Initial Environmental Examination

June 2017

Cambodia: Provincial Water Supply and Sanitation Project
Wastewater Subprojects

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

CURRENCY EQUIVALENTS

(as of 15 June 2017)

Currency unit	–	riel (KR)
KR1.00	=	$0.000245
$1.00	=	KR4,087.00

ABBREVIATIONS

ADB	-	Asian Development Bank
AHs		affected households
BB	-	Battambang
CEMO	-	construction environmental monitoring officer
CEMP	-	contractors' environmental management plan
CLAC	-	commune land acquisition committee
DEIA	-	Department of Environmental Impact Assessment
DMS	-	detailed measurement survey
DPWT	-	Provincial Department of Public Works and Transport
EA	-	executing agency
EMP	-	Environmental Management Plan
ES	-	environment specialist
GDR	-	General Department of Resettlement
GRM	-	grievance redress mechanism
GRP	-	glass reinforced plastic
HHs		households
IA	-	implementing agency
IEE	-	initial environmental examination
IMO	-	independent monitoring organization
IRC	-	Inter-Ministerial Resettlement Committee
MoE	-	Ministry of Environment
MOWRAM	-	Ministry of Water Resources and Meteorology
MPW/100ml	-	most probable number (of bacteria) per 100 millilitres of water
NAPA	-	National Action Programme of Action (for climate change)
O&M	-	operation and maintenance
PIH	-	Provincial Department of Industry and Handicrafts
POE	-	Provincial Department of Environment
PGRC	-	provincial grievance redress committee
PIAC	-	project implementation assistance consultants
PIU	-	project implementation unit
PSMO	-	project safeguards management officer
PMU	-	project management unit
RGC	-	Royal Government of Cambodia
RWG	-	resettlement working group
WWTP	-	wastewater treatment plant

NOTE

In this report, "$" refers to US dollars.

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EXECUTIVE SUMMARY

1.1 Introduction

1. The Provincial Water Supply and Sanitation Project (PWSSP) will build on the investment made for the Urban Water Supply Project (UWSP) to improve urban water supply services in provincial towns. The PWSSP is aligned with phase 3 of the government's rectangular strategy for growth, employment, equity, and efficiency, Cambodia's National Strategic Development Plan (NSDP) for 2014–2018. It will improve and expand urban water supply, wastewater and septage management services in the selected towns and comprises six subprojects, two of which are for water supply improvements and four of which are for the improvement of wastewater and septage treatment and conveyance.

2. This initial environmental examination (IEE) is prepared per Asian Development Bank's (ADB) Safeguard Policy Statement of June 2009 and the Royal Government of Cambodia (RGC) Law on Environmental Protection and Natural Resource Management (December 1996). It covers the four wastewater subprojects of PWSSP, in Battambang, Siem Reap, Sihanoukville and Kampong Cham, which are to be implemented by the Ministry of Public Works and Transport (MPWT).

1.2 Description of the Project

3. The PWSSP outputs are: (i) water supply systems improved and service coverage increased through the development of new water supply intakes and treatment facilities, replacement of old water mains, and expansion of the distribution network; (ii) septage management and sewerage services provided through the provision of septage collection and treatment and the development of expanded sewerage systems; and (iii) project implementation and operation and maintenance (O&M) developed to complement ongoing institutional development and capacity building in procurement, financial management, and governance.

1.3 Wastewater subprojects

4. **Battambang Wastewater subproject.** This subproject aims to extend and improve existing facilities in Battambang town to increase the capacities to handle projected sewerage loadings from the area for which service coverage is proposed up to 2025, containing the densely populated areas of the town centre to the west of the Sangké River, and most of the intermediately populated areas just outside the centre, to the year 2040. It is expected to directly benefit some 8,500 households (HHs), with 46,750 inhabitants who will be connected to the sewer.

5. Battambang currently has a 1,000m^3/day lagoon-based wastewater treatment plant (WWTP) that was constructed in 1994 which was intended to serve 15,000 people over 89ha of the core city area on the west side of the Sangké River. The treatment plant is still operating but is now limited to a capacity of 450m^3/day because of general degradation of the system. The sewerage network in the town center is at present combined with the stormwater system and consists of concrete pipes from 800mm to 1500mm in diameter, installed between the colonial period and recent years. The existing pipes flow in a north-westerly direction to discharge into rice fields and a flood plain near the proposed new wastewater treatment plant.

6. The subproject is divided into two phases where Phase 1 covers an area of about 415 ha to the west of the river, designed to collect wastewater up to the year 2040, covering three

densely populated sangkats.[1] Phase 2 is designed to collect wastewater from an extended area of four suburban communes further westward from the river as these communes develop, beyond 2025, again to year 2040. The subproject will comprise (i) decommissioning the existing 5.8 ha WWTP lagoon site, (ii) construction of a new wastewater treatment plant (WWTP) at a new location, immediately outside the city, (iii) installation of trunk sewers, (iv) construction of pump stations and (v) installation of smaller diameter collector pipelines in the secondary streets.

7. **Sihanoukville wastewater subproject**. This subproject will significantly expand wastewater services in the city by increasing the capacity of the existing lagoon based WWTP on the same land footprint, tripling the existing waste water treatment plant capacity. The waste water coverage will be extended to 5 new blocks incorporating the city centre and beach front areas. The subproject is expected to directly benefit over 10,000 HHs containing 46,217 inhabitants who will be connected to the sewer.

8. The existing lagoon wastewater treatment plant was constructed and commissioned in 2008 with a total capacity of 6,900m^3/day, of which 5,700m^3/day was for households (3,368 households) and 1,200m^3/day for industry. This design capacity came from projections to year 2010 only. The sewerage system currently serves the central part of the town with total area 321 ha.

9. The subproject aims to increase the capacity of the wastewater treatment plant, the coverage of the sewer network, including extension of trunk mains and local conveyance pipelines and the installation of pump stations in each sub-catchment of the extended service area. Improved septage disposal and treatment facilities will also be provided. it will comprise (i) trunk sewer expansion, (ii) increased capacity of the existing wastewater treatment plant (WWTP), (iii) sludge and septage management and (iv) installation of area pump stations.

10. Unplasticized polyvinyl chloride (uPVC) pipe is proposed for trunk sewers with a diameter of 400 mm or less and for the conveyance pipes of 100mm diameter or less that are to be installed along the roads within the proposed service areas. Glass reinforced plastic (GRP) or reinforced concrete pipe is proposed for all trunk sewers with a diameter greater than 400mm.

11. The upgraded wastewater treatment plant will require regular sampling of influent and effluent waters and periodical desludging of the anaerobic lagoons when they approach 50% depth of settled sludge. Concrete access ramps to the ponds, a compact mobile excavator and a dewatering container and sludge pumps will be provided for the purpose. A vacuum truck is also to be provided to Provincial Department of Public Works (DPWT). Dewatered sludge can be used as cover for the city's proposed landfill, which is due to be constructed in 2017.

12. **Kampong Cham subproject.** This subproject will provide septage facilities. The existing combined sewer system cover a limited part of the central area, handling both wastewater and stormwater and drains directly into the Mekong River. Most latrines use septic tanks, there are very few toilets connected to the sewer. This subproject will provide a new separate and self-contained septage receiving and treatment facility and associated equipment. The facility will have a receiving well, primary lagoons, maturation pond, dewatering container, sludge pumps

[1] A *sangkat* is an urban administrative division, referring to a part of a town or city, and equivalent to a village (*phum*) in rural areas.

and sludge drying bed as well as a mobile excavator. A vacuum truck is also to be provided to DPWT. The subproject would serve an estimated 36,031 people.

13. Kampong Cham currently has no wastewater collection system other than direct or indirect disposal to road drains by households and businesses or septage treatment facilities. Vacuum trucks dispose of the sludge from septic tanks in open fields, resulting in contamination of the fields.

14. The proposed site of the septage facility is a 5.2 area of largely scrub land in Phkay Proek village area, about 18 km outside Kampong Cham. The area has been allocated by the Provincial Governor. Existing land use is mainly degraded shrub land interspersed with some irrigated rice fields, and quarrying for building stone. However, the DPWT has expressed concerns about the distance of the site from the town and an effort is continuing to locate a suitable alternative site closer to Kampong Cham.

15. **Siem Reap subproject.** This subproject will replace and upgrade a 3.7km length of failed main trunk sewer. The opportunity is also being taken to upgrade the size of the pipe to accommodate increased future flows. The sewer was commissioned in 2010, is made of glass reinforced plastic (GRP) pipe and was designed and installed to collect wastewater from the center of Siem Reap over an area of 2.4km^2. At present the pipeline is not functioning, preventing wastewater in a central part of the town from reaching the wastewater treatment plant (WWTP) and causing it to back-up and be discharged over overflow weirs into the town drainage, until being finally released onto the lower lying land beyond the town. The sewer is to be replaced with a stronger pipe made of ductile iron, installed using trenchless technology. It will connect to a WWTP of capacity 2,776m^3/day, intended to serve only the central area of Siem Reap. The use of trenchless technology has been proposed following an examination of options, and provides a cost-effective solution that entails less disruption to traffic and business and less spoil than open trenching would generate during the construction period.

1.4 Policy Legal and Administrative Framework

16. National requirements for environmental management and assessment are set out in the Law on Environmental Protection and Natural Resource Management (December 1996), and the Sub-decree on Environmental Impact Assessment No. 72. ANRK.BK of August 1999. Article 6 of the Law on Environmental Protection and Natural Resource Management states that an environmental impact assessment (EIA) shall be prepared on every project and activity, private or public. A two-stage process is specified for environmental assessment, like that required by the ADB, whereby an Initial Environmental Impact Assessment (IEIA) is prepared for most projects. The IEIA may either suffice for environmental clearance, or form the basis for a more substantial EIA.

17. The primary responsibility for undertaking environmental assessment of projects lies with the Project Owner, the MPWT and the DPWT of the province where the project is to take place.

1.5 Description of the Environment

18. The project towns, except for Sihanoukville, are situated in the Tonlé Sap basin, on low lying land surrounding the Tonlé Sap great lake and its wetland periphery. Sihanoukville is on the coast, in the south west of the country, at the foot of the Cardamom Mountains. In both the Tonlé Sap basin and the coastal area, the main rock types are sedimentary with intrusions of igneous rhyolite. The country is underlain by the relatively stable continental block and earthquake risks are low. Soils around the Tonlé Sap basin include podzols and saturated

hydromorphic soils which have developed under conditions of poor drainage while in the coastal area they are mainly alluvial, formed by accumulation of alluvium and tidal action including sand deposition, soils are wet and have a high salt content.

19. Cambodia has a moist tropical climate. The main wet season, the southwest monsoon, occurs between June and October. Average monthly rainfall is around 1,500mm varying considerably from year to year.

20. Water resources in the Tonlé Sap basin are relatively abundant, but the quality and quantity of available surface water varies and is vulnerable to sedimentation from river bank erosion and to the effects of damage to forested areas in the basin. Pollution is also a growing problem. The total estimated ground-water resource in Cambodia[2] is around 17.6 billion m^3, readily recharged by rainwater. While the resource is copious, its distribution is uneven and where groundwater is also used for irrigation in some locations.

21. Uneven rainfall distribution over the year, flooding and drought are expected to be influenced with climate change, exacerbating already high levels of variability of precipitation from year to year.

22. The project towns are provincial capitals, which are both expanding and increasing in population density. Ornamental trees have been planted along main streets, but as older buildings are becoming replaced with large retail facilities, hotels and apartment blocks, trees are often removed, with greater emphasis placed on green spaces and parks within the towns. The towns are expanding outwards, into low density residential areas at the periphery and farmland immediately beyond.

23. No known ancient relicts occur in the project towns, however some older areas are distinctive and have some cultural value, though in many cases these are being replaced as the city centers intensify. Other items of cultural significance include colonial era buildings, and monuments, many of which feature distinctive Khmer architecture and have been built since independence in 1946.

24. Public health in Cambodia is improving, for example the under-five mortality rate decreased from 83 per 1,000 live births in 2005 to 28.7 per 1,000 in 2015. However, 15% of infant deaths are attributable to diarrheal diseases and therefore improving sanitary conditions remains an important challenge. In comparison to the development of water supplies in cities and towns in Cambodia, the wastewater sector is still in an early stage of development with the discharge of untreated wastewater into lakes and waterways commonplace.

25. Agriculture and tourism are the mainstays of the economy in the Tonlé Sap basin, while Sihanoukville's economy is dominated by its position as the country's only deep water port.

26. Poverty is prevalent in the towns, an estimated 14% of households in the areas to be served by the subprojects are poor, and approximately half of these are very poor, using the Ministry of Planning categorization system IDPoor[3].

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[2] MOWRAM (2001) National Water Sector Profile, Kingdom of Cambodia. MOWRAM, Phnom Penh.

[3] ID Poor categorizes households as poor category 1 (P1 - very poor), poor category 2 (P2 - poor), or not poor, based on an assessment covering occupation, education and income as well as health and disabilities of all family members, housing status and conditions, access to watsan facilities, household debt, economic shocks, vulnerabilities and any recent factors improving household livelihoods.

27. Unexploded ordnance remaining from the earlier period of civil conflict remains in much of the country, though less so in urban environments where the ground and soil has been extensively disturbed in the decades since civil conflict.

1.6 Anticipated Environmental Impacts and Mitigation Measures

1.6.1 Impacts related to location

28. Potential impacts were screened during the process of design review and IEE preparation.

29. The projects are in urban or peri-urban areas. There will be limited effects on vegetation. No mature trees will be removed because of works within the towns. Small trees of diameter less than 20cm will be removed at the septage facility near Kampong Cham, the impact is minor and mitigated by the inclusion of tree planting in the landscaping of the facility.

30. Within the urban centres, construction activity of public infrastructure and private buildings has disturbed soils extensively over the past two decades since civil conflict resulting in UXO, and therefore risks are limited although it will be necessary for contractors to be aware of potential risks and have procedures to ensure sites are free of UXO contamination.

31. Impacts on public and private property have been assessed in detail and are limited. A resettlement due diligence report has been prepared in the case of Siem Reap, Kampong Cham and Sihanoukville where impacts are limited and there are no Affected Households. In the case of Battambang, where land will be required for the new wastewater treatment plant, a Resettlement Plan has been completed for the subproject. Four affected households (AHs) will lose a total of 48,026m^2 of land, equivalent to 71 % of their total productive land. The RGC will provide 18,060m^2 of productive land which is not privately used. The land for the WWTP will be established through reorganization of land boundaries. No residential land or primary structures will be lost, and no relocation will occur. No trees, crops or services will be affected. The four AHs that will lose productive land will be compensated in-cash or in-kind, detail is provided in the Resettlement Plan for the Battambang subproject.

1.6.2 Impacts related to construction

32. Pipe placing during construction will involve impedance to traffic, including access to individual properties. The input is temporary and will be mitigated by requiring the contractor to taking steps to provide warning to the affected public, diversion routes and signage, liaise regularly with traffic police and schedule work to periods of low traffic as much as possible. In the case of Siem Reap, while trenchless technology will be used the pipe is to be replaced underneath a major urban road and one lane of traffic will be blocked. The contractor will be obliged to maintain at least one lane of traffic and to prepare and submit a detailed traffic management plan for approval.

33. Where pipes are to be laid within the public right of way, an estimated 1,784 road access points to private properties will be affected and reinstated as part of construction work.

34. The works will cause noise and vibration which will be mitigated by providing information to the public, disallowing noise generating activities to take place outside daytime work hours and ensuring that all construction equipment and vehicles are kept in good working order with working exhaust mufflers. Siem Reap will require special provisions to accommodate 24/7 construction shifts requested by the government and provincial authorities and the community to

complete construction activities quicker and reduce disruption to the community and tourism activities in the town.

35. Construction waste will include packaging of equipment, fuels, lubricants, materials, equipment and food. Import, use and disposal of any potentially hazardous materials must comply with the Sub-Decree on Solid Waste Management. ANRK.BK No. 36 of 27 April 1999, ensuring no illegal dumping of hazardous waste. All other solid waste will be taken to a landfill or municipal waste disposal site. Untreated sewerage in the pipe to be replaced will be taken to the wastewater treatment plant.

36. Release of silt from excavations from pipe trenches and foundations and temporary stockpiles of material will be mitigated by stabilization of soils once the pipes are in place, use of silt fences during the excavations to contain silt and avoiding excavation in wet weather.

37. In Battambang, the existing WWTP will be decommissioned and the future use of the land is as yet unknown. Sludge will need to be removed and rendered safe before disposal. The sludge should be removed from the ponds and placed on surrounding land and treated by drying or composting until safe to handle. Following treatment, sludge should be tested to ensure it is safe to handle, and made available to members of the public who wish to use it on agricultural land, or disposed of at the city's solid waste facility. A decommissioning strategy will be needed to allocate responsibility for removal, treatment and testing of sludge and rules for distribution or disposal of sludge.

38. Risks of soil and water pollution may arise from the use of vehicles and plant. The contractor will be required to ensure that vehicles and plant are maintained in sound operable condition, free of leaks and to prepare and submit a plan for spill management.

39. Pollution from exhaust fumes from vehicles and plant, and dust from materials and work sites will be limited by requiring vehicles and equipment to be well maintained and trucks to be fitted with tarpaulins to cover loads and application of water will be applied to suppress dust around work sites and material stockpiles where needed. Floodlights and lighting to accommodate the 24/7 construction on Siem Reap will again require specialist provisions to mitigate unacceptable impacts.

40. The use of plant and machinery, handling of untreated sewage in the spoil (in Siem Reap), use of compressed air lines and cables and excavations are potential hazards to the public, risks are to be mitigated by providing notices to the public identifying hazards; erection of safety barriers/covers for area of open excavation and provision of watch persons to control access.

41. To ensure occupational health and safety, contractors will be required to appoint health and safety officers for each site with specific responsibilities and to provide personal protective equipment to the workforce, appropriate to each site.

1.6.3 Impacts Related to Operation

42. Risks of operational failure will endanger public health. Correct operation and continuous maintenance of the WWTP facilities at Battambang and Sihanoukville will be particularly

important where trickling filters will be used[4]. The necessary level of operation and maintenance needs to be ensured by training, provision of operational manuals and employment of staff of sufficient capabilities and numbers. Training is also required to ensure operator occupational Health and Safety.

43. The WWTPs pose a potential hazard to the communities, particularly children. Each plant is to have a perimeter fence, which is to be checked regularly to control access.

1.6.4 Global, Transboundary and Cumulative Impacts

44. The proposed improvements will occur within and around the project towns. The environmental impacts identified through screening will almost all be confined to the towns and their immediate environment. Investment in improved sanitation is at an early stage in Cambodia and the projects will set an important precedent in improving sanitation in towns and cities in the country. The build-up of knowledge and capacities is an important and positive cumulative impact.

1.6.5 Analysis of Alternatives

45. Alternatives to the subprojects are alternative towns in which to make investments in sanitation improvements. The subprojects however were selected with the assistance of the design consultants engaged under the Cities Development Initiative for Asia using agreed screening and prioritization criteria. Alternatives with the subprojects would concern the layout and pipe type for the wastewater collection network and wastewater treatment method. These alternatives form an essential part of the subproject rationale and are described as part of the project description. In Siam Reap, alternatives concern mainly the choice of method to replace the failed interceptor pipe and material for the new pipe. The "no project" alternative would allow per capita generation of wastewater and deterioration of infrastructure to go unmitigated, as towns and cities expand.

