KINGDOM OF CAMBODIA

MINISTRY OF INDUSTRY AND HANDICRAFT

URBAN WATER SUPPLY AND SANITATION PROJECT

(ADB PPTA: TA-8125-CAM)

FEASIBILITY STUDY FOR KAMPONG CHAM SUBPROJECT

November 2013

Prepared by

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Document Status						
Rev No	**Author/editor**	**Reviewer**		**Approved for Issue**		
		Name	**Signature**	**Name**	**Signature**	**Date**
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ABBREVIATIONS AND EQUIVALENTS

ADB	Asian Development Bank
ADF	Asian Development Fund
AP	Affected persons
APs/AHs	Affected persons/affected households
ASR	ADB's Annual Sector Review
BOO	Build-Operate-Own
BOT	Build-Operate-Transfer
COBP	Country Operations Business Plan
CPP	Community Participation Plan
CPS	Country Partnership Strategy
DMC	Developing Member Countries
DMF	Design and Monitoring Framework
DPWS	Department of Potable Water Supply
EA	Executing Agency
EGM	Effective Gender Mainstreaming
EMP	Environmental Management Plan
FAR	Feasibility Assessment Report
FS	Feasibility Study
GAP	Gender Action Plan
HHs	Households
IAs	Implementing Agencies
IEEs	Initial Environmental Examinations
IOL/SES	Inventory of Losses and Socioeconomic Survey
IR	Inception Report
ISCD	Institutional Strengthening & Capacity Development
JICA	Japan International Cooperation Agency
LARP	Land Acquisition and Resettlement Plan
LARF/LARP	Land Acquisition and Resettlement Framework and Plan
MEF	Ministry of Economy and Finance
MIH	Ministry of Industry and Handicraft
MOU	Memorandum of Understanding
MOWRAM	Ministry of Water Resources Management and Meteorology
MPWT	Ministry of Public Work and Transport
MRD	Ministry of Rural Development
NCB	National Competitive Bidding
NRW	Non-revenue Water
O&M	Operation and Maintenance
PAM	Project Administration Manual
PDIH	Provincial Department of Industry and Handicraft
PDR	People Democratic Republic
pm	Person-months
PMU	Project Management Unit
PPP	Public Private Participation
PPPs	Public-Private Partnership
PPTA	Project Preparation Technical Assistance
PPWSA	Phnom Penh Water Supply Authority
REA	Rapid Environmental Assessment

RRP	
SCS	Stakeholder Communication Survey
SPS	Safeguards Policy Statement
SRWSA	Siem Reap Water Supply Authority
SR	Safeguards Requirements
TA	Technical Assistance
TOR	Terms of Reference
WOPs	Water Operators' Partnerships
WTP	Water Treatment Plant

UNITS

ha	Hectare
lpcd	Liters per capita per day
l/s	Liters per second
m	Meter
mg/l	Milligrams per Liter
mm	Millimeter
m^3/day	Cubic meters per day

Figure 1.1 - Location of Project Towns

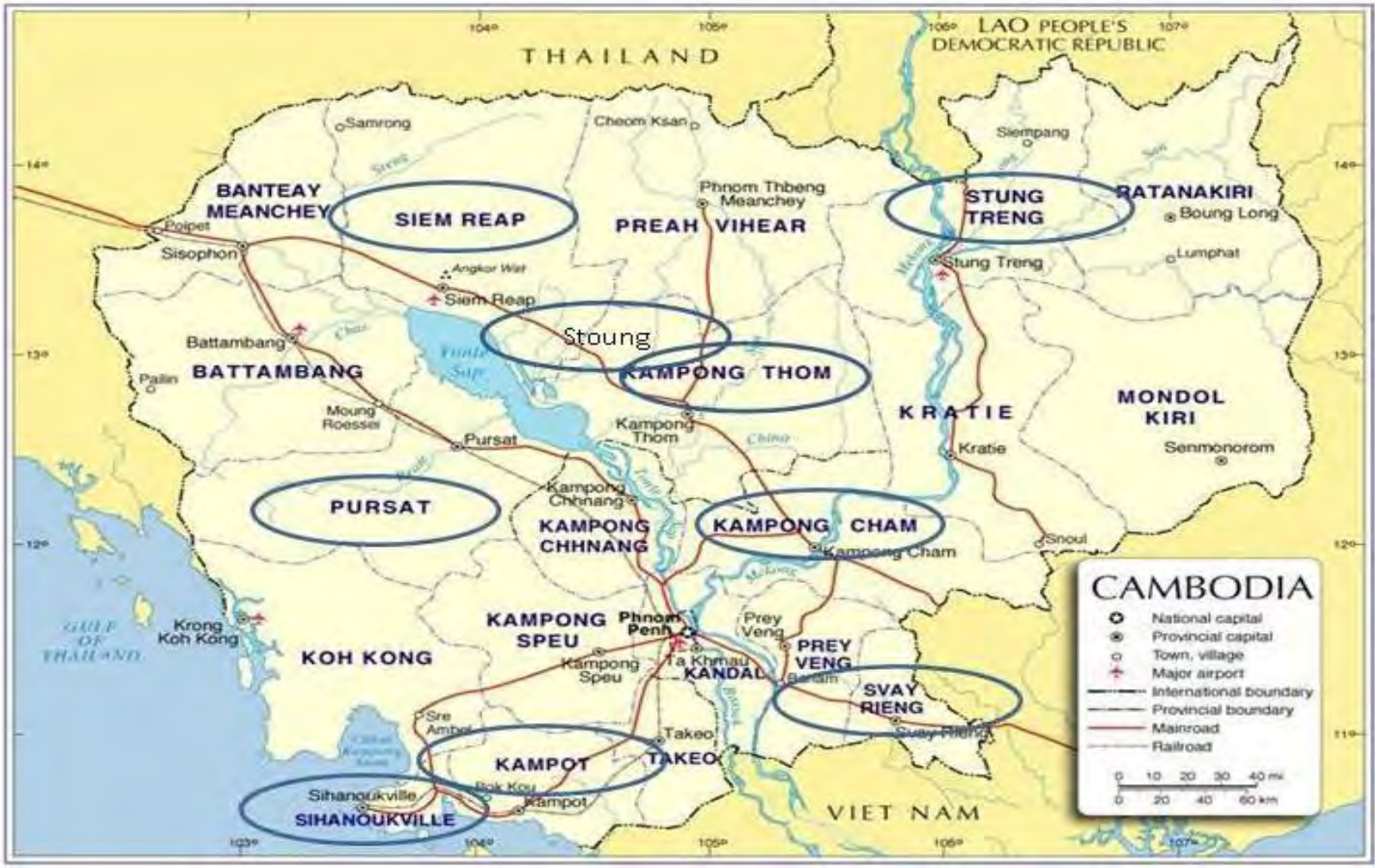
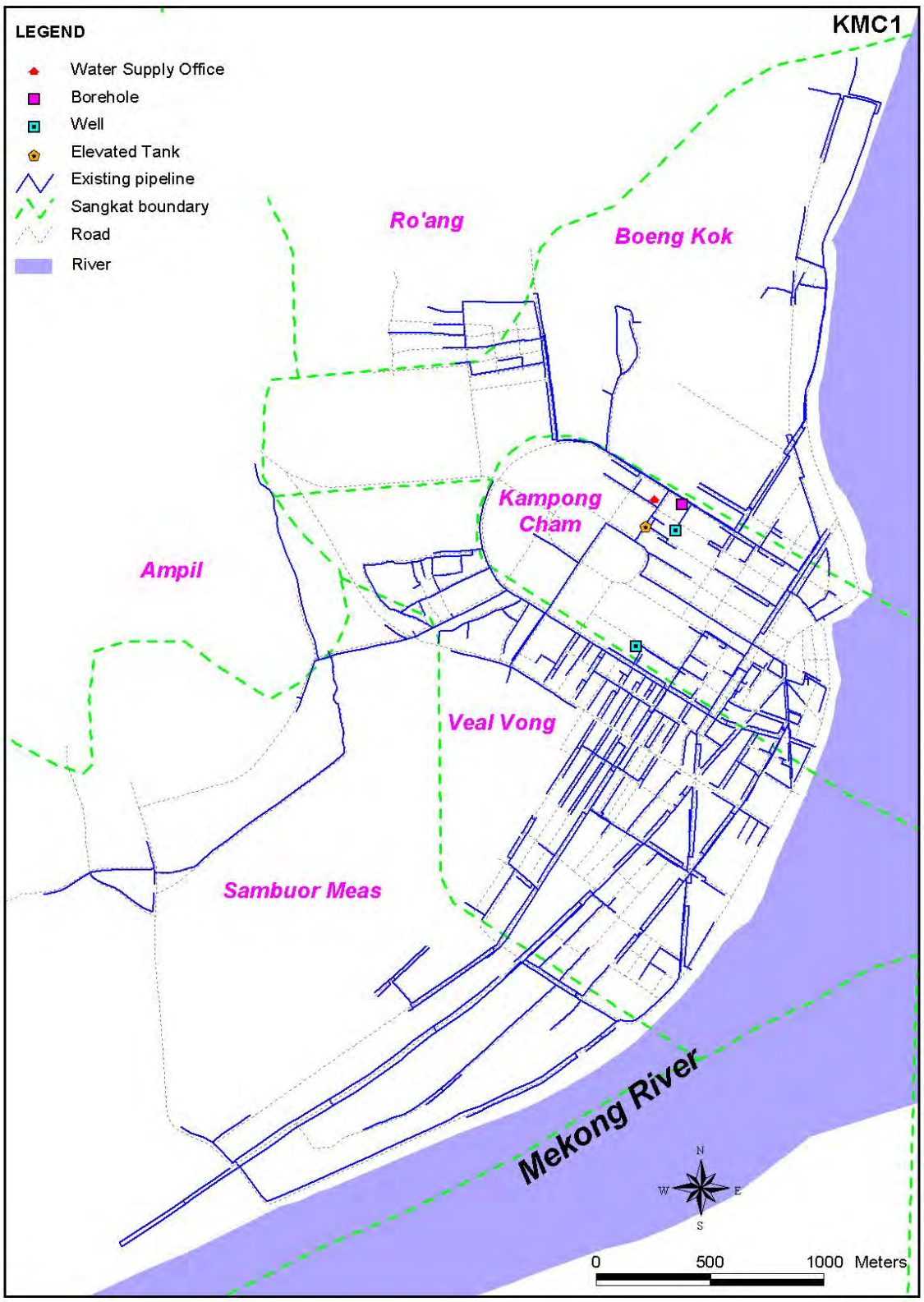


Figure 1.2 Location Plan of Proposed Kampong Cham Subproject



1. EXECUTIVE SUMMARY

1.1 Project Description

1. Expected outputs of the overall Project include: (i) water treatment plants provided or improved in eight towns; (ii) water distribution systems improved and coverage increased in six towns; (iii) existing pumping stations rehabilitated in five towns; and (iv) institutional capacity of MIH and regulatory system strengthened, under a piggy-backed technical assistance.

1.2 Rationale

2. During 2011, through the ADB's Water Operators' Partnerships Program, ADB was able to re-engage in the urban water supply sector with MIH. Consequently ADB's Country Operations Business Plan 2010-2013 includes an Asian Development Fund loan for the Project for approval in 2014. The UWSP will assist the government to address the three core constraints identified in the ADB Country Partnership Strategy (2011-2013): (i) insufficient funds to expand coverage and improve services; (ii) weak sector planning and implementation capacity of responsible authorities at the central and sub-national levels; and (iii) inadequate (or sometimes weak) institutional and legal framework.

1.2.1 Background

3. The proposed Project "Urban Water Supply Project" (UWSP) will provide necessary facility improvements to the six provincial towns previously funded by ADB and to three provincial towns that have been funded by other bilateral or multilateral agencies, and expand public access to sustainable and safe water supply services for the urban population in Cambodia. In addition, the Project will address institutional weaknesses through the development of improved institutional structures, a regulatory framework, and appropriate capacity development.

1.3 Project Impact and Outcome

4. The impact of the proposed Project will be expanded access to sustainable and safe water supply services for the urban population in Cambodia and better functioning water treatment plants providing higher quality water. MIH targets are to increase the proportion of the urban population in the project area with access to safe water to 85% by 2018 and 90% by 2025, and the project will assist these aims. The outcome of the project will be improved water supply infrastructure and service provisions in selected provincial waterworks.

1.4 Candidate Towns

5. There are nine candidate towns: Kampong Cham, Kampong Thom, Kampot, Pursat, Siem Reap, Sihanoukville, Stoung, Stung Treng and Svay Rieng. Originally Battambang was to be included but this was removed at the request of the Provincial Waterworks.

1.5 Feasibility Study Context

6. The feasibility studies include: (i) needs assessment, supply and demand analysis, (ii) selection of technology, equipment, and facilities for the identified subprojects considering least cost and life cycle approach and the capacities of the local authorities to manage, operate, and maintain; (iii) assessment of economic and financial viability and sustainability for each of the subprojects; (iv) assessment of policy and legal capacity, including other institutional issues and mechanisms related to the financial management, procurement, and anticorruption; (v) poverty, social, and gender analysis and preparation of a poverty and social strategy, a gender action plan, stakeholder communication survey (SCS), and a Community Participation Plan (CPP), where required; and (vi) review of impacts on environment, involuntary resettlement, and indigenous peoples.

1.6 Subproject Description

1.6.1 Output 1 - Water Supply Development

7. The Kampong Cham subproject aims to improve the provision of safe, affordable, reliable piped water supply to individual household connections to communities within the six core

sangkats/communes having Y2012 population of about 63,865. The works proposed under the PPTA are summarised in Table 1.1 below and described in detail in Section 5.2.2.

1.6.2 Output 2 – Strengthening of Institutional capacity of MIH and Regulatory System

8. The Institutional Strengthening and Capacity Development is to (i) identify key stakeholders; (ii) assess institutional capacity constraints; (iii) develop institutional capacity building plan; and (iv) prepare terms of reference for strengthening sector regulation TA.

1.7 Cost Estimate

9. The subproject cost is estimated at $1.356 million equivalent, including taxes and duties. Table 1.1 provides a summary of the Kampong Cham Subproject cost estimate.

Table 1.1: Kampong Cham Subproject Cost Estimate ($'000's)

		Totals
No	**Description**	**(inc tax)**
		US$000
1	**Water Supply Development**	
1.1	2 new boreholes including casing, screen, pump testing, pump controls, building & power connection.	300
1.2	Add parallel pipe to improve hydraulics	280
1.3	Pipeline extensions	200
1.4	Replace gas chlorination system	50
1.5	Fittings for zoning	14
1.6	Extensions to office buildings	80
1.7	3 new transformers	36
1.8	New 100m borehole, pump, control panel, building and all pipework	150
1.9	Rehabilitate old elevated tank at school	20
	Total for Water Supply Development	**1,130**
	TOTAL ESTIMATED BASE COST[a]	
	Contingencies 20%	226
	TOTAL ESTIMATED SUBPROJECT COST	**1,356**

1.8 Financing Plan

10. The project will be financed by ADB and the national government. ADB loan will finance KR 5467 million while the government will finance KR 602 million which includes government taxes. The financing plan is shown in Table 1.2.

Table 1.2: KCPWW Financing Plan (KR million)

Items	% Total	Total
ADB	90.1	5,467
Disbursement	89.2	5,415
Interest During Construction	0.9	52
Government	9.9	602
Equity Contribution	0.9	55
Taxes, Duties and Other	9.0	547
Total Financed	100.0	6,069

Source: Consultant's estimate

1.9 Executing Agency and Implementation Arrangements

11. MIH will be the Executing Agency, and the existing project management unit (PMU) based in the Department of Potable Water Supply (DPWS) will be expanded to execute and manage the Project on behalf of MIH with the consulting service to be provided by the project implementation

assistance consultants (PIAC). The Project implementing units (PIUs) are expected to be organized by the nine (9) implementation agencies (IAs) of the provincial waterworks. The nine (9) PIUs will be responsible for day-to-day coordination and supervision of subproject implementation in these provincial towns.

1.10 Implementation Period

12. The proposed Project is scheduled for implementation over five years from 2014 to 2018. The final design is proposed for a one year period between mid-2014 and mid-2015. Following this, a two year construction period would have the works commissioned in August 2017. A proposed Implementation schedule is included in Appendix A.

1.11 Procurement

13. The procurement shall be carried out under International Competetive Bidding (NCB) as three packages; one package Stung Treng; one package Siem Reap; and the remaining 7 subprojects as one package. The full Procurement Plan is contained in the Supplementary Appendices of the main PPTA report.

1.12 Consulting Services

14. The project implementation assistance consultants (PIAC) on the design and engineering review, tendering assistance, and construction management are provided under Bank financing will be selected in advance and engaged in accordance with the ADB's Guidelines on the Use of Consultants. An individual consultant will be engaged to prepare the PIAC terms of reference and to assist the EA on the preparation of the Request for Proposal. The PIAC consulting services will be signed once the loan becomes effective to provide under a single consulting package, by an association of international and domestic consulting firms. The lead consulting firm will provide the services of the Team Leader who will be responsible for managing the overall consulting services during the project implementation.

1.13 Economic and Financial Analyses

15. Economic and Financial analyses for Kampong Cham are contained in Section 7, and in full in Appendix H.

1.14 Tariff and Affordability

16. KCPWW existing lifeline consumption is 10 m3. It is recommended that this be reduced1 to 7 m3 by 2015. The proposed tariff increase for the first 7 m3 consumption was made higher to approximate the actual O&M cost which is about KR900 per m3 in 2012. Assuming a 100% loan, debt service is only KR132 per m3 water sold. Proposed tariff increases, therefore, for 0% loan, 50% and 100% loan scenario is the same (Table 1.3). The proposed tariff for government and commercial customers were made higher such that subsidy from these two type of customers are extended to the household customers especially the poor.

[1] For basic water needs, estimated consumption is 45 to 50 liters per capita per day. This translates to a consumption of about 7 m3 per month for a household of 4 to 5 persons.

Table 1.3: KCPWW Proposed Tariff Rate - 0%, 50% or 100% Loan

Category	2015	2018	2021	2023
Household, 0 - 7 m3	750	950	1,100	1,200
above 7 m3	1,200	1,300	1,400	1,600
Government	1,500	1,650	1,750	1,750
Commercial	1,250	1,750	2,000	2,000
Tariff Increase (average)	34%	27%	16%	9%

Source: Consultant's estimate

1.15 Subproject Benefits and Beneficiaries

17. At the end of year 2023, KCPWW is projected to have a total of 8,813 water service connections, an increase of 2,382 from the 2014 projected level. In terms of served population, the investments will directly benefit an additional 11,352 persons within the service area (Table 1.4).

Table 1.4: KCPWW Projected Service Connection

Item	2014	2015	2020	2023
Service area population	63,929	63,961	64,121	64,217
Population served	29,918	30,692	41,270	41,270
% Served	47%	48%	64%	64%
Number of connection	6,431	6,602	8,753	8,813

1.16 Land Acquisition and Compensation

18. The overall project has Involuntary Resettlement Categorisation B. There are two areas of land to be acquired in Stoung (225m2) and Svay Rieng (9m2). The Resettlement Due Diligence report for Kampong Cham is contained in Appendix K.

1.17 Environmental Impacts

19. An Initial Environmental Examination (IEE) was carried out for Kampong Cham, and is contained in Appendix J. The subproject is classified as Category B. The overall conclusion is that providing the mitigation, compensation and enhancement measures are implemented in full, there should be no significant negative environmental impact as a result of location, planning, design, construction and operation of the project. There are benefits stemming from recommended mitigation and enhancement measures, and major improvements in quality of life and individual and public health once the project is in operation.

1.18 Indigenous Peoples

20. The Indigenous Peoples Impact sceening checklist has been completed and is contained in Appendix F. While there are ethnic minorities, like the Chinese, Lao and Vietnamese, they have already integrated in the mainstream society that will benefit from safe and potable water. There are no expected negative effects on ethnic groups.

2. PROJECT RATIONALE, IMPACT AND OUTCOME

2.1 Rationale

21. During 2011, through the ADB's Water Operators' Partnerships Program, ADB was able to re-engage in the urban water supply sector with MIH. In January 2012, MIH signed a twinning agreement with the PPWSA, which is currently providing support to four provincial waterworks been included in the Project through direct peer-to-peer knowledge transfer. In February 2012, the Ministry of Economy and Finance (MEF) requested ADB to consider financing the Project in accordance with the strategy of Cambodia's Public Debt Management, to ensure sustainable economic growth. Consequently ADB's Country Operations Business Plan 2010-2013 includes an Asian Development Fund loan for the Project for approval in 2014. The project supports the ADB's annual sector review, country partnership strategy, and the water operational plan 2011–2020

22. The UWSP will assist the government to address the three core constraints identified in the ADB Country Partnership Strategy (2011-2013): (i) insufficient funds to expand coverage and improve services; (ii) weak sector planning and implementation capacity of responsible authorities at the central and sub-national levels; and (iii) inadequate (or sometimes weak) institutional and legal framework.

2.1.1 Background

23. The proposed Project "Urban Water Supply Project " (UWSP) will provide necessary facility improvements to the six provincial towns previously funded by ADB and to three provincial towns that have been funded by other bilateral or multilateral agencies, and expand public access to sustainable and safe water supply services for the urban population in Cambodia. In addition, the Project will address institutional weaknesses through the development of improved institutional structures, a regulatory framework, and appropriate capacity development.

24. This UWSP is in line with (i) Cambodian National Strategic Development Plan (2009-2013) and (ii) action plan of Ministry of Industry and Handicraft (MIH) to facilitate private sector partnerships, strengthening the management of public owned waterworks, and integration urban water supply with urban environmental management. The proportion of the urban population in the project area with access to safe water will be increased to 85% by 2018 and 90% by 2025 as targeted by MIH. In addition, a potential target date for 100% coverage could be assumed as 2030.

2.1.2 Project Outline

25. The feasibility studies include: (i) needs assessment, supply and demand analysis, (ii) selection of technology, equipment, and facilities for the identified subprojects considering least cost and life cycle approach and the capacities of the local authorities to manage, operate, and maintain; (iii) assessment of economic and financial viability and sustainability for each of the subprojects; (iv) assessment of policy and legal capacity, including other institutional issues and mechanisms related to the financial management, procurement, and anticorruption; (v) poverty, social, and gender analysis and preparation of a poverty and social strategy, a gender action plan, stakeholder communication survey (SCS), and a Community Participation Plan (CPP), where required; and (vi) review of impacts on environment, involuntary resettlement, and indigenous peoples.

2.2 Project Impact and Outcome

26. The impact of the proposed Project will be expanded access to sustainable and safe water supply services for the urban population in Cambodia and better functioning water treatment plants providing higher quality water. MIH targets are to increase the proportion of the urban population in the project area with access to safe water to 85% by 2018 and 90% by 2025, and the project will assist these aims. The outcome of the project will be improved water supply infrastructure and service provisions in selected provincial waterworks.

3. Profile of Kampong Cham Area

3.1 Town Location and Profile

27. Kampong Cham city is the capital of Kampong Cham Province and is on National Road 6 approximately 125km from Phnom Penh, about half way between Phnom Penh and Kratie. Kampong Cham is the third largest city in Cambodia after Phnom Penh and Battambang, but is the most populous Province.

28. Rubber is the primary industry in the Province

3.2 Natural Features

3.2.1 Topography

29. Kampong Cham is a flat area on the Mekong flood plain close to the centre of Cambodia. There are no hills in the area.

3.2.2 Climate

30. The climate, in common with other non-coastal areas of Cambodia, is hot all year with a distinct rain season May – October and a drier season November – February.

3.2.3 Surface water

31. There is only one surface water source in Kampong Cham, the Mekong river. This is currently used by some private households but not by the Provincial Waterworks. JICA have a current proposal to build a conventional water treatment plant using the Mekong as the raw water source, to serve the higher areas of the town to the north and east.

3.2.4 Groundwater

32. The existing water supply system uses groundwater from two older dug wells and one borehole normally used as a supplement in the dry season. Water quality is monitored regularly and is good, with close to neutral pH, and very low colour and turbidity.

3.3 Socio-Economic Conditions

33. The full Socio-economic report is contained in Appendix D. A summary of key indicators is provided below.

3.3.1 Population and Household Characteristics

34. The populations provided below are for the service area within Kampong Cham

Table 3.1: Kampong Cham Population Characteristics

No	Core Sangkhat/Commune	2012 Pop'n.	No. HH	Persons/ HH
1	Sangkat Boeng Kok	8,707	1,797	4.8
2	Sangkat Kompong Cham	7,172	1,261	5.7
3	Sangkat Vielvong	15,752	3,117	5.1
4	Sangkat Sombuormeas	14,977	2,532	5.9
5	Koh Roka Commune	6,106	1,490	4.1
6	Ampil Commune	11,151	2,678	4.2
		63,865	**12,875**	

3.3.2 Ethnicity

35. The breakdown by ethnic group is given in Table 3.2 below;

Table 3.2: Core village population by ethnic group

No.	Minority	2008		2009		2010	
		Families	People	Families	People	Families	People
1	Cham[2]	487	2,207	458	2,355	455	2,327
2	Vietnamese	79	312	75	320	68	296
3	Laos	0	0	0	0	0	0

Note:Number of indigenous and minority population are additional data, so some commune/sangkat may not be recorded.

3.3.3 Population Growth and Migration

36. Population growth from the 2008 National Survey3 shows an average national urban growth rate of 2.21%. For the purposes of this study we have used growth rates for individual towns, provided by each Provincial Waterworks4. For Kampong Cham this is low at 0.05% showing that there is migration out of Kampong Cham probably for work in the nearby capital.

3.3.4 Education

Table 3.3: Education level by household

Education Level	Service and Non-service areas	
	n	Percentage (%)
No Education	14	14.7
Primary School	31	32.6
Secondary School	36	37.9
High School	10	10.5
Bachelor Degree and above	4	4.2
Total	**95**	**100**

Source: Socio-economic survey, July 2013

3.3.5 Health and Hygiene Conditions

37. Survey data on health status relating to waterborne diseases show that 8.9% of people were afflicted by water-related diseases (4HHs), while 91.1% (41HHs) reported that they have not suffered from water-related diseases during the previous 12 months. Approximately 8.9% reported having had a health problem in the five days prior to the survey. The most commonly reported health problems for household members are gastroenteritis and typhoid fever.

3.3.6 Land and House Tenure

38. 97.8% of all houses are owner-occupied, with 1.1% renting and another 1.1% doing neither. The range of average house sizes in the target area are; up to 25m2 (18.9%), 26-50m2 (55.8%), 51-

[2]or Khmer Islamic

[3] General Population Census 2008 National Report, August 2009

[4] Data collected by head of each commune

100m2 (21.1%) and over 100m2 (4.2%). The percentage of houses connected to power supply is 98.9% for the project area, while 1.1% of households use kerosene lamp for lighting.

3.3.7 Occupations and Livelihoods

39. Main occupations are provided in Table 3.4.

Table 3.4: Main Occupation of the HH head in the project area

No.	Main income sources of HH head	Service and Non-service areas	
		# of respondent	Percentage
1	Government employee	15	15.8
2	NGOs/IOs staff	1	1.05
3	Worker at private companies/Factories	4	4.2
4	Small-scale business owner	28	29.5
5	Motor taxi driver	4	4.2
6	Transportation service provider	4	4.2
7	Construction worker	7	7.4
8	Seft-employed	1	1.05
9	Farming/Agriculture	19	20
10	Other	12	12.6
	Total	**95**	**100**

Source: Socio-economic survey, July 2013

3.3.8 Income and Poverty Levels

40. The average annual household income is 12,607,500 Riels ($3,152) for those households connected to the water supply system, but for households not connected, the average annual income is lower at 11,772,000 Riels ($2,943).

41. Approximately 1.1% of the population were found to be living in poverty as shown in Table 3.5.

Table 3.5: Status of wealth ranking in Kampong Cham City

Wealth Ranking	n	%
Extremely poor	1	1.1
Poor	52	54.7
Average	31	32.6
Wealthy	11	11.6
Total	**95**	**100.0**

Source: Socio-economic survey, July 2013

3.4 Existing Water Supply and Sanitation

3.4.1 Water Supply

42. The existing water supply system was originally commissioned in 1942, with the existing two hand dug wells as the source. The system was damaged during the war period in the 1970's, but the

pipeline network has largely been rehabilitated since, with 14.5km of new pipe installed under a UNHABITAT project[5] in 2010-12 and a further 38.5km of small diameter pipe installed by the Provincial Waterworks. The total network has 81km of pipe.

43. Well water is chlorinated and pumped directly into supply, but if demand is low water can flow back to the 500m3 elevated tank. The intention was always to pump to the tank, but as the water pressure at the ends of the system is low, direct pumping provides some additional pressure over the static head from the tank.

44. The existing two dug wells are approximately 15m deep, and the depth of water in these wells can reduce to as little as 88cm in the dry season[6]. The IA initially requested that these be deepened to 20m. Following an inspection of the wells, it is clear that the structure would need to be strengthened prior to deepening the wells. Well #2 has eroded horizontally at the base of the well, forming a "cave" extending several meters out from the well wall. As part of any implementation works, a structural analysis of these 2 wells would need to be undertaken.

45. The wells are currently served by one 6-stage vertical turbine pump in each[7], with electric motors[8] at the top of each well and pump at the base with a long rotary shaft between them. This shaft vibrates and in the past has been damaged. These pumps were installed under the 2006 ADB Provincial Towns Improvement Project. The 2 pumps produced 2,205,000m3 in 2012. The third, supplementary source is a 40m deep borehole with 100mm diameter casing drilled in 1970. A new submersible pump was installed in 2006 with 7.5kW motor, with capacity of 40m3/hr.

46. Both wells have a pair of parallel I-beams approximately 4m below the surface, originally used for well access when they were shallower in the past. Additionally there is another lower capacity pump in each well with riser pipe, previously used during the dry season. These are the original pumps installed prior to the 2006 project[9]. The design capacity of the WTP is 5,760m3/day.

47. The access ladders in both wells are unsafe and would need replacements. There is an air blower and duct in each well for ventilation prior to access for maintenance. Currently a lamp is lowered into the well when needed. Permanent halogen lighting inside the wells would improve conditions.

48. Considering the difficulties in safely deepening and rehabilitating these dug wells, new boreholes would likely be cheaper and easier to install, leaving the wells as they are for the Water Authority to use if ever required. This was discussed with the Water Authority and MIH and was agreed as the appropriate course of action.

49. Non-revenue water was measured at 56% in 1998 but has since been reduced to 11.8% in 201210, mainly through pipe replacements. This is thought to be all physical leakage as there are no illegal connections or non-payment of bills reported in Kampong Cham.

50. The Water Authority has reported only 80% utilisation of the WTP capacity. These figures can be misleading. This percentage was based on the average 2012 annual production and an assumed WTP capacity of 7,600m3/day. In reality the WTP design capacity is 5,760m3/day, the higher figure being what the KCWA put through the WTP with both duty and standby pumps running. Running the WTP at this higher flowrate, exceeding the design capacity, reduces water quality and is not

[5] The Mekong Region Water & Sanitation Initiative

[6] Water Authority presentation 24/4/2013. Peak wet season well depth is 7.36m

[7] Pentair Aurora Vertical turbine-1500, size 11EH-6 stage, 1475rpm, 75HP, nom. capacity 241m^3/hr, nom. head 57m, www.aurorapump.com

[8] US Electrical Motors (Emerson) Lower end BRG 7314-BEP, Upper end BRG 6213-JC3, 75HP, 50Hz, 1480RPM

[9] .Model unknown

[10] This is a Water Authority estimate. No comprehensive NRW study or top-down water balance has been carried out.

adviseable. Secondly, the average annual production is estimated from pump running hours, as there are no working bulk meters at the WTP.

51. It is clear from observation at the WTP that the flowrate is indeed exceeding the design capacity of 5,760m3/hr. The reasons for this are;

- If the recorded annual average flowrate for 2012 is used along with the design WTP capacity, the plant is running at an average of (2,205,586/365)/5,760 = 105% of capacity. The peaks during dry season are much higher.
- From observation the elevated tank never gets filled. The well pumps are pumping directly into supply with no excess water available for filling storage. This shows that the full 240m^3/hr (5,760m3/day) is being consumed by customers and NRW.

Table 3-6: Main Sources of Household Water

Water Sources are used for drinking by HHs	Dry season		Wet season		Both wet-dry seasons	
	n	%	n	%	n	%
a. Piped (town) water connected to a point inside house	-	-	-	-	5	5.3
b. Piped (town) water connected to a point outside house	-	-	-	-	11	11.6
c. Piped (private) water connected to a point inside house	-	-	-	-	25	26.3
d. Piped (private) water connected to a point outside house	-	-	-	-	37	38.9
e. Owned protected well, (fully covered)	-	-	-	-	1	1.1
f. Shared protected well, (fully covered)	-	-	-	-		-
g. Owned un-protected well (open and dug well)	-	-	-	-	1	1.1
h. Shared un-protected well	-	-	-	-	-	-
i. Owned piped supply	-	-	-	-	1	1.1
j. Shared piped supply	-	-	-	-	-	-
k. River	-	-	-	-	-	-
l. Bottled water	-	-	-	-	15	15.8
m. Lake/reservoir/irrigation canal	-	-	-	-	-	-
n. Rainwater	-	-	10	10.5	-	-

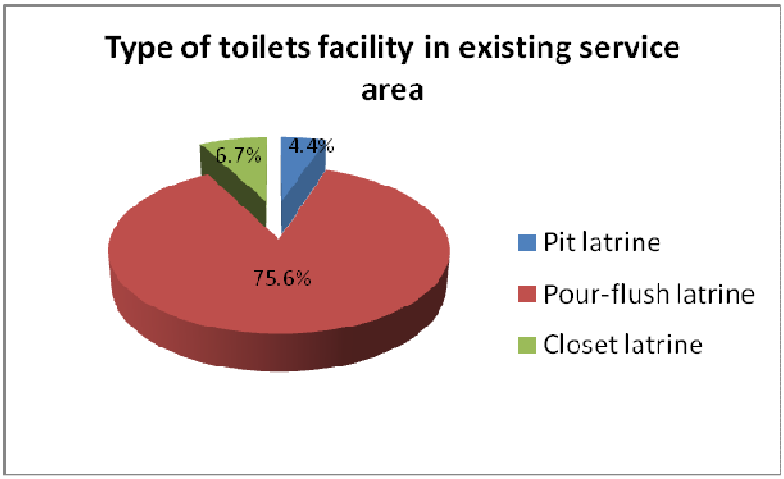
Source: Socio-economic survey, July 2013

3.4.2 On-Site Sanitation

52. From survey results only 13% of households do not have a latrine of some kind.

53. Figure 3.1 shows the type of sanitation facilities in use.

Figure 3.1: Sanitation facilities by type



Source: Socio-economic survey, July 2013

4. POPULATION GROWTH AND WATER DEMAND FORECASTS

4.1 General

54. Kampong Cham is the capital city of the Province and acts as a market for the surrounding area.

55. At present, there is no agro-processing or industrial development in Kampong Cham consuming water or which could affect water quality, and nothing planned. There is no mine in the region.

4.2 Population Projections

56. The population projections11 to 2030 are set out in Table 4.1. Within the core villages, total population is forecast to increase from about 63,865 in 2012 to about 64,442 in 2030.

Table 4.1: Population Projections for Kampong Cham's Core Villages

Year 2012 Population	Growth Rate %	Forecast Population 2014	Forecast Population 2020	Forecast Population 2025	Forecast Population 2030
63,865	0.05	63,929	64,121	64,281	64,442

4.3 Water Demand Forecasts

4.3.1 General Approach

57. Whilst the scope of proposed works under this project does not include increasing the capacity of the Kampong Cham water supply system, demand forecasts have been produced to illustrate the shortfall of available treated water into the near future. Water demand forecasts for the Kampong Cham subproject were prepared by making separate projections of each component of demand, including:

- Demand for domestic use (based on per capita consumption, coverage targets and population projections);
- Demand for industry (based on a % of domestic use, and specific allowances for large industries);

[11] 2012 populations and growth rate provided by the Provincial Waterworks

- Demand for services (based on a % of domestic use, and specific allowances for large services areas);
- Physical losses as a % of total demand, excluding the demand of large industrial zones.
- Production losses in treatment plant (based % of total demands).

4.3.2 Domestic Consumption

58. Water demand and consumption data for other provincial and district towns in Cambodia show that domestic consumption accounts for about 90% of total demand. Per capita consumption figures for urban water supply systems in Cambodia can vary widely, particularly with strong reliance on rainwater collection during the wet season. Experience in other towns in Cambodia indicates that piped connections directly to the house will usually increase water consumption over time. The Feasibility Study has adopted a per capita consumption figure of 120 lpcd, plus 10% for non-domestic use which includes demand from industry and services, 15% for physical losses (leakage), and 50m3/day for backwashing filters in the WTP.

4.3.3 Water Demand Forecasts

59. Table 4-2 summarizes the demand forecasts for the Kampong Cham subproject. By 2030, the average daily water demand for the areas listed in Table 3.1 is expected to be 12,850m3/day, comprising 72% domestic consumption, with the remaining 28% being for institutions, public use, services, handicraft and small industries, and allowances for physical losses and backwashing the filters.

Table 4.2: Water Demand Forecasts for Kampong Cham Subproject

No.	Items	Unit	Forecasts				
			2012	2014	2020	2025	2030
A.	**Domestic Demand**						
1	Growth Rate	%	0.05	0.05	0.05	0.05	0.05
2	Population in Core Area		63,865	63,929	64,121	64,281	64,442
3	Coverage in Core Area	%	90	100	100	100	100
4	Population with Piped Water	No.	57,479	63,929	64,121	64,281	64,442
5	Per Capita Consumption	l/c/d	120	120	120	120	120
6	Total Domestic Demand	m3/d	6,897	7,671	7,695	7,714	7,733
B.	**Non-domestic demand**						
1	Services, Schools, Small Industry, Institutions, Hotels	%	20	20	20	20	20
2							
3	Total Non-domestic demand	m3/d	1,379	1,534	1,539	1,543	1,547
C.	**Subtotal Water Demand All Categories**	m3/d	8,277	9,206	9,233	9,256	9,280
D.	**Non Revenue Water (NRW) in Distribution system**						
1	NRW as % Average Daily Water Production	%	15	15	15	15	15
2	NRW (physical losses only-pipelines and WTP)	m3/d	1,242	1,381	1,385	1,388	1,392
E.	**Average Daily Water Production (C+D) rounded**	m3/d	9,520	10,590	10,620	10,640	10,670
F.	**Peak Annual Water Demand (Max day Max month)**						
1	Peak Annual Water Demand		1.20	1.20	1.20	1.20	1.20
2	Peak Annual Water Demand	m3/d	11,424	12,708	12,744	12,768	12,804
3	Peak Annual Water Demand	l/s	132	147	148	148	148
G.	**Required Treatment Plant Output (rounded)**	m3/d	11,420	12,710	12,740	12,770	12,800
H.	**Treatment Plant Backwashing**						
1	Treatment Plant Backwashing	m3/d	50	50	50	50	50
I.	**WTP Capacity**						
1	Required WTP Capacity	m3/d	11,470	12,760	12,790	12,820	12,850
2	Required WTP Capacity	l/s	132.75	147.69	148.03	148.38	148.73
	Total Required Source Capacity (Rounded)	**m3/d**					12,850
	Total Required Source Capacity	**l/s**					150.00

4.3.4 Future Demand Requirements

60. The table shows that the existing water treatment plant from 2006, at 5,760m3/day, is already insufficient to meet demand with 2014 demand projected at 12,760m3/day. This subproject is not intended to address future demands, but to rehabilitate the current existing WTP assets, improve water quality and improve security of supply.

61. The proposed JICA funded treatment plant will need to make up this shortfall in demand, requiring a capacity of 7,090m3/day to meet water requirements to 2030.

5. SUBPROJECT DESCRIPTION

5.1 Introduction

62. The proposed works are designed to improve operational improvements, increased water quality and security of supply. This improved water supply scheme is not designed to increase capacity of supply as this will be addressed under a separate proposed project funded by JICA.

5.2 Output 1: Water Supply Development

63. Expected outputs of the overall Project include: (i) water treatment plants provided or improved in eight towns; (ii) water distribution systems improved and coverage increased in six towns; (iii) existing pumping stations rehabilitated in five towns; and (iv) institutional capacity of MIH and regulatory system strengthened, under a piggy-backed technical assistance.

5.2.1 Preliminary Designs

64. The proposed water supply scheme design improvements are based on limited topographical, hydrological and water quality data, and are preliminary.

5.2.2 Description of Proposed Water Supply System

65. The Kampong Cham subproject aims to improve the provision of safe, affordable, reliable piped water supply to individual household connections to communities within the six core sangkats/communes having Y2012 population of about 63,865. The works proposed under the PPTA are summarised in Table 5.1 below;

Table 5.1: Proposed new infrastructure for Kampong Cham

Kampong Cham	Full FS	A- Drill 2 new boreholes to replace wells 1 and 2, with new submersible pumps (capacities to be refined but no more than capacity of system). This includes casing, screen, pump testing, pump controls, building & power connection.
		B - Add 3 lengths of 110mm diameter pipe (1,420m, 1,000m, 885m) and one length of 300mm diameter of 1,660m to run in parallel with existing pipe
		C - Add 5 lengths of 110mm diameter pipe (2,000m, 1,200m, 1,500m, 350m, 340m) and 5 lengths of 63mm pipe (900m, 850m, 380m, 500m, 1090m) for extensions to current system.
		D- Replace current gas chlorination system
		E- Gate valves and bulk meters for 5 zones -sizes required are 1x315mm dia, 2x200mm dia, 1x150mm dia, 1x100mm dia.
		F - Second floors for existing office and laboratory buildings
		G - New transformers (3)
		H - New 100m deep borehole for higher end of town with submersible pump, wellhead, controls, pump building, power supply, fencing, rising main to existing elevated reservoir
		I - Rehabilitate existing elevated reservoir and provide connection into network

5.2.2.1 Pump replacement

66. The current raw water pumps were commissioned in 2006 and cause problems with the long shaft between motor (at the surface) and the pump approximately 15m below. There are two options;

Option 1

67. It is proposed to replace them with submersible pumps mounted on an auto-coupling with guide rails for easy removal from the well. As the WTP capacity is not being increased, new pumps will be sized to match current WTP capacity. A second WTP is being planned under a current JICA project to increase supply into the distribution network.

