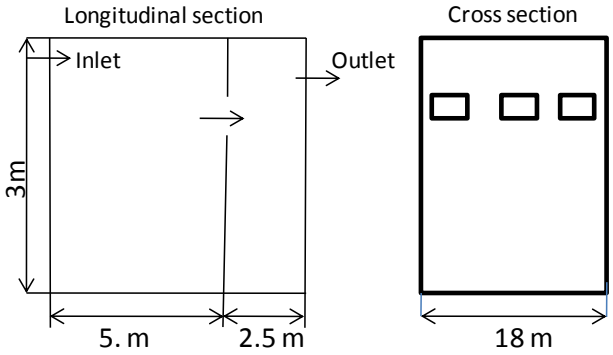


c) Anaerobic filter dimension

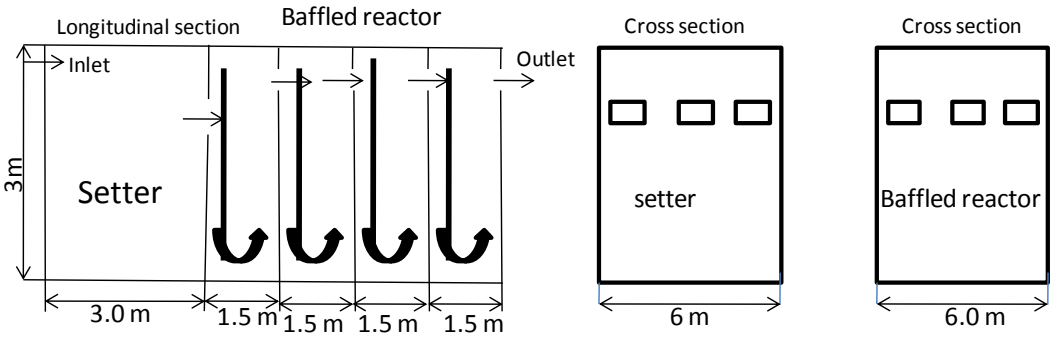


4) DEWATS: 200 m3/d

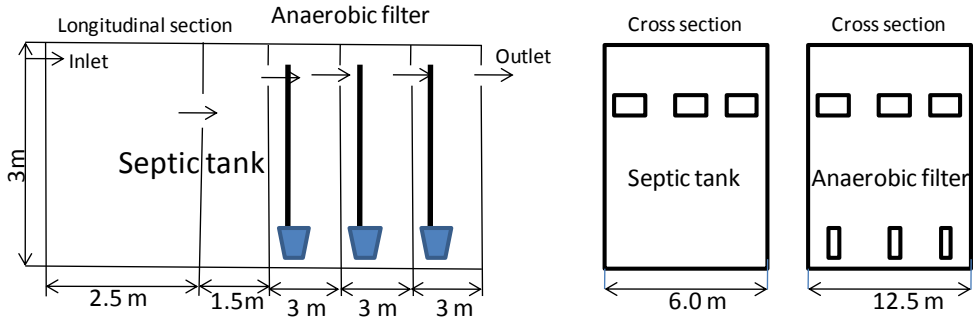
a) Septic tank



b) Anaerobic baffled reactor dimensions



c) Anaerobic filter dimension



Range:

BOD5/user: 40-65

Water consuption per user: 50-300 Litres/day. Chosen: 165 l/d

II) **Urban area with daily wastewater flow of 1000 m3/d**

1) Spreadsheet for calculating septic tank dimensions

General spreadsheet for septic tank, input and treatment data

	daily waste water flow	time of most waste water flow	max. flow at peak hours	COD inflow	BOD5 inflow	HRT inside tank	settleable SS/COD ratio	COD removal rate	COD outflow	BOD5 outflow
	m^3/day	h	m^3/h	mg/l	mg/l	h	mg/l	%	mg/l	mg/l
	1000	12	83	633	333	18	0.42	0.46	343	171
Range:						12-24 h	0.35-0.42			