1.7 Information Disclosure, Consultation and Participation

46. Consultation began early in the project preparation stage with visits to the subproject sites and involved MPWT and their provincial agencies and utility operators, and with the local municipal and sangkat/commune officials and village representatives. These included socio-economic surveys (SES) and focus group discussions (FGDs) for disclosure of land acquisition and resettlement and the likely environmental and social impacts.

47. The SES found that respondents were concerned about problems of inadequate water supply and sanitation infrastructure poor health conditions, especially for the poorer communities. Poor water supply coupled with poor sanitation was seen to be contributing to regular incidence of diarrhea and dysentery, major causes of death in infants. Poor water and sanitation was also seen to be contributing to growth stunting in young children. Lack of sanitation was also linked to kidney and urinary tract diseases especially in women who may “hold back” rather than go outside at night to urinate. Many HHs reported diarrhea in infants up to 5 years of age, and this is seen to be due to unclean water and poor sanitation.

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[4] The use of trickling filters involves passing effluent over media where it is treated by bacterial activity. It is necessary to maintain a constant flow, to prevent drying of the media, when the bacteria may dry out and die and to keep the layer of bacteria on the media thin to prevent clogging. This requires constant and skilled monitoring and the ability to fix mechanical problems promptly, to prevent failure of the plant.

48. Concerns over construction included generation of noise and dust, the latter possibly giving rise to increased respiratory tract infections or asthma, disruption of access to homes, and noise from machines. Measures to control these impacts are included in the environmental management plans (EMPs).

49. The consultations identified few negative impacts from the proposed sanitation improvements, and any negative impacts identified are more than mitigated by overwhelmingly positive benefits from the improved sanitation. With improvements in health, reduced expenditure on medical treatment is seen to improve household finances.

50. Consultations also took place as part of the assessment of land acquisition and resettlement impacts. The contacted participants (i) showed high interest in the subproject and (ii repeatedly mentioned their expectations about the subproject, as water supply and sanitation are topics of high importance. The discussion with the participants concerned in general more wastewater operational matters including environmental matters and likely construction impacts rather than resettlement items.

51. The draft IEE will be presented to commune officials and the public. Copies will be left for review for a period of 30 days. During construction and operation, communities in and around the subproject area will kept informed of construction activities that are likely to cause noise and dust nuisance, or disruption to roads and pathways.

1.7.1 Grievance Redress Mechanism

52. A grievance redress mechanism (GRM) has been prepared for the project and is included in the IEE and Resettlement Plan documents. It provides a set of clear procedures to receive, record, and address any concerns or complaints raised and multiple entry points including verbal and written complaints, availability of a hotline number, anonymous drop-boxes and/or email. This grievance redress mechanism has been designed to address displaced households' grievances and complaints regarding land acquisition, compensation and resettlement in a timely and satisfactory manner. Costs associated with processing and addressing complaints are to be borne by the project.

1.8 Conclusion

53. The overall finding of the IEE confirms that the subproject is Category B, that it will not cause significant environmental problems and that potential adverse impacts are manageable through the effective implementation of the EMP. No further environmental assessment is therefore required, beyond the issues to be reviewed during detailed design.

2 Introduction

54. The Provincial Water Supply and Sanitation Project (PWSSP) will build on the investment made for the Urban Water Supply Project (UWSP) project to improve urban water supply services in provincial towns. The PWSSP will improve and expand not only urban water supply, but also sanitation services in similar towns and contribute to the Government's target for 100% urban water supply coverage by 2025 as well as align with proposed government targets for urban sanitation.

55. The PWSSP is aligned with phase 3 of the government's rectangular strategy for growth, employment, equity, and efficiency, Cambodia's National Strategic Development Plan (NSDP) for 2014-2018. It is also consistent with Government Plans to facilitate private sector partnerships, to strengthen the management of public owned water works, and to integrate urban water supply with urban environmental management.

56. The PWSSP will improve and expand urban water supply, wastewater and septage management services in the selected towns and comprises six subprojects, two of which are for improved water supply and four of which are for the improvement of wastewater and septage treatment and conveyance. The feasibility studies for the subprojects include social and environmental safeguards assessment and management plans. This initial environmental examination (IEE) is prepared per ADB's Safeguard Policy Statement (2009) and the Royal Government of Cambodia (RGC) Law on Environmental Protection and Natural Resource Management (December 1996), further guidance is provided in the Sub-decree on Environmental Impact Assessment (1999).

3 Description of the Project

3.1 Provincial Water Supply and Sanitation Project

57. The Provincial Water Supply and Sanitation Project (PWSSP) is to improve and expand urban water supply in selected towns and wastewater and septage management services in the same or similar towns to contribute to the Government's targets for urban water supply and effective urban sanitation. The combined outputs will include: (i) water supply systems improved and service coverage increased through the development of new water supply intakes and treatment facilities, replacement of old water mains, and expansion of the distribution network; (ii) septage management and sewerage services provided through the provision of septage collection and treatment and the development of expanded sewerage systems; and (iii) project implementation and operation and maintenance (O&M) developed to complement ongoing institutional development and capacity building in procurement, financial management, and governance.

58. PWSSP is aligned with phase 3 of the government's rectangular strategy for growth, employment, equity, and efficiency, Cambodia's National Strategic Development Plan (NSDP) for 2014-2018, and Government Plans to facilitate private sector partnerships, to strengthen the management of public owned water works, and to integrate urban water supply and sanitation with urban environmental management. With development partner support, the urban water supply services in Cambodia have been significantly improved in the past three years. All provincial public waterworks (PWWs) are recording profits from their operations while providing improved quality of services. The wastewater subsector has also made positive steps forward in recent years, although this sector is in the early stages of its development. As urbanization continues and the city centers become larger the focus will move to the need for more efficient

septic tank construction and maintenance for suburban areas and piped collection systems and treatment for the more densely populated core urban areas.

59. ADB is supporting the Government of Cambodia to address the core problem of inadequate water supply and sanitation infrastructure and services with a programmed approach that envisages the combination of lending and nonlending assistance to finance infrastructure, institutional reforms, and capacity building based on a draft sector road map and investment program developed for a 20-year design horizon. The provincial Water Supply and Sanitation Project (PWSSP) will build on the investment made for the Urban Water Supply and Sanitation Project (UWSP), which is currently being implemented, to improve urban water supply services in provincial towns, while potential further investments could target other provincial and sub-provincial towns. The PWSSP will contribute to the Government's target for 100% urban water supply coverage by 2025 and align with proposed government targets for urban sanitation. In addition, PWSSP will also contribute to financial autonomy of the provincial public waterworks (PWWs).

60. The PWSSP will extend water supply coverage and treatment in Battambang, and Kampong Cham and sanitation coverage and wastewater treatment capacities with improved septage management in Battambang and Sihanoukville, and improved septage management in Kampong Cham. The project will also provide for the replacement of the failed interceptor sewer in the town of Siem Reap. This IEE has been developed for the proposed improved wastewater and septage facilities for Battambang and Kampong Cham, Siem Reap and Sihanoukville.

61. A Project Participation Plan (PP) has been developed ensure information sharing on the Project with the beneficiary households, communities, and key stakeholders. The PP’s purpose is to enable feedback from these groups and target beneficiaries about the potential impact and effectiveness of the PWSSP to enhance positive benefits and mitigate negative impacts, leading to improved design of the project, reduced risks and increased beneficiary impact for the targeted groups and strengthened local ownership. The plan outlines, for each stakeholder group, their involvement in the project, purpose and mechanisms for their participation, parties responsible for facilitating the consultation and participation, timing and costs. The PP together with the stakeholder communication strategy (SCS) serve to guide the PWSSP’s implementation. Around 302,022 people in 71,592 households are expected to have access to the extended water supply and wastewater systems provided under the Project by 2022.

62. The DPWTs with the assistance of the PIAC will convene meetings and arrange focus group discussions with project beneficiaries, including poor and vulnerable households, female headed households and affected peoples, to inform them of project purpose, scope, benefits and construction schedules and elicit views and feedback. Feedback will be recorded and used to input into design and implementation. Participants will be asked about their views on the severity of construction impacts and perceptions on environmental issues including the quality of effluent discharged at the WWTP. DPWT will record and implement appropriate actions with the support of the PIAC.

3.2 Battambang Wastewater Subproject

3.2.1 Objectives

63. The Battambang Wastewater subproject aims to extend and improve existing facilities in Battambang town to increase the capacities to handle projected sewerage loadings from the proposed 2025 (Phase 1) service area containing the densely populated areas of the town

centre to the west of the Sangké River, and most of the intermediately populated areas just outside the centre to the year 2040.

64. After completion in 2022 the wastewater subproject of Battambang is expected to directly benefit some 8,500 HHs who will have been connected to the sewer. The number of HHs accounts for 46,750 inhabitants of whom half are female. They will have improved living environments and hygiene. The social impacts are overwhelmingly positive as the villages will experience a better and reliable wastewater scheme and improved sanitation leading to an increase of their living quality.

3.2.2 Existing Wastewater and Septage Facilities

65. Battambang currently has a 1,000m^3/day lagoon-based wastewater treatment plant (WWTP) that was constructed in 1994 by the non-government organization (NGO) SAWA, funded by the European Union. It was intended to serve 15,000 people over 89ha of the main downtown area on the west side of the Sangké River. The treatment plant is still operating but is now limited to a capacity of 450m^3/day because of general degradation of the system. The existing WWTP depicted in **Figure 1** covers an area of 5.8ha including the lagoons, pump house, administration / laboratory building and surrounding space.

66. The sewerage network in the town center is at present combined with the stormwater system and consists of concrete pipes from 800mm to 1500mm in diameter, installed between the colonial period and recent years. The coverage and existing pipe network is shown in **Figure 2**. These pipes are to be retained for stormwater only, with wastewater separated in the new system. The existing pipes flow in a north-westerly direction to discharge into rice fields and a flood plain near the proposed new wastewater treatment plant.

67. The existing WWTP layout consists of the three main stages of lagoon treatment process; comprising an anaerobic pond, facultative pond and a maturation pond or wetland:

(i) Anaerobic ponds: consisting of two 5m depth ponds. A pump station was installed at the downstream end.
(ii) Facultative ponds: 2 circular ponds in parallel, with an average diameter of 63m, and average depth 1.5m with a deep fermentation pit (diameter 21m, and 3m depth) in each pond.
(iii) Maturation pond or wetland.

3.2.3 Proposed Coverage Area

68. The wastewater subproject in Battambang is divided into two phases where Phase 1 covers an area of about 415 ha to the west of the river, designed to collect wastewater up to the year 2040, covering three densely populated sangkats. Phase 2 is designed to collect wastewater from an extended area of four suburban communes further westward from the river as these communes develop, beyond 2025, again to year 2040. **Figure 3** shows the Phase 1 and Phase 2 service areas. The proposed coverage is divided into 13 Blocks, four covered in Phase 1 and the remainder in Phase 2.

Figure 1: Existing WWTP (constructed in 1994)

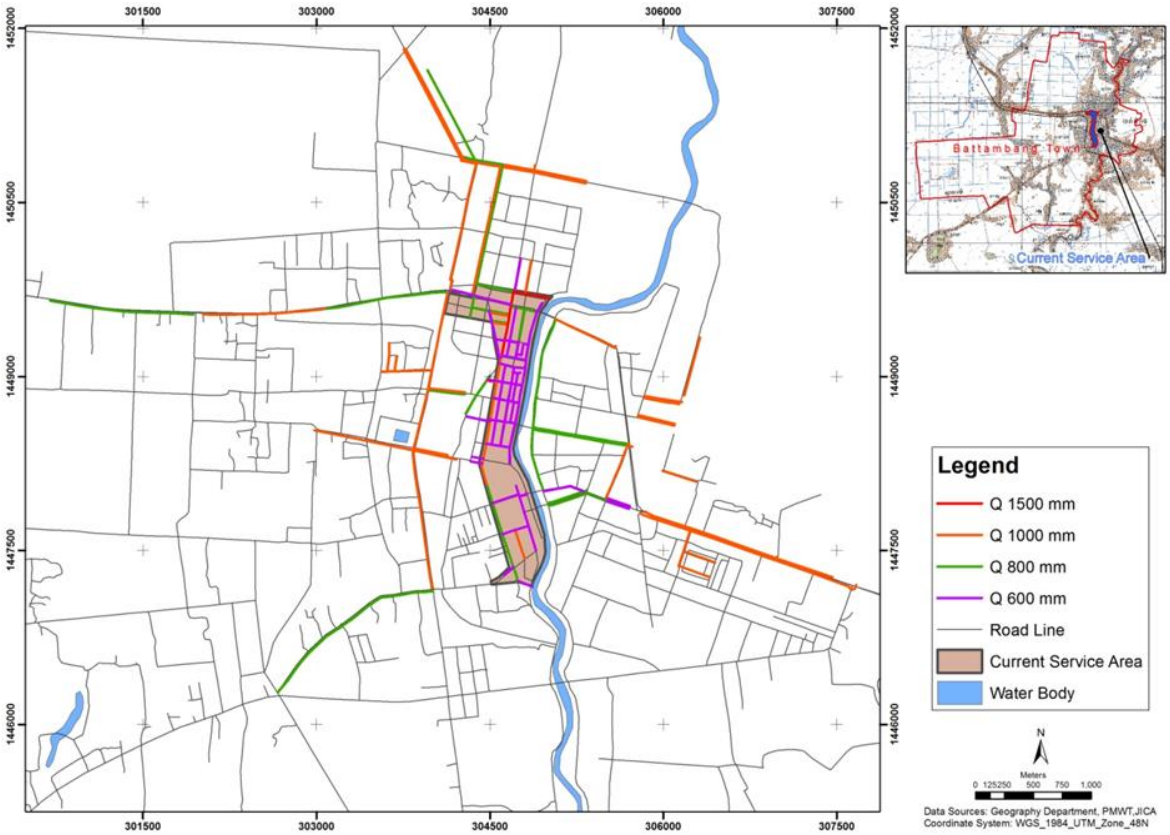

Figure 2: Coverage of 1994 EU funded (SAWA) WW Project

3.2.4 Proposed Wastewater and Septage Facilities

69. The wastewater and sanitation improvements in Battambang town to be developed in two phases until the year 2040 are illustrated in **Figure 3**. The subproject involving the initial Phase 1 activities has 5 main components:

(i) Decommissioning the existing 5.8ha WWTP lagoon site
(ii) Construction of a new wastewater treatment plant (WWTP)
(iii) Installation of trunk sewers
(iv) Construction of pump stations
(v) Installation of smaller diameter collector pipelines in the secondary streets.

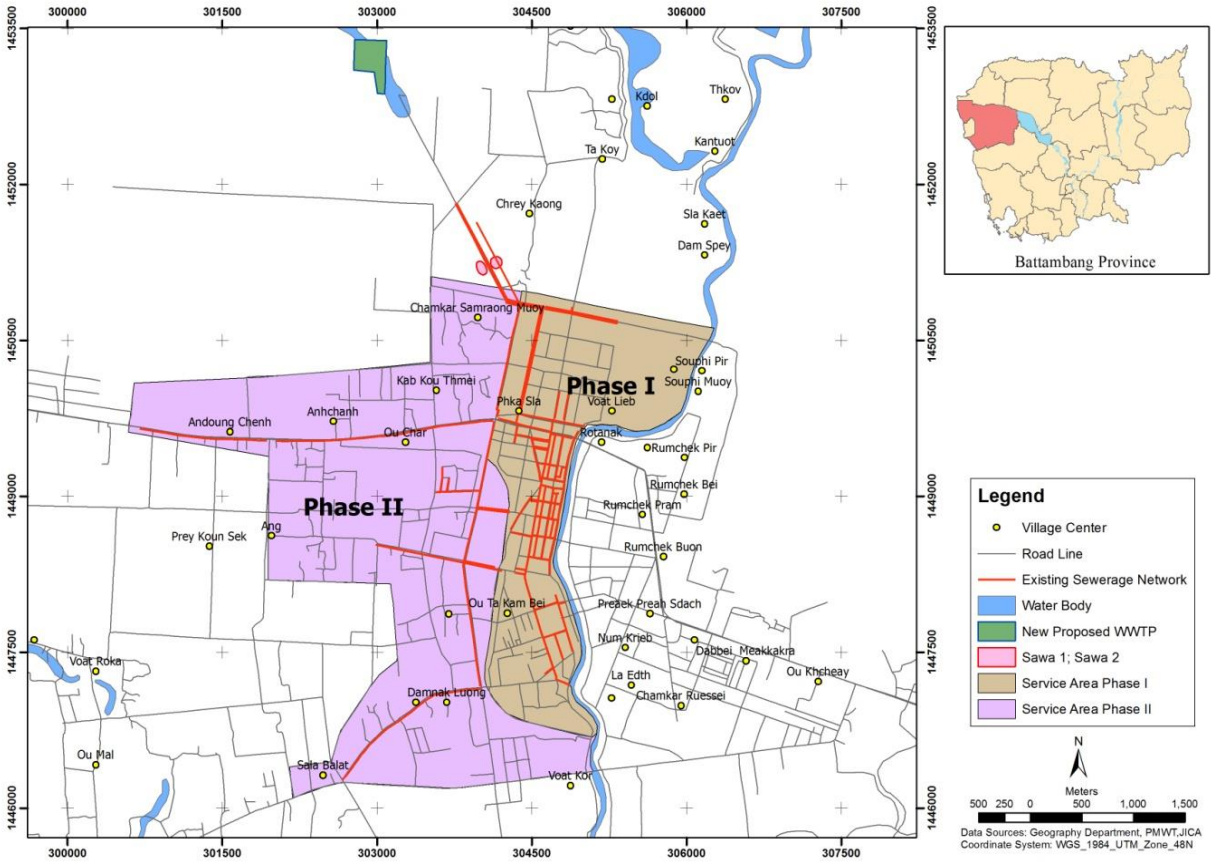

Figure 3: Phase 1 Service Area

70. The new WWTP will be located on a 6.6 ha site in Chrey Kaong village, Sangkat Sla Kaet, Battambang town. It will consist of 4 anaerobic ponds, 4 trickling filters, a sludge drying bed and a septage receiving facility with a drying bed, dewatering container, and equipment for desludging and site cleansing. The sewerage system for Battambang Town is designed to convey wastewater only, separate from stormwater with the existing pipes being retained for collection and disposal of rain water. There are in total 3 pump stations proposed for the Phase 1 service area, two pumps in the town and one at the WWTP.

71. The Cities Development Initiative for Asia (CDIA) pre-engineering design studies cover the pipelines and network required for the separated wastewater system. Pipe diameters of the

trunk sewer designed by the CDIA team range from 100mm to 450mm with a total length of 15.39km for the phase 1 area. Small diameter collection mains of 100mm diameter or less with a total length of 46km will also be constructed along both sides of the roads in the service area for household and property connections. The materials proposed for the trunk sewer pipes are glass reinforced plastic (GRP) or reinforced concrete for the largest pipes above 400mm diameter and unplasticized polyvinyl chloride (uPVC) for pipes with diameter of 400mm and under. Per the preliminary design, the wastewater collection pipes will be laid along both sides of the road however during due diligence work by the PPTA consultants it has been proposed that the pipes are laid either along the edges of the road carriageways or where development intrudes onto the road side walks and shoulders, directly underneath the road carriageway to avoid land acquisition and resettlement impacts. Free connections will be provided to all existing residential properties in the proposed new Phase 1 service area with the provision of some 8,500 new connections by 2022 on completion of the proposed civil works.

3.3 Sihanoukville Wastewater Subproject

3.3.1 Objectives

72. The PWSSP will significantly expand wastewater services in Sihanoukville, by increasing the capacity of the existing lagoon based WWTP on the same land footprint and extending the coverage area of the system. For Sihanoukville the capacity of the existing waste water treatment plant will be tripled, the waste water coverage will be extended to 5 new blocks incorporating the city centre and the beach areas fronting onto the coastal waters of the Gulf of Thailand.

