Chapter 5
Subjects in Water Supply Sector and Development Direction

Chapter 5 Issues in the Water Supply Sector and Development Policy

5.1 Issues in the Urban Water Supply

5.1.1 Policy of Sorting Out Issues and Developing Countermeasures

The issues and concerns for the existing urban water supply system shall be classified as follows:

- National level
- Provincial level
- Specific water supply project level

The focus of past studies was mainly on the national level and on major public water supply projects. In Cambodia, 24 provinces were the subjects of investigation in this study, all of which shall have the following content analysis:

- Results of past studies
- Provincial governance in water supply projects, which has not been analyzed in past studies
- Provincial public water supply projects that have been analyzed but shall be comparatively studied

The content analysis approach for this study is described below:

① From the data collected in the 24 provinces, confirm the organizational structure/s of the urban water supply sector. In addition, draw out the focus of the study by subject matter on a per province basis.
② Analyze the contents of both the national level studies and the major public water project studies and compare with the current status for both levels in order to classify and organize the issues and concerns accordingly;
③ Based on the logical arrangement of content, make a summary of derived commonalities of issues and problems and categorize these by province;
④ Examine what countermeasures may be applicable per content category or subject area.

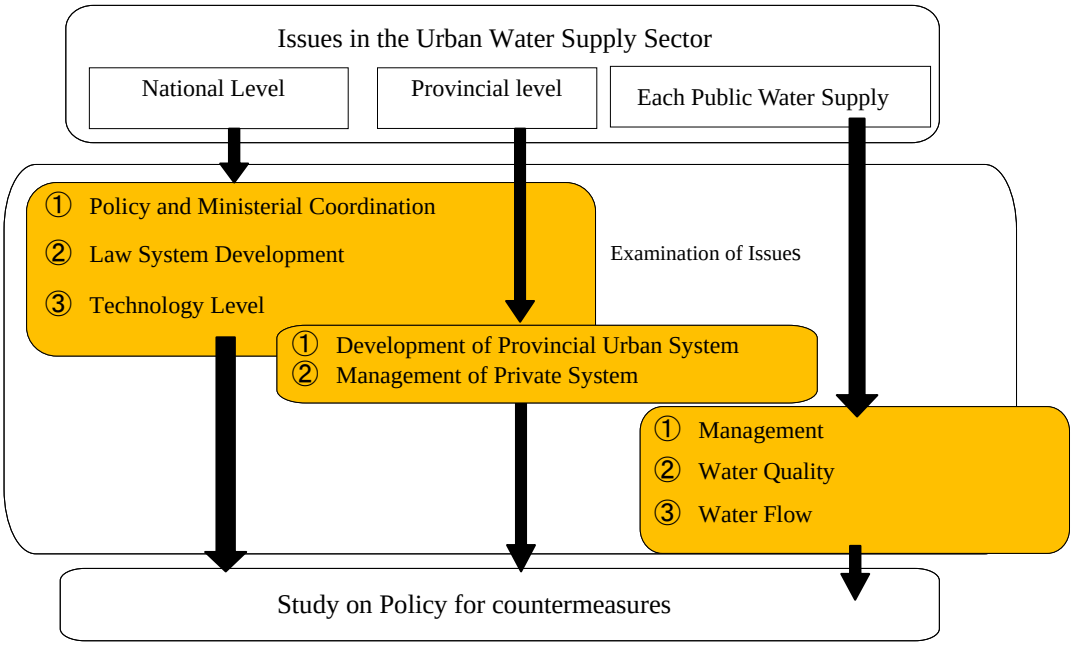


Figure 5.1.1 Flow Chart of the Study on Issues and Countermeasures

5.1.2 Sorting Out of National Level Issues

At the outset, urban water supply studies are reviewed, after which the subject / focal areas are drawn out. Particular attention is given to national level governance issues in the water sector; the presence and/ or absence of enabling or relevant laws and regulations; and the need for technical plans and programs for water supply infrastructure development. All these areas are considered as vital inputs toward the improvement of the water supply sector.

A. Incompleteness of Master Plan

The development plan prepared by MIME is heavily dependent on the assistance provided by bilateral or multilateral donor / aid agencies. This plan does not have the appropriate financial allocations from the Ministry's own budget. Rather, MIME must apply for a supplemental budget from the Ministry of Finance on a per project basis. This situation has severely impaired the capacity of MIME to come up with a comprehensive and implementable master development plan for the sector.

B. Legislation of water related laws and regulations

The water sector is in need of basic laws (Royal Decrees and Sub-Decrees) as well as rules and regulations (Prakas) to rationalize the sector and to guide current and future plans, programs and activities. The absence of basic laws, such as the "water act" or the "water quality standard", has considerably slowed down sector development. It has only been recently that the Law on Water Resources has been enacted.

C. Expiration of water quality standard and fragile water quality inspection structure

The water quality standard has already become obsolete. The new (revised) standard is still undergoing review. Together with this revised standard is the need for a strengthened / developed water quality inspection structure. Furthermore, water supply projects should promote daily O&M activities. Presently these are more an exception than the rule.

D. Streamlining in License System

The current licensing system requires the approval of the provincial government, a process that is time consuming. MIME is now reviewing the licensing system with the aim of reducing license processing time. This will mean the release of licenses only with MIME's authorization. However, processing time is only half the problem. Monitoring after release is limited. There are no supervisory or supporting services performed in monitoring project progress. A case in point is having a license revoked if no work progress is observed following the number of cases where work did not commence even with the release of licenses.

E. Jurisdiction conflict between MIME and MRD on small-scale piped water supply

Negotiations between MIME and MRD as to which agency has jurisdiction over small-scale water supply have not been resolved. MIME has taken the stance that safe water supply through a piped system shall be provided to rural areas under PDRD. Towards this end, MIME has

commenced negotiations with PDRD which will put several completed water supply systems under the latter's jurisdiction. Progress, however, on this matter has remained unclear.

F. Lack of governance by the Ministry of Water Resources and Meteorology (MOWRAM) in water source development project

There is a water utilization competition in the development of water sources between power and irrigation and water supply. Even if water supply sources for water supply are critical, this is not clearly prioritized. There is a felt need to establish prioritization criteria for water rights, and not depend on "first come first served" or on strength of political power.

G. Limited opportunities for communication and technical training for water supply engineers

Training for water supply engineers has been few and inadequate, while venues for professional interaction among water supply engineers are quite limited. The establishment of a Cambodian Water Association is one way of mitigating both issues. Another issue is the lack of sufficient capacity in MIME's laboratories for water quality analysis.

H. Insufficient Coordination among Donor Agencies

There are a number of donors for the water supply sector in the country. Given the differences in assistance policies of the donor agencies, the Royal Government of Cambodia should coordinate all aid efforts so that the scope of work for each project is well defined to avoid duplication of efforts.

Requests from existing water supply systems have different water source development, water facilities and equipment, transmission and distribution requirements, in addition to human resource and capacity development needs. In this sense, coordination is crucial to ensure the most efficient and effective use of donor funds.

I. Optimizing Water Treatment Methods

Existing projects have mostly been large scale; requiring sizeable volume of surface water. Treatment employed is usually the coagulated sedimentation method. However, the slow sand filtration method is also applicable, and should be looked into particularly for smaller systems located in mountainous areas.

There are other water source issues that need addressing, such as arsenic contamination and the continued deterioration of Tonle Sap Lake. It may be timely to start developing local water treatment technologies, which can be spearheaded by university-level research institutes in Cambodia.

5.1.3 Examination of Provincial Level Issues

Provincial level urban water supply issues can be classified into two categories, as follows:

- Reduction of un-served area
- Control and supervision of low quality private water supply utilities

A. Un-served areas in urban water supply system

There are several communes who are in dire need of water service but are not connected to a water supply system. Some of the reasons for this are the question of economic feasibility, national border issues and the interference by private companies.

B. Unclear plan of delegation of water supply service

The Government enacted the Operation and Management Law of Commune Sangkat (Herein after C/S Law) to showcase its decentralization policy in 2001. MIME also intends to follow this policy; however, delegating management to DIME or to the provincial level has rarely been done except for cases when a public water supply corporation is established in the area. On the contrary, there is a tendency of strengthening control by the government, even temporarily.

Investments for provincial public water supply must pass MIME's approval because MIME is the authority and contact point for raising funds or getting overseas assistance. This situation contributes to the increasing dependence on MIME. Full managerial and financial autonomy may still be far off because of limitations in human resource capability, as well as an underdeveloped market in Cambodia. However, there are signs that this can happen sooner, if tariff income can be made to support capital investments, including debt repayment.

In provinces where private water supply is dominant, decentralizing alternatives are transferring the authority of management and operation from MIME to the provincial government or to DIME. However, the licensing scheme of the government is centralized. Decentralization is hampered by the lack of qualified, and technically capable staff at DIME. Some specific issues are as follows: Project management was not conducted prior to the issuance of the license; and water quality analysis can be conducted by the central government or by some large companies.

C. Virtually non-existent un-served area reduction program

In provinces where public water supply service holds initiative, in most cases, DIME transfers the authority on water supply to the water supply division. This is particularly for provinces where the public water supply is autonomous. In such cases, DIME could not present correctly the needs of urban water supply in the province, or even the needs in the province without investigation.

Public corporatization is an effective way to improve autonomy by the provincial water supply; however, reportedly, DIMEs sometimes do not show cooperative attitude to the issue of public corporatization due to possibility of losing income from these provincial water supply.

D. Undeveloped accounting system and obscure accounting

There may be prepared financial statements; however, there is no uniform accounting standard / method which has been developed and/or implemented for use by the water supply system. Neither has the present accounting system been mastered by the accounting personnel. There have been frequent cases of vagueness in the financial statements such as: Adjustment of stock variation by profit and loss account, profit left as having a deficit, and unknown treatment of income loss. Such accounting method is a concern when it comes to the evaluation of project

sustainability.

E. Lack of training and capacity development program

Private water supply companies do not necessarily have adequate technical/managerial capability. Examples are the ability to solve water intake problems as they occur during the dry season, or management risks when supplying un-treated or insufficiently treated water, or when faced with project-related setbacks.

F. Vague contract contents/items

Some public water supply systems and public water sources were developed by local leaders who wielded political power. The license to operate these systems was given by MIME, which makes these facilities out of DIME's control.

As to concession and BTO contracts, "special" transactions are sometimes observed in the province. In most cases, contracts are not published when local leaders are involved, giving rise to issues of transparency and fairness. For privatization to succeed, there is the need for human resources who can manage project contracts with the public good and welfare in mind. While exceptions exist, more often than not, water supply system development plans have been suspended due to poor management practices.

5.1.4 Classification of Water Supply Project Level Issues and Concerns

A. Shortage of Management Capacity

Because of the insufficient ability of the management personnel, problems are sometimes overlooked even water sales income shortage and loss is observed in financial statement.

B. Undeveloped fund procurement system

As capital market is still undeveloped, fund procurement is quite difficult. The only available funds are grant aid offered by donor agencies or long-term loan fund. This results to water supply projects with an irregular fund composition.

Public water systems managers are not aggressive in seeking other sources of funds, and only wait for / expect donor assistance. Private water systems are better organized and self-reliant, and expand their service areas by re-investing their own funds from water income.

C. Imbalanced investment to WTP and distribution network

There are cases where the water supply projects do not come up with the projected returns considering the amount of the investments made. This is caused by an imbalance in the investment decisions between the WTP and the distribution network. A large portion of the funds was invested in the WTP, and remainder was applied to develop the distribution network. So, even if the WTP has the capacity to serve the area, there is no corresponding capacity on the distribution network side. What suffers, therefore, is the expected income to be raised, as customers cannot connect to the system.

D. Insufficient water source capacity and water quality deterioration

Insufficient water source capacity and remarkable water intake amount decrease by seasonal water level fluctuation are observed. Generally, water demand rises during dry season, every May and water level tends to be lowered and thus necessary raw water amount cannot be fully secured.

A symptoms regarding eutrophication in the Tonle Sap Lake was observed due to population increase and change of life style. Water quality in the river catchment area shows the deterioration of the water quality. Progress of eutrophication will make it harder to secure the water source capacity.

Decrease of river flow and deterioration of water quality by development of the water source area is also observed.

E. Functional issues of WTP

During the French regime, many WTPs were constructed which were operated by rapid coagulated sedimentation method to deal with the high turbidity in raw water. But after some time, the mechanical equipment began to fail, and unfortunately, the local market lacked the technology to repair the equipment. To remedy the situation, chemical agitation was designed utilizing gravity flow.

However, compared to the mechanical control method, the natural gravity method needed skillful flow adjustments and control during the water treatment process to make sure that treatment is efficient. In the WTP sites, inefficient coagulated sedimentation was observed, thus, turbidity could not be removed and was carried over to the filtration tank which caused serious clogging. The production staff regarded this as a plant operational issue, leading to plant capacity shortage, which it really is not.

F. Shortage of distribution network capacity

Fund shortage, insufficient water source capacity and so on brought the shortage of distribution network capacity even though additional service area is available for the expansion. Such cases were recognized in many provinces.

G. Water leakage from deteriorated pipes

Buried pipes, however, were not destroyed and are still in use although these pipes have greatly deteriorated becoming sources of water leakages.

H. Water leakage by inferior construction work

Notwithstanding the replacement of aggravated pipes, there have been cases that leakage was not largely protected. Such cases are supposedly caused by inferior pipes material and poor construction work. Since 1990, rehabilitation of water supply system re-started and in early stage, cheap thin PVC pipes were used with incorrect construction work. This resulted water leakage even pipes are still new. There have been cases contractor uses cheap and low-grade

material pipes arbitrarily for construction when the work is left to contractor without supervision, according to JICA Technical Cooperation Team.

I. Improper procurement and inventory control of equipment and chemicals

In some areas located far from huge commercial cities (Phnom Penh and Battambang), O&M materials, tools and equipment are not properly stored. But with the recent improvement in roads and accessibility, inventory management has become better except for public water utilities.

Procurement of supplies and materials like chlorine gas is either expensive or its prices unstable. Inventory control is poor resulting to a large annual fluctuation in material and equipment costs as evidenced in the financial statements.

J. Lack of capacity for technical staff and difficulty of finding qualified technical staff

The skills of existing staff can be improved with training and technology transfer, which most projects have a component of. For example, PPWSA has achieved a certain level of technical capacity, brought about by their training programs. In fact, PPWSA has been a recipient of numerous awards as a model of a very well managed water utility.

However, this same capacity is not found in many public water supply agencies/utilities. Therefore, continuous training and development programs are required.

K. Need for improvement in water sales income

Based on the analysis of the collected financial statements, a large number of projects are not yet self-supporting. However, it would be the last resort to either raise water tariff or increase water supply to raise revenues. Instead, cost saving and other revenue generating measures can be implemented to improve the utility's financial outlook.

One such measure comes from an analysis of user complaints, such as the inaccuracy of meters, or their non-cooperation with the water utility even if a house connection has already been installed. Affordability surveys must be conducted to know the extent of the user's ability and willingness to pay. Information and education campaigns must be designed to let the customers know of what the utility can do, on one hand, and what responsibilities they have as customers, on the other hand. The water utilities must be customer-centered, and provide the best possible service at all times. A mutually beneficial relationship between the utility and the customer must be nurtured.

5.1.5 Examination of Extracted Issues

The following tables summarize the classification of issues and concerns from the content analysis made according to the three levels – national, provincial and project. **Table 5.1.1** provides the summary of the classification of issues and a description of the issues' contents for the national level.

Table 5.1.1 Summary of National Level Issues

Categories	Detail Description of Issue
A1. National policy, adjustment between related agencies	A1-1. Incompleteness of Master Plan A1-2. Room for better communication between MIME and DIME A1-3. Authorization delegation A1-4. Jurisdiction conflict between MIME and MRD on small-scaled piped water supply A1-5. Lack of governance by the Ministry of Water Resources and Meteorology (MOWRAM) in water source development A1-6. Insufficient coordination among Donor Agencies
A2. Laws and regulations	A2-1. Legislation of water related laws and regulations A2-2. Expiration of water quality standard and fragile water quality inspection structure A2-3. Streamline of license system A2-4. Undeveloped accounting system and obscure accounting
A3. National level technology standard	A3-1. Water quality aggravation in Tonle Sap River Basin A3-2. Limited opportunity for communication and technical training for water supply engineers A3-3. Optimizing of water treatment methods

Note) Though issues of A1-2, A1-3 and A3-1 were not described in the previous section, these are added as they are considered as vital items to maintain sound function of water supply sector and water supply system.

The classification of main topics for the provincial level studies is:

- project promotion to reduce un-served area
- Private project quality upgrading where private system is dominant

The classification of the main topics for the public system (project) level studies is::

- Subjects in projects before the system modernization
- Subjects to maximize the system modernization effects

Table 5.1.2 provides the tabulation of the technical/managerial topics of public/private urban water supply system in each province.

The provincial-level and water supply project level classification of topics have been derived from an analysis of previous studies and field survey data results. There may be other areas of interest, however, that will need a more detailed investigation, and this can be done during project preparation stage.

- Every province has several private water supply systems/utilities; however these do not supply safe and adequate water to the customers in their service areas;

- MIME and DIME have authority and supervision over the private systems/utilities but are hampered due to insufficient number of trained and qualified staff;
- There are still many areas that remain un-served even in the urban areas;
- The existing capacity of the WTPs and the corresponding distribution networks is insufficient;
- Leakages in the existing network become revenue losses for the systems/utilities.

5.1.6 Problem-Solution Matrix

The proposed solutions for the problems drawn out of the issues and concerns' categorization are shown in this section.