Option 2

68. Take the wells and existing vertical turbine pumps out of service and replace them with 2 new deep boreholes and submersible pumps close to the current well sites. New submersible pumps and boreholes will need controls, power supply, casing and screen, pump testing and a building.

69. For both the options, the proposed new raw water pumps will both pump to the elevated tank, not directly into supply as at present. A new dedicated rising main will be required for Well #2. Well #1 is inside the WTP compound and an existing rising main can be used.

70. New submersible pumps, whether centrifugal type for Option 1 or multi-stage borehole pumps for Option2, will be far more efficient than the current pumps, which are losing much energy through vibration and heat generation. The energy used per household per cubic meter of water received will be reduced.

71. Option 2 is proposed on the grounds that the existing wells are unsafe to work in. Nothing is known of their structural strength, and further digging to deepen them could lead to collapse. At least one eroded cave out from the base of one well has been identified and there may be more faults. The wells have never been pumped dry and it is likely that any deepening of them would need to be done in wet or submerged conditions unless a very large dewatering pump as used, and there would then be the issue of where to discharge this water.

72. In addition to safety factors and the difficult working environment down the wells, the works required in dewatering, strengthening with custom made prefabricated reinforced concrete rings or slabs and excavating by hand would very likely be far more expensive than drilling new boreholes, where the aquifer level and drilling costs are known. A least cost analysis has been carried out and is contained in Appendix O.

73. Friction loss calculations and the pump duty curve are in Appendix L.

5.2.2.2 Abandonment of well structures

74. The current well structures are around 70 years old and have been deepened over that time. The walls are reinforced with brick or masonary down to a depth of around 10-12m and are bare earth after that. Well #2 has a horizontal cave extending out from its base, caused by long term erosion and pumping out of silt from the well. Instead of undertaking an expensive structural assessment and strengthening works prior to deepening the wells it is proposed to abandon them and replace them with new boreholes as described above. The IA has expressed a wish to retain the dug wells and pumps in case of the failure of proposed submersible pumps. However, it is recommended that electrical transformers will be selected to allow running of the proposed borehole pump and the existing smaller 7.5kW borehole pump (plus general site power) simultaneously, and not the older well pump at the same time.

5.2.2.3 Pipe to improve hydraulics of existing network

75. There are six lengths of pipe to be added to the reticulation in parallel to existing pipe with the intention of improving pressure. The scope originally included 3 lengths of DN110mm and one length of DN300mm, but two further lengths of DN63mm have been added at the request of the IA. These areas currently have a demand that exceeds supply and the existing small diameter pipes are reported as one reason for this. The required pipe lengths and sizes are given in Table 5.2 below

Table 5.2: Proposed parallel pipelines

Pipe size (mm)	Length (m)
DN110	1420
DN110	1000
DN110	885
Subtotal 110mm	*3305*
DN300	1660

76. The locations of these proposed pipelines are shown in Appendix M.

5.2.2.4 Extensions to Distribution network

77. There are eight lengths of pipe proposed to be used to extend the system. The Water Authority will connect new customers themselves, outside of this proposed project. These pipe lengths and sizes are summarized in Table 5.3 below.

Table 5-3: Proposed pipeline extensions.

Pipe size (mm)	Length (m)
DN110	2000
DN110	1200
DN110	1500
DN110	350
DN110	340
Subtotal DN110mm	*5390*
DN63	900
DN63	850
DN63	380
DN63	500
DN63	1090
Subtotal DN63m	*3720*

78. The locations of these proposed pipelines are shown in Appendix M.

5.2.2.5 Replacement of Gas Chlorination system

79. The current gas chlorination system installed under the 2006 ADB project is a high quality European brand, but has failed both at Kampong Cham and the other 5 towns under this previous project. This may be due to poor installation or lack of locally available spares. Repairs have been made with locally available materials rather than proprietary parts which is dangerous when used with pressurized chlorine gas. Some design faults identified with the brand currently installed have been identified, being;

- The pressure gauges appear to have no diaphragm and no oil filled chamber to separate the chlorinated water from the meter workings. This has caused corrosion in all 6 towns.
- The existing set-up has hoses and pipes connecting the one tonne chlorine cylinders to a regulator. Leaks in this hose and pipe arrangement causes high pressure chlorine leaks. A better design is to have a vacuum regulator directly connected to the cylinder. If pipe downstream of the vacuum regulator leaks, the vacuum is broken and the regulator closed, sealing the valve and preventing leaks.
- The existing system does not have a heater on the cylinder outlet. This serves to ensure that the liquid chlorine in the cylinder turns to gas before it leaves the cylinder valve. During transportation of the cylinder to the site, the liquid chlorine is disturbed and often fills the fixed internal outlet tube. If not heated and vapourised this liquid chlorine can damage equipment downstream.

80. A gas scrubber system should be provided with the gaseous chlorination system as a safety measure. This is lacking at Kampong Cham presently. The scrubber removes the chlorine from the air in the event of a serious leak in the system.

81. It is recommended to replace the entire chlorination system with a brand that is available locally or at least regionally, with after sales service and easy access to spare parts. For the purpose of this Feasibility Study, the same manufacturer as used at PPWSA has been selected and invited to provide a proposal and budget price. This is contained in Appendix B.

5.2.2.6 Valves and Meters for Zoning

82. The IA wishes to set up several DMA's[12] close to the river bridge. The gate valves and meters required for this are listed in Table 5.4 below.

Table 5-4: Fittings for establishment of DMA's.

Size (mm)	Gate valve Qty	Bulk meter Qty
100		1
150	2	1
200		1
250	2	1
300	1	
400		1

5.2.2.7 Extensions to existing office building

83. The IA has provided plans and a cost estimate for the proposed extensions to the current office building and adjacent laboratory. The proposal is to build new walls to join the existing two adjacent buildings into one, and build a second floor with new roof. The current office is small and has no separate meeting room, or working space other than the Director's office. The plans and cost estimate are provided in Appendix B.

5.2.2.8 Provision of new transformer

84. Currently the two main wells and smaller borehole are running on 2 separate generators all the time – there is no mains connection. The subproject proposes to supply and install three

[12] District metering areas

transformers, one at each of the two existing sites and a third at the proposed third site (Item I in Table 5.2 above). The transformer at Well site #1 will be sized to supply the proposed deep borehole and the current 40 borehole. The transformer at Well site #2 will be sized to supply the proposed new deep borehole only. The two existing dug wells with vertical turbine pumps will not be required to run at the same time as the proposed new borehole pumps.

5.2.2.9 New borehole pumping facility

85. A third borehole and pumpstation has been requested by DPWS/MIH. This is to serve the higher areas of the town and is intended to deliver to an existing 200m3 elevated water tank that used to serve a school but has been disused for some time. This elevated tank is from the colonial time and needs rehabilitating. The pumpstation will include borehole drilling, casing and screen installation, pump testing of the borehole, well head pipe and fittings, pump building, Operators office/toilet, rising main to reservoir, and security fencing. The depth of the borehole is estimated to be 100m deep at this stage, and submersible pump selected and priced based on this. The borehole depth and pump selection will need to be confirmed during implementation. Whilst sufficient raw water can be supplied to meet the current WTP design capacity from the proposed 2 new boreholes described under 5.2.2.1 above, this third borehole has been requested by DPWS/MIH specifically to supplement treated water supply to the higher end of town until the proposed JICA surface water WTP is constructed and commissioned.

5.2.2.10 Rehabilitation of existing elevated tank

86. The existing 200m3 elevated reservoir used to serve a school and is currently unused. The District Governor has suggested that it can be used to serve the north and eastern area of town that currently suffers from low pressure. It will need an internal inspection and water tightness test carrying out, and following this may need some rehabilitation. This could be in the form of application of waterproofing cement additives internally, or additional structural work.

5.3 Consultation Activities during Preparation of Kampong Cham Feasibility Study

87. A series of community visits and consultations occurred during the finalization of the 2013 Feasibility Study to inform district and village authorities about the subproject and gather information and feedback from local authorities, people living in core villages and other stakeholders. Consultation activities during the project site visits in 2013 are detailed below:

(i) Initial reconnaissance visit March 2013: Team Leader and National water engineer visited the site for an initial inspection and discussion with the Provincial Waterworks.

(ii) Second engineering site visit 25 April 2013: International and National water engineers visited Kampong Cham facility, collected data, and finalized scope following Inception workshop.

(iii) Third engineering meeting 23 May 2013: Director and Deputy visited PPTA office to finalize details on raw water pumps, office extension and other proposed works.

(iv) Environmental and Resettlement specialist visit: This joint visit was carried out between June 3rd -11th to collect data to aid the finalization of the IEE and LACP.

(v) Socio-economic specialist visit: a visit for the purpose of carrying out the socio-economic survey was undertaken on 18-27th June.

5.4 Operation and Maintenance of Project Facilities

5.4.1 Capacity to Operate and Maintain the Proposed Water Supply System

88. The Kampong Cham Provincial Waterworks have many years experience in operating and maintaining their treatment plant, and have full time staff including an experienced mechanic, who has kept old pumps running using both genuine parts and parts copied and machined locally. There is a good understanding of how pumps work and the routine maintenance required.

89. The proposed new borehole pumps will require far less maintenance than the current well pumps with their overly long rotating shafts which vibrate badly. In addition there is a service agent present in capital Phnom Penh should spares or assistance be required.

90. The proposed new gas chlorination equipment is similar to the current equipment, but if the recommended manufacturer is used, there will be far greater options for professional servicing and provision of spares as needed. The proposed model is the same as used in Phnom Penh by PPWSA, and there is an agent in Phnom Penh that can provide servicing. Problems faced with the current gas chlorination equipment are mainly due to a lack of a regional office to provide support, spares and technical assistance when required. Whilst the preferred equipment cannot be specified by manufacturer, for future operation it would be beneficial to the Water Authority.

5.4.2 Management Arrangements

91. The PIAC will provide Project technical, safeguards, accounting and management assistance on a daily basis as well as support the PIUs with project implementation

92. At the start of Project implementation, the PMU and PIAC will (i) update the initial environment examinations and due diligence reports (IEEs and DDRs) and prepare EMPs submit to MOE for review and approval; (ii) clear potential unexploded ordnance (UXO) remain on site; and (iii) acquire necessary land before subproject bids are tendered.

5.4.3 Operation and Maintenance Plans

93. The Operation and Maintenance plan for each subproject can be divided into two types, those with a full conventional WTP and those with chlorinated groundwater being pumped to an elevated tank and fed into supply. For Kampong Cham, an Outline Operation and Maintenance Plan reflecting the latter has been developed and is presented in full in Appendix N.

5.5 Lessons learned in Cambodia and the SE Asia region

94. There are several “lessons learned” in both the region and inside the national water sector that would benefit the 9 project towns under this PPTA;

- As at PPWSA, use of standardized chlorination equipment that has a regional office that can offer technical support, spares and specialist staff when needed. PPWSA has selected equipment supplied by Severn Trent Services (STS), and equipment from this manufacturer has been recommended for the towns requiring replacement chlorination equipment under this study. STS have a main office in Singapore, but have local representation in Phnom Penh. However, final selection of equipment of equal or better specifications will be decided at tendering as specific brands cannot be specified in Contract documents.
- High density polyethylene pipe (HDPE) is favoured in Cambodia, even for larger diameters. As most of Cambodia is flat, as are all of the 9 towns under this study, system pressures are not higher than 60m head. As such, a PN6 rated pipe would be sufficient. However, experience has shown that for the pipes un to and including 90mm diameter, which may have domestic connections tapped from them, a PN8 minimum pipe is required, even for very low pressures. The reason for this is that the tapping saddles used can deform the thinner pipe wall thicknesses on PN6 pipe, which causes leakage.
- Automated valves linked to a central control panel were designed and installed under the 2006 Provincial Towns project. All of these have failed in the 6 towns where they were installed. The lesson here is to keep the WTPs simple and keep valves as manually operated. With the relatively smaller size of these WTPs (mostly under 6,000m^3/day), valve automation is not necessary and inappropriate.

- Alum and poly dosing lines under the previous Provincial Towns project used long lengths of uPVC pipe that followed buildings and structures, necessitating several 90 degree bends and causing significant headloss in the delivery pipe. This has caused the pipes to get blocked by sediment. In addition, the uPVC dosing pipes are exposed to direct sunlight. UV light will break down uPVC pipe over time. A better solution, as used in two recent projects in Laos, is to use ABS (acrylonitrile butadiene styrene) pipe, and select a more direct route for the pipe, minimizing bends and low points.
- For the water sector as a whole, a database of all water projects could be set up, to include design drawings, calculations, contract documents, demand calculations, feasibility reports, final design reports and other useful documentation, for each system. This would serve as an easily accessible online resource library for all Water Authority staff in the country. It is relatively easy and inexpensive (under US$40,000) to set up and populate, and solves the common problem of drawings and documents getting lost. Many of the available hard copy resources for Cambodian water supply systems are either misplaced, or are reportedly stacked in disorder in a storeroom so dirty that nobody is willing to enter. Such a database was set up and released in neighbouring Laos in 2012-13 with assistance from UNHABITAT, and can be viewed at;

http//:laowtp.info
by pressing “login as guest”.

- Several of the project towns under this PPTA have had extensions added to serve areas that were outside of the original design core area, without considering required design pressures or treatment plant capacity. This often results in the WTP being operated above its design capacity, which can reduce water quality, and often has negative effects on service pressure to other parts of the reticulation network. Typically, to increase system pressure to serve these unplanned extensions, water is diverted around any elevated storage tank and pumped directly into the system in order to increase delivery pressure by a few metres head. This is bad operating practice as it eliminates the storage facility and increases leakage loss. Any pipeline extensions should be made in a planned way and carried out simultaneously with WTP capacity upgrades as required.

5.6 Public Private Partnerships (PPP)

95. Options and viability for potential PPP for Kampong Cham subproject was discussed with the Director of the Department of Potable Water Supply13.

96. In common with all towns in general, the urban water supply systems are seen as best managed by the government where possible. Installation and commissioning of the elements of work under this subproject require specialist contractors and involvement of public bodies is limited.

97. There are some peri-urban areas in Cambodia where whole water supply concessions have been granted to private companies to construct and manage water supply systems. This is not strictly PPP, as the private company needs only to acquire a license – there is no partnership as such. There are both good and bad examples of these private concessions throughout the country.

[13] Mr Tan Sokchea

98. A possible area where a PPP could be utilized in the future is in the supply of bulk treated water to customers who are either just outside of the WTP service area or are inside the area but receive low pressure. Private water tankers could be used to fill up with (and pay for) treated water from the WTP and deliver and sell to customers with their own storage tanks.

5.7 Contract Packaging of Subproject

99. A number of packaging options were examined and discussed between the PPTA team, MIH and ADB. These options are presented below in Table 5.5.

Table 5.5: Subproject Contract Packaging Options

No. packages	Subproject Towns included	Advantages/disadvantages
2	Stung Treng Siem Reap plus 7 rehab towns	**Advantages:** • Small number of packages reduces tendering and contract management admin. • Larger packages makes them more attractive to international bidders. • Easier to standardise on equipment. **Disadvantages:** • Limited opportunity for NCB
3	Stung Treng Siem Reap 7 rehab towns	**Advantages:** • Three good sized packages attractive to ICB bidders • Small number of packages reduces tendering and contract management admin. • Easier to standardise on equipment **Disadvantages:** • Limited opportunity for NCB
4	Stung Treng Siem Reap 3 southern rehab towns (Svay Rieng, Kampot, Sihanoukville) 4 northern towns (Kampong Cham, Kampong Thom, Pursat, Stoung)	**Advantages:** • 2 larger and 2 smaller packages, the smaller of which could be NCB if an exception to the $1M limit relaxed **Disadvantages:** • More tender and contract management admin • More difficult to standardise on equipment with larger number of packages.
9	9 separate contracts	**Advantages:** • Each IA is responsibe for their own

		subproject and has direct ownership • 7 of the 9 subprojects could be let as NCB **Disadvantages:** • More tender and contract management admin • Some activities may not be suitable for many national contractors due to lack of specialist experience. • More difficult to standardise on equipment with larger number of packages.

100. During discussions, initially the option of two large contracts, one for Stung Treng and one for the other 8 towns, was favoured for the simplicity of the bidding process, contract administration, and the attractiveness of the larger packages to international bidders.

101. After further discussion, 9 separate contracts was favoured, as greater weight was put on having the contracts out to tender quickly, and having 7 of them of a size that would permit NCB would help achieve this. The procedures for approving and tendering NCB are far less time consuming compared to ICB. Additional benefits would be that each IA would have ownership of their own subproject, and that national contractors would benefit from both the experience and the business.

102. A perceived obstacle with having 7 of the subprojects as NCB is the technical nature of some of the rehabilitation work. Installation and commissioning of gas chlorination equipment, bladder tanks for surge protection, and proper construction of filter underdrains are all areas requiring a degree of specialist knowledge and experience. For this reason, coupled with the simplicity of having a lesser number of contract packages, a compromise of three packages was selected, being Stung Treng, Siem Reap, and the 7 rehabliitation subprojects.

103. These 3 packages will all need to be ICB due to their value, but this does not exclude national contractors from bidding, provided they meet the prequalification requirements. Additionally, if national contractors have difficulty meeting prequalification requirements, they can still benefit from these contracts by subcontracting.

6. SUBPROJECT COSTS AND FINANCING PLAN

6.1 Cost Estimates

104. The subproject cost is estimated at $1.356 million equivalent, including taxes. A summary of the cost estimates is given in Table 6.1.

Table 6.1 - Subproject Capital Cost

		Totals
No	**Description**	**(inc tax)**
		US$000
1	**Water Supply Development**	
1.1	2 new boreholes including casing, screen, pump testing, pump controls, building & power connection.	300
1.2	Add parallel pipe to improve hydraulics	280
1.3	Pipeline extensions	200
1.4	Replace gas chlorination system	50
1.5	Fittings for zoning	14
1.6	Extensions to office buildings	80
1.7	3 new transformers	36
1.8	New 100m borehole, pump, control panel, building and all pipework	150
1.9	Rehabilitate old elevated tank at school	20
	Total for Water Supply Development	**1,130**
	TOTAL ESTIMATED BASE COST[a]	
	Contingencies 20%	226
	TOTAL ESTIMATED SUBPROJECT COST	**1,356**

Source: Consultant's estimate, 2013.

6.2 Least Cost Analysis

105. For Kampong Cham a least cost analysis was carried out between Options 1 and 2 for improving the raw water source as described under Section 5.2.2.1:

Option 1: Improve existing dug well structures, deepen wells, add lighting and safe ladders and replace pumps with submersibles, autocouplings and guiderails.

Option 2: Abandon existing wells, and replace with two boreholes with submersible pumps.

106. It should be noted that Option 2 was favoured not only from a least-cost perspective but also from the perspective of safety and water source security. The existing wells are structurally unsound and their collapse could both endanger life and the towns' water supply.

6.3 Financing Plan

107. The project will be financed by ADB and the national government. ADB loan will finance KR 5467 million while the government will finance KR 602 million which includes government taxes. The financing plan is shown in Table 6-2.

Table 6-2: KCPWW Financing Plan (KR million)

Items	% Total	Total
ADB	90.1	5,467
Disbursement	89.2	5,415
Interest During Construction	0.9	52
Government	9.9	602
Equity Contribution	0.9	55
Taxes, Duties and Other	9.0	547
Total Financed	100.0	6,069

Source: Consultant's estimate

7. SUBPROJECT FINANCIAL AND ECONOMIC ASSESSMENT

7.1 Approach and Methodology: Financial Assessment

108. The financial analysis was done in three levels: (i) examination of the historical and current financial performance; (ii) evaluation of the feasibility of the proposed subproject under CUWSP; and (iii) evaluation of the financial sustainability taking into account the impact of the proposed subproject to the future operation of PWWs and WSA.

109. Following the Asian Development Bank (ADB) guidelines[14], four basic indicators for the financial viability of a water supply project have been identified. These are the following:

- Financial Internal Rate of Return (FIRR). It is the discount rate at which the revenues and costs generated by the project are equal to zero. A project is considered financially viable if the computed FIRR is equal to or higher than the weighted average cost of capital (WACC) that is used in financing the development of the proposed water supply project.

- Debt Service Coverage Ratio (DSCR). It measures the solvency of the PWWs/WSA and shows how many times debt service for a given period is covered by operations. DSCR should at least be 1.3 after project completion.

- Annual cash balance. Projected annual cash balances should be positive all throughout the projection period.

- Tariff affordability. Household monthly water bill should not be more than 5% of the average monthly household income of the low income group.

7.1.2 Financing Plan.

110. The project will be financed by ADB and the national government. Part of the ADB and national government funds will be on-lent to the PWWs/ WSA. Annual debt service was estimated based on preliminary discussions with MIH and MEF. The on-lending terms for the purpose of this study are as follow:

- Maturity period of 32 years, including 8 years grace period on principal payment while interest is capitalized during construction;

- Fixed interest rate[15] of 1.25% per annum for the first 8 years and 1.75% per annum for the next 24 years; and

- Foreign exchange risk to be borne by the national government.

7.1.3 Proposed Water Tariff.

111. Three scenarios were tested in the design of the water tariff based on the amount of loan, as a percent of project costs, passed on to the 8 PWWs. For Siem Reap WSA, 100% loan was assumed. For the 8 PWWs, the three scenarios tested were: (1) 0% loan-100% grant; (2) 50% loan-50% grant; and (3) 100% loan-0% grant.

7.1.4 Other Assumptions

112. The main assumptions used in the financial projections include:

- Estimates of annual water revenues are based on the total water billed for the year and the corresponding tariffs for the same year. Connection fees, for non-poor household customers

[14] ADB, *Financial Management and Analysis of Projects* (2005).

[15] ADB's interest rate to the national government is 1% and 1.5% respectively.

are included as other revenues and assumed to be paid by the customers in 24 equal installments.

- The investment cost of the proposed project and the O&M costs are prepared on an annual basis in August 2013 prices. Increases in costs due to inflation are covered through a provision for price contingencies both for the investment costs and the O&M costs.

- The incremental O&M costs, which is the difference between "with the project" and "without the project" scenario, were used in the evaluation. O&M costs include: 1) administration; 2) chemical; 3) power; 4) maintenance of facilities; 5) salaries and wages; and 6) other O&M items.

- Projected O&M costs "without the project" are based on actual O&M costs as presented in the historical revenue and expense statements. It is assumed that there will be minimal increases in the service connections as water supply demand approaches the maximum water supply capacity of the existing system, hence there will be no increases in the number of personnel. The unit cost of O&M is assumed to increase following the local inflation rate.

- Projected O&M costs "with the project", except maintenance of facilities, are based on historical unit costs. Maintenance of facilities cost is based on engineering estimate of the required maintenance level of the facilities.

- Depreciation allowance is considered a non-cash item. However, for purposes of estimating the net income, it was included as expense in the projected income statement. Annual depreciation costs for the new facilities were calculated using the straight-line method based on the service life[16] of each type of asset.

- Water tariff "without the project", is assumed to increase in the future to cover increases in O&M. For purposes of the projection, it is assumed that water tariffs will have to be increased by 5% starting 2015 and every four years thereafter until 2027 for Siem Reap, Stung Treng and Svay Rieng; for Kampong, because current tariff is low, the assumed increases are 10%.

- Water Revenue "without the project". As mentioned earlier, since the existing facilities are already nearing its maximum operating capacities, it is assumed that there will be no further additional connections after the water supply capacities are reached in 2017. Volume of water sold after this period will remain constant. Any increase in projected revenue is then due to the assumed increase in water tariff.

- Water Revenue "with the project". Based on the technical study, the proposed improvements in the water supply system can provide the water requirements of the projected beneficiaries up to year 2019 (Siem Reap) to 2023 (Kampong Cham, Stung Treng and Svay Rieng). The volume of water sold is therefore assumed to increase up to that year and is assumed to remain constant at the that level. Any increase in projected revenue after this period is then due to the assumed increase in water tariff.

7.2 Approach and Methodology: Economic Assessment

113. The economic analysis was undertaken in accordance with the procedures set out in the ADB Handbook for the Economic Analysis of Water Supply Projects (1999) and related ADB guidelines17. The period of analysis extends over 30 years from the start of project implementation in 2015 up until 2044. Costs and benefits were quantified at August 2013 prices and were converted to their economic cost equivalents using shadow prices. Both costs and benefits were treated as increments to a "without the project" situation.

[16] Using PWWs/WSA asset life schedule.

[17] *Guidelines for the Economic Analysis of Projects (1997).*

114. The economic viability of the project was determined by computing the economic internal rate of return (EIRR) and comparing the result with the economic opportunity cost of capital (EOCC) of 12%. An EIRR exceeding the assumed EOCC indicates that the project is economically viable. The viability of the investments was then tested for changes in key variables such as capital costs, O&M costs and benefits through sensitivity analysis. Distribution of project benefits and poverty impact analysis were also undertaken to determine how much of the net economic benefits resulting from the investments will directly benefit the poor.

115. The economic viability of the proposed investments in water supply was determined considering the following benefits: (1) incremental gross revenue; (2) the value of time saved for not having to collect water from existing non-piped sources; (3) medical cost savings due to reduced morbidity from waterborne diseases; and (4) avoided income loss (productivity savings) because of reduced incidence of diseases. Economic costs were derived from the estimates of capital investments and O&M costs in financial terms, removing all duties and taxes and multiplying the net results by the conversion factors (CF). The following CFs were applied: 1.0 for traded goods and non-traded goods, and 0.7 for unskilled labor.

116. The proposed investments which aim to improve the population's access to piped water supply in the area, will form part of the Government's overall development plan for the water supply sector, which also aims to achieve the targets set under the Millennium Development Goal18.

7.3 Kampong Cham Provincial Waterworks (KCPWW)

7.3.1 Historical Financial Performance

117. Kampong Cham Provincial Waterworks, from 2008 to 2012, was able to cover total expenses except in 2008 where cost recovery was only 90% of total expenses. However only 60 to 90% of total expenses and depreciation was covered for the same period. Existing tariff for households for the first 10 m3 is only KR550 per m3 while total cost (2012) per m3 sold is KR900. Current ratio was high for the five-year period while account receivable was high at 53 days equivalent of annual water sales as of end 2012.

Table 7.1: KCPWW Financial Indicators, 2008-2012

Financial Indicators	2008	2009	2010	2011	2012
Cost Recovery:					
Total expenses	0.9	1.2	1.1	1.1	1.1
Total expenses & Depreciation	0.6	0.8	0.8	0.8	0.9
Current Ratio	19.8	18.4	26.5	16.6	12.8
Operating Ratio	1.1	0.8	0.9	0.9	0.9
Account Receivable (Days)	76	64	66	59	53

[18] MDG's Target No. 10, Goal No. 7: Halve, by 2015 the proportion of people without sustainable access to safe drinking water and sanitation. For urban water supply in Cambodia, people with access to safe drinking water is about 64% in 2004. Per MDG, this should reach 80% by 2015. Source: Key Indicators of Developing Asian and Pacific Countries, 2006, ADB.

7.3.2 Projected Financial Performance

7.3.2.1 Investment Costs.

118. The total investment cost for the water supply project is approximately KR 6342 million (assuming 50% loan), including price and physical contingencies and interest during construction. Table 7.2 presents a summary of the investment costs.

Table 7.2: KCPWW Total Investment Cost (KR million)

Items	% Total	Total
Civil Works	59.1	3,745
Equipment and Materials	5.7	364
Total Base Cost	64.8	4,109
Physical Contingency	13.0	822
Price Contingency	12.4	787
Total Contingencies	25.6	1,609
Interest During Construction (IDC)	0.8	51
Taxes and Duties	9.0	572
Total Cost	100.0	6,342

Source: Consultant's estimate

7.3.2.2 Financing Plan.

119. The project will be financed by KR 3196 million loan (on-lending) and KR 3145 million grant from the government. The financing plan is shown in Table 7.3.

Table 7.3: KCPWW Financing Plan (KR million)

Items	% Total	Total
ADB Loan (On-lending)	50.4	3,196
Disbursement	49.6	3,145
IDC	0.8	51
Government Grant	49.6	3,145
Own Fund	9.9	629
ADB Fund	39.7	2,516
Total	100.0	6,342

Source: Consultant's estimate

7.3.2.3 Water Tariff.

120. KCPWW existing lifeline consumption is 10 m3. It is recommended that this be reduced19 to 7 m3 by 2015. The proposed tariff increase for the first 7 m3 consumption was made higher to approximate the actual O&M cost which is about KR900 per m3 in 2012. Assuming a 100% loan, debt service is only KR132 per m3 water sold. Proposed tariff increases, therefore, for 0% loan, 50% and 100% loan scenario is the same (Table 7.4). The proposed tariff for government and commercial

[19] For basic water needs, estimated consumption is 45 to 50 liters per capita per day. This translates to a consumption of about 7 m3 per month for a household of 4 to 5 persons.

customers were made higher such that subsidy from these two type of customers are extended to the household customers especially the poor.

Table 7.4: KCPWW Proposed Tariff Rate - 0%, 50% or 100% Loan

Category	2015	2018	2021	2023
Household, 0 - 7 m3	750	950	1,100	1,200
above 7 m3	1,200	1,300	1,400	1,600
Government	1,500	1,650	1,750	1,750
Commercial	1,250	1,750	2,000	2,000
Tariff Increase (average)	34%	27%	16%	9%

Source: Consultant's estimate

7.3.2.4 Weighted Average Cost of Capital.

121. On the basis of the financing mix and the loan interest rate of 1.25% to 1.75% and the assumed cost of equity of 6.0%20 of the government, the WACC is computed at -0.06%. Table 7.5 shows the computation of the WACC. However, since ADB guidelines require a minimum hurdle rate of 4% for the financial analysis, the FIRR will be evaluated based on 4%.

Table 7.5: KCPWW Weighted Average Cost of Capital – 50% Loan

Items	Capital	% of Total	Nominal Rate	Tax Rate	After Tax Rate	Inflation rate	Real Rate	WACC Real
Loan (ADB Funds)	3,196	50%	1.6%	20.0%	1.3%	1.8%	-0.5%	-0.24%
Grant (ADB Funds)	2,516	40%	1.6%	0.0%	1.6%	1.8%	-0.2%	-0.06%
Grant (Gov't Funds)	629	10%	6.0%	0.0%	6.0%	3.5%	2.4%	0.24%
Total Capital Investment	6,342	100%						**-0.06%**

Source: Consultant's estimate

7.3.2.5 Financial Internal Rate of Return.

122. Financial assessment of the project shows that the project is financially viable with an FIRR of 12.5%. Sensitivity analyses were likewise conducted to determine the effects of adverse changes on the project such as increase in capital and O&M costs, revenues not realized as expected and delay in operation. The scenarios evaluated and the summary results of the analyses are presented in Table 7.6. The results show that the project is viable under the four scenarios evaluated.

[20] Cambodia treasury bill, 91 days maturity issued by MEF.

Table 7.6: KCPWW Summary Result of FIRR

Items	FIRR	FNPV[21]
Base case	11.8%	5,813
Capital cost plus 20%	8.0%	4,722
O&M cost plus 10%	10.8%	5,249
Revenue less 10%	7.9%	3,574
1-Year delay in benefit	8.5%	5,331

Source: Consultant's estimate

7.3.2.6 Affordability of Water Rates.

123. A major consideration in the estimate of tariff is the ability of target beneficiaries to pay for their monthly water bill. Based on the socio-economic survey, respondents in the service area are willing to pay KR 1,260 per m3 of water consumed while proposed tariff (1-7 m3 consumption) by 2023 is KR 1,200. Another measure of affordability is ratio of monthly water bill to the total household income. For KCPWW service area, the estimated monthly income belonging to the poor households for 2013 is KR 634,000. Using the affordability criteria, the monthly water bill is about KR 5250 (KR750 x 7 m3) in 2015 is only 0.8% of the monthly income of poor households. In all subsequent years the monthly water bill is less than 5% of the estimated monthly income. Hence, the proposed level of water tariff is deemed affordable to the low income or poor households.

124. However, since this financial assessment is based on averages, it is possible that some households will actually pay a monthly bill more than 5% of their monthly household income. Also, even with the 5% benchmark, it is possible that poor households with a monthly bill of less than 5% of their monthly income cannot afford to pay the monthly water bill. To address this, provincial waterworks can offer discounts to legitimate beneficiaries22 to ensure that they continue to receive piped water supply.

7.3.2.7 Impact of the Project on the KCPWW's Financial Operation.

125. Selected financial indicators were computed to provide an indication of the KCPWW's future financial performance. Annual financial indicators for years 2015 to 2020 and 2025 are shown in Table 7.7.

126. Revenues can cover O&M cost and depreciation during the projection period except in 2016 and 2017;

127. Current ratio is high which ranged from 8 to 13 from 2015 to 2025;

128. Operating ratio is more than 1 in 2016 and 2017, indicating that total operating revenue is lower than total operating cost;

129. Debt service coverage ratio is higher than 1.3 for all years until 2025; and

130. Accounts receivable is equivalent to 30 days of total revenue.

[21] Financial Net Present Value.

[22] Can be identified in coordination with the local authority in the commune level.

Table 7.7: KCPWW Summary of Financial Indicators

Financial Indicators[23]	2015	2016	2017	2018	2019	2020	2025
Cost Recovery:							
O&M	1.3	1.2	1.2	1.4	1.4	1.3	1.5
O&M + Depreciation	1.0	0.9	0.9	1.0	1.0	1.0	1.2
Current Ratio	8.3	9.0	9.3	11.1	12.2	13.5	10.4
Operating Ratio	1.0	1.1	1.1	1.0	1.0	1.0	0.9
Debt Service Coverage Ratio	-	-	-	-	23.3	23.5	8.2
Account Receivable (Days)	30	30	30	30	30	30	30

Source: Consultant's estimate

7.3.3 Economic Assessment

7.3.3.1 Project Rationale

131. Direct involvement of the Government in the provision of improved water supply services stems from the minimal participation of the private sector in its development. There used to be four private operators in Kampong Cham but only two are still operating at present. One private operator24 now serves about 105 customers. There is no connection fee but the operator charges KR 2500 per m3 for domestic customers compared to the KCPWW's KR 550 per m3 for the first 10 m3 and KR 900 per m3 for consumption above 10 m3. The minimal investments for improving existing services and the high connection fee25 will continue to deprive an increasing number of people in Kampong Cham of this basic service, which could have long-term impact on their health and well-being. Government's involvement in this project will help improve the provision of water supply services especially to the poor households.

132. The parameters and values used in quantifying the economic benefits of water supply improvement are shown in Table 7.8. There are other benefits that could result from improved water supply but such benefits as income generated from the use of water for livelihood purposes and the multiplier effect of increased income, among others, were not included in the analysis for lack of data.

[23] Cost recovery-O&M=total operating revenues / total O&M cost; cost recovery-O&M+depreciation=total operating revenues / total O&M cost and depreciation; current ratio=current assets / current liabilities; operating ratio=total operating cost / total operating revenue: debt service coverage ratio=internal cash generation / total debt service; days account receivable=account receivables / total water sales x 365 days.

[24] Water supplied by the private operator is not treated.

[25] KR440,000 per connection, equivalent to about one month salary of KCPWW personnel.

Table 7.8: Assumptions for Economic Benefits Computation

No.	Item	Value
1	Price of 20-liter bottled water, KR	8,000
2	Bottled water consumed, lpcd	1
3	Bottled water user, %	16%
4	Willingness to pay, KR/m3	1,263
5	Households who store water, %	34%
6	Storage facility cost, KR	297,716
7	Households who collect water, %	33%
8	Collection time per day, hours	0.5
9	Households who treat water, %	77%
10	Water treatment cost, KR	39,890
11	Morbidity rate, %	1.6%
12	Economically active population, %	41%
13	Average days indisposed, days	9
14	Average daily wage rate, KR	35,994
15	Medical cost per capita, KR	86,063

Source: Socio-economic survey, July 2013

7.3.3.2 Economic Costs.

133. The estimated economic cost equivalent of the proposed capital investments is approximately KR 4661 million.

7.3.3.3 EIRR and Sensitivity Analysis.

134. Given the stream of economic benefits and costs over the 30-year period, the EIRR of the investments for KCPWW is 21% which is higher than the assumed EOCC of 12%. Sensitivity test results based on (1) 20% increase in capital costs, (2) 10% increase in O&M costs, (3) 10% decrease in benefits, and (4) 1 year delay in realization of the benefits show the EIRR still above the EOCC. Table 7.9 summarizes the results of the base case analysis and the sensitivity tests.

Table 7.9: KCPWW EIRR and Sensitivity Test Results

Items	EIRR	ENPV
Base case	21.1%	10,788
Capital cost plus 20%	15.0%	8,928
O&M cost plus 10%	19.7%	10,077
Benefits less 10%	16.1%	8,068
1-Year delay in benefit	14.6%	9,922

Source: Consultant's estimate

7.3.3.4 Project Beneficiaries.

135. At the end of year 2023, KCPWW is projected to have a total of 8813 water service connections, an increase of 2382 from the 2014 projected level. In terms of served population, the investments will directly benefit an additional 11352 persons within the service area (Table 7.10).

Table 7.10: KCPWW Projected Service Connection

Item	2014	2015	2020	2023
Service area population	63,929	63,961	64,121	64,217
Population served	29,918	30,692	41,270	41,270
% Served	47%	48%	64%	64%
Number of connection	6,431	6,602	8,753	8,813

Source: Consultant's estimate

7.3.3.5 Project Sustainability.

136. The project financial sustainability is highly dependent on the realization of the targeted new service connections and the implementation of the proposed water tariff increases to generate funds to cover O&M cost and depreciation.

7.3.3.6 Poverty Impact.

137. The water supply project is expected to generate total net economic benefits (NEB)26 of about KR 1162 million. Approximately KR 894 million will accrue to water consumers, many of whom are current users of water from wells, rainwater, river water and other sources and who are expected to connect to the improved piped water supply system to be made possible through this Project. Local labor, for which a significant amount of person-days will be needed for construction of the new facilities and their eventual operation, will gain about KR 267 million.

138. The poverty impact ratio (PIR) for the water supply investments is 0.30, which means that 30% of the NEB will directly benefit the poor. Poverty incidence in the service area is around 30%.

Table 7.11: KCPWW Poverty Impact Ratio

Items	**Government /Economy**	**Labor**	**Consumers**	**Total**
Gains and losses	-	267	894	1,162
Financial return to PWW	71			71
Benefits (Losses)	71	267	894	1,232
Proportion of poor	0.30	0.30	0.30	
Benefits to poor	21	80	268	370
Poverty Impact Ratio				0.30

Source: Consultant's estimate

[26] NEB is the difference between the present value of economic benefits and financial revenues.

Appendix A: Kampong Cham Subproject Implementation Schedule

ID	Task Mode	Task Name	Duration	Start	Finish
1		Completion of PPTA			Mon 4/11/13
2		Tendering of Implementation project	30 days	Mon 3/02/14	Fri 14/03/14
3		Tender evaluation	30 days	Mon 17/03/14	Fri 25/04/14
4		**Final design & contract management**	**524 days**	**Tue 1/07/14**	**Fri 1/07/16**
5		Final design & contract documentation	261 days	Tue 1/07/14	Tue 30/06/15
6		Tenders close - construction package 1		Mon 3/08/15	
7		Tenders close - construction package 2		Mon 3/08/15	
8		Tender award - package 1 & 2		Mon 17/08/15	
9		Construction Package 1 - Stung Treng	500 days	Mon 31/08/15	Fri 28/07/17
10		Construction Package 2 - Siem Reap plus 7 others	500 days	Mon 31/08/15	Fri 28/07/17
11		Commissioning			Fri 11/08/17

Project: schedule.mpp
Date: Tue 10/09/13

Task		External Milestone		Manual Summary Rollup	
Split		Inactive Task		Manual Summary	
Milestone		Inactive Milestone		Start-only	
Summary		Inactive Summary		Finish-only	
Project Summary		Manual Task		Deadline	
External Tasks		Duration-only		Progress	

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Project: schedule.mpp
Date: Tue 10/09/13

Task		External Milestone		Manual Summary Rollup	
Split		Inactive Task		Manual Summary	
Milestone		Inactive Milestone		Start-only	
Summary		Inactive Summary		Finish-only	
Project Summary		Manual Task		Deadline	
External Tasks		Duration-only		Progress	

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Appendix B: Cost Estimate Breakdowns for Kampong Cham Subproject

Including;

- Chlorination equipment
- Office building
- Pipelines
- Valves

Appendix C: Water Quality Test Results for Kampong Cham Subproject

Annual test results are published for all 9 subproject towns. The data presented here is from the "Annual Report on Water Quality Analysis 2010, 1st Edition, MIH".