Dimension of septic tank

	desludging interval	inner width of septic tank	min. water depth at outlet point	inner length of first chambe		length of second chamber		volume incl. sludge	actual volume of septic tank	biogas 70% CH4 50% dis solved
	chosen	chosen	chosen	requir.	chosen	requir.	chosen	requir.	check	calcul.
	months	m	m	m	m	m	m	m^3	m^3	m^3/d
	12.0	18.0	3.0	22.5	22.0	11.3	12.00	1823.8	1836.0	72.5

2) Spreadsheet for the calculation of anaerobic baffled reactor dimensions

General spreadsheet for Anaerobic baffled reactor (ABR) with integrated setter

daily waste water flow	time of most waste water flow	max. peak flow per hour	COD inflow	BOD5 inflow	COD/BOD ratio	settleable SS / COD ratio	lowest digester temperature	de sludging interval	HRT in settler (no settler HRT=0)	COD removal rate in settler
m³/day	h	m³/h	mg/l	mg/l	ratio	mg/l	°C	months	h	%
1000	12	83	633	333	1.9	0.42	25	12	1.5	23

Treatment data

BOD5 removal rate in settler	inflow into baffl ed reactor		COD/ BOD5 ratio after settler	factors to calculate COD removal rate of anaerobic filter			COD rem. 25°, COD 1500	theor. rem. rate acc. to factors	COD rem. rate baffl e onl	COD out
	COD	BOD5								
%	mg/l	mg/l	mg/l	f overload	f strenght	f temp	f HRT %	%	%	mg/l
24	489	253	1.94	1.00	0.91	1.00	87.00	79.00	81.00	93
1.06	←	COD/BOD Rremoval facor					COD/BOD Rremoval facor =			1.025

Dimensions of setter

total COD removal rate	total BOD5 removal rate	BOD5 out	inner masonry measurements chosen acc. to required volume		sludge accum. rate	length of settler	length of settler	ABR: max. upflow velocity	ABR: number of upflow chambers	depth at outlet
			width	depth		Calcul	chosen			
%	%	mg/l	m	m	l/g COD	m	m	m/h	No.	m
87.00	89	36	18	2.9	0.0042	4.7	3.0	1.6	5	3.0
Range								1.4-2 m/h		

Dimension of ABR

length of chambers should not exceed half dept		area of single upflow chamber	width of chambers		actual upflow velocity	width of downflow shaft	actual volume of baffled reactor	actual total HRT	org. load (BOD5)	biogas (ass: CH4 70% 50% dissolved)
calcul.	chosen	calcul.	calcul.	chosen	calcul.	chosen	calcul.	calcul.	calcul.	calcul.
m	m	m²	m	m	m/h	m	m³	h	kg/m³*d	m³/d
1.5	1.5	46.3	30.9	18.0	3.1	1.2	729.0	18.4	1.3	335.0

3) **Spreadsheet for calculating aerobic filter dimension**

HRT inside AF: range 24-48h; Chosen: 24 h
Disludging interval: chosen: 36 months
Specific surface of filter medium: 80-120
Voids in filter mass: 30-45%

General spreadsheet for anaerobic filter (AF) with integrated septic tank (ST)

daily waste water flow	time of most waste water flow	max. peak flow per hour	COD inflow	BOD5 inflow	SS settl./ COD ratio	lowest digester temperature	HRT in septic tank	de sludging interval	COD removal septic tank	BOD5 removal septic tank	BOD/ COD removal factor
given	given	calcul.	given	given	given	given	chosen	chosen	calcul.	calcul.	calcul.
m³/day	h	m³/h	mg/l	mg/l	mg/l	°C	h	month	%	%	ratio
1000	12	83	633	333	0.42	25	2	36	35	37	1.06

Treatment data

COD inflow in AF	BOD5 inflow into AF	specific surface of filter medium	voids in filter mass	HRT inside AF react	factors to calculate COD-removal rate of anaerobic filter				COD removal rate (AF only)	COD outflow of AF	COD removal rate of total system
calcul.	calcul.	given	given	chosen	calculated according to graphs				calcul.	calcul.	calcul.
mg/l	mg/l	m²/m³	%	h	f-temp	f-strength	f-surface	f-HRT	%	mg/l	%
411	209	100	35	24	1.00	0.91	1.00	0.60	70	123	81