Table 5.1.2 Summary of Issues found in each Province (Urban Water Supply)

Issues in large Category	Issues in detailed Category	Name of Proivinces																							No. of Provinces	Page to be referred
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
		Banteay Meanchey	Battambang	Kampong Cham	Kampong Chhnang	Kampong Speu	Kampong Thom	Kampot	Kandal	Koh Kong	Kratie	Mondul Kiri	Phnom Penh	Preah Vihear	Prey Veng	Pursat	Ratanak Kiri	Siem Reap	Preah Sihanouk	Stung Treng	Svay Rieng	Takeo	Otdar Meanchey	Kep	Pailin		
B1. Issues in Urban Water Supply System Development	B1-1-1 : Un-served areas in urban water supply area												No remarkable issues were recognized													9	p5-14
	B1-1-2 : Virtually non-existent un-served area treduction																									3	p5-14
	B2-1-1 : Obscure authority of DIME for private WSS																									3	p5-14
B2 : Issues on Private System Management	B2-1-2 : Supervisory capacity shortage in private system																									8	p5-15
	B2-1-3 : Technical capacity shortage																									15	p5-15
	B2-2-1 : Vague contract contents/items																									4	p5-15
C1 : Issues on Public System Management	C1-1-1 : Improper procurement and inventory control of equipment and																									2	p5-16
	C1-1-2 : Technical capacity shortage of staff																									4	p5-16
	C1-2-1 : Shortage of management capacity																									1	p5-16
	C1-2-2 : Imbalanced investment to WTP and distribution system																									2	p5-16, 17
	C1-2-3 : Undeveloped fund procurement system																									1	p5-17
	C1-2-4 : Need for improvement in water sales income																									3	p5-17
C2 : Issues on Suppled Water Quality	C2-1-1 : Functional issues of WTP																									6	p5-17
	C2-2-1 : Insufficient water source capacity and water quality deterioration																									4	p5-18
	C2-2-2 : Imprudent development in upstream area of water source																									3	p5-18
C3 : Issues on Water Supply Amount	C3-1-1 : Shortage of distribution network capacity																									8	p5-18, 19
	C3-2-1 : Water leakage from deteriorated pipes																									5	p5-19
	C3-2-2 : Water leakage caused by inferior construction																									2	p5-19
	To be improved	2	1	2	2	3	3	4	1	2	3	1	0	3	4	2	3	0	3	1	2	2	1	1	1		47
	Serious Issues	1	4	2	5	0	1	3	1	2	2	0	0	1	2	3	1	0	1	2	2	1	1	0	1		36
	Page to be referred	p4-3	p4-13	p4-24	p4-35	p4-49	p4-59	p4-71	p4-84	p4-92	p4-101	p4-114	p4-122	p4-133	p4-142	p4-152	p4-167	p4-176	p4-188	p4-202	p4-212	p4-225	p4-235	p4-243	p4-251		

Legend To be improved **Serious Issues**

Table 5.1.3 Proposed Solution for Extracted Issues

Issues		Proposed Solution
A1-1	Incompleteness of Master Plan	Solution：Establishment of comprehensive long-term development plan While there are major policies on the sector, these must be translated into a long-term plan that specifies doable targets defined by realistic timelines, as well as financial and other resources to realize the plan. While donor funds will invariably make up the bulk of the financial resources for the sector, the plan should also show funds sourcing strategies. A review of the existing master plan should take into consideration the following factors: • Need for a systematic and institutionalized process for fund procurement, complete with development of human resources for this purpose; • Introduce the concept of privatization in water supply systems as a means to provide the public with safe water and reliable water service; and prepare the guidelines for privatization; • Design water tariff policies, systems and schedules to enable utilities to sustain operations; and • Develop an investment manual to ensure efficient fund application based on the long term plan priorities.
A1-2	Room for better communication between MIME and DIME	Solution：Clarify the roles and responsibilities of DIME over public and private water supply DIME has control and supervision over public water supply systems in the provincial areas, except for those that have been organized into a Water Supply Authority (WSA). It also has supervision over private water supply systems. However, the discharge of this function has been quite inconsistent across type of utility and across provinces. In addition to this, DIME also lacks qualified personnel who can act as supervisors or coordinators over these water supply systems. Some concrete measures that can be implemented are: • Review the organizational mandate of DIME and clarify its current role/function in: (i) the control, supervision and management of public water supply systems; (ii) coordinating with MIME on the supervision of private water supply systems; • Develop human resource policies with regard to (i) qualification criteria for hiring of needed specialists and (ii) the qualification criteria for promotion of deserving staff; and • Provide avenues for training of DIME staff through: (i) formal training; (ii) rotation of work; (iii) interaction with other professionals in conferences.

Issues		Proposed Solution
A1-3	Authorization delegation	Solution : Fix up the Accounting System at DIME. A public water supply system is transformed into a Water Supply Authority (WSA) so that it can become a self-supporting entity. WSAs are also run like an economic public enterprise (like PPWSA and SRWSA) and have self-autonomy. However, reportedly DIME tends to view this as a loss over expected income, as well as a loss over having "power". To remedy this, it is proposed that: • Separate immediately the account due to the established WSA from DIME's books; • Transfer all assets due the new WSA and reflect in DIME books; • Clarify liabilities as to where these would be reflected.; and • Re-organize the structure at DIME after the establishment of any WSA
A1-4	Jurisdiction conflict between MIME and MRD on small-scaled pipe water supply	Solution : Final decision on jurisdictional conflict between MIME and MRD on small-scale village water supply MIME has been supporting the implementation of piped water supply systems, even for small villages. In this connection, there exists a conflict between MIME and MRD based jurisdiction. Their differing legal opinions are currently under discussion, but the conflict has not yet been fully settled. The need for continuous discussion and consultation on the matter is urgent, such that a need for higher Government advice may be needed, so that water supply development can go on unhampered.
A1-5	Lack of governance by the Ministry of Water Resources and Meteorology (MOWRAM) in water source development	Solution : Transparency in the allocation of water rights Cambodia has very pronounced wet and dry seasons, which affect water sources for domestic water supply. The Ministry of Water Resources (MOWRAM) implements the Law on Water Resources, but it has to be more transparent in the allocation criteria for water rights, because of potential conflicts on who has priority use. For example, during the dry season, who should be allocated more water, domestic water supply or power and irrigation. Another real example is allocation of water on the upper streams of rivers where water supply systems already have their existing water sources. Clear procedures should be developed and strictly implemented even on the EIA-side and monitored within the life of the water right of the water system. If not, future projects should prepare alternative water source development plans with estimates.
A1-6	Insufficient coordination among Donor Agencies	Solution : Establishment of an aid coordinating body/unit Cambodia is at the stage of rapid development, and many bilateral and multilateral grant aid agencies are offering assistance to the country. However, each donor comes with its strategies and target priority projects. While MIME is the

Issues		Proposed Solution
		government agency that receives donor requests, there is a need for a formal body/unit to coordinate aid in the sector, so that the priorities of Government can dovetail with the assistance being offered.
A2-1	Legislation of water related laws and regulations	Solution：Enactment of a Water Supply or Provincial Water Utilities Act The Water Resources Management Act or Water Act was approved in 2007 and is the comprehensive framework that guides the sustainable use of water resources. This law, sometimes called "Water Act" is implemented by the Ministry on Water Resources and Meteorology (MOWRAM). However, there needs to be other water-related laws (Royal Kram, decrees and sub-decrees) that have to be developed and enacted, like the "water utilities management or water supply management act" that will provide for the institutional and technical standards for provincial water supply systems' management, operation and maintenance. This law would help make provincial water supply systems operate in a sustainable manner. There would be a need therefore of: - A legal adviser to draft the law; - After the law is enacted, then setting up important institutional and financial mechanisms to ensure the implementation of the law; and - Support systems like training of organizational personnel to successfully implement the law.
A2-2	Expiration of water quality standard and fragile water quality inspection structure	Solution：Fast track the review and revision of the National Water Quality Standards The National Drinking Water Quality Standards is being reviewed and revised. But equally important is strengthening the existing water quality surveillance and monitoring system, which should be independent of service providers. Therefore, these are proposed: • To standardize the frequency of water quality testing and monitoring for public and private water supply systems; • Standardize the procedures for water quality monitoring across Ministries as well as public and private water agencies; • Ensure the collaborative efforts of all Ministries and water supply agencies involved in providing safe water; • Strengthen enforcement of the water quality standards; and • Provide for appropriate and adequate infrastructure to conduct water quality surveillance and monitoring

Issues		Proposed Solution
		activities.
A-2-3	Streamline of license system	Solution：Rationalize the licensing system MIME is reviewing the current water supply licensing system, which will most likely put the entire system under its control. This streamlining the procedure, but may bring in potential conflict with MRD, which is in charge of rural water supply systems and the provincial government, which is in charge of town water supply. These are proposed to make the licensing system more transparent: • Publish all documentary requirements, procedures and criteria for preparation of license; • Status of license application should be open to the public; • Public consultation is also necessary to increase transparency in the process; and • Publication of statistics and annual reports to monitor investment efficiency.
A2-4	Undeveloped accounting system and Obscure accounting	Solution：Develop better water utility accounting and financial management systems While most urban water supply systems do prepare financial statements, the method still differs from project to project, and from water system to water system. There is a national accounting system (General Accounting Plan) and the Law on Corporate Accounts in Cambodia. However, this has to be applied in the water utility operation context. The proposal is therefore to: • Establish and publish a standard accounting procedure for water supply systems/utilities; and • Disseminate this procedure to all water utilities.
A3-1	Water quality aggravation trend in Tonle Sap River Basin	Solution：Establish a long term inland surface water pollution control plan Tonle Sap Lake is called the “mother lake” it is a source of water and livelihood for Cambodians. But pollution threatens this lake brought about by the negative effects of an increasing population. Preventive activities to arrest the deterioration of Tonle Sap Lake and preserve it as a water source are: • Undertake a regional water source environmental survey in Tonle Sap Lake; • Introduction of pollution load reduction schemes such as sewerage system in Siem Reap or Battambang provinces which discharge sewage directly into the lake; and • Undertake continuous surveillance and monitoring, and publish results.
A3-2	Limited opportunity for	Solution：Professional interaction among water supply technical staff

Issues		Proposed Solution
	communication and technical training for water supply engineers	Human resource development for the sector does not only rely on traditional forms of education and training. Non-traditional forms like setting up formal meetings and interactions where experiences can be shared should be encouraged. MIME's plan to support the establishment of a Cambodia Water Association, which will have those involved in the water industry as members, is the step in the right direction and should be supported.
A3-3	Optimizing of water treatment method	Solution：Creation of a water technology research institute Many of the existing WTPs designed to treat raw river water with high turbidity are based on technologies available in advanced countries. While this, in itself, is not bad, treatment technologies should be suitable to the local Cambodian conditions. In this sense, a research institute that would advance indigenous technologies should be established, if possible as an adjunct institute of a technical university. This research institute can also be the take off point to do water environmental researches, and would increase the number of scientists and technicians specializing on water and wastewater.
B1-1-1	Un-served areas in urban water supply system	Solution：Full implementation of feasibility studies There are still unserved areas in the water supply system. This is dependent on many factors, such as the number of beneficiaries, water source shortages, and high water requirements. These, however, should be reviewed in detail based on the actual local conditions. After such survey, then confirmation will be made on the actual reason why the water supply project was not implemented as per feasibility study.
B1-1-2	Virtually non-existent un-served area reduction program	Solution：Clarify DIME's role over private water supply systems/utilities in reducing unserved areas There are provinces where more private water supply systems/utilities operate as opposed to public water utilities. If these private WWS are managed efficiently, then DIME assists only when requested. However, if the opposite is true, DIME needs to have its role clarified insofar as to how much it could involve itself in private WWS management and operations particularly in expanding services to unserved areas.
B2-1-1	Obscure authority of DIME for private water supply project	Solution： Clarify DIME's role over private water supply utilities DIME's role for public water supply systems is much clearer than its role for private water supply. There is a need to clarify its role and the limits of its authority over private water supply/utilities to be able to exercise its authority more effectively.

Issues		Proposed Solution
B2-1-2	Supervisory capacity shortage in private system	Solution：Development and extension of supervision method for private WSS Some cases found mainly in rather small-scaled and less-funded private WSS that supplies quite technically problematic water and that project was frustrated due to fund shortage. DIME must supervise such system and must act as assistance supporting agency. However, current DIME has any technical ability and any skill and equipment needed for water quality analysis. If no public WSS exists, foreign assistance is not available. Technical assistance structure building is indispensable measure to promote self-reliance system development. Concrete procedures are shown below: ① Along with the revision of water quality standard, technical issues on water pollution control shall also be extracted and be arranged; ② Prepare master plan focusing on system management and develop supervision standard; ③ Provision of preliminary water quality analysis equipment and skill. Detailed analysis shall be entrusted to advanced project such as PPWSA; and ④ Provision of laboratory in public WSS as base laboratory for plural provision is also effective.
B2-1-3	Technical capacity shortage of private water utility	Solution：Institutionalize technical and financial support system for private WSS Many provinces depend on private WSS to provide water to their constituents. However, these private WSS need technical and financial assistance to upgrade their facilities and enable them to expand their service coverage and improve the quality of their services. Private utilities cannot access public technical and financial support; and NGO assistance is very limited in scope. There is a need to institutionalize support services to private WSS by developing fund provision schemes or technology transfer programs.
B2-2-1	Vague contract contents/items	Solution：Higher transparency in contracts The importance of having clear and transparent contracts from the national to the local levels means that accountability and responsibility can be pinpointed. In this way, the benefits from a water supply contract, which should accrue to the people and the Government, can be objectively measured. In like manner, any deviation from the contract can be corrected. However, an important condition for governance is creating an open and transparent environment.
C1-1-1	Improper procurement and inventory control of equipment and chemicals	Solution：Developing a procurement process and inventory management system There is a need to develop a procurement system that would allow the WSS to procure goods and services in a very transparent manner. This will enable the utility to: (i) negotiate for the best terms and conditions; (ii) take advantage of economies of scale in procurement; (iii) shield the utility from escalation costs; and (iv) ensure that funds for goods and services are not used for any other purpose than intended/budgeted.

Issues	Proposed Solution
	Together with the procurement system is the development of an appropriate inventory management system. This will keep procured supplies and equipment protected and accounted for at all times. Personnel who are assigned to this function should be properly trained as well.
C1-1-2 Technical capacity shortage of staff	Solution：Continuing training of technical staff Training and development should be seen as a continuing and on-going activity. The WSS should develop a training program based on a training needs assessment (TNA) so that relevant training is given to its staff. As the WSS improves and gets new facilities, the technical personnel must also upgrade and update their capacities to operate and maintain the water system. In addition, they should be kept abreast with new technologies.
C1-2-1 Shortage of management capacity	Solution：Developing human resources It is not only the technical staff of the WSS that must be trained. Training should be given to all the personnel of the water utility – the managerial level, and the commercial, finance and administration staff. Everyone contributes to the sustainability of the WSS, thus everyone must be trained accordingly. This begins with the mindset of the top management of WSS in believing in the power of trained and enabled personnel in transforming the WSS into a performing utility.
C1-2-2 Imbalanced investment to WTP and distribution system	Solution：Analyzing options for network development optimization In the field survey, it was observed that many water utilities had WTP capacity is more than the water supplied through the network. Even if the WTPs were rehabilitated, the amount of water distributed to the service area did not increase. Thus, expected water revenues (amount of water sold) did not also increase. The amount invested becomes difficult to recover; affecting both the utility's as well as the project's sustainability. Urgent measures that can be done are: • Get the ratio between the amount of investment and the amount of water supply for all projects; • Projects where the amount of water supply does not match with the investment means an impending deficit. These projects should be evaluated through management simulation even with the possibility of the project becoming bankrupt; • The WSS / project that faces a serious deficit should increase water supply by examining the root causes of the distribution network capacity shortages such as water leakages and/or the possibility of design defects; and • The capacity of the project implementing agency should be examined. What targets did they set and how do they

Issues		Proposed Solution
		plan to achieve these? What monitoring system do they have to ensure that targets are realized? What about the technical skill level of those operating and maintaining the system?
C1-2-3	Undeveloped fund procurement system	Solution：Develop a fund procurement system for water supply projects Presently, water supply projects are funded by the government; by donor agencies, and by private water supply system investors. But to accelerate the provision of water supply to all urban, provincial and rural areas, funds must be available from the capital markets or from the banking system through direct fund procurement. Water supply projects must be seen as a good investment opportunity, and one way to make this happen is through project transparency.
C1-2-4	Need for Improvement in water sales income	Solution：Proper accounting and auditing system and skills Most of the water supply projects in Cambodia rely on aid and/or loans coming from donor agencies. Cases of accumulated deficits are common among these projects, which unfortunately, DIME is not even aware of. The failure of balancing income and expenditure falls largely on the accountant as well as the accounting system utilized. It is also the accountant that gives important financial information to the head/s of the utility so that proper action can be taken. However, skillful accountants are difficult to find. In addition, all water utilities should also be audited by a third party so that deficiencies in the accounting system can be uncovered, and improved.
C2-1-1	Functional issues of WTP	Solution：Rehabilitation of WTPs Large scale WTP rehabilitation programs by ADB, supported by JICA, have improved WTP capacities of a number of water works systems. But there are still many remaining projects where WTPs need rehabilitation as these do not function to full capacity. Issues on raw water quality should be looked into so as not to lower the functional capacity of the WTP.
C2-2-1	Insufficient water source capacity and water quality deterioration	Solution：Establish long-term program to preserve water sources Most of the large scale WTP use surface water. In the dry season, it is expected that water levels decrease. But it has been observed that water quality also deteriorates. These problems get compounded as during the dry season water demand reaches its peak. Thus, it is of utmost importance to secure existing raw water sources by having a program to protect these sources from pollution and to preserve its quality.