73. After completion in 2022, the wastewater subproject of Sihanoukville is expected to directly benefit over 10,000 HHs who will have been connected to the sewer. The number of HHs accounts for 46,217 inhabitants of whom half are female. As for Battambang they will have improved living environments and hygiene. The social impacts are overwhelmingly positive as the villages will experience a better and reliable wastewater scheme and improved sanitation leading to an increase of their living quality.

3.3.2 Existing Wastewater Facilities

74. The existing lagoon wastewater treatment plant was constructed and commissioned in 2008 under the ADB funded Provincial Towns Improvement Project (PTIP). The wastewater treatment plant (WWTP) was designed with the total capacity of 6,900m^3/day, of which 5,700m^3/day was for households (3,368 households) and 1,200m^3/day for industry (mainly the brewery operated by the Cambrew company only was considered during design). This design capacity came from projections to year 2010 only. The sewerage system currently serves the central part of the town with total area 321 ha in Sangkhat Pir (Sangkhat 2), Sangkhat Buon (Sangkhat 4) and Sangkhat Mouy (Sangkhat 1). The proportion of coverage in each area is; Sangkhat 2 (38.7%), Sangkhat 4 (8.6%) and Sangkhat 1 (0.4%). The current total population inside this service area is estimated to be about 21,341 people. Approximately 52% of this population is currently connected.

3.3.3 Proposed Improvements

75. The sanitation subproject for Sihanoukville aims to increase the capacity of the wastewater treatment plant, the coverage of the sewer network, including extension of trunk mains and local conveyance pipelines and the installation of pump stations in each sub-

catchment of the extended service area. Improved septage disposal and treatment facilities will also be provided.

76. The proposed wastewater and sanitation subproject in Sihanoukville has 4 components:

(i) Trunk sewer expansion
(ii) Increased capacity of the existing wastewater treatment plant (WWTP)
(iii) Sludge and septage management
(iv) Installation of area pump stations

77. The subproject extends the future service area to 5 new blocks as illustrated in **Figure 4.** The proposed trunk sewer development and the location of five proposed pump stations to be sited at the lowest point of each catchment are shown in **Figure 5**. The main trunk sewers will accept effluent from the smaller diameter conveyance pipelines, which are either existing or will be installed along each road in the five proposed service areas and connected to private homes or institutional users.

78. Unplasticized polyvinyl chloride (uPVC) pipe is proposed for trunk sewers with a diameter of 400 mm or less and for the conveyance pipes of 100mm diameter or less that are to be installed along the roads within the proposed service areas. Glass reinforced plastic (GRP) or reinforced concrete pipe is proposed for all trunk sewers with a diameter greater than 400mm. Per preliminary design, the wastewater collection pipes will be laid along both sides of the road, however, in the course of due diligence work by the PPTA consultants it has been proposed that the pipes are laid either along the edges of the road carriageways or where development intrudes onto the road side walks and shoulders, directly underneath the road carriageway to avoid land acquisition and resettlement impacts. Trunk mains of 250mm to 1,200mm diameter of some 32.1 km total length and conveyance pipelines of 100mm diameter and 45.27 km length will be constructed.

79. Free connections will be provided to all existing residential properties in the five new service areas, plus all those properties from the first 2008 service area that have not yet been connected (8,295 connections in total). The original 2002 design, commissioned in 2008, allowed for 3,368 connections in the existing service area by 2010. This will have risen to 5,075 connections by 2020, of which 1,787 connections have been made.

80. The existing WWTP has a maximum capacity of 6,900m^3/day which has already been reached in serving the 1,767 connections made to date (approximately 3,000m^3/day) plus wastewater from Cambrew. No further land is available for expansion of the WWTP and the installation of odour capped and floating solar powered aerators (mixers) illustrated in **Figure 6** are proposed under the CDIA pre-engineering design to increase the WWTP capacity to 20,500m^3/day, with all work accommodated within the existing land footprint of the WWTP site.

81. O&M requirements will be largely the same as they are now, focused around sampling of influent and effluent waters and periodical desludging of the anaerobic lagoons when they approach 50% depth of settled sludge. This will be made easier for the operators under the proposed subproject with the construction of concrete access ramps to the ponds and the provision of a compact mobile excavator, portable sludge pumps and a dewatering container.

82. When a lagoon is ready for desludging it will be dewatered during the dry season using the sludge pumps. Once dewatered, the lagoon will be left for several weeks for evaporation to thicken the sludge, before it is removed using the excavator and a truck, and deposited in

batches into the sludge dewatering container, which will thicken the sludge further. It can then be carted to the landfill for disposal. Dewatered sludge can be used as cover for the city's proposed landfill, which is due to be constructed in 2017. Once landfill material has been compacted in layers every 1-2 weeks, it is capped, and dewatered treated sludge is ideal for this purpose.

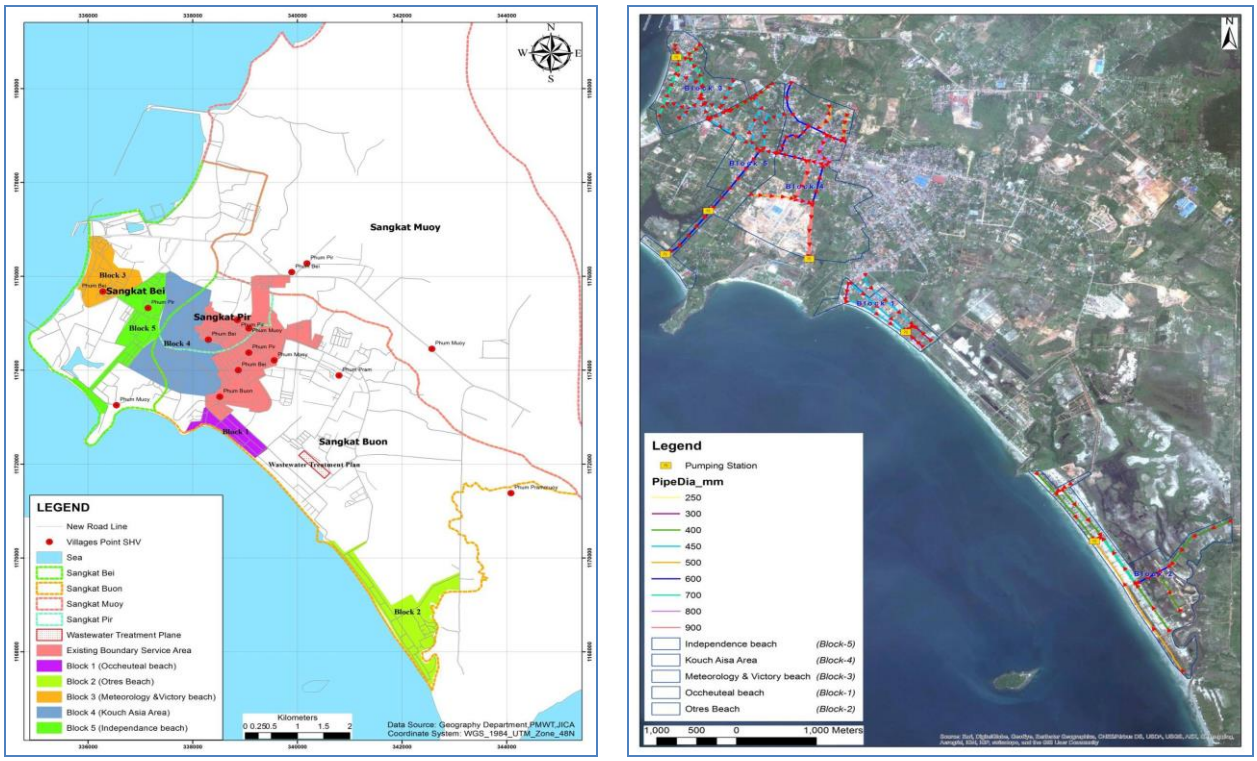

Figure 4: Extended Service Areas

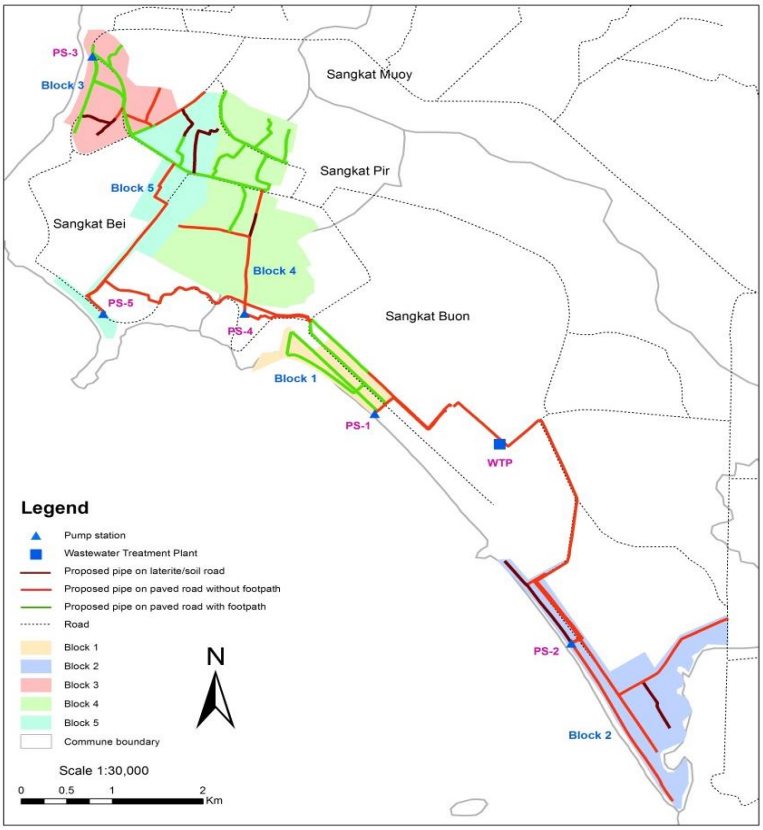

Figure 5: Proposed Extended Service Areas, Trunk Sewers and Pump Station Locations

Figure 6 Existing WWTP and Proposed Solar Aerators

3.4 Kampong Cham Wastewater Subproject

3.4.1 Objectives

83. In Kampong Cham, the existing combined sewer system covers a limited part of the central area, handling both wastewater and stormwater and drains directly into the Mekong River. Most latrines use septic tanks, there are very few toilets connected to the sewer.

84. Kampong Cham is at an early stage in the development of wastewater systems and at present relies largely on septic tanks. However, as identified under the CDIA study, the number of septic tanks, both functional and non-operational in the town, is not known and as a first step in the development of wastewater systems an assessment of the septic tank situation is required. This study would also look at a uniform septic tank design and guidelines for maintenance and desludging. The proposed study would require separate funding from PWSSP which has not yet been confirmed.

85. This subproject proposes a new separate and self-contained septage receiving and treatment facility with receiving well, primary lagoons, maturation pond and sludge drying bed. The subproject would serve an estimated 36,031 people. In addition, the provision of collection, cleansing and desludging equipment (vacuum truck, water blaster, small wheeled excavator, sludge pump and dewatering container) has been foreseen, and improved septage management is proposed.

3.4.2 Existing Sanitation Facilities

86. As indicated, sanitation infrastructure in Kampong Cham currently comprises of septic tanks. There is no reticulated wastewater collection other than direct or indirect disposal to road drains by households and businesses within a limited central city area. At present, there are no septage treatment facilities and vacuum trucks dispose of the sludge from septic tanks in open fields, resulting in contamination of the surrounding environment. Sludge (septage) collected from septic tanks has already undergone a degree of anaerobic decomposition inside the septic tanks but requires further treatment prior to drying and release. This subproject focuses on establishing septage facilities for safe disposal of the sludge. Most households use a pour flush to septic tank or a pit system.

87. In Kampong Cham, there is at present only a small number of vacuum truck operators. As operators become busier, carrying more loads per day, the incentive to invest in more trucks will arise, which is likely to result in greater private sector participation. Currently the operators

mostly deposit the septage onto agricultural land or at other locations where the practice is unmanaged and the suitability of the land to safely receive the septage has not been confirmed.

3.4.3 Proposed Improvements

88. The proposed subproject involves the construction of a septage treatment facility for receiving waste collected privately and by DPWT operated vacuum trucks from Kampong Cham town. The proposed site of the septage facility is a 5.2 ha area of land in Phkay Proek village area, Mien commune, Prey Chhor district, about 18 km outside Kampong Cham. The area has been allocated by the Provincial Governor. It is located on a plateau at an elevation between 15m and 20m above mean sea level (amsl). The location of the site and layout of the septage area is depicted in **Figure 7**.

89. Existing land use is mainly degraded shrub land interspersed with some irrigated rice fields, and quarrying for building stone. The subproject can be located on the available site without compromising the parcels of land currently used as rice fields. Treated and dried sludge will be disposed of at approved land fill sites where it will be suitable for use as a cover material.

90. The subproject will also include capacity building for DPWT and private vacuum truck operators and a public awareness campaign aimed at increased understanding of the operation of septic tanks and the need for maintenance and appropriate disposal.

91. For the sustainability of the septage treatment facility it is vital to have both the support of the private vacuum truck operators through licensing and increased awareness of the owners of the septic tanks in proper upkeep, including regular emptying. Across Cambodia it is currently apparent that householders only empty their septic tanks as a last resort when there is an odor or drainage problem due to overflow of the septic tanks.

92. The DPWT has expressed concerns about the distance of the site from the town and has questioned whether the facility will be used due to the time and cost of transporting the septage between the town and the facility. An effort is continuing to locate a suitable alternative site closer to Kampong Cham. Meantime the assessment of the existing site shown in Figure 7 is continuing.

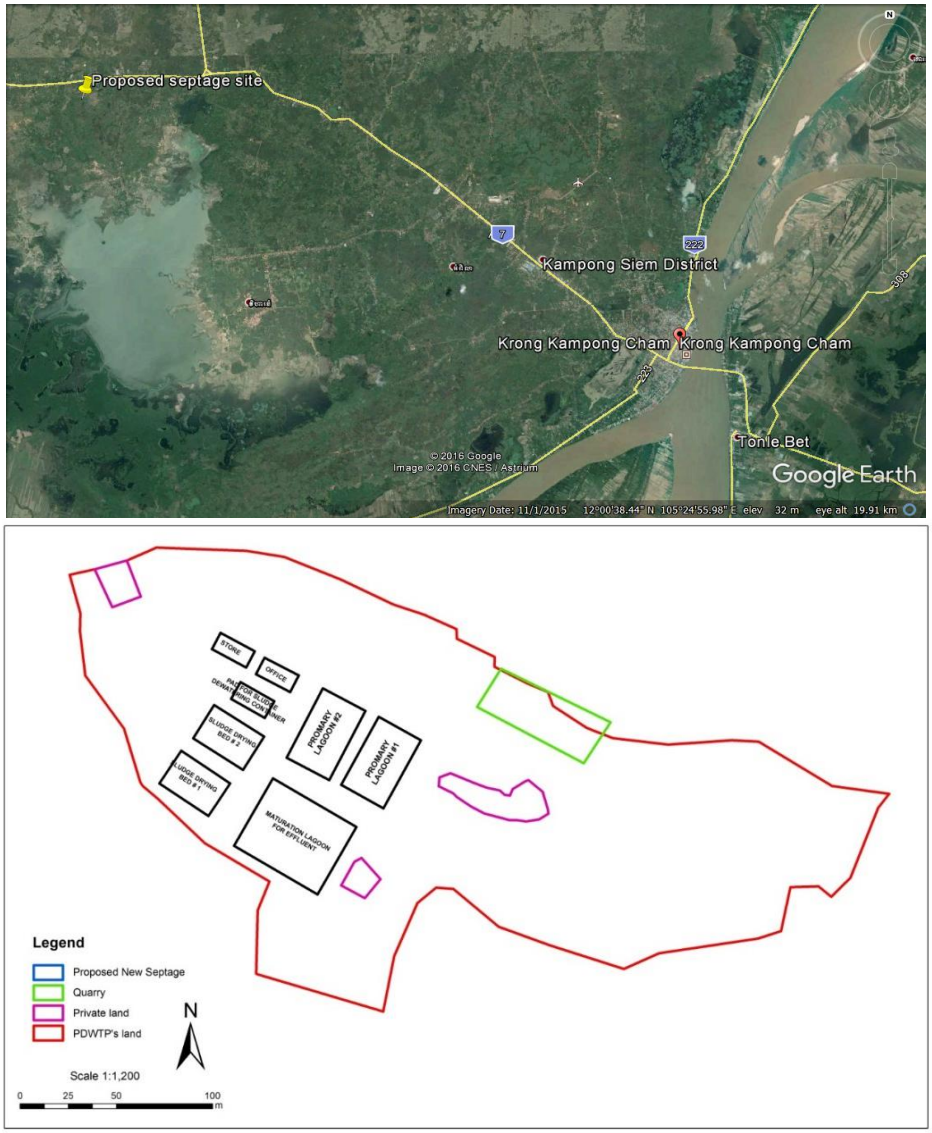

Figure 7: Proposed Location and Layout of Septage Area

3.5 Siem Reap Wastewater Subproject

3.5.1 Objectives

93. The proposal for Siem Reap relates to the urgent need to replace a 3.7km length of failed main trunk interceptor sewer. The opportunity is also being taken to upgrade the size of the pipe to accommodate increased future flows. The subproject has a high cost and has required several options with different construction methods to be evaluated. The subproject addresses the failure of an interceptor sewer which was commissioned in 2010 and constructed as a subproject of the ADB funded Mekong Tourism Development Project. The 3.7km interceptor sewer, composed of glass reinforced plastic (GRP) pipe was designed and installed to collect wastewater from the center of Siem Reap over an area of 2.4km^2, and to convey it to a pump station south of the town and thence to a waste water treatment plant (WWTP). Following installation, between 2011 and 2014, the pipeline failed in 5 locations and the pipe collapsed,

showing clear signs of a compression failure. At present the pipeline is not functioning, preventing wastewater in a central part of the town from reaching the WWTP. It is proposed that the sewer is replaced with a larger and stronger pipe made of ductile iron, installed using trenchless technology and following the same vertical and horizontal alignment.

94. The interceptor sewer starts at the upstream end at the junction with National Road No.6 and runs from north to south down Sivatha Rd, shown in **Error! Reference source not found.**Figure 8: Alignment of Proposed Interceptor Sewer, then turns southwest onto Wat Chork St, crossing the Ring Road, and ending at the pump station. The pipe invert at the upstream end is at 3m depth (600mm diam.) and at the downstream end reached its maximum invert level depth at 8.3m (700mm diam.). The grade of the 632m of 600mm pipe is 0.237% and the downstream 3,043m of 700mm pipe 0.187%.

3.5.2 Existing Wastewater Facilities

95. The interceptor sewer is intended to connect to a WWTP of capacity 2,776m^3/day, intended to serve only the central area of Siem Reap. The existing (failed) 600mm diameter sewer has a capacity of 25,800m^3/day and the downstream section of 700mm diameter has a capacity of 30,070m^3/day. The design capacity of the pump station at the downstream end of the interceptor sewer is 20,750m^3/day.

96. Meantime wastewater treatment capacity in the city has increased following improvements to the WWTP under Korean funding, which also provided for two additional pump stations, however the commissioning of these awaits the restoration of the interceptor sewer to full functionality. The capacity of the WWTP has now been increased to 8,000m^3/day however this can only treat about 50% of wastewater generated at the current time (2016), and even when extended to 16,000m^3/day, it will not be of sufficient capacity include sewage from the eastern side of the city to 2030. A separate eastern WWTP will be required to serve the eastern zone.