Dimension of septic tank

BOD/ COD removal factor	BOD5 rem. rate of total system	BOD5 outflow of AF	inner width of septic tank	min. water depth at inlet point	inner length of first chamber		length of second chamber		sludge accum.	volume incl. sludge	actual volume of septic tank
calcul.	calcul.	calcul.	chosen	chosen	calcul.	chosen	calcul.	chosen	calcul.	requir.	calcul.
ratio	%	mg/l	m	m	m	m	m	m	l/kg BOD	m³	m³
1.1	86	139	18	2.9	4.26	5.00	2.13	2.00	0.0	333	365

Dimension of aerobic filter

volume of filter tanks	depth of filtertanks	length of each tank	number of filter tanks	width of filter tanks	space below perforated slabs	filter high (top 40cm below water level)	Biogas production: out of septic tank	Biogas production: out of anaerobic filter	Biogas production: total	Check: org. load on filter volume COD	Check: max. up-flow velocity inside filter voids
calcul.	chosen	calcul.	chosen	requir.	chosen	calcul.	assump.: 70% CH4, 50% dissolved			calcul.	calcul.
m³	m	m	No	m	m	m	m³/d	m³/d	m³/d	kg/m³*d	m/h
1000	2.9	9.0	3	18	1.10	1.4	55	72	127	1.93	1.5
Range										< 4.5	< 2

ESTIMATING GHG EMISSIONS OF PAKXAN CONTROLLED LANDFILL

Source: Annex B, Climate Risk and Vulnerability Assessment, Lao PDR: Fourth Greater Mekong Subregion Corridor Towns Development Project

A. Controlled Landfill

The tool used was "Estimation Tool for Greenhouse Gas (GHG) Emissions from Municipal Solid Waste (MSW) Management is Life Cycle Perspective". Nirmala Menikpura. Janya Sang-Arun. Institute for Global Environmental Strategies (IGES).

Inputted data:

	Pakxan	Remarks
Solid waste generated (tonnes per month)	790	Per Engr's report, all 3 cells may be used up even before 2035. Hence, used the average of MSW generated per month in 2034 and 2035.
Collection vehicle capacity (m3)	15	
Diesel consumption per trip including collection	8.4L round	
Diesel consumption of landfill equipment, per month	25% of that of collection truck	
Waste composition	(See Table 1)	
Recyclable at the landfill	(See Table 2)	

Table 1. Adopted Waste Composition

Please enter the compostion of landfilling waste

Component	Percentage (%)
Food waste	24.00
Garden waste	26.00
Plastics	13.60
Paper	5.20
Textile	1.30
Leather/rubber	1.70
Glass	11.30
Metal	3.50
Hazardous waste	0.00
Others	13.40
Total	**100.00**

Source: Solid Waste Management Solid Waste Management in Laos.
A power point presentation by:
Mr Thevarack Phonekeo
Director
Socio- Environment Division. National Secretariat for GMS.
Water Resources and Environment Administration (WREA)
Mr. Phouthasom Inthavong
Deputy Head
Urban Development Division Department of Housing and Urban Planning
Ministry of Public Works and Transport (MPWT)
https://www.iges.or.jp/en/archive/wmr/pdf/activity100728/5_Lao_Day1_Session2.pdf

Table 2. Composition of Recyclables at Dumpsite*

Type of recyclable	Percentage (%)
Paper	15.58
Plastic	74.13
Aluminium	1.90
Steel	0.00
Glass	8.40
Total	**100.00**

*Based on: Composition of Municipal Solid Waste at Dumpsite
Source: Waste Management and Activities of Cambodia in the Application of Basel Convention.
A PPt presentation prepared by:
Mr. Chin Sothun
Department of Environmental Pollution Control, MOE, Cambodia.
Workshop 2010 of Asian Network of Prevention of Illegal Transboundary Movement of Hazardous Waste. 29 November-02 December 2010.
Allson Paradise Angkor Hotel, Siem Reap, Cambodia.