Issues		Proposed Solution
C2-2-2	Imprudent development in upstream area of water sources	Solution：Develop and implement water resource development criteria
C3-1-1	Shortage of distribution network capacity	Solution：Develop distribution network Some WTPs in the provinces have remaining capacity, but this is not being utilized. There is a need to expand water service by developing the distribution network. But before embarking on this investment program, the following should be performed: • Collect and analyze five-year data on water supply production: volume of treated water, volume of water supplied; volume of metered water consumption; number of leaks repaired. This will provide the effective volume of water produced against actual volume lost to leaks; • Collect the following data: WTP capacity calculations, design drawings, and water meter accuracy. This will help assess the accuracy of all data collected; • Verify the specifications and procedures involved in the installation of the distribution network to find out whether there were inadequacies. Investigate how supervision and inspections were done at the sites; • Conduct hydraulic analysis by comparing the existing service area and/or service condition with the results of the analysis. Look for mismatching of pipes – or the difference between the results of the analysis and the existing service condition – which may be caused by clogged pipeline, improper valve operation, or pipe leaks. The existing network capacity shall then be estimated with a comprehensive evaluation of these results; • Estimate future water demand by computing water demand in the areas surrounding the existing service area. Plan the network expansion based on this demand and the present pipe capacity; • Network design should include: (i) review of the pipe and gate valve installation methods; (ii) standardization of pipe installation method; (iii) proper procurement of materials and equipment; • Construction supervision over the work of the contractor should strictly conform to design and procedures. The contractor must be made to perform the work based on drawings and specifications; and • Confirmation and evaluation of project benefits by regular monitoring of production and sales
C3-2-1	Water leakage from deteriorated pipes	Solution：Rehabilitate and/or develop distribution network Many of the pipelines are old; and pipelines that were laid during the 1990s were of inferior materials. This contributes to high NRW, a condition that is aggravated by water source shortages. Refer to C3-1-1 for concrete measures to address this problem.
C3-2-2	Water leakage by inferior construction work	Solution：Rehabilitate and/or distribution network Same as C3-2-1 Refer to C3-1-1 for concrete measures to address this problem.

5.2 The Rural Water Supply and Sanitation Sector

5.2.1 Policies on Consideration of Ways to Sort and Solve Issues

Issues in the rural water supply and sanitation sector will be identified and sorted with the following policies:

1) Issues in all 24 provinces where the field surveys were conducted will be identified.
2) The issues in the sector identified in the previous surveys will be reviewed in order to identify issues relevant to the current conditions and the identified issues will be sorted anew. (New issues will also be identified.)
3) After consolidating the issues identified both in 1) and in 2), the identified issues will be classified into the four categories shown in the figure below.
4) Ways to solve the classified issues will be considered.

The figure below shows the flow of the consideration.

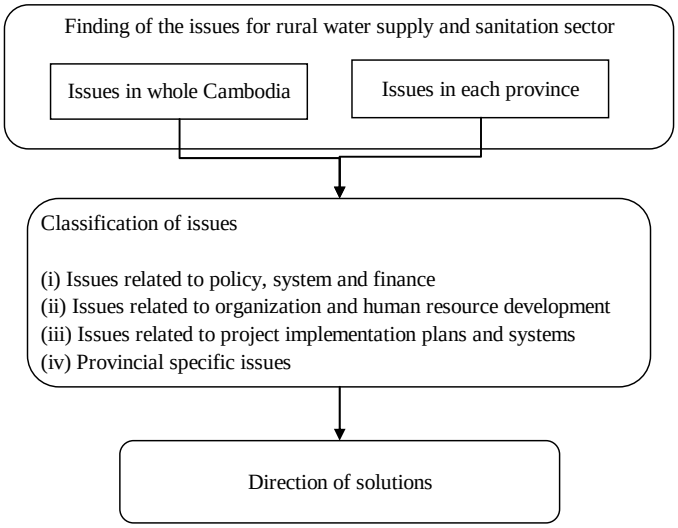


Figure 5.2.1 Flow Chart of Consideration of Ways to Sort and Solve Issues

5.2.2 Ways to Sort and Solve Issues

(1) Identification of issues at the national level

1) Insufficient sector budget

The total amount of the development budget of MRD of year 2010 is US$ 14,395,100. However, only approx. 11 % and 4% of this amount are appropriated to the water supply and sanitation sectors, respectively. Thus, the revenue basis of these sectors is weak.

Meanwhile, the National Strategic Development Plan of Cambodia appropriates 10 % of the budget to rural development, which includes the rural water supply and sanitation sector.

However, most of the budget is allocated to development of rural roads and the priority of the rural water supply and sanitation sector is low.

2) Establishment of a sustainable facility maintenance system

A Establishment of procedures for the management of Maintenance Fund

"Ensuring sustainability" is one of the priority issues in the rural water supply and sanitation sector. A survey on facility maintenance by residents conducted under the Sailor Program in the past found that WSUGs (Water and Sanitation Users' Groups) were working only in 30% of the surveyed villages and even the working ones were not implementing their activities fully. One of the findings of particular importance of the survey was that saving had not been made to facility maintenance funds regularly and insufficiency in fund was hindering sustainable facility maintenance. The following are considered as the reasons for failure to make regular saving:

- Incomes of villagers are too low and too unstable to make regular saving to the funds.
- Villagers have had no experience in financial management and are not familiar with the management methods.
- They do not understand fully why they have to save money for maintenance and renewal of the facilities.
- Although the National Policy on Water Supply and Sanitation (NPWSS) and the WSUG Guidelines refer to collection of fund for operation and maintenance of facilities, they provide no concrete collection method or procedure.

There is a need to establish a transparent fund management method which is easy to be implemented by villagers.

B Sustainable implementation of operation and maintenance procedures

The training on organizational management of WSUGs and maintenance of pumps is usually provided only for a short time during project implementation. Follow-up of the facility monitoring has not been implemented continuously. (In most cases, the follow-up was implemented for the first two to three years after the completion.) Sufficient attention has not been paid to the maintenance of existing facilities once a certain period of time has passed since the completion of their construction. For these reasons, WSUGs have not implemented the operation and maintenance procedures sustainably.

C Establishment of supply chains

NPWSS imposes responsibility of operation and maintenance of the facilities on their users. However, sufficient mechanism has not been established to ensure that users can take the responsibility. In particular, establishment of supply chains to provinces is urgently required

because it is difficult to procure spare parts of the hand pumps in almost all the provinces.

D. Creation of awareness of ownership among villagers

The following have been reported as factors impeding creation of awareness of ownership among villagers:

(a) Since NPWSS does not have a clear provision on the ownership of facilities constructed with support from the government, donors and NGOs, it is difficult to motivate villagers to be actively involved in operation and maintenance of the facilities.

(b) One of the users usually offers land for a facility free of charge. However, there is no clear system or policy on the ownership of the facilities or lease and assignment of the land. Therefore, there have been problems such as landowners restricting access of users to the land or selling the land without consent of WSUGs. In many cases of such problems, WSUGs have to accept the intention of the landowners and, thus, the leadership of WSUGs is compromised.

(c) Signboards stating the names of benefactors are installed on facilities constructed with support from donors and NGOs. It is suggested that the signboards impede creation of awareness of independent maintenance of facilities among villagers. For example, when a well has broken down, villagers are likely to request the benefactor to repair it, instead of taking their own action to solve the problem.

(d) NPWSS provides the responsibility of facility maintenance to WSUGs. However the legal status of WSUGs is unclear and their activities have no legal power. It is suggested that such a circumstance makes it difficult to develop independence of WSUGs.

The ownership of facilities may be either given directly to villagers or leased to them while the government retains the ownership. In either case, there is a need to establish a mechanism in which villagers are required to bear their fair share of responsibilities together with making them more aware of the need for the maintenance.

3) Poor availability of sanitation facilities

The proportion of people with access to improved sanitation in rural areas in Cambodia is 23 %. This figure is the lowest among the five countries in the sub-region. Approximately 75 % people still defecate outdoors. A survey of economic impact of sanitary conditions conducted by WSP (WSP 2008) estimates the annual economic loss derived from the inappropriate sanitation facilities at US$ 448 million (of approx. US$ 32 *per capita*), which corresponds to 7.2 % of the GDP of Cambodia (in 2005). Damage to health, cost of water, damage to the tourist industry and the economic loss for the time spent to fetch water are estimated at US$ 187 million (42 %), US$ 150 million (33 %), US$ 74 million (16 %) and US$ 38 million (9 %),

respectively, as the breakdown of the loss. These figures show that the inappropriate sanitation is seriously affecting people's health.

The problems in the sanitation sector in Cambodia have been analyzed as follows:

- While availability of sanitation facilities is critically low, there is no practical strategy to solve the problem. Since the sanitation sector is still considered a sub-sector of the rural water supply and sanitation sector, the government has no individual policy specific to the sanitation sector. Because of the lack of policy, MRD and other relevant government offices (the Ministries of Health, Education, Youth and Sports, Women's Affairs and Interior (MOH, MOEYS, MOWA and MOI) have not been able to act effectively.
- The Government of Cambodia gives improvement in sanitation a low priority and gives small budgetary allocation to the sanitation sector.
- No sanitation project has been implemented at the national level. (All projects in the past were implemented in small numbers of provinces and districts.)
- Villagers are not so aware of the importance of sanitation and do not possess correct knowledge or practices.

As sanitation facilities are owned by individuals, donors and NGOs have shown little interest in and provided little support to the sanitation sector. However, as the social effect of the inappropriate sanitary environment can no longer be ignored as mentioned above, improvement in availability of sanitation facilities is as important a task as supply of safe water.

4) Policy- and system-related issues

A Division of duties in the piped water supply

Exchange of note between MIME and MRD, which defined the division of duties in the small-scale piped water supply between the two ministries, in 2005 made their respective responsibilities in the sector clear on paper. The following are the main points of the note:

- MRD is responsible for community-operated small-scale piped water supply systems.
- MIME is responsible for small-scale piped water supply systems in rural areas operated by the private sector.
- When a community has given up operating the facility by itself and hired a private company to operate it, MIME will automatically assume the responsibility for the facility.
- Water user fees of community-operated systems are decided by the communities which operate the systems.

However, as MRD has little experience in maintenance of small-scale piped water supply systems, it does not have sufficient knowledge and expertise in operation and maintenance of the facilities. Therefore, MRD is likely to face various issues related to facility operation and

maintenance. Thus, there is a need for human resource development to train experts in MRD.

B Rules on collection of water fees and operation and maintenance fund

NPWSS stipulates that villagers are to decide water fees of rural water supply facilities. However, as mentioned in (2) above, many villagers have no experience in managing a fund and little knowledge of how to manage it.

Water supply facilities can last 10 to 15 years in general. Money is required for daily maintenance and replacement of old equipment. However, sufficient information on these issues has not been provided to villagers. No policy or guidelines provide clearly who bears the maintenance and replacement costs. For these reasons, the maintenance fund has not been collected systematically and the number of cases in which broken-down facilities have been left unrepaired because of shortage of fund is on the increase.

C Standardization of the levels of services

Because there is no regulation defining the levels of services provided by water supply and sanitation facilities, water supply facilities with different specifications have been provided by different donor agencies. As a variety of facility types, such as tube wells, hand-dug wells and community ponds, are available for rural water supply systems depending on local conditions, minimum standards for services (especially standards on water quality) provided by water supply facilities have to be defined.

D Development of technical manuals

Lack of standard design criteria for planning, design and construction of rural water supply and sanitation facilities has resulted in facility construction with different specifications by respective donor agencies. As standardization of the specifications and procedures is important for reducing labor in planning and design and for efficient facility maintenance, MRD has to realize the standardization urgently.

E Improvement in quality control

As actual construction works of rural water supply and sanitation facilities are often implemented in remote areas, owners cannot supervise the works of contractors sufficiently because of the distance and time required for site visits. Therefore, there are cases in which contractors do not meet technical specifications.

In addition, the problems of poor quality of construction materials and equipment have emerged. Of particular concern is the deterioration of the quality of Afridev Handpumps, which are widely used in rural water supply systems, in recent years. Poor quality of consumables, such

as U-seals, and rods and pistons, which normally do not require frequent replacement, has led to breakdowns. Deterioration of the quality of copied products of Afridev pump, such as VN6 pumps, has also been noticed. These facts have made establishment of a quality control system an important issue.

F Review of the water quality control system

The Drinking Water Quality Standards (DWQS) for small-scale water supply facilities (those serving 100 or less people or supplying water at the rate of 10 m^3/day or less), which have seven parameters, apply to the quality of water provided by water supply facilities constructed in rural areas. DWQS stipulate that monitoring of groundwater sources (in rural areas) and surface water sources has to be implemented every three and two years, respectively, after commencement of operation of water supply facilities. However, DWQS do not provide actual monitoring procedures: There is no provision on who conducts water quality examination, who manages the examination data or who makes public the results or no description of monitoring methods. In addition, it is unclear which government ministry (MIME, MRD, MOH, MOE or MOWRAM) is responsible for the water quality monitoring. For these reasons, water quality is not being controlled strictly at present.

G Measures to promote devolution

In accordance with the Government's policy of devolution, the Act on Operation and Management of Communes/Sangkats (C/S Act) was enacted in 2001 and 1621 commune/sangkat councils (among which 111 are sangkat councils) were established with members elected in the local elections held in 2002.

C/S Act stipulates that a commune council has its own revenue, budget and assets and has responsibility to prepare and report development plans at the commune level. The responsibility includes preparation of development plans in the water supply and sanitation sector at the commune level. At present, the priority of the sector concerned is low and infrastructure development, such as construction of rural roads, accounts for 80 % of the plans.

Meanwhile, at the provincial level, Provincial Department of Rural Development (PDRD), led by the executive committee (ExCOM), will assume a new role of coordinating activities in cooperation with various departments in the sector.

Therefore, under the new framework of devolution, measures to gradually transfer the function and technology of MRD to the local organizations are required for the development in rural water supply and sanitation sector.

5) Issues related to organizational capacity and human resource development

A Improvement of capacity of personnel in the water supply and sanitation sector

In the water supply and sanitation sector, 139 (83 in DRWS and 56 in DRHC) and approx. 100 (average of approx. four per province) personnel are working in the central government and local governments, respectively. In order to achieve the sector targets by 2025, improvement in capacity of personnel at the central, provincial and community levels is required. In order to promote the devolution in future, capacity development of local organizations and PDRDs in particular, is of particular importance. Capacity development in the following areas is urgently required.

- Capacity to implement the PDCA Cycle, consisting of Plan, Do, Check and Act, appropriately
- Capacity to manage information including data acquisition, storage (database) and analyses
- Capacity to examine and control water quality
- Capacity to supervise construction works (quality, schedule and safety supervision)
- Technology to maintain water supply facilities (Hardware element: replacement of parts: Software elements: data recording and fund management)
- Methods of sanitation and gender education

B Human resource development in the water supply and sanitation sector

Non-existence of education and training institution to train people with professional technology in the rural water supply and sanitation sector has resulted in shortage of human resource with the professional knowledge in both the public and the private sectors.

C Division of duties in the water and sanitation sector among government ministries concerned

The ministries listed below are involved in the water and sanitation sector and supply of drinking water, in particular. Lack of legal system to control this division of duties has led to duplication of work among ministries and ill-defined sharing of responsibilities.

- MOWRAM: Planning and control of water resources
- MRD: Rural water supply and sanitation
- MIME: Piped water supply in rural towns and establishment of quality standards for drinking water
- MOH: Monitoring of water quality at the sources of public water supply systems
- MOP: Monitoring of the progress toward CMDGs

D Establishment of multi-sector cooperation for the achievement of CMDGs

The water supply and sanitation sector is closely linked to five of the CMDGs. There is a need for prioritized budgetary measures by the government and strengthening cooperation among ministries.

Goal 7: Ensure environmental sustainability
Goal 1: Eradicate extreme poverty and hunger
Goal 2: Achieve universal nine-years basic education
Goal 3: Promote gender equality and empower women
Goal 4: Reduce child mortality

6) Issues related to project implementation plans

A Construction of an efficient and sustainable information management system

Although many water supply facilities including tube wells have been constructed with support from donors and NGOs in the rural water supply sector, lack of a systematic database has resulted in the following issues:

- The number of wells constructed and actual usage of water sources in the entire country are not known.
- Groundwater potential (amount, quality and levels of groundwater) in the entire country is not known.
- It is not possible to prepare efficient development plans with support from the government, donors and NGOs.
- Integrated water resource management including water for agricultural and industrial use is not implemented.

B Verification of the actual proportions of people with access to safe water and improved sanitation

As mentioned in Chapter 3, numerous data on the proportions of people with access to safe water and improved sanitation have been made public in Cambodia and they have created confusion. The main causes of the confusions are as follows:

- There is no clear definition of safe and unsanitary water.
- There is no single database in which data on water supply facilities constructed by different organizations or projects are integrated.
- The existing databases have not been maintained properly.
- Villagers do not provide accurate responses in the interviews on water sources they use.

MRD intends to adopt the census data taken in 2008 as the official figures. However, there is discrepancy between the published census data and the actual situation on the ground

recognized by PDRD of each province. (For example, even non-working wells and wells which dry up during the dry seasons are counted in the census.) Consensus has to be reached again among the relevant organizations on definition of safe water.

C Nationwide rural water supply master plan (not developed)

Only two surveys for preparation of a master plan for rural water supply, "Groundwater Development Project in Southern Cambodia (2002)" and "Groundwater Development Project in Central Cambodia (2002)," have been implemented in Cambodia. These studies elucidated distribution of groundwater aquifers, water quality and development potential in the five southern and two central provinces, resulting in a high success rate in the construction of deep wells. Therefore, it is desirable to elucidate groundwater development potential in provinces where surveys on the potential have not been conducted.

7) Active participation of the private sector

Participation of the private sector is an important component in developing rural water supply and sanitation services. NPWSS mentions a need for developing an environment for the participation of the private sector, which provides high-quality services at low cost in response to demands of communities.

As a means to promote private sector participation, the Water Suppliers Association was established in 2002 with 85 companies (including drilling companies, manufacturers of equipment, investors and operators of water supply networks, and manufacturers of water jugs and pumps) under the ASPER project (supported by MRD and Burgeap). The main purposes of the establishment of the association were cooperation between companies and development of a stable business environment. The association was also expected to play a leadership role in making the industry vibrant and act as a self-regulator. However, lack of long-term government support has resulted in suspension of its activities.

(2) Issues at the provincial level

The issues at the provincial level in the rural water supply and sanitation sector are included in those at the national level mentioned above. The current state in the 23 provinces, excluding the capital, Phnom Penh, is more or less the same in principle. Therefore, in the following, issues found in each province are summarized in a table based on the result described in Chapter 4 and issues at the national level and, then, the most characteristic points among the issues are described in detail.

However, some issues which were not included in the explanation of PDRDs on the issues at the provincial level have been deduced from data at hand and provided data.

Table 5.2.1 shows the issues found in each province.