3.5.3 Proposed Improvements

97. An options study on construction methods and choice of pipe and vertical alignment were made, examining two key decisions. First, whether to use the same alignment and gradient as the existing pipe, and second, whether to use open trenches for the installation, or underground trenchless technology.

98. The option of using a shallow alignment instead of a deep alignment would require multiple pump stations, while a deeper alignment would allow gravity flow. The study found that lifetime cost effectiveness was better for trenching up to a depth of 10 m without multiple in-line pumps.

99. The use of an open trench is also problematic, where serious problems are anticipated with dewatering, achieving compaction of bedding material and backfill to support the pipe, operating in a deep trench, unavoidable lengthy road closures, and disruption and impairment of the main tourist centre[1] and associated business activities.

[1] Foreign visitors 2,124,863, national visitors 2,886,453; Ministry of Tourism. *Tourism Statistics January-December 2015*. Phnom Penh.

Figure 8: Alignment of Proposed Interceptor Sewer

100. It is therefore proposed that the pipe will follow the horizontal and vertical alignments of the existing failed interceptor pipe. Trenchless technology using pipe thrusting, micro-tunnelling, pipe bursting or pipe cutting and bursting will be used. A Design, Build and Implement approach will allow contractors to present options from the full range of proven trenchless techniques methods available, in the interests of attracting cost competitive bids.

101. Pipe thrusting entails thrusting or jacking the pipe from an access shaft using hydraulic rams while excavation ahead occurs through a cutting ring mounted on the leading pipe, and by feeding pipes into the pipe train as the work progresses along the length of pipe in question. Micro-tunnelling employs a small cutting head or tunnelling machine also mounted on the leading pipe. Bursting and cutting singularly, or in combination, utilizes the existing pipe cavity, cutting, fragmenting and dispersing the existing pipe material in the surrounding soil, using a conical “cutting head followed immediately by a bursting head” drawn through the old pipe. The bursting head base is larger than the pipe diameter being replaced and slightly larger than the new pipe diameter and the rear of the bursting head is attached to the new pipe. The front of the cutting head is connected to a cable or rod, which pulls the head through from an insertion pit to a reception pit, situated typically some 100m further along the pipe alignment. Pipe thrusting and micro-tunnelling also involves working in similar lengths along the pipeline. The CDIA consultant handling the pre-engineering feasibility study has consulted an experienced contractor based in Singapore and confirmed that pipes of the desired diameter can be installed using the cutting and bursting technique.

102. The trenchless technology causes far less traffic and utility disruption than open trench techniques, but traffic flow will still be impeded. At the access (or insertion) pit sites, a generator, compressor, hoist, operator cabin and stock of pipe sections are needed, taking up space on and

around the urban road. For pipe thrusting, hoists will be required for the removal of excavated materials with space for loading for removal from site. At the reception pit site, less equipment is required. **Figures 9 and 10** illustrate examples of micro-tunnelling and cutting and pipe bursting techniques.

103. Due to the utilization of the existing pipe cavity, less spoil is generated by the technique than by conventional open trench installation. The subproject environmental management plan (EMP) incorporates provision for the safe and environmentally acceptable handling, transport and disposal of contaminated spoil and septage and faecal matter removed from the old pipeline.

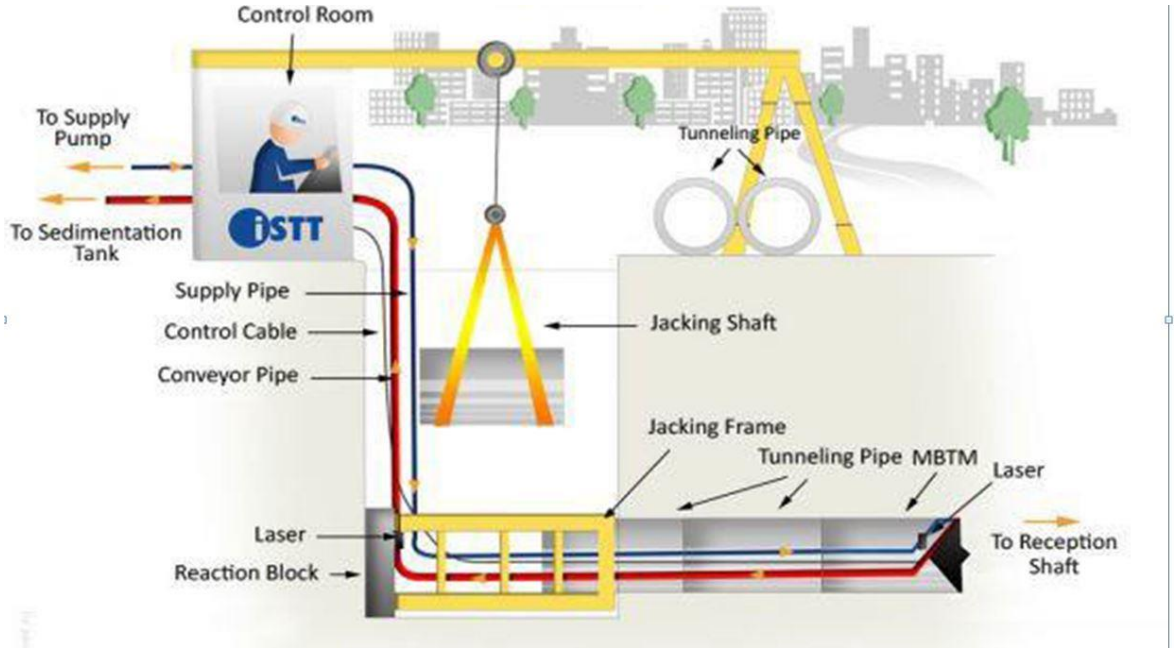

Figure 9: Trenchless Technology – Micro-tunnelling

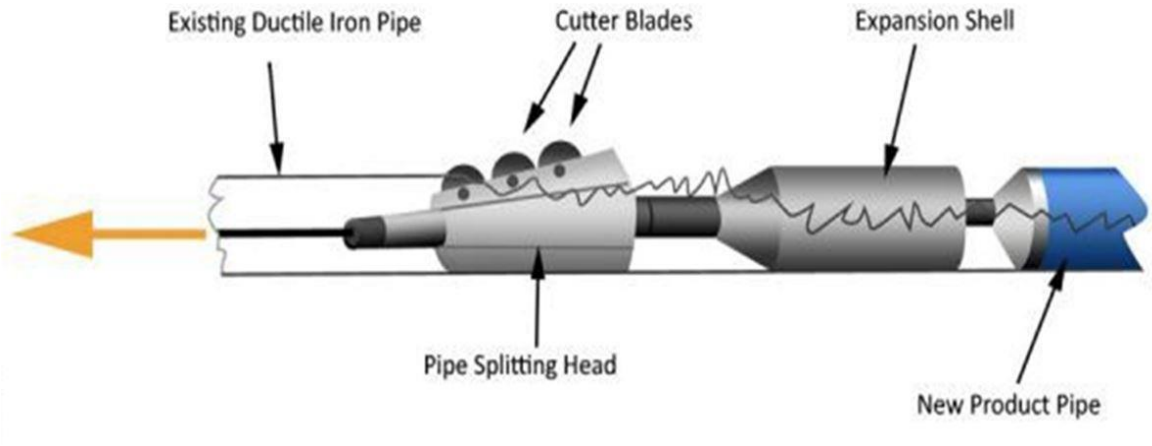

Figure 10: Trenchless Technology – Pipe Splitting and Pipe Bursting

4 Policy Legal and Administrative Framework

4.1 Legislation for Environmental Management

104. The primary legislation for environmental assessment in Cambodia is the Law on Environmental Protection and Natural Resource Management (December 1996), further guidance is provided in the Sub-decree on Environmental Impact Assessment No. 72.ANRK.BK of August 1999.

105. Article 6 of the Law on Environmental Protection and Natural Resource Management states that an environmental impact assessment (EIA) shall be done on every project and activity, private or public, and shall be reviewed and evaluated by the Ministry of Environment or its provincial departments before being submitted to Royal Government of Cambodia (RGC) for approval. General provisions for each EIA, the institutional responsibilities, requirements for EIA procedures and conditions for approvals are covered in that Sub-decree. A two-stage process is specified for environmental assessment, similar to that required by the ADB, whereby an Initial Environmental Impact Assessment (IEIA) is prepared for most projects. The IEIA may either suffice for environmental clearance, or form the basis for a more substantial EIA. An Annex of the Sub-decree specifies the types of project that require an IEIA and if appropriate, EIA. The required scope and format of the IEIA resembles that of the IEE required under ADB requirements (ADB Safeguards Policy Statement, 2009).

106. Under the Sub-decree, the Ministry of Environment (MoE) is responsible for review of IEIAs and EIAs and to collaborate with the line ministries. The MoE has the authority to approve or reject a project. The Council for the Development of Cambodia (CDC) has overall jurisdiction over projects and has the power to comment and require amendments or additions to IEIAs and EIAs. The MoE has further responsibility in the monitoring of project implementation. The MoE implements these responsibilities through its Department of Environmental Impact Assessment and Monitoring. Besides the MoE, other ministries with responsibility for the project have the right to examine and approve projects, following MoE review. Provincial and Urban authorities with

responsibility for the project are required to ensure that Project Owners prepare EIAs and submit them to the Provincial Environment Office.

107. The primary responsibility for undertaking environmental assessment of projects lies with the Project Owner, and the assessment work is carried out by the Project Owner or consultants retained for the purpose. The owner of the wastewater subprojects is the MPWT and the DPWT of the province where the project is to take place.

108. The specified IEIA/EIA process consists of the identification of environmental impacts, review and examination of alternatives to the proposed project and the communication of information to stakeholders. A report format is also specified in Annex 7 of the Sub-decree. In the case of both IEIAs and EIAs, MoE is required to respond, providing findings and recommendations to the Project Owner, within thirty working days of submission.

109. Article 1 of the Sub-decree states that public participation is to be encouraged in the implementation of the IEIA process so that the conceptual inputs and suggestions of the public are taken into consideration prior to the implementation of any project.

110. Consultation was carried out with the MOE, which established MOE are supportive of the project in view of the urgency to expand water supply and sanitation in major towns to address environmental pollution and public health issues. The MOE clarified national requirements for environmental approvals. Water treatment plants that will supply more than 10,000 users and all new wastewater treatment projects require an Environmental Impact Assessment (EIA) under the Sub-Decree on Environmental Impact Assessment (1999). The Battambang and Sihanoukville subprojects both involve new wastewater treatment plants and will therefore require EIAs for project approval. EIAs for these subprojects will be prepared during the detailed engineering design stage.

4.2 Cambodian Environmental Standards

111. Following promulgation of the Law on Environmental Protection and Natural Resource Management several sub-decrees have been issued that provide requirements on specific aspects of environmental protection. These include the Sub-Decree on Management of Solid Waste (1999), the Sub-Decree on Water Pollution Control (1999) and the Sub-Decree on the Control of Air Pollution and Noise Disturbance (2000).

112. The **Sub-Decree on Solid Waste Management**, ANRK.BK No. 36 of 27 April 1999 includes requirements for the handling and disposal of hazardous, or potentially hazardous waste. Some specialist lubricants, paints or other chemicals may be used in construction and their import, handling and disposal needs to comply with the requirements. Requirements are set out in Chapter 3 of the sub-decree and include allocating responsibility to the owner (or user) for temporary storage in a safe manner, and reporting to the Ministry of Environment on the type and amount of the waste, sources, packing and transport arrangement and process and management. The sub-decree also requires the Ministry of Environment to issue Prakas on standard relating to permissible quantities of toxins or hazardous substances contained in hazardous waste for disposal. Prakas № 387 (MOE), Implementation of Standard Limitation of Poisonous Quantity or Hazardous Substance Permitted for Disposal, was issued on 30 September 2015.

113. The the **Sub-Decree on Water Pollution Control**, No. 27 ANRK.BK issued 6 April 1999 sets standards to safeguard human health and biodiversity conservation. summarizes the effluent standards for effluent discharge into a public water area.

Table 1: Effluent Standards in Cambodia

Test	Unit	Discharge to Protected public water area (Std1)	Discharge to public water area and sewer (Std2)
pH	6-9	5-9	
BOD	Mg/l	<30	<80
COD	Mg/l	<50	<100
TSS	Mg/l	<60	<120
TDS	Mg/l	<1000	<2000
Grease and oil	Mg/l	<5	<15
Detergents	Mg/l	<5	<15
Nitrate	Mg/l	<5	<20
Phosphate	Mg/l	<3	<6
Ammonia	Mg/l	<5	<7

Table 2: Water Quality Standards for Rivers

No	Parameter	Unit	Standard Value
1	pH	mg/l	6.5 – 8.5
2	BOD_5	mg/l	1 – 10
3	Suspended Solid	mg/l	25 – 100
4	Dissolved Oxygen	mg/l	2.0 - 7.5
5	Coliform	MPN/100ml	< 5000

Table 3: Water Quality Standards for Lakes and Reservoirs

No	Parameter	Unit	Standard Value
1	pH	mg/l	6.5 – 8.5
2	COD	mg/l	1 – 8
3	Suspended Solid	mg/l	1 – 15
4	Dissolved Oxygen	mg/l	2.0 - 7.5
5	Coliform	MPN/100ml	< 1000
6	Total Nitrogen	mg/l	1.0 – 0.6
7	Total Phosphorus	mg/l	0.005 – 0.05

Table 4: Water Quality Standards for Coastal Waters

No	Parameter	Unit	Standard Value
1	pH	mg/l	7.0 – 8.3
2	COD	mg/l	2 – 8
4	Dissolved Oxygen	mg/l	2 - 7.5
5	Coliform	MPN/100ml	< 1000
5	Oil content	mg/l	0
6	Total Nitrogen	mg/l	1– 1.0
7	Total Phosphorus	mg/l	0.02 – 0.09

114. The Sub-Decree on the Control of Air Pollution and Noise Disturbance, No. 42 ANK/BK issued 9 June 2000, is to protect the quality of environment and public health from air pollutants and noise pollution and applies to all movable sources and immovable sources of air and noise

pollution. It sets ambient air quality standards (Table 5) and maximum permitted noise levels (Table 6).

Table 5: Ambient Air Quality Standards

Parameters	Period 1h Average mg/m^3	Period 8h Average mg/m^3	Period 24h Average mg/m^3	Period 1year Average mg/m^3
Carbon monoxide (CO)	40	20	-	-
Nitrogen dioxide (NO_2)	0.3	-	0.1	-
Sulfur dioxide (SO_2)	0.5	-	0.3	0.1
Ozone (O_3)	0.2	-	-	-
Lead (Pb)	-	-	0.005	-
Total Suspended Particulate matter (TSP)	-	-	0.33	0.1

Table 6: Maximum Permitted Noise Level in Public and Residential Area (dB (A))

Location	Period		
	06:00 to 18:00	18:00 to 22:00	22:00 to 06:00
Silence Area - Hospital - Library - School - Nursery	45	40	35
Resident Area - Hotel - Administration place - House	60	50	45
Commercial, Services Areas and mix	70	65	50
Small Industrial factories intermingling in residential areas	75	70	50

115. The sub-decree No. 42 also provides for monitoring of air quality (chapter 4), however a country synthesis report on Air Quality Management states that this only takes place regularly in Phnom Penh[6] and this remains the case.

4.3 Environmental Health and Safety Guidelines of the International Finance Corporation

116. The International Finance Corporation (IFC) of the World Bank Group provide Environmental, Health, and Safety (EHS) Guidelines, which are technical reference documents, occasionally updated, to promote good industry practice. These include guidelines for water and sanitation. The EHS Guidelines give performance levels and management measures that are generally considered to be achievable for new facilities with existing technology at reasonable cost. When host country regulations differ from the levels and measures presented in the EHS

[6] Asian Development Bank and the Clean Air Initiative for Asian Cities (CAI-Asia) Center. (2006) Country Synthesis Report on Air Quality Management, Manila.

Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures are recommended, justification is called for, demonstrating that the choice for any alternate performance levels is protective of human health and the environment.

117. For sanitation, the EHS guidelines on Impacts and Management cover several areas, including septage management, collection and treatment of wastewater in an urban situation, and on sludge treatment. For septage management, recommended measures include:

- Promotion of correct septic tank design and improvement of septic tank maintenance. Septic tank design should balance effluent quality and maintenance needs
- Regular collection of fecal sludge and septic waste;
- Use appropriate collection vehicles, such as vacuum tanker trucks
- Use of treatment facilities so that untreated septage is not discharged to the environment.

118. For centralized sewerage collection and treatment, emphasis is given to considering the receiving water body use (whether navigation, recreation, irrigation, or drinking) together with its assimilative capacity to establish a site-specific discharge quality that is consistent with the most sensitive use. The most significant environmental impacts related to wastewater and sludge treatment, discharge, are release of liquid effluents, generation of solid waste, generation of air emissions and odors, use of hazardous chemicals and ecological impacts.

119. Treated wastewater (liquid effluents) may be reused for irrigation or other purposes if regulated or, if not re-used, discharged to the sea; rivers; large surface water bodies; smaller, closed surface water bodies; wetlands or lagoons. Suggestions in the guidelines to prevent, minimize, and control liquid effluents include:

- Employing treatment technologies that consider factors such as the quality and quantity of raw wastewater and its variability; available land area for the treatment facility; resources construction, operation, maintenance, and repair; availability of skilled operators, operator training, maintenance personnel, treatment chemicals, and replacement parts;
- Designing, constructing, operating, and maintaining wastewater treatment facilities to achieve effluent water quality consistent with applicable national requirements (or internationally accepted standards) based on the assimilative capacity and the most sensitive end use of the receiving water;
- Use of appropriate sludge treatment technologies that are designed based on the quantity and sources of sludge; available resources for sustained operation
- Consideration of land application or other beneficial re-use of wastewater treatment plant residuals because of risks to human health and the environment, based on guidance from the World Health Organization (WHO) and applicable national requirements;
- Management of air emissions from wastewater treatment operations include covering emission points where practical, or ventilation

120. Guidelines on protecting community health and safety are provided in connection with wastewater and septage collection, and for wastewater and sludge treatment. Potential impacts include emissions of harmful liquid effluents, air emissions and odours and physical hazards.

121. Means of managing community health risks or nuisance associated with air emissions and odours include providing bigger areas; siting facilities away from densely populated neighbourhoods and sensitive receptors such as hospitals and schools.

122. The guidelines also cover physical hazards to workers and visitors to sites, including restriction of access to waste management facilities using perimeter fencing, lockable gates, lighting and appropriate security measures.

123. Risks associated with land application, where excreta-related pathogens and toxic chemicals may be present in the wastewater include:

- Treating wastewater and sludge used for land application in a manner consistent with WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater and applicable national requirements;
- Withholding effluent for two weeks prior to harvesting;
- Restricting irrigation with treated wastewater to crops that are cooked before eating;
- Restricting public access

124. With regard to performance standards, the guidelines recommend that the choice of sanitation technology and design of wastewater treatment begin with a determination of the required level and type of treatment and in consideration of alternatives, considering appropriate treatment technologies; quality and quantity of raw wastewater and its variability; available land area for the treatment facility; resources for capital expenditures, training, operation, maintenance, and repair; and availability of skilled operators, maintenance personnel, treatment chemicals, and replacement parts. The guidelines recommend using applicable national requirements or internationally accepted standards, with effluent water quality goals based on the assimilative capacity and the most sensitive end use of the receiving water, using effluent standards that set limits for key parameters such as biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), nitrogen, phosphorous, etc. Indicative values for treated discharges, given in the guidelines are shown in below, against the relevant Cambodian standards (from Table 1).