Results: GHG Emissions from Controlled Landfill Operations

Pakxan

Activity	Direct GHG Emissions	Indirect GHG Savings	Net GHG Emissions	Unit
Transportation	1.51	0.00	1.51	kg of CO2-eq/tonne of waste
Landfilling of mix MSW	666.30	0.00	666.30	kg of CO2-eq/tonne of mix waste
Composting	0.00	0.00	0.00	kg of CO2-eq/tonne of organic waste
Anaerobic digestion	0.00	0.00	0.00	kg of CO2-eq/tonne of organic waste
Mechanical Biological Treatment (MBT)	0.00	0.00	0.00	kg of CO2-eq/tonne of waste
Recycling	1844.79	2252.79	-408.00	kg of CO2-eq/tonne of mixed recyclables
Incineration	0.00	0.00	0.00	kg of CO2-eq/tonne of incinerated waste
Open burning	0.00	0.00	0.00	kg of CO2-eq/tonne of open burned waste
GHG emission from whole system	**881.51**	**408.51**	**473.00**	**kg of CO2-eq/tonne of collected waste**
Total GHG emissions per month	**850,113.07**	**394,080.24**	**456,032.84**	**kg of CO2-eq/monthly managed waste**

Climate Mitigation Calculations

Results: Simulation of GHG Emissions from Controlled Landfill Operations With Mitigation Measures in Place

Mitigation Measures:

- Waste to be collected is reduced by 15% due to active recycling at source.
- Waste collection frequency is every other day except for market waste.
- Composting of about 20% of the waste collected at the landfill site

Pakxan

Activity	Direct GHG Emissions	Indirect GHG Savings	Net GHG Emissions	Unit
Transportation	1.51	0.00	1.51	kg of CO2-eq/tonne of waste
Landfilling of mix MSW	666.30	0.00	666.30	kg of CO2-eq/tonne of mix waste
Composting	177.00	892.50	-715.50	kg of CO2-eq/tonne of organic waste
Anaerobic digestion	0.00	0.00	0.00	kg of CO2-eq/tonne of organic waste
Mechanical Biological Treatment (MBT)	0.00	0.00	0.00	kg of CO2-eq/tonne of waste
Recycling	1844.79	2252.79	-408.00	kg of CO2-eq/tonne of mixed recyclables
Incineration	0.00	0.00	0.00	kg of CO2-eq/tonne of incinerated waste
Open burning	0.00	0.00	0.00	kg of CO2-eq/tonne of open burned waste
GHG emission from whole system	**782.60**	**476.60**	**306.00**	**kg of CO2-eq/tonne of collected waste**
Total GHG emissions per month	**439,173.86**	**267,609.99**	**171,563.86**	**kg of CO2-eq/monthly managed waste**

DOCUMENTATION OF STAKEHOLDER CONSULTATION

A. Public Dissemination Meeting and Consultation

Venue: Meeting Room of Department of Public Work and Transport, Borikhamxay Province

Date/Time	Organization/s	Attendees	Highlights
27Apr2018	District Government, DPWT, UDAA, DONRE, affected villages and HHs	• Mr. Somchith Phomsavath, Deputy of District Governor • Mr. Bounpheng Mahavong , a deputy of DONRE in Borikhamxay Province. • Mr.Thonglit Fongsinoun, a head of DPWT of Borikhamxay. • Mrs. Matikha , a representative from UDAA . • Participants from affected villages (See complete list in the Attendance Sheets below.)	• Objectives of the meeting: o to present the results of the IEE and Resettlement Plan; and o to solicit feedback on the results from the participants. • Agreements made by participants after the presentation, discussion and comments: o Approval of compensation to affected persons (APs) shall follow the procedure of law, such as: When the project is approved, there shall be a committee to take responsibility for each section, especially to prepare the draft of agreed document by APs. Then, it is proposed to the National Assembly for approval. o Regarding the waste pickers at the existing dumpsite. During construction, they can continue to recover recyclables. They have requested the project to provide the safeguard measures management plan for them during landfill construction. After construction, they will be the first priority group to be considered for formal employment in the recycling activity at the controlled landfill. o To assign the DPWT to endorse to DONRE the approval of the summary plan of IEE and Resettlement Plan (RP), and Policy Framework and Entitlement Matrix. o In case a DEWATS network will affect HH asset/s, a detailed survey and consultation/s with stakeholders should be conducted during design to conclude if the case would require/involve compensation or not. o Regarding the groundwater in the area surrounding the landfill site, it is agreed that the Head of Nasommo Village shall inform the villagers not to drink the water from well, based on the groundwater analysis conducted by the DONRE Pakxan for the IEE.