Month average	**Temp (C)**	**Turbidity NTU**	**Res chlorine (mg/l)**	**pH**	**Colour TCU**	**TDS (mg/l)**	**Conductivity**
LIMIT		**<5**	**0.2-0.5**	**6.5-8.5**	**<5**	**800**	**1600**
Jan	27.7	1	0.73	6.9	<2	-	436
Feb	28.3	1	0.72	6.89	<2	222	446
Mar	29.5	1	0.72	7.03	<2	239	477
Apr	28.2	1	-	6.74	<2	217	434
May	28.5	1	-	6.73	<2	225	450
Jun	27.5	0.7	-	6.87	0	232	465
Jul	29.1	0	0.43	7.31	0.1	236	472
Aug	28.7	0	0.59	7.1	0	229	458
Sept	28.6	0	0.74	7.14	0.1	229	452
Oct	28.7	0	0.75	7.17	0	228	446
Nov	28.6	0	0.84	7.16	0	228	456
Dec	28.4	0	0.87	6.79	0	234	467

Appendix D: Socio-economic Survey Report for Kampong Cham Subproject

Appendix E: Cancelled

Appendix F: Ethnic Groups Screening Form

Appendix G: Gender Plan for Kampong Cham Subproject

Appendix H: Kampong Cham Subproject Financial and Economic Analysis

Appendix I: Cancelled

Appendix J: Initial Environmental Examination for Kampong Cham Subproject

Appendix K: Land Acquisition and Compensation Plan for Kampong Cham Subproject

Appendix L: Pump calculations and duty curves

Appendix M: Map of proposed pipelines – extensions and parallel pipes

Appendix N: Outline Operations & Maintenance Plan

Operational Procedures

WTP area	Procedure
Raw water pumps	Can be controlled (on/off) by level transducers in the main elevated clear water tank, or manually by Operator.
Chlorination	Depending on the final chlorination equipment selected, dosing rate can be set manually, can be set to match flowrate from the pumps, or can be set through a feedback loop that measures residual at the end of the reticulation system, or another selected location. A manual selection rate is recommended.
Use of elevated tank	Often water is pumped directly into supply in order to utilize a few extra meters of head from the pumps to reach new extension areas in the town. This does not represent good operational practice and water should be pumped to the elevated tank at all times. If some areas that have had recent extensions are too far or too elevated to receive water from the WTP or elevated tank under normal operation, the town can be zoned with some areas receiving preferential water at certain times of the day by operating boundary valves.
Pumping records and meter readings	Pump records should be kept, and bulk meter readings for clear water being pumped to the elevated tank recorded daily. Additionally a second bulk meter on the delivery line from the elevated tank downstream of any bypass would be beneficial.
Reticulation	
Washout valves	All washout valves on the system, installed at low points, should be opened every month to flush out the line as required.
Valves on the distribution system	Valves should be kept either fully open or fully closed.

Maintenance schedule

WTP area	Procedure
Raw water pumps	These submersible borehole pumps are very durable but should be removed from the bore every 2 years for a routine inspection and maintenance. This is made easy with the auto-coupling and guiderail installations.
Chlorination equipment	Equipment should be inspected regularly for signs of corrosion and gas pressure checked. Any specialist maintenance required can be assisted by PPWSA and/or the local agent for the equipment either in Phnom Penh or regionally. Only genuine spares from the equipment manufacturer should be used when dealing with gaseous chlorine.
Pump wellheads	The building containing the borehole pump should be kept clear and tidy and not used as a general storage shed. At regular intervals the sampling tap on the wellhead should be turned on to ensure no air is trapped.
Washout valves and gate valves on reticulation system	Open and close valves and clean valve chamber twice a year.
Reticulation	
Gate valves	All gate valves on the pipelines should be kept either fully shut or fully open as required.
Washout valves	Any washout valves, normally installed at low points, should be periodically (6 monthly) opened to flush out any debris.
Chambers	All valve chambers should be kept dry, clean and accessible.
Domestic connections	Any leaks on the upstream side of the meter should be recorded by meter readers and repaired promptly.
Physical leaks	All leaks reported or noticed by WA staff should be repaired promptly.

Appendix O: Least Cost Analysis

KINGDOM OF CAMBODIA

MINISTRY OF INDUSTRY AND HANDICRAFT

URBAN WATER SUPPLY AND SANITATION PROJECT

(ADB PPTA: TA-8125-CAM)

FEASIBILITY STUDY FOR SIEM REAP SUBPROJECT

November 2013

Prepared by

Egis Eau in association with Key Consultants (Cambodia) Ltd.

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Document Status						
Rev No	**Author/editor**	**Reviewer**		**Approved for Issue**		
		Name	**Signature**	**Name**	**Signature**	**Date**
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APPENDICES

ABBREVIATIONS AND EQUIVALENTS

ADB	Asian Development Bank
ADF	Asian Development Fund
AP	Affected persons
APs/AHs	Affected persons/affected households
ASR	ADB's Annual Sector Review
BOO	Build-Operate-Own
BOT	Build-Operate-Transfer
COBP	Country Operations Business Plan
CPP	Community Participation Plan
CPS	Country Partnership Strategy
DMC	Developing Member Countries
DMF	Design and Monitoring Framework
DPWS	Department of Potable Water Supply
EA	Executing Agency
EGM	Effective Gender Mainstreaming
EMP	Environmental Management Plan
FAR	Feasibility Assessment Report
FS	Feasibility Study
GAP	Gender Action Plan
HHs	Households
IAs	Implementing Agencies
IEEs	Initial Environmental Examinations
IOL/SES	Inventory of Losses and Socioeconomic Survey
IR	Inception Report
ISCD	Institutional Strengthening & Capacity Development
JICA	Japan International Cooperation Agency
LARP	Land Acquisition and Resettlement Plan
LARF/LARP	Land Acquisition and Resettlement Framework and Plan
MEF	Ministry of Economy and Finance
MIH	Ministry of Industry and Handicraft
MOU	Memorandum of Understanding
MOWRAM	Ministry of Water Resources Management and Meteorology
MPWT	Ministry of Public Work and Transport
MRD	Ministry of Rural Development
NCB	National Competitive Bidding
NRW	Non-revenue Water
O&M	Operation and Maintenance
PAM	Project Administration Manual
PDIH	Provincial Department of Industry and Handicraft
PDR	People Democratic Republic
pm	Person-months
PMU	Project Management Unit
PPP	Public Private Participation
PPPs	Public-Private Partnership
PPTA	Project Preparation Technical Assistance
PPWSA	Phnom Penh Water Supply Authority
REA	Rapid Environmental Assessment

RRP

SCS	Stakeholder Communication Survey
SPS	Safeguards Policy Statement
SRWSA	Siem Reap Water Supply Authority
SR	Safeguards Requirements
TA	Technical Assistance
TOR	Terms of Reference
WOPs	Water Operators' Partnerships
WTP	Water Treatment Plant

UNITS

ha	Hectare
lpcd	Liters per capita per day
l/s	Liters per second
m	Meter
mg/l	Milligrams per Liter
mm	Millimeter
m^3/day	Cubic meters per day

Figure 1-1 - Location of Project Towns

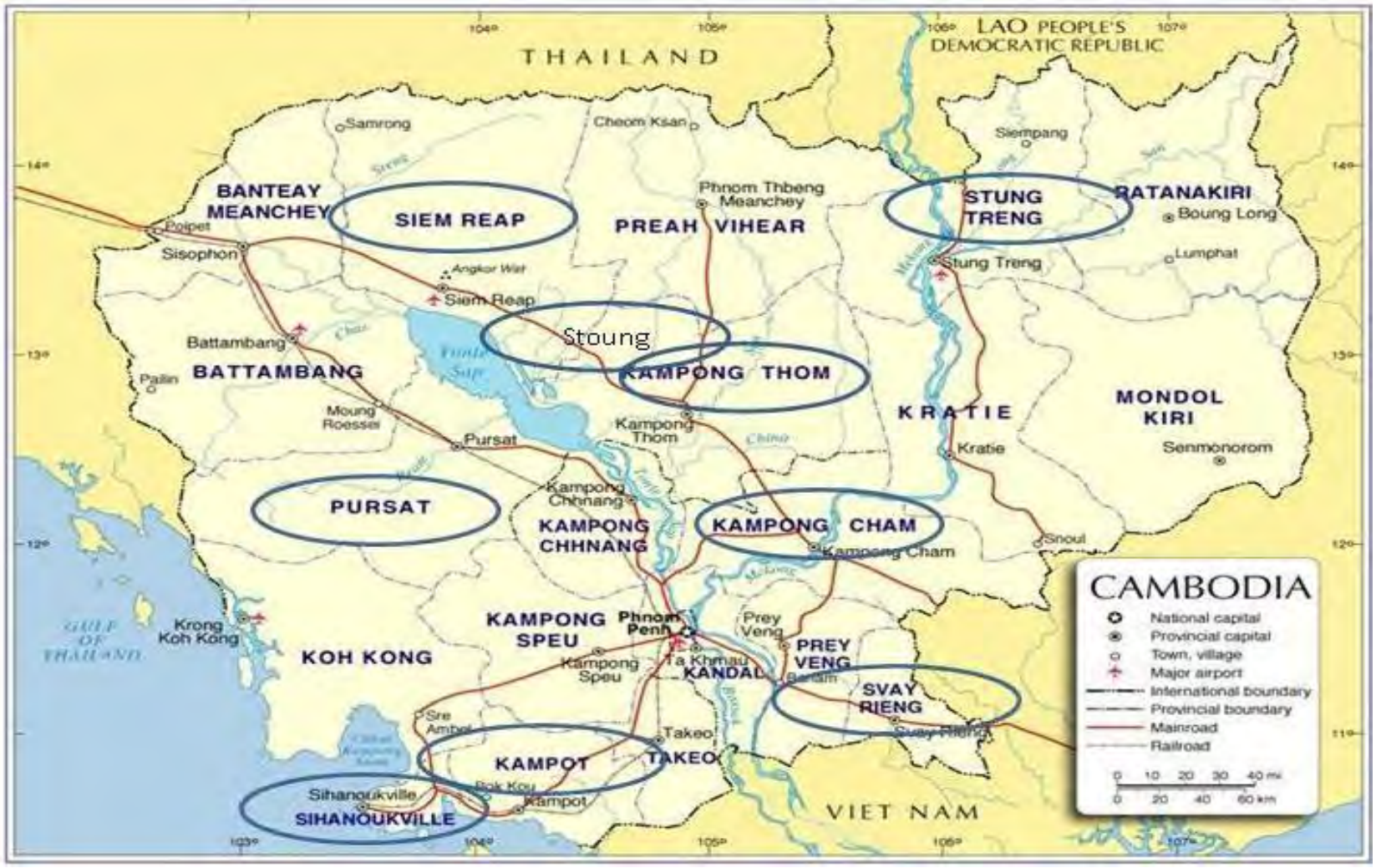
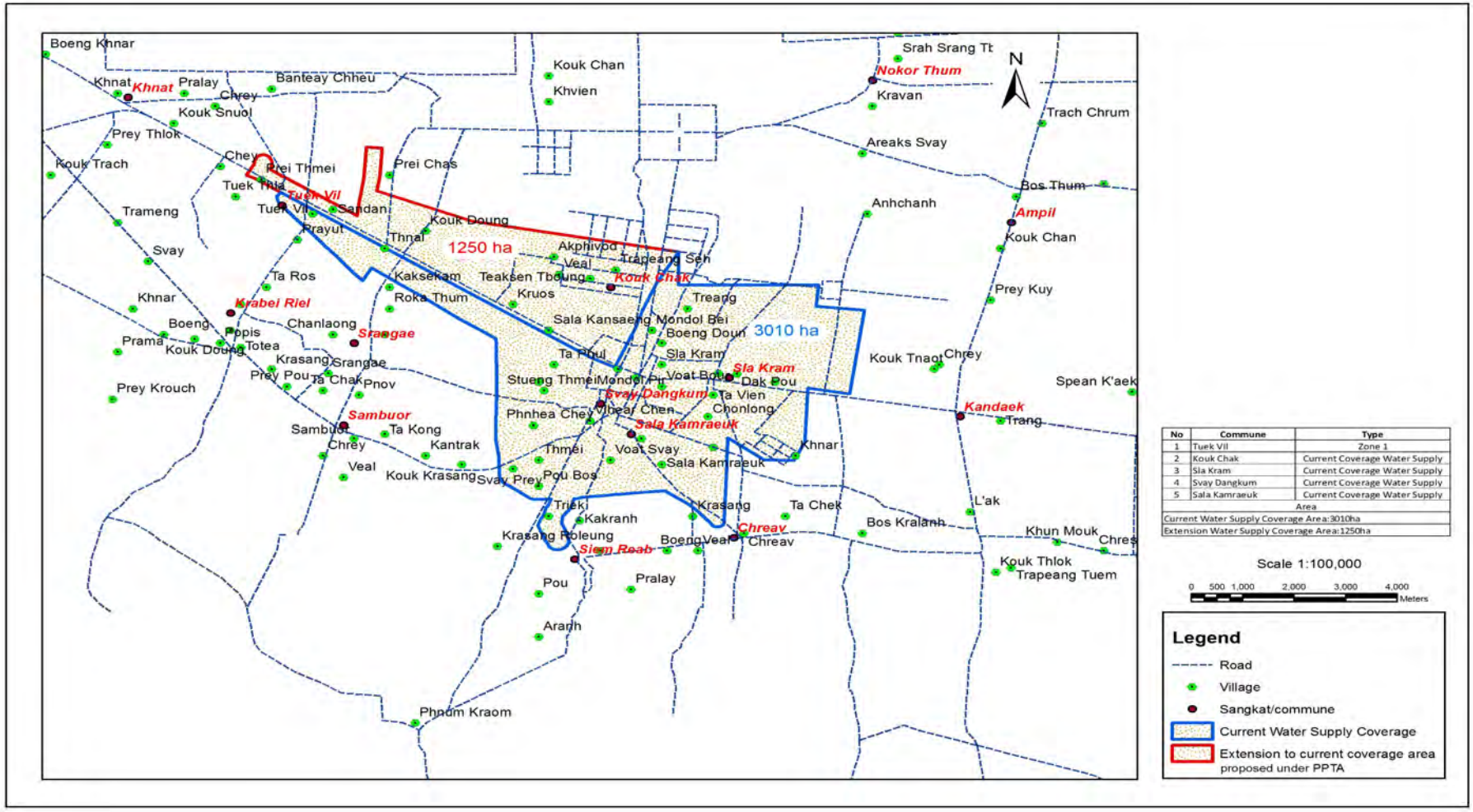


Figure 1-2 Location Plan of Proposed Siem Reap Subproject



1. EXECUTIVE SUMMARY

1.1 Project Description

1. Expected outputs of the overall Project include: (i) water treatment plants provided or improved in eight towns; (ii) water distribution systems improved and coverage increased in six towns; (iii) existing pumping stations rehabilitated in five towns; and (iv) institutional capacity of MIH and regulatory system strengthened, under a piggy-backed technical assistance.

1.2 Rationale

2. During 2011, through the ADB's Water Operators' Partnerships Program, ADB was able to re-engage in the urban water supply sector with MIH. Consequently ADB's Country Operations Business Plan 2010-2013 includes an Asian Development Fund loan for the Project for approval in 2014. The UWSP will assist the government to address the three core constraints identified in the ADB Country Partnership Strategy (2011-2013): (i) insufficient funds to expand coverage and improve services; (ii) weak sector planning and implementation capacity of responsible authorities at the central and sub-national levels; and (iii) inadequate (or sometimes weak) institutional and legal framework.

1.3 Background

3. The proposed Project "Urban Water Supply Project " (UWSP) will provide necessary facility improvements to the six provincial towns previously funded by ADB and to three provincial towns that have been funded by other bilateral or multilateral agencies, and expand public access to sustainable and safe water supply services for the urban population in Cambodia. In addition, the Project will address institutional weaknesses through the development of improved institutional structures, a regulatory framework, and appropriate capacity development.

1.4 Project Impact and Outcome

4. The impact of the proposed Project will be expanded access to sustainable and safe water supply services for the urban population in Cambodia and better functioning water treatment plants providing higher quality water. MIH targets are to increase the proportion of the urban population in the project area with access to safe water to 85% by 2018 and 90% by 2025, and the project will assist these aims. The outcome of the project will be improved water supply infrastructure and service provisions in selected provincial waterworks.

1.5 Candidate Towns

5. There are nine candidate towns: Kampong Cham, Kampong Thom, Kampot, Pursat, Siem Reap, Sihanoukville, Stoung, Stung Treng and Svay Rieng. Originally Battambang was to be included but this was removed at the request of the Provincial Waterworks.

1.6 Feasibility Study Context

6. The feasibility studies include: (i) needs assessment, supply and demand analysis, (ii) selection of technology, equipment, and facilities for the identified subprojects considering least cost and life cycle approach and the capacities of the local authorities to manage, operate, and maintain; (iii) assessment of economic and financial viability and sustainability for each of the subprojects; (iv) assessment of policy and legal capacity, including other institutional issues and mechanisms related to the financial management, procurement, and anticorruption; (v) poverty, social, and gender analysis and preparation of a poverty and social strategy, a gender action plan, stakeholder communication survey (SCS), and a Community Participation Plan (CPP), where required; and (vi) review of impacts on environment, involuntary resettlement, and indigenous peoples.

1.7 Subproject Description

1.7.1 Output 1 - Water Supply Development

7. The Siem Reap subproject aims to improve the provision of safe, affordable, reliable piped water supply to individual household connections to communities within the six core urban zones having Y2012 population of about 141,187.The works proposed under the PPTA are summarised in Table 1.1 below and in more edtail in Section 5.2.2.

1.7.2 Output 2 – Strengthening of Institutional capacity of MIH and Regulatory System

8. The Institutional Strengthening and Capacity Development is to (i) identify key stakeholders; (ii) assess institutional capacity constraints; (iii) develop institutional capacity building plan; and (iv) prepare terms of reference for strengthening sector regulation TA.

1.8 Cost Estimate

9. The subproject cost is estimated at $7.442 million equivalent, including taxes and duties. Table 1.1 provides a summary of the Siem Reap Subproject cost estimate.

Table 1.1: Siem Reap Subproject Cost Estimate ($'000's)

No	Description	Totals (inc tax)
		US$000
2	**Water Supply Development**	
2.1	Install main pipe diameter 600mm 6.5 Km from Treatment Plant to Zone 1, including road reinstatement	2,806.0
2.2	Install distribution network in Zone 1 (up to 250mm dia.) and Install distribution network in APSARA zone - for houses in same commune as Zone 1.	2,196.0
2.3	Install domestic meters and household connections	1,200.0
	Total for Water Supply Development	
	TOTAL ESTIMATED BASE COST[a]	**6,202.0**
	Total Contingencies	1,240.4
	TOTAL ESTIMATED SUBPROJECT COST	**7,442.4**

1.9 Financing Plan

10. The project will be financed by ADB and the national government. ADB loan will finance KR 30387 million while the government will finance KR 3312 million which includes government taxes. The financing plan is shown in Table 1.2

Table 1.2: SRWSA Financing Plan (KR million)

Items	% Total	Total
ADB	90.2	30,387
Disbursement	88.5	29,807
IDC	1.7	580
Government	9.8	3,312
Equity Contribution	0.9	301
Taxes, Duties and Other	8.9	3,011
Total	100.0	33,699

Source: Consultant's estimate

1.10 Executing Agency and Implementation Arrangements

11. MIH will be the Executing Agency, and the existing project management unit (PMU) based in the Department of Potable Water Supply (DPWS) will be expanded to execute and manage the Project on behalf of MIH with the consulting service to be provided by the project implementation assistance consultants (PIAC). The Project implementing units (PIUs) are expected to be organized by the nine (9) implementation agencies (IAs) of the provincial waterworks. The nine (9) PIUs will be responsible for day-to-day coordination and supervision of subproject implementation in these provincial towns.

1.11 Implementation Period

12. The proposed Project is scheduled for implementation over five years from 2014 to 2018. The final design is proposed for a one year period between mid-2014 and mid-2015. Following this, a two year construction period would have the works commissioned in August 2017. A proposed Implementation schedule is included in Appendix A.

1.12 Procurement

13. The procurement shall be carried out under International Competetive Bidding (NCB) as three packages; one package Stung Treng; one package Siem Reap; and the remaining 7 subprojects as one package. The full Procurement Plan is contained in the Supplementary Appendices of the main PPTA report.

1.13 Consulting Services

14. The project implementation assistance consultants (PIAC) on the design and engineering review, tendering assistance, and construction management are provided under Bank financing will be selected in advance and engaged in accordance with the ADB's Guidelines on the Use of Consultants. An individual consultant will be engaged to prepare the PIAC terms of reference and to assist the EA on the preparation of the Request for Proposal. The PIAC consulting services will be signed once the loan becomes effective to provide under a single consulting package, by an association of international and domestic consulting firms. The lead consulting firm will provide the services of the Team Leader who will be responsible for managing the overall consulting services during the project implementation.

1.14 Economic and Financial Analyses

15. Economic and Financial analyses are contained in Section 7, and in Appendix H.

1.15 Tariff and Affordability

16. For the period 2015 to 2023, only a 6 to 12% tariff increase (average) is required for SRWSA to cover O&M, depreciation and loan amortization. The proposed increases in the tariff will result to a monthly bill of not more than 5% of the family income of the low income group.

Table 1.3: SRWSA Proposed Tariff Rate – 100% Loan

Category	Consumption	2015	2018	2021	2023
Domestic/Government	0 to 7 m3	1,100	1,200	1,350	1,500
	8 to 15 m3	1,500	1,600	1,800	1,950
	15 to 30 m3	1,800	1,920	2,160	2,340
	> 30 m3	2,000	2,130	2,400	2,600
Commercial	0 to 50 m3	1,900	2,020	2,280	2,470
	51 to 150 m3	2,400	2,560	2,890	3,130
	151 to 350 m3	2,900	3,090	3,480	3,770
	> 350 m3	3,400	3,620	4,080	4,420
Tariff Increase (Average)		0%	6%	12%	8%

Source: Consultant's estimate

1.16 Subproject Benefits and Beneficiaries

17. At the end of year 2023, SRWSA is projected to have a total of 5819 water service connections, an increase of 931 from the 2014 projected level. In terms of served population, the investments will directly benefit an additional 5322 persons within the service area (Table 1.4).

Table 1.4: SRWSA Projected Service Connection

Item	2014	2015	2020	2023
Service area population	156,490	164,753	213,089	248,656
Population served	22,572	22,595	27,894	27,894
% Served	14%	14%	13%	11%
Number of connection	4,888	4,897	5,819	5,819

Source: Consultant's estimate

1.17 Land Acquisition and Compensation

18. The overall project has Involuntary Resettlement Categorisation B. There are two areas of land to be acquired in Stoung (225m2) and Svay Rieng (9m2). The Resettlement Due Diligence report for Siem Reap is contained in Appendix K.

1.18 Environmental Impacts

19. An Initial Environmental Examination (IEE) was carried out for Siem Reap, and is contained in Appendix J. The subproject is classified as Category B. The overall conclusion is that providing the mitigation, compensation and enhancement measures are implemented in full, there should be no significant negative environmental impact as a result of location, planning, design, construction and operation of the project. There are benefits stemming from recommended mitigation and enhancement measures, and major improvements in quality of life and individual and public health once the project is in operation.

1.19 Indigenous Peoples

20. The Indigenous Peoples Impact sceening checklist has been completed and is contained in Appendix F. While there are ethnic minorities, like the Chinese, Lao and Vietnamese, they have already integrated in the mainstream society that will benefit from safe and potable water. There are no expected negative effects on ethnic groups.

2. PROJECT RATIONALE, IMPACT AND OUTCOME

2.1 Rationale

21. During 2011, through the ADB's Water Operators' Partnerships Program, ADB was able to re-engage in the urban water supply sector with MIH. In January 2012, MIH signed a twinning agreement with the PPWSA, which is currently providing support to four provincial waterworks been included in the Project through direct peer-to-peer knowledge transfer. In February 2012, the Ministry of Economy and Finance (MEF) requested ADB to consider financing the Project in accordance with the strategy of Cambodia's Public Debt Management, to ensure sustainable economic growth. Consequently ADB's Country Operations Business Plan 2010-2013 includes an Asian Development Fund loan for the Project for approval in 2014. The project supports the ADB's annual sector review, country partnership strategy, and the water operational plan 2011–2020

22. The UWSP will assist the government to address the three core constraints identified in the ADB Country Partnership Strategy (2011-2013): (i) insufficient funds to expand coverage and improve services; (ii) weak sector planning and implementation capacity of responsible authorities at the central and sub-national levels; and (iii) inadequate (or sometimes weak) institutional and legal framework.

2.2 Background

23. The proposed Project "Urban Water Supply Project " (UWSP) will provide necessary facility improvements to the six provincial towns previously funded by ADB and to three provincial towns that have been funded by other bilateral or multilateral agencies, and expand public access to sustainable and safe water supply services for the urban population in Cambodia. In addition, the Project will address institutional weaknesses through the development of improved institutional structures, a regulatory framework, and appropriate capacity development.

24. This UWSP is in line with (i) Cambodian National Strategic Development Plan (2009-2013) and (ii) action plan of Ministry of Industry and Handicraft (MIH) to facilitate private sector partnerships, strengthening the management of public owned waterworks, and integration urban water supply with urban environmental management. The proportion of the urban population in the project area with access to safe water will be increased to 85% by 2018 and 90% by 2025 as targeted by MIH. In addition, a potential target date for 100% coverage could be assumed as 2030.

2.3 Project Outline

25. The feasibility studies include: (i) needs assessment, supply and demand analysis, (ii) selection of technology, equipment, and facilities for the identified subprojects considering least cost and life cycle approach and the capacities of the local authorities to manage, operate, and maintain; (iii) assessment of economic and financial viability and sustainability for each of the subprojects; (iv) assessment of policy and legal capacity, including other institutional issues and mechanisms related to the financial management, procurement, and anticorruption; (v) poverty, social, and gender analysis and preparation of a poverty and social strategy, a gender action plan, stakeholder communication survey (SCS), and a Community Participation Plan (CPP), where required; and (vi) review of impacts on environment, involuntary resettlement, and indigenous peoples.

2.4 Project Impact and Outcome

26. The impact of the proposed Project will be expanded access to sustainable and safe water supply services for the urban population in Cambodia and better functioning water treatment plants providing higher quality water. MIH targets are to increase the proportion of the urban population in the project area with access to safe water to 85% by 2018 and 90% by 2025, and the project will assist these aims. The outcome of the project will be improved water supply infrastructure and service provisions in selected provincial waterworks.

3. Profile of Siem Reap Area

3.1 Town Location and Profile

27. Siem Reap city is the capital of Siem Reap Province and is on National Road 6 approximately six hours drive north from Phnom Penh at the top of the Tonle Sap lake.

28. Tourism is the primary industry in the Province, with over 2 million visitors annually, mainly for the Angkor World Heritage Site. There is also a significant fishing and agriculture industry based around the Tonle Sap.

3.2 Natural Features

3.2.1 Topography

29. Siem Reap is at the northern end of the Tonle Sap and is flat. There are mountains to the west but not within visible range.

3.2.2 Climate

30. The climate, in common with other non-coastal areas of Cambodia, is hot all year with a distinct rain season May – October and a drier season November – February

3.2.3 Surface water

31. The main surface water source in Siem Reap is the Tonle Sap, which recedes several kilometers each dry season. This is currently used by many private households near the lake, but not currently by the Water Authority for the raw water source. There is a stream, the Siem Reap stream, which runs from mountains to the north, collects in the Angkor period man-made West Baray, and then runs through the town centre.

3.2.4 Groundwater

32. Groundwater is currently used as the source for raw water for the Siem Reap Water Supply Authority. The bores are spread around the town area. There are also many unregulated boreholes extracting water for individual hotels around the town area. This over-extraction is said to be lowering the water table to the extent that the nearby Angkor temples are being damaged.

3.3 Socio-Economic Conditions

3.3.1 Population and Household Characteristics

33. The populations provided below are for the service area within Siem Reap.

Table 3.1: Siem Reap Population Characteristics

No	Core Sangkhat/Commune	2013 Pop'n.	No. HH	Persons/ HH
1	Zone 1 (includes APSARA area)	53,396	10,594	5.04
2	Zone 2	6,189	1,272	4.87
3	Zone 3	21,277	3,930	5.41
4	Zone 4	48,950	9,321	5.25
5	Zone 5	8,436	1,690	4.99
6	Zone 6	2,939	557	5.28
		141,187	**27,364**	

3.3.2 Ethnicity

34. From the "Poverty, Social and Gender analysis" contained in the main report supplementary appendices, the breakdown of ethnic groups in the wider Siem Reap town are provided in Table 3.2.

Table 3.2: Ethnic groups in Siem Reap

Ethnic Group	Cham	Vietnamese	Chinese
No. households	215	673	3,188

3.3.3 Population Growth and Migration

35. Population growth from the 2008 National Survey1 shows an average national urban growth rate of 2.21%. For the purposes of this study we have used growth rates for individual towns, provided by each Provincial Waterworks2. For Siem Reap this is 5.28% showing strong growth.

3.3.4 Education

36. Table 3.3 shows education levels by surveyed households

Table 3.3: Education levels

Level of Education	n	%
No Education	7	14
Primary School	20	40
Secondary School	10	20
High School	12	24
Bachelor Degree and above	1	2
Total	**50**	**100**

Source: *Socio-economic survey, July 2013*

[1] General Population Census 2008 National Report, August 2009

[2] Data collected by head of each commune

3.3.5 Health and Hygiene Conditions

37. Survey data on health status shows that the health of all household members is good. Approximately 3.2% of the survey sample reported having had a health problem in the 14 days prior to the survey. The most commonly reported health problem for household members in both treatment and control groups is diarrhea.

3.3.6 Land and House Tenure

38. 96.8% of all houses are owner-occupied and the remaining 3.2% renting. The range of average house sizes is up to 25m2 (28.4%), 26-50m2 (30.5%), 51-100m2 (24.2%) and over 100m2 (16.8%). The percentage of houses connected to power supply is 87.4% for the project area while 12.6% of household use kerosene lamps for lighting and batteries.

3.3.7 Occupations and Livelihoods

39. Main occupations are provided in Table 3.4.

Table 3.2: Main Occupation (population of core villages)

No.	Main occupation	n	%
1	Government employee	16	17
2	NGOs/IOs staff	4	4
3	Worker at private companies/Factories	11	12
4	Small-scale business owner	22	23
5	Motor taxi driver	10	11
6	Transportation service provider	2	2
7	Construction worker	7	7
8	Self-employed	4	4
9	Farming/Agriculture	3	3
10	Other (mechanic, baby sitter, cook).	16	17
Total		**95**	**100**

Source: Socio-economic survey, July 2013

3.3.8 Income and Poverty Levels

40. The average annual income for households with a connection to the piped water supply system is 31,772,000 Riels($7,943), but for households not connected, the average annual income is lower at 11,331,680 Riels ($2,833).

41. Approximately 1% of the households surveyed were found to be living in poverty, as shown in Table 3.5.

Table 3.5: Status of wealth ranking in Siem Reap City

Wealth Ranking	n	%
Extremely poor	1	1
Poor	42	44
Average	42	44
Wealthy	10	11
Total	**95**	**100.0**

Source: Socio-economic survey, July 2013

3.4 Existing Water Supply and Sanitation

3.4.1 Water Supply

42. The first water treatment facility was built in 1930 using the Siem Reap stream as a source, and produced 200m3/day, mainly to feed the Angkor Hotel. The site of the old WTP is in what is now the centre of town on the location of the current SRWSA offices.

43. In 1960 the USA upgraded the WTP to 1,000m3/day using the same source. During the Pol Pot period 1975-79 the system deteriorated due to lack of staff and spares, and was reduced to 3 hours per day operation. In 1998 France changed the source to groundwater, which was in use until 2005.

44. In 2005 JICA constructed a new WTP near to the airport, with multiple boreholes supplying groundwater to the WTP. The WTP has capacity 8,000m3/day and uses pre-chlorination, aeration and filtration. The old French WTP in the town centre was demolished. There are 15 boreholes spread along National Road 6. There is a proposal to add two further boreholes, and two extra filters are currently being constructed. It is projected that this will add 5,000m3/day additional capacity.

45. There is a severe water shortage for Siem Reap and many hotels have their own borehole and treatment. It is estimated that hotel abstraction alone is 25,000m3/day.

46. Since 2011 there has been a further JICA project to design and construct a new 60,000m3/day WTP. This will pump raw surface water 8.6km from the Tonle Sap to the WTP which will be based on the existing Phnom Penh WTP.

47. There is a further proposal to construct another WTP next to the current WTP near the airport on a vacant site adjacent to the existing WTP, which will be fed raw water from the West Baray lake.

Table 3.6: Current and proposed WTP capacities

WTP	Current capacity (2013)(m^3/day)	Proposed capacity (m^3/day)
Airport WTP	8,000	
Proposed airport WTP additional bores & filters		5,000
Proposed JICA surface water WTP from Tonle Sap		60,000
Proposed new surface water WTP near airport		17,000

Table 3.7: Main Sources of Household Water

Water Sources	Dry season		Wet season		Both wet-dry seasons	
	n	%	n	%	n	%
a. Piped (town) water connected to a point inside house	-	-			14	14.7
b. Piped (town) water connected to a point outside house	-	-			6	6.3
c. Piped (private) water connected to a point inside house	-	-				
d. Piped (private) water connected to a point outside house	-	-				
e. Piped community water supply	-	-				
f. Private well, not shared, manual	-	-			28	29.5
g. Private well, shared, manual	-	-			17	17.9
h. Community well, manual	-	-				
i. Private well, with water pump	-	-			36	37.9
j. Community well, with water pump	-	-				
k. Private well. by truck/cart/bicycle	-	-				
l. River water catered by truck/cart/bicycle	-	-				
m. Reservoir / lake/ irrigation canal, manually collected	-	-				
n. River/stream water drawn via water pump	-	-				
o. Rainwater	-	-	11	11.6		

Source: Socio-economic survey, July 2013

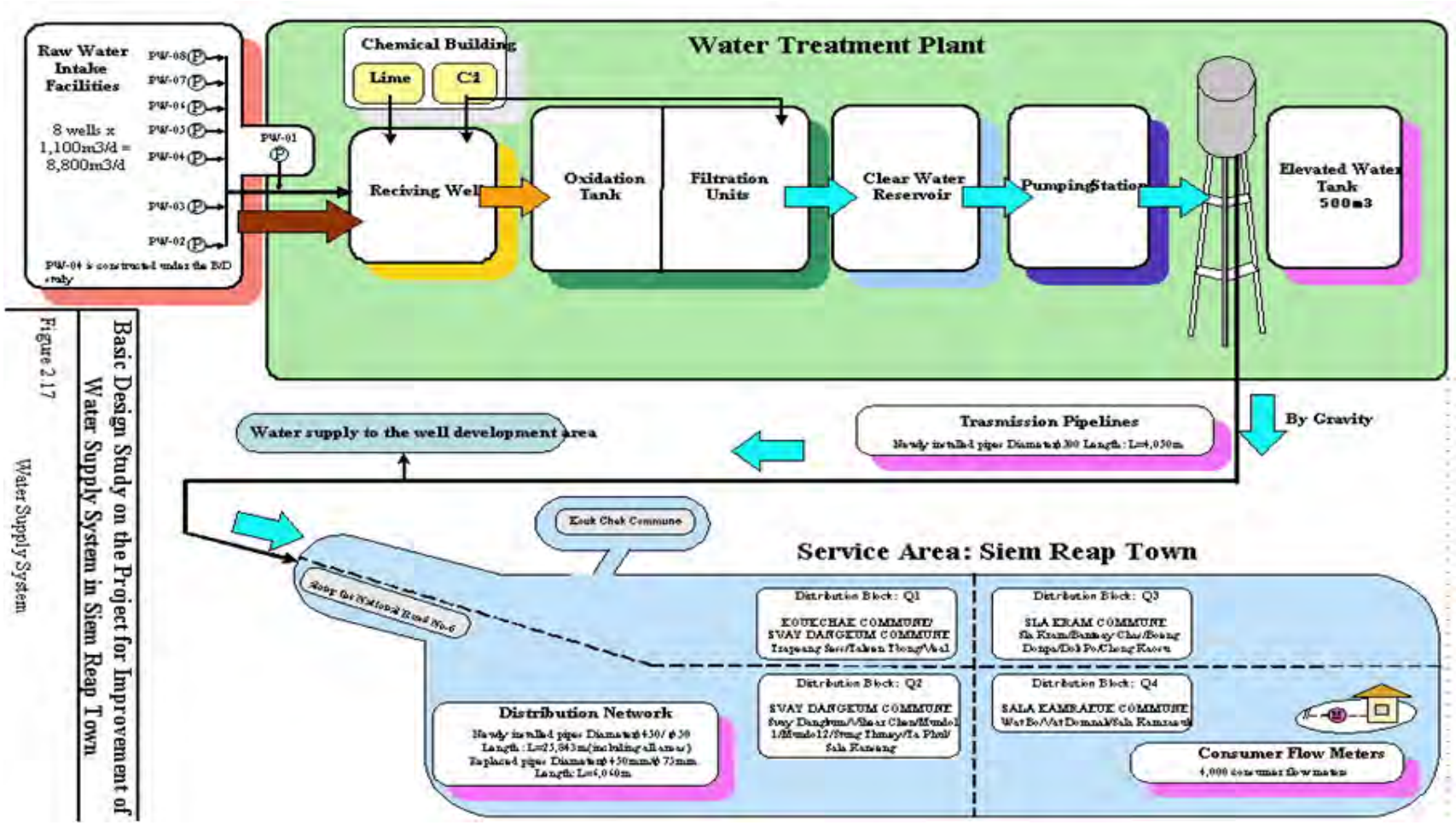


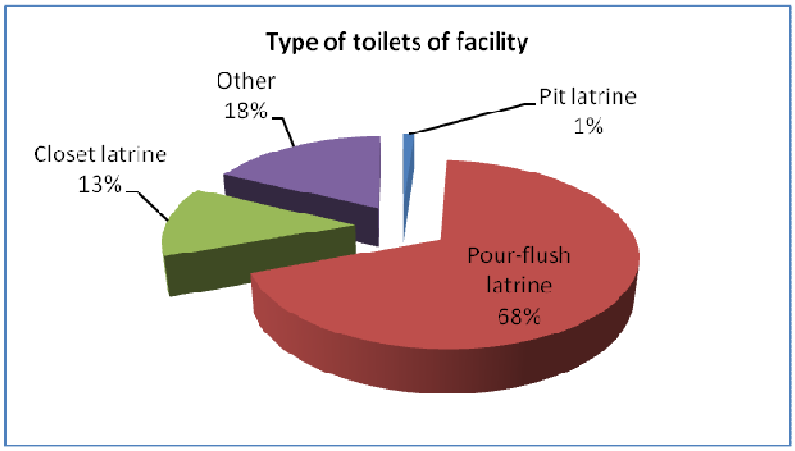
Figure 3-1: Current WTP and distribution system at Siem Reap

3.4.2 On-Site Sanitation

48. From survey results only 18% of households do not have a latrine of some kind.

49. Figure 3.2 shows the type of sanitation facilities in use.

Figure 3.2: Latrine types in use in Siem Reap



4. POPULATION GROWTH AND WATER DEMAND FORECASTS

4.1 General

50. Siem Reap is the capital city of the Province and acts as a market for the surrounding area.

51. At present, there is no agro-processing or industrial development in Siem Reap consuming water or which could affect water quality, and nothing planned. There is no mine in the region. By far the biggest impact on water demand is the growing tourism sector

4.2 Population Projections

52. The population projections3 are set out in Table 4.1. Within the core urban zones, total population is forecast to increase from about 141,187 in 2012 to about 356,468 in 2030.

Table 4.1: Population Projections for Siem Reap's Core Villages

Year 2012 Population	Growth Rate %	Forecast Population 2014	Forecast Population 2020	Forecast Population 2025	Forecast Population 2030
141,187	5.28	156,490	213,089	275,608	356,468

4.3 Water Demand Forecasts

4.3.1 General Approach

53. Whilst the scope of proposed works under this project does not include increasing the capacity of the Siem Reap water supply system, demand forecasts have been produced to illustrate the shortfall of available treated water into the near future. Water demand forecasts for the Siem Reap subproject were prepared by making separate projections of each component of demand, including:

- Demand for domestic use (based on per capita consumption, coverage targets and population projections);
- Demand for industry (based on a % of domestic use, and specific allowances for large industries);
- Demand for services (based on a % of domestic use, and specific allowances for large services areas);
- Physical losses as a % of total demand, excluding the demand of large industrial zones.
- Production losses in treatment plant (based % of total demands).

4.3.2 Domestic Consumption

54. Water demand and consumption data for other provincial and district towns in Cambodia show that domestic consumption accounts for about 90% of total demand. Per capita consumption figures for urban water supply systems in Cambodia can vary widely, particularly with strong reliance on rainwater collection during the wet season. Experience in other towns in Cambodia indicates that piped connections directly to the house will usually increase water consumption over time. The Feasibility Study has adopted a per capita consumption figure of 120 lpcd, plus 10% for non-domestic use which includes demand from industry and services, 15% for physical losses (leakage), and 50m3/day for backwashing filters in the WTP.

4.3.3 Water Demand Forecasts

55. Table 4-2 summarizes the demand forecasts and design criteria for the Siem Reap subproject. By 2030, the average daily water demand is expected to be 120,000m3/day, comprising

[3] 2012 populations and growth rate provided by the SRWSA

43% domestic consumption, with the remaining 57% being for institutions, tourism, public use, services, handicraft and small industries, and allowances for physical losses and backwashing the filters.