Table 7: Comparison of Cambodian Effluent Standards with Indicative Values for Treated Sanitary Sewage Discharges from IFC Guidelines

Test	Unit	Discharge to Protected public water area (Std1)	Discharge to public water area and sewer (Std2)	IFC Guideline Indicative Values for Treated Sanitary Sewage Discharges
pH	6-9	5-9		6 - 9
BOD	Mg/l	<30	<80	30
COD	Mg/l	<50	<100	125
TSS	Mg/l	<60	<120	50
TDS	Mg/l	<1000	<2000	
Grease and oil	Mg/l	<5	<15	10
Detergents	Mg/l	<5	<15	
Phosphate	Mg/l	<3	<6	2 (total phosphorus)
Nitrate	Mg/l	<5	<20	10 (total nitrogen)
Ammonia	Mg/l	<5	<7	

125. The guidelines state that sludge quality for land application should be consistent with WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater and applicable national requirements.

126. For use of effluent in agriculture, including the land application of sludge, the EHS guidelines refer to *Guidelines for the Safe Use of Wastewater, Excreta and Greywater* published by WHO in 2006, providing detailed technical guidelines policy issues and regulatory measures, covering the use of wastewater, greywater and excreta in agriculture, aquaculture. The guidelines are available on the WHO website at: http://www.who.int/water_sanitation_health/publications/gsuweg1/en/

4.4 ADB Environmental Safeguard Requirements

127. The ADB environment safeguards requirements are set out in the Safeguard Policy Statement (SPS 2009). All ADB-financed projects must undergo environmental assessment, with management plans prepared as appropriate, to avoid adverse impacts of projects on the environment and affected people, minimize, mitigate, and/or compensate for adverse project impacts when avoidance is not possible, and help borrowers/clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks. The process commences with environmental screening and categorization using checklists developed by the ADB to determine (i) the significance of potential impacts or risks of the project to the environment, (ii) level of assessment and institutional resources required to address the safeguards issues, and (iii) information disclosure and consultation requirements of the project. Based on screening projects can be categorized as A, if impacts are irreversible, diverse, or unprecedented and over a wider area. For category A projects, a full environmental impact assessment (EIA) is required. Category B applies if environmental impacts which are site specific, less adverse than those of Category A and an initial environmental examination (IEE) is required. Category C applies to project is likely to have minimal or no adverse environmental impacts, in which case no EIA or IEE is required. are the smallest and least complex and does not require an EIA or IEE. The proposed subprojects are classified as Category B and require an IEE. The IEE is discussed with the executing agency (EA) and other stakeholders and upon approval is disclosed on the ADB website.

128. The SPS further requires the development of an environmental management plan (EMP) specifying the required mitigation and monitoring and who is responsible for implementation. Monitoring of EMP implementation by the EA is reported to ADB.

4.5 Climate Change Considerations

129. Water supply and sanitation services are vulnerable to projected changes in climate conditions including storm events and periods of drought. The ADB requires screening for climate risk and climate risk and vulnerability assessments (CRVA) and identification of climate-proofing options at the project level. sector guidance on ADB requirements is set out in *Guidelines for Climate Proofing Investment in the Water Sector: Water Supply and Sanitation* (2016). The CRVA includes identifying climate related risks, the drivers of vulnerability, development of climate change scenarios and an assessment of impacts on the project. Climate change adaptation options are developed and agreed. A Climate Risk and Vulnerability Assessment has been prepared for this project, based on site visits and projections for the project sites.

5 Description of the Environment

5.1 Physical Resources

5.1.1 Topography, Geology and Soils

130. The project towns, except for Sihanoukville, are situated in the Tonlé Sap basin, on low lying land surrounding the Tonlé Sap great lake and its wetland periphery. Sihanoukville is on the

coast, in the south west of the country, at the foot of the Cardamom Mountains which lie to the west of the Tonlé Sap basin and topography at the subproject area is undulating, while much of the city's development is on slopes overlooking the coast. Underlying rock in all project towns is generally sedimentary, deposited during the Mezozoic geological era (70 – 250 million years ago). The main rock types are consolidated shale, slate, sandstone, conglomerate and limestone. Intrusions of igneous granite like rock, of a type known as rhyolite, occur over the landscape, as small, generally conical shaped hills. Raised limestone outcrops also occur. In Sihanoukville, the predominant rock type is sandstone, with shales, clay marl and conglomerates incorporated. In certain strata, the sandstone is intensely fissured, giving it a high hydraulic conductivity except where clay is present.

131. Soils around the Tonlé Sap basin include podzols, which developed under forest vegetation, and saturated hydromorphic soils which have developed under conditions of poor drainage. Soils around Sihanoukville's coastal fringe where the subproject is located are alluvial, formed by accumulation of alluvium and tidal action including sand deposition. The soils are wet, favouring anaerobic conditions and have a high salt content.

132. Cambodia has a moist tropical climate, consistent of its location just 10-13 degrees north of the equator. The climate features warm to hot temperatures throughout the year and an annual monsoon cycle of alternating wet and dry seasons. The main wet season, the southwest monsoon, occurs between June and October, when reduced air pressures over Central Asia cause air to be drawn landward from the Indian Ocean. Approximately 80% of all rainfall occurs during this season. Conversely, during the cooler months between November and May, air flows over Cambodia originate from Central Asia and are drier, resulting in cooler and less rainy weather. Average monthly rainfall is around 1,500mm. However, total rainfall can vary considerably from year to year, resulting in occasional years of severe flooding and conversely, years of significantly low rainfall. Both can result in severe difficulties, as the floods of the late 1990's have demonstrated. Years of low rainfall may raise the risks of water use conflicts in some areas. The average daily temperature in Cambodia is 28^{o}C, temperatures can fall to 17^{o}C in January and be as high as 40^{o}C in May and June. Sihanoukville receives significantly higher levels of precipitation, though highly variable from year to year, ranging from 2,700mm per year to over 4,000mm per year.

133. Earthquake risks in Cambodia are generally low, as the country is underlain by the relatively stable continental block. The margins of the Mekong basin, mainly in neighbouring countries do experience earthquakes and tremors though seldom exceeding 6.5 on the Richter scale.

5.1.2 Water Resources

134. Water resources in the Tonlé Sap basin are relatively abundant, fed by precipitation and the inflow from the Mekong river. They are however increasingly vulnerable to damage through the impedance of drainage flows by roads and the effects of irrigation and resource conflicts can occur.

135. The quality and quantity of available surface water varies. Within the Tonlé Sap basin, there are 11 sub-basins among which annual flows vary significantly, and in some smaller rivers the flows regularly cease for a period during the dry season. Flows are often affected by river diversion, in several cases dating from the Angkorian period as the construction of canals and of large artificial lakes was a feature of the ancient Khmer civilization. The diversion of streams and construction of bunds to retain water on rice fields causes greater evapotranspiration, and reduced flow in the rivers, particularly at the onset of the dry season.

136. Surface water quality is vulnerable to sedimentation from river bank erosion and to the effects of damage to forested areas in the basin, which has occurred prolifically in recent decades

when natural forest logging intensified. Pollution is also a growing problem, mainly associated with poor solid and liquid waste disposal practices in large and small towns. Levels of coliform bacteria and biological oxygen demand of surface water are often high, particularly during the dry season.

137. The total estimated ground-water resource in Cambodia[7] is around 17.6 billion m^3, readily recharged by rainwater. While the resource is copious, its distribution is uneven and where groundwater is extracted for irrigation use as well as water supply, resource conflicts may potentially arise. A further concern in Siem Reap is the risk of groundwater extraction for any expansion of the city's water supply causing subsidence beneath the nearby Angkor temples.

138. Water quality testing does not take place on a regular basis at water supply facilities around the country. While MIH have the mandate for water testing and require all public waterworks to conduct water quality testing every three months, this does not currently take place.

139. RGC drinking water quality standards prepared by the (former) Ministry of Industry, Mines and Energy in 2004 set out responsibilities for water quality monitoring and guidance on frequency, method and parameters to be monitored. These were upheld by standards prepared by the Ministry of Industry and Handicrafts in 2015. However, required water quality monitoring does not take place due to logistical and budgetary constraints. Outside the government structure, the Mekong River Commission undertakes regular water quality monitoring, though this is confined to permanent stations on the Mekong River or major tributaries, therefore there are no stations near Sihanoukville or Battambang. One station is situated at Kampong Cham. Published data reports findings per quality class. Water quality at Kampong Cham was reported as B (Good) on as scale of A (High) to E (Very Poor). Mekong River Commission (2015).[8]

Ambient Air and Noise Quality

140. In Siem Reap, issues with air quality in and around the temples attributed to high levels of vehicle usage, and in the city associated with tourism activity at night time, have received attention in the local press[9]. Regular, systematic monitoring of air quality, while mandated in the Sub-Decree on the Control of Air Pollution and Noise Disturbance, (2000), does not currently take place outside Phnom Penh (as mentioned in section 4.2).

5.1.3 Climate Change

141. The effects of climate change predicted in Cambodia include (i) an increase in ambient temperature consistent with the phenomenon of global warming; (ii) a prolonged hot period of the year with a longer and warmer dry season; and (iii) a later, briefer and more intense wet season, resulting in higher levels of precipitation. Climate related hazards include flooding which can threaten the operation of wastewater treatment plant and spread untreated or partially treated wastewater. Although flooding is a natural occurrence in much of the country, it can reach extreme levels and cause damage to infrastructure, as seen during typhoon Ketzana in October 2009. Devastating floods used to occur about every five years (in 1961, 1966, 1978, 1984, 1991, and 1996). Recently, however, damaging floods have occurred almost every year since 1999, with floods in 2000 and 2011 particularly severe. Also of significance to water availability is the distribution of precipitation over the year and periods of drought can appear.

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[7] MOWRAM (2001) National Water Sector Profile, Kingdom of Cambodia. MOWRAM, Phnom Penh.

[8] Mekong River Commission (2015). 2013 Lower Mekong Regional Water Quality Monitoring Report. Technical Paper No.51.

[9] http://www.phnompenhpost.com/post-weekend/calls-shhh-noisy-pub-street;
http://www.tourismcambodia.com/news/localnews/13072/apsara-national-authority-pollution-level-in-angkor-area-is-not-yet-critical.htm

142. A Climate Risk and Vulnerability Assessment has been prepared for this project, based on site visits and projections for the project sites. Projections show that the increase in intensity of rainfall during extreme weather events does not vary across the country. The 1 in 10-year event by 2030 under RCP 8.5[10] will experience a 4 % increase in 1 hour rainfall intensity and by 2050 under RCP 8.5 there will be a 7% increase in 1 hour rainfall intensity. The 1 in 100 year event by 2030 under RCP 8.5 will experience a 7 % increase in 1 hour rainfall intensity and by 2050 under RCP 8.5 there will be a 12% increase in 1 hour rainfall intensity. The projected results show that by the year 2050 daily peak temperatures could reach 49.5^{o}C. This would be a 1 in 100 year event. A more common scenario would be daily peak temperatures reaching 47^{o}C which would be a 1 in 10 year event. The highest probability of a severe drought occurring is 7.5% by the year 2050 in Battambang, equating to a 1 in 13 year event. The highest probability of an extreme drought occurring is 4.29% by the year 2030 in Siem Reap, equating to a 1 in 23 year event.

5.2 Ecological Resources

5.2.1 Overview

143. The project towns are provincial capitals, which are both expanding and increasing in population density. Ornamental trees have been planted along main streets, but as older buildings are becoming replaced with large retail facilities, hotels and apartment blocks, trees are often removed, with greater emphasis placed on green spaces and parks within the towns. The towns are expanding outwards, into low density residential areas at the periphery and farmland immediately beyond.

144. Siem Reap and Battambang and Kampong Cham are in the Tonlé Sap basin, around the Tonlé Sap lake. The Tonlé Sap lake has a unique annual cycle in which water from the Mekong river flows inwards continuously for approximately half of the year, and this water drains out steadily for the other half of the year. This has resulted in a correspondingly unique ecosystem dominated by species that are adapted to thrive in the substantial zone around the lake that endures major changes in dry and inundated conditions and has significant biodiversity conservation value. The lake, its wetland margin including unique "flooded forests" and a surrounding buffer zone form the Tonlé Sap Biosphere Reserve. The provincial towns lie outside the Tonlé Sap Biosphere Reserve, however, stormwater and wastewater from the towns flows towards the reserve.

145. Sihanoukville also features rapid intensification in its centre and expansion at its periphery, although trees have largely been kept in place around some of the hotel developments. The surrounding marine environment coastal area features coral formations and seagrass beds, which are vulnerable to marine pollution and sedimentation. An extensive wetland area featuring waterways and mangrove forests occurs to the south of the city, within the Ream National Park.

5.3 Items of Historical and Cultural Significance

146. The highly significant remnants of the Angkorian civilization, which occupied much of what is now north and northwest Cambodia from the ninth to the fifteenth centuries, generally lie outside

[10] Representative Concentration Pathways (RCPs) are four greenhouse gas concentration (not emissions) trajectories adopted by the IPCC for its fifth Assessment Report (AR5) in 2014. They represent four possible climate futures, all of which are considered possible depending on how much greenhouse gases are emitted in the years to come. The four RCPs, RCP2.6, RCP4.5, RCP6, and RCP8.5, are named after a possible range of radiative forcing values in the year 2100 relative to pre-industrial values. RCP 2.6 assumes that global annual GHG emissions (measured in CO2-equivalents) peak between 2010–2020, with emissions declining substantially thereafter. Emissions in RCP 4.5 peak around 2040, then decline In RCP 6, emissions peak around 2080, then decline. In RCP 8.5, emissions continue to rise throughout the 21st century, this is the most pessimistic, extreme scenario.

the modern cities. They are important economic assets, supporting a major tourism industry of which the city of Siem Reap is the main hub. Siem Reap has over 300 hotels and guesthouses, supporting a large transitory tourist population which places significant demands on the city's infrastructure.

147. The development of the project towns, particularly Battambang, Siem Reap and Kampong Cham, was strongly influenced by the French colonial era from 1867 to 1946 and buildings from that era are distinctive and remain in parts of each town, though many of the larger administrative buildings have been replaced during recent decades, while some commercial and residential buildings are being replaced as the city centers intensify. Other items of cultural significance include colonial era buildings and monuments, many of which feature distinctive Khmer architecture and have been built since independence in 1946.

5.4 Human and Economic Development

5.4.1 Health

148. Public health in Cambodia, is improving, for example the under-five mortality rate decreased from 83 per 1,000 live births in 2005 to 28.7 per 1,000 in 2015 but remains a significant challenge. A significant portion of the population does not have access to piped water supply and fewer have access to improved sanitation. An estimated 14% of infant deaths are attributed to diarrheal diseases. In comparison to the development of water supplies in Phnom Penh and the provincial towns in Cambodia, the wastewater sector is still in an early stage of development with the discharge of untreated wastewater into lakes and waterways commonplace, even in the capital, Phnom Penh, placing communities living near discharge areas and affected waterways at risk.

5.4.2 Livelihoods

149. Agriculture and tourism are the mainstays of the economy in the Tonle Sap basin, particularly around Battambang and Kampong Cham. Battambang in particularly has long been renowned for quality rice, fruit and vegetable production. Plantation based industries including rubber, oil palm and fruit orchards are becoming prolific particularly around Kampong Cham, while the economy in Siem Reap is dominated by the tourism industry associated with the Angkor temple complex.

150. Sihanoukville benefits from its position as the country's only deep water port. The city's coastline, nearby Ream National Park and Kbal Chhay waterfall attract national and international visitors, supporting a tourism industry. Some manufacturing industry has developed, utilizing ready access to international markets.

5.4.3 Poverty

151. A socio-economic survey of the areas to be serviced by sanitation improvements for the project was undertaken during the PPTA. Fourteen percent of households were found to be poor, approximately half of which are very poor, using the Ministry of Planning categorization system IDPoor. IDPoor uses a proxy means test with participatory elements, categorizing HHs as poor category 1 (P1 - very poor), poor category 2 (P2 - poor), after an assessment of occupation, education and income, health and disabilities of all family members, housing status and conditions, access to water and sanitation facilities, household debt, economic shocks and vulnerabilities.

5.4.4 Ethnic Groups

152. The main ethnic minority populations in Cambodia are the Cham, the Chinese, the Vietnamese and the Khmer Loeu. The Khmer Loeu are indigenous hill tribes and are more often amongst the poorest and most vulnerable.

5.4.5 Unexploded Ordnance

153. Unexploded ordnance remaining from the earlier civil conflict is widespread around the country, resulting from both aerial drops and from ground fighting. Clearance of areas either known or suspected to contain live ordnance is a slow and expensive process, but is taking place steadily, in much of the country. Unexploded devices are typically encountered when ploughing fields, searching for scrap metal and even by children playing. Due to the prolonged and complex nature of the conflict in the region, the placing of ordnance is difficult to predict and, except where thorough clearance has taken place, or in areas that are frequented by people and livestock. Where there is a significant risk of the presence of unexploded ordnance, specialist clearance and/or verification services are necessary.

6 Anticipated Environmental Impacts and Mitigation Measures

6.1 Method of Assessment

154. The potential impacts were screened during the process of design review and IEE preparation, to identify potential impacts related to location, construction and operation, stakeholders were consulted, and suitable mitigation measures and an environmental management plan developed. The area of influence for each subproject comprises the inner core areas of the towns where sewerage services will be improved, the pipeline alignments leading to the treatment facilities and in the case of Sihanoukville, Battambang and Kampong Cham, the sites of the treatment facilities themselves.

6.2 Environmental Impacts Related to Location

155. The projects are in urban or peri-urban areas. In the town centres, intensive development of public infrastructure including roads, commercial and residential buildings, replacing older buildings with modern multistorey buildings has taken place and is ongoing. These developments increase the density of both commercial entities and private dwellings, generating greater volumes of wastewater. As these changes have been occurring, investment in wastewater infrastructure has received relatively little attention. As described in section 3, infrastructure in the Battambang, Sihanoukville and Kampong Cham is inadequate while that in Siem Reap suffers from the failure of a major interceptor sewer. Untreated or inadequately treated wastewater therefore flows from the towns into nearby waterways, severely impairing water quality and posing public health issues. The subprojects have been identified and designed to directly address these problems and enable reliable collection of wastewater via sewerage networks in Sihanoukvile, Siem Reap and Battambang and by means of improved septage collection in Kampong Cham and improved treatment to meet wastewater discharge standards. A major positive impact on the urban and periurban environment in the subproject towns is therefore predicted.

156. **Effects on vegetation**. Pipe laying and replacement in the city centres will not involve removal of street trees, and urban parks will not be affected. Immediately outside the towns, where wastewater treatment plants will be constructed in Battambang and a septage facility will be built near Kampong Cham, land will be taken up for the facilities. No mature trees will be removed,

though small trees of diameter less than 20cm will be removed near Kampong Cham. The effect is minor and mitigated by the inclusion of tree planting in the landscaping of the wastewater treatment plants and septage facility, using species chosen on consultation with the Provincial Department of Environment (PDOE). For Sihanoukville, the upgrading of the WWTP will occur within the land footprint of the existing treatment plant, with no impacts on vegetation or natural features.