GMS4

FORM NO. 1A

1

ໂຄງການພັດທະນາຕົວເມືອງຕາມແລວເສດຖະກິດອານຸພາກພື້ນແມ່ນ້ຳຂອງສີ່

TA-9192 REG: Fourth Greater Mekong Subregion Corridor Towns Development Project(GMS4)

ຊື່ຫ້ອງການໂຄງການຂັ້ນແຂວງ: ຫ້ອງການປະສານງານໂຄງການພັດທະນາຕົວເມືອງຕາມແລວທາງອະນຸພາກພື້ນແມ່ນ້ຳຂອງ4, ເມືອງ:..........................

ກອງປະຊຸມ: ເຜີຍແຜ່ ຂໍ້ມູນ ຜົນການສຶກສາ

ການປົກປັກຮັກສາ ສິ່ງແວດລ້ອມ ແລະ ການປົກປ້ອງສັງຄົມ-ການຍົກຍ້າຍສິ່ງກີດຂວາງ

ຂອງໂຄງການພັດທະນາຕົວເມືອງ, ເມືອງ: ປາກຊັນ

1027 8:30- 12:00

ວັນທີ 27- 4. 2018

ສະຖານທີ່ ພະແນກ ຍທຂ ແຂວງບໍລິຄຳໄຊ

ລ/ດ	ຊື່ ແລະ ນາມສະກຸນ	ເພດ (ຍິງ/ ຊາຍ)	ພາກສ່ວນ (ຫ້ອງການ)	ຕຳແໜ່ງ	ເບີໂທ	ລາຍເຊັນ
1	2	3	4	5	6	7
1	[illegible]	ຊ	[illegible]	[illegible]	22822288	[signature]
2	[illegible]	ຊ	[illegible]	[illegible]	22228045	[signature]
3	[illegible]	ຊ	[illegible]	[illegible]	22215361	[signature]
4	[illegible]	ຍ	[illegible]	ຮອງປະທານ	28518070	[signature]
5	[illegible]	ຊ	[illegible]	[illegible]	98876666	[signature]
6	[illegible]	ຊ	[illegible]	[illegible]	55693634	[signature]
7	[illegible]	ຊ	[illegible]	[illegible]	22822751	[signature]
8	[illegible]	ຍ	[illegible]	[illegible]	22237779	[signature]
9	[illegible]	ຍ	[illegible]	[illegible]	22016988	[signature]
10	[illegible]	ຊ	[illegible]	[illegible]	22453730	[signature]
11	[illegible]	ຍ	[illegible]	[illegible]	0309954152.	[signature]
12	[illegible]	ຊ	[illegible]	[illegible]	56544615	[signature]
13	[illegible]	ຊ	[illegible]	[illegible]	55570058	[signature]
14	[illegible]	ຊ	[illegible]	[illegible]	23402109	[signature]
15	[illegible]	ຊ.	[illegible]	[illegible]	22101703.	[signature]
16	[illegible]	ຊ	[illegible]	[illegible]	030449108	[signature]

GMS4

FORM NO. 1A 2

ໂຄງການພັດທະນາຕົວເມືອງຕາມແລວເສດຖະກິດອານຸພາກພື້ນແມ່ນ້ຳຂອງສີ່

TA-9192 REG: Fourth Greater Mekong Subregion Corridor Towns Development Project(GMS4)

ຊື່ຫ້ອງການໂຄງການຂັ້ນແຂວງ: ຫ້ອງການປະສານງານໂຄງການພັດທະນາຕົວເມືອງຕາມແລວທາງອະນຸພາກພື້ນແມ່ນ້ຳຂອງ4, ເມືອງ:...........................