Table 4-2: Water Demand Forecasts for Siem Reap Subproject

No.	Items	Unit	Forecasts				
			2012	2014	2020	2025	2030
A.	**Domestic Demand**						
1	Growth Rate	%	5.28	5.28	5.28	5.28	5.28
2	Population in Core Area		141,187	156,490	213,089	275,608	356,468
3	Coverage in Core Area	%	90	100	100	100	100
4	Population with Piped Water	No.	127,068	156,490	213,089	275,608	356,468
5	Per Capita Consumption	l/c/d	120	120	120	120	120
6	Total Domestic Demand	m3/d	15,248	18,779	25,571	33,073	42,776
B.	**Non-domestic demand**						
1	Services, Schools, Small Industry, Institutions, Hotels	%	100	100	100	100	100
2							
3	Total Non-domestic demand	m3/d	15,248	18,779	25,571	33,073	42,776
C.	**Subtotal Water Demand All Categories**	m3/d	30,496	37,558	51,141	66,146	85,552
D.	**Non Revenue Water (NRW) in Distribution system**						
1	NRW as % Average Daily Water Production	%	15	15	15	15	15
2	NRW (physical losses only-pipelines and WTP)	m3/d	4,574	5,634	7,671	9,922	12,833
E.	**Average Daily Water Production (C+D) rounded**	m3/d	35,070	43,190	58,810	76,070	98,390
F.	**Peak Annual Water Demand (Max day Max month)**						
1	Peak Annual Water Demand		1.20	1.20	1.20	1.20	1.20
2	Peak Annual Water Demand	m3/d	42,084	51,828	70,572	91,284	118,068
3	Peak Annual Water Demand	l/s	487	600	817	1,057	1,367
G.	**Required Treatment Plant Output (rounded)**	m3/d	42,080	51,830	70,570	91,280	118,070
H.	**Treatment Plant Backwashing**						
1	Treatment Plant Backwashing	m3/d	50	50	50	50	50
I.	**WTP Capacity**						
1	Required WTP Capacity	m3/d	42,130	51,880	70,620	91,330	118,120
2	Required WTP Capacity	l/s	487.62	600.46	817.36	1,057.06	1,367.13
	Total Required Source Capacity (Rounded)	**m3/d**					**120,000**
	Total Required Source Capacity	**l/s**					**1,370.00**

4.3.4 Future Demand Requirements

56. This subproject is not intended to address future demands, but to complete the pipe network in Zone 1 and the APSARA zone that were omitted from a previous JICA project due to budget constraints.

57. If all of the new facilities summarized in section 3.4.1 are constructed, the total capacity of the 3 WTP facilities will be 90,000m3/day. This will provide sufficient water supply capacity to meet the projected 2025 population, but a further 30,000m3/day will be required to meet demand until 2030 based on the demand projections presented above.

5. SUBPROJECT DESCRIPTION

5.1 Introduction

58. The proposed works are designed to improve extensions to the current service area to include Zone 1 and the APSARA area. This improved water supply scheme is not designed to increase capacity of supply. An increase in capacity of supply is required in order for there to be sufficient water to serve these new supply areas, and this is being addressed separately by SRWSA with assistance from JICA.

5.2 Output 1: Water Supply Development

59. Expected outputs of the overall Project include: (i) water treatment plants provided or improved in eight towns; (ii) water distribution systems improved and coverage increased in six towns; (iii) existing pumping stations rehabilitated in five towns; and (iv) institutional capacity of MIH and regulatory system strengthened, under a piggy-backed technical assistance.

5.2.1 Preliminary Designs

60. The proposed water supply scheme design improvements are based on limited topographical, hydrological and water quality data and are preliminary.

5.2.2 Description of Proposed Water Supply System

61. The Siem Reap subproject aims to improve the provision of safe, affordable, reliable piped water supply to individual household connections to communities within the six core urban zones having Y2012 population of about 141,187.

62. The works proposed under the PPTA are summarised in Table 5.1 below;

Table 5.1: Proposed new infrastructure for Siem Reap

Siem Reap	Full FS	
		A- Install main pipe diameter 600mm 6.5 Km from Treatment Plant to Zone 1, including road reinstatement
		B- Install distribution network in Zone 1 (up to 250mm dia.) and Install distribution network in APSARA zone - for houses in same commune as Zone 1.
		C -Install domestic meters and household connections

5.2.2.1 Install main pipe from WTP to Zone 1

63. A new dedicated main supply pipeline is required to deliver treated water from the WTP to Zone 1. Zones 2-5 have been supplied under JICA funding but Zone 1 was omitted due to cost, so will be covered under this proposal. A route has been selected by SRWSA that will follow the main road, keeping to the side of the tarseal wherever possible. Schematic drawings of the proposed pipelines are in Appendix L.

5.2.2.2 Install all new distribution network in Zone 1

64. Zone 1 requires a new distribution system designing and installing. Under this PPTA a preliminary design will show the pipeline routes and approximate sizes based on road maps, aerial photos and a physical survey of property densities. A full topographical survey and demand analysis using a hydraulic modeling package such as EPAnet is recommended for the final design and implementation stage. Schematic drawings of the proposed pipelines are in Appendix L.

5.2.2.3 Install all new distribution network in APSARA zone

65. The APSARA zone is within the boundaries of the protected World Heritage zone, but properties that were here when the zone was set up can stay here provided no new houses are built. The part of the APSARA zone falling under this scope is immediately adjoining Zone 1. Similar to Zone 1, a new distribution system needs designing and installing. Schematic drawings of the proposed pipelines are in Appendix L.

5.2.2.4 Install domestic meters and household connections

66. A total of 8,000 households will require a small diameter connection to the rider main, with a standard SRWSA water meter installed.

5.3 Consultation Activities during Preparation of Siem Reap Feasibility Study

67. A series of community visits and consultations occurred during the finalization of the 2013 Feasibility Study to inform district and village authorities about the subproject and gather information and feedback from local authorities, people living in core villages and other stakeholders. Consultation activities during the project site visits in 2013 are detailed below:

(i) Initial reconnaissance visit March 2013: Team Leader and National water engineer visited the site for an initial inspection and discussion with the Siem Reap Water Supply Authority.

(ii) Second engineering site visit 30th April 2013: International and National water engineers visited Siem Reap facility, collected data, and finalized scope following Inception workshop.

(iii) Environmental and Resettlement specialist visit: This joint visit was carried out between June 3rd -11th to collect data to aid the finalization of the IEE and LACP.

(iv) Socio-economic specialist visit: a visit for the purpose of carrying out the socio-economic survey was undertaken on 18-27th June.

5.4 Operation and Maintenance of Project Facilities

5.4.1 Capacity to Operate and Maintain the Proposed Water Supply System

68. The Siem Reap Water Supply Authority have many years experience in operating and maintaining their treatment plant, and have full time Operator staff. There is a good understanding of how pumps work and the routine maintenance required.

69. The proposed works under this project are limited to new reticulation and domestic connections, which will enable the SRWSA to collect more revenue. It is likely that to operate this extended system, further O&M staff will be required to read meters and for basic line maintenance.

5.4.2 Management Arrangements

70. The PIAC will provide Project technical, safeguards, accounting and management assistance on a daily basis as well as support the PIUs with project implementation

71. At the start of Project implementation, the PMU and PIAC will (i) update the initial environment examinations and due diligence reports (IEEs and DDRs) and prepare EMPs submit to MOE for review and approval; (ii) clear potential unexploded ordnance (UXO) remain on site; and (iii) acquire necessary land before subproject bids are tendered.

5.4.3 Operation and Maintenance Plans

72. The Operation and Maintenance plan for each subproject can be divided into two types, those with a full conventional WTP and those with chlorinated groundwater being pumped to an elevated tank and fed into supply. For Siem Reap, an Operation and Maintenance Plan reflecting the latter has been developed and is presented in full in Appendix M.

5.5 Lessons learned in Cambodia and the SE Asia region

73. There are several "lessons learned" in both the region and inside the national water sector that would benefit the 9 project towns under this PPTA;

- As at PPWSA, use of standardized chlorination equipment that has a regional office that can offer technical support, spares and specialist staff when needed. PPWSA has selected equipment supplied by Severn Trent Services (STS), and equipment from this manufacturer has been recommended for the towns requiring replacement chlorination equipment under this study. STS have a main office in Singapore, but have local representation in Phnom Penh. However, final selection of equipment of equal or better specifications will be decided at tendering as specific brands cannot be specified in Contract documents.
- High density polyethylene pipe (HDPE) is favoured in Cambodia, even for larger diameters. As most of Cambodia is flat, as are all of the 9 towns under this study, system pressures are not higher than 60m head. As such, a PN6 rated pipe would be sufficient. However, experience has shown that for the pipes un to and including 90mm diameter, which may have domestic connections tapped from them, a PN8 minimum pipe is required, even for very low pressures. The reason for this is that the tapping saddles used can deform the thinner pipe wall thicknesses on PN6 pipe, which causes leakage.
- Automated valves linked to a central control panel were designed and installed under the 2006 Provincial Towns project. All of these have failed in the 6 towns where they were installed. The lesson here is to keep the WTPs simple and keep valves as manually operated. With the relatively smaller size of these WTPs (mostly under 6,000m^3/day), valve automation is not necessary and inappropriate.
- Alum and poly dosing lines under the previous Provincial Towns project used long lengths of uPVC pipe that followed buildings and structures, necessitating several 90 degree bends and causing significant headloss in the delivery pipe. This has caused the pipes to get blocked by sediment. In addition, the uPVC dosing pipes are exposed to direct sunlight. UV light will break down uPVC pipe over time. A better solution, as used in two recent projects in Laos, is to use ABS (acrylonitrile butadiene styrene) pipe, and select a more direct route for the pipe, minimizing bends and low points.
- For the water sector as a whole, a database of all water projects could be set up, to include design drawings, calculations, contract documents, demand calculations, feasibility reports, final design reports and other useful documentation, for each system. This would serve as an easily accessible online resource library for all Water Authority staff in the country. It is relatively easy and inexpensive (under US$40,000) to set up and populate, and solves the common problem of drawings and documents getting lost. Many of the available hard copy resources for Cambodian water supply systems are either misplaced, or are reportedly stacked in disorder in a storeroom so dirty that nobody is willing to enter. Such a database was set up and released in neighbouring Laos in 2012-13 with assistance from UNHabitat, and can be viewed at;

http//:laowtp.info
by pressing "login as guest".

- Several of the project towns under this PPTA have had extensions added to serve areas that were outside of the original design core area, without considering required design pressures or treatment plant capacity. This often results in the WTP being operated above its design capacity, which can reduce water quality, and often has negative effects on service pressure to other parts of the reticulation network. Typically, to increase system pressure to serve these unplanned extensions, water is diverted around any elevated storage tank and pumped directly into the system in order to increase delivery pressure by a few metres head. This is bad operating practice as it eliminates the storage facility and increases leakage loss. Any pipeline extensions should be made in a planned way and carried out simultaneously with WTP capacity upgrades as required.

5.6 Public Private Partnerships

74. Options and viability for potential PPP for Siem Reap subproject was discussed with the Director of the Department of Potable Water Supply4.

75. In common with all towns in general, the urban water supply systems are seen as best managed by the government where possible. Installation and commissioning of the elements of work under this subproject require specialist contractors and involvement of public bodies is limited.

76. There are some peri-urban areas in Cambodia where whole water supply concessions have been granted to private companies to construct and manage water supply systems. This is not strictly PPP, as the private company needs only to acquire a license – there is no partnership as such. There are both good and bad examples of these private concessions throughout the country.

77. A possible area where a PPP could be utilized in the future is in the supply of bulk treated water to customers who are either just outside of the WTP service area or are inside the area but receive low pressure. Private water tankers could be used to fill up with (and pay for) treated water from the WTP and deliver and sell to customers with their own storage tanks.

5.7 Contract Packaging of Subproject

78. A number of packaging options were examined and discussed between the PPTA team, MIH and ADB. These options are presented below in Table 5.2.

Table 5.2: Subproject Contract Packaging Options

No. packages	Subproject Towns included	Advantages/disadvantages
2	Stung Treng Siem Reap plus 7 rehab towns	**Advantages:** • Small number of packages reduces tendering and contract management admin. • Larger packages makes them more attractive to international bidders. • Easier to standardise on equipment. **Disadvantages:**

[4] Mr Tan Sokchea

		• Limited opportunity for NCB
3	Stung Treng Siem Reap 7 rehab towns	**Advantages:** • Three good sized packages attractive to ICB bidders • Small number of packages reduces tendering and contract management admin. • Easier to standardise on equipment **Disadvantages:** • Limited opportunity for NCB
4	Stung Treng Siem Reap 3 southern rehab towns (Svay Rieng, Kampot, Sihanoukville) 4 northern towns (Kampong Cham, Kampong Thom, Pursat, Stoung)	**Advantages:** • 2 larger and 2 smaller packages, the smaller of which could be NCB if an exception to the $1M limit relaxed **Disadvantages:** • More tender and contract management admin • More difficult to standardise on equipment with larger number of packages.
9	9 separate contracts	**Advantages:** • Each IA is responsibe for their own subproject and has direct ownership • 7 of the 9 subprojects could be let as NCB **Disadvantages:** • More tender and contract management admin • Some activities may not be suitable for many national contractors due to lack of specialist experience. • More difficult to standardise on equipment with larger number of packages.

79. During discussions, initially the option of two large contracts, one for Stung Treng and one for the other 8 towns, was favoured for the simplicity of the bidding process, contract administration, and the attractiveness of the larger packages to international bidders.

80. After further discussion, 9 separate contracts was favoured, as greater weight was put on having the contracts out to tender quickly, and having 7 of them of a size that would permit NCB

would help achieve this. The procedures for approving and tendering NCB are far less time consuming compared to ICB. Additional benefits would be that each IA would have ownership of their own subproject, and that national contractors would benefit from both the experience and the business.

81. A perceived obstacle with having 7 of the subprojects as NCB is the technical nature of some of the rehabilitation work. Installation and commissioning of gas chlorination equipment, bladder tanks for surge protection, and proper construction of filter underdrains are all areas requiring a degree of specialist knowledge and experience. For this reason, coupled with the simplicity of having a lesser number of contract packages, a compromise of three packages was selected, being Stung Treng, Siem Reap, and the 7 rehabliitation subprojects.

82. These 3 packages will all need to be ICB due to their value, but this does not exclude national contractors from bidding, provided they meet the prequalification requirements. Additionally, if national contractors have difficulty meeting prequalification requirements, they can still benefit from these contracts by subcontracting.

6. COSTS AND FINANCING PLAN

6.1 Cost Estimates

83. The subproject cost is estimated at $7.442 million equivalent, including taxes. A summary of the cost estimates is given in Table 6-1.

Table 6-1 - Subproject Capital Cost

No	Description	Totals (inc tax)
		US$000
2	**Water Supply Development**	
2.1	Install main pipe diameter 600mm 6.5 Km from Treatment Plant to Zone 1, including road reinstatement	2,806.0
2.2	Install distribution network in Zone 1 (up to 250mm dia.) and Install distribution network in APSARA zone - for houses in same commune as Zone 1.	2,196.0
2.3	Install domestic meters and household connections	1,200.0
	Total for Water Supply Development	
	TOTAL ESTIMATED BASE COST[a]	**6,202.0**
	Total Contingencies	1,240.4
	TOTAL ESTIMATED SUBPROJECT COST	**7,442.4**

Source: Consultant's estimate, 2013.

6.2 Least cost analysis

84. No least cost analysis was carried out for Siem Reap as alternative solutions were not presented for consideration.

6.3 Financing Plan

85. The project will be financed by ADB and the national government. ADB loan will finance KR 30387 million while the government will finance KR 3312 million which includes government taxes. The financing plan is shown in Table 1.2

Table 6.2: SRWSA Financing Plan (KR million)

Items	% Total	Total
ADB	90.2	30,387
Disbursement	88.5	29,807
IDC	1.7	580
Government	9.8	3,312
Equity Contribution	0.9	301
Taxes, Duties and Other	8.9	3,011
Total	100.0	33,699

Source: Consultant's estimate

7. SUBPROJECT FINANCIAL AND ECONOMIC ASSESSMENT

7.1 Approach and Methodology: Financial Assessment

86. The financial analysis was done in three levels: (i) examination of the historical and current financial performance; (ii) evaluation of the feasibility of the proposed subproject under CUWSP; and (iii) evaluation of the financial sustainability taking into account the impact of the proposed subproject to the future operation of PWWs and WSA.

87. Following the Asian Development Bank (ADB) guidelines5, four basic indicators for the financial viability of a water supply project have been identified. These are the following:

- Financial Internal Rate of Return (FIRR). It is the discount rate at which the revenues and costs generated by the project are equal to zero. A project is considered financially viable if the computed FIRR is equal to or higher than the weighted average cost of capital (WACC) that is used in financing the development of the proposed water supply project.

- Debt Service Coverage Ratio (DSCR). It measures the solvency of the PWWs/WSA and shows how many times debt service for a given period is covered by operations. DSCR should at least be 1.3 after project completion.

- Annual cash balance. Projected annual cash balances should be positive all throughout the projection period.

- Tariff affordability. Household monthly water bill should not be more than 5% of the average monthly household income of the low income group.

7.1.2 Financing Plan.

88. The project will be financed by ADB and the national government. Part of the ADB and national government funds will be on-lent to the PWWs/ WSA. Annual debt service was estimated based on preliminary discussions with MIH and MEF. The on-lending terms for the purpose of this study are as follow:

- Maturity period of 32 years, including 8 years grace period on principal payment while interest is capitalized during construction;

- Fixed interest rate[6] of 1.25% per annum for the first 8 years and 1.75% per annum for the next 24 years; and

- Foreign exchange risk to be borne by the national government.

7.1.3 Proposed Water Tariff.

89. Three scenarios were tested in the design of the water tariff based on the amount of loan, as a percent of project costs, passed on to the 8 PWWs. For Siem Reap WSA, 100% loan was assumed. For the 8 PWWs, the three scenarios tested were: (1) 0% loan-100% grant; (2) 50% loan-50% grant; and (3) 100% loan-0% grant.

7.1.4 Other Assumptions

90. The main assumptions used in the financial projections include:

- Estimates of annual water revenues are based on the total water billed for the year and the corresponding tariffs for the same year. Connection fees, for non-poor household customers

[5] ADB, *Financial Management and Analysis of Projects* (2005).

[6] ADB's interest rate to the national government is 1% and 1.5% respectively.

are included as other revenues and assumed to be paid by the customers in 24 equal installments.

- The investment cost of the proposed project and the O&M costs are prepared on an annual basis in August 2013 prices. Increases in costs due to inflation are covered through a provision for price contingencies both for the investment costs and the O&M costs.

- The incremental O&M costs, which is the difference between "with the project" and "without the project" scenario, were used in the evaluation. O&M costs include: 1) administration; 2) chemical; 3) power; 4) maintenance of facilities; 5) salaries and wages; and 6) other O&M items.

- Projected O&M costs "without the project" are based on actual O&M costs as presented in the historical revenue and expense statements. It is assumed that there will be minimal increases in the service connections as water supply demand approaches the maximum water supply capacity of the existing system, hence there will be no increases in the number of personnel. The unit cost of O&M is assumed to increase following the local inflation rate.

- Projected O&M costs "with the project", except maintenance of facilities, are based on historical unit costs. Maintenance of facilities cost is based on engineering estimate of the required maintenance level of the facilities.

- Depreciation allowance is considered a non-cash item. However, for purposes of estimating the net income, it was included as expense in the projected income statement. Annual depreciation costs for the new facilities were calculated using the straight-line method based on the service life[7] of each type of asset.

- Water tariff "without the project", is assumed to increase in the future to cover increases in O&M. For purposes of the projection, it is assumed that water tariffs will have to be increased by 5% starting 2015 and every four years thereafter until 2027 for Siem Reap, Stung Treng and Svay Rieng; for Kampong, because current tariff is low, the assumed increases are 10%.

- Water Revenue "without the project". As mentioned earlier, since the existing facilities are already nearing its maximum operating capacities, it is assumed that there will be no further additional connections after the water supply capacities are reached in 2017. Volume of water sold after this period will remain constant. Any increase in projected revenue is then due to the assumed increase in water tariff.

- Water Revenue "with the project". Based on the technical study, the proposed improvements in the water supply system can provide the water requirements of the projected beneficiaries up to year 2019 (Siem Reap) to 2023 (Kampong Cham, Stung Treng and Svay Rieng). The volume of water sold is therefore assumed to increase up to that year and is assumed to remain constant at the that level. Any increase in projected revenue after this period is then due to the assumed increase in water tariff.

7.2 Approach and Methodology: Economic Assessment

91. The economic analysis was undertaken in accordance with the procedures set out in the ADB Handbook for the Economic Analysis of Water Supply Projects (1999) and related ADB guidelines8. The period of analysis extends over 30 years from the start of project implementation in 2015 up until 2044. Costs and benefits were quantified at August 2013 prices and were converted to their economic cost equivalents using shadow prices. Both costs and benefits were treated as increments to a "without the project" situation.

[7] Using PWWs/WSA asset life schedule.

[8] *Guidelines for the Economic Analysis of Projects (1997).*

92. The economic viability of the project was determined by computing the economic internal rate of return (EIRR) and comparing the result with the economic opportunity cost of capital (EOCC) of 12%. An EIRR exceeding the assumed EOCC indicates that the project is economically viable. The viability of the investments was then tested for changes in key variables such as capital costs, O&M costs and benefits through sensitivity analysis. Distribution of project benefits and poverty impact analysis were also undertaken to determine how much of the net economic benefits resulting from the investments will directly benefit the poor.

93. The economic viability of the proposed investments in water supply was determined considering the following benefits: (1) incremental gross revenue; (2) the value of time saved for not having to collect water from existing non-piped sources; (3) medical cost savings due to reduced morbidity from waterborne diseases; and (4) avoided income loss (productivity savings) because of reduced incidence of diseases. Economic costs were derived from the estimates of capital investments and O&M costs in financial terms, removing all duties and taxes and multiplying the net results by the conversion factors (CF). The following CFs were applied: 1.0 for traded goods and non-traded goods, and 0.7 for unskilled labor.

94. The proposed investments which aim to improve the population's access to piped water supply in the area, will form part of the Government's overall development plan for the water supply sector, which also aims to achieve the targets set under the Millennium Development Goal9.

7.3 Siem Reap Water Supply Authority (SRWSA)

7.3.1 Historical Financial Performance

95. From 2008 to 2012, SRWSA was able to cover total expenses and depreciation allowance. Operating ratio ranged from 0.57 to 0.81 from 2008 to 2012. Current ratio, between 3 to 22, was high for the five-year period while account receivable was low at 18 days equivalent of annual water sales as of end 2012.

Table 7.1: SRWSA Financial Indicators, 2008-2012

Financial Indicators	2008	2009	2010	2011	2012
Cost Recovery:					
Total expenses	1.64	1.56	1.81	1.92	2.28
Total expenses & Depreciation	1.29	1.23	1.45	1.56	1.77
Current Ratio	5.73	2.71	8.42	21.84	21.83
Operating Ratio	0.77	0.81	0.69	0.64	0.57
Account Receivable (Days)	10	36	32	24	18

7.3.2 Projected Financial Performance

7.3.2.1 Investment Costs.

96. The total investment cost for the water supply project is approximately KR 35350 million, including price and physical contingencies and interest during construction. Table 7.2 presents a summary of the development costs.

[9] MDG's Target No. 10, Goal No. 7: Halve, by 2015 the proportion of people without sustainable access to safe drinking water and sanitation. For urban water supply in Cambodia, people with access to safe drinking water is about 64% in 2004. Per MDG, this should reach 80% by 2015. Source: Key Indicators of Developing Asian and Pacific Countries, 2006, ADB.

Table 7.2: SRWSA Total Investment Cost (KR million)

Items	% Total	Total
Civil Works	63.8	22,553
Total Base Cost	63.8	22,553
Physical Contingency	12.8	4,511
Price Contingency	13.0	4,582
Total Contingencies	25.7	9,093
Interest During Construction	1.5	540
Taxes and Duties	9.0	3,165
Total Cost	100.0	35,350

Source: Consultant's estimate

7.3.2.2 Financing Plan.

97. The project will be financed by KR 35350 million loan (100% loan) including interest during construction of KR540 million. The financing plan is shown in Table 7.3.

Table 7.3: SRWSA Financing Plan (KR million)

Items	% Total	Total
ADB Loan (On-lending)	100.0	35,350
Disbursement	98.5	34,810
Interest During Construction	1.5	540
Total	100.0	35,350

Source: Consultant's estimate

7.3.2.3 Water Tariff.

98. For the period 2015 to 2023, only a 6 to 12% tariff increase (average) is required for SRWSA to cover O&M, depreciation and loan amortization. The proposed increases in the tariff will result to a monthly bill of not more than 5% of the family income of the low income group.

Table 7.4: SRWSA Proposed Tariff Rate – 100% Loan

Category	Consumption	2015	2018	2021	2023
Domestic/Government	0 to 7 m3	1,100	1,200	1,350	1,500
	8 to 15 m3	1,500	1,600	1,800	1,950
	15 to 30 m3	1,800	1,920	2,160	2,340
	> 30 m3	2,000	2,130	2,400	2,600
Commercial	0 to 50 m3	1,900	2,020	2,280	2,470
	51 to 150 m3	2,400	2,560	2,890	3,130
	151 to 350 m3	2,900	3,090	3,480	3,770
	> 350 m3	3,400	3,620	4,080	4,420
Tariff Increase (Average)		0%	6%	12%	8%

Source: Consultant's estimate

7.3.2.4 Weighted Average Cost of Capital.

99. On the basis of the financing mix and the loan interest rate of 1.25% to 1.75% and the assumed cost of equity of 6.0%10 of the government, the WACC is computed at -0.5%. Table 7.5 shows the computation of the WACC. However, since ADB guidelines require a minimum hurdle rate of 4% for the financial analysis, the FIRR will be evaluated based on 4%.

Table 7.5: SRWSA Weighted Average Cost of Capital

Items	Capital	% of Total	Nominal Rate	Tax Rate	After Tax Rate	Inflation rate	Real Rate	WACC Real
Loan (ADB Funds)	35,350	100%	1.6%	20.0%	1.3%	1.8%	-0.5%	-0.5%
Grant (ADB Funds)	-	0%	1.6%	0.0%	1.6%	1.8%	-0.2%	0.0%
Grant (Gov't Funds)	-	0%	6.0%	0.0%	6.0%	3.5%	2.4%	0.0%
Total Capital Investment	35,350	100%						**-0.5%**

Source: Consultant's estimate

7.3.2.5 Financial Internal Rate of Return.

100. The tariff required to cover O&M cost, depreciation and debt service is not enough to generate an FIRR higher than the 4% hurdle rate; further tariff rate increases from 2027 and onwards of 22% are needed resulting to an FIRR of 5.3%. Sensitivity analyses were likewise conducted to determine the effects of adverse changes on the project such as increase in capital and O&M costs, revenues not realized as expected and delay in operation. The scenarios evaluated and the summary results of the analyses are presented in Table 7.6. The results show that the project is viable under the five scenarios evaluated.

Table 7.6: SRWSA Summary Result of FIRR

Items	FIRR	FNPV
Base case	5.3%	57,747
Capital cost plus 20%	4.2%	51,553
O&M cost plus 10%	5.0%	55,070
Revenue less 10%	4.3%	45,141
1-Year delay in benefit	4.4%	49,584

Source: Consultant's estimate

7.3.2.6 Affordability of Water Rates.

101. Based on the socio-economic survey, respondents in the service area are willing to pay KR 2,350 per m3 of water consumed while proposed tariff (1-7 m3 consumption) by 2023 is KR 1,500. Another measure of affordability is ratio of monthly water bill to the total household income. For SRWSA service area, the estimated monthly income belonging to the poor households for 2013 is KR 761,000. Using the affordability criteria, the monthly water bill is about KR 7700 (KR1100 x 7 m3) in 2015 is only 1.0% of the monthly income of poor households. In all subsequent years the monthly water bill is less than 5% of the estimated monthly income. Hence, the proposed level of water tariff is deemed affordable to the low income or poor households.

7.3.2.7 Impact of the Project on the SRWSA's Financial Operation.

102. Selected financial indicators were computed to provide an indication of the SRWSA's future financial performance.

[10] Cambodia treasury bill, 91 days maturity issued by MEF.

103. Revenues can cover O&M cost and depreciation during the projection period;

104. Current ratio is high which ranged from 6 to 8 from 2015 to 2025;

105. Operating ratio is less than 1 from 2015 to 2025 indicating that total operating revenue is higher than total operating cost;

106. Debt service coverage ratio is higher than 1.3 for all years until 2025.

107. Annual financial indicators for years 2015 to 2020 and 2025 are shown in Table 7.7.

Table 7.7: SRWSA Summary of Financial Indicators

Financial Indicators	2015	2016	2017	2018	2019	2020	2025
Cost Recovery:							
O&M	2.06	2.06	1.96	1.85	1.62	1.61	1.66
O&M + Depreciation	1.67	1.63	1.44	1.33	1.22	1.22	1.31
Current Ratio	8.65	8.25	8.15	8.11	8.15	8.34	6.23
Operating Ratio	0.68	0.69	0.76	0.80	0.85	0.85	0.80
Debt Service Coverage Ratio	-	-	-	-	7.55	7.71	2.17
Account Receivable (Days)	18	18	18	18	18	18	18

Source: Consultant's estimate

7.3.3 Economic Assessment

7.3.3.1 Project Rationale

108. The parameters and values used in quantifying the economic benefits of water supply improvement are shown in Table 7.8.

Table 7.8: SRWSA Assumptions for Economic Benefits Computation

No.	Item	Value
1	Price of 20-liter bottled water, KR	8,000
2	Bottled water consumed, lpcd	1
3	Bottled water user, %	32%
4	Willingness to pay, KR/m3	1,741
5	Households who store water, %	83%
6	Storage facility cost, KR	562,922
7	Households who collect water, %	79%
8	Collection time per day, hours	0.5
9	Households who treat water, %	77%
10	Water treatment cost, KR	140,573
11	Morbidity rate, %	8.4%
12	Economically active population, %	46%
13	Average days indisposed, days	64
14	Average daily wage rate, KR	24,107

15	Medical cost per capita, KR	496,250

Source: Socio-economic survey, July 2013

7.3.3.2 Economic cost

109. The economic cost equivalent of the proposed capital investments is approximately KR 25439 million.

7.3.3.3 EIRR and Sensitivity Analysis.

110. Given the stream of economic benefits and costs over the 30-year period, the EIRR of the investments for SRWSA is 16.8% which is higher than the assumed EOCC of 12%.

111. Sensitivity test results based on (1) a 20% increase in capital costs, (2) a 10% increase in O&M costs, (3) a 10% decrease in benefits, and (4) a 1 year delay in realization of the benefits show the EIRR still above the EOCC. Table 7.9 summarizes the results of the base case analysis and the sensitivity tests.

Table 7.9: SRWSA EIRR and Sensitivity Test Results

Items	EIRR	ENPV
Base case	16.8%	106,872
Capital cost plus 20%	13.5%	100,143
O&M cost plus 10%	16.4%	104,130
Benefits less 10%	14.4%	90,079
1-Year delay in benefit	13.7%	96,924

Source: Consultant's estimate

7.3.3.4 Project Beneficiaries.

112. At the end of year 2023, SRWSA is projected to have a total of 5819 water service connections, an increase of 931 from the 2014 projected level. In terms of served population, the investments will directly benefit an additional 5322 persons within the service area (Table 7.10).

Table 7.10: SRWSA Projected Service Connection

Item	**2014**	**2015**	**2020**	**2023**
Service area population	156,490	164,753	213,089	248,656
Population served	22,572	22,595	27,894	27,894
% Served	14%	14%	13%	11%
Number of connection	4,888	4,897	5,819	5,819

Source: Consultant's estimate

7.3.3.5 Project Sustainability.

113. The project financial sustainability is highly dependent on the realization of the targeted new service connections and the implementation of the proposed water tariff increases to generate funds to cover O&M cost and depreciation.

7.3.3.6 Poverty Impact.

114. The water supply project is expected to generate total net economic benefits (NEB) of about KR 15124 million. Approximately KR 13620 million will accrue to water consumers, many of whom are current users of water from wells, rainwater, river water and other sources and who are expected to connect to the improved piped water supply system to be made possible through this Project. Local labor, for which a significant amount of person-days will be needed for construction of the new facilities and their eventual operation, will gain about KR 1503 million.

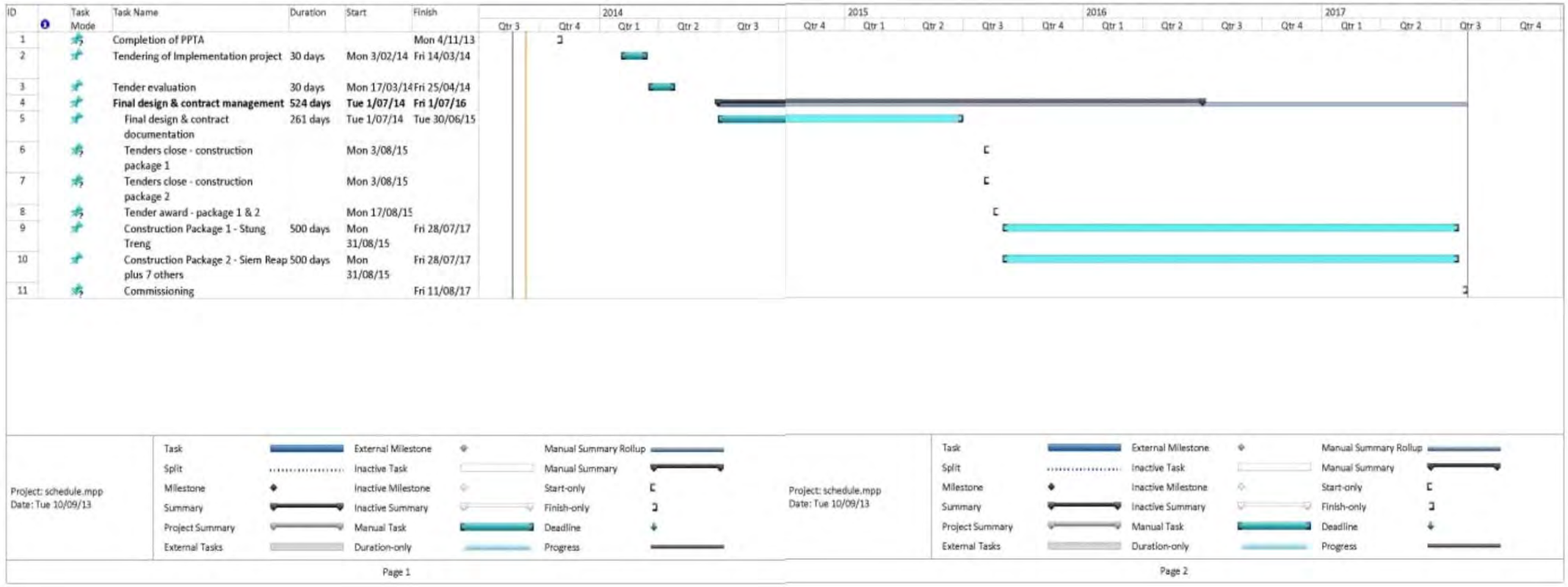
115. The poverty impact ratio (PIR) for the water supply investments is 0.39, which means that 39% of the NEB will directly benefit the poor. Poverty incidence in the service area is around 39%.

Table 7.11: SRWSA Poverty Impact Ratio

Items	Government /Economy	Labor	Consumers	Total
Gains and losses	-	1,503	13,620	15,124
Financial return to PWW	(10,228)			(10,228)
Benefits (Losses)	(10,228)	1,503	13,620	4,896
Proportion of poor	0.39	0.39	0.39	
Benefits to poor	(3,989)	586	5,312	1,909
Poverty Impact Ratio				0.39

Source: Consultant's estimate

Appendix A: Siem Reap Subproject Implementation Schedule



Appendix B: Cost Estimate for Siem Reap Subproject – water supply development

Appendix C: Water Quality Test Results for Siem Reap Subproject

Month average	Temp (C)	Turbidity NTU	Res chlorine (mg/l)	pH	Colour TCU	TDS (mg/l)	Conductivity (us/cm)
LIMIT		**<5**	**0.2-0.5**	**6.5-8.5**	**<5**	**800**	**1600**
Jan	28.9	<1	0.3	6.65	<1	41	82
Feb	30	<1	0.3	6.88	<1	48	97
Mar	29.9	<1	<1	6.76	<1	44	89
Apr	30.8	<1	0.4	6.86	<1	47	93
May	30.5	<1	0.4	6.74	<1	44	88
Jun	29.3	<1	0.4	6.71	<1	47	94
Jul	29.5	<1	0.4	6.7	<1	51	102
Aug	29.6	<1	0.4	6.8	<1	45	89
Sept	29.7	<1	0.4	6.99	<1	56	111
Oct	28.7	<1	0.4	6.86	<1	53	105
Nov	28.4	<1	0.4	6.84	<1	48	97
Dec	28.4	<1	0.4	6.80	<1	46	93

Appendix D: Socio-economic Survey Report for Siem Reap Subproject

Appendix E: cancelled

Appendix F: Ethnic Groups Screening Form

Appendix G: Gender Plan for Siem Reap Subproject

Appendix H: 9 Subproject Towns Financial and Economic Analysis

Appendix I: deleted

Appendix J: Initial Environmental Examination for Siem Reap Subproject

Appendix K: Land Acquisition and Compensation Plan for Siem Reap Subproject

Appendix L – Pipeline extension location schematics

Appendix M – Outline Operation and Maintenance Plan

Operational Procedures

WTP area	Procedure
Raw water pumps	Can be controlled (on/off) by level transducers in the main elevated clear water tank, or manually by Operator.
Chlorination	Depending on the final chlorination equipment selected, dosing rate can be set manually, can be set to match flowrate from the pumps, or can be set through a feedback loop that measures residual at the end of the reticulation system, or another selected location. A manual selection rate is recommended.
Use of elevated tank	Often water is pumped directly into supply in order to utilize a few extra meters of head from the pumps to reach new extension areas in the town. This does not represent good operational practice and water should be pumped to the elevated tank at all times. If some areas that have had recent extensions are too far or too elevated to receive water from the WTP or elevated tank under normal operation, the town can be zoned with some areas receiving preferential water at certain times of the day by operating boundary valves.
Pumping records and meter readings	Pump records should be kept, and bulk meter readings for clear water being pumped to the elevated tank recorded daily. Additionally a second bulk meter on the delivery line from the elevated tank downstream of any bypass would be beneficial.
Reticulation	
Washout valves	All washout valves on the system, installed at low points, should be opened every month to flush out the line as required.
Valves on the distribution system	Valves should be kept either fully open or fully closed.

Maintenance schedule

WTP area	Procedure
Raw water pumps	These submersible borehole pumps are very durable but should be removed from the bore every 2 years for a routine inspection and maintenance. This is made easy with the auto-coupling and guiderail installations.
Chlorination equipment	Equipment should be inspected regularly for signs of corrosion and gas pressure checked. Any specialist maintenance required can be assisted by PPWSA and/or the local agent for the equipment either in Phnom Penh or regionally. Only genuine spares from the equipment manufacturer should be used when dealing with gaseous chlorine.
Pump wellheads	The building containing the borehole pump should be kept clear and tidy and not used as a general storage shed. At regular intervals the sampling tap on the wellhead should be turned on to ensure no air is trapped.
Washout valves and gate valves on reticulation system	Open and close valves and clean valve chamber twice a year.
Reticulation	
Gate valves	All gate valves on the pipelines should be kept either fully shut or fully open as required.
Washout valves	Any washout valves, normally installed at low points, should be periodically (6 monthly) opened to flush out any debris.
Chambers	All valve chambers should be kept dry, clean and accessible.
Domestic connections	Any leaks on the upstream side of the meter should be recorded by meter readers and repaired promptly.
Physical leaks	All leaks reported or noticed by WA staff should be repaired promptly.