157. **Unexploded Ordnance (UXO) risks**. The subproject work sites are in urban areas and are occupied by the urban populations. Consultations with provincial government agencies, communes and village chiefs has not identified any potential risk of UXO. Bid documents will emphasize the need for contractors to be aware of the risk with a requirement to consult the provincial, district and village administrations regarding potential risks and to plan their work accordingly. Where unexpected UXO are encountered, the contract documents shall require that work is to cease until the UXO contamination has been identified and any necessary clearance and decontamination has been undertaken by a specialized contractor, managed by the respective project management unit (PMU) and project implementation unit (PIU). A clearance certificate and appropriate supporting documentation must be submitted to the Government and ADB before any works start in areas where the presence of UXO is suspected.

158. **Loss of land and effects on property**. Impacts on public and private property are limited. Within the towns, pipe laying will entail disruption to traffic and access to individual properties. These effects are temporary and concrete aprons and similar structures will be reinstated as part of the works. In the case of Battambang, new land will be required for the new wastewater treatment plant.

159. A Resettlement Plan has been completed for the Battambang subproject. It found that the subproject involves physical changes through civil works mainly within existing corridors of impacts along pubic right-of-ways and site specific land requirements for wastewater treatment facilities. The PPTA team took (i) a preliminary measurement survey (PMS), and (ii) a socio-economic survey of affected households (SESAH) after the feasibility study and preliminary design. The surveys found that four affected households (AHs) will lose a total of 48,026m^2 of land, equivalent to 71 % of their total productive land. RGC will provide 18,060m^2 productive land. No residential land or primary structures will be lost, and no relocation will occur. Where pipes are to be laid within the public right of way, an estimated 1,784 road access points to private properties will be affected and reinstated as part of construction work. No trees, crops or services will be affected. The four AHs that will lose productive land will be compensated in-cash or in-kind. Depending on their decision, to be made in 2018, the income situation must be re-surveyed and support is to be provided by the Interministerial Resettlement Committee for income restoration to a minimum of pre-project level. Three of the AHs, housing 19 affected persons, are socially vulnerable, and all 4 AHs housing 23 people in total, are severely affected by more than 10% loss of their total owned productive land.

160. Screening in Siem Reap and Sihanoukville similarly confirmed that there will be no permanent impacts on property, income, land or trees, but there will be temporary impacts where access to properties is affected during construction but is to be reinstated. In Kampong Cham, no such impacts are envisaged about the construction of the septage facility.

Flood risks associated with climate change.

161. The Battambang wastewater treatment plant is located on a flat site likely to be vulnerable to flooding. The CRVA recommends that flood calculations used in detailed design should allow an increase of 12% on short duration rainfall intensity for the design of site drainage and bund height.

162. The Kampong Cham septage treatment facility is on an elevated site that is unlikely to be flooded. Sludge drying beds are open to the weather and may be inundated with intense rainfall. Light weight free standing roofs over the sludge beds should be considered.

163. The Sihanoukville wastewater treatment plant site is located close to the sea but not immediately adjacent to it. Sea level rise is not considered to be a threat at this site but flood risk should be considered when designing the pumping stations. The increased temperatures may stimulate the bacterial action in the lagoons. Temperature more than 40^{o}C may be encountered. This should be factored into the efficiency calculations of the additional surface aerators.

164. The replacement interceptor sewer at Siem Reap will be in an area classed has having a moderate risk of flooding. This may impact on the construction program. Other than that no major climate change impacts are envisioned.

6.3 Environmental Impacts Related to Construction

165. **Impedance of traffic**. Pipe placing or replacing will involve impedance to traffic, including access to individual properties. The input is temporary and will be mitigated by requiring the contractor to (i) provide notices to the public advising of timing and duration of construction work and the effects on traffic routes during construction; (ii) place "safety first" traffic signs and warning signs, (iii) identify and mark detours when necessary, (iv) arrange temporary traffic signals, (v) liaise regularly with traffic police (vi) clearly demarcate construction sites and (vii) to the extent practicable, schedule work that blocks roadways to periods of low traffic.

166. In the case of Siem Reap, trenchless technology will be used. This will cause some disruption, depending on the precise choice of technique by the contractor. It is expected that an air compressor and a drilling unit will need to be set up at the start and end of the works, and at intervals along the length of the pipe that is to be replaced. This will unavoidably block one land of traffic, while pipe sections and removed material will be placed at the construction site temporarily and may obstruct the sidewalk. The contractor will be obliged to (i) maintain one free traffic lane, (ii) provision of a detailed traffic management plan for review and approval by the implementation consultant, (iii) provide notices to the public, (iv) place traffic safety signs and detour sign and (v) fence off the construction sites.

167. **Noise pollution and vibration**. Excavation and pipe laying within the town centres will cause noise and vibration, as will the improvement of the wastewater treatment plant at Sihanoukville and the construction of the new wastewater treatment plant at Battambang. To mitigate the impacts for Battambang, Kampong Cham, and Sihanoukville the contractors will be required to (i) provide information on scheduled work to affected persons through direct liaison and via the local media about the timing and duration of the works (ii) limit construction activities to normal daylight working hours (iii) adhere to the planned work schedule and (iv) ensure that all construction equipment and vehicles are kept in good working order with working exhaust mufflers. In Siem Reap the community and the government and provincial agencies have requested 24/7 construction to advance the work and reduce the overall period of disruption. While the contractor will be required to comply with the above general conditions, additional conditions will be imposed with respect to work during night hours, for the use of noisy equipment, methods of operation which limit noise and related disturbance (e.g. hydraulic rather than pneumatic equipment, and confining

the noisier activities to daylight working hours. Also the masking of lamps and floodlights to prevent spillage of light onto adjacent residential properties and guesthouses/hotels.

168. **Waste Generation**. Construction waste will include packaging of equipment, fuels, lubricants, materials, equipment and food. Some specialist lubricants and paint for marking may be hazardous. Imports of such materials for the work and their disposal of surplus materials and of packaging must comply with the Sub-Decree on Solid Waste Management. ANRK.BK No. 36 of 27 April 1999, ensuring no illegal dumping of hazardous waste. All other solid waste will be taken to a landfill or municipal waste disposal site.

169. In the case of Siem Reap, pipe replacement could release an estimated 120 to 150 m^3 of untreated sewerage sludge in the pipe. The material will be removed section by section as the work proceeds. The untreated sewage will be brought to the surface and transported by a vacuum truck if feasible (the material may contain fragments of the old pipe that would make the use of a vacuum hose infeasible) or in a truck with a sealed and covered tray to prevent spillage, and transported to the city's wastewater treatment plant.

170. **Release of silt**. Excavations from pipe trenches and foundations for structures will involve making temporary stockpiles of material that will either be removed or re-used as backfill. To prevent soil release contractors will be required to exercise caution to prevent erosion losses, ensuring that (i) excavated areas are rapidly refilled on completion of works (ii) stabilize soils once the pipeline is in place (iii) place silt fences around temporary piles of excavated material and (iv) avoid excavation of trenches in wet weather to the extent practicable.

171. **Wastewater and sludge.** Existing wastewater flows will not require management during construction, as the connections to the new systems will function only on the commissioning of the new WWTPs. Sludge from lagoons excavated in Battambang and Sihanoukville should be allowed to dry and then be covered, or excavated and disposed at an approved landfill where the material (deactivated sludge) will be suitable for use as landfill cover, or distributed for land application. The subprojects include provision of sludge pumps, small wheeled excavators, dewatering containers and drying beds. It is envisaged that ponds that will be de-sludged will take place after intervals of at least a year, while digestion takes place to kill pathogens. Drying further kills pathogens and helminth worm eggs. National effluent standards have been used in design. These include coliform concentrations of 5,000 MPN / 100ml. World Health Organization (WHO) standards stipulate concentrations for verification monitoring of less than 100,000 E.coli per 100ml for restricted irrigation.[11] The WHO guidelines also state that "treatment of excreta, thermophilic digestion (50 °C for 14 days) and composting in aerated piles for one month at 55–60 °C (plus 2–4 months for further maturation) are procedures that will satisfy the reduction of pathogens to achieve the health-based target values", As this level of treatment is much briefer than the treatment specified for the WWTPs, the sludge will be compliant with WHO standards for land application.

172. **Soil and water pollution**. The use of vehicles and plant can cause risks of soil and water pollution, in the event of leaks and spills of fuel, lubricants, hydraulic fluid or other fluids used for vehicle operation. To reduce risks and limit impacts the contractor will be required to ensure that vehicles and plant are maintained in sound operable condition, free of leaks and that the condition of vehicles and equipment is regularly checked. The contractor will prepare and submit a plan for spill management, including provision of spill kits, training/briefing of workers on procedures on

[11] WHO (2006) Guidelines for the Safe Use of Wastewater, Excreta and Greywater. WHO, Geneva

handling spills and allocation of responsibility within the contractor's team for ensuring that spill kits are available and that workers know how to use them.

173. **Air and dust pollution**. Potential sources of air pollution are exhaust fumes from vehicles and plant, dust from transport of construction and waste materials and areas around work sites where soil and debris is deposited. The mitigation measures are to require vehicles and equipment to be well maintained and tuned and fitted with exhaust baffles. Trucks are to be fitted with tarpaulins to cover loads when carrying fine material. Water will be applied to suppress dust around work sites where needed.

174. **Community health and safety risks**. The use of plant and machinery, handling of untreated sewage (in Siem Reap), use of compressed air lines and cables and excavations are all potential hazards to the public. Risks are to be mitigated by providing notices to the public identifying hazards; erection of safety barriers/covers for area of open excavation and provision of watch persons to control access.

175. **Occupational Health and Safety**. To reduce day to day risks associated with working with heavy equipment in trafficked areas, contractors will be required to appoint health and safety officers for each site and to ensure regular briefing of the construction workforce on health and safety issues. Personal protective equipment to be provided to the workforce, appropriate to each site. In the case of Siem Reap, contractors will be required to arrange inoculations against infectious diseases.

6.4 Environmental Impacts Related to Operation

176. **Risks of inadequate effluent quality**. The preliminary design of the system carried out by the CDIA team has been based on the national effluent discharge standard for coliforms when discharged to lakes and reservoirs under 1000MPN/100ml or less. This is more stringent than the requirement for discharge into a river and has been used as discharge will not be directly to the river but through a series of public irrigation waterways, thus taking account of EHS guidelines which emphasise the intended use of the receiving water body. Required lagoon dimensions have been calculated to meet these effluent standards and can be accommodated on the site. Consistent attainment of the standard requires correct day to day operation. Failure to carry out the day to day tasks involved in operation, undertake routine maintenance and carry out repairs to the ponds and equipment as required could impair the effectiveness of the wastewater treatment plant. This is especially important in the case of Battambang, where trickling filters will be used at the plant. Successful operation of the plant involves keeping flows of effluent constant to ensure that bacteria involved in the treatment process are kept alive. Critical tasks particular to the use of trickle filters are, (i) monitoring of pump operation (ii) rapid rectification of any failures of the pumps and of the rotating arm that distributes effluent over the filter media surface (iii) monitoring of odour, to identify anaerobic conditions which can arise from a shortage of air in the system or excessive or unexpected loads. Regular monitoring and reporting on the findings are required to ensure that the plant is effective. Provision is included for test kits and training in their use.

177. **Regular maintenance**. Regular backwashing to clean filters. This involves diversion of treated effluent back into the anaerobic ponds, to clear filters. Material released from the filters will then be treated within the ponds.

178. **Sludge management**. The preliminary design assumes that sludge is removed as the anaerobic lagoons approach being half-full, this is likely to occur once a year. This involves dewatering the lagoons so that they dry to a level where sludge can be handled and emptied. For

this purpose, the design includes concrete access ramps and provision for a compact excavator (in Battambang and Sihanoukville), assisted by portable submersible sludge pumps. The sludge is then dried to kill both helminth worm eggs and pathogens. A mechanised sludge press is also included to expedite the drying process. Sludge is to be delivered to a landfill, or disposed by land application. Where it is to be disposed by land application, sludge should be tested to ensure that contaminant levels comply with national standards for discharge to public water areas (see Table 2 and also para 170). Treatment of sludge at the proposed septage facility at Kampong Cham also involves storage for at least a year in treatment ponds and pressing and drying, prior to distribution or disposal.

179. The necessary level of operation and maintenance needs to be ensured by training, provision of operational manuals and employment of staff of sufficient capabilities and numbers.

180. **Operator occupational Health and Safety**. In addition to training, including training in recognizing and rectifying risks and hazards, the provision of personal safety equipment and its continuous use is necessary and shall be issued and worn. Health and safety will be recognized as primary an employer responsibility. The treatment involves microbial digestion and no hazardous chemicals are used.

181. **Community Health and Safety**. The wastewater treatment plants and to a lesser extent, the septage facility are potentially hazardous, particularly to children. Regular checking of the perimeter fence to ensure it is effective to prevent members of the public from entering the WWTP, and control of access is necessary to reduce or eliminate these dangers. Impacts of odour or air emissions are limited. In Battambang, the new treatment plant site is sited away from the town or any village area, on a large site consistent with EHS guidelines for managing odors and emissions. In Sihanoukville, the issue of odour does not currently arise, and as a further protection measure the proposed solar mixers are to be fitted with odour caps to contain any emissions.

182. **Risk of pipe failure**. Failure of sewage pipes (including potential repeat failure in Siem Reap) would cause release of untreated sewage and release into waterways, entailing human health hazards. The risks are mitigated by early detection. This is achieved by regular inspection to monitor leaks and any blockages. Training in O&M, provision of site log books and help ensure regular inspection.

183. **Greenhouse Gas Emissions**. The infrastructure to be installed by the project will include water and wastewater treatment facilities, which require energy for pumping, aeration and in addition, treatment of domestic wastewater will involve the emission of ammonia (CH_4) and nitrous oxide (N_2O), over and above baseline levels. Baseline levels, under the "without project" scenario are estimated at 1.64 kilotons of CO_2 equivalent per year. The expected emissions from power and wastewater treatment, for the wastewater projects under the "with project" scenario is 14.42 kilotons of CO_2 equivalent per year[12]. Table 8 gives the breakdown by subproject. However, the emissions levels are expected to be partially mitigated using advanced low-carbon technology for the Sihanoukville WWTP where the use of solar powered mixers will reduce energy demand by 8611 KWhrs/day, equating to a reduction of 2.2 kilotons of CO_2 equivalent per year[13].

[12] Agence France de Developpment team calculations
[13] Estimated using online calculator provided by the US EPA https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

Table 8: Estimated annual Green House Gas emissions per year

Subproject	Estimated emissions (t CO_2 equiv/year) without project	Estimated emissions (t CO_2 equiv/year) without project	Effect of use of solar powered mixers
Battambang Wastewater	250	6,479	-
Kampong Cham Septage	0	2,036	-
Sihanoukville Wastewater	1,391	5,908	-2,200
Total	1,641	14,423	12,223

6.5 Global, Transboundary and Cumulative Impacts

184. The proposed improvements will occur within and around the project towns. The negative environmental impacts identified through screening will almost all be confined to the towns and their immediate environment. However, the improvements in collection and treatment will substantially reduce discharge of untreated sewerage into waterways, including rivers and streams that flow into the Tonlé Sap great lake.

185. The sector review raises the fact that investments in sanitation in Cambodia's cities and towns has not occurred at a similar pace to investments in water supplies, with problems such as release of untreated sewage, overloading of wastewater facilities commonplace. The subprojects are expanding wastewater treatment capacity in the case of Battambang and Sihanoukville, rectifying an existing failure in the case of Siem Reap, and introducing septage management, as a minimum investment in sanitation, in the case of Kampong Cham. Impacts on public health are expected to be significant and positive. Training and experience of staff who will operate and maintain the systems may add to the build-up of capability required to manage further improvements in waste collection and treatment in the future.

7 Analysis of Alternatives

7.1 Alternatives to the Subprojects

186. An alternative to the subprojects would be the use of investment funds in alternative towns to contribute to the Government's target for 100% urban water supply and improved sanitation coverage by 2025, in different towns and in water supply improvements rather than sanitation. The subprojects were chosen from among other candidate subprojects based on feasibility, cost effectiveness, scale of impact, fit with national policy and ADB country strategy and financial capacity of the town administration.

7.2 Alternatives within the Subprojects

187. The scope of the subprojects is largely defined by rehabilitation and expanding urban sanitation services focusing on the provision of septage management services and/or sewerage system development and treatment to complete the expansion of the water supply systems. Alternatives in the cases of Battambang and Sihanoukville would concern the layout and pipe type for the wastewater collection network and wastewater treatment method. These alternatives form an essential part of the subproject rationale and are described as part of the project description.

Limitations in land availability limits the options for wastewater treatment methods, requiring the use of a partially mechanised systems. In Kampong Cham, the proposed site for the septage treatment facility is approximately 18km from the city, entailing significant transportation costs. An alternative site, closer to the city, is being considered by the DPWT and the Governor's office.

188. In Siem Reap, alternatives concern mainly the choice of method to replace the failed interceptor pipe and of material for the new pipe. Regarding method, the option of trench digging has been considered, but will not be used because of the high level of disruption to traffic and business that will be caused, while trenchless technologies would be suitable. A design and build approach has been selected, allowing the contractor to identify the precise method of pipe replacement, and of material for the new pipe.

189. Scope for alternative, low carbon technologies that offer lower operational costs are being reviewed. As mentioned in section 6.4 above, the use of solar powered aerators are expected to be deployed for the WWTP at Sihanoukville. A study is under way to examine the use of low carbon technologies including a high-rate trickle filter for Battambang.

7.3 The no project alternative

190. The subproject is designed to address the sanitation situation in the project towns, all of which feature population growth, increasing per capita wastewater generation and deteriorating infrastructure. The subproject designs take into account future wastewater generation and in its absence the rate of deterioration of public health, quality of life and economic potential of the city would accelerate.

8 Information Disclosure, Consultation and Participation

8.1 Consultations and information disclosure during subproject design

191. Consultation began early in the project preparation stage with visits to the subproject sites and discussions with the provincial officers relating to the consultants who prepared the pre-engineering designs. The consultation has continued and will continue throughout project preparation and implementation, to provide timely disclosure of relevant and adequate information in an understandable and readily accessible form to key stakeholders. Consultation was organised to occur in an atmosphere free of intimidation or coercion, was gender inclusive and enabled the incorporation of all relevant views into the project design and arrangements for implementation.

192. The consultation involved Ministry of Public Works and Transport (MPWT) and their provincial agencies and utility operators, and local municipal and sangkat/commune officials and village representatives. Transparent consultation processes were also adopted for public village meetings during the socio-economic surveys (SES) and focus group discussions (FGDs) and during subsequent public meetings to explain the pre-engineering designs and for disclosure of land acquisition and resettlement and the likely environmental and social impacts. The environmental considerations have therefore been identified with the provincial authorities, the commune/sangkat authorities and their communities. The information made available includes the specific activities, schedules, anticipated environment and social impacts and mitigation measures and monitoring processes. Comment received during the village meetings and the other discussions with respect to environmental concerns have been incorporated into the mitigation measures proposed for detailed design and implementation. All persons met have been informed about the subproject in general and the environmental aspects in particular.

8.1.1 Feedback

Impacts on Health

193. An extensive socio-economic survey (SES) was undertaken of the villages in the water supply and wastewater/sanitation subproject areas in Battambang, Kampong Cham, Sihanoukville and Siem Reap at the outset of the PPTA activities. Core problems of inadequate water supply and sanitation infrastructure and services identified the degradation of the natural environment and poor health conditions, especially for the poorer communities. Poor water supply coupled with poor sanitation was seen to be contributing to regular incidence of diarrhea and dysentery, a major cause of death in infants. Poor water and sanitation was also seen to be contributing to growth stunting in young children. Lack of sanitation was also linked to kidney and urinary tract diseases especially in women who may "hold back" rather than go outside at night to urinate. Many HHs reported diarrhea in infants up to 5 years of age, and this is seen to be due to unclean water and poor sanitation.