ກອງປະຊຸມ: ເຜີຍແຜ່ ຂໍ້ມູນ ຜົນການສຶກສາ

ການປົກປັກຮັກສາ ສິ່ງແວດລ້ອມ ແລະ ການປົກປ້ອງສັງຄົມ-ການຍົກຍ້າຍສິ່ງກີດຂວາງ

ຂອງໂຄງການພັດທະນາຕົວເມືອງ, ເມືອງ: ປາກ ຊັນ

ສະຖານທີ່ ຫ້ອງປະຊຸມ ຍທຂ ແຂວງ ບໍລິຄຳໄຊ

ວັນທີ 29.4.2019

ລ/ດ	ຊື່ ແລະ ນາມສະກຸນ	ເພດ (ຍິງ/ ຊາຍ)	ພາກສ່ວນ (ຫ້ອງການ)	ຕຳແໜ່ງ	ເບີໂທ	ລາຍເຊັນ
1	2	3	4	5	6	7
1	ທ. [illegible]	ຊາຍ	[illegible]	[illegible]	55450245	
2	ທ. [illegible]	ຊາຍ	[illegible]	[illegible]	55100401	
3	ນ. [illegible]					
4	ທ. [illegible]	ຊາຍ	ຍທຂ ແຂວງ	[illegible]	28262743	
5	ນ [illegible]	ຍິງ	—	—	99726951	
6	ນ [illegible]	ຍິງ	—	—	22332282	
7						
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TERMS OF REFERENCE OF INTERNATIONAL AND NATIONAL ENVIRONMENTAL SPECIALISTS OF THE PROJECT IMPLEMENTATION CONSULTANT

REG: Fourth Greater Mekong Subregion Corridor Towns Development Project

The Environmental Specialists (ES) will provide technical assistance and support to the Project Coordination Unit (PCU), Project Implementation Units (PIUs) and the Public Works and Transport Research Institute (PTRI) in environmental safeguard policy compliance and conduct and/or facilitate capacity building in project/subproject environmental management. He/she will ensure that while performing his/her tasks, capacity building in environmental management is carried out. Capacity building will be highly focused in training the PCU, particularly its Environmental Safeguard Officer (ESO) and the environmental focal points in the PIUs as well as staff of the PITR.

A. International Environment Specialist (4 person-months)

- Provide technical assistance and support to the PCU in incorporating relevant mitigation measures in the detailed designs.
- Finalize the capacity building plan based on the preliminary activities outlined by the PPTA Team in collaboration with PCU, PIUs, and PTRI.
- At the onset of DED, in collaboration with the MONRE/DONRE, conduct an orientation on the: (i) Environmental Protection Law 2012 (No. 29/NA) and relevant associated ministerial agreements and guidelines; (ii) Safeguard Policy Statement (SPS) 2009 of the Asian Development Bank (ADB); (iii) ADB-cleared EMP to the PCU, PIUs, the Design Consultant and PTRI, including its implementation, monitoring, and reporting.
- Support the PCU and PIUs in establishing the mechanisms for EMP implementation, monitoring, reporting, conducting public consultations and information disclosure, and activating the grievance redress mechanism (GRM) at the project, subproject, town and village levels.
- Provide technical assistance to the PCU in complying with the country's environmental safeguard requirements to ensure no delay in the commencement of the construction phase resulting from delay in obtaining the required environmental clearance/permit from the MONRE/DONRE. This would include assistance in the: (i) drafting of the TOR for the conduct of ESIA/IEE for the subprojects in coordination with PTRI; (ii) ensuring the TOR for the controlled landfill ESIA/IEE includes the conduct of environmental studies required by MONRE/DONRE that are not covered in the scope of works of the Environmental Compliance Audit (ECA) of the existing dumpsite; and (ii) engagement of a firm that is nationally certified/registered to provide the ESIA/IEE services.
- Monitor compliance of the subprojects with the environmental assessment and clearance requirements of the MONRE/DONRE and that the Environmental Compliance Certificate (ECC) of each subproject is secured by MPWT prior to start of construction.
- Assist the PMU in preparing for procurement by ensuring that the Environmental Management Plan (EMP) is part of the tender documents and civil works contracts and that environmental criteria is included in the evaluation of bids.
- Contract third party environmental monitoring group/institutes for the conduct of baseline environmental surveys.
- Assist the PMU in ensuring that contractors prepare their respective contractor's EMP (CEMP) that complies with the requirements of ADB Safeguards Policy Statement (2009).
- Assist the PMU in institutionalizing and implementing the grievance redress mechanism, undertaking pre-construction environmental quality monitoring as recommended in the EMP, and reviewing and evaluating the CEMP to ensure that these are responsive to ADB SPS (2009).