Appendix P: Implementation Schedule

KINGDOM OF CAMBODIA

MINISTRY OF INDUSTRY AND HANDICRAFT

URBAN WATER SUPPLY AND SANITATION PROJECT

(ADB PPTA: TA-8125-CAM)

FEASIBILITY STUDY FOR STUNG TRENG SUBPROJECT

November 2013

Prepared by

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Document Status						
Rev No	**Author/editor**	**Reviewer**		**Approved for Issue**		
		Name	**Signature**	**Name**	**Signature**	**Date**
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ABBREVIATIONS AND EQUIVALENTS

ADB	Asian Development Bank
ADF	Asian Development Fund
AP	Affected persons
APs/AHs	Affected persons/affected households
ASR	ADB's Annual Sector Review
BOO	Build-Operate-Own
BOT	Build-Operate-Transfer
COBP	Country Operations Business Plan
CPP	Community Participation Plan
CPS	Country Partnership Strategy
DMC	Developing Member Countries
DMF	Design and Monitoring Framework
DPWS	Department of Potable Water Supply
EA	Executing Agency
EGM	Effective Gender Mainstreaming
EMP	Environmental Management Plan
FAR	Feasibility Assessment Report
FS	Feasibility Study
GAP	Gender Action Plan
HHs	Households
IAs	Implementing Agencies
IEEs	Initial Environmental Examinations
IOL/SES	Inventory of Losses and Socioeconomic Survey
IR	Inception Report
ISCD	Institutional Strengthening & Capacity Development
JICA	Japan International Cooperation Agency
LARP	Land Acquisition and Resettlement Plan
LARF/LARP	Land Acquisition and Resettlement Framework and Plan
MEF	Ministry of Economy and Finance
MIH	Ministry of Industry and Handicraft
MOU	Memorandum of Understanding
MOWRAM	Ministry of Water Resources Management and Meteorology
MPWT	Ministry of Public Work and Transport
MRD	Ministry of Rural Development
NCB	National Competitive Bidding
NRW	Non-revenue Water
O&M	Operation and Maintenance
PAM	Project Administration Manual
PDIH	Provincial Department of Industry and Handicraft
PDR	People Democratic Republic
pm	Person-months
PMU	Project Management Unit
PPP	Public Private Participation
PPPs	Public-Private Partnership
PPTA	Project Preparation Technical Assistance
PPWSA	Phnom Penh Water Supply Authority
REA	Rapid Environmental Assessment

RRP	
SCS	Stakeholder Communication Survey
SPS	Safeguards Policy Statement
SRWSA	Siem Reap Water Supply Authority
SR	Safeguards Requirements
TA	Technical Assistance
TOR	Terms of Reference
WOPs	Water Operators' Partnerships
WTP	Water Treatment Plant

UNITS

ha	Hectare
lpcd	Liters per capita per day
l/s	Liters per second
m	Meter
mg/l	Milligrams per Liter
mm	Millimeter
m^3/day	Cubic meters per day

Figure 1-1 - Location of Project Towns

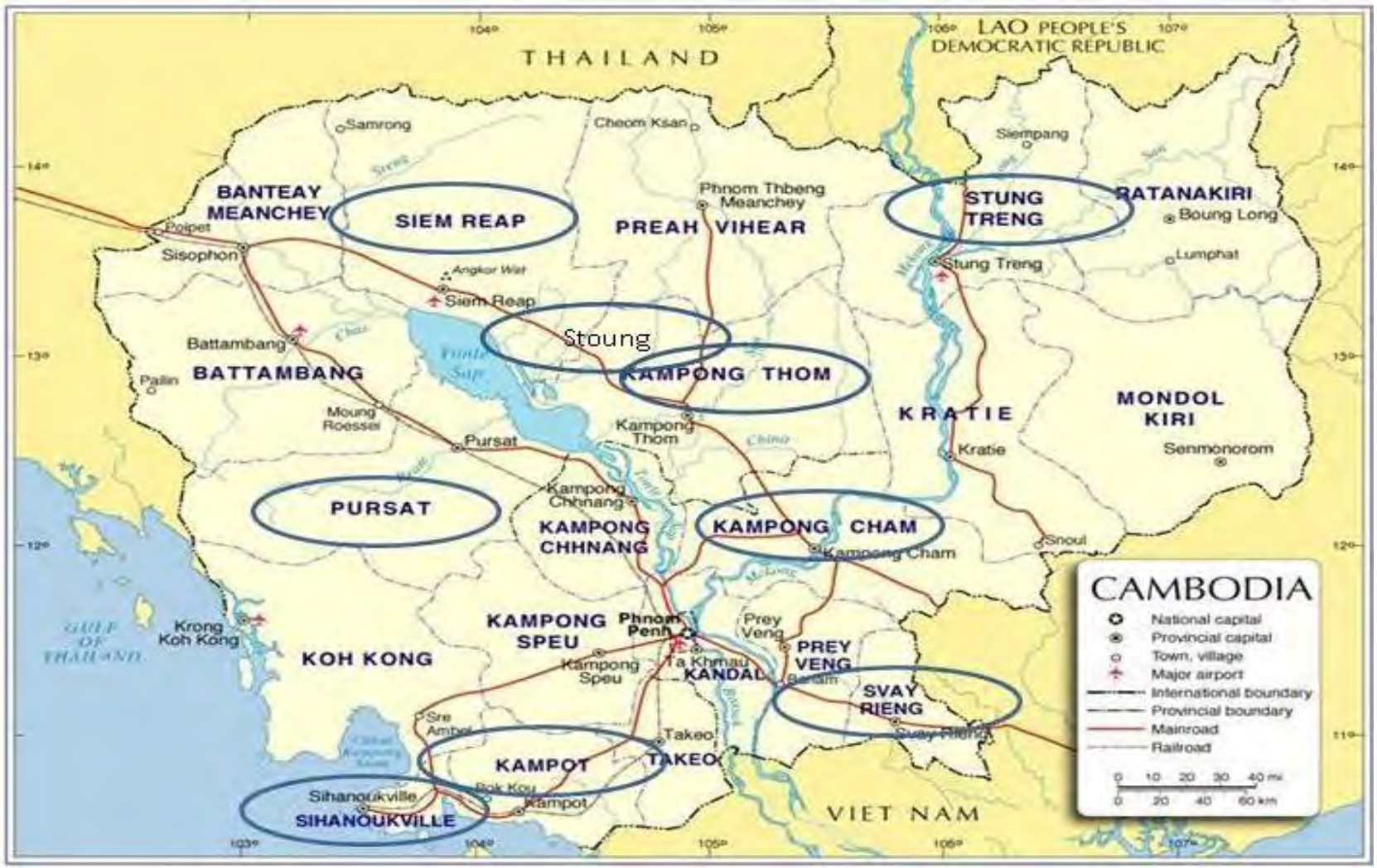
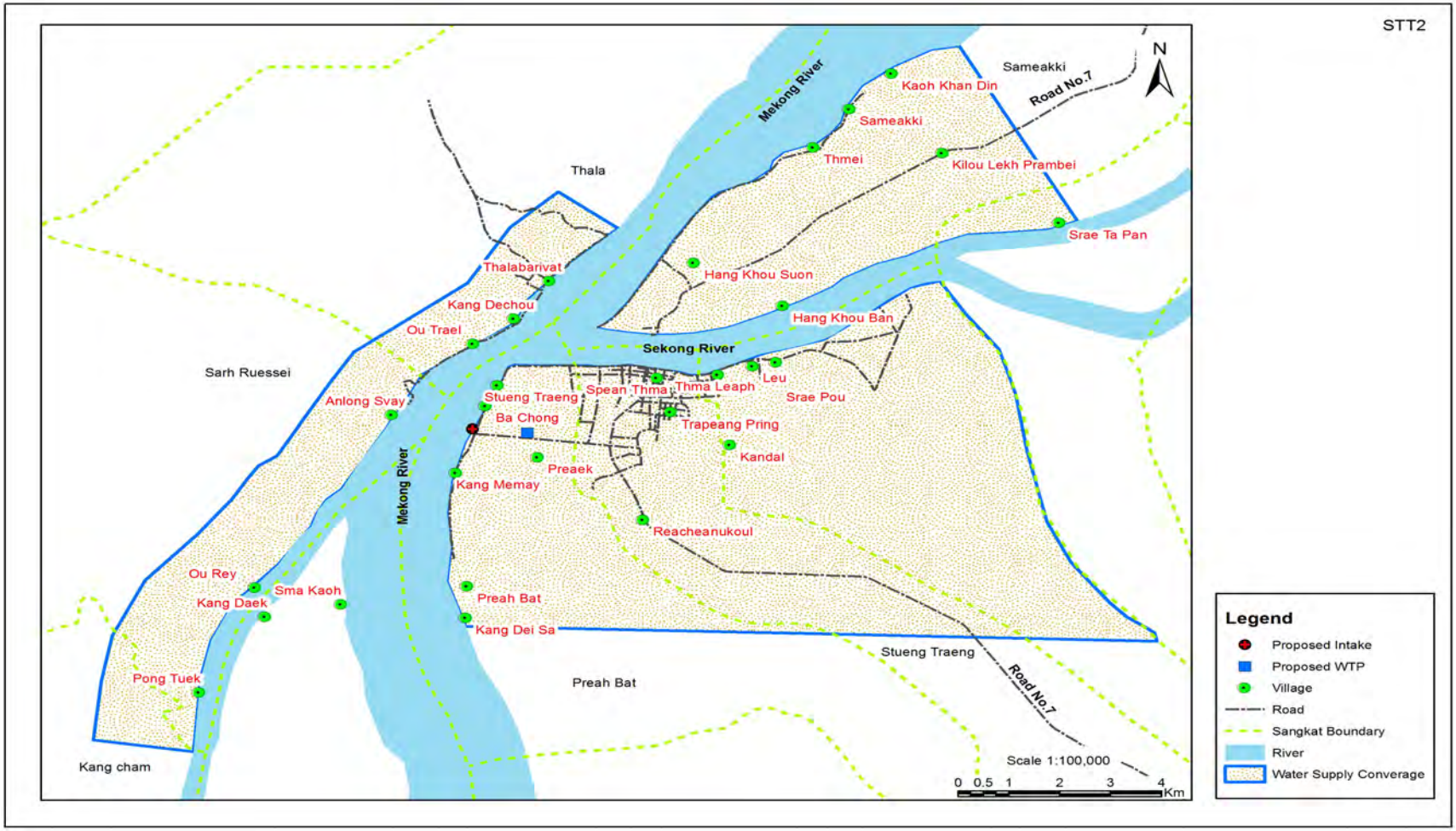


Figure 1-2 Location Plan of Proposed Stung Treng Subproject



1. EXECUTIVE SUMMARY

1.1 Project Description

1. Expected outputs of the overall Project include: (i) water treatment plants provided or improved in eight towns; (ii) water distribution systems improved and coverage increased in six towns; (iii) existing pumping stations rehabilitated in five towns; and (iv) institutional capacity of MIH and regulatory system strengthened, under a piggy-backed technical assistance.

1.2 Rationale

2. During 2011, through the ADB's Water Operators' Partnerships Program, ADB was able to re-engage in the urban water supply sector with MIH. Consequently ADB's Country Operations Business Plan 2010-2013 includes an Asian Development Fund loan for the Project for approval in 2014. The UWSP will assist the government to address the three core constraints identified in the ADB Country Partnership Strategy (2011-2013): (i) insufficient funds to expand coverage and improve services; (ii) weak sector planning and implementation capacity of responsible authorities at the central and sub-national levels; and (iii) inadequate (or sometimes weak) institutional and legal framework.

1.3 Background

3. The proposed Project "Urban Water Supply Project " (UWSP) will provide necessary facility improvements to the six provincial towns previously funded by ADB and to three provincial towns that have been funded by other bilateral or multilateral agencies, and expand public access to sustainable and safe water supply services for the urban population in Cambodia. In addition, the Project will address institutional weaknesses through the development of improved institutional structures, a regulatory framework, and appropriate capacity development.

1.4 Project Impact and Outcome

4. The impact of the proposed Project will be expanded access to sustainable and safe water supply services for the urban population in Cambodia and better functioning water treatment plants providing higher quality water. MIH targets are to increase the proportion of the urban population in the project area with access to safe water to 85% by 2018 and 90% by 2025, and the project will assist these aims. The outcome of the project will be improved water supply infrastructure and service provisions in selected provincial waterworks.

1.5 Candidate Towns

5. There are nine candidate towns: Kampong Cham, Kampong Thom, Kampot, Pursat, Siem Reap, Sihanoukville, Stoung, Stung Treng and Svay Rieng. Originally Battambang was to be included but this was removed at the request of the Provincial Waterworks.

1.6 Feasibility Study Context

6. The feasibility studies include: (i) needs assessment, supply and demand analysis, (ii) selection of technology, equipment, and facilities for the identified subprojects considering least cost and life cycle approach and the capacities of the local authorities to manage, operate, and maintain; (iii) assessment of economic and financial viability and sustainability for each of the subprojects; (iv) assessment of policy and legal capacity, including other institutional issues and mechanisms related to the financial management, procurement, and anticorruption; (v) poverty, social, and gender analysis and preparation of a poverty and social strategy, a gender action plan, stakeholder communication survey (SCS), and a Community Participation Plan (CPP), where required; and (vi) review of impacts on environment, involuntary resettlement, and indigenous peoples.

1.7 Subproject Description

1.7.1 Output 1 - Water Supply Development

7. Expected outputs of the overall Project include: (i) water treatment plants provided or improved in eight towns; (ii) water distribution systems improved and coverage increased in six towns; (iii) existing pumping stations rehabilitated in five towns; and (iv) institutional capacity of MIH and regulatory system strengthened, under a piggy-backed technical assistance.

1.7.2 Output 2 – Strengthening of Institutional capacity of MIH and Regulatory System

8. The Institutional Strengthening and Capacity Development is to (i) identify key stakeholders; (ii) assess institutional capacity constraints; (iii) develop institutional capacity building plan; and (iv) prepare terms of reference for strengthening sector regulation TA.

1.8 Cost Estimate

9. The subproject cost is estimated at $13.473 million equivalent, including taxes and duties. Table 1.1 provides a summary of the Stung Treng Subproject cost estimate.

Table 1.1: Stung Treng Subproject Cost Estimate ($'000's)

		Totals
No	**Description**	**(inc tax)**
		US$000
1	**Water Supply Development**	
1.1	P&G and Intake on Mekong	80.0
1.2	New WTP of 7,950m^3/day capacity with elevated storage tank and underground tank	1,208.0
1.3	New/rehabilitated tanks on old WTP site	150.0
1.4	Electrical & mechanical	160.0
1.5	New distribution system all districts	9,630.0
	Total for Water Supply Development	
	TOTAL ESTIMATED BASE COST	11,228.0
	Total Contingencies	2,246.0
	TOTAL ESTIMATED SUBPROJECT COST	13,473.0

1.9 Financing Plan

10. The project will be financed by ADB and the national government. ADB loan will finance KR 54459 million while the government will finance KR 5993 million which includes government taxes. The financing plan is shown in Table 1.2

Table 1.2: STPWW Financing Plan (KR million)

Items	% Total	Total
ADB	90.1	54,459
Disbursement	89.2	53,936
IDC	0.9	523
Government	9.9	5,993
Equity Contribution	0.9	545
Taxes, Duties and Other	9.0	5,448
Total Financed	100.0	60,452

Source: Consultant's estimate

1.10 Executing Agency and Implementation Arrangements

11. MIH will be the Executing Agency, and the existing project management unit (PMU) based in the Department of Potable Water Supply (DPWS) will be expanded to execute and manage the Project on behalf of MIH with the consulting service to be provided by the project implementation assistance consultants (PIAC). The Project implementing units (PIUs) are expected to be organized by the nine (9) implementation agencies (IAs) of the provincial waterworks. The nine (9) PIUs will be responsible for day-to-day coordination and supervision of subproject implementation in these provincial towns.

1.11 Implementation Period

12. The proposed Project is scheduled for implementation over five years from 2014 to 2018. The The final design is proposed for a one year period between mid-2014 and mid-2015. Following this, a two year construction period would have the works commissioned in August 2017. A proposed Implementation schedule is included in Appendix A.

1.12 Procurement

13. The procurement shall be carried out under International Competetive Bidding (NCB) as three packages; one package Stung Treng; one package Siem Reap; and the remaining 7 subprojects as one package. The full Procurement Plan is contained in the Supplementary Appendices of the main PPTA report.

1.13 Consulting Services

14. The project implementation assistance consultants (PIAC) on the design and engineering review, tendering assistance, and construction management are provided under Bank financing will be selected in advance and engaged in accordance with the ADB's Guidelines on the Use of Consultants. An individual consultant will be engaged to prepare the PIAC terms of reference and to assist the EA on the preparation of the Request for Proposal. The PIAC consulting services will be signed once the loan becomes effective to provide under a single consulting package, by an association of international and domestic consulting firms. The lead consulting firm will provide the services of the Team Leader who will be responsible for managing the overall consulting services during the project implementation.

1.14 Economic and Financial Analyses

15. Economic and Financial analyses are contained in Section 7, and in full in Appendix H.

1.15 Tariff and Affordability

16. For a 0 and 50% loan, the required tariffs are shown in Table 1.3 while for a 100% loan, the required tariffs are shown in Table 7.5. The block tariff rate (first block is 1 to 7 m3 consumption) is proposed for household connections to reduce the impact of tariff rate increases to the poor households. The proposed tariff increases (average) will ensure that the STPWW will cover its O&M, depreciation and debt service by 2023. The proposed increases in the tariff will result to a monthly bill of not more than 5% of the family income of the low income group.

Table 1.3: STPWW Proposed Tariff Rate – 0 to 50% Loan

Category	2015	2018	2021	2023
Household, 0 to 7 m3	1,700	1,700	1,700	1,700
above 7 m3	1,800	2,250	2,250	2,250
Government	1,800	2,250	2,250	2,250
Commercial	1,900	2,400	2,400	2,400
Tariff Increase (average)	21%	19%	0%	0%

Source: Consultant's estimate

1.16 Subproject Benefits and Beneficiaries

17. At the end of year 2024, STPWW is projected to have a total of 7780 water service connections, an increase of 5274 from the 2014 projected level. In terms of served population, the investments will directly benefit an additional 26350 persons within the service area (Table 1.4).

Table 1.4: STPWW Projected Service Connection

Item	2014	2015	2020	2024
Service area population	38,867	39,322	41,676	43,661
Population served	12,200	13,254	36,969	38,550
% Served	31%	34%	89%	88%
Number of connection	2,506	2,738	7,390	7,780

Source: Consultant's estimate

1.17 Land Acquisition and Compensation

18. The overall project has Involuntary Resettlement Categorisation B. There are two areas of land to be acquired in Stoung (225m2) and Svay Rieng (9m2). The Resettlement Due Diligence report for Stung Treng is contained in Appendix K.

1.18 Environmental Impacts

19. An Initial Environmental Examination (IEE) was carried out for Stung Treng, and is contained in Appendix J. The overall conclusion is that providing the mitigation, compensation and enhancement measures are implemented in full, there should be no significant negative environmental impact as a result of location, planning, design, construction and operation of the project. There are benefits stemming from recommended mitigation and enhancement measures, and major improvements in quality of life and individual and public health once the project is in operation.

1.19 Indigenous Peoples

20. The Indigenous Peoples Impact sceening checklist has been completed and is contained in Appendix F. While there are ethnic minorities, like the Chinese, Lao and Vietnamese, they have already integrated in the mainstream society that will benefit from safe and potable water. There are no expected negative effects on ethnic groups.

2. PROJECT RATIONALE, IMPACT AND OUTCOME

Rationale

21. During 2011, through the ADB's Water Operators' Partnerships Program, ADB was able to re-engage in the urban water supply sector with MIH. In January 2012, MIH signed a twinning agreement with the PPWSA, which is currently providing support to four provincial waterworks been included in the Project through direct peer-to-peer knowledge transfer. In February 2012, the Ministry of Economy and Finance (MEF) requested ADB to consider financing the Project in accordance with the strategy of Cambodia's Public Debt Management, to ensure sustainable economic growth. Consequently ADB's Country Operations Business Plan 2010-2013 includes an Asian Development Fund loan for the Project for approval in 2014. The project supports the ADB's annual sector review, country partnership strategy, and the water operational plan 2011–2020

22. The UWSP will assist the government to address the three core constraints identified in the ADB Country Partnership Strategy (2011-2013): (i) insufficient funds to expand coverage and improve services; (ii) weak sector planning and implementation capacity of responsible authorities at the central and sub-national levels; and (iii) inadequate (or sometimes weak) institutional and legal framework.

Background

23. The proposed Project "Urban Water Supply Project " (UWSP) will provide necessary facility improvements to the six provincial towns previously funded by ADB and to three provincial towns that have been funded by other bilateral or multilateral agencies, and expand public access to sustainable and safe water supply services for the urban population in Cambodia. In addition, the Project will address institutional weaknesses through the development of improved institutional structures, a regulatory framework, and appropriate capacity development.

24. This UWSP is in line with (i) Cambodian National Strategic Development Plan (2009-2013) and (ii) action plan of Ministry of Industry and Handicraft (MIH) to facilitate private sector partnerships, strengthening the management of public owned waterworks, and integration urban water supply with urban environmental management. The proportion of the urban population in the project area with access to safe water will be increased to 85% by 2018 and 90% by 2025 as targeted by MIH. In addition, a potential target date for 100% coverage could be assumed as 2030.

Project Outline

25. The feasibility studies include: (i) needs assessment, supply and demand analysis, (ii) selection of technology, equipment, and facilities for the identified subprojects considering least cost and life cycle approach and the capacities of the local authorities to manage, operate, and maintain; (iii) assessment of economic and financial viability and sustainability for each of the subprojects; (iv) assessment of policy and legal capacity, including other institutional issues and mechanisms related to the financial management, procurement, and anticorruption; (v) poverty, social, and gender analysis and preparation of a poverty and social strategy, a gender action plan, stakeholder communication survey (SCS), and a Community Participation Plan (CPP), where required; and (vi) review of impacts on environment, involuntary resettlement, and indigenous peoples.

Project Impact and Outcome

26. The impact of the proposed Project will be expanded access to sustainable and safe water supply services for the urban population in Cambodia and better functioning water treatment plants providing higher quality water. MIH targets are to increase the proportion of the urban population in the project area with access to safe water to 85% by 2018 and 90% by 2025, and the project will assist these aims. The outcome of the project will be improved water supply infrastructure and service provisions in selected provincial waterworks.

3. Profile of Stung Treng Area

Town Location and Profile

27. Stung Treng town is located at the confluence of the Mekong and Sekong rivers along Highway 13 in Stung Treng Province in the north east of Cambodia. The province borders the Lao PDR to the north, Rattanakiri Province to the east, Kratie Province to the south and Preah Vihear Province to the west.

28. Stung Treng town is the capital of Stung Treng Province and consists of 17 villages in 4 Sangkhats.

29. The Stung Treng Provincial Department of Industry, Mines and Energy (PDIH) administers and operates the urban water supply, under the Ministry of Industry and Handicraft (MIH).

30. The town of Stung Treng had a 2012 population of 33,592.

Natural Features

3.2.1 Topography

31. Stung Treng is situated around the confluence of two rivers, the Mekong and the Tonle San. There are low hills rising up from the riverbanks to around 40m above riverbank level on all sides of the two rivers.

3.2.2 Climate

32. Stung Treng is humid and tropical but with some variation over the period of a year. The monthly average rainfall varies between 20mm in December – March up to 310mm in August, with temperature typically varying between 23 and 31 decrees celcius1.

3.2.3 Surface water

33. The Mekong river joins with the Sekong at Stung Treng and according to annual hydrographs for the two rivers is likely to constrain the flow of the Sekong at its mouth. The maximum average flood stage of the Mekong at Stung Treng is 44.3m and occurs mainly in August. The maximum height reached over 2000-2008 is 48.8masl in August 2001. The Yali dam and other hydropower developments on the Xesan River will effect flow and water quality.

34. The Mekong's flood discharge may reach a magnitude of 60,000m3/s, while low flow values are in the order of 2,000m3/s, giving a ration between peak and base flow of about 30:1.

3.2.4 Groundwater

35. Little information is available concerning large scale groundwater use in Stung Treng, although it constitutes a common source of domestic water supply throughout the province, with shallow wells to a depth of 7-12m. The arsenic map prepared under the National Drinking Water Quality Assessment for Cambodia in 2001 shows the Province as very low risk for arsenic contamination.

Socio-Economic Conditions

3.3.1 Population and Household Characteristics

36. The populations provided below are for the service area within Stung Treng.

[1] From records taken 2000-2008 from Stung Treng Province weather station

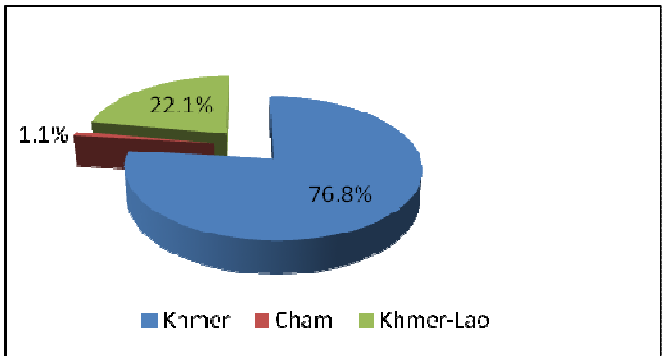
Table 3.1: Stung Treng Population Characteristics

No	Core Village by Sangkhat/Commune	2012 Pop'n.	No. HH	Persons/ HH
	Stung Treng			
1	Prek	4,656	898	5.2
2	Trapeang Pring	1,791	335	5.3
3	Kadal	1,673	313	5.3
4	Spean Thmor	1,791	355	5.0
5	Rachea Nukol	4,966	974	5.1
	Sreah Ruessei			
6	Thmor Leat	1,143	223	5.1
7	Leu	1,078	209	5.2
8	Sre Pur	1,946	378	5.1
	Preah Bat			
9	Bachong	1,377	256	5.4
10	Kang Meamay	655	119	5.5
11	Kang Dei Sa	905	167	5.4
	Sammaki			
12	Hangkho Suon	1,455	269	5.4
13	Thmey	1,028	196	5.2
14	Koh khondin	757	168	4.5
15	Kilolak Prambey	385	83	4.6
16	Hangkho Ban	932	168	5.5
17	Kham Phan	665	132	5.0
	Ou Rey			
18	Pong Tik	692	151	4.6
19	Ou Rey	976	220	4.4
20	Onlong Svay	941	191	4.9
	Thalaborivat			
21	Ou Trel	1,553	317	4.9
22	Kang Decho	464	97	4.8
23	Thalaborivat	1,763	389	4.5
	TOTALS	**33,592**	**6,608**	**5.1**

3.3.2 Ethnicity

37. Figure 3.1 shows the breakdown of ethnic minorities in the survey area.

Figure 3.1: Khmer and Ethnic minorities



3.3.3 Population Growth and Migration

38. Population growth from the 2008 National Survey2 shows an average national urban growth rate of 2.21%. For the purposes of this study we have used growth rates for individual towns, provided by each Provincial Waterworks3. For Stung Treng this is 1.17% showing a reasonable growth rate.

3.3.4 Education

39. Table 3.2 shows education levels in the surveyed areas.

Table 3.2: Basic education completed (population of core villages)

Education level	Service and Non-service areas	
	Respondent	Percent (%)
No Education	22	23.2
Primary School	53	55.8
Secondary School	16	16.8
High School	4	4.2
Total	**95**	**100.0**

Source: Socio-economic survey, July 2013

3.3.5 Health and Hygiene Conditions

40. Survey data on health status relating to waterborne diseases show that 9.6% of people were afflicted by water-related diseases, with a further 3.2% suffering from malaria or dengue, and 2.1% with skin diseases such as scabies.

3.3.6 Land and House Tenure

41. 96.8% of all houses are owner occupied, with 2.1% of houses rented and a further 1.1% doing neither. The range of average house sizes in the target area are; up to 25m2 (44.2%), 26-50m2 (21.1%), 51-100m2 (26.3%) and over 100m2 (8.4%). There are 41.1% of households with access to

[2] General Population Census 2008 National Report, August 2009

[3] Data collected by head of each commune

public electricity, 18.9% of households sharing electricity with their neighbors, 5.3% using batteries, 7.4% using a generator, and 27.4% using kerosene lamps and candles.

3.3.7 Occupations and Livelihoods

42. Main occupations are shown in Table 3.3.

Table 3.3: Main occupations of heads of household

Main income sources of HH head	n	%
Government employee	17	17.9
Small-scale business owner	14	14.7
Motor taxi driver	2	2.1
Transportation service provider	2	2.1
Construction worker	5	5.3
Seft-employed	4	4.2
Farming/Agriculture	28	29.5
Other (Please specify)	23	24.2
Total	95	100.0

Source: Socio-economic survey, July 2013

3.3.8 Income and Poverty Levels

43. The incomes here were classified into two categories: households connected to water supply and households not connected to water supply. The average annual income is $ 3,859(15,434,840 Riel) for households connected to the water supply and $1,996(7,983,600 Riel) for households not connected.

44. Approximately 1.1% of the population were found to be living in poverty as shown in Table 3.4.

Table 3.4: Status of wealth ranking in Stung Treng

Wealth Ranking	n	(%)
Extremely poor	1	1.1
Poor	58	61.1
Medium	22	23.2
Wealthy	14	14.7
Total	**95**	**100.0**

Existing Water Supply and Sanitation

3.4.1 Water Supply

45. The existing water treatment plant was originally constructed in 1962 and the raw water source is the Sekong River, upstream of its confluence with the Mekong River. The WTP consists of intake pumps, flocculation, sedimentation and filtration. The filters have long since been emptied of sand to increase flow rate and now act as further sedimentation only. Water is collected in a “clear” water tank and then can be pumped up to an elevated tank to provide a constant head for delivery to the reticulation system. Alum is dosed at the head of the flocculation tank but dosing is not measured or calculated relative to turbidity. No chlorine is dosed.

46. In 2009 the reticulation supplied 1,490 households4. This has not changed up to 2013. The estimated raw water pump rate to the WTP is 100m3/hr or 27.8l/s. A significant portion of the reticulation is the original French system and was designed to supply a population of 10,000. The total population of Stung Treng is now more than double this. The composition of the water supply pipe network, according to the records of the Provincial Waterworks, is shown in Table 3.5.

Table 3.5; Existing pipe in Stung Treng

Type of Pipe	**Length**	**Date laid**
Asbestos cement 200mm	1,337	Laid 1948 to 1969
Asbestos cement 100mm	1,128	
Asbestos cement 80mm	820	
Asbestos cement 80mm	342	
Asbestos cement 60mm	205	
Subtotal	3,832	
PVC 150mm	128	Laid from 1979
PVC 100mm	5,836	
PVC 75mm	197	
PVC 60mm	11,693	
PVC 50mm	1,115	
Subtotal	18,996	
Total	**22,828**	

47. The WTP is in poor condition and is not operating correctly. There are many large long term leaks in the structural concrete, no filtration and no flow measurement or control other than at the raw water is pumps, which are unmetered.

48. In the peri-urban areas of Stung Treng, water supply comes under the Provincial Department of Rural Development. Some boreholes have been provided and in 2009 a pilot project commenced to provide a water supply to a commune on the town outskirts.

49. The NGO Partner for Development has recently provided two water supply systems (untreated) for nearby villages outside of the main Stung Treng municipal area. The Department also provides 4m3 ferro-cement rainwater tanks for domestic use and 35m3 tanks for schools in addition to portable domestic sand filters.

[4] August 2009 revision of information supplied by Stung Treng Water Authority.

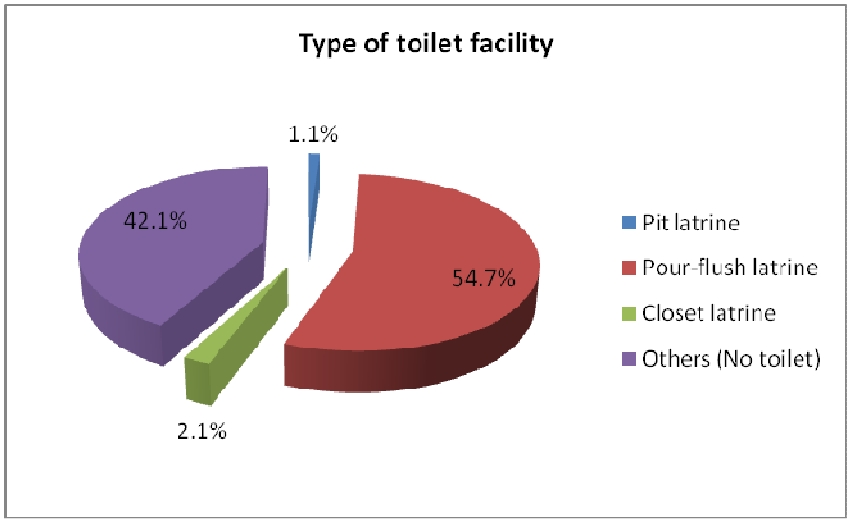
Table 3.6: Main Sources of Household Water for all uses

Water Sources	Dry season		Wet season		Both wet-dry seasons	
	n	%	n	%	n	%
a. Piped (town) water connected to a point inside house					7	7.4
b. Piped (town) water connected to a point outside house					13	13.7
c. Piped (private) water connected to a point inside house					1	1.1
d. Piped (private) water connected to a point outside house					3	3.2
e. Piped community water supply					0	0
f. Private well, not shared, manual	2	2.1			10	10.5
g. Private well, shared, manual			1	1.1	6	6.3
h. Community well, manual					19	20.0
i. Private well, with water pump	1	1.1				
j. Community well, with water pump						
k. Private well. by truck/cart/bicycle	1	1.1				
l. River water catered by truck/cart/bicycle	5	5.3			20	21.1
m. Reservoir / lake/ irrigation canal, manually collected						
n. River/stream water drawn via water pump	2	2.1			11	11.6
o. Rainwater			68	71.6		

3.4.2 On-Site Sanitation

50. The socio economic survey indicates that 42.1% of all households do not have latrines, while 57.9% of them do. Of these, 20% are attached to the house and 37.9% are separate to the house, on average 7.7m away.

Figure 3.2: Types of latrine



Source: Socio-economic survey, July 2013

4. POPULATION GROWTH AND WATER DEMAND FORECASTS

4.1 General

51. Stung Treng is the capital city of the Province and acts as a market for the surrounding area.

52. At present, there is no agro-processing or industrial development in Stung Treng consuming water or which could affect water quality, and nothing planned. There is no mine in the region.

4.2 Population Projections

53. The population projections5 are set out in Table 4-1. Within the core villages, total population is forecast to increase from about 33,592 in 2012 to about 41,416 in 2030.

Table 4-1: Population Projections for Stung Treng's Core Villages

Year 2012 Population	Growth Rate %	Forecast Population 2014	Forecast Population 2020	Forecast Population 2025	Forecast Population 2030
33,592	1.17	34,383	36,868	39,076	41,416

4.3 Water Demand Forecasts

4.3.1 General Approach

54. Water demand forecasts for the Stung Treng subproject were prepared by making separate projections of each component of demand, including:

- Demand for domestic use (based on per capita consumption, coverage targets and population projections);
- Demand for industry (based on a % of domestic use, and specific allowances for large industries);
- Demand for services (based on a % of domestic use, and specific allowances for large services areas);
- Physical losses as a % of total demand, excluding the demand of large industrial zones.
- Production losses in treatment plant (based % of total demands).

4.3.2 Domestic Consumption

55. Water demand and consumption data for other provincial and district towns in Cambodia show that domestic consumption accounts for about 90% of total demand. Per capita consumption figures for urban water supply systems in Cambodia can vary widely, particularly with strong reliance on rainwater collection during the wet season. Experience in other towns in Cambodia indicates that piped connections directly to the house will usually increase water consumption over time. The Feasibility Study has adopted a per capita consumption figure of 120 lpcd, plus 10% for non-domestic use which includes demand from industry and services, 15% for physical losses (leakage), and 50m3/day for backwashing filters in the WTP.

4.3.3 Water Demand Forecasts

56. Table 4.2 summarizes the demand forecasts and design criteria for the Stung Treng subproject. By 2030, the average daily water production at the water treatment plant is expected to be 7,950m3/day, comprising 75% domestic consumption, with the remaining 25% being for institutions, public use, services, handicraft and small industries, and allowances for physical losses and backwashing the filters.

[5] 2012 populations and growth rate provided by the Provincial Waterworks

Table 4.2: Water Demand Forecasts for Stung Treng Subproject

No.	Items	Unit	Forecasts				
			2012	2014	2020	2025	2030
A.	**Domestic Demand**						
1	Growth Rate	%	1.17	1.17	1.17	1.17	1.17
2	Population in Core Area		33,592	34,383	36,868	39,076	41,416
3	Coverage in Core Area	%	90	100	100	100	100
4	Population with Piped Water	No.	30,233	34,383	36,868	39,076	41,416
5	Per Capita Consumption	l/c/d	120	120	120	120	120
6	Total Domestic Demand	m3/d	3,628	4,126	4,424	4,689	4,970
B.	**Non-domestic demand**						
1	Services, Schools, Small Industry, Institutions, Hotels	%	15	15	15	15	15
2							
3	Total Non-domestic demand	m3/d	544	619	664	703	745
C.	**Subtotal Water Demand All Categories**	m3/d	4,172	4,745	5,088	5,392	5,715
D.	**Non Revenue Water (NRW) in Distribution system**						
1	NRW as % Average Daily Water Production	%	15	15	15	15	15
2	NRW (physical losses only-pipelines and WTP)	m3/d	626	712	763	809	857
E.	**Average Daily Water Production (C+D) rounded**	m3/d	4,800	5,460	5,850	6,200	6,570
F.	**Peak Annual Water Demand (Max day Max month)**						
1	Peak Annual Water Demand		1.20	1.20	1.20	1.20	1.20
2	Peak Annual Water Demand	m3/d	5,760	6,552	7,020	7,440	7,884
3	Peak Annual Water Demand	l/s	67	76	81	86	91
G.	**Required Treatment Plant Output (rounded)**	m3/d	5,760	6,550	7,020	7,440	7,880
H.	**Treatment Plant Backwashing**						
1	Treatment Plant Backwashing	m3/d	50	50	50	50	50
I.	**WTP Capacity**						
1	Required WTP Capacity	m3/d	5,810	6,600	7,070	7,490	7,930
2	Required WTP Capacity	l/s	67.25	76.39	81.83	86.69	91.78
	Total Required Source Capacity (Rounded)	**m3/d**					7,950
	Total Required Source Capacity	**l/s**					92.00

57. This demand assessment provides that a WTP of capacity 7,950m3/day will be required to serve the projected population in Stung Treng at that time. The previous ADB Mekong Regional PPTA from 2009 recommended a WTP of 5,760m3/day. This was a rough estimate and was sized at 5,760m3/day to be the same as the six WTPs constructed under the 2006 ADB Provincial Towns Project. Additionally, the previous 2009 study did not include provision to serve the villages across the new Mekong bridge in Ou Rei and Thalabarivat districts. It can be seen from the population projection estimates above, that today 5,760m3/day would not even serve the current population to the standards given.

5. SUBPROJECT DESCRIPTION

5.1 Introduction

58. The proposed works are designed to replace the existing WTP and intake with a new, larger capacity WTP and new Mekong river intake, to provide sufficient water to meet the needs of the projected 2030 population in the service area.

5.2 Output 2: Water Supply Development

59. Expected outputs of the overall Project include: (i) water treatment plants provided or improved in eight towns; (ii) water distribution systems improved and coverage increased in six towns; (iii) existing pumping stations rehabilitated in five towns; and (iv) institutional capacity of MIH and regulatory system strengthened, under a piggy-backed technical assistance.

5.2.1 Preliminary Designs

60. The proposed water supply scheme design improvements are based on limited topographical, hydrological and water quality data and are preliminary. The proposed system was modelled using EPAnet software, with ground levels based on map contours (as opposed to full topographical survey results) and demands based on house counts in the field prorated against the 7,950m3/day peak demand capacity.

61. The chosen pipe size was deliberately conservative, with a 400mm diameter main “spine” through the centre of the system and a 315mm ring main around the whole town. There are also several further 315mm mains running across the ring main through the most populated areas of town. The reason for this size selection is that there is little head available, with the area being very flat, and headlosses need to be kept to a minimum, especially in the more distant service areas across the two rivers. The main elevated tank will have water level at RL80m, and much of the town is above RL60. However, this larger diameter pipe is expensive, and during final design a more detailed model may be able to show that a smaller diameter can be used for some mains, reducing the cost.

5.2.2 Description of Proposed Water Supply System

62. The Stung Treng subproject aims to improve the provision of safe, affordable, reliable piped water supply to individual household connections to communities within the six core communes (23 vilages) having Y2012 population of about 33,592. The improved water supply scheme is designed to supply about 41,416 people in the town with 120lpcd by 2030.

63. The works proposed under the PPTA are summarised in Table 5.1 below;

Table 5.1: Proposed new infrastructure for Stung Treng

Stung Treng	Full FS	**Full new water supply system**
		A - P&G and Intake on Mekong
		B - New WTP of 7,950m^3/day capacity with elevated storage tank and underground tank
		C - New/rehabilitated tanks on old WTP site
		D - Electrical & mechanical
		E - New distribution system all districts

64. The existing water treatment plant in Stung Treng is not considered worth trying to rehabilitate. Water retaining structures are leaking profusely and the arrangement of tanks and channels does not allow the treatment process to work. A new WTP is proposed at a new

location approximately 7km downstream from the current WTP, 1,400m inland from the Mekong River. The current WTP is in the centre of town and draws raw water from the Sekong River.

65. The existing distribution system is in a similar state of disrepair and is mostly very old as shown in Table 3.4 above. It is proposed to replace the complete distribution system.

66. The proposal to build a new system for Stung Treng was first evaluated in 2009 under a previous Regional ADB PPTA6. At this time two options were considered in consultation with the EA. Both options involve the construction of a new WTP at the proposed location, but differ in proposed service area. Option 1 included the Sangkhats of Stung Treng, Srah Ruessei, Preah Bat and Sameakki, the latter on the opposite side of the Sekong River, with villages spread along National Route 7 that runs north to the Lao border. Serving Sameakki Sangkhat will involve the construction of a distribution main along the existing bridge over the Sekong River. Option 2 includes only the three Sangkhats of Stung Treng, Srah Ruessei and Preah Bat.

67. Since 2009, construction has started on a new bridge crossing the main Mekong river, and because of this a third option has been tabled by MIH. The bridge is 1,730m long and is due to be opened in early 2014. This option is to supply the six villages along the river on the opposite side of the Mekong in the two Sangkhats of Uo Rey and Thalaborivat. This third option has been selected for development.

68. Water supply improvements proposed are replacement of the existing WTP and raw water pump station on the Mekong River with 7,950m3/day (330m3/hr) capacity, a 1.4km long raw water transmission main to the proposed WTP (approximately 400mm diameter), and a completely new distribution system.