Table 5.2.1 Summary of Issues found in each Province (Rural Water Supply)

Subjects in large Category	Subjects in detailed Category	Name of Provinces																							No. of Provinces
		1 Banteay Meanchey	2 Battambang	3 Kampong Cham	4 Kampong Chhnang	5 Kampong Speu	6 Kampong Thom	7 Kampot	8 Kandal	9 Koh Kong	10 Kratie	11 Mondul Kiri	12 Phnom Penh	13 Preah Vihear	14 Prey Veng	15 Pursat	16 Ratanak Kiri	17 Siem Reap	18 Preah Sihanouk	19 Stung Treng	20 Svay Rieng	21 Takeo	22 Otdar Meanchey	23 Kep	24 Pailin	
Subjects in Rural Water Supply and Sanitation System Development	A : Un-served areas of water supply system	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■		■	■	■	■	22
	B : Inactive un-served area reduction program									■	■	■					■			■						6
	C : Un-served areas of sanitary system	■		■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■		21
	D : Inactive un-served area reduction program			■				■	■	■	■	■		■			■		■			■		■	■	12
Subjects of Water Sources	A : Areas suffered by groundwater arsenic risk			■	■		■		■		■		■		■										■	8
	B : Areas suffered by high content of Iron and Salinity in groundwater	■	■					■										■	■			■		■		7
	C : Obscure groundewater potential	■	■				■	■		■	■	■		■		■	■	■	■	■			■	■	■	16
	D : Dependent on unsanitary surface water	■				■		■	■								■			■		■		■	■	9
	E : Dependent on unsanitary private wells			■											■						■					3
	F : Isolated from water source	■				■		■		■	■	■	■	■		■	■	■	■	■		■	■	■	■	17
Other Subjects	Refer to Section 3) A to B	**Each province excluded Phnom Penh has subjects described in Section 3) A to B**												**Each province excluded Phnom Penh has subjects described in Section 3) A to B**											
	To be improved	4	3	5	3	4	4	7	5	6	7	5	3	5	3	4	6	5	6	5	2	6	3	6	6	113
	Serious Subjects	2	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	1	0	0	1	1	0	8
	Page to be referred	p4-7	p4-19	p4-28	p4-43	p4-52	p4-65	p4-78	p4-87	p4-95	p4-107	p4-116	p4-128	p4-137	p4-146	p4-161	p4-170	p4-182	p4-196	p4-206	p4-218	p4-229	p4-237	p4-245	p4-254	

Legend ■ To be improved ■ **Serious Subjects**

1) Issues related to promotion of rural water supply and sanitation at the provincial level

A Short of measures to solve the problem of rural water supply facilities lacking

a. Mondul Kiri Province is characterized as a province inhabited by people of 11 ethnic minorities (who account for approx. 80 % of the total population of the province) and given low developmental priority including the priority for infrastructure development as the province is sparsely populated (population density of 4 people/km^2) and located far from Phnom Penh. For these reasons, donors have provided little support and the government has allocated insufficient developmental budget to the province. At present, a project supported by IMF is the only major water supply and sanitation project implemented in the province.

b. Like Mondul Kiri Province, Ratanak Kiri Province is characterized as a province inhabited by people of 8 ethnic minorities and given low developmental priority including the priority for infrastructure development as the province is sparsely populated (population density of 14 people/km^2) and located far from Phnom Penh. For these reasons, donors have provided little support and the government has allocated insufficient developmental budget to the province. Therefore, the proportion of people with access to improved water sources derived from the Census 2008 is approx. 27.9 %, which is far below the national average.

c. Kratie Province has not received donor support since the completion of the water supply project implemented by USAID from 1994 to 2000 (construction of approx. 630 wells). Because the provincial capital is located approx. 315 km from Phnom Penh along the National Highways Nos. 6 and 7 and the population density of the province is low (29 people/km^2), priority for developmental assistance of the province is relatively low compared with those of other provinces. MRD allocated approx. 1.2 % of the total development budget to the development of the sector in Kratie Province in Fiscal year 2009. Thus, revenue sufficient to implement the provincial development plan is not ensured.

2) Issues related to water sources

A Existence of risky areas with arsenic contamination of groundwater sources

a. The risk of arsenic contamination in the groundwater has been detected in the area along the Mekong River in the western part of Kampong Cham Province. The groundwater in the same area tends to have high salt and iron concentrations. As the groundwater development is not appropriate in this area, development of alternative water sources has to be promoted.

b. Arsenic has been detected in the groundwater in Kampong Chhnang Province and MRD designates the province as an arsenic high-risk area. Groundwater in the province also has been found to have high iron concentration. However, PDRD has not conducted

examination of water quality actively because it does not possess the examination equipment. PDRD does not seem to consider deterioration of water quality as a crisis.

c. Arsenic has been detected in groundwater in Kampong Thom Province and MRD designates the province as an arsenic high-risk area. Groundwater in the province has also been found to have high iron concentration. However, PDRD has not conducted examination of water quality actively because it does not possess the examination equipment. As it is not possible to improve the quality of such groundwater sources, conversion to water supply facilities using surface water as the water source is urgently required. However, the only measure so far taken by PDRD is prohibition of the use of the polluted water sources and no other measures, such as construction of alternative water sources, have been taken.

d. Kandal Province surrounds the City of Phnom Penh and has population density of 355 people/km^2, the second highest in the country following the City of Phnom Penh. Water is supplied through water distribution networks of PPWSA in some towns in the province. Meanwhile, the Census 2008 puts the proportion of people with access to protected water sources in rural areas at 33.5 %. However, risk of arsenic contamination at groundwater sources along the Mekong and Pasak Rivers has already detected. Among the 1,607 villages nationwide included in the list of arsenic-pollution risk areas published by MRD, 39 %, or 624 villages, are found in this province, which has a total of 1,083 villages. This figure makes Kandal Province the province with the highest risk of arsenic pollution in the country. For this reason, approx. 60 % of villagers in rural areas depend on unsanitary water, such as water sold by venders and river water. Development of alternative water sources using technology appropriate for the economic conditions of the area is required urgently.

e. Seventy-eight point eight percent of households in Prey Veng Province rely on tube wells. However, risk of arsenic contamination in groundwater has been detected in the area along the Mekong River, which flows from north to the south in the western part of the province and southeastern part of the province near the border with Vietnam. Educational activities for the villagers to switch water sources from the wells to alternative sources have to be implemented urgently.

f. The Mekong River flows from north to south in Kratie Province. Risk of arsenic contamination at groundwater sources has been detected in the area along the river in the south of the province. Therefore, many residents of villages along the river are drinking untreated river water. Approximately 25 % of households in the province rely on unsanitary spring water and river water.

B Existence of areas with poor-quality groundwater sources (with iron and salt)

a. Arsenic has been detected at groundwater sources in Poipet Town in Banteay Meanchey Province. Although its concentration is below the allowable limit of the national standard of Cambodia, there are areas in the province where risk of arsenic contamination is on the increase year after year. Therefore, measures have to be taken immediately in Poipet Town. Since it is impossible to improve the condition of contaminated groundwater sources, there is an urgent need to convert existing water supply facilities to those using surface water as the water source. Under such circumstances, PDRD recognizes the importance of water quality monitoring. However, it has never conducted examination of water quality for the reason of lack of budget.

b. In Battambang Province, arsenic at the concentration below the allowable limit has been detected in groundwater. Iron has also been detected in groundwater. Since there are areas where risk of arsenic contamination is increasing year by year, it is extremely important to implement water quality monitoring. However, PDRD has never conducted water quality examination because it does not possess the examination equipment. Because the concentration of arsenic detected in the groundwater is below the allowable limit, PDRD does not seem to have sense of crisis toward deteriorating water quality.

c. In Bantey Means District in Kampot Province, the shallow groundwater tastes sour and deep groundwater contains high concentrations of salt and iron. Thus, it is difficult to develop groundwater by digging wells. Since possibility of other districts in the province having the similar groundwater cannot be excluded on the basis of the geological structure in Cambodia, use of surface water at water supply facilities has to be considered.

d. Since salt water has been detected in groundwater in some areas in Siem Reap and Preah Sihanouk Provinces, there is an urgent need to convert to water supply facilities using surface water as the water source.

e. Quality of groundwater in Takeo Province is not good in general because of high salt and iron concentrations. Therefore, approx. 40 % and 20 % of the residents depend on surface water and unprotected dug wells, respectively. However, these water sources do not ensure safe and stable water supply as they are unsanitary and they may dry up during the dry seasons. Groundwater sources in general have potential to be sources of water for domestic use in rural areas for their availability, cost-effectiveness and safety. However, in areas with low groundwater development potential, residents have to rely on surface water. Therefore, there is a need to utilize technology appropriate for the local conditions to ensure safe and

stable water supply sources.

f. Since Kep Province is located in the coastal area south of Kampot Province, groundwater contains salt at the level unsuitable for drinking and, thus, development of ground water has limited potential. For this reason, 40.6 % and 36.9 % of residents depend on surface water and unprotected dug wells, respectively, and only 9.3 % of people use tube wells.
The surface water used by the residents is often located far from their places of residence and approx. 54.7 % of households spend more than five minutes to go to water sources from their houses. In addition, many water sources dry up during the dry seasons. However, since the number of available water sources is limited, people endure such a situation.
The province concerned is expected to be served by an urban water supply system in future. However, it is unknown when the service of the system begins. Therefore, until the plan for the water supply system has realized, water supply facilities will have to be constructed at the commune level using technologies appropriate for individual communes.

C Dependence on unsanitary surface water

a. In Stung Treng Province, where three rivers, the Mekong River and its two tributaries, Tonle San and Tonle Kong, flow, approx. 70 % of the households depend on unsanitary surface water. Use of surface water requires purification of source water. However, the low population density (10 people/km^2) and high poverty rate in the province makes it difficult to construct water purification plant for the reasons of cost-effectiveness and difficulty in maintaining the facilities. Therefore, it is necessary to prepare appropriate development plan and disseminate technology for the use of surface water for domestic use in rural areas.

b. In Ratanak Kiri Province, where 53.5 % and 15.5 % of households depend on surface water, such as river water, and shallow groundwater from shallow wells, respectively, improvement of water quality is a major task. In areas where volcanic rocks are found, there is a problem of bedrock being too hard to dig wells.

D Dependence on unsanitary privately-owned wells

a. Although the Census 2008 puts the proportions of people with access to improved water sources in Prey Veng and Svay Rieng Provinces at high levels of 85.5 % and 93.0 %, respectively, PDRDs in these provinces consider these figures not reflecting the proportion of people with access to safe drinking water but reflecting the proportion of people with access to the water sources they accept. As it is easy to obtain water from underground sources in these provinces because of the relatively high groundwater level, *ca.* 80 % of households in

these provinces (78.8% in Prey Veng Province and 86.6 % in Svay Rieng Province) depend on tube wells. However, many of the tube wells do not meet the quality standards for drinking water of Cambodia. Cases of bacterial contamination caused by insufficient design depths and cases of drying up of the wells because of the use of shallow groundwater near the ground surface are examples of the problems observed at these wells. Such a situation requires surveys of the quality of groundwater which is being used and educational activities on importance of the use of safe water to the residents.

b. "District Data Book, Oct. 2009" of UNDP puts the total number of wells with pumps in Kampong Cham Province at 57,435. Meanwhile, "Water Supply System Data, 2008" of PDRD estimates the number of tube wells in the province at 3,905. Existence of privately-owned wells is considered to account for most of the difference between these two figures. Many of the privately-owned wells are shallow wells and, in many cases, quality of water in these wells does not meet the quality standards for drinking water of Cambodia. Many residents drink water from unsanitary sources as long as it does not taste bad and tend to use water sources nearby even if there are safe water sources at a distance from their living places. Therefore, there is a need to make people fully aware of the risk of drinking unsanitary water.

E Water sources located far from the living places

a. Although the Census 2008 puts the proportion of people with access to improved water sources in Mondul Kiri Province at 41.1 %, which is almost the same as the national average, 57.3 % of households in the province have to use water sources located more than five minutes from their houses, which makes fetching water a heavy burden on them. It is the policy of MRD to construct a tube well per 20 to 25 households (or 150m/1 well). However, it is difficult to apply this policy in areas where population density is low as is the case with Mondul Kiri Province, which has a population density of 4 people/km^2.

b. Although the Census 2008 puts the proportion of people with access to improved water source in Preah Vihear Province at 44.5%, which is above the national average, *ca.* 54 % of households in the province have to use water sources located more than five minutes from their houses, which put heavy burden of fetching water on women and children.

3) Other issues

A. Provision of water supply facilities to the poverty groups

In Phnom Penh Province, according to the Census 2008, of a total of 17,379 households in the province's rural areas, 10,155 households, or 58%, still use unsanitary water sources. In

Phnom Penh City, its entire area will be covered with a water distribution network of PPWSA in the near future. There still is a need, however, for inexpensive rural water supply facilities among poverty groups in the city (illegal residents and low income earners) who have been coming into existence due to social differences and rapid urbanization. In areas where water service is in place, however, the administration system of WSUG for rural water supply facilities have already been disrupted and many facilities are left unattended even if they are not workable. For poverty groups, too, water sources that are usable are necessary.

B. Improvement of sanitation environment

In the Census 2008, Phnom Penh Province marked the highest diffusion rate of sanitation services but the drainage paths for supplied water have not been developed enough. Sewage is discharged untreated and deteriorates residents' sanitation environment.

(3) Lists of issues

Issues presented in the above sections (1) and (2) can be aligned and grouped into 4: (i) policy, system and finance; (ii) organization and human resource development; (iii) project implementation plans and systems; and (iv) regional specific issues. **Table 5.2.2** below shows issues for the entire sector and **Table 5.2.3** shows regional specific issues.

Table 5.2.2 List of Issues (for the Entire Sector)

Classification	Issues
A1. Issues related to policy, system and finance	A1-1: Sustainable implementation of operation and maintenance procedures A1-2: Establishment of supply chains A1-3: Creation of awareness of ownership among villagers A1-4: Development of technical manuals A1-5: Poor availability of sanitation facilities A1-6: Measures to promote devolution A1-7: Review of the water quality management system A1-8: Integration of service level A1-9: Improvement in quality control A1-10: Insufficient sector budget A1-11: Establishment of procedures for the management of Maintenance Fund A1-12: Division of duties in the piped water supply
A2. Issues related to organization and human resource development	A2-1: Improvement of capacity of personnel in the water supply and sanitation sector A2-2: Human resource development in the water supply and sanitation sector A2-3: Division of duties in the water and sanitation sector among government ministries concerned A2-4: Establishment of multi-sector cooperation for the achievement of CMDGs
A3. Issues related to project implementation plans and systems	A3-1: Construction of an efficient and sustainable information management system A3-2: Verification of the actual proportions of people with access to safe water and improved sanitation A3-3: Opportunities to improve capacity of PDRD staff A3-4: Active participation of the private sector A3-5: Nationwide rural water supply master plan A3-6: Low rate of supply of improved water A3-7: Unsanitary privately-owned wells

Table 5.2.3 List of Issues (Local Specific Issues)

Classification	Regional relevance (Regional characteristics)	Issues
B1. Local specific issues	B1-1 Developing areas （6 provinces: Preah Vihear, Stung Treng, Ratanak Kiri, Kratie, Mondol Kiri, Kon Kong）	B1-1-1: Prioritizing order of the water supply and sanitation facility development
	B1-2 Areas of poor-quality groundwater (13 provinces: Kratie, Kampong Thom, Kampong Cham, Kampong Chhnang, Prey Veng, Kandal, Pailin, Kep, Takeo, Kampot, Siem Reap and Preah Sihanouk)	B1-2-1: Diffusion of appropriate technology and securing of safe water sources
	B1-3 Areas highly dependent on shallow groundwater (tube wells) (2 provinces: Prey Veng and Svay Rieng)	B1-3-1: Securing of safe water sources
	B1-4 Areas covered by the urban water supply network (1 province: Phnom Penh)	B1-4-1: Provision of water supply facilities to poverty groups
		B1-4-2: Improvement of sanitation environment

(4) Direction of solutions

The direction of how to solve above issues can be reviewed as follows.

Table 5.2.4 Proposed Solutions

Issues		Proposed solutions
A1-1	Sustainable implementation of operation and maintenance procedures	Solution 1: To construct a maintenance system which will be mainly supported by the public authorities (i) To strengthen the framework of local organizations of PDRDs and DORDs (MRD's line organizations) (ii) To implement monitoring and training on a regular basis targeting at WSUG Solution 2: To make the private sector carry out maintenance works (i) To specify that the village committee and the commune council should take the responsibility to manage WSUGs (ii) To make each commune (governing an average of 8.7 villages, 3 at minimum and 30 at maximum) conclude contracts with private professional companies to subcontract the maintenance works of water supply facilities
A1-2	Establishment of supply chains	Solution 1: To establish a spare parts supply network mainly with support of public authorities (i) To standardize water supply equipment (ii) To make each provincial PDRD purchase spare parts of equipment in bulk and manage such parts (iii) To make parts available through DORDs and WSUGs Solution 2: To implement a supply model on a trial basis through a joint effort of the public and private sectors (i) To standardize water supply equipment (ii) To offer incentives to private companies (distribution system and tax incentive) (iii) To develop a network of spare parts sales agencies in provincial and district capitals (iv) To secure demands for spare parts (by generally banning free provision of parts by donors and NGOs and making this known to residents) (v) To make MRD and PDRDs manage the entire supply chain until a market is created
A1-3	Creation of awareness of ownership among villagers	Solution 1: To clarify how the ownership of facilities should be transferred to WSUGs (residents) (i) To specify that the village committee and the commune council should be responsible for administration of WSUGs (ii) To transfer the ownership of facilities to WSUGs (through registration of facilities at the commune council

Issues		Proposed solutions
		under the name of the representative of WSUGs)
A1-4	Development of technical manuals	Solution 1: To examine facilities constructed through past projects and develop technical manuals (i) Technical manuals (draft) ♦ Water supply project examination manual ♦ Water supply program planning and designing manual ♦ Water supply facilities construction management manual ♦ WSUGs monitoring manual ♦ WSUGs instruction manual ♦ Water quality monitoring manual ♦ Facility maintenance manual for WSUGs ♦ Organization operation manual for WSUGs
A1-5	Poor availability of sanitation facilities	Solution 1: To enhance financial support to individual households (i) To support only the construction of underground structure of lavatory with grant assistance provided by donors or NGOs for the poorest group households (ii) To support the construction of lavatory with microfinance for the middle-class and poverty group households (iii) To support the promotion of lavatory construction through the Condition Cash Transfers (CCT) currently being formulated by MRD (iv) To support the establishment of a subsidy system for the construction of sanitary facilities Solution 2: To work to increase residents' sanitation habits and promote changes in their consciousness (i) To work to make residents in all 23 provinces excluding Phnom Penh to make them cease the habit of outdoor elimination of human waste through a CLTS method Solution 3: To enhance collaboration between related ministries/agencies and support organizations (i) The government should clarify the role and responsibility of related ministries/agencies and take the initiative in the prioritized policy issues.