Wastewater and Sanitation

194. Most people in the wastewater and sanitation subproject towns already use a basic flush to septic tank toilet system, much more so in Battambang and Sihanoukville than Kampong Cham where around 26% of HHs report still using the bush. The flush toilets are not always used and this is usually due to lack of water supply to facilitate cleaning. There is little awareness of what happens in the event of septage overflow and for domestic waste water, from kitchen and bathrooms, there is usually no system in place other than to discharge the waste directly out onto the roadside street drains, into the house yard or garden area.

195. Disposal of solid and liquid domestic waste is haphazard to say the least. Women participating in the FGDs indicated that very little thought is given to environmental or health considerations from inappropriate disposal, and people did whatever was easiest. This is one explanation for the excessive amount of trash and litter that can be seen lining roads in Cambodia and accumulating on the verges of peoples' houses. Women reported that improper disposal created environmental problems, provided breeding places for mosquitoes and flies, and created bad smells. Domestic waste water was reported to usually be disposed of without any specialized system, either emptying into the yard, or being diverted and flowing into roadside drains, reflecting a local practice that may previously have been viable in a rural environment but which was now unacceptable in a peri-urban environment.

196. Concerns over construction included generation of noise and dust, the latter possibly giving rise to increased respiratory tract infections or asthma, disruption of access to homes, and noise from machines. Measures to control these impacts are included in the EMPs.

197. Problems resulting from poor septage management were also discussed by the women's FDGs, and the following issues were identified: (i) no fresh air contributing to a bad environment; (ii) bad smells; (iii) sanitation problems and poor health; and, (iv) many mosquitoes and flies. The women focal groups considered the benefits of have an effective waste water disposal and sewage system, concluding that improved waste water and sewage disposal was a priority.

Possible Project Negative Impacts

198. The consultations identified few negative impacts from the proposed sanitation improvements, and any negative impacts identified are more than mitigated by overwhelmingly

positive benefits from the improved sanitation. With improvements in health, reduced expenditure on medical treatment are seen to improve HH finances.

199. As indicated above, other negative impacts identified included possible disruption to property access and dust from the construction and installation of the civil works. This is seen to impact more on women given that they may have to assist young children to get to school, go to the market and stay at home to look after sick family members, given that increased and uncontrolled dust during construction could contribute to an increase in respiratory disorders (such as asthma and bronchitis), illnesses that are more likely to affect the very young and very old. However, the dust generated by pipe installation will be kept to a minimum and the effect will be temporary, lasting around 1-2 days and localised. Most pipelines are not immediately adjacent to dwellings. Dust control measures such as spraying water over loose soil, sweeping and clearance of spilled spoil were advanced by the respondents as a method to reduce dust in construction areas, under requirements that can be incorporated into the civil works contracts for the Project. Other negative impacts were largely deemed to be insignificant.

Siem Reap Interceptor Sewer

200. The immediate impact, and disruption from replacing the pipe, will be felt by the businesses and HHs located adjacent to the pipeline route, which cuts through the central part of Siem Reap town. The pipeline follows a 3.7 km route along Sivatha Street and Wat Chork Street with 8 villages in the immediate impact area.

201. The SES interviewed a total of 253 people, comprised of 150 men and 103 women (41%). Of the respondents interviewed some 59% were owners of the property, some 30% were renting the property and around 11% were mangers of business establishments. Only 21% of the establishments surveyed were solely residential, and of some 191 businesses, 97% are open every day (7 days a week). Respondents were asked as to what they thought would be the main negative impacts on their business and livelihood if the pipeline was replaced. The main concerns expressed related to disruption to business and livelihood, traffic congestion and disruption to property access: (i) road access (6%); (ii) affected business (20%); (iii) problems with traffic (12%); (iv) difficulty in accessing road (8%); (v) difficulties in managing business (3%); and, (vi) difficulty in moving back and forth. All businesses require vehicular access or agreed alternative arrangements.

202. The respondents were also asked to make suggestions as to how negative impacts could be reduced, minimizing disruption to life and businesses. The responses included: (i) ensuring the construction of a quality drainage system (72%); (ii) extending the work day for construction to reduce the period of disruption (4%); (iii) quick construction (23%); (iv) short construction time for our business (29%); and, (v) ensuring a strong and good drainage system (10%).

203. To minimize disruption to access and business, most respondents (82%) would prefer the underground trenchless technology and for the pipe replacement to be done in short stretches rather than the whole road with closure of one side of the road only (71%). In relation to road closure, people preferred (93%) that only half the road was closed at any one time to allow continued vehicle travel.

8.2 Continuing Consultation with Resettlement Surveys and Consultation:

204. The disclosure of the land acquisition, resettlement and compensation information, consultation and participation of residents for the subprojects took place in a series of public meetings during January and February 2017. This involved fieldwork (DMS, household surveys,

consultation meetings in villages and transect walks) performed by the PWW/DPWT and the PPTA consultants. The consultation involved a description of project (and each respective subproject) and its current status; a general introduction into resettlement; an explanation of the Grievance Redress Mechanism; coverage of the likely construction impacts with particular reference to pipes in public right-of-ways; and clarification on environmental construction management relating to traffic and traffic management, access to properties, construction impacts including noise, dust and air pollution, operation of construction equipment and hours of operation, and environmental considerations.

205. **Battambang wastewater subproject**: Two (2) public commune meetings convened again during the same period involving 101 commune residents (48 female and 53 male).

206. **Sihanoukville wastewater subproject**: A public meeting for 3 combined Sangkats in February 2017 involving 30 chiefs of villages and Sangkats (commune) (3 female and 27 male).

207. **Kampong Cham Septage subproject**: Meetings were held with key stakeholders, including provincial and district officials, village office holders.

208. **Siem Reap Wastewater (Interceptor Sewer) subproject**: Two public commune meetings convened in February 2017 involving 54 commune residents (22 female and 32 male).

209. The contacted participants (i) showed high interest in the subproject and (ii) repeatedly mentioned their expectations towards the subproject, as water supply and sanitation are topics of high importance. The discussion with the participants concerned in general more wastewater operational matters including environmental matters and likely construction impacts rather than resettlement items.

8.3 Further Information Disclosure and Public Consultation

210. This draft IEE and a Khmer translation of the executive summary will be provided to commune officials for public disclosure. Affected persons in the subproject area will be kept informed of construction activities that are likely to cause noise and dust nuisance, or disruption to roads and pathways and will be made aware of the grievance redress mechanism and consultations will take place regularly to gain feedback and ensure that impacts are being adequately managed

9 Grievance Redress Mechanism

211. A PMUs will be established in the General Department of Potable Water Supply within MIH. The PMU will be responsible for implementing environmental requirements, including the Grievance Redress Mechanism (GRM). The GRM is project specific and covers environmental as well as resettlement safeguards and appears in each project EMP and resettlement plan (RP). It provides for receipt and management of any public concerns or issues which may arise due to the subprojects. The GRM comprises: (i) a set of clear procedures for the project to receive, record, and address any concerns which are raised; (ii) specific contact details for individuals at the commune chief, PMUs, PIUs or contractors, and (iii) the POE.

212. All contractors and work staff will be briefed by the PMU/PIUs on the GRM. Contractors and workers will be instructed to be courteous to local residents, and in the event they are approached by the general public with an issue, to immediately halt their work and report the issue to the foreman. The foreman will immediately report the issue to the PMU/PIU for action.

213. There are multiple entry points to the GRM, including face-to-face meetings, written complaints, telephone conversations, anonymous drop-boxes for written comments, and/or e-mail. All concerns received will be treated confidentially and professionally. The identity of individuals will not be circulated among subproject agencies or staff and will only be shared with senior staff, and then only when there is clear justification. In the construction period and the initial operational period covered by loan covenants. The PMUs will report on GRM to ADB, including complaints and their resolution in the quarterly project progress reports ,and semi-annual environmental monitoring reports up to the project completion report.

9.1 Basic steps for resolving complaints are as follows and illustrated in Figure EMP-1.

Step 1: For environmental problems during the construction and operational stages, the affected person (AP) can register his/her complaint directly with the contractors or with the PMU complaint center phone. A joint hotline for resettlement and environment issues will be established within PMU. Complaints related to land acquisition and resettlement issues can also be directed through the communerelevant agencies in accordance with the RP. Contractors are required to set up a complaint hotline and designate a person in charge of handling complaints, and advertise the hotline number at the main entrance to each construction site, together with the hotline number of the PMU complaint center. The contractors are required to maintain and update a Complaint Register to document all complaints. The contractors are also required to respond to the complainant in writing within 7 calendar days on their proposed solution and how it will be implemented. If the problem is resolved and the complainant is satisfied with the solution, this can be recorded by the PMU or PIU complaint center and follow-up should be carried out during the next project site visit by the independent monitoring organization (IMO). The contractors are required to report complaints received, handled, resolved and unresolved to the PMU complaint center immediately, and to the IA and PMU monthly (through progress reporting).

Step 2: If no appropriate solution can be found during step 1, the contractor has the obligation to forward the complaint to the PMU/PIU complaint center, and the local POE. The POE shall immediately notify PMU/PIU upon receiving the complaint. For an oral complaint, proper written records shall be made. Once a complaint is registered and put on file, the PMU complaints center will immediately notify ADB and others concerned to discuss acceptable solutions. The PMU complaint center will assess the eligibility of the complaint, identify the solution and provide a clear reply for the complainant within 14 calendar days. The IMO will assist the PMU/PIU complaint center in addressing the complaint, and follow-up with the AP. The PMU/PIU complaint center will also inform the ADB project team and submit all relevant documents. Meanwhile, the PMU/PIU complaint center will convey the complaint/grievance and suggested solution to the contractors, IA and/or facility operator in a timely manner. The contractors will implement the agreed redress solution and report the outcome to the PMU/PIU complaint center within fifteen (15) working days.

Step 3: In case no solution can be identified by the PMU complaint center, or the complainant is not satisfied with the proposed solution, the PMU complaint center will organize, within 14 calendar days, a multi-stakeholder hearing (meeting) involving all relevant stakeholders (including the complainant, IA, contractors, and local POE). The hearing shall identify a solution acceptable to all, and formulate an action plan.

214. The tracking and documenting of grievance resolutions by PMU/PIU will include the following elements: (i) tracking forms and procedures for gathering information from project personnel and complainant(s); (ii) regular updating of the GRM database by the PMU environmental safeguards officer; (iii) processes for informing stakeholders about the status of a case; and (iv) procedures to retrieve data for reporting purposes, including the periodic reports to the ADB.

215. At any time, an AP may contact ADB (Southeast Asia Department) directly, including the ADB Cambodia Resident Mission.

216. If the above steps are unsuccessful, persons who are, or may in the future be, adversely affected by the project may submit complaints to ADB's Accountability Mechanism. The Accountability Mechanism provides an independent forum and process whereby people adversely affected by ADB-assisted projects can voice, and seek a resolution of their problems, as well as report alleged violations of ADB operational policies and procedures. Before submitting a complaint to the Accountability Mechanism, affected people should make a good faith effort to solve their problems by working with the concerned ADB operations department. Only after doing that, and if they are still dissatisfied, should they approach the Accountability Mechanism.[14]

10 Conclusion

217. The overall finding of the IEE is that the Project will result in significant environmental benefits, as it is conceived and designed to address major environmental issues associated with inadequate wastewater collection, treatment and disposal in the project towns. It will not have significant adverse environmental impacts and potential adverse impacts are manageable through the effective implementation of the EMP. No further environmental assessment is therefore required, beyond the issues to be reviewed during detailed design.

218. The wastewater subprojects classification of Category B is confirmed.

[14] See: http://compliance.adb.org/

ENVIRONMENTAL MANAGEMENT PLAN:

Wastewater Subprojects

1 Environmental Management Plan

1.1 Objectives

1. This EMP sets out the needs for environmental management of the wastewater subprojects of the PWSSP in terms of institutional responsibilities to ensure mitigation and monitoring takes place during the pre-construction, construction and operation phases of each subproject, meeting the requirements of the RGC and the ADB's SPS.

1.2 Institutional Responsibilities

2. The PWSSP is scheduled for implementation over 5 years from December 2017 to December 2022. The PWSSP has two Executing Agencies; MIH is the Executing Agency for the water supply subprojects and MPWT is the Executing Agency for the wastewater and septage management improvement and the Siem Reap interceptor sewer replacement subprojects). MPWT's function covers the facilitation, coordination and development of urban wastewater systems, septage management and desludging through public or private operators licensed by MPWT and the provincial/ municipal governments throughout the country.

3. Two PMUs will be established in: (i) the General Department of Potable Water Supply (GDPWS) within MIH for the water supply subprojects; and, (ii) the General Department of Public Works (GDPW) within MPWT for the wastewater and septage subprojects, with full-time staff to execute and manage the Project. Each PMU will have appointed procurement officers and an environmental safeguards officer who will be responsible for EMP implementation for the subprojects. International and national environment consultants will be recruited through the PIAC consulting services to support the PMUs and provincial PIUs with supervision of implementation of the EMPs.

4. PIUs will be established in the provincial Public Water Works (PWWs) at Battambang and Kampong Cham, and the provincial Departments of Public Works and Transport (DPWTs) at Battambang, Kampong Cham, Sihanoukville and Siem Reap, with responsibility for daily oversight and supervision of subproject implementation. The PWWS and DPWTs will be the Implementing Agencies (IAs) and the PIUs will also be fully staffed to ensure that there is sufficient resource capacity for effective and efficient oversight of construction activities.

5. A Coordinating Committee (CC) will be established for project and sector coordination between MIH and MPWT. MIH will have responsibility for the coordination and consolidation of reports to MEF and ADB and will recruit the Project Implementation Assistance Consultants (PIAC) to assist the Project Management Units (PMUs) and Project Implementation Units (PIUs).

6. MIH and MPWT will be the respective subproject owners, within the meaning of the Law on Environmental Protection and Natural Resource Management (December 1996) with further guidance provided in the Subdecree on Environmental Assessment No. 72 ANRK.BK of August 1999. These laws require an environmental impact assessment (EIA) for every private or public project or activity, with the review and evaluation of the EIA by the Department of Environment Impact Assessment (DEIA) within the Ministry of Environment (MOE). The infrastructure subprojects for PWSSP require an IEIA following a format resembling that of the IEE, based on the IEIA it will be determined if a more detailed DEIA is needed.

7. MOE and the POEs play a role in submittal, review, and approval of the IEE, and monitoring and reporting. This work takes place during the implementation phase. The Environmental

Consultants attached to PIAC will revise and update the IEE based on final designs, and the document should be translated into Khmer prior to submittal to MOE, which will engage the POE from the province where the subproject is to take place in the review process. Only after ADB approves and discloses the updated IEE and DEIA approves the EMP for the subproject can a contract be signed between the IA and the contractor for the works. The PIU supported by the PIAC Environment Consultants will provide environmental inputs for the quarterly project progress reports and prepare semi-annual safeguard monitoring reports. The PMU will be responsible for submittal of reports to the EA and ADB.

8. The roles and responsibilities for the project are summarised below:

Table 9: Institutional Responsibilities for Environmental Management

Entity	Environmental Roles and Responsibilities
MIH	(i) Executing agency of the project responsible for overall project implementation and compliance with loan covenants and IEEs/EMPs.
MPWT	(i) Implementing Agency for wastewater subprojects
PMUs	(i) Responsible for project management, coordination, monitoring and supervision, including ensuring implementation of environmental mitigation and monitoring measures; (ii) Ensure timely submission for Government approvals related to environmental management; (iii) Ensure that the project's environmental management plans included in the IEEs are incorporated in the bidding documents and contract documents for all civil works; (iv) Review and approval of designs prepared by Contractors for works procured as Design and Build contracts; (v) Ensure EMPs are updated following detailed engineering design, as necessary; (vi) Review the CEMPs prepared by the Contractors for compliance with standards set in the EMP, instruct revisions as necessary, and approve prior to commencement of construction (vii) Ensure public disclosure of relevant project information and ongoing public consultation as per the EMP requirements; (viii) Co-ordinate and report on the project specific safeguards GRM, ensure that necessary actions to resolve complaints are taken, documented and reported; (ix) Ensure monitoring of environmental parameters specified in the EMPs; (x) Ensure compliance with loan covenants in accordance with agreed formats and frameworks; (xi) Oversee monthly environmental monitoring of the project and submit semi-annual environmental monitoring reports to ADB for disclosure on ADB's website; (xii) Oversee project compliance with relevant national and provincial requirements and co-ordinate with the relevant agencies; (xiii) Review and validate semi-annual environmental monitoring reports prepared with the assistance of the PIAC; (xiv) Lead follow-up consultation meetings with relevant institutions, stakeholders and affected persons on environmental issues; (xv) With the assistance of the PIAC, undertake regular construction site inspections and oversee implementation of the CEMPs by contractors;

Entity	Environmental Roles and Responsibilities
PIAC	(i) For works procured as Design and Build contracts, review designs in detail, checking for compliance with requirements in the EMPs, and advise PMU of any necessary revisions to the IEE and EMP prior to approval; (ii) Support PMUs with update of IEEs/EMPs following detailed engineering design; (iii) Check Bill of Quantities to ensure Contractors made adequate provisions for environmental mitigation and monitoring; (iv) On behalf of PMUs, and working with PIUs supervise the civil works packages and implementation of EMP mitigation and monitoring measures.
PIAC Environment Specialists (International and National)	(i) Review the detailed designs prepared for each subproject for compliance with the EMPs prepared during the PPTA. Update the IEEs and EMPs to reflect changes, modifications and additions that have potential impacts during construction and operation phases of the subprojects. (ii) Examine the CEMPs prepared by contractors for compliance with the EMP and advise PMU of revisions that need to be incorporated prior to approval and commencement of civil works; (iii) Ensure that all associated project facilities have the required permits prior to commencement of civil works; (iv) Brief PIAC engineering and PIU supervision staff on EMP provisions and provide checklists to ensure that they will be able to adequately supervise on a day-to-day basis the contractors and subcontractors about proper and timely implementation of mitigation measures specified in the EMP; (v) Monitor implementation of environmental mitigation measures and environmental performance of contractors based on the EMP schedule and assist MIH / MPWT in the preparation of semi-annual environmental monitoring reports for submission to ADB; (vi) Undertake training for the MIH/PMU, MPWT/PMU and PIU staff on environmental management and monitoring, to build their capacity in these areas. The training will be implemented through on-the-job training and workshops based on the provisions of the EMP; and (vii) Ensure that the affected stakeholders and sensitive receptors (eg. hospitals, schools, temples) are regularly updated on project activities and are aware of the multiple entry points to the project safeguards GRM.
Construction Contractor	(i) In the case of Design and Build contracts, prepare detailed designs in compliance with the EMPs for each subproject (ii) Appoint an Environment, Health and Safety Officer to manage, monitor and report on EMP implementation; (iii) Prepare site-specific CEMP containing the method statements for compliance with environmental management standards in the EMPs; (iv) Allocate sufficient funding for proper and timely implementation of environmental mitigation and monitoring measures; (v) Conduct daily inspection of the site and ensure the implementation of the CEMP during the construction phase; (vi) Prepare/submit monthly reports on mitigation and monitoring activities to the PMUs through the PIAC; and (vii) Act as the local entry point for the project GRM, conduct immediate

Entity	Environmental Roles and Responsibilities
	investigation of any complaint, report all complaints and their resolution to the PMUs. Ensure the timely and appropriate resolution of the complaint or incident in accordance with the GRM.
ADB	(i) Monitor and supervise the overall environmental performance of the project, review the semi-annual environmental monitoring reports and disclose the reports on ADB website in accordance with ADB Public Communications Policy (2011); and (ii) Conduct missions to review environmental compliance and provide advice on corrective actions.