5.2.2.1 New Mekong intake, raw water pump station and 1.4km transmission main

69. A new concrete tower intake on the Mekong River is to be constructed with submersible pumps, guide rails and auto-couplings for easy removal. The pumps will have frequency inverters to adjust speed depending on whether river water levels are low or high. The control panel shall be on top of the tower protected from the sun and weather. The rising main shall reach the riverbank via a walkway bridge, attached to the underside. From here 1.4km of rising main are required to reach the WTP

5.2.2.2 New WTP of 7,950m^3/day capacity with elevated storage tank

70. The proposed WTP will consist of inlet chamber, presedimentation tank, chemical mixing building, flocculation tank, sedimentation tank, rapid sand filters, backwash tank, air blower, clear water tank, clear water pumps and an elevated storage tank. From the elevated storage tank, water can be gravity fed to distribution.

5.2.2.3 Rehabilitate existing 500m^3 elevated storage tank in old WTP

71. Subject to a condition inspection, the existing elevated tank in the existing WTP could be salvaged and a pump station built next to it to provide better mains pressure in the town centre area. An existing in-ground tank may be able to be rehabilitated for use as the pump chamber rather than building a new one. The town centre is 7km from the proposed WTP and so approximately 15m headloss can be expected along this main, leaving only 10-15m head for the town supply. With this low head, by the time the customer tap at the edge of town is reached pressure could be very low. This will all require hydraulic modeling and further study during final design stage.

5.2.2.4 New distribution system for Stung Treng, Srah Ruessei & Preah Bat districts

72. New HDPE distribution pipe is required for this area, the main central area of Stung Treng. All existing pipe shall be abandoned. New domestic connections with new meters and

[6] Mekong Region Water Supply & Sanitation Project

meter boxes shall also be installed and old ones removed. Fire hydrants and washout valves shall be installed at high and low points. The pipelines shall follow the existing roads, and whilst approximate pipe sizes are given for budgeting purposes in this report, a full hydraulic analysis and modelling will be required under final design to confirm pipe sizes. As the network is being designed as brand new, the opportunity should be taken to create manageable supply zones with gate valves and bulk meters, so that each zone can be closed off in future for NRW investigation purposes. This also applies for the other 2 main supply zones across the two bridges. The proposed distribution system is shown on a plan in Appendix O.

5.2.2.5 New distribution system for Sammakki district across the Sekong River bridge

73. There is no distribution pipework in this area, and all proposed pipe and fittings shall be new. The bridge crossing shall be attached with painted galvanized iron clamps and include a central air valve and washouts at either end. The proposed distribution system is shown on a plan in Appendix O.

5.2.2.6 New distribution system for Ou Rey and Thalaborivat districts across new Mekong bridge.

74. There is no distribution pipework in this area, and all proposed pipe and fittings shall be new. The bridge crossing shall be attached with painted galvanized iron clamps and include a central air valve and washouts at either end. The proposed distribution system is shown on a plan in Appendix O.

5.3 Consultation Activities during Preparation of Stung Treng Feasibility Study

75. A series of community visits and consultations occurred during the finalization of the 2013 Feasibility Study to inform district and village authorities about the subproject and gather information and feedback from local authorities, people living in core villages and other stakeholders. Consultation activities during the project site visits in 2013 are detailed below:

(i) Initial reconnaissance visit March 2013: Team Leader and National water engineer visited the site for an initial inspection and discussion with the Provincial Waterworks.

(ii) Previous site visits 2009:

(iii) Initial engineering site visit March 2013: International Team Leader and National water engineers visited Stung Treng facility, collected data, and discussed scope prior to Inception workshop.

(iv) Environmental and Resettlement specialist visit: This joint visit was carried out between June 3rd -11th to collect data to aid the finalization of the IEE and LACP.

(v) Socio-economic specialist visit: a visit for the purpose of carrying out the socio-economic survey was undertaken on 18-27th June.

5.4 Operation and Maintenance of Project Facilities

5.4.1 Capacity to Operate and Maintain the Proposed Water Supply System

76. The capacity of staff to operate a new WTP at Stung Treng is very low. Both during and after commissioning of the new WTP, the Stung Treng Water Authority will need assistance and training in understanding the requirements of day-to-day operation of a properly designed WTP, in particular;

- Managing flowrates through the WTP, and measurement and recording of daily flowrates
- Valve operation
- Correct flocc tank operation, what to look for, and setting of submerged baffle gap sizes

- Flow measurement through the inlet channel with Parshal flume
- Correct filter operation, frequency of backwashing, operation of blower and regulation of backwash flow, and what to look for during a backwash cycle.
- Understanding setting of level controls in the tanks and their relation to pump on/off
- Pump control panels
- System pressure in the pipelines
- Understanding of zoning in the distribution system, location and purpose of boundary valves.

5.4.2 Management Arrangements

77. The PIAC will provide Project technical, safeguards, accounting and management assistance on a daily basis as well as support the PIUs with project implementation

78. At the start of Project implementation, the PMU and PIAC will (i) update the initial environment examinations and due diligence reports (IEEs and DDRs) and prepare EMPs submit to MOE for review and approval; (ii) clear potential unexploded ordnance (UXO) remain on site; and (iii) acquire necessary land before subproject bids are tendered.

5.4.3 Operation and Maintenance Plans

79. The Operation and Maintenance plan for each subproject can be divided into two types, those with a full conventional WTP and those with chlorinated groundwater being pumped to an elevated tank and fed into supply. For Stung Treng, an Operation and Maintenance Plan reflecting the former has been developed and is presented in full in Appendix L.

5.5 Lessons learned in Cambodia and the SE Asia region

80. There are several “lessons learned” in both the region and inside the national water sector that would benefit the 9 project towns under this PPTA;

- As at PPWSA, use of standardized chlorination equipment that has a regional office that can offer technical support, spares and specialist staff when needed. PPWSA has selected equipment supplied by Severn Trent Services (STS), and equipment from this manufacturer has been recommended for the towns requiring replacement chlorination equipment under this study. STS have a main office in Singapore, but have local representation in Phnom Penh. However, final selection of equipment of equal or better specifications will be decided at tendering as specific brands cannot be specified in Contract documents.
- High density polyethylene pipe (HDPE) is favoured in Cambodia, even for larger diameters. As most of Cambodia is flat, as are all of the 9 towns under this study, system pressures are not higher than 60m head. As such, a PN6 rated pipe would be sufficient. However, experience has shown that for the pipes un to and including 90mm diameter, which may have domestic connections tapped from them, a PN8 minimum pipe is required, even for very low pressures. The reason for this is that the tapping saddles used can deform the thinner pipe wall thicknesses on PN6 pipe, which causes leakage.
- Automated valves linked to a central control panel were designed and installed under the 2006 Provincial Towns project. All of these have failed in the 6 towns where they were installed. The lesson here is to keep the WTPs simple and keep valves as manually operated. With the relatively smaller size of these WTPs (mostly under 6,000m^3/day), valve automation is not necessary and inappropriate.

- Alum and poly dosing lines under the previous Provincial Towns project used long lengths of uPVC pipe that followed buildings and structures, necessitating several 90 degree bends and causing significant headloss in the delivery pipe. This has caused the pipes to get blocked by sediment. In addition, the uPVC dosing pipes are exposed to direct sunlight. UV light will break down uPVC pipe over time. A better solution, as used in two recent projects in Laos, is to use ABS (acrylonitrile butadiene styrene) pipe, and select a more direct route for the pipe, minimizing bends and low points.
- For the water sector as a whole, a database of all water projects could be set up, to include design drawings, calculations, contract documents, demand calculations, feasibility reports, final design reports and other useful documentation, for each system. This would serve as an easily accessible online resource library for all Water Authority staff in the country. It is relatively easy and inexpensive (under US$40,000) to set up and populate, and solves the common problem of drawings and documents getting lost. Many of the available hard copy resources for Cambodian water supply systems are either misplaced, or are reportedly stacked in disorder in a storeroom so dirty that nobody is willing to enter. Such a database was set up and released in neighbouring Laos in 2012-13 with assistance from UNHabitat, and can be viewed at;

http//:laowtp.info
by pressing “login as guest”.

- Several of the project towns under this PPTA have had extensions added to serve areas that were outside of the original design core area, without considering required design pressures or treatment plant capacity. This often results in the WTP being operated above its design capacity, which can reduce water quality, and often has negative effects on service pressure to other parts of the reticulation network. Typically, to increase system pressure to serve these unplanned extensions, water is diverted around any elevated storage tank and pumped directly into the system in order to increase delivery pressure by a few metres head. This is bad operating practice as it eliminates the storage facility and increases leakage loss. Any pipeline extensions should be made in a planned way and carried out simultaneously with WTP capacity upgrades as required.

5.6 Public Private Partnerships

81. Options and viability for potential PPP for Stung Treng subproject was discussed with the Director of the Department of Potable Water Supply[7].

82. In common with all towns in general, the urban water supply systems are seen as best managed by the government where possible. Installation and commissioning of the elements of work under this subproject require specialist contractors and involvement of public bodies is limited.

83. There are some peri-urban areas in Cambodia where whole water supply concessions have been granted to private companies to construct and manage water supply systems. This is not strictly PPP, as the private company needs only to acquire a license – there is no partnership as such. There are both good and bad examples of these private concessions throughout the country.

[7] Mr Tan Sokchea

84. A possible area where a PPP could be utilized in the future is in the supply of bulk treated water to customers who are either just outside of the WTP service area or are inside the area but receive low pressure. Private water tankers could be used to fill up with (and pay for) treated water from the WTP and deliver and sell to customers with their own storage tanks.

5.7 Contract Packaging of Subproject

85. A number of packaging options were examined and discussed between the PPTA team, MIH and ADB. These options are presented below in Table 5.2.

Table 5.2: Subproject Contract Packaging Options

No. packages	Subproject Towns included	Advantages/disadvantages
2	Stung Treng Siem Reap plus 7 rehab towns	**Advantages:** • Small number of packages reduces tendering and contract management admin. • Larger packages makes them more attractive to international bidders. • Easier to standardise on equipment. **Disadvantages:** • Limited opportunity for NCB
3	Stung Treng Siem Reap 7 rehab towns	**Advantages:** • Three good sized packages attractive to ICB bidders • Small number of packages reduces tendering and contract management admin. • Easier to standardise on equipment **Disadvantages:** • Limited opportunity for NCB
4	Stung Treng Siem Reap 3 southern rehab towns (Svay Rieng, Kampot, Sihanoukville) 4 northern towns (Kampong Cham, Kampong Thom, Pursat, Stoung)	**Advantages:** • 2 larger and 2 smaller packages, the smaller of which could be NCB if an exception to the $1M limit relaxed **Disadvantages:** • More tender and contract management admin • More difficult to standardise on equipment with larger number of packages.
9	9 separate contracts	**Advantages:** • Each IA is responsibe for their own

		subproject and has direct ownership • 7 of the 9 subprojects could be let as NCB **Disadvantages:** • More tender and contract management admin • Some activities may not be suitable for many national contractors due to lack of specialist experience. • More difficult to standardise on equipment with larger number of packages.

86. During discussions, initially the option of two large contracts, one for Stung Treng and one for the other 8 towns, was favoured for the simplicity of the bidding process, contract administration, and the attractiveness of the larger packages to international bidders.

87. After further discussion, 9 separate contracts was favoured, as greater weight was put on having the contracts out to tender quickly, and having 7 of them of a size that would permit NCB would help achieve this. The procedures for approving and tendering NCB are far less time consuming compared to ICB. Additional benefits would be that each IA would have ownership of their own subproject, and that national contractors would benefit from both the experience and the business.

88. A perceived obstacle with having 7 of the subprojects as NCB is the technical nature of some of the rehabilitation work. Installation and commissioning of gas chlorination equipment, bladder tanks for surge protection, and proper construction of filter underdrains are all areas requiring a degree of specialist knowledge and experience. For this reason, coupled with the simplicity of having a lesser number of contract packages, a compromise of three packages was selected, being Stung Treng, Siem Reap, and the 7 rehabliitation subprojects.

89. These 3 packages will all need to be ICB due to their value, but this does not exclude national contractors from bidding, provided they meet the prequalification requirements. Additionally, if national contractors have difficulty meeting prequalification requirements, they can still benefit from these contracts by subcontracting.

6. COSTS AND FINANCING PLAN

6.1 Cost Estimates

90. The subproject cost is estimated at $13.473 million equivalent, including taxes. A summary of the cost estimates is given in Table 6.1.

Table 6.1 - Subproject Capital Cost

		Totals
No	**Description**	**(inc tax)**
		US$000
1	**Water Supply Development**	
1.1	P&G and Intake on Mekong	80.0
1.2	New WTP of 7,950m^3/day capacity with elevated storage tank and underground tank	1,208.0
1.3	New/rehabilitated tanks on old WTP site	150.0
1.4	Electrical & mechanical	160.0
1.5	New distribution system all districts	9,630.0
1.6	**Total for Water Supply Development**	
	TOTAL ESTIMATED BASE COST[a]	11,228.0
	Total Contingencies	2,246.0
	TOTAL ESTIMATED SUBPROJECT COST	13,473.0

Source: Consultant's estimate, 2013.

91. From Section 5.2.1, it is reiterated here that the cost may be brought down during final design stage, after detailed hydraulic modeling, by reducing the size of the 315m diameter mains to 250mm. The larger 315mm size has been specified under this preliminary design as a conservative measure to minimize pipeline headlosses.

6.2 Least Cost Analysis

92. A least cost analysis has been carried out for Stung Treng to establish the economic feasibility of extending the current service area across the Mekong and Sekong rivers to Ou Rey, Thalaborivat and Sammaki districts. This has been made possible by the existing cridge over the Sekong to Sammaki, and the bridge under construction to Ou Rey and Thalaborivat.

93. A least cost analysis was carried out in 2009 under a previous PPTA8 for the inclusion of Sammaki district only, and this was found to be the preferred option on economic grounds.

94. The current least cost analysis reached the same conclusion for the additional service area (Ou Rey and Thalaborivat) across the new Mekong bridge.

95. The full least cost analysis is contained in Appendix P.

[8] TA6484-REG, Mekong Water Supply & Sanitation Project

6.3 Financing Plan

96. The project will be financed by ADB and the national government. ADB loan will finance KR 54459 million while the government will finance KR 5993 million which includes government taxes. The financing plan is shown in Table 6.2.

Table 6.2: STPWW Financing Plan (KR million)

Items	% Total	Total
ADB	90.1	54,459
Disbursement	89.2	53,936
IDC	0.9	523
Government	9.9	5,993
Equity Contribution	0.9	545
Taxes, Duties and Other	9.0	5,448
Total Financed	100.0	60,452

Source: Consultant's estimate

7. SUBPROJECT FINANCIAL AND ECONOMIC ASSESSMENT

7.1 Approach and Methodology: Financial Assessment

97. The financial analysis was done in three levels: (i) examination of the historical and current financial performance; (ii) evaluation of the feasibility of the proposed subproject under UWSP; and (iii) evaluation of the financial sustainability taking into account the impact of the proposed subproject to the future operation of PWWs and WSA.

98. Following the Asian Development Bank (ADB) guidelines9, four basic indicators for the financial viability of a water supply project have been identified. These are the following:

- Financial Internal Rate of Return (FIRR). It is the discount rate at which the revenues and costs generated by the project are equal to zero. A project is considered financially viable if the computed FIRR is equal to or higher than the weighted average cost of capital (WACC) that is used in financing the development of the proposed water supply project.

- Debt Service Coverage Ratio (DSCR). It measures the solvency of the PWWs/WSA and shows how many times debt service for a given period is covered by operations. DSCR should at least be 1.3 after project completion.

- Annual cash balance. Projected annual cash balances should be positive all throughout the projection period.

- Tariff affordability. Household monthly water bill should not be more than 5% of the average monthly household income of the low income group.

7.1.1 Financing Plan.

99. The project will be financed by ADB and the national government. Part of the ADB and national government funds will be on-lent to the PWWs/ WSA. Annual debt service was estimated based on preliminary discussions with MIH and MEF. The on-lending terms for the purpose of this study are as follow:

- Maturity period of 32 years, including 8 years grace period on principal payment while interest is capitalized during construction;

- Fixed interest rate[10] of 1.25% per annum for the first 8 years and 1.75% per annum for the next 24 years; and

- Foreign exchange risk to be borne by the national government.

7.1.2 Proposed Water Tariff.

100. Three scenarios were tested in the design of the water tariff based on the amount of loan, as a percent of project costs, passed on to the 8 PWWs. For Siem Reap WSA, 100% loan was assumed. For the 8 PWWs, the three scenarios tested were: (1) 0% loan-100% grant; (2) 50% loan-50% grant; and (3) 100% loan-0% grant.

7.1.3 Other Assumptions

101. The main assumptions used in the financial projections include:

[9] ADB, *Financial Management and Analysis of Projects* (2005).

[10] ADB's interest rate to the national government is 1% and 1.5% respectively.

- Estimates of annual water revenues are based on the total water billed for the year and the corresponding tariffs for the same year. Connection fees, for non-poor household customers are included as other revenues and assumed to be paid by the customers in 24 equal installments.

- The investment cost of the proposed project and the O&M costs are prepared on an annual basis in August 2013 prices. Increases in costs due to inflation are covered through a provision for price contingencies both for the investment costs and the O&M costs.

- The incremental O&M costs, which is the difference between "with the project" and "without the project" scenario, were used in the evaluation. O&M costs include: 1) administration; 2) chemical; 3) power; 4) maintenance of facilities; 5) salaries and wages; and 6) other O&M items.

- Projected O&M costs "without the project" are based on actual O&M costs as presented in the historical revenue and expense statements. It is assumed that there will be minimal increases in the service connections as water supply demand approaches the maximum water supply capacity of the existing system, hence there will be no increases in the number of personnel. The unit cost of O&M is assumed to increase following the local inflation rate.

- Projected O&M costs "with the project", except maintenance of facilities, are based on historical unit costs. Maintenance of facilities cost is based on engineering estimate of the required maintenance level of the facilities.

- Depreciation allowance is considered a non-cash item. However, for purposes of estimating the net income, it was included as expense in the projected income statement. Annual depreciation costs for the new facilities were calculated using the straight-line method based on the service life[11] of each type of asset.

- Water tariff "without the project", is assumed to increase in the future to cover increases in O&M. For purposes of the projection, it is assumed that water tariffs will have to be increased by 5% starting 2015 and every four years thereafter until 2027 for Siem Reap, Stung Treng and Svay Rieng; for Kampong, because current tariff is low, the assumed increases are 10%.

- Water Revenue "without the project". As mentioned earlier, since the existing facilities are already nearing its maximum operating capacities, it is assumed that there will be no further additional connections after the water supply capacities are reached in 2017. Volume of water sold after this period will remain constant. Any increase in projected revenue is then due to the assumed increase in water tariff.

- Water Revenue "with the project". Based on the technical study, the proposed improvements in the water supply system can provide the water requirements of the projected beneficiaries up to year 2019 (Siem Reap) to 2023 (Kampong Cham, Stung Treng and Svay Rieng). The volume of water sold is therefore assumed to increase up to that year and is assumed to remain constant at the that level. Any increase in projected revenue after this period is then due to the assumed increase in water tariff.

7.2 Approach and Methodology: Economic Assessment

102. The economic analysis was undertaken in accordance with the procedures set out in the ADB Handbook for the Economic Analysis of Water Supply Projects (1999) and related ADB guidelines12. The period of analysis extends over 30 years from the start of project implementation in 2015 up until 2044. Costs and benefits were quantified at August 2013 prices and were converted to their economic

[11] Using PWWs/WSA asset life schedule.

[12] *Guidelines for the Economic Analysis of Projects (1997).*

cost equivalents using shadow prices. Both costs and benefits were treated as increments to a "without the project" situation.

103. The economic viability of the project was determined by computing the economic internal rate of return (EIRR) and comparing the result with the economic opportunity cost of capital (EOCC) of 12%. An EIRR exceeding the assumed EOCC indicates that the project is economically viable. The viability of the investments was then tested for changes in key variables such as capital costs, O&M costs and benefits through sensitivity analysis. Distribution of project benefits and poverty impact analysis were also undertaken to determine how much of the net economic benefits resulting from the investments will directly benefit the poor.

104. The economic viability of the proposed investments in water supply was determined considering the following benefits: (1) incremental gross revenue; (2) the value of time saved for not having to collect water from existing non-piped sources; (3) medical cost savings due to reduced morbidity from waterborne diseases; and (4) avoided income loss (productivity savings) because of reduced incidence of diseases. Economic costs were derived from the estimates of capital investments and O&M costs in financial terms, removing all duties and taxes and multiplying the net results by the conversion factors (CF). The following CFs were applied: 1.0 for traded goods and non-traded goods, and 0.7 for unskilled labor.

105. The proposed investments which aim to improve the population's access to piped water supply in the area, will form part of the Government's overall development plan for the water supply sector, which also aims to achieve the targets set under the Millennium Development Goal13.

7.3 Stung Treng Provincial Waterworks (STPWW)

106. A full financial and economic analysis report can be found in Appendix H.

7.3.1 Historical Financial Performance

107. From 2011 to 2012, STPWW was able to cover total expenses and depreciation allowance but with a very small margin. Current ratio was moderate for the two-year period while account receivable as of end 2012 was low at 14 days equivalent of annual water sales.

Table 7.1: STPWW Financial Indicators, 2011-2012

Financial Indicators	2011	2012
Cost Recovery:		
Total expenses	1.15	1.08
Total expenses & Depreciation	1.02	1.01
Current Ratio	2.05	3.20
Operating Ratio	0.98	0.99
Account Receivable (Days)	44	14

[13] MDG's Target No. 10, Goal No. 7: Halve, by 2015 the proportion of people without sustainable access to safe drinking water and sanitation. For urban water supply in Cambodia, people with access to safe drinking water is about 64% in 2004. Per MDG, this should reach 80% by 2015. Source: Key Indicators of Developing Asian and Pacific Countries, 2006, ADB.

7.3.2 Projected Financial Performance

7.3.2.1 Investment Costs.

108. The total investment cost for the water supply project is approximately KR 64745 million, including price and physical contingencies and interest during construction. Table 7.2 presents a summary of the investment costs.

Table 7.2: STPWW Total Investment Cost (KR million)

Items	% Total	Total
Civil Works	62.2	40,247
Equipment and Materials	0.9	582
Total Base Cost	63.1	40,828
Physical Contingency	12.6	8,166
Price Contingency	14.3	9,232
Total Contingencies	26.9	17,398
Interest During Construction	1.1	696
Taxes and Duties	9.0	5,823
Total Cost	100.0	64,745

Source: Consultant's estimate

7.3.2.2 Financing Plan.

109. The financing plan assumes a 50% loan. Total loan is KR 32721 million, including interest during construction of KR 696 million. The balance of KR 32024 will come from government and ADB fund in the form of grant to STPWW. The financing plan is shown in Table 7.3.

Table 7.3: STPWW Financing Plan (KR million)

Items	% Total	Total
ADB Loan (On-lending)	50.5	32,721
Disbursement	49.5	32,024
Interest During Construction	1.1	696
Government	49.5	32,024
Own Fund	9.9	6,405
ADB Fund	39.6	25,620
Total	100.0	64,745

Source: Consultant's estimate

7.3.2.3. Water Tariff.

110. For a 0 and 50% loan, the required tariffs are shown in Table 7.4 while for a 100% loan, the required tariffs are shown in Table 7.5. The block tariff rate (first block is 1 to 7 m3 consumption) is proposed for household connections to reduce the impact of tariff rate increases to the poor households. The proposed tariff increases (average) will ensure that the STPWW will cover its O&M, depreciation and debt service by 2023. The proposed increases in the tariff will result to a monthly bill of not more than 5% of the family income of the low income group.

Table 7.4: STPWW Proposed Tariff Rate – 0 to 50% Loan

Category	2015	2018	2021	2023
Household, 0 to 7 m3	1,700	1,700	1,700	1,700
above 7 m3	1,800	2,250	2,250	2,250
Government	1,800	2,250	2,250	2,250
Commercial	1,900	2,400	2,400	2,400
Tariff Increase (average)	21%	19%	0%	0%

Source: Consultant's estimate

Table 7.5: STPWW Proposed Tariff Rate – 100% Loan

Category	2015	2018	2021	2023
Household, 0 to 7 m3	1,700	1,700	1,700	1,700
above 7 m3	1,800	2,250	2,250	2,500
Government	1,800	2,250	2,500	2,650
Commercial	1,900	2,400	2,650	2,800
Tariff Increase (average)	21%	19%	5%	8%

Source: Consultant's estimate

7.3.2.4 Weighted Average Cost of Capital.

111. On the basis of the financing mix and the loan interest rate of 1.25% to 1.75% and the assumed cost of equity of 6.0%[14] of the government, the WACC is computed at -0.05%. Table 7.6 shows the computation of the WACC assuming a 50% loan. However, since ADB guidelines require a minimum hurdle rate of 4% for the financial analysis, the FIRR will be evaluated based on 4%.

Table 7.6: STPWW Weighted Average Cost of Capital

Items	Capital	% of Total	Nominal Rate	Tax Rate	After Tax Rate	Inflation rate	Real Rate	WACC Real
Loan (ADB Funds)	32,024	50%	1.7%	20.0%	1.3%	1.8%	-0.5%	-0.2%
Grant (ADB Funds)	25,620	40%	1.7%	0.0%	1.7%	1.8%	-0.1%	-0.1%
Grant (Gov't Funds)	6,405	10%	6.0%	0.0%	6.0%	3.5%	2.4%	0.2%
Total Capital Investment	64,049	100%						**-0.05%**

Source: Consultant's estimate

7.3.2.5 Financial Internal Rate of Return.

112. The proposed tariff increases to cover O&M, depreciation and debt service are not enough to attain an FIRR higher than the WACC. Further tariff increases of 25%, therefore, are proposed starting in 2027 and every four years thereafter. The resulting FIRR is 5.6%. Sensitivity analyses were likewise conducted to determine the effects of adverse changes on the project such as increase in capital and O&M costs, revenues not realized as expected and delay in operation. The scenarios

[14] Cambodia treasury bill, 91 days maturity issued by MEF.

evaluated and the summary results of the analyses are presented in Table 7.7. The results show that the project is viable under the four scenarios evaluated.

Table 7.7: STPWW Summary Result of FIRR

Items	FIRR	FNPV
Base case	5.6%	8,612
Capital cost plus 20%	4.0%	2
O&M cost plus 10%	5.5%	8,216
Revenue less 10%	4.6%	3,003
1-Year delay in benefit	4.8%	4,210

Source: Consultant's estimate

7.3.2.6 Affordability of Water Rates.

113. Based on the socio-economic survey, respondents in the service area are willing to pay KR 1,820 per m3 of water consumed while proposed tariff (1-7 m3 consumption) by 2023 is KR 1,700. Another measure of affordability is ratio of monthly water bill to the total household income. For STPWW service area, the estimated monthly income belonging to the poor households for 2013 is KR 665,000. Using the affordability criteria, the monthly water bill is about KR 11900 (KR 1700 x 7 m3) in 2015 is only 2% of the monthly income of poor households. In all subsequent years the monthly water bill is less than 5% of the estimated monthly income. Hence, the proposed level of water tariff is deemed affordable to the low income or poor households.

114. Impact of the Project on the STPWW's Financial Operation. Selected financial indicators were computed to provide an indication of the STPWW's future financial performance.

- Revenues can cover O&M cost and depreciation between 2015 and 2025;
- Current ratio is high which ranged from 3 to 18 from 2015 to 2025;
- Operating ratio is less than or equal to 1;
- Debt service coverage ratio is higher than 1.3 for all years until 2025; and
- Accounts receivable is low at 18 days equivalent of annual revenue.

115. Annual financial indicators for years 2015 to 2020 and 2025 are shown in Table 7.8

Table 7.8: Summary of Financial Indicators

Financial Indicators	2015	2016	2017	2018	2019	2020	2025
Cost Recovery:							
O&M	1.3	1.3	1.7	2.1	2.7	2.5	2.4
O&M + Depreciation	1.3	1.2	1.0	1.0	1.0	1.1	1.4
Current Ratio	2.9	3.6	6.4	9.9	15.5	17.9	4.9
Operating Ratio	0.8	0.9	1.0	1.0	1.0	0.9	0.7
Debt Service Coverage Ratio	-	-	-	-	-	4.9	1.8
Account Receivable (Days)	18	18	18	18	18	18	18

Source: Consultant's estimate

7.3.3. Economic Assessment

7.3.3.1 Economic Benefits.

116. The parameters and values used in quantifying the economic benefits of water supply improvement are shown in Table 7.9. There are other benefits that could result from improved water supply but such benefits as income generated from the use of water for livelihood purposes and the multiplier effect of increased income, among others, were not included in the analysis for lack of data.

Table 7.9: Assumptions for Economic Benefits Computation

No.	Item	Value
1	Price of 20-liter bottled water, KR	8,000
2	Bottled water consumed, lpcd	1
3	Bottled water user, %	32%
4	Willingness to pay, KR/m3	1,829
5	Households who store water, %	83%
6	Storage facility cost, KR	454,053
7	Households who collect water, %	80%
8	Collection time per day, hours	0.5
9	Households who treat water, %	93%
10	Water treatment cost, KR	61,947
11	Morbidity rate, %	11.6%
12	Economically active population, %	44%
13	Average days indisposed, days	3
14	Average daily wage rate, KR	22,177
15	Medical cost per capita, KR	36,875

Source: Socio-economic survey, July 2013

7.3.3.2 Economic Costs.

117. The estimated economic cost equivalent of the proposed capital investments is about KR 46096 million.

7.3.3.3 EIRR and Sensitivity Analysis.

118. Given the stream of economic benefits and costs over the 30-year period, the EIRR of the investments for STPWW is 17% which is higher than the assumed EOCC of 12%. Sensitivity test results based on (1) 20% increase in capital costs, (2) 10% increase in O&M costs, (3) 10% decrease in benefits, and (4) 1 year delay in realization of the benefits show the EIRR still above the EOCC. Table 7.10 summarizes the results of the base case analysis and the sensitivity tests.

Table 7.10: STPWW EIRR and Sensitivity Test Results

Items	EIRR	ENPV
Base case	17.2%	172,371
Capital cost plus 20%	14.1%	161,949
O&M cost plus 10%	17.2%	171,462
Benefits less 10%	15.4%	149,014
1-Year delay in benefit	14.7%	161,052

Source: Consultant's estimate

7.3.3.4 Project Beneficiaries.

119. At the end of year 2023, STPWW is projected to have a total of 7780 water service connections, an increase of 5274 from the 2014 projected level. In terms of served population, the investments will directly benefit an additional 26350 persons within the service area (Table 7.11).

Table 7.11: STPWW Projected Service Connection

Item	2014	2015	2020	2023
Service area population	38,867	39,322	41,676	43,156
Population served	12,200	12,727	25,375	38,550
% Served	31%	32%	61%	89%
Number of connection	2,506	2,638	5,190	7,780

Source: Consultant's estimate

7.3.3.5 Project Sustainability.

120. The project financial sustainability is highly dependent on the realization of the targeted new service connections and the implementation of the proposed water tariff increases to generate funds to cover O&M cost and depreciation. It is proposed that a block tariff be implemented starting in 2015 to minimize the impact of subsequent tariff increases to the poor households.

7.3.3.6 Poverty Impact.

121. The water supply project is expected to generate total net economic benefits (NEB)15 of about KR 21387 million. Approximately KR 18843 million will accrue to water consumers, many of whom are current users of water from wells, rainwater, river water and other sources and who are expected to connect to the improved piped water supply system to be made possible through this Project. Local labor, for which a significant amount of person-days will be needed for construction of the new facilities and their eventual operation, will gain about KR 2544 million.

122. The poverty impact ratio (PIR) for the water supply investments is 0.45, which means that 45% of the NEB will directly benefit the poor. Poverty incidence in the service area is around 45%.

[15] NEB is the difference between the present value of economic benefits and financial revenues.

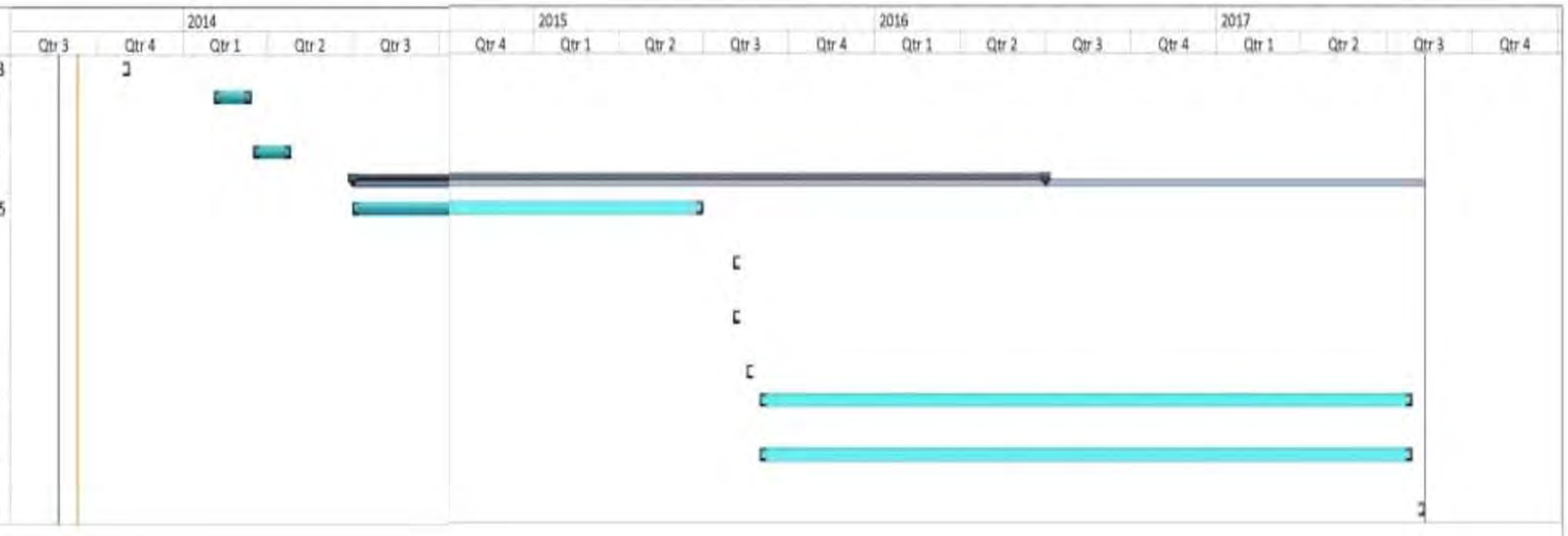
Table 7.12: STPWW Poverty Impact Ratio

Items	Government /Economy	Labor	Consumers	Total
Gains and losses	-	2,544	18,843	21,387
Financial return to PWW	(12,489)			(12,489)
Benefits (Losses)	(12,489)	2,544	18,843	8,897
Proportion of poor	0.45	0.45	0.45	
Benefits to poor	(5,620)	1,145	8,479	4,004
Poverty Impact Ratio				0.45

Source: Consultant's estimate

Appendix A: Stung Treng Subproject Implementation Schedule

ID	Task Mode	Task Name	Duration	Start	Finish
1		Completion of PPTA			Mon 4/11/13
2		Tendering of Implementation project	30 days	Mon 3/02/14	Fri 14/03/14
3		Tender evaluation	30 days	Mon 17/03/14	Fri 25/04/14
4		**Final design & contract management**	**524 days**	**Tue 1/07/14**	**Fri 1/07/16**
5		Final design & contract documentation	261 days	Tue 1/07/14	Tue 30/06/15
6		Tenders close - construction package 1		Mon 3/08/15	
7		Tenders close - construction package 2		Mon 3/08/15	
8		Tender award - package 1 & 2		Mon 17/08/15	
9		Construction Package 1 - Stung Treng	500 days	Mon 31/08/15	Fri 28/07/17
10		Construction Package 2 - Siem Reap plus 7 others	500 days	Mon 31/08/15	Fri 28/07/17
11		Commissioning			Fri 11/08/17



Project: schedule.mpp
Date: Tue 10/09/13

Task — External Milestone — Manual Summary Rollup
Split — Inactive Task — Manual Summary
Milestone — Inactive Milestone — Start-only
Summary — Inactive Summary — Finish-only
Project Summary — Manual Task — Deadline
External Tasks — Duration-only — Progress

Page 1

Project: schedule.mpp
Date: Tue 10/09/13

Task — External Milestone — Manual Summary Rollup
Split — Inactive Task — Manual Summary
Milestone — Inactive Milestone — Start-only
Summary — Inactive Summary — Finish-only
Project Summary — Manual Task — Deadline
External Tasks — Duration-only — Progress

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Appendix B: Cost Estimate for Stung Treng Subproject

Appendix C: Water Quality Test Results for Stung Treng Subproject

Data not available

Month average	Temp (C)	Turbidity NTU	Res chlorine (mg/l)	pH	Colour TCU	TDS (mg/l)	Conductivity (us/cm)
LIMIT		**<5**	**0.2-0.5**	**6.5-8.5**	**<5**	**800**	**1600**
Jan							
Feb							
Mar							
Apr							
May							
Jun							
Jul							
Aug							
Sept							
Oct							
Nov							
Dec							

Appendix D: Socio-economic Survey Report for Stung Treng Subproject

Appendix E: Cancelled

Appendix F: Ethnic Groups Screening Form

Appendix G: Gender Plan for Stung Treng Subproject

Appendix H: 9 Subproject Towns Financial and Economic Analysis

Appendix I: Cancelled

Appendix J: Initial Environmental Examination for Stung Treng Subproject

Appendix K: Land Acquisition and Compensation Plan for Stung Treng Subproject

Appendix L – Outline Operation & Maintenance Plan

Operational Procedures

WTP area	Procedure
Raw water pumps	Can be controlled (on/off) by level transducers in the main clear water tank, or manually by Operator.
Flocculation tank inlet weir	Set so that there is always a hydraulic break between water in the inlet channel and the first flocc channel.
Flocculation tank baffles	Baffle slot sizes on lower end of alternate baffles, which are calculated and specified during final design, should be adhered to. When baffles are moved during cleaning of the flocc tank, these slot sizes should be reset to the design dimensions. Failure to do this may result in incorrect velocity gradient across the flocc tank resulting in poor flocc formation.
Sed tank collection launders	The stainless steel collection launders should be set at a level that allows for the prescribed headloss across the flocc tank. If the launders are set too high it has the effect of "backing up" the flocc tank and reducing the hydraulic gradient across it. This is normally set during design by calculating the hydraulics across the full WTP, but is sometimes neglected.
Filters – bypass of water	For filters to operate properly, the plenum floor that holds up the gravel and sand layers needs to be sealed. No water should pass between the plenum floor and the vertical filter walls, or through the plenum floor except through the inserted filter nozzles. Additionally, water should not be allowed to take a "short cut" between the edge of the sand layer and the filter wall. This can be stopped by roughening the inside filter wall with a sand/cement mix.
Filters – backwashing	Filters should be backwashed when the sand becomes sufficiently blocked with debris and silt to slow the passage of water through the media. This can be judged by marking a dirty water level inside the filter, and when it is reached, a backwash is due. Similarly a low water level mark should be visible and this minimum water level in the filter kept by partially closing the clean water outlet valve to the clear water tank. The backwash cycle begins with air scour by itself to loosen the sand media and help release dirt. This should carry on for around 3-5 minutes. The air blower is then turned off and backwash valve opened partially at first and then gradually opened further, in order to maintain the design backwash flowrate as the head in the backwash tank decreases. The backwash valve should never be just opened fully for the backwash cycle.
Reticulation	
Washout valves	All washout valves on the system, installed at low points, should be opened every month to flush out the line as required.
Valves on the distribution system	Valves should be kept either fully open or fully closed.

Maintenance Schedule

Raw water pumps	New submersible pumps should be raised using the auto-coupling & guiderails once per year to inspect the pumps and perform routine maintenance.
Flocculation tank	The flocc tank should be taken offline, one chamber at a time (there are 2 chambers), and cleaned out using shovels and a water blaster. Any repairs to baffles or replacement of rotten wooden baffles can take place at this time.
Sedimentation tank	The sedimentation tank should be taken offline, one at a time, and cleaned out annually.
Slide gates on all tanks	These should be inspected regularly and if not opening and closing easily, remedial action taken – either lubrication of threads or replacement of rubber seals.
Filters	Filter media will gradually become more blocked over time despite regular backwashing. Approximately every 5 years the sand and gravel media will need either removing and thoroughly washing before replacement, or new graded & washed sand placed. At this time, the nozzles and underdrains can also be inspected for damage.
Dosing pipelines	Check for leaks regularly and fix. Clean up spills and leaks.
Chemical mixing area	Keep floor clean
Chemical mixing tanks	When alum and poly tanks start to fill to the outlet pipe level with sediment they should be taken offline and cleaned out.
Pumps & blowers – general	Maintenance plan to follow manufacturers manual
Chlorination equipment - general	Maintenance plan to follow manufacturers manual
Reticulation	
Gate valves	All gate valves on the pipelines should be kept either fully shut or fully open as required.
Washout valves	Any washout valves, normally installed at low points, should be periodically (6 monthly) opened to flush out any debris.
Chambers	All valve chambers should be kept dry, clean and accessible.
Domestic connections	Any leaks on the upstream side of the meter should be recorded by meter readers and repaired promptly.
Physical leaks	All leaks reported or noticed by WA staff should be repaired promptly.