Issues		Proposed solutions
		(ii) To enhance information exchange and cooperation between the government and support organizations at the National Cooperation Committee on Water Supply and Sanitation (NCCWSS) and the Water and Sanitation working group (WATSAN)
A1-6	Measures to promote devolution	Solution 1: To develop action plans for MRD and local organizations targeting at the promotion of the decentralization of the water supply and sanitation sector (i) Review of the responsibility of MRD and local organizations (PDRDs and DORDs) (ii) Addition of new and redistribution of existing staff at the local level (iii) Capacity development plans for local level staff Solution 2: Implementation of capacity development of PDRD staff (i) Implementation of training using the manuals developed in the above Solution 1 (iii) and A1-4
A1-7	Review of the water quality management system	Solution 1: To develop a water quality management system for drinking water sources (i) The responsible organizations (MRD, MIME and PPWSA) should manage water sources under their control and MOWRAM should manage the entire network of water sources by collecting and consolidating data from each organization. (ii) Each facility owner should commission a third party organization to make regular monitoring and submit the result to PDRDs. The examination cost should be the responsibility of the facility owner. (iii) PDRDs should manage information on each of these water sources. (iv) If the result of water quality test shows any deviation from predefined guidelines, the water source cannot be approved as a source of drinking water. (v) Review of drinking water quality guidelines (defining the responsibility of the above and other related parties) Solution 2: To work to improve water quality testing institutes (i) To set up a water quality laboratory at least in each base province (ii) To enhance capacity of such water quality institutes' staff

Issues		Proposed solutions
A1-8	Review of the water quality control system	Solution 1: To examine facilities constructed under previous projects to develop a service standard manual (i) To establish service standards for each water supply facility ♦ Water sources to be used for drinking water should comply with the Cambodia's national drinking water quality guidelines. ♦ Support organizations should develop and maintain facilities based on the service standards. ♦ Eventually an informed choice manual should be developed combining the guidelines for management of the maintenance fund described in A1-11. (ii) Organizations supporting facility development should issue a certificate of the facility's quality for MRD and WSUG after the completion of construction.
A1-9	Improvement in quality control	Solution 1: To foster human resources who have thorough knowledge of quality control (i) To development a checklist for implementation of quality control (ii) To foster facilitators (implementation of training for MRD and PDRD staff) Solution 2: To enhance quality assurance (i) To register private companies and suppliers (ii) To offer incentives for quality assurance (bidding conditions and construction performance assessment, etc.)
A1-10	Insufficient sector budget	Solution 1: Review of the sectoral budget distribution: In the National Strategic Development Plan, of all sectors, the healthcare sector receives the highest budget distribution at the rate of 17.14%. As mentioned in Chapter 3, deterioration of water supply and sanitation environment not only generate water-related diseases but also give economic losses to the tourism sector and the damage is reported to account for 7.2% of the country's GDP (2005). MRD should share information on such influence with the government, related ministries and agencies and should cooperate with related sectors to lobby the government for more effective budget distribution. Solution 2: Efficient budget execution with a limited public treasury: Of MRD's budget for water supply for FY2009, approx. 68% was allocated as workover costs of existing facilities. Workover of existing facilities are

Issues		Proposed solutions
		more inexpensive than the construction of new facilities and the cost-benefit performance is higher. But, malfunction of existing facilities is caused by the fact that a sustainable maintenance system has not been established. Therefore, efforts should be made to solve the issue fundamentally and the budget execution as symptomatic treatment should be cut down in the future.
A1-11	Establishment of procedures for the management of Maintenance Fund	Solution 1: To make understand that the facilities should be operated and renewed only with the users' reserve fund a. Users' obligation, or water fee, should be determined based on the standard maintenance and administration costs and renewal costs calculated for each water supply facility. b. Water supply service to be provided to residents should be determined on the basis of informed choice and depending on their paying capacity. c. Simple and practical guidelines should be developed for residents and the reserve fund should be managed in accordance with such guidelines. d. In order to ensure transparency in the fund, WSUG's annual income and expenditure report should be submitted to the commune council. Solution 2: A subsidy system should be established for facility maintenance and renewal led by MRD.
A1-12	Division of duties in the piped water supply	Solution 1: Even if the current memorandum is respected, sharing of works related to piped water supply should be clearly defined in the national water supply and sanitation policy. (i) To establish a sustainable maintenance and administration system based on the above A1-1 (ii) MRD, in cooperation with MIME and PPWSA, should support the enhancement of PDRD and DORD's technology and operational ability related to piped water supply.
A2-1	Improvement of capacity of personnel in the water supply and sanitation sector	Solution 1: To provide opportunities to ensure human resources for training and to offer effective training (i) To establish a national training center and local satellite training centers in cooperation with MIME (ii) To develop trainers and establish training courses Solution 2: To strengthen a network of water-suppliers (Refer to A3-4 below)

Issues		Proposed solutions
		Solution 3: To provide incentives for participation in training courses (i) To establish a national qualification system (ii) To give license to private companies (for well construction, workover and pump repair) and to integrate training programs
A2-2	Human resource development in the water supply and sanitation sector	Solution 1: To work to encourage existing educational institutes (Institute of Technology of Cambodia, Royal University of Phnom Penh, etc.) to offer courses for fostering engineers of water supply and sanitation facilities
A2-3	Division of duties in the water and sanitation sector among government ministries concerned	Solution 1: To make coordination in preparation for the legislation of the "law related to water and sanitation" and clarify how works should be shared among ministries and agencies under the leadership of the National Cooperation Committee on Water Supply and Sanitation (NCCWSS).
A2-4	Establishment of multi-sector cooperation for the achievement of CMDGs	Solution: To promote collaboration among ministries and agencies using the function of the National Cooperation Committee on Water Supply and Sanitation (NCCWSS) (i) To organize regular committee meetings and to promote information sharing (ii) To provide information from the committee to the government (iii) To establish a system to replace the committee chairman on regular intervals
A3-1	Construction of an efficient and sustainable information management system	Solution 1: MRD should lead the construction of a groundwater database for rural water supply facilities and the Ministry of Water Resources and Meteorology should centrally manage water sources including surface water. (i) To secure continued financial support from the government to create a system that diverse organizations can browse and use effectively (ii) To develop an information management manual that clarifies the role of each organization and the method and procedures of information management (iv) Also concerning new development projects supported by donors and NGOs, the information management sheet should be submitted in accordance with the above-mentioned manual.

Issues		Proposed solutions
		Solution 2: To construct a system to monitor groundwater (i) Monitoring should be carried out at a regular interval at each provincial water sources to promote stable use of groundwater under the leadership of PDRD.
A3-2	Verification of the actual proportions of people with access to safe water and improved sanitation	Solution 1: How to calculate the rate of water supply should be determined and made known to related organizations under the leadership of MRD and MIME. (i) Eventually, water sources that can supply safe drinking water should be made the basis of the water supply rate calculation (complying with the water quality guidelines). (ii) If there is any seasonal variation in use of water sources between rainy and dry seasons, a period of the dry season when water volume is the lowest should be made the basis of calculation. Solution 2: How to calculate the diffusion rate of lavatory should be defined and made known to related organizations under the leadership of MRD (responsible for rural sanitation) and MPWT (responsible for urban sanitation).
A3-3	Opportunities to improve capacity of PDRD staff	Refer to A2-1.
A3-4	Active participation of the private sector	Solution 1: To reorganize the Water Suppliers Association in cooperation with MIME (i) To secure continued support from the government Solution 2: To introduce a preferential treatment mechanism for new-entry companies (i) To introduce a financing system and a subsidy system (ii) To simplify registration procedures and decrease entry cost (iii) To reduce tax burden
A3-5	Nationwide rural water supply master plan	Solution 1: To develop a water supply and sanitation master plan combined with support to community activities in developing regions Solution 2: To evaluate the groundwater development potential in various areas around the nation, develop hydraulic geological maps and formulate an effective groundwater development plan based on the database

Issues		Proposed solutions
		mentioned in A3-1 above
A3-6	Low rate of supply of improved water	Solution 1: Promotion of construction of new facilities (1) Review of the government's sectoral budget distribution and effective execution of budgets (Refer to A1-10 above) (ii) To incorporate water supply and sanitation facilities development plans into the provinces and communes' development strategy plans (5-year plans), plans of the Ministry of Development and Investment Planning (3-year plans) and the provincial investment plans (annual plans) and to secure funds for sectoral development in provinces and communes' budgets (iii) To promote the groundwater development program conducted by MRD's digging crew for areas where the poorest in society live (iv) To obtain support from donors and NGOs (v) To establish a subsidy system for new construction projects Solution 2: To reduce the failure rate of existing facilities and refurbish non-operational facilities (i) To construct a sustainable management system (Refer to A1-1 above) (ii) To development a quality control system (Refer to A1-9 above) Solution 3: Reduction of facilities' cost and diffusion of appropriate technology (Refer to A1-1 above)
A3-7	Unsanitary private wells	Solution of 1: To promote activities to improve residents' awareness of safe water use (i) To promote IEC (Information, Education and Communication) activities to improve residents' awareness of safe water use (ii) To establish a government's subsidy system so that groups of households can secure safe drinking water sources
B1-1-1	Low priority is given to development of water supply and sanitation facilities	Solution 1: To develop an overall master plan for regional development including water supply and sanitation plans with an aim to improve rural residents' living standards and reduce poverty and to promote phased implementation of projects. The overall regional development master plan should have 3 major

Issues		Proposed solutions
		focuses—securing of safe water sources, improvement of sanitation environment and plans to improve living standards (i) Understanding of groundwater development potentials (ii) Formulation of effective plans for water supply facilities (iii) Formulation of programs to effectively improve sanitation environment, including both software and hardware (iv) Formulation of programs to improve community-level living standards
B1-2-1	Diffusion of appropriate technology and securing of safe water sources	Solution 1: To establish water processing technology suitable to each region's condition, because regions where groundwater development is difficult are forced to depend on surface water (i) To clarify the water processing service standards (from households to water purification plants) in relation with above-mentioned A1-8 (ii) To create planning and designing manuals for water processing service standards in relation with above-mentioned A1-4 Solution 2: To carry out sanitation education concerning safe water use for residents
B1-3-1	Securing of safe water sources	Solution 1: Same as the above-mentioned B1-2-1
B1-4-1	Provision of water supply facilities to poverty groups	Solution 1: To investigate needs for water supply facilities except for urban pipe networks and to maintain and administrate existing facilities under the leadership of the government so that at least a minimum of public service can be provided to poverty group
B1-4-2	Improvement of sanitation environment	Solution 1: To formulate urban sewage development plans under the leadership of MPWT which is the responsible ministry and to implement projects based on the plans Solution 2: To support the development of small-scale catch basins at each household for the time being under the cooperation between MRD, MPWT, MOH, MOE, etc.

5.3 Urban and Rural Water Supply System Development

5.3.1 Current Water Demand and Future Demand Projection

(1) Current water demand

Cambodian water demand has been increasing owing to its urbanization and population growth and as described in Chapter 4. Current water demand is now higher than water supply amount. As a result, temporal water supply is popular in urban water supply and in case of village water supply, they use unsanitary water not suitable for potable use, such as river water and pond water when regular water source, represented by groundwater is not available.

(2) Target year

As development level differs by each province, respective target year setting is ideal but since it is so time-consuming work, it is not affordable within this limited study period. Therefore, unified target year of 2025, 15 years later from now is set due to the following reasons:

- The Rectangular Strategy set the target to supply safe water to all citizens within 20 years. Though specific target year was not described in the plan, 2025 is almost corresponding to "20 year after" of the year 2004 when the plan was established.
- The rural water supply and sanitation policy set the target to supply stable and safe potable water to all villagers until 2025.
- The target year of the Millennium Development Goal is set at 2015, but it is too early as the target year for this study.

(3) Policy in population projection

As national census was held in 2008, population and population growth data by commune is available.

Commune-wise population projection was conducted by the following three methods. Though the results of Method 3 deemed to be the one most reflecting the locality, they were compared with the results of Method 1 and 2 for cross-checking.

Method 1 : Apply the provincial average population growth rate to urban and rural area population projection.

Method 2 : Apply national average population growth rate in urban area to urban area population projection. While that of rural area is applied to rural area population projection.

Method 3 : Apply provincial average population growth rate of urban area to urban area population projection. While that of rural area is applied to rural area population projection.

As a result, extremely high growth rates that can not be explained by natural growth were observed in some provinces facing national border. These provinces are affected by social growth, namely population influx. However, as such high population inflow rate will not likely

last for several decades, some adjustment on population projection is needed for such provinces. Thus, upper limit of the ratio of estimated population in 2025 against the current population was set by 200% and if the calculated population by Method 3 exceeds 200%, the projected population was set by the said upper limit. Four province of Pailin, OtdarMeanchey, Mondol Kiri and Ratana Kiri corresponded to this case.

Table 5.3.1 Comparison of Population Projection

		Current Population			Projection Method 1 (Adopt provincial growth rate for both urban and rural)					Projection Method 2 (Adopt average growth rate of urban or rural respectively)				Projection Method 3 (Adopt growth rate for each area)						Increase from 2008
		Urban	Rural	Total	Provincial growth rate	a. Urban ⇒Urban	b. Rural ⇒Urban	c. Rural ⇒Rural	Total (a+b+c)	a. Urban ⇒Urban 2.21 %	b. Rural ⇒Urban 1.38 %	c. Urban ⇒Rural 1.38 %	Total (a+b+c)	Provincial urban growth rate	Provincial rural growth rate	a. Urban ⇒Urban	b. Rural ⇒Urban	c. Rural ⇒Rural	Total (a+b+c)	
		2008	2008	2008		2025	2025	2025		2025	2025	2025				2025	2025	2025		
1	Banteay Meanchey	181,396	496,476	677,872	1.56	236,001	162,083	483,849	881,933	263,036	140,913	485,829	889,778	2.92	1.10	295,886	112,075	485,883	893,844	132%
2	Battambang	180,853	844,321	1,025,174	2.28	265,320	515,485	723,165	1,503,970	262,247	325,042	740,805	1,328,094	0.21	2.78	187,420	589,376	755,696	1,532,492	149%
3	Kampong Cham	118,242	1,561,750	1,679,992	0.43	127,189	973,553	706,374	1,807,116	171,459	1,418,009	553,507	2,142,975	0.05	0.46	119,251	1,000,922	687,552	1,807,725	108%
4	Kampong Chhnang	43,130	429,211	472,341	1.22	53,003	182,533	344,941	580,477	62,542	187,500	354,325	604,367	0.33	1.32	45,615	185,621	350,779	582,015	123%
5	Kampong Speu	54,505	662,439	716,944	1.79	73,693	677,642	217,996	969,331	79,037	612,299	223,947	915,283	1.26	1.84	67,434	683,327	219,824	970,585	135%
6	Kampong Thom	31,871	599,538	631,409	1.03	37,936	142,662	570,968	751,566	46,214	174,294	582,547	803,055	0.15	1.08	32,695	165,731	553,931	752,357	119%
7	Kampot	48,274	537,576	585,850	1.03	57,460	410,364	229,508	697,332	70,001	440,343	238,281	748,625	0.64	1.06	57,751	412,441	230,671	700,863	120%
8	Kandal	195,898	1,069,382	1,265,280	1.62	257,440	1,333,670	71,658	1,662,768	284,064	1,265,810	84,153	1,634,027	2.93	1.40	320,068	1,270,063	84,434	1,674,565	132%
9	Koh Kong	36,053	81,428	117,481	0.12	36,796	0	83,104	119,900	52,279	0	102,792	155,071	(1.48)	0.92	27,981	0	95,145	123,126	105%
10	Kratie	35,964	283,253	319,217	1.93	49,773	35,305	356,717	441,795	52,151	32,202	325,368	409,721	(0.10)	2.22	35,357	37,052	374,369	446,778	140%
11	Mondul Kiri	4,859	56,248	61,107	6.34	13,816	0	159,938	173,754	7,046	0	71,006	78,052	5.76	6.39	12,590	0	161,222	173,812	284%
12	Phnom Penh	1,242,992	84,623	1,327,615	2.83	1,997,583	135,994	0	2,133,577	1,802,420	106,827	0	1,909,247	2.68	5.37	1,948,623	205,909	0	2,154,532	162%
13	Preah Vihear	10,679	160,460	171,139	3.61	19,515	2,849	290,375	312,739	15,485	0	202,561	218,046	3.10	3.64	17,944	2,863	291,807	312,614	183%
14	Prey Veng	33,079	914,293	947,372	0.01	33,136	515,832	400,017	948,985	47,967	880,254	273,933	1,202,154	(0.65)	0.03	29,607	522,380	396,586	948,573	100%
15	Pursat	25,650	371,511	397,161	0.69	28,831	96,236	321,346	446,413	37,194	108,080	360,908	506,182	(0.57)	0.79	23,274	97,871	326,818	447,963	113%
16	Ratanak Kiri	19,317	131,149	150,466	4.67	41,968	5,295	279,640	326,903	28,011	0	165,561	193,572	5.40	4.57	47,231	5,209	275,131	327,571	218%
17	Siem Reap	174,265	722,178	896,443	2.52	266,045	472,197	630,332	1,368,574	252,696	294,711	616,948	1,164,355	5.28	1.96	417,917	371,983	632,516	1,422,416	159%
18	Preah Sihanouk	89,447	131,949	221,396	2.54	137,010	48,546	153,566	339,122	129,704	40,009	126,561	296,274	2.93	2.28	161,805	46,496	147,079	355,380	161%
19	Stung Treng	17,022	94,649	111,671	3.20	29,078	0	161,681	190,759	24,683	0	119,482	144,165	1.17	3.61	20,744	0	172,961	193,705	173%
20	Svay Rieng	17,029	465,759	482,788	0.09	17,291	215,329	257,607	490,227	24,694	363,020	224,938	612,652	0.02	0.09	17,087	215,329	257,607	490,023	101%
21	Takeo	14,456	830,450	844,906	0.66	16,166	753,285	175,432	944,883	20,962	900,290	148,049	1,069,301	0.56	0.67	15,896	754,557	175,727	946,180	112%
22	Otdar Meanchey	18,694	167,125	185,819	8.64	76,477	72,336	611,365	760,178	27,108	11,716	199,260	238,084	4.36	9.26	38,617	125,673	627,478	791,768	426%
23	Kep	4,678	31,075	35,753	2.21	6,783	45,061	0	51,844	6,783	39,228	0	46,011	1.52	2.31	6,046	45,817	0	51,863	145%
24	Pailin	15,674	54,812	70,486	11.24	95,855	276,173	59,033	431,061	22,728	0	69,193	91,921	6.10	13.36	42,889	462,055	0	504,944	716%
Total		2,614,027	10,781,655	13,395,682	1.54	3,974,165	7,072,430	7,288,612	18,335,207	3,790,511	7,340,547	6,269,954	17,401,012	2.21	1.38	3,989,728	7,312,750	7,303,216	18,605,694	139%

Source：2008 Census

(4) Policy in classification of Urban/Rural area in 2025

According to the population projection methods described in the previous section, population by commune was estimated. 2008 Census adopted the following classification criteria:

a) Commune population density exceeds 200 person/km^2
b) Total commune population surpasses 2,000 persons
c) Total number of agricultural workers is less than 50% of total commune population

Then, communes were classified into the following three categories:

Description	Categories
Communes satisfies criteria a) and b) or communes belong to the provincial capital but currently regarded as "Rural Area"	Developing Rural Area, Sub-urban Area
Currently recognized as "Urban Area"	Urban Area
Areas are not corresponding to the abovementioned	Rural Area

Projected population in 2025 and population in 2008 in each commune category are shown in **Table 5.3.2**. Total population of 162 communes categorized as urban area in 2008 was 2,614,027. It is anticipated to be increased to 3,930,743 in 2025, approximately 1.5 times.