1.2.1 Capacities for Environmental Management

Review of Environmental Assessments and Issuance of Environmental Licences

9. The PMUs within the General Department of Public Water Supply (GDPWS) within MIH and the General Department of Public Works within MPWT are yet to be established. As such there are no staff currently dedicated to environmental planning for PWSSP. Also within both general departments there is no strong mandate for environmental management, other than the responsibilities flowing from, but limited to specific projects although the MPWT now has a Social and Environmental Office, established with support of recent transport sector projects. Technical staff do have some capacity to manage infrastructure on a broad, strategic level as well as on a day to day level. To be able to review environmental assessments, technical staff members need to acquire an understanding of the principles and processes of environmental assessment. This should be sufficient to enable the staff of both general departments to engage and direct consultants in the preparation of environmental assessments.

10. MOE has requested that the project provide for adequate consulting services to prepare the domestic environmental assessments of subprojects following final design, to help ensure that the IEEs and the EMPs are completed to an adequate standard, with appropriate provisions for monitoring and training of the staff of DPWT.

Preparation of contract documentation

11. Support to the PMU for the procurement of civil works, consulting services and equipment will be provided by the PIAC. The PMU Consultants will be responsible for the inclusion of EMPs, including monitoring and reporting requirements, into bidding documents.

Capacities relating to environmental management during construction

12. MPWT and MIH staff have some experience or capacity in the implementation of EMPs, been acquired mainly on past or ongoing projects in the sector, but few staff are familiar with the requirements. Support for EMP implementation, including inspection of ongoing and completed work to check for compliance with EMP provisions and preparation of progress reports to government and ADB, will be provided by the implementation consultants. In order to be able to undertake these functions, technical staff from each ministry need to have an understanding of contractual arrangements for construction, and the provisions under each EMP.

13. Local contractors will be engaged for some packages, such as the septage treatment facility at Kampong Cham. Few contracting firms in Cambodia have experience of environmental

management, particularly preparation and implementation of CEMPs. Guidance in CEMP preparation can be provided to contractors by the implementation consultants.

Capacities relating to operation and maintenance of infrastructure:

14. Adequate operation and maintenance of water and sanitation infrastructure has not taken place to the standard and extent necessary to keep sanitation infrastructure in operable condition. This is one of the reasons that the proposed subprojects are necessary. The two ministries require assistance in ensuring competent operation, regular and periodic maintenance and phased replacement and upgrading of assets.

1.3 Impacts and Mitigation

15. Table 10 summarizes the potential impacts and mitigation measures for the four wastewater subprojects in relation to location, construction and operation identified in the IEE.

16. Costs of applying the mitigation measures are included in the infrastructure construction and operating costs and therefore not EMP costs per se. Contractors will need to budget for costs of undertaking the required mitigation measures in their bid price.

Table 10: Environmental Management Plan

Impacts	Location	Mitigation Measures	Source of Funds	Responsibility for Implementation	Responsibility for Supervision
Pre-Construction Stage					
Effects on private property or land	Battambang	Implementation of Resettlement Plan / Land Acquisition and Compensation Plan	Quoted in Resettlement Plan	DPWT	GDR
Disturbance of Unexploded Ordnance	Battambang Sihanoukville Siem Reap Kampong Cham	Consultations with district government agencies, communes and village chiefs has not identified any potential risk of UXO. Where unexpected UXO are encountered work is to cease and clearance and decontamination is to be undertaken by a registered agency.	Construction Cost	Contractor	PIAC
Construction Impacts	Battambang Sihanoukville Siem Reap Kampong Cham	Preparation of Contractor's Environmental Management Plan providing specific detail in relation to chosen construction methods	Construction Cost	Contractor	PIAC

Impacts	Location	Mitigation Measures	Source of Funds	Responsibility for Implementation	Responsibility for Supervision
General impacts on local residents	Battambang Sihanoukville Siem Reap Kampong Cham	Provision of information to the public on Grievance Redress Mechanism	Project Management Cost	PMO / PIU	-
Greenhouse gas emissions	Battambang Sihanoukville	Design, procurement of and installation of equipment employing low carbon technology such as solar aerators for WWTP in Sihanoukville and Battambang to reduce both power consumption and GHG emissions	Co-financing agencies	ADB / AFD	-
Climate risk and vulnerability mitigation	Battambang Sihanoukville Siem Reap Kampong Cham	Incorporation of recommendations from CRVA into detailed design	Design cost	PMO / PIU / PIAC	-

Impacts	Location	Mitigation Measures	Source of Funds	Responsibility for Implementation	Responsibility for Supervision
Construction stage impacts					
Impeding access to property or facilities, or traffic disruption during the installation of sewer system.	Battambang Sihanoukville	Notices to the public, placing safety first traffic signs, planned detours, temporary traffic signals, cooperation with traffic police; fencing off the construction sites, scheduling work that blocks roadways to periods of low traffic, arrangement of temporary detours during roadway blockages.	Construction Cost	Contractor	PIAC

Impacts	Location	Mitigation Measures	Source of Funds	Responsibility for Implementation	Responsibility for Supervision
Obstruction of traffic from compressors and pipelaying equipment placed at the surface	Siem Reap	Minimizing the footprint of surface equipment, ensuring at least one lane of traffic is kept open at all times. The Contractor is to prepare a traffic management plan including arrangements to control traffic, alternatives routes if feasible, and arrangements for liaison with traffic police. The traffic plan is to be submitted to the supervision consultant for review and approval.	Construction Cost	Construction contractor	PIAC

Impacts	Location	Mitigation Measures	Source of Funds	Responsibility for Implementation	Responsibility for Supervision
Noise pollution and vibration	Battambang Sihanoukville Siem Reap Kampong Cham	Providing information to the affected persons through direct liaison and via the local media about the timing and duration of the works. Construction activities will be limited to normal daylight working hours. A work schedule will be followed. All construction equipment and vehicles will be in good working order with working mufflers and noise compression.	Construction Cost	Contractor	PIAC

Impacts	Location	Mitigation Measures	Source of Funds	Responsibility for Implementation	Responsibility for Supervision
Waste generation from construction activities	Battambang Sihanoukville Kampong Cham	All solid waste must be disposed of at a landfill or approved disposal site. Importation and disposal of all materials including lubricants and fluids used with the operation of vehicles and plant and paints shall comply with legislation and not include any banned materials must comply with the Sub-Decree on Solid Waste Management. ANRK.BK No. 36 of 27 April 1999	Construction Cost	Contractor	PIAC

Impacts	Location	Mitigation Measures	Source of Funds	Responsibility for Implementation	Responsibility for Supervision
Waste generation from construction activities	Siem Reap	All solid waste must be disposed of at a licensed landfill or approved disposal site. Existing waste in the pipes to be replaced must be extracted and taken to the wastewater treatment plant, or other site identified by DPWT. Importation and disposal of all materials including lubricants and fluids used with the operation of vehicles and plant and paints shall comply with legislation and not include any banned materials must comply with the Sub-Decree on Solid Waste Management. ANRK.BK No. 36 of 27 April 1999	Construction Cost	Construction Contractor	PIAC

Impacts	Location	Mitigation Measures	Source of Funds	Responsibility for Implementation	Responsibility for Supervision
Release of silt	Battambang, Sihanoukville, Siem Reap, Kampong Cham	Exercise caution to prevent erosion losses, close excavations rapidly and stabilize soils once the pipeline is in place. Use of silt fences around temporary piles of excavated material. Avoid excavation of trenches in wet weather to the extent practicable.	Construction Cost	Contractor	PIAC

Impacts	Location	Mitigation Measures	Source of Funds	Responsibility for Implementation	Responsibility for Supervision
Soil and water pollution	Battambang, Sihanoukville, Siem Reap, Kampong Cham	Vehicles and plant are to be maintained in sound operable condition, free of leaks. The condition of vehicles and equipment will be periodically checked. Contractor to prepare and submit a plan for spill management, including provision of spill kits, training/briefing of workers on procedures on handling spills and allocation of responsibility within the contractor's team for ensuring that spill kits are available and that workers know how to use them.	Construction Cost	Contractor	PIAC

Impacts	Location	Mitigation Measures	Source of Funds	Responsibility for Implementation	Responsibility for Supervision
Air and dust pollution	Battambang, Sihanoukville, Siem Reap, Kampong Cham	Require vehicles and equipment to be well maintained and tuned and fitted with exhaust baffles. Trucks to be fitted with Tarpaulins to cover loads when carrying fine material. Apply water to suppress dust where needed and sweep to remove and clear spoil on surfaces.	Construction Cost	Contractor	PIAC
Community health and safety hazards	Community health and safety hazards	Notice to the public identifying hazards. Erection of safety barriers/covers for area of open excavation and provision of watch person to control access.	Construction Cost	Contractor	PIAC

Impacts	Location	Mitigation Measures	Source of Funds	Responsibility for Implementation	Responsibility for Supervision
Occupational health and safety hazards	Battambang, Sihanoukville, Kampong Cham	Contractors to appoint health and safety officers for each site and to ensure regular briefing of construction workforce on health and safety issues. Adequate personal protective equipment to be provided to the workforce.	Construction Cost	Contractor	PIAC
Occupational health and safety hazards	Siem Reap	Contractors to appoint health and safety officers for each site and to ensure regular briefing of construction workforce on health and safety issues. Adequate personal protective equipment to be provided to the workforce, potential for works involved in handling untreated sewage from the old pipe. Specialist advice to be obtained from health professionals and inoculations arranged as appropriate for workers.	Construction Cost	Contractor	PIAC

Impacts	Location	Mitigation Measures	Source of Funds	Responsibility for Implementation	Responsibility for Supervision
Impacts During Operation					
Inadequate effluent quality	Battambang, Sihanoukville WWTPs	Training in operation and maintenance required for the plant to maintain the design performance level, consistent with EHS guidelines Employment of sufficient trained staff to ensure round the clock attendance. Monitoring of pump operation, rapid rectification of failures, regular monitoring of effluent quality. Periodical backwashing to clean filters	Training budget	Implementation consultants / Contractor DPWT	MPWT
Potential harmful effects of sludge disposal	Battambang, Sihanoukville, Kampong Cham	Periodical partial dewatering of lagoons and removal of sludge after retention period of at least one year and drying of sludge and delivery to landfill consistent with EHS guidelines. If applying to land, testing prior to land application.	Operation Cost	DPWT	MPWT

Impacts	Location	Mitigation Measures	Source of Funds	Responsibility for Implementation	Responsibility for Supervision
Operator occupational health and safety	Battambang, Sihanoukville, Siem Reap, Kampong Cham	Operators trained to recognize risks and hazards. Personal safety equipment issued and worn. Health and safety recognized as primary employer responsibility.	Operation Cost	Implementation consultants / Contractor DPWT	MPWT
Community Health and Safety Hazards	Battambang, Sihanoukville, Siem Reap, Kampong Cham	Operate a security system to regularly check perimeter fence and ensure it is effective to prevent members of the public and unauthorized visitors from entering the WWTP	Construction and Operation Cost	DPWT	MPWT

Impacts	Location	Mitigation Measures	Source of Funds	Responsibility for Implementation	Responsibility for Supervision
Risk of failure or defects causing release of effluent from the pipe	Siem Reap, Battambang, Sihanoukville	Ongoing inspection and maintenance of system to monitor leaks and any potential blockages. Ensure routine maintenance and system checks take place; training of O&M staff, provision of site log books to record routine maintenance and checks. System of monitoring to ensure maintenance and checking takes place.	Operation Cost	DPWT - Operator	MPWT
Flood risks associated with climate change	Battambang, Sihanoukville,	Inclusion of a bund around the WWTP ponds, above projected maximum flood height to prevent release of untreated wastewater into flood waters. To be confirmed by CRVA.	Operation Cost	DPWT - Operator	MPWT

1.4 Environmental Monitoring

1.4.1 Monitoring Plan

17. The design of the environmental monitoring system is based on an analysis of the key environmental performance issues associated with each stage of the subproject, set out in Table 11 below.

Table 11: Analysis of Environmental Monitoring Needs

Phase	Key Environmental Performance Issues	Environmental Performance Indicator	Means of Monitoring
Design/Preconstruction	Inclusion of mitigation measures in design/build and/or detailed design documentation and construction activities	Compliance with EMP design measures	Compliance monitoring
Construction	Adherence to provisions in the EMP to mitigate construction impacts	Compliance with EMP	Compliance monitoring
	Direct effects on communities from impacts such as accidental damage, dust generation, noise generation and safety	Views and opinions of communities	Community feedback Grievance redress mechanism
Operation	Access to improved sanitation	Connections to sewer system	Project progress and completion reports Community feedback
	Effectiveness of sewage collection and treatment	General functioning: Odour, occurrence of blockages Effluent quality Receiving water quality	Inspections Community feedback Effluent Quality Monitoring prior to discharge Monitoring of receiving water quality

18. Three areas of environmental monitoring are identified: compliance monitoring, community feedback and water quality monitoring. These are in addition to monitoring measures in the Design and Monitoring Framework for the PWSSP.

- Compliance Monitoring, to ensure that mitigation specified in the EMP is carried out to an adequate standard
- Community feedback, under the Community Action and Participation Program for the project
- Water quality monitoring, prior to construction to establish baseline parameters, during construction and during operation. Water quality testing prior to and during construction should be undertaken for influent and effluent water. Cost estimates included in pre-engineering design for Battambang, Sihanoukville and Siem Reap provide for test kits, to be kept at the WWTP administration buildings with a cost allocation of US$ 25,000 each. A further $10,000 is allocated for training in monitoring to enable the WWTP to undertake regular weekly monitoring of the effluent quality at the point of discharge.

19. Compliance monitoring is required during detailed design and construction for the subproject, to ensure that mitigation specified in the EMP is carried out to an adequate standard. Compliance monitoring is a function of the PIU and its cost of this monitoring is part of the running cost of the PIU.

20. Community feedback provides for the monitoring of environmental indicators gauged by public perception. Appropriate indicators are:

- Reductions in the incidence of waterborne diseases
- Effectiveness of improved drainage (appearance of the town, odor, impact on businesses

21. Costs of environmental assessment and monitoring during construction are project costs. Environmental monitoring during operation is carried out by the DPWT, and costs will be met from O&M budgets prepared and managed by the DPWT.

Table 12: Environmental Monitoring Plan

Impact to be Monitored	Means of Monitor-ing	Construction Phase			Operation Phase		
		Freq-uency	Respo nsible Agency	Indicative Annual Cost	Freq-uency	Respo n-sible Agency	Indicati ve Annual Cost
General Construc tion Impacts	Comm-unity Feed-back	To be establis hed by PIAC	PIU	Covered in project participation plan	To be establis hed by PIAC	DPWT	Operat -ional Cost
Complia nce with EMP	Inspecti ons	As set up by super-vising engin-eers	PMU / PIAC	Included in project management and consultancy cost	To be estab-lished by PIAC	DPWT	Operat -ional Cost
Quality of effluent discharg ed at WWTP	Comm-unity Feed-back	To be establis hed by PIAC	PIU	Covered in project participation plan	To be establis hed by PIAC	DPWT	Operat -ional Cost
	Testing of sample s using portabl e test kits	Prior to constru c-tion	PDIH	TBA	As require d for WSP	PDIH	Normal Oper-ating Cost
Effective ness of sewerag e system	Commu nity Feed-back: occurre nce of odours and block-ages	To be establis hed by PIAC	PIU	Minor	To be establis hed by PIAC	PDIH	Minor

1.4.2 Reporting

22. EMP compliance monitoring will be undertaken by the PIU, with support of the PIAC. Effects will be monitored by means of community feedback and laboratory testing. Consistent with reporting requirements set out in the Project Administration Manual (PAM) PMU will prepare reports to be consolidated by MIH and sent to ADB on a quarterly basis, giving overall project progress with coverage of environmental issues and semi-annual environmental monitoring will be similarly prepared and sent to ADB. To facilitate monitoring and enable responses to emerging issues, monthly reports will be prepared by the PIUs. Table 13 provides the reporting schedule.

Table 13: Reporting Schedule

Type	Prepared by	Environmental Monitoring Coverage	Submitted to	Frequency
Project Progress reports	PMU with assistance by PIAC, consolidated by MIH	Summary of monitoring activity and issues arising	ADB	Quarterly
Environmental Monitoring Reports	PMU with assistance by PIAC, consolidated by MIH	Project activities over reporting period; Progress with EMP implementation including monitoring activities; Issues arising and action taken	ADB	Semi-annually
Project Completion Report	PMU with assistance by PIAC, consolidated by MIH	Summary of EMP implementation activities, issues arising, action taken; lessons learned.	ADB	Once, following physical completion
Construction Progress Report	PIU with assistance from PIAC and information provided by the contractor	Summary of compliance with EMP	PIU	Monthly

23. Monthly reporting to the PMU should provide an accurate summary of issues arising and action taken, so that the PMU is aware of major or emerging issues that need to be addressed, and can readily compile quarterly project progress reports. A recommended format appears below.

Recommended Monthly Report Format

Reporting Particulars

Reporting Period	
Name and position of person compiling the report	
Date of completion	
Circulation list	

Status of the Subproject

Current Status (provide completion dates as applicable)					
Identification	**Preparation** (including IEE/EMP)	**Approval**	**No Objection**	**Procurement**	**Completion**

Compliance with EMP

Mitigation measures included in the EMP being included in the design and/or implemented yes/no
If no, particulars of noncompliance:

Mitigation Measure	Party Responsible for Implementation	Nature of Non Compliance	Action Taken/Recommended

Significant Events or Developments During the Period

Describe:

(i) Significant construction that has taken place for each subproject
(ii) Storm events that have occurred at subproject sites
(iii) Any notable incidents

Wastewater Test Results

Location	Parameter	Maximum Value	Measured Value
	pH		
	BOD		
	COD		
	TSS		
	TDS		
	Grease and oil		
	Detergents		
	Nitrate		
	Phosphate		
	Ammonia		

Community Consultations

Date	Location	Outcomes	Issues Arising	Action Taken

Complaints Received

Date	Location	GRM Process Followed yes/no	Action Taken yes/no

Action

Describe:

(v) Action recommended in the report on the previous period and progress
(iv) Action to be taken to address issues arising from monitoring activities

Commentary

Provide any explanatory notes on the findings, and any issues to do with follow up action

Photographs

Provide photographs to illustrate issues relating to issues arising from complaints, good or bad construction practice and general construction progress.

Recommended Semi-Annual Report Format

1. Introduction

Reporting Period	
Name and position of person compiling the report	
Date of completion	
Circulation list	

2. Description of the Project and Environment

Summary from IEE so that the report can be "stand alone", including any updates (eg major storm events, major developments in the subproject vicinity)

3. Project Construction Progress

4. Institutional Arrangements for EMP Implementation

Summary from IEE, amended/updated as necessary

5. Internal Environmental Supervision

a) Supervision Activities

b) Status of compliance with the EMP

c) Issues arising and action taken

5. External Environmental Monitoring and Assessment

a) Introduction

b) Water Quality Monitoring and Assessment

c) Air Quality Monitoring and Assessment

d) Assessment of compliance with EMP

e) Findings from stakeholder consultations

f) Summary of major issues based on monitoring results

6. Recommendations

Including corrective measures if necessary

7. Conclusion

Appendices:

Monitoring Reports

Location Maps

Photographs

Other items that support the text of the report