Appendix M – Modelling files

Appendix N – Pump calculations & duty curve

Appendix O – Plan showing proposed distribution system

Appendix P: Least Cost Analysis

Appendix Q: Proposed WTP Structure Dimensions

KINGDOM OF CAMBODIA

MINISTRY OF INDUSTRY AND HANDICRAFT

URBAN WATER SUPPLY AND SANITATION PROJECT

(ADB PPTA: TA-8125-CAM)

FEASIBILITY STUDY FOR SVAY RIENG SUBPROJECT

November 2013

Prepared by

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Document Status						
Rev No	**Author/editor**	**Reviewer**		**Approved for Issue**		
		Name	**Signature**	**Name**	**Signature**	**Date**
0	**Andrew Henricksen**	**Michael Lee**		**Michael Lee**		

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ABBREVIATIONS AND EQUIVALENTS

ADB	Asian Development Bank
ADF	Asian Development Fund
AP	Affected persons
APs/AHs	Affected persons/affected households
ASR	ADB's Annual Sector Review
BOO	Build-Operate-Own
BOT	Build-Operate-Transfer
COBP	Country Operations Business Plan
CPP	Community Participation Plan
CPS	Country Partnership Strategy
DMC	Developing Member Countries
DMF	Design and Monitoring Framework
DPWS	Department of Potable Water Supply
EA	Executing Agency
EGM	Effective Gender Mainstreaming
EMP	Environmental Management Plan
FAR	Feasibility Assessment Report
FS	Feasibility Study
GAP	Gender Action Plan
HHs	Households
IAs	Implementing Agencies
IEEs	Initial Environmental Examinations
IOL/SES	Inventory of Losses and Socioeconomic Survey
IR	Inception Report
ISCD	Institutional Strengthening & Capacity Development
JICA	Japan International Cooperation Agency
LARP	Land Acquisition and Resettlement Plan
LARF/LARP	Land Acquisition and Resettlement Framework and Plan
MEF	Ministry of Economy and Finance
MIH	Ministry of Industry and Handicraft
MOU	Memorandum of Understanding
MOWRAM	Ministry of Water Resources Management and Meteorology
MPWT	Ministry of Public Work and Transport
MRD	Ministry of Rural Development
NCB	National Competitive Bidding
NRW	Non-revenue Water
O&M	Operation and Maintenance
PAM	Project Administration Manual
PDIH	Provincial Department of Industry and Handicraft
PDR	People Democratic Republic
pm	Person-months
PMU	Project Management Unit
PPP	Public Private Participation
PPPs	Public-Private Partnership
PPTA	Project Preparation Technical Assistance
PPWSA	Phnom Penh Water Supply Authority
REA	Rapid Environmental Assessment

RRP	
SCS	Stakeholder Communication Survey
SPS	Safeguards Policy Statement
SRWSA	Siem Reap Water Supply Authority
SR	Safeguards Requirements
TA	Technical Assistance
TOR	Terms of Reference
WOPs	Water Operators' Partnerships
WTP	Water Treatment Plant

UNITS

ha	Hectare
lpcd	Liters per capita per day
l/s	Liters per second
m	Meter
mg/l	Milligrams per Liter
mm	Millimeter
m^3/day	Cubic meters per day

Figure 1-1 - Location of Project Towns

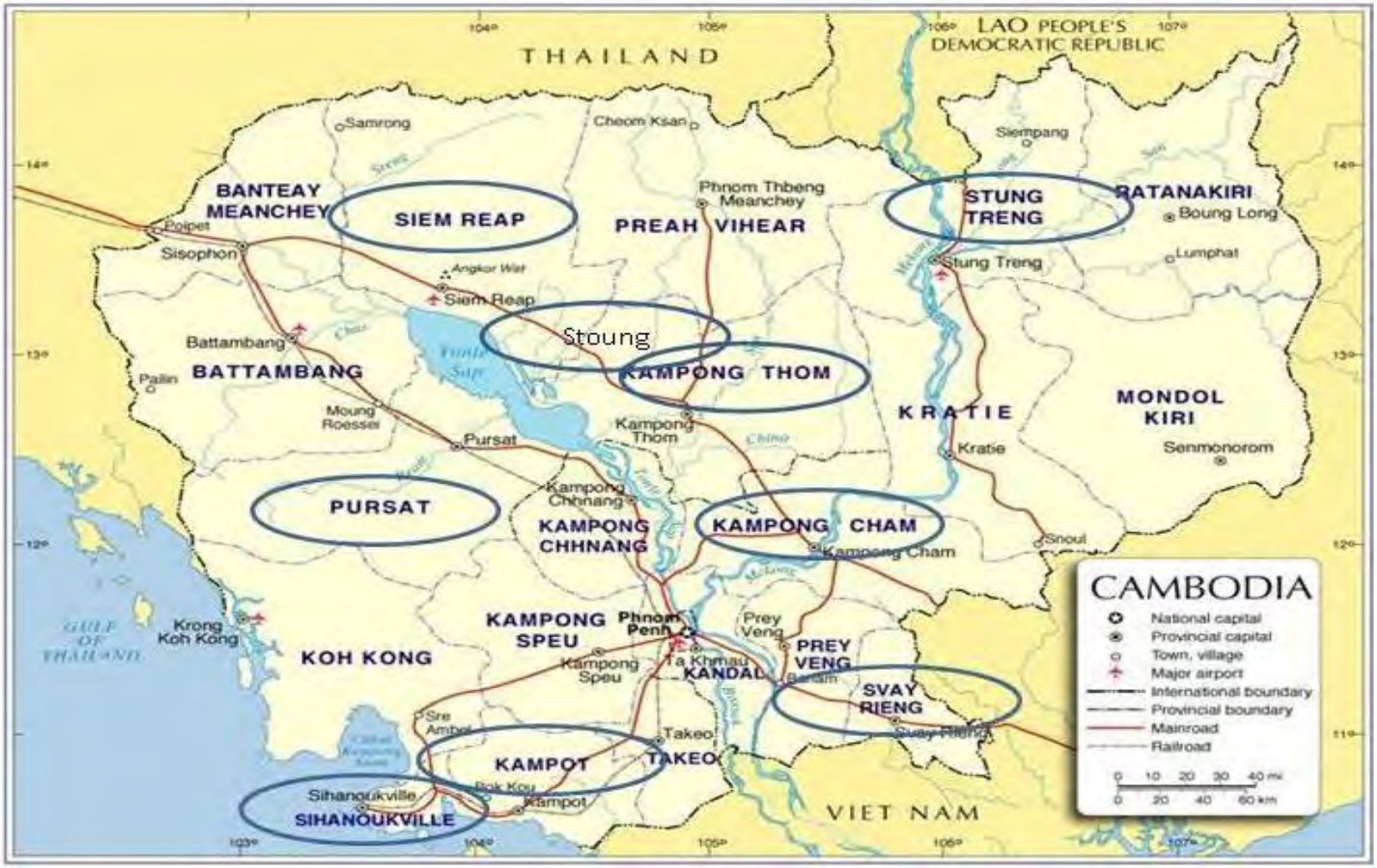
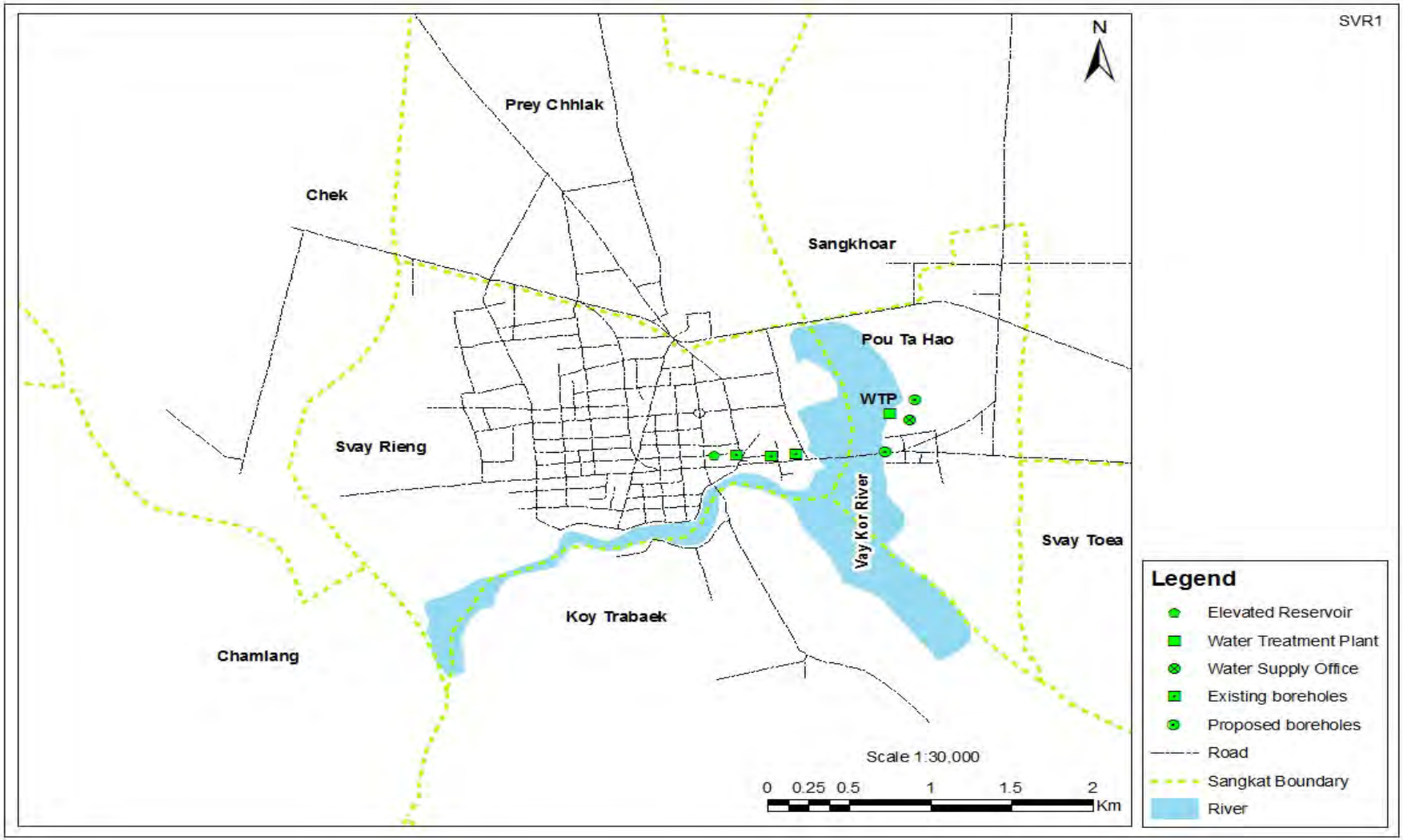


Figure 1-2 Location Plan of Proposed Svay Rieng Subproject



1. EXECUTIVE SUMMARY

1.1 Project Description

1. Expected outputs of the overall Project include: (i) water treatment plants provided or improved in eight towns; (ii) water distribution systems improved and coverage increased in six towns; (iii) existing pumping stations rehabilitated in five towns; and (iv) institutional capacity of MIH and regulatory system strengthened, under a piggy-backed technical assistance.

1.2 Rationale

2. During 2011, through the ADB's Water Operators' Partnerships Program, ADB was able to re-engage in the urban water supply sector with MIH. Consequently ADB's Country Operations Business Plan 2010-2013 includes an Asian Development Fund loan for the Project for approval in 2014. The UWSP will assist the government to address the three core constraints identified in the ADB Country Partnership Strategy (2011-2013): (i) insufficient funds to expand coverage and improve services; (ii) weak sector planning and implementation capacity of responsible authorities at the central and sub-national levels; and (iii) inadequate (or sometimes weak) institutional and legal framework.

1.3 Background

3. The proposed Project "Urban Water Supply Project " (UWSP) will provide necessary facility improvements to the six provincial towns previously funded by ADB and to three provincial towns that have been funded by other bilateral or multilateral agencies, and expand public access to sustainable and safe water supply services for the urban population in Cambodia. In addition, the Project will address institutional weaknesses through the development of improved institutional structures, a regulatory framework, and appropriate capacity development.

1.4 Project Impact and Outcome

4. The impact of the proposed Project will be expanded access to sustainable and safe water supply services for the urban population in Cambodia and better functioning water treatment plants providing higher quality water. MIH targets are to increase the proportion of the urban population in the project area with access to safe water to 85% by 2018 and 90% by 2025, and the project will assist these aims. The outcome of the project will be improved water supply infrastructure and service provisions in selected provincial waterworks.

1.5 Candidate Towns

5. There are nine candidate towns: Kampong Cham, Kampong Thom, Kampot, Pursat, Siem Reap, Sihanoukville, Stoung, Stung Treng and Svay Rieng. Originally Battambang was to be included but this was removed at the request of the Provincial Waterworks.

1.6 Feasibility Study Context

6. The feasibility studies include: (i) needs assessment, supply and demand analysis, (ii) selection of technology, equipment, and facilities for the identified subprojects considering least cost and life cycle approach and the capacities of the local authorities to manage, operate, and maintain; (iii) assessment of economic and financial viability and sustainability for each of the subprojects; (iv) assessment of policy and legal capacity, including other institutional issues and mechanisms related to the financial management, procurement, and anticorruption; (v) poverty, social, and gender analysis and preparation of a poverty and social strategy, a gender action plan, stakeholder communication survey (SCS), and a Community Participation Plan (CPP), where required; and (vi) review of impacts on environment, involuntary resettlement, and indigenous peoples.

1.7 Subproject Description

1.7.1 Output 1 - Water Supply Development

7. The Svay Rieng subproject aims to improve the provision of safe, affordable, reliable piped water supply to individual household connections to communities within the seven core sangkats having Y2012 population of about 44,936. The works proposed under the PPTA are summarised in Table 1.1 below and in more detail in Section 5.2.2.

1.7.2 Output 2 – Strengthening of Institutional capacity of MIH and Regulatory System

8. The Institutional Strengthening and Capacity Development is to (i) identify key stakeholders; (ii) assess institutional capacity constraints; (iii) develop institutional capacity building plan; and (iv) prepare terms of reference for strengthening sector regulation TA.

1.8 Cost Estimate

9. The subproject cost is estimated at $1.3 million equivalent, including taxes and duties. Table 1.1 provides a summary of the Svay Rieng Subproject cost estimate.

Table 1.1: Svay Rieng Subproject Cost Estimate ($'000's)

		Totals
No	**Description**	**(inc tax)**
		US$000
1	**Water Supply Development**	
1.1	Change iron/manganese package plant filters with conventional filters & aeration	60.0
1.2	Install transformer 160KVA to feed new BH and office	24.0
1.3	Replace current chlorination system	50.0
1.4	Replace old pipeline network with 5.2 Km of new HDPE	145.0
1.5	Addition of 2 new 190m deep boreholes, submersible pumps, control panels, wellheads, power supply & pump buildings	300.0
1.6	Expand new pipe network with 23.5 Km	290.0
1.7	Add frequency inverters to 3 intake pumps (Capacity about 100m3/h)	40.0
1.8	Drain for current elevated tank	5.0
1.9	Install bulk flowmeters to replace non-working ones for raw water, backwash, clear water and 3 existing boreholes.	20.0
1.10	Addition of sludge drying bed in WTP grounds	10.0
1.11	Build 2-3 storey administrative office in the same area of the elevated water tower	100.0
1.12	Valves and fittings for zoning purposes, approx 5 of each	30.0
1.13	Land acquisition 9m^3 for new borehole outside of WTP site.	10.0
	Total for Water Supply Development	
	TOTAL ESTIMATED BASE COST[a]	1,084.0
	Contingencies 20%	**216..8**
	TOTAL ESTIMATED SUBPROJECT COST	**1,300.8**

1.9 Financing Plan

10. The project will be financed by ADB and the national government. ADB loan will finance KR 5239 million while the government will finance KR 577 million which includes government taxes. The financing plan is shown in Table 1.2.

Table 1.2: SRPWW Financing Plan (KR million)

Items	% Total	Total
ADB	90.1	5,239
Disbursement	89.2	5,190
IDC	0.9	49
Government	9.9	577
Equity Contribution	1.0	56
Taxes, Duties and Other	9.0	521
Total	100.0	5,816

Source: Consultant's estimate

1.10 Executing Agency and Implementation Arrangements

11. MIH will be the Executing Agency, and the existing project management unit (PMU) based in the Department of Potable Water Supply (DPWS) will be expanded to execute and manage the Project on behalf of MIH with the consulting service to be provided by the project implementation assistance consultants (PIAC). The Project implementing units (PIUs) are expected to be organized by the nine (9) implementation agencies (IAs) of the provincial waterworks. The nine (9) PIUs will be responsible for day-to-day coordination and supervision of subproject implementation in these provincial towns.

1.11 Implementation Period

12. The proposed Project is scheduled for implementation over five years from 2014 to 2018. The final design is proposed for a one year period between mid-2014 and mid-2015. Following this, a two year construction period would have the works commissioned in August 2017. A proposed Implementation schedule is included in Appendix A.

1.12 Procurement

13. The procurement shall be carried out under International Competetive Bidding (NCB) as three packages; one package Stung Treng; one package Siem Reap; and the remaining 7 subprojects as one package. The full Procurement Plan is contained in the Supplementary Appendices of the main PPTA report.

1.13 Consulting Services

14. The project implementation assistance consultants (PIAC) on the design and engineering review, tendering assistance, and construction management are provided under Bank financing will be selected in advance and engaged in accordance with the ADB's Guidelines on the Use of Consultants. An individual consultant will be engaged to prepare the PIAC terms of reference and to assist the EA on the preparation of the Request for Proposal. The PIAC consulting services will be signed once the loan becomes effective to provide under a single consulting package, by an association of international and domestic consulting firms. The lead consulting firm will provide the services of the Team Leader who will be responsible for managing the overall consulting services during the project implementation.

1.14 Economic and Financial Analyses

15. Economic and Financial analyses are contained in Section 7, and in Appendix H.

1.15 Tariff and Affordability

16. The required tariff to cover O&M cost, depreciation and debt service (0, 50 or 100% loan) are shown in Table 1.3. The block tariff is proposed to reduce the impact of tariff rate increases to the poor households. The proposed tariff for government and commercial customers are made higher than household customers to allow subsidy from these customers towards household customers. This proposal will improve financial sustainability of the SRPWW and at the same time protect poor household customers from high monthly bills.

Table 1.3: SRPWW Proposed Tariff Rate – 0, 50 or 100% Loan

Category	2015	2018	2021	2023
Household, 0 to 7 m3	1,200	1,500	1,650	1,650
above 7 m3	1,600	2,000	2,200	2,200
Government	1,600	2,000	2,200	2,200
Commercial	1,650	2,150	2,400	2,500
Tariff Increase (average)	26%	26%	10%	1%

Source: Consultant's estimate

1.16 Subproject Benefits and Beneficiaries

17. At the end of year 2023, SRPWW is projected to have a total of 5198 water service connections, an increase of 3039 from the 2014 projected level. In terms of served population, the investments will directly benefit an additional 14993 persons within the service area (Table 1.4).

Table 1.4: SRPWW Projected Service Connection

Item	2014	2015	2020	2023
Service area population	44,954	44,963	45,008	45,035
Population served	10,536	11,570	22,944	25,529
% Served	23%	26%	51%	57%
Number of connection	2,159	2,376	4,653	5,198

Source: Consultant's estimate

1.17 Land Acquisition and Compensation

18. The overall project has Involuntary Resettlement Categorisation B. There are two areas of land to be acquired in Stoung (225m2) and Svay Rieng (9m2). The Land Acquisition and Resettlement Plan for Svay Rieng is contained in Appendix K.

1.18 Environmental Impacts

19. An Initial Environmental Examination (IEE) was carried out for Svay Rieng, and is contained in Appendix J. The subproject is classified as Category B. The overall conclusion is that providing the mitigation, compensation and enhancement measures are implemented in full, there should be no significant negative environmental impact as a result of location, planning, design, construction and operation of the project. There are benefits stemming from recommended mitigation and enhancement measures, and major improvements in quality of life and individual and public health once the project is in operation.

1.19 Indigenous Peoples

20. The Indigenous Peoples Impact sceening checklist has been completed and is contained in Appendix F. While there are ethnic minorities, like the Chinese, Lao and Vietnamese, they have

already integrated in the mainstream society that will benefit from safe and potable water. There are no expected negative effects on ethnic groups.

2. PROJECT RATIONALE, IMPACT AND OUTCOME

2.1 Rationale

21. During 2011, through the ADB's Water Operators' Partnerships Program, ADB was able to re-engage in the urban water supply sector with MIH. In January 2012, MIH signed a twinning agreement with the PPWSA, which is currently providing support to four provincial waterworks been included in the Project through direct peer-to-peer knowledge transfer. In February 2012, the Ministry of Economy and Finance (MEF) requested ADB to consider financing the Project in accordance with the strategy of Cambodia's Public Debt Management, to ensure sustainable economic growth. Consequently ADB's Country Operations Business Plan 2010-2013 includes an Asian Development Fund loan for the Project for approval in 2014. The project supports the ADB's annual sector review, country partnership strategy, and the water operational plan 2011–2020

22. The UWSP will assist the government to address the three core constraints identified in the ADB Country Partnership Strategy (2011-2013): (i) insufficient funds to expand coverage and improve services; (ii) weak sector planning and implementation capacity of responsible authorities at the central and sub-national levels; and (iii) inadequate (or sometimes weak) institutional and legal framework.

2.2 Background

23. The proposed Project "Urban Water Supply Project " (UWSP) will provide necessary facility improvements to the six provincial towns previously funded by ADB and to three provincial towns that have been funded by other bilateral or multilateral agencies, and expand public access to sustainable and safe water supply services for the urban population in Cambodia. In addition, the Project will address institutional weaknesses through the development of improved institutional structures, a regulatory framework, and appropriate capacity development.

24. This UWSP is in line with (i) Cambodian National Strategic Development Plan (2009-2013) and (ii) action plan of Ministry of Industry and Handicraft (MIH) to facilitate private sector partnerships, strengthening the management of public owned waterworks, and integration urban water supply with urban environmental management. The proportion of the urban population in the project area with access to safe water will be increased to 85% by 2018 and 90% by 2025 as targeted by MIH. In addition, a potential target date for 100% coverage could be assumed as 2030.

2.3 Project Outline

25. The feasibility studies include: (i) needs assessment, supply and demand analysis, (ii) selection of technology, equipment, and facilities for the identified subprojects considering least cost and life cycle approach and the capacities of the local authorities to manage, operate, and maintain; (iii) assessment of economic and financial viability and sustainability for each of the subprojects; (iv) assessment of policy and legal capacity, including other institutional issues and mechanisms related to the financial management, procurement, and anticorruption; (v) poverty, social, and gender analysis and preparation of a poverty and social strategy, a gender action plan, stakeholder communication survey (SCS), and a Community Participation Plan (CPP), where required; and (vi) review of impacts on environment, involuntary resettlement, and indigenous peoples.

2.4 Project Impact and Outcome

26. The impact of the proposed Project will be expanded access to sustainable and safe water supply services for the urban population in Cambodia and better functioning water treatment plants providing higher quality water. MIH targets are to increase the proportion of the urban population in the project area with access to safe water to 85% by 2018 and 90% by 2025, and the project will assist these aims. The outcome of the project will be improved water supply infrastructure and service provisions in selected provincial waterworks.

3. Profile of Svay Rieng Area

3.1 Town Location and Profile

27. Svay Rieng city is the capital of Svay Rieng Province and is on National Road 1 close to the Vietnamese border where National Road 1 continues to Ho Chi Minh City. Svay Rieng is around 3 hours driving time from Phnom Penh and a ferry crossing is required en route.

28. Agriculture is the primary industry in the Province

3.2 Natural Features

3.2.1 Topography

29. Svay Rieng is a very flat area around the Waiko lake. There are no hills or mountains in the area.

3.2.2 Climate

30. The climate, in common with other non-coastal areas of Cambodia, is hot all year with a distinct rain season May – October and a drier season November – February.

3.2.3 Surface water

31. There is only one surface water source in Svay Rieng, the Waiko river. This is currently used by some private households but was analysed under the 2006 ADB Provincial Towns project and found to have poor water quality. Groundwater was selected for the 2006 project.

3.2.4 Groundwater

32. Groundwater use is dominant in Svay Rieng, with both the WTP and private households not on the WTP system using it. The main WTP uses 2 deep boreholes and many households in the town use water from either open wells or boreholes.

3.3 Socio-Economic Conditions

3.3.1 Population and Household Characteristics

33. The populations provided below are for the service area within Svay Rieng.

Table 3.1: Svay Rieng Population Characteristics

No	Core Sangkhat	2012 Pop'n.	No. HH	Persons/ HH
1	Sangkat Svay Rieng	13,521	2,762	4.9
2	Sangkat Pur Tahor	1,992	409	4.9
3	Sangkat Koy Trorbek	2,707	625	4.3
4	Sangkat Chek	9,697	2,100	4.6
5	Sangkat Prey Chhlak	3,235	673	4.8
6	Sangkat Sangkhor	8,349	1,635	5.1
7	Sangkat Svay Toeu	5,435	1,208	4.5
	Totals	**44,936**	**9,412**	**4.8**

3.3.2 Ethnicity

34. The breakdown by ethnic group is given in Table 3.2 below;

Table 3.2: Ethnic diversity in Svay Rieng

Ethnicity	n	%
Khmer	94	98.90
Vietnam	1	1.10
Total	**95**	**100**

Source: Socio-economic survey, July 2013

3.3.3 Population Growth and Migration

35. Population growth from the 2008 National Survey1 shows an average national urban growth rate of 2.21%. For the purposes of this study we have used growth rates for individual towns, provided by each Water Supply Authority2. For Svay Rieng this is 0.02% showing a low growth rate.

3.3.4 Education

36. Table 3.3 shows education levels in the surveyed areas.

Table 3.3: Basic education completed

Education Levels	n	%
No Education	8	8.42
Primary School	46	48.42
Secondary School	24	25.26
High School	15	15.79
Bachelor Degree and above	2	2.11
Total	**95**	**100**

Source: Socio-economic survey, July 2013

3.3.5 Health and Hygiene Conditions

37. Survey data on health status relating to waterborne diseases show that 8.4% of households were afflicted by water-related diseases. There were no reported incidences of malaria or dengue fever.

3.3.6 Land and House Tenure

38. 97.89% of all houses are owner-occupied, with 1.05% of houses rented and a further 1.05% neither.. The range of average house sizes in the target area are; up to 25m2 (21.05%), 26–50m2 (47.37%), 51-100m2 (25.26%), and over 100m2 (6.32%). There are 91.58% of households with access to public electricity while 8.42% of households take electricity from neighbors or used batteries, candles and kerosene.

3.3.7 Occupations and Livelihoods

39. Main occupations are shown in Table 3.4.

[1] General Population Census 2008 National Report, August 2009

[2] Data collected by head of each commune

Table 3.4: Main Occupations

No.	Main occupation	n	%
1	Government employee	21	22.11
2	NGOs/IOs staff	1	1.05
3	Worker at private companies/Factories	6	6.32
4	Small-scale business owner	27	28.42
5	Motor taxi driver	1	1.05
6	Transportation service provider	3	3.16
7	Construction worker	10	10.53
8	Farming/Agriculture	15	15.79
9	Other (Cooker, Teaching, Tailor, pension, Waiter)	11	11.58
	Total	**95**	**100**

Source: Socio-economic survey, July 2013

3.3.8 Income and Poverty Levels

40. The incomes here were classified into two categories: households connected to water supply and households not connected to water supply. The average income for a household with a piped connection is 29,136,000 Riels ($7,284), and without connection is 16,377,600 Riels ($4,094).

41. Approximately 1.1% of the population were found to be living in poverty as shown in Table 3.5.

Table 3.5: Status of wealth ranking in Svey Rieng

Wealth Ranking	n	%
Extremely poor	2	2.1
Poor	57	60
Average	23	24.2
Wealthy	13	13.7
Total	**95**	**100**

Source: Socio-economic survey, July 2013

3.4 Existing Water Supply and Sanitation

3.4.1 Water Supply

42. The existing water supply system was started in 1948 under the period of colonial rule, using the Vaiko river as a raw water source. In 1951 an elevated tank was constructed by the USA fed from a deep borehole.

43. Rehabilitation followed the war period in 1980, led by a Vietnamese expert, and in 1985 the elevated tank was repaired by OXFAM and pipelines extended. The elevated tank has steel compression bands fitted over concerns that the ferrocement tank had weakened.

44. In 1995 a SaWa3 project added an office building and installed 2 generators

[3] Danish NGO

45. The current Svay Rieng WTP was built under the ADB Provincial Towns project in 2006. It uses raw water from 3 deep (190m) boreholes, which is pre-chlorinated and then put through 2 package-plant type iron/manganese filters, before further chlorination and storage. The pumps are set at around 27m and are Grundfos SP-95-5-AB submersibles set in 300mm diameter casings. The boreholes have static water level depths of 6m and 12m in the dry season. The SP-95 pumps have a maximum capacity of about 95m3/hr at 51m TDH from IA data.

46. BH1 is next to an existing elevated reservoir with the “M-Phone” logo painted on it. The flowmeter on the BH1 rising main seems operational but is inaccurate and the pressure gauge does not work. The wellhead consists of pressure gauge, tap, NRV, dismantling coupling, gate valve, electromagnetic flowmeter and 100mm pipe. The flowmeters on all 3 boreholes are “Trimec dual pulse flow transducers”(Australian brand). The pump can be operated from the main control panel next to the borehole.

47. BH2 & BH 3 are the same set-up as BH1, and can be operated manually from a panel in the borehole building, or remotely from the master control panel next to BH1.

48. The WTP is new but has some failings – the gas chlorination system, in common with Kampong Cham and Kampot, has failed. The various water meters (insertion and ultrasonic) around the WTP do not work. The iron/manganese filters have been problematic since the beginning and do not appear to be appropriate technology. The filters frequently block and need backwashing very regularly – customers complain about red stained water. The filters have had holes cut into the base in order to unblock them but this is not a long term solution.

49. The distribution network has been extended by ADB and JICA projects in the past.

50. The Provincial Waterworks has reported only 39% utilisation of the WTP capacity. These figures can be misleading and do not necessarily represent demand. The average annual production is estimated from pump running hours, as there are no working bulk meters at the WTP.

51. The Provincial Waterworks has repeatedly reported problems with power supply. To meet close to the WTP capacity, borehole pumps must supply 240m3/hr total. The three pumps are 95m3/hr, and due to power restrictions, only one can run at a time. This limits the flow through the WTP to 2,280m3/day. The reported production for 2012 of 1,862m3/day was due to the Water Authority running a pump for only 20 hours/day at that time. In 2013 a single pump is running for 24 hours and therefore the WTP is producing 2,280m3/day.

52. The WTP can process 5,760m3/day but currently is limited by the fact that only one pump can run at any one time due to power supply restrictions.

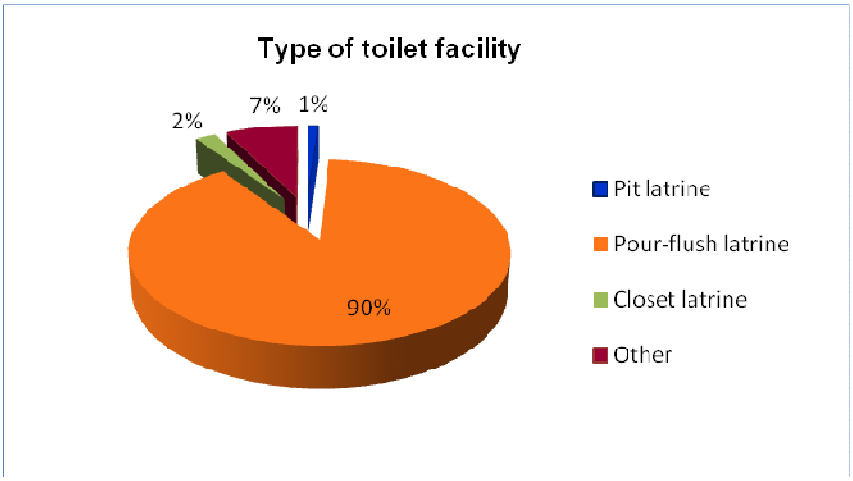
Table 3.6: Main Sources of Household Water for all uses

Water Sources	Dry season		Wet season		Both wet-dry seasons	
	n	%	n	%	n	%
a. Piped (town) water connected to a point inside house	-	-	-	-	-	-
b. Piped (town) water connected to a point outside house	-	-	-	-	20	21.1
c. Piped (private) water connected to a point inside house	-	-	-	-	-	-
d. Piped (private) water connected to a point outside house	-	-	-	-	-	-
e. Piped community water supply	-	-	-	-	-	-
f. Private well, not shared, manual	-	-	-	-	14	14.7
g. Private well, shared, manual	-	-	-	-	2	2.1
h. Community well, manual	-	-	-	-	5	5.3
i. Private well, with water pump	-	-	-	-	55	57.9
j. Community well, with water pump	-	-	-	-	3	3.2
k. Private well. by truck/cart/bicycle	-	-	-	-	-	-
l. River water catered by truck/cart/bicycle	-	-	-	-	-	-
m. Reservoir / lake/ irrigation canal, manually collected	-	-	-	-	-	-
n. River/stream water drawn via water pump	-	-	-	-	1	1.1
o. Rainwater	-	-	52	54.7		

3.4.2 On-Site Sanitation

53. The socio-economic survey indicates that 7.37% of all households do not have latrines, while 92.63% of them do. Of these, 43.16% are attached to house and 49.47% are separate from the house, on average 9.15m away.

Figure 3.1: Types of latrine



Source: Socio-economic survey, July 2013

4. POPULATION GROWTH AND WATER DEMAND FORECASTS

4.1 General

54. Svay Rieng is the capital city of the Province and acts as a market for the surrounding area. It is close to Vietnam and has an international border post.

4.2 Population Projections

55. The population projections4 are set out in Table 4-1. Within the core villages, total population is forecast to increase from about 44,936 in 2012 to about 45,089 in 2030.

Table 4-1: Population Projections for Svay Rieng's Core Villages

Year 2012 Population	Growth Rate %	Forecast Population 2014	Forecast Population 2020	Forecast Population 2025	Forecast Population 2030
44,936	0.02	44,954	45,008	45,053	45,089

4.3 Water Demand Forecasts

4.3.1 General Approach

56. Whilst the scope of proposed works under this project does not include increasing the capacity of the Svay Rieng water supply system, demand forecasts have been produced to illustrate the shortfall of available treated water into the near future. Water demand forecasts for the Svay Rieng subproject were prepared by making separate projections of each component of demand, including:

- Demand for domestic use (based on per capita consumption, coverage targets and population projections);
- Demand for industry (based on a % of domestic use, and specific allowances for large industries);
- Demand for services (based on a % of domestic use, and specific allowances for large services areas);
- Physical losses as a % of total demand, excluding the demand of large industrial zones.
- Production losses in treatment plant (based % of total demands).

4.3.2 Domestic Consumption

57. Water demand and consumption data for other provincial and district towns in Cambodia show that domestic consumption accounts for about 90% of total demand. Per capita consumption figures for urban water supply systems in Cambodia can vary widely, particularly with strong reliance on rainwater collection during the wet season. Experience in other towns in Cambodia indicates that piped connections directly to the house will usually increase water consumption over time. The Feasibility Study has adopted a per capita consumption figure of 120 lpcd, plus 10% for non-domestic use which includes demand from industry and services, 15% for physical losses (leakage), and 50m3/day for backwashing filters in the WTP.

4.3.3 Water Demand Forecasts

58. Table 4-2 summarizes the demand forecasts and design criteria for the Svay Rieng subproject. By 2030, the average daily water production at the water treatment plant is expected to be 8,650m3/day, comprising 75% domestic consumption, with the remaining 25% being for institutions,

[4] 2012 populations and growth rate provided by the Provincial Waterworks

public use, services, handicraft and small industries, and allowances for physical losses and backwashing the filters.

Table 4-2: Water Demand Forecasts for Svay Rieng Subproject

No.	Items	Unit	Forecasts				
			2012	2014	2020	2025	2030
A.	**Domestic Demand**						
1	Growth Rate	%	0.02	0.02	0.02	0.02	0.02
2	Population in Core Area		44,936	44,954	45,008	45,053	45,089
3	Coverage in Core Area	%	90	100	100	100	100
4	Population with Piped Water	No.	40,442	44,954	45,008	45,053	45,089
5	Per Capita Consumption	l/c/d	120	120	120	120	120
6	Total Domestic Demand	m3/d	4,853	5,394	5,401	5,406	5,411
B.	**Non-domestic demand**						
1	Services, Schools, Small Industry, Institutions, Hotels	%	15	15	15	15	15
2							
3	Total Non-domestic demand	m3/d	728	809	810	811	812
C.	**Subtotal Water Demand All Categories**	m3/d	5,581	6,204	6,211	6,217	6,222
D.	**Non Revenue Water (NRW) in Distribution system**						
1	NRW as % Average Daily Water Production	%	15	15	15	15	15
2	NRW (physical losses only-pipelines and WTP)	m3/d	837	931	932	933	933
E.	**Average Daily Water Production (C+D) rounded**	m3/d	6,420	7,130	7,140	7,150	7,160
F.	**Peak Annual Water Demand (Max day Max month)**						
1	Peak Annual Water Demand		1.20	1.20	1.20	1.20	1.20
2	Peak Annual Water Demand	m3/d	7,704	8,556	8,568	8,580	8,592
3	Peak Annual Water Demand	l/s	89	99	99	99	99
G.	**Required Treatment Plant Output (rounded)**	m3/d	7,700	8,560	8,570	8,580	8,590
H.	**Treatment Plant Backwashing**						
1	Treatment Plant Backwashing	m3/d	50	50	50	50	50
I.	**WTP Capacity**						
1	Required WTP Capacity	m3/d	7,750	8,610	8,620	8,630	8,640
2	Required WTP Capacity	l/s	89.70	99.65	99.77	99.88	100.00
	Total Required Source Capacity (Rounded)	**m3/d**					**8,650**
	Total Required Source Capacity	**l/s**					**100.00**

4.3.4 Future Demand Requirements

59. The table shows that the existing water treatment plant from 2006, at 5,760m3/day, is already insufficient to meet demand with 2014 demand projected at 8,610m3/day. This subproject is not intended to address future demands, but to rehabilitate the current existing WTP assets, improve water quality and improve security of supply.

60. A further 2,890m3/day of treated water will be required to meet projected 2030 demands.

5. SUBPROJECT DESCRIPTION

5.1 Introduction

61. The proposed works are designed to improve operational improvements, increased water quality and security of supply. This improved water supply scheme is not designed to increase capacity of supply.

5.2 Output 2: Water Supply Development

5.2.1 Preliminary Designs

62. The proposed water supply scheme design improvements are based on limited topographical, hydrological and water quality data and are preliminary.

5.2.2 Description of Proposed Water Supply System

63. The Svay Rieng subproject aims to improve the provision of safe, affordable, reliable piped water supply to individual household connections to communities within the seven core sangkats having Y2012 population of about 44,936.

64. The works proposed under the PPTA are summarised in Table 5.1 below;

Table 5.1: Proposed new infrastructure for Svay Rieng

Svay Rieng	Full FS	
		A- Change iron/manganese package plant filters with conventional filters & aeration
		B- Install transformer 160KVA to feed new BH and office
		C- Replace current chlorination system
		D- Replace old pipeline network with 5.2 Km of new HDPE
		E- Addition of 2 new 190m deep boreholes, submersible pumps, control panels, wellheads, power supply & pump buildings
		F- Expand new pipe network with 23.5 Km
		G- Add frequency inverters to 3 intake pumps (Capacity about 100m3/h)
		H - Drain for current elevated tank
		I- Install bulk flowmeters to replace non-working ones for raw water, backwash, clear water and 3 existing boreholes.
		J- Addition of sludge drying bed in WTP grounds
		K- Build 2-3 storey administrative office in the same area of the elevated water tower
		L - Valves and fittings for zoning purposes, approx 5 of each
		M - Land acquisition 9m^3 for new borehole outside of WTP site.

5.2.2.1 Change iron/manganese package plant filters with conventional filters & aeration

65. The iron/manganese package plant filters installed during the 2006 Provincial Towns project have reportedly never worked well and have frequently blocked. This could be due to an incorrect specification or incorrect operation, or a combination of the two. They are a cause of ongoing difficulty for the Water Authority and they have requested that they be decommissioned and replaced by

conventional aeration and rapid sand filtration. This is a more appropriate level of technology for the Provincial Waterworks, and and has been seen to work effectively in the region, such as at the Gio Linh water treatment plant in Quang Tri, Vietnam.

66. It is proposed that the aeration system will receive raw water from the WTP inlet chamber where it will run down a series of elevated cascades prior to entering the filters. Both the inlet chamber and aeration tower will need to be elevated approximately 3m above the filter inlet channel invert.

5.2.2.2 Install transformer 160KVA to feed new BH and office

67. A new transformer is required to provide power to the proposed borehole at the WTP site plus the WTP office.

5.2.2.3 Replacement of Gas Chlorination system

68. The current gas chlorination system installed under the 2006 ADB project is a high quality European brand, but has failed both at Svay Rieng and the other 5 towns under this previous project. This may be due to poor installation or lack of locally available spares. Repairs have been made with locally available materials rather than proprietary parts which is dangerous when used with pressurized chlorine gas. It is recommended to replace the entire chlorination system with a brand that is available locally or at least regionally, with after sales service and easy access to spare parts. Some design faults identified with the brand installed have been identified, being;

- The pressure gauges appear to have no diaphragm and no oil filled chamber to separate the chlorinated water from the meter workings. This has caused corrosion in all 6 towns.
- The existing set-up has hoses and pipes connecting the one tonne chlorine cylinders to a regulator. Leaks in this hose and pipe arrangement causes high pressure chlorine leaks. A better design is to have a vacuum regulator directly connected to the cylinder. If pipe downstream of the vacuum regulator leaks, the vacuum is broken and the regulator closed, sealing the valve and preventing leaks.
- The existing system does not have a heater on the cylinder outlet. This serves to ensure that the liquid chlorine in the cylinder turns to gas before it leaves the cylinder valve. During transportation of the cylinder to the site, the liquid chlorine is disturbed and often fills the fixed internal outlet tube. If not heated and vapourised this liquid chlorine can damage equipment downstream.