Table 5.3.2 Adopted Population Projection of Urban and Rural

No.	Province	a. Urban		b.Semi urban		c.Rural		Total (a+b+c)	
		2008	2025	2008	2025	2008	2025	2008	2025
1	Banteay Meanchey	181,396	295,886	0	112,075	496,476	485,883	677,872	893,844
2	Battambang	180,853	187,420	0	589,376	844,321	755,696	1,025,174	1,532,492
3	Kampong Cham	118,242	119,251	0	1,000,922	1,561,750	687,552	1,679,992	1,807,725
4	Kampong Chhnang	43,130	45,615	0	185,621	429,211	350,779	472,341	582,015
5	Kampong Speu	54,505	67,434	0	683,327	662,439	219,824	716,944	970,585
6	Kampong Thom	31,871	32,695	0	165,731	599,538	553,931	631,409	752,357
7	Kampot	48,274	57,751	0	412,441	537,576	230,671	585,850	700,863
8	Kandal	195,898	320,068	0	1,270,063	1,069,382	84,434	1,265,280	1,674,565
9	Koh Kong	36,053	27,981	0	0	81,428	95,145	117,481	123,126
10	Kratie	35,964	35,357	0	37,052	283,253	374,369	319,217	446,778
11	Mondul Kiri	4,859	8,853	0	0	56,248	113,361	61,107	122,214
12	Phnom Penh	1,242,992	1,948,623	0	205,909	84,623	0	1,327,615	2,154,532
13	Preah Vihear	10,679	17,944	0	2,863	160,460	291,807	171,139	312,614
14	Prey Veng	33,079	29,607	0	522,380	914,293	396,586	947,372	948,573
15	Pursat	25,650	23,274	0	97,871	371,511	326,818	397,161	447,963
16	Ratanak Kiri	19,317	43,390	0	4,785	131,149	252,757	150,466	300,932
17	Siem Reap	174,265	417,917	0	371,983	722,178	632,516	896,443	1,422,416
18	Preah Sihanouk	89,447	161,805	0	46,496	131,949	147,079	221,396	355,380
19	Stung Treng	17,022	20,744	0	0	94,649	172,961	111,671	193,705
20	Svay Rieng	17,029	17,087	0	215,329	465,759	257,607	482,788	490,023
21	Takeo	14,456	15,896	0	754,557	830,450	175,727	844,906	946,180
22	Otdar Meanchey	18,694	18,126	0	19,632	167,125	333,880	185,819	371,638
23	Kep	4,678	6,046	0	45,817	31,075	0	35,753	51,863
24	Pailin	15,674	11,974	0	45,932	54,812	83,066	70,486	140,972
Total		2,614,027	3,930,743	0	6,790,162	10,781,655	7,022,449	13,395,682	17,743,355
Commune		162	162	0	647	1,459	812	1,621	1,621

(5) Recognition of Urban/Rural area in the target year

Transition from "rural area" to "urban area" or "semi-urban area" is shown in **Figure 5.3.1** and **Figure 5.3.2**.

Current urban/rural ratio is 2 : 8, but the projection shows that the ratio will transfer to ratio among "urban area", "semi-urban area" and "rural area" of 2 : 4 : 4 in 2025.

Total area of "developing rural area, semi-urban area" corresponds to 11% of the total national land area and that of urban area is 1%. Therefore, 60% of national population will concentrate to 12% of total land area in 2025.

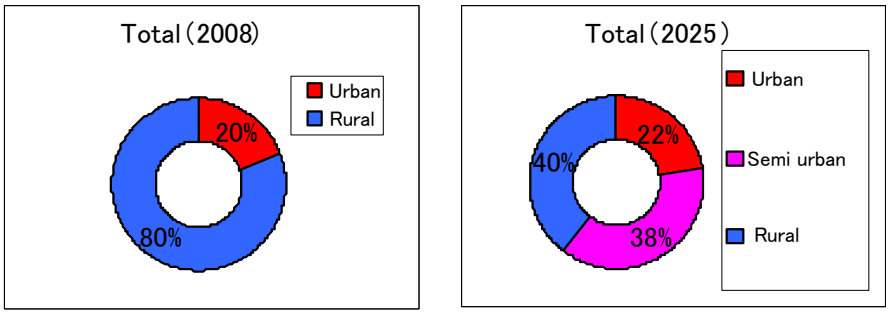


Figure 5.3.1 Population Proportion of Urban and Rural

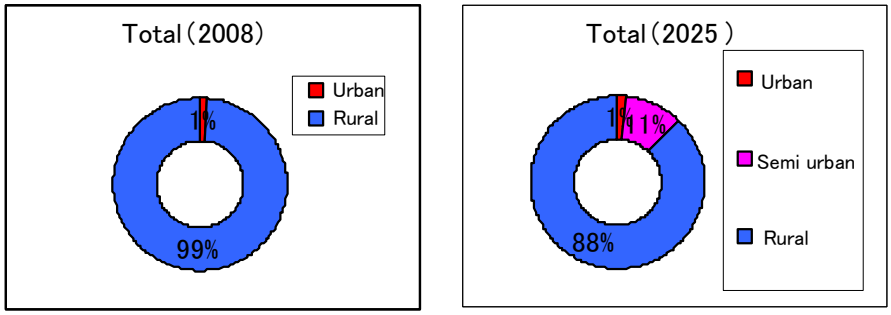


Figure 5.3.2 Area Proportion of Urban and Rural

Transition in commune number of each category is displayed in **Table 5.3.3** and province-wise transition is shown in **Figure 5.3.3**.

Table5.3.3 Comparison of Number of Commune by Category

Category	2008	2025
Urban	162	162
Semi urban	0	647
Rural	1,459	812
Total	1,621	1,621

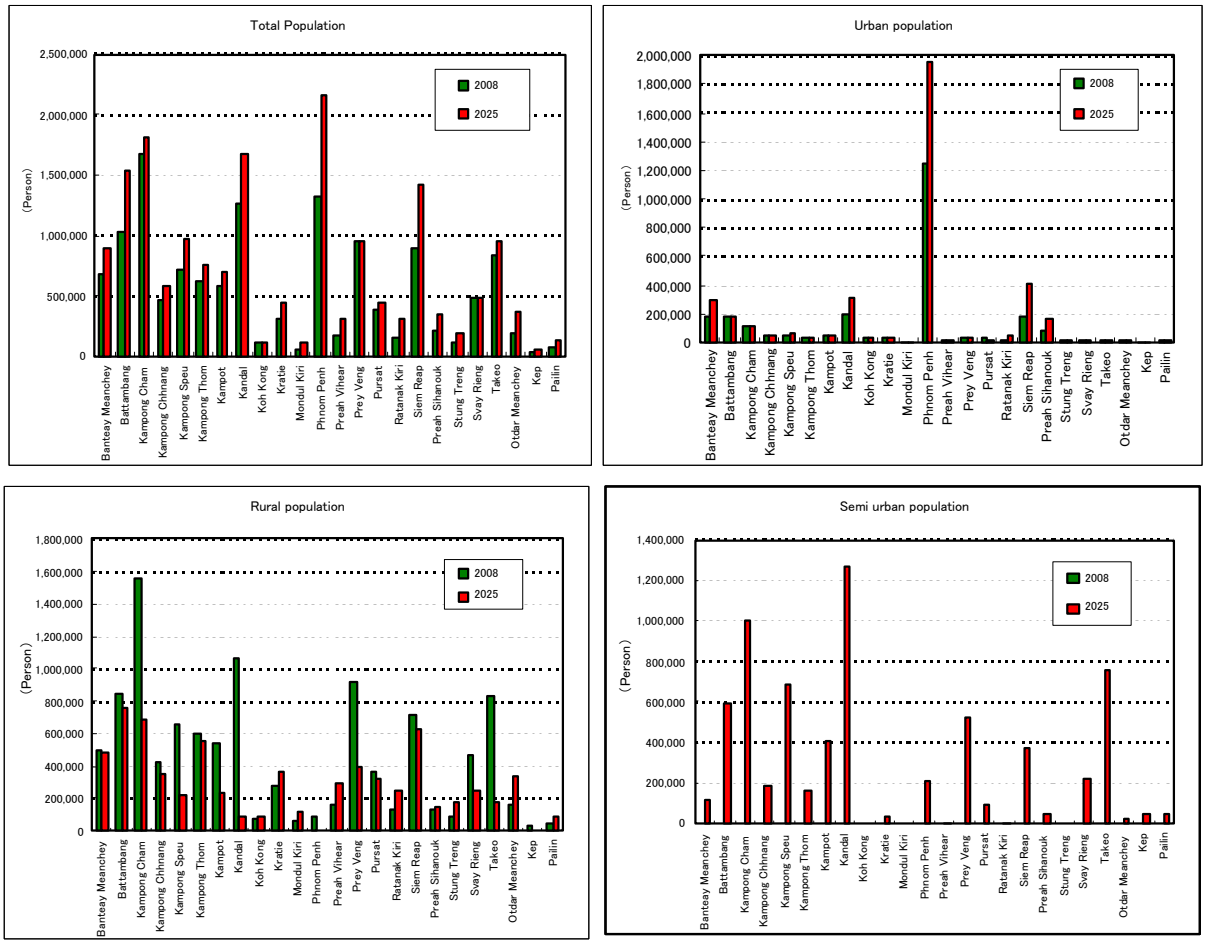


Figure 5.3.3 Population Comparison between 2008 and Target Year

Composition of urban area and rural area in 2008 and 2025 is illustrated in **Figure 5.3.4** and **Figure 5.3.5**. Since many rural areas surrounding Phnom Penh are anticipated to be transferred to semi-urban area, it is suggesting the potentials in future urbanization.

However, it is noteworthy that "semi-urban area" involves the followings:

- Communes to be substantially urbanized with growing residential areas
- Rural areas with growing population without infrastructure development

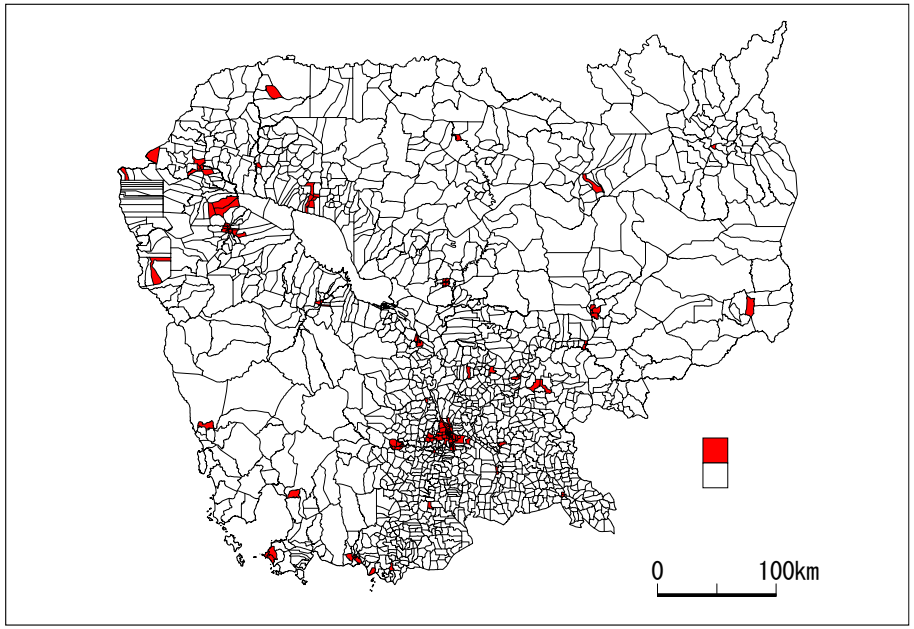


Figure 5.3.4 Existing Urban Areas in 2008

Source: 2008 Census

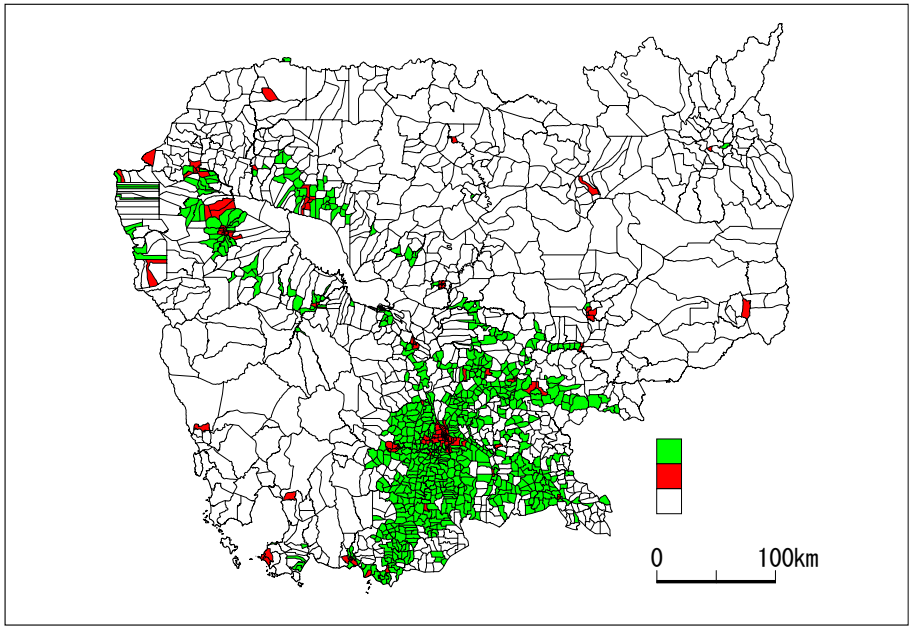


Figure 5.3.5 Projected Urban Areas in 2025

Source: Projected by Study Team based on 2008 Census

(6) Unit water consumption rate setting

Unit water consumption rate in urban water supply is calculated based on efficient water consumption, deducting water leakage amount and service population in typical six provinces.

Table 5.3.4 shows the unit water consumption rate for urban water supply. The results are ranging from 90 to 170L/capita/day, but 170L/capita/day seemed rather high considering the current status of Cambodia. Thus, 120L/capita/day, the second rate is adopted.

As to the rate in rural area, MRD has no standard; therefore, 40L/capita/day is adopted based on the design criteria employed in four Japanese Grant Aid projects.

Table 5.3.4 Unit Water Consumption Rate in Urban Water Supply

Province	Water Production (m3/day)	Leakage （%）	Effected consumption (m3/day)	Service Population (Person)	Per capita consumption (lpcd)
Battambang	7,730	30.0	5,946	66,538	89.4
Kampong Cham	4,580	14.2	4,011	39,723	101.0
Kratie	100	29.0	78	1,480	52.4
Prey Veng	1,300	20.0	1,083	8,100	133.7
Pursat	2,850	22.0	2,336	19,025	122.8
Svay Rieng	1,343	19.0	1,129	6,660	169.5

(7) Future water demand projection

By estimated urban and rural population in 2025 and unit water consumption rate, future water demand was estimated. **Table 5.3.5** shows provincial-wise estimated water demand of urban and rural water supply system. As to "developing rural area, sub-urban area", unit water consumption of rural area was adopted.

Table 5.3.5 Water Demand Projection

		Water Demand (m3.day)								
		Present			Projection		Breakdown			
		Urban	Rural	Total	Urban	Rural	Urban --> Urban	Rural --> Urban	Rural --> Rural	Total
					(a)	(b+c)	(a)	(b)	(c)	(a+b+c)
		120 lpcd	40 lpcd		120 lpcd	40 lpcd	120 lpcd	40 lpcd	40 lpcd	
		2008	2008	2008	2025	2025	2025	2025	2025	2025
1	Banteay Meanchey	21,768	19,859	41,627	35,506	23,918	35,506	4,483	19,435	59,425
2	Battambang	21,702	33,773	55,475	22,490	53,803	22,490	23,575	30,228	76,293
3	Kampong Cham	14,189	62,470	76,659	14,310	67,539	14,310	40,037	27,502	81,849
4	Kampong Chhnang	5,176	17,168	22,344	5,474	21,456	5,474	7,425	14,031	26,930
5	Kampong Speu	6,541	26,498	33,038	8,092	36,126	8,092	27,333	8,793	44,218
6	Kampong Thorn	3,825	23,982	27,806	3,923	28,786	3,923	6,629	22,157	32,710
7	Karnpot	5,793	21,503	27,296	6,930	25,724	6,930	16,498	9,227	32,655
8	Kandal	23,508	42,775	66,283	38,408	54,180	38,408	50,803	3,377	92,588
9	Koh Kong	4,326	3,257	7,583	3,358	3,806	3,358	0	3,806	7,164
10	Kratie	4,316	11,330	15,646	4,243	16,457	4,243	1,482	14,975	20,700
11	Mondul Kiri	583	2,250	2,833	1,062	4,534	1,062	0	4,534	5,597
12	Phnorn Penh	149,159	3,385	152,544	233,835	8,236	233,835	8,236	0	242,071
13	Preah Vihear	1,281	6,418	7,700	2,153	11,787	2,153	115	11,672	13,940
14	Prey Veng	3,969	36,572	40,541	3,553	36,759	3,553	20,895	15,863	40,311
15	Purs at	3,078	14,860	17,938	2,793	16,988	2,793	3,915	13,073	19,780
16	Ratanak Kiri	2,318	5,246	7,564	5,207	10,302	5,207	191	10,110	15,508
17	Siern Reap	20,912	28,887	49,799	50,150	40,180	50,150	14,879	25,301	90,330
18	Preah Sihanouk	10,734	5,278	16,012	19,417	7,743	19,417	1,860	5,883	27,160
19	Stung Treng	2,043	3,786	5,829	2,489	6,918	2,489	0	6,918	9,408
20	Svay Rieng	2,043	18,630	20,674	2,050	18,917	2,050	8,613	10,304	20,968
21	Takeo	1,735	33,218	34,953	1,908	37,211	1,908	30,182	7,029	39,119
22	Otdar Meanchey	2,243	6,685	8,928	2,175	14,140	2,175	785	13,355	16,316
23	Kep	561	1,243	1,804	726	1,833	726	1,833	0	2,558
24	Pailin	1,881	2,192	4,073	1,437	5,160	1,437	1,837	3,323	6,597
Total		313,683	431,266	744,949	471,689	552,504	471,689	271,606	280,898	1,024,194

5.3.2 Urban and Rural Water Supply System Development

The captioned is conducted based on the following policies.

(1) Basic Conditions

Design target year is set by 2025 as aforementioned. The target administrative unit for water supply system development is "Commune". As stated in Chapter 2, Cambodian administrative units are comprised of 24 provinces, 193 districts, 1,621 communes and 14,074 villages.

(2) Evaluation criteria for urban area

Future development of urban/rural areas depends on the potentials in urban infrastructure upgrading and tourism resource. Further, the urbanization is largely affected by public/private strategic investment. However, since this study does not include the establishment of urban planning, the existing urban plan is taken into consideration.

(3) Type of proposed water supply system

Based on the current water supply status, the following six types of water supply system are proposed.

Table 5.3.6 Recommended Water Supply System Types

Category	Type	System Composition and Explanation
Urban Water Supply	U-I Type	Mainly served by private system. Support is offered to upgrade the service level.
	U-II Type	Direct assistance on public system. Expand the service area by system improvement and expansion, water source development and water leakage reduction
	U-III Type	To be adopted in areas where water supply service is still not fully developed in spite of sufficient target service population. F/S for urban water supply system is needed.
Rural Water Supply	R-I Type	Small piped water supply facilities operated by community
	R-II Type	Tube well operated by community
	R-III Type	Rain season: Rainwater collection tank, Dry season: Community pond, surface water and water treatment equipment at household level

(4) Location of water supply systems

Comparing urban/rural water supply system, elements to be considered on feasibility assessment differs as investment scale varies.

In case of urban system, as unit investment scale is large, specific information such as current status of water supply project and needs in communes, shall be evaluated by pin-point.

While in case of rural water supply, feasibility assessment shall be done by cross-sectional viewpoint utilizing quantitative index such as commune population and water source availability. Since unit investment scale of rural system is small and many standardized facilities are available, feasibility shall be examined by numerical criterion.

Through the examination, the existence of "semi-urban area" having population density

equivalent to the urban areas was identified. These areas are substantially villages but they have possibility of future population growth which makes service by urban system feasible in the long term. Therefore, though rural system shall be developed urgently to deal with the increasing water demand, transition to urban system shall also be taken into account from long term viewpoint.

To display such complicated situation, the visual expression showing the adoption of six types of water supply system by commune was executed on GIS drawing.

Selection flow is shown in **Figure 5.3.6**.

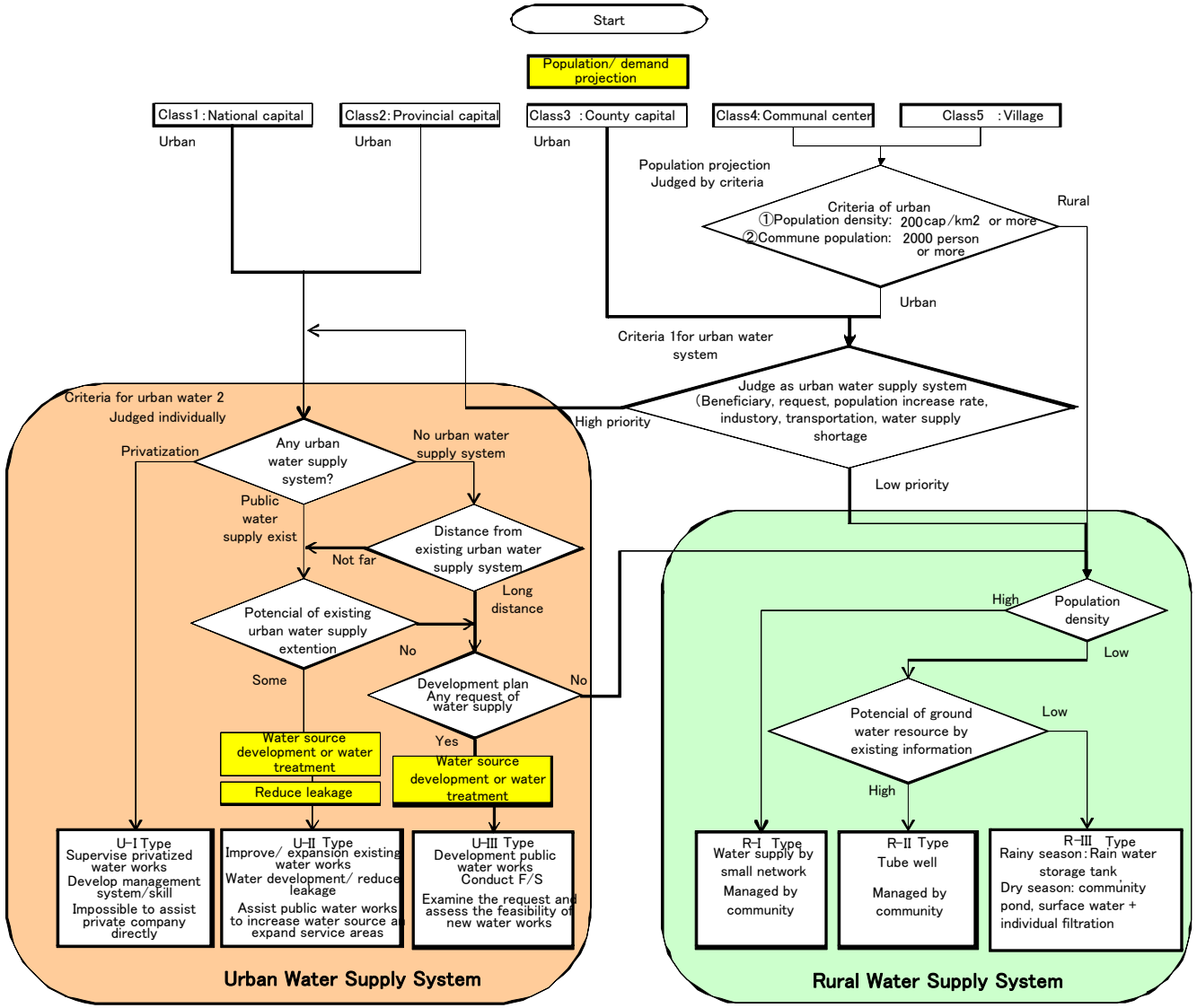


Figure 5.3.6 Study Flow Chart for Urban and Rural Water Supply Expansion

The specific procedures for the selection of the type of service are as follows:

1. Population projection and area analysis will be performed commune-wise and the classification of “urban area”, “developing rural area, sub-urban area” and “rural area” will be displayed on the GIS drawings according to the result.

2. Regarding to the communes defined as “urban area”, potential of service by urban system shall be assessed as follows:.

【U-1 Type】

U-1 Type shows communes without existing public system or communes isolated/far from the public system. Urgent development of water supply by public service system is deemed to be unrealistic in these communes due to financial constraint. If they are currently served by private system, the same service should be maintained through the future. Assistance shall be rendered to upgrade the service quality by the private system.

【U-2 Type】

This type is communes currently served by public system or located in the urbanized area in the category, adjoining to the existing public service system. They are supposed to be served by public system by expanding the existing system or connecting the area to the adjoining public system through the future.

【U-3 Type】

U-3 Type is communes without any water supply system, not located adjoining to the existing public system, and recognized as urbanized communes. Shortage of water supply by the existing rural system in the near future will be serious and urgent for the residents in this category. If the condition for new construction of public system is considered to be favorable and the areas have some degree of scale for the water supply system, there will be possibility of introduction of urban water supply based on the investigation of existing water supply system. In such case, needs of conducting F/S for starting public or private system with assistance of private system will be confirmed upon evaluation of the following factors:

- Projection of current and future water demand and shortage
- Needs of commune residents towards water supply service by urban system
- Willingness of surrounding private system to offer water supply service

Priority for the detailed study should be given to the areas for strong needs and requests for the urban water supply.

3. As to communes defined as “rural area”, groundwater development potential shall be evaluated based on the data listed in the following table to locate communes where groundwater development is difficult in quantitatively and qualitatively. Then, classification into R-1 to R-3 shall be conducted.

Table 5.3.7 List of Evaluation Materials for Groundwater Development Potential

Item		Judging data
Groundwater quantity		・The Study on Groundwater Development in Southern Cambodia（1996～2001）by JICA ・The Study on Groundwater Development in Central Cambodia（2000～2002）by JICA
Groundwater quality	Arsenic	・ANNUAL REPORT 2009 by A Report prepared for the Arsenic Inter-Ministerial Sub-Committee Arsenic Secretariat, Ministry of Rural Development
	Fluorine	・The Study on Groundwater Development in Southern Cambodia（1996～2001）by JICA ・The Study on Groundwater Development in Central Cambodia（2000～2002）by JICA
	Iron	・The Study on Groundwater Development in Southern Cambodia（1996～2001）by JICA ・The Study on Groundwater Development in Central Cambodia（2000～2002）by JICA ・Hearing to PDRD
	Salt	・The Study on Groundwater Development in Southern Cambodia（1996～2001）by JICA ・The Study on Groundwater Development in Central Cambodia（2000～2002）by JICA ・Hearing to PDRD ・Communes along sea

【R-1 Type】

Criteria on small-scale piped system selection established by MRD are:

- Densely inhabited areas
- Areas where groundwater utilization is difficult

Even though some communes are currently served by groundwater, if population density is high, the potential for piped water system development is judged to be high. Therefore, small-scale piped systems are proposed for communes with a population exceeding 2,000 and population density surpassing 180 person/km^2.

【R-2 Type】

This pattern is the most basic rural water supply system.

【R-3 Type】

Communes where piped water supply system is not feasible and groundwater production potential is insufficient, shall be served by R-3 type.

4. Communes classified into "developing rural area, sub-urban area" have potentials to be served by either urban or rural system. Communes located next to the existing service area of public/private system may be served by the existing system if it is expanded.

   U-1 type is applicable to communes located near to private system, while U-2 type is applicable to communes located in vicinity of public system.

   Communes which are not corresponding to the abovementioned cases, feasibility of introduction of the following system shall be examined.

   - Communes where well construction is possible: R-2 type
   - Communes having demand for the system: R-1 type or U-3 type

(5) Provincial service area plan

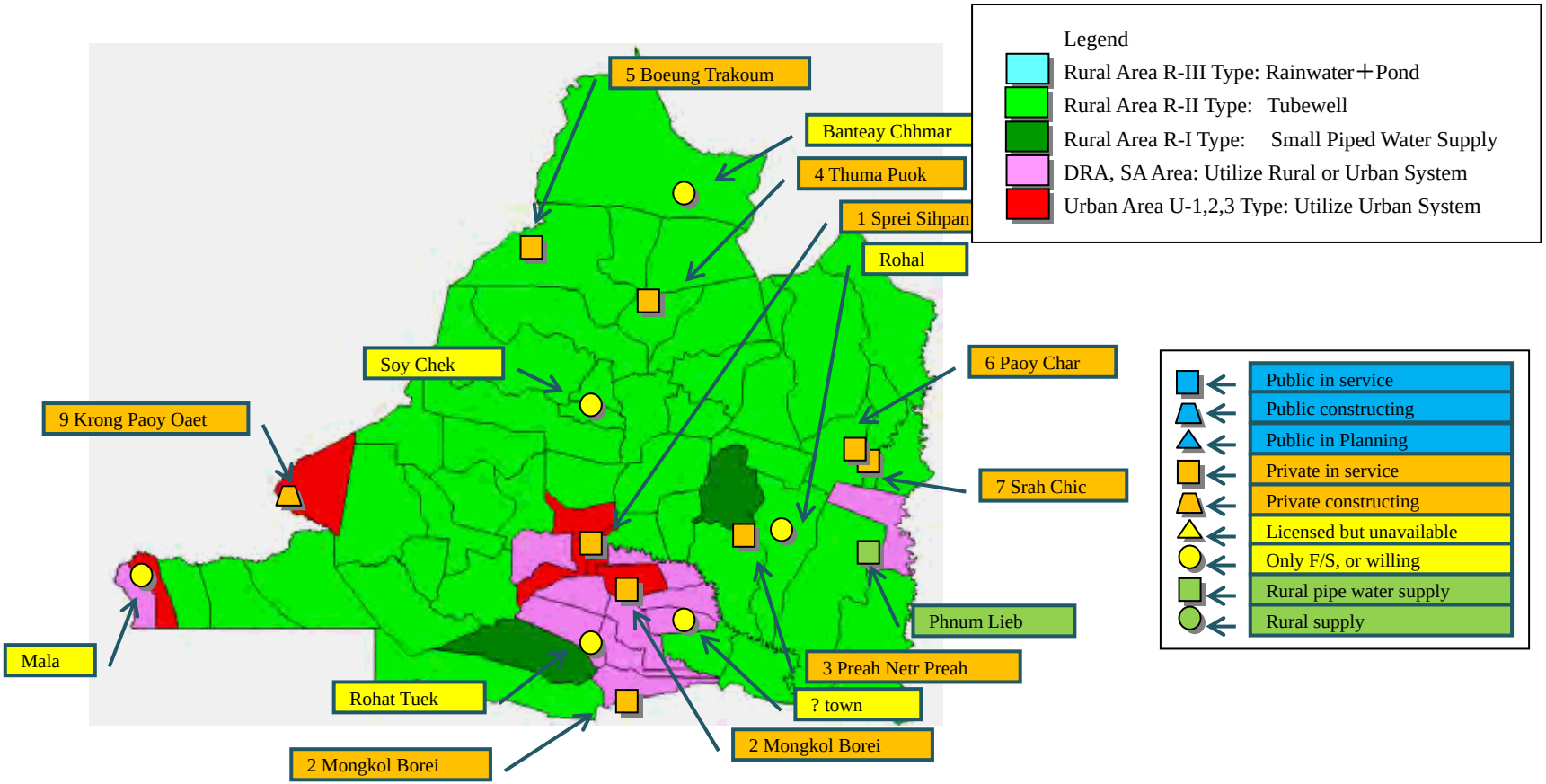
Provincial-wise service area plan prepared based on the aforementioned conditions is displayed from the next page.

Based on the result of the analysis mentioned above, breakdown of commune water supply system in target year of 2025 is as follows:

Table 5.3.8 Number of Communes by recommended Water Supply System（2025）

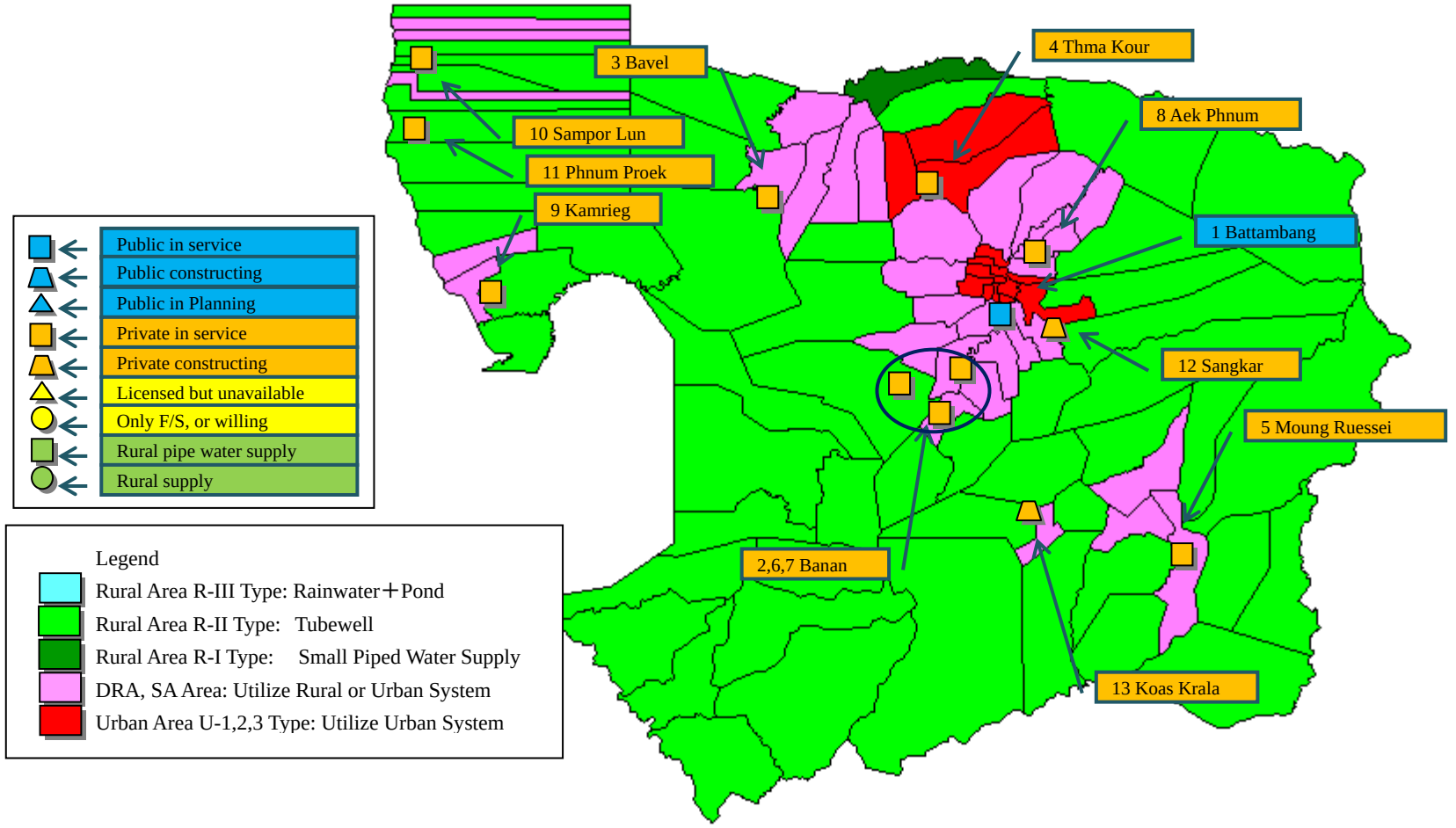
Number of Communes in 2008		Number of Communes in 2025	
Urban	162	Urban（Existing Urban Areas）	162
		Developing Rural Area, Sub-urban Area	647
Rural	1,459	R-I Type	61
		R-II Type	610
		R-III Type	141
		Rural Total	812
Urban＋Rural Total	1,621	Urban＋Rural Grand Total	1,621

Examination results are illustrated on the following drawings.



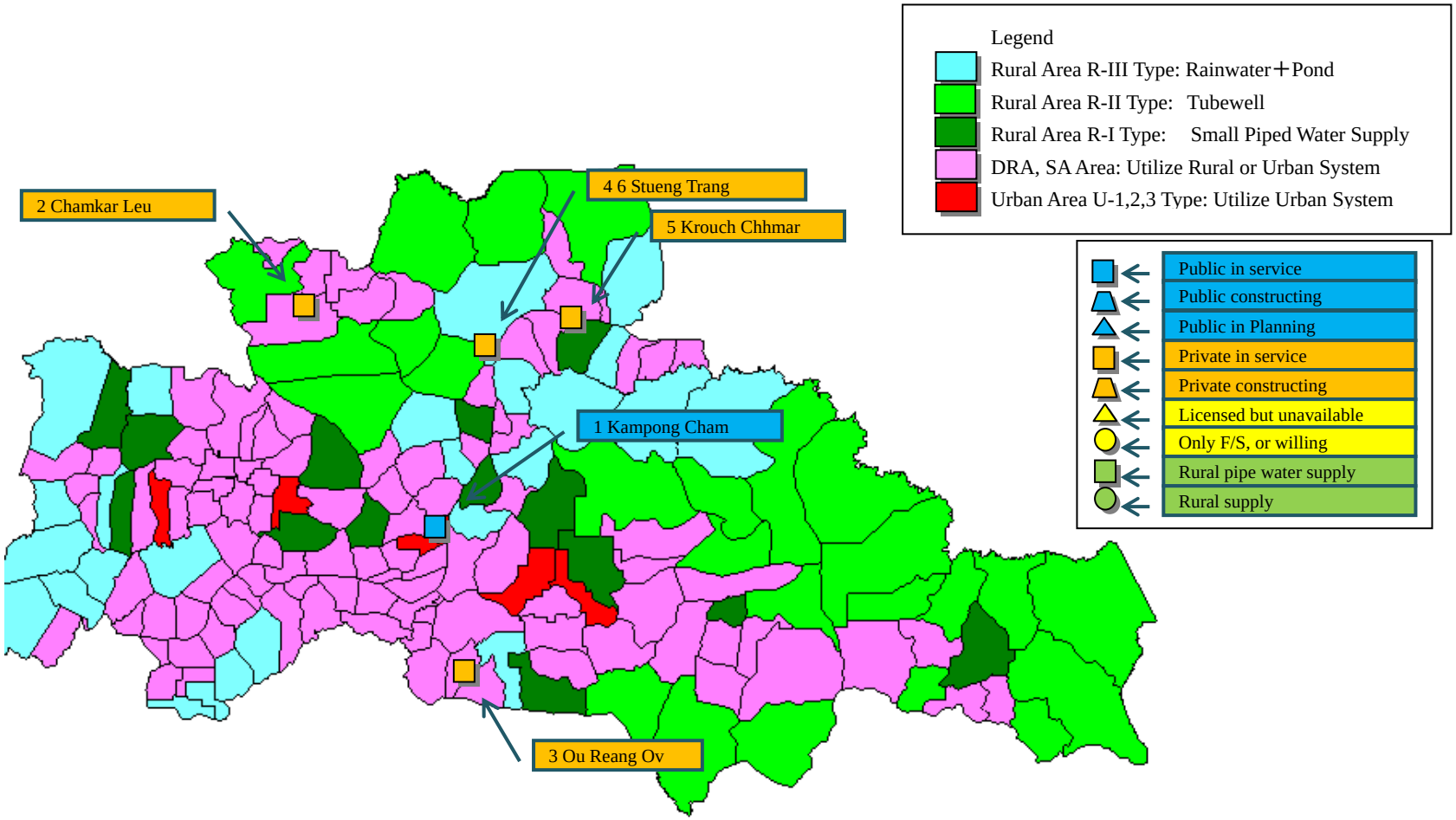
Source: Study Team

Figure 5.3.7 Proposed Water Supply Service System（Banteay Meanchey Province）



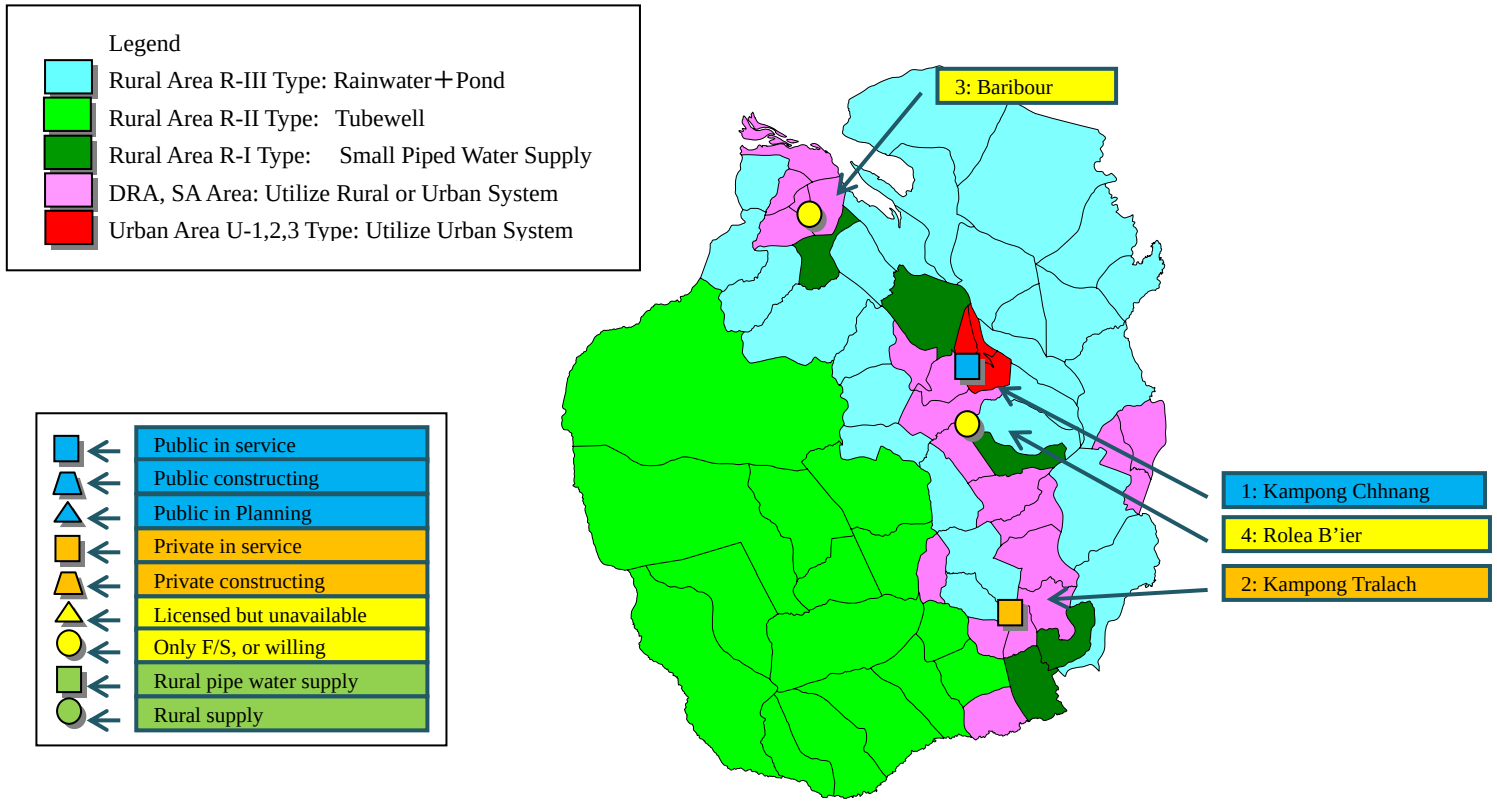
Source: Study Team

Figure5.3.8 Proposed Water Supply Service System（Battambang Province）



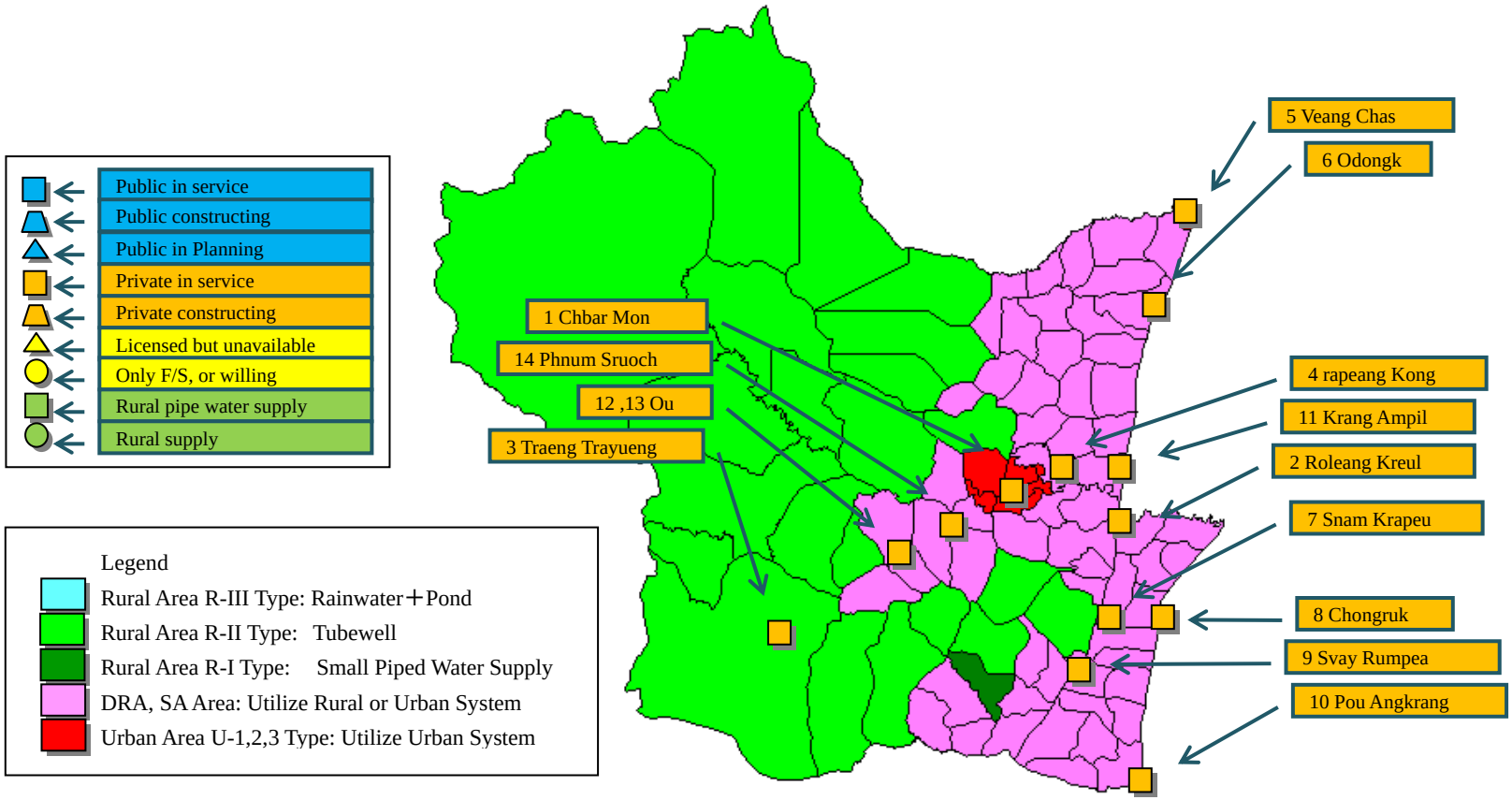
Source: Study Team

Figure 5.3.9 Proposed Water Supply Service System（Kampong Cham Province）



Source: Study Team

Figure 5.3.10 Proposed Water Supply Service System（Kampong Chhnang Province）



Source: Study Team

Figure 5.3.11 Proposed Water Supply Service System（Kampong Speu Province）

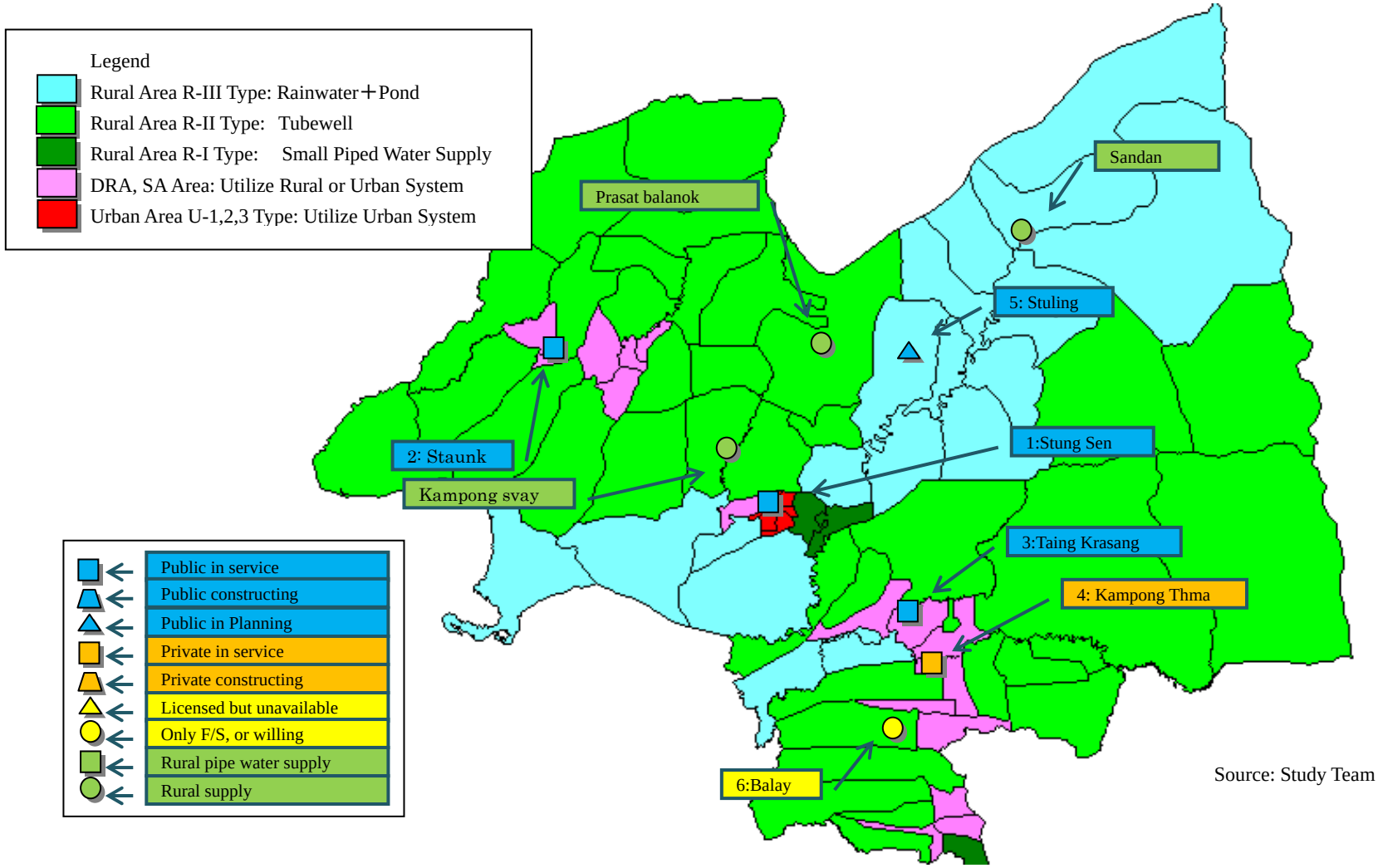