- Coordinate with the MPWT/DPWT, DHUP, MONRE/DONRE, UDAA, PTRI, and other agencies on regulatory compliance issues that may affect or are affecting the subproject during implementation.
- Prepare the necessary status reports for compliance with the conditions set out in the approved ESIA/IEE reports.
- Assist the PMU and PTRI in the preparation of monthly report on status of implementation of EMP and monitoring plan for input to the PMU's monthly progress report.
- Assist the PMU and PTRI in the preparation of semi-annual environmental monitoring report to be submitted to ADB.

B. National Environment Specialist (20 person-months)

- Assist the International Environment Specialist, in designing and carrying out initial orientation to PCU and PIUs in environmental assessment and management, including the preparation of material and instruction in the Lao language.
- Visit each subproject town and provide guidance on the updating of the IEE/EMP, in based on the detailed design.
- Coordinate with the consultants who will conduct the Environmental Compliance Audit (ECA) of the existing dumpsites and ensure that environmental sampling and meaningful public consultations are conducted and relevant issues are identified and assessed into the corrective action plan.
- Coordinate with the social and resettlement specialists on stakeholder consultations related to environment aspects and/or responses to grievances through the grievance redress mechanism.
- Assist with preparation and review of IEEs/EMPs and coordinate with PIUs for any further investigations or reporting that may be necessary.
- Provide inputs to bidding and construction supervision team, design engineer and procurement specialist to ensure that EMPs are integrated in contract and bidding documents.
- Monitor compliance of the subprojects with the environmental assessment and clearance requirements of the MONRE/DONRE and that the Environmental Compliance Certificate (ECC) of each subproject is secured by MPWT prior to start of construction.
- Work with the PMU, PIUs and PTRI to ensure EMP implementation monitoring is included within the overall project monitoring progress reports.
- Provide inputs to progress reports, environmental monitoring reports and project completion report.
- Visit subproject towns during construction and provide guidance on supervision and compliance monitoring, advise PIUs of any actions required to ensure EMP compliance.
- Visit subproject towns where construction has been completed and assist with establishing environmental monitoring procedures for the operation phase of the subprojects.
- Review, revise and update the EMPs for each subproject.

Qualifications:

The Environmental Safeguard Specialists shall meet the following minimum qualification requirements:

A. International Environment Specialist

- Master's degree in environmental science/engineering or equivalent;
- 10 years of professional experience in environmental impact assessment, and in managing the environmental performance including environmental monitoring and

environmentally responsible procurement, of infrastructure projects for basic urban services; and
- 10 years of relevant experience in Southeast Asia, preferably in the Mekong Region.

B. National Environment Specialist

- Master's degree in environmental science/engineering or equivalent;
- 5 years of professional experience in environmental impact assessment and in managing the environmental performance including environmental monitoring, of donor-financed urban infrastructure projects in Lao PDR; and
- a good command of written and spoken English and experienced in preparing reports in English and Lao.

Duration of Assignment:

The duration of assignment will be: (i) 4 person-months for the International ES; and (ii) 20 person-months for the national ES – spread over 5 years.