69. A gas scrubber system should be provided with the gaseous chlorination system as a safety measure. This is lacking at Svay Rieng presently. The scrubber removes the chlorine from the air in the event of a serious leak in the system.

70. For the purpose of this Feasibility Study, the same manufacturer as used at PPWSA has been selected and invited to provide a proposal and budget price. This is contained in Appendix B.

5.2.2.4 Replace old pipeline network with 5.2 Km of new HDPE

71. A section of the existing network with poor condition old pipe has been identified for replacement.

5.2.2.5 Addition of 2 new 190m deep boreholes, submersible pumps, control panels, wellheads, power supply & pump buildings

72. The Svay Rieng Water Authority initially requested three new borehole pumps for the existing boreholes, but further to this, requested two new complete boreholes with pumps, power supply and all ancilliary equipment. The purpose of these 2 borehole and pumps was not intended to increase capacity but to provide a standby facility to the existing pumps. In the future, if the WTP capacity is increased, then these two proposed boreholes could be used to provide an increased quantity of raw water over the current maximum requirement of 5,760m3/day.

5.2.2.6 Expand new pipe network with 23.5 km of new pipe

73. The Water Authority have identified an area requiring a pipeline extension. The route and lengths have been surveyed by SRWA staff. They did not request domestic connections to be included and will connect households themselves as the demand arises.

5.2.2.7 Add frequency inverters to 3 existing intake pumps (Capacity about 100m^3/h)

74. For slow start up and stop, and for increased power efficiency, frequency inverters are proposed for the existing three borehole pumps.

5.2.2.8 Drain for current elevated tank

75. The existing elevated tank (with the M-Phone mural) is from colonial times and has been reinforced with circumferential bands by Oxfam. The tank has no drain and one is required for maintenance and inspection purposes.

5.2.2.09 Install bulk flowmeters

76. Bulk flow meters are required for all borehole pumps, raw water, clear water pumped from the main clear water tank, and backwash water fed to the filters. These meters should be specified correctly and care taken to install them correctly, as many meters installed in 2006 and since are not working. Electromagnetic meters for raw water and mechanical meters for clear water should be specified.

5.2.2.10 Addition of sludge drying bed in WTP grounds

77. There is currently no sludge drying bed for Svay Rieng. To meet environmental standards one is required.

5.2.2.11 Build 2-3 storey administrative office

78. The current Water Authority office is small and has no dedicated space for bill payment and administration. A new office of 2-3 storeys has been requested by the SRWA.

5.2.2.12 Valves and fittings for zoning purposes

79. The IA wishes to set up several DMA's5 close to the river bridge. The gate valves and meters required for this are listed in Table 5.2 below.

Table 5.2: Valves & Meters required for Zoning

Size (mm)	Gate valve Qty	Bulk meter Qty
110	**7**	**-**
150	**5**	**-**
200	**-**	**4**

5.2.2.13 Land acquisition for new borehole by bridge

80. An estimated area of 9m2 is required for a proposed new borehole on the private property next to the bridge. The resettlement specialists have reported on discussions held with the property owners.

[5] District metering areas

5.3 Consultation Activities during Preparation of Svay Rieng Feasibility Study

81. A series of community visits and consultations occurred during the finalization of the 2013 Feasibility Study to inform district and village authorities about the subproject and gather information and feedback from local authorities, people living in core villages and other stakeholders. Consultation activities during the project site visits in 2013 are detailed below:

(i) Initial reconnaissance visit March 2013: Team Leader and National water engineer visited the site for an initial inspection and discussion with the Provincial Waterworks.

(ii) Second engineering site visit 26th April 2013:International and National water engineers visited Svay Rieng facility, collected data, and finalized scope following Inception workshop.

(iii) Environmental and Resettlement specialist visit: This joint visit was carried out between June 3rd -11th to collect data to aid the finalization of the IEE and LACP.

(iv) Socio-economic specialist visit: a visit for the purpose of carrying out the socio-economic survey was undertaken on 18-27th June.

5.4 Operation and Maintenance of Project Facilities

5.4.1 Capacity to Operate and Maintain the Proposed Water Supply System

82. The Svay Rieng Provincial Waterworks has experience gained form operating the WTP constructed in 2006, but would benefit from further training in use of the aeration cascade and the rapid sand filters to be installed. Training in proper backwashing, adjustment of proper backwash delivery pressure and the signs to look for during a backwash cycle should be given.

83. Otherwise, there will be no differences to the current operating regime following the proposed works.

5.4.2 Management Arrangements

84. The PIAC will provide Project technical, safeguards, accounting and management assistance on a daily basis as well as support the PIUs with project implementation

85. At the start of Project implementation, the PMU and PIAC will (i) update the initial environment examinations and due diligence reports (IEEs and DDRs) and prepare EMPs submit to MOE for review and approval; (ii) clear potential unexploded ordnance (UXO) remain on site; and (iii) acquire necessary land before subproject bids are tendered.

5.4.3 Operation and Maintenance Plans

86. The Operation and Maintenance plan for each subproject can be divided into two types, those with a full conventional WTP and those with chlorinated groundwater being pumped to an elevated tank and fed into supply. For Svay Rieng, an Operation and Maintenance Plan reflecting the latter has been developed and is presented in full in Appendix L.

5.5 Lessons learned in Cambodia and the SE Asia region

87. There are several “lessons learned” in both the region and inside the national water sector that would benefit the 9 project towns under this PPTA;

- As at PPWSA, use of standardized chlorination equipment that has a regional office that can offer technical support, spares and specialist staff when needed. PPWSA has selected equipment supplied by Severn Trent Services (STS), and equipment from this manufacturer has been recommended for the towns requiring replacement chlorination equipment under this study. STS have a main office in Singapore, but have local representation in Phnom Penh. However, final selection of equipment of equal or better

specifications will be decided at tendering as specific brands cannot be specified in Contract documents.

- High density polyethylene pipe (HDPE) is favoured in Cambodia, even for larger diameters. As most of Cambodia is flat, as are all of the 9 towns under this study, system pressures are not higher than 60m head. As such, a PN6 rated pipe would be sufficient. However, experience has shown that for the pipes un to and including 90mm diameter, which may have domestic connections tapped from them, a PN8 minimum pipe is required, even for very low pressures. The reason for this is that the tapping saddles used can deform the thinner pipe wall thicknesses on PN6 pipe, which causes leakage.
- Automated valves linked to a central control panel were designed and installed under the 2006 Provincial Towns project. All of these have failed in the 6 towns where they were installed. The lesson here is to keep the WTPs simple and keep valves as manually operated. With the relatively smaller size of these WTPs (mostly under 6,000m^3/day), valve automation is not necessary and inappropriate.
- Alum and poly dosing lines under the previous Provincial Towns project used long lengths of uPVC pipe that followed buildings and structures, necessitating several 90 degree bends and causing significant headloss in the delivery pipe. This has caused the pipes to get blocked by sediment. In addition, the uPVC dosing pipes are exposed to direct sunlight. UV light will break down uPVC pipe over time. A better solution, as used in two recent projects in Laos, is to use ABS (acrylonitrile butadiene styrene) pipe, and select a more direct route for the pipe, minimizing bends and low points.
- For the water sector as a whole, a database of all water projects could be set up, to include design drawings, calculations, contract documents, demand calculations, feasibility reports, final design reports and other useful documentation, for each system. This would serve as an easily accessible online resource library for all Water Authority staff in the country. It is relatively easy and inexpensive (under US$40,000) to set up and populate, and solves the common problem of drawings and documents getting lost. Many of the available hard copy resources for Cambodian water supply systems are either misplaced, or are reportedly stacked in disorder in a storeroom so dirty that nobody is willing to enter. Such a database was set up and released in neighbouring Laos in 2012-13 with assistance from UNHabitat, and can be viewed at;

http//:laowtp.info
by pressing “login as guest”.

- Several of the project towns under this PPTA have had extensions added to serve areas that were outside of the original design core area, without considering required design pressures or treatment plant capacity. This often results in the WTP being operated above its design capacity, which can reduce water quality, and often has negative effects on service pressure to other parts of the reticulation network. Typically, to increase system pressure to serve these unplanned extensions, water is diverted around any elevated storage tank and pumped directly into the system in order to increase delivery pressure by a few metres head. This is bad operating practice as it eliminates the storage facility and increases leakage loss. Any pipeline extensions should be made in a planned way and carried out simultaneously with WTP capacity upgrades as required.

5.6 Public Private Partnerships

88. Options and viability for potential PPP for Svay Rieng subproject was discussed with the Director of the Department of Potable Water Supply6.

89. In common with all towns in general, the urban water supply systems are seen as best managed by the government where possible. Installation and commissioning of the elements of work under this subproject require specialist contractors and involvement of public bodies is limited.

90. There are some peri-urban areas in Cambodia where whole water supply concessions have been granted to private companies to construct and manage water supply systems. This is not strictly PPP, as the private company needs only to acquire a license – there is no partnership as such. There are both good and bad examples of these private concessions throughout the country.

91. A possible area where a PPP could be utilized in the future is in the supply of bulk treated water to customers who are either just outside of the WTP service area or are inside the area but receive low pressure. Private water tankers could be used to fill up with (and pay for) treated water from the WTP and deliver and sell to customers with their own storage tanks.

5.7 Contract Packaging of Subproject

92. A number of packaging options were examined and discussed between the PPTA team, MIH and ADB. These options are presented below in Table 5.3.

Table 5.3: Subproject Contract Packaging Options

No. packages	Subproject Towns included	Advantages/disadvantages
2	Stung Treng Siem Reap plus 7 rehab towns	**Advantages:** • Small number of packages reduces tendering and contract management admin. • Larger packages makes them more attractive to international bidders. • Easier to standardise on equipment. **Disadvantages:** • Limited opportunity for NCB
3	Stung Treng Siem Reap 7 rehab towns	**Advantages:** • Three good sized packages attractive to ICB bidders • Small number of packages reduces tendering and contract management admin. • Easier to standardise on equipment **Disadvantages:**

[6] Mr Tan Sokchea

		• Limited opportunity for NCB
4	Stung Treng Siem Reap 3 southern rehab towns (Svay Rieng, Kampot, Sihanoukville) 4 northern towns (Kampong Cham, Kampong Thom, Pursat, Stoung)	**Advantages:** • 2 larger and 2 smaller packages, the smaller of which could be NCB if an exception to the $1M limit relaxed **Disadvantages:** • More tender and contract management admin • More difficult to standardise on equipment with larger number of packages.
9	9 separate contracts	**Advantages:** • Each IA is responsibe for their own subproject and has direct ownership • 7 of the 9 subprojects could be let as NCB **Disadvantages:** • More tender and contract management admin • Some activities may not be suitable for many national contractors due to lack of specialist experience. • More difficult to standardise on equipment with larger number of packages.

93. During discussions, initially the option of two large contracts, one for Stung Treng and one for the other 8 towns, was favoured for the simplicity of the bidding process, contract administration, and the attractiveness of the larger packages to international bidders.

94. After further discussion, 9 separate contracts was favoured, as greater weight was put on having the contracts out to tender quickly, and having 7 of them of a size that would permit NCB would help achieve this. The procedures for approving and tendering NCB are far less time consuming compared to ICB. Additional benefits would be that each IA would have ownership of their own subproject, and that national contractors would benefit from both the experience and the business.

95. A perceived obstacle with having 7 of the subprojects as NCB is the technical nature of some of the rehabilitation work. Installation and commissioning of gas chlorination equipment, bladder tanks for surge protection, and proper construction of filter underdrains are all areas requiring a degree of specialist knowledge and experience. For this reason, coupled with the simplicity of having a lesser number of contract packages, a compromise of three packages was selected, being Stung Treng, Siem Reap, and the 7 rehabliitation subprojects.

96. These 3 packages will all need to be ICB due to their value, but this does not exclude national contractors from bidding, provided they meet the prequalification requirements.

Additionally, if national contractors have difficulty meeting prequalification requirements, they can still benefit from these contracts by subcontracting.

6. COSTS AND FINANCING PLAN

6.1 Cost Estimates

97. The subproject cost is estimated at $1.3 million equivalent, including taxes. A summary of the cost estimates is given in Table 6.1.

Table 6.1 - Subproject Capital Cost

		Totals
No	**Description**	**(inc tax)**
		US$000
1	**Water Supply Development**	
1.1	Change iron/manganese package plant filters with conventional filters & aeration	60.0
1.2	Install transformer 160KVA to feed new BH and office	24.0
1.3	Replace current chlorination system	50.0
1.4	Replace old pipeline network with 5.2 Km of new HDPE	145.0
1.5	Addition of 2 new 190m deep boreholes, submersible pumps, control panels, wellheads, power supply & pump buildings	300.0
1.6	Expand new pipe network with 23.5 Km	290.0
1.7	Add frequency inverters to 3 intake pumps (Capacity about 100m3/h)	40.0
1.8	Drain for current elevated tank	5.0
1.9	Install bulk flowmeters to replace non-working ones for raw water, backwash, clear water and 3 existing boreholes.	20.0
1.10	Addition of sludge drying bed in WTP grounds	10.0
1.11	Build 2-3 storey administrative office in the same area of the elevated water tower	100.0
1.12	Valves and fittings for zoning purposes, approx 5 of each	30.0
1.13	Land acquisition 9m^3 for new borehole outside of WTP site.	10.0
	Total for Water Supply Development	
	TOTAL ESTIMATED BASE COST[a]	1,084.0
	Contingencies 20%	**216..8**
	TOTAL ESTIMATED SUBPROJECT COST	**1,300.8**

Source: Consultant's estimate, 2013.

6.2 Least cost analysis

98. No least cost analysis was carried out for Svay Rieng as alternative solutions were not presented for consideration.

6.3 Financing Plan

99. The project will be financed by ADB and the national government. ADB loan will finance KR 5239 million while the government will finance KR 577 million which includes government taxes. The financing plan is shown in Table 6.2.

Table 6.2: SRPWW Financing Plan (KR million)

Items	% Total	Total
ADB	90.1	5,239
Disbursement	89.2	5,190
IDC	0.9	49
Government	9.9	577
Equity Contribution	1.0	56
Taxes, Duties and Other	9.0	521
Total	100.0	5,816

Source: Consultant's estimate

7. SUBPROJECT FINANCIAL AND ECONOMIC ASSESSMENT

7.1 Approach and Methodology: Financial Assessment

100. The financial analysis was done in three levels: (i) examination of the historical and current financial performance; (ii) evaluation of the feasibility of the proposed subproject under UWSP; and (iii) evaluation of the financial sustainability taking into account the impact of the proposed subproject to the future operation of PWWs and WSA.

101. Following the Asian Development Bank (ADB) guidelines7, four basic indicators for the financial viability of a water supply project have been identified. These are the following:

- Financial Internal Rate of Return (FIRR). It is the discount rate at which the revenues and costs generated by the project are equal to zero. A project is considered financially viable if the computed FIRR is equal to or higher than the weighted average cost of capital (WACC) that is used in financing the development of the proposed water supply project.

- Debt Service Coverage Ratio (DSCR). It measures the solvency of the PWWs/WSA and shows how many times debt service for a given period is covered by operations. DSCR should at least be 1.3 after project completion.

- Annual cash balance. Projected annual cash balances should be positive all throughout the projection period.

- Tariff affordability. Household monthly water bill should not be more than 5% of the average monthly household income of the low income group.

7.1.1 Financing Plan.

102. The project will be financed by ADB and the national government. Part of the ADB and national government funds will be on-lent to the PWWs/ WSA. Annual debt service was estimated based on preliminary discussions with MIH and MEF. The on-lending terms for the purpose of this study are as follow:

- Maturity period of 32 years, including 8 years grace period on principal payment while interest is capitalized during construction;

- Fixed interest rate[8] of 1.25% per annum for the first 8 years and 1.75% per annum for the next 24 years; and

- Foreign exchange risk to be borne by the national government.

7.1.2 Proposed Water Tariff.

103. Three scenarios were tested in the design of the water tariff based on the amount of loan, as a percent of project costs, passed on to the 8 PWWs. For Siem Reap WSA, 100% loan was assumed. For the 8 PWWs, the three scenarios tested were: (1) 0% loan-100% grant; (2) 50% loan-50% grant; and (3) 100% loan-0% grant.

7.1.3 Other Assumptions

104. The main assumptions used in the financial projections include:

[7] ADB, *Financial Management and Analysis of Projects* (2005).

[8] ADB's interest rate to the national government is 1% and 1.5% respectively.

- Estimates of annual water revenues are based on the total water billed for the year and the corresponding tariffs for the same year. Connection fees, for non-poor household customers are included as other revenues and assumed to be paid by the customers in 24 equal installments.

- The investment cost of the proposed project and the O&M costs are prepared on an annual basis in August 2013 prices. Increases in costs due to inflation are covered through a provision for price contingencies both for the investment costs and the O&M costs.

- The incremental O&M costs, which is the difference between "with the project" and "without the project" scenario, were used in the evaluation. O&M costs include: 1) administration; 2) chemical; 3) power; 4) maintenance of facilities; 5) salaries and wages; and 6) other O&M items.

- Projected O&M costs "without the project" are based on actual O&M costs as presented in the historical revenue and expense statements. It is assumed that there will be minimal increases in the service connections as water supply demand approaches the maximum water supply capacity of the existing system, hence there will be no increases in the number of personnel. The unit cost of O&M is assumed to increase following the local inflation rate.

- Projected O&M costs "with the project", except maintenance of facilities, are based on historical unit costs. Maintenance of facilities cost is based on engineering estimate of the required maintenance level of the facilities.

- Depreciation allowance is considered a non-cash item. However, for purposes of estimating the net income, it was included as expense in the projected income statement. Annual depreciation costs for the new facilities were calculated using the straight-line method based on the service life[9] of each type of asset.

- Water tariff "without the project", is assumed to increase in the future to cover increases in O&M. For purposes of the projection, it is assumed that water tariffs will have to be increased by 5% starting 2015 and every four years thereafter until 2027 for Siem Reap, Stung Treng and Svay Rieng; for Kampong, because current tariff is low, the assumed increases are 10%.

- Water Revenue "without the project". As mentioned earlier, since the existing facilities are already nearing its maximum operating capacities, it is assumed that there will be no further additional connections after the water supply capacities are reached in 2017. Volume of water sold after this period will remain constant. Any increase in projected revenue is then due to the assumed increase in water tariff.

- Water Revenue "with the project". Based on the technical study, the proposed improvements in the water supply system can provide the water requirements of the projected beneficiaries up to year 2019 (Siem Reap) to 2023 (Kampong Cham, Stung Treng and Svay Rieng). The volume of water sold is therefore assumed to increase up to that year and is assumed to remain constant at the that level. Any increase in projected revenue after this period is then due to the assumed increase in water tariff.

7.2 Approach and Methodology: Economic Assessment

105. The economic analysis was undertaken in accordance with the procedures set out in the ADB Handbook for the Economic Analysis of Water Supply Projects (1999) and related ADB guidelines10. The period of analysis extends over 30 years from the start of project implementation in 2015 up until 2044. Costs and benefits were quantified at August 2013 prices and were converted to their economic

[9] Using PWWs/WSA asset life schedule.

[10] *Guidelines for the Economic Analysis of Projects (1997).*

cost equivalents using shadow prices. Both costs and benefits were treated as increments to a "without the project" situation.

106. The economic viability of the project was determined by computing the economic internal rate of return (EIRR) and comparing the result with the economic opportunity cost of capital (EOCC) of 12%. An EIRR exceeding the assumed EOCC indicates that the project is economically viable. The viability of the investments was then tested for changes in key variables such as capital costs, O&M costs and benefits through sensitivity analysis. Distribution of project benefits and poverty impact analysis were also undertaken to determine how much of the net economic benefits resulting from the investments will directly benefit the poor.

107. The economic viability of the proposed investments in water supply was determined considering the following benefits: (1) incremental gross revenue; (2) the value of time saved for not having to collect water from existing non-piped sources; (3) medical cost savings due to reduced morbidity from waterborne diseases; and (4) avoided income loss (productivity savings) because of reduced incidence of diseases. Economic costs were derived from the estimates of capital investments and O&M costs in financial terms, removing all duties and taxes and multiplying the net results by the conversion factors (CF). The following CFs were applied: 1.0 for traded goods and non-traded goods, and 0.7 for unskilled labor.

108. The proposed investments which aim to improve the population's access to piped water supply in the area, will form part of the Government's overall development plan for the water supply sector, which also aims to achieve the targets set under the Millennium Development Goal11.

7.3 Svay Rieng Provincial Waterworks (SRPWW)

109. A full financial and economic analysis report can be found in Appendix H.

7.3.1 Historical Financial Performance

110. From 2008 to 2012, SRPWW was able to cover total expenses except in 2010 where cost recovery was only 97%. However only 40 to 80% of total expenses and depreciation was covered for the same period. Current ratio was moderate for the five-year period while account receivable as of end 2012 was high at 81 days equivalent of annual water sales.

Table 7.1: SRPWW Financial Indicators, 2008-2012

Financial Indicators	2008	2009	2010	2011	2012
Cost Recovery:					
Total expenses	1.2	1.1	0.97	1.3	1.6
Total expenses & Depreciation	0.4	0.5	0.5	0.7	0.8
Current Ratio	5.8	4.5	3.0	4.1	5.2
Operating Ratio	2.3	2.1	1.9	1.5	1.3
Account Receivable (Days)	103	136	131	87	81

[11] MDG's Target No. 10, Goal No. 7: Halve, by 2015 the proportion of people without sustainable access to safe drinking water and sanitation. For urban water supply in Cambodia, people with access to safe drinking water is about 64% in 2004. Per MDG, this should reach 80% by 2015. Source: Key Indicators of Developing Asian and Pacific Countries, 2006, ADB.

7.3.2 Projected Financial Performance

7.3.2.1 Investment Costs.

111. The total investment cost for the water supply project is approximately KR 6069 million, including price and physical contingencies and interest during construction. Table 7.2 presents a summary of the investment costs.

Table 7.2: SRPWW Total Investment Cost (KR million)

Items	% Total	Total
Civil Works	57.2	3,473
Equipment and Materials	7.1	433
Land Acquisition	0.7	40
Physical Contingency	13.0	788
Price Contingency	12.2	741
Total Contingencies	25.2	1,529
Interest During Construction	0.8	51
Taxes and Duties	9.0	543
Total Cost	100.0	6,069

Source: Consultant's estimate

7.3.2.2 Financing Plan.

112. The financing plan assumes a 50% loan and 50% grant. Total loan amount is KR 3060 including interest during construction of KR 51 million. Grant funds will come from government (KR 602 million) and from ADB (KR 2407 million). The financing plan is shown in Table 7.3.

Table 7.3: SRPWW Financing Plan (KR million)

Items	% Total	Total
ADB Loan (On-lending)	50.4	3,060
Disbursement	49.6	3,009
Interest During Construction	0.8	51
Government	49.6	3,009
Own Fund	9.9	602
ADB Fund	39.7	2,407
Total	100.0	6,069

Source: Consultant's estimate

7.3.2.3 Water Tariff.

113. The required tariff to cover O&M cost, depreciation and debt service (0, 50 or 100% loan) are shown in Table 7.4. The block tariff is proposed to reduce the impact of tariff rate increases to the poor households. The proposed tariff for government and commercial customers are made higher than household customers to allow subsidy from these customers towards household customers. This proposal will improve financial sustainability of the SRPWW and at the same time protect poor household customers from high monthly bills.

Table 7.4: SRPWW Proposed Tariff Rate – 0, 50 or 100% Loan

Category	2015	2018	2021	2023
Household, 0 to 7 m3	1,200	1,500	1,650	1,650
above 7 m3	1,600	2,000	2,200	2,200
Government	1,600	2,000	2,200	2,200
Commercial	1,650	2,150	2,400	2,500
Tariff Increase (average)	26%	26%	10%	1%

Source: Consultant's estimate

7.3.2.4 Weighted Average Cost of Capital.

114. On the basis of the financing mix and the loan interest rate of 1.25% to 1.75% and the assumed cost of equity of 6.0%12 of the government, the WACC is computed at -0.1%. Table 7.5 shows the computation of the WACC. However, since ADB guidelines require a minimum hurdle rate of 4% for the financial analysis, the FIRR will be evaluated based on 4%.

Table 7.5: SRPWW Weighted Average Cost of Capital

Items	Capital	% of Total	Nominal Rate	Tax Rate	After Tax Rate	Inflation rate	Real Rate	WACC Real
Loan (ADB Funds)	3,060	50%	1.6%	20.0%	1.3%	1.8%	-0.5%	-0.2%
Grant (ADB Funds)	2,407	40%	1.6%	0.0%	1.6%	1.8%	-0.2%	-0.1%
Grant (Gov't Funds)	602	10%	6.0%	0.0%	6.0%	3.5%	2.4%	0.2%
Total Capital Investment	6,069	100%						**-0.1%**

Source: Consultant's estimate

7.3.2.5 Financial Internal Rate of Return.

115. Financial assessment of the project shows that the project is financially viable with an FIRR of 12%. Sensitivity analyses were likewise conducted to determine the effects of adverse changes on the project such as increase in capital and O&M costs, revenues not realized as expected and delay in operation. The scenarios evaluated and the summary results of the analyses are presented in Table 7.6. The results show that the project is still viable under the four scenarios evaluated.

Table 7.6: SRPWW Summary Result of FIRR

Items	FIRR	FNPV
Base case	12.1%	5,021
Capital cost plus 20%	8.1%	3,975
O&M cost plus 10%	8.9%	2,906
Revenue less 10%	5.4%	1,552
1-Year delay in benefit	7.3%	4,168

Source: Consultant's estimate

7.3.2.6 Affordability of Water Rates.

[12] Cambodia treasury bill, 91 days maturity issued by MEF.

116. Based on the socio-economic survey, respondents in the service area are willing to pay KR 1740 per m3 of water consumed while proposed tariff (1-7 m3 consumption) by 2023 is KR 1650. Another measure of affordability is ratio of monthly water bill to the total household income. For SRPWW service area, the estimated monthly income belonging to the poor households for 2013 is KR 723,000. Using the affordability criteria, the monthly water bill is about KR 8400 (KR 1200 x 7 m3) in 2015 is only 1.2% of the monthly income of poor households. In all subsequent years the monthly water bill is less than 5% of the estimated monthly income. Hence, the proposed level of water tariff is deemed affordable to the low income or poor households.

7.3.2.7 Impact of the Project on the SRPWW's Financial Operation.

117. Selected financial indicators were computed to provide an indication of the SRPWW's future financial performance. Annual financial indicators for years 2015 to 2020 and 2025 are shown in Table 7.7.

- Revenues can cover O&M cost and depreciation from 2015 to 2020, except in 2015 and 2017;
- Current ratio is high which ranged from 11 to 18 from 2015 to 2025;
- Operating ratio is less than or equal to 1, except in 2015 and 2017;
- Debt service coverage ratio is higher than 1.3 for all years until 2025; and
- Accounts receivable is 18 days equivalent of total annual revenue.

Table 7.7: SRPWW Summary of Financial Indicators

Financial Indicators	2015	2016	2017	2018	2019	2020	2025
Cost Recovery:							
O&M	1.6	1.6	1.6	1.6	1.6	1.6	1.6
O&M + Depreciation	0.9	1.0	0.9	1.0	1.0	1.1	1.2
Current Ratio	14.7	17.1	18.2	17.4	17.8	17.8	11.1
Operating Ratio	1.1	1.0	1.1	1.0	1.0	0.9	0.9
Debt Service Coverage Ratio	-	-	-	-	21.7	23.7	7.3
Account Receivable (Days)	18	18	18	18	18	18	18

Source: Consultant's estimate

7.3.3. Economic Assessment

7.3.3.1 Economic Benefits.

118. The parameters and values used in quantifying the economic benefits of water supply improvement are shown in Table 7.8.

119. There are other benefits that could result from improved water supply but such benefits as income generated from the use of water for livelihood purposes and the multiplier effect of increased income, among others, were not included in the analysis for lack of data.

Table 7.8: Assumptions for Economic Benefits Computation

No.	Item	Value
1	Price of 20-liter bottled water, KR	8,000
2	Bottled water consumed, lpcd	1
3	Bottled water user, %	32%
4	Willingness to pay, KR/m3	1,741
5	Households who store water, %	83%
6	Storage facility cost, KR	562,922
7	Households who collect water, %	79%
8	Collection time per day, hours	0.5
9	Households who treat water, %	77%
10	Water treatment cost, KR	140,573
11	Morbidity rate, %	8.4%
12	Economically active population, %	46%
13	Average days indisposed, days	64
14	Average daily wage rate, KR	24,107
15	Medical cost per capita, KR	496,250

Source: Socio-economic survey, July 2013

7.3.3.2 Economic Costs.

120. The economic cost equivalent of the proposed capital investments is about KR 4444 million.

7.3.3.3 EIRR and Sensitivity Analysis.

121. Given the stream of economic benefits and costs over the 30-year period, the EIRR of the investments for SRPWW is 26% which is higher than the assumed EOCC of 12%. Sensitivity test results based on (1) 20% increase in capital costs, (2) 10% increase in O&M costs, (3) 10% decrease in benefits, and (4) 1 year delay in realization of the benefits show the EIRR still above the EOCC. Table 7.9 summarizes the results of the base case analysis and the sensitivity tests.

Table 7.9: SRPWW EIRR and Sensitivity Test Results

Items	**EIRR**	**ENPV**
Base case	26.5%	16,289
Capital cost plus 20%	20.2%	14,848
O&M cost plus 10%	22.9%	13,633
Benefits less 10%	19.2%	11,284
1-Year delay in benefit	16.2%	14,477

Source: Consultant's estimate

7.3.3.4 Project Beneficiaries.

122. At the end of year 2023, SRPWW is projected to have a total of 5198 water service connections, an increase of 3039 from the 2014 projected level. In terms of served population, the investments will directly benefit an additional 14993 persons within the service area (Table 7.10).

Table 7.10: SRPWW Projected Service Connection

Item	2014	2015	2020	2023
Service area population	44,954	44,963	45,008	45,035
Population served	10,536	11,570	22,944	25,529
% Served	23%	26%	51%	57%
Number of connection	2,159	2,376	4,653	5,198

Source: Consultant's estimate

7.3.3.5 Project Sustainability.

123. The project financial sustainability is highly dependent on the realization of the targeted new service connections and the implementation of the proposed water tariff increases to generate funds to cover O&M cost and depreciation.

7.3.3.6 Poverty Impact.

124. The water supply project is expected to generate total net economic benefits (NEB)13 of about KR 2833 million. Approximately KR 2555 million will accrue to water consumers, many of whom are current users of water from wells, rainwater, river water and other sources and who are expected to connect to the improved piped water supply system to be made possible through this Project. Local labor, for which a significant amount of person-days will be needed for construction of the new facilities and their eventual operation, will gain about KR 277 million.

125. The poverty impact ratio (PIR) for the water supply investments is 0.25, which means that 25% of the NEB will directly benefit the poor. Poverty incidence in the service area is around 25%.

Table 7.11: SRPWW Poverty Impact Ratio

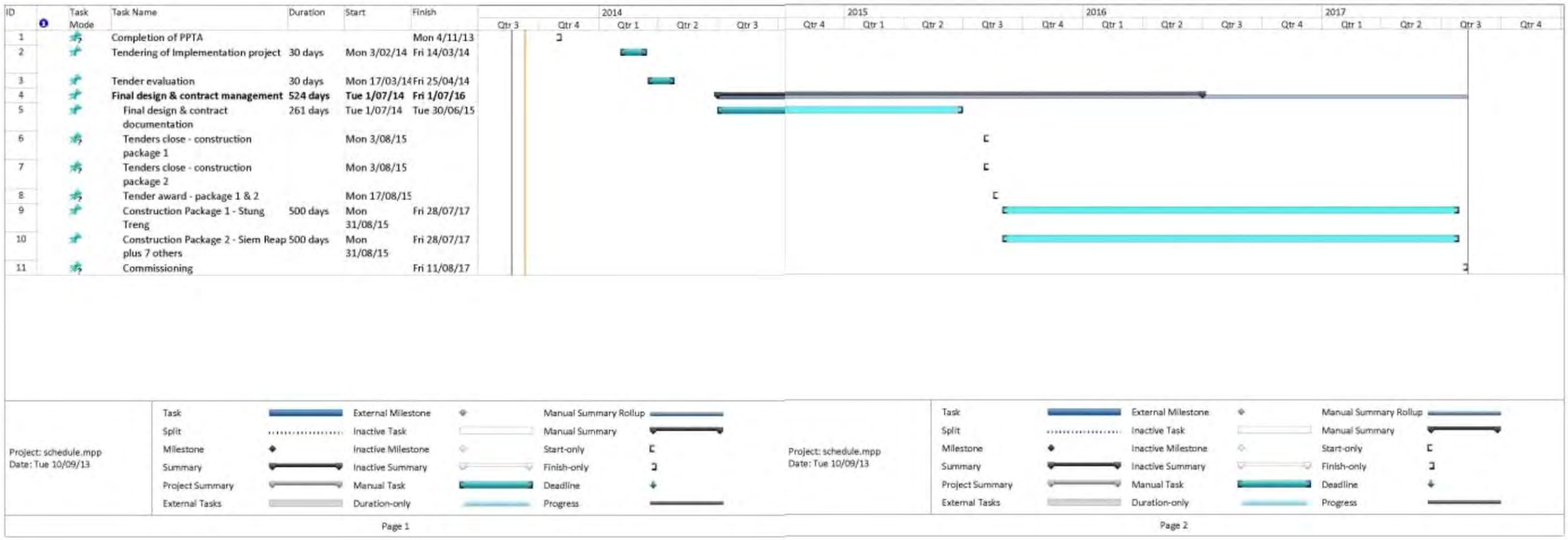
Items	Government /Economy	Labor	Consumers	Total
Gains and losses	-	277	2,555	2,833
Financial return to PWW	103			103
Benefits (Losses)	103	277	2,555	2,935
Proportion of poor	0.25	0.25	0.25	
Benefits to poor	26	69	639	734
Poverty Impact Ratio				0.25

Source: Consultant's estimate

[13] NEB is the difference between the present value of economic benefits and financial revenues.

Appendix A: Svay Rieng Subproject Implementation Schedule

ID	Task Mode	Task Name	Duration	Start	Finish
1		Completion of PPTA			Mon 4/11/13
2		Tendering of Implementation project	30 days	Mon 3/02/14	Fri 14/03/14
3		Tender evaluation	30 days	Mon 17/03/14	Fri 25/04/14
4		**Final design & contract management**	**524 days**	**Tue 1/07/14**	**Fri 1/07/16**
5		Final design & contract documentation	261 days	Tue 1/07/14	Tue 30/06/15
6		Tenders close - construction package 1		Mon 3/08/15	
7		Tenders close - construction package 2		Mon 3/08/15	
8		Tender award - package 1 & 2		Mon 17/08/15	
9		Construction Package 1 - Stung Treng	500 days	Mon 31/08/15	Fri 28/07/17
10		Construction Package 2 - Siem Reap plus 7 others	500 days	Mon 31/08/15	Fri 28/07/17
11		Commissioning			Fri 11/08/17



Project: schedule.mpp
Date: Tue 10/09/13

Task		External Milestone		Manual Summary Rollup	
Split		Inactive Task		Manual Summary	
Milestone		Inactive Milestone		Start-only	
Summary		Inactive Summary		Finish-only	
Project Summary		Manual Task		Deadline	
External Tasks		Duration-only		Progress	

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Project: schedule.mpp
Date: Tue 10/09/13

Task		External Milestone		Manual Summary Rollup	
Split		Inactive Task		Manual Summary	
Milestone		Inactive Milestone		Start-only	
Summary		Inactive Summary		Finish-only	
Project Summary		Manual Task		Deadline	
External Tasks		Duration-only		Progress	

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Appendix B: Cost Estimate Breakdowns for Svay Rieng Subproject

Appendix C: Water Quality Test Results for Svay Rieng Subproject

Month average	Temp (C)	Turbidity NTU	Res chlorine (mg/l)	pH	Colour TCU	TDS (mg/l)	Conductivity (us/cm)
LIMIT		**<5**	**0.2-0.5**	**6.5-8.5**	**<5**	**800**	**1600**
Jan	29.3	1	0.13	7.7	7		289
Feb	29.7	0.9	0.09	7	7		290
Mar	30	0.9	0.06	7	5		287
Apr	30.5	1.2	0.11	7	8		285
May	30.7	1.1	0.1	6.9	6		279
Jun	30.6	1.2	0.09	6.6	6.8		270
Jul	30.1	1.1	0.06	6.8	4.8		276
Aug	29.9	1.4	0	6.8	3.8		282
Sept	28.7	1.3	0.01	6.6	3.8		270
Oct	29.3	1.1	0.09	6.8	5.7		276
Nov	28.3	1.2	0.08	6.6	9.7		272
Dec	28	1	0.18	6.7	10.2		278

Appendix D: Socio-economic Survey Report for Svay Rieng Subproject

Appendix E: deleted

Appendix F: Ethnic Groups Screening Form

Appendix G: Gender Plan for Svay Rieng Subproject

Appendix H: 9 Subproject Towns Financial and Economic Analysis

Appendix I: Cancelled

Appendix J: Initial Environmental Examination for Svay Rieng Subproject

Appendix K: Land Acquisition and Compensation Plan for Svay Rieng Subproject

Appendix L: Outline Operation & Maintenance Plan

Operational Procedures

WTP area	Procedure
Raw water pumps	Can be controlled (on/off) by level transducers in the main clear water tank, or manually by Operator.
Flocculation tank inlet weir	Set so that there is always a hydraulic break between water in the inlet channel and the first flocc channel.
Flocculation tank baffles	Baffle slot sizes on lower end of alternate baffles, which are calculated and specified during final design, should be adhered to. When baffles are moved during cleaning of the flocc tank, these slot sizes should be reset to the design dimensions. Failure to do this may result in incorrect velocity gradient across the flocc tank resulting in poor flocc formation.
Sed tank collection launders	The stainless steel collection launders should be set at a level that allows for the prescribed headloss across the flocc tank. If the launders are set too high it has the effect of "backing up" the flocc tank and reducing the hydraulic gradient across it. This is normally set during design by calculating the hydraulics across the full WTP, but is sometimes neglected.
Filters – bypass of water	For filters to operate properly, the plenum floor that holds up the gravel and sand layers needs to be sealed. No water should pass between the plenum floor and the vertical filter walls, or through the plenum floor except through the inserted filter nozzles. Additionally, water should not be allowed to take a "short cut" between the edge of the sand layer and the filter wall. This can be stopped by roughening the inside filter wall with a sand/cement mix.
Filters – backwashing	Filters should be backwashed when the sand becomes sufficiently blocked with debris and silt to slow the passage of water through the media. This can be judged by marking a dirty water level inside the filter, and when it is reached, a backwash is due. Similarly a low water level mark should be visible and this minimum water level in the filter kept by partially closing the clean water outlet valve to the clear water tank. The backwash cycle begins with air scour by itself to loosen the sand media and help release dirt. This should carry on for around 3-5 minutes. The air blower is then turned off and backwash valve opened partially at first and then gradually opened further, in order to maintain the design backwash flowrate as the head in the backwash tank decreases. The backwash valve should never be just opened fully for the backwash cycle.
Reticulation	
Washout valves	All washout valves on the system, installed at low points, should be opened every month to flush out the line as required.
Valves on the distribution system	Valves should be kept either fully open or fully closed.

Maintenance Schedule

Raw water pumps	New submersible pumps should be raised using the auto-coupling & guiderails once per year to inspect the pumps and perform routine maintenance.
Flocculation tank	The flocc tank should be taken offline, one chamber at a time (there are 2 chambers), and cleaned out using shovels and a water blaster. Any repairs to baffles or replacement of rotten wooden baffles can take place at this time.
Sedimentation tank	The sedimentation tank should be taken offline, one at a time, and cleaned out annually.
Slide gates on all tanks	These should be inspected regularly and if not opening and closing easily, remedial action taken – either lubrication of threads or replacement of rubber seals.
Filters	Filter media will gradually become more blocked over time despite regular backwashing. Approximately every 5 years the sand and gravel media will need either removing and thoroughly washing before replacement, or new graded & washed sand placed. At this time, the nozzles and underdrains can also be inspected for damage.
Dosing pipelines	Check for leaks regularly and fix. Clean up spills and leaks.
Chemical mixing area	Keep floor clean
Chemical mixing tanks	When alum and poly tanks start to fill to the outlet pipe level with sediment they should be taken offline and cleaned out.
Pumps & blowers – general	Maintenance plan to follow manufacturers manual
Chlorination equipment - general	Maintenance plan to follow manufacturers manual
Reticulation	
Gate valves	All gate valves on the pipelines should be kept either fully shut or fully open as required.
Washout valves	Any washout valves, normally installed at low points, should be periodically (6 monthly) opened to flush out any debris.
Chambers	All valve chambers should be kept dry, clean and accessible.
Domestic connections	Any leaks on the upstream side of the meter should be recorded by meter readers and repaired promptly.
Physical leaks	All leaks reported or noticed by WA staff should be repaired promptly.

Appendix M: Pump calculations and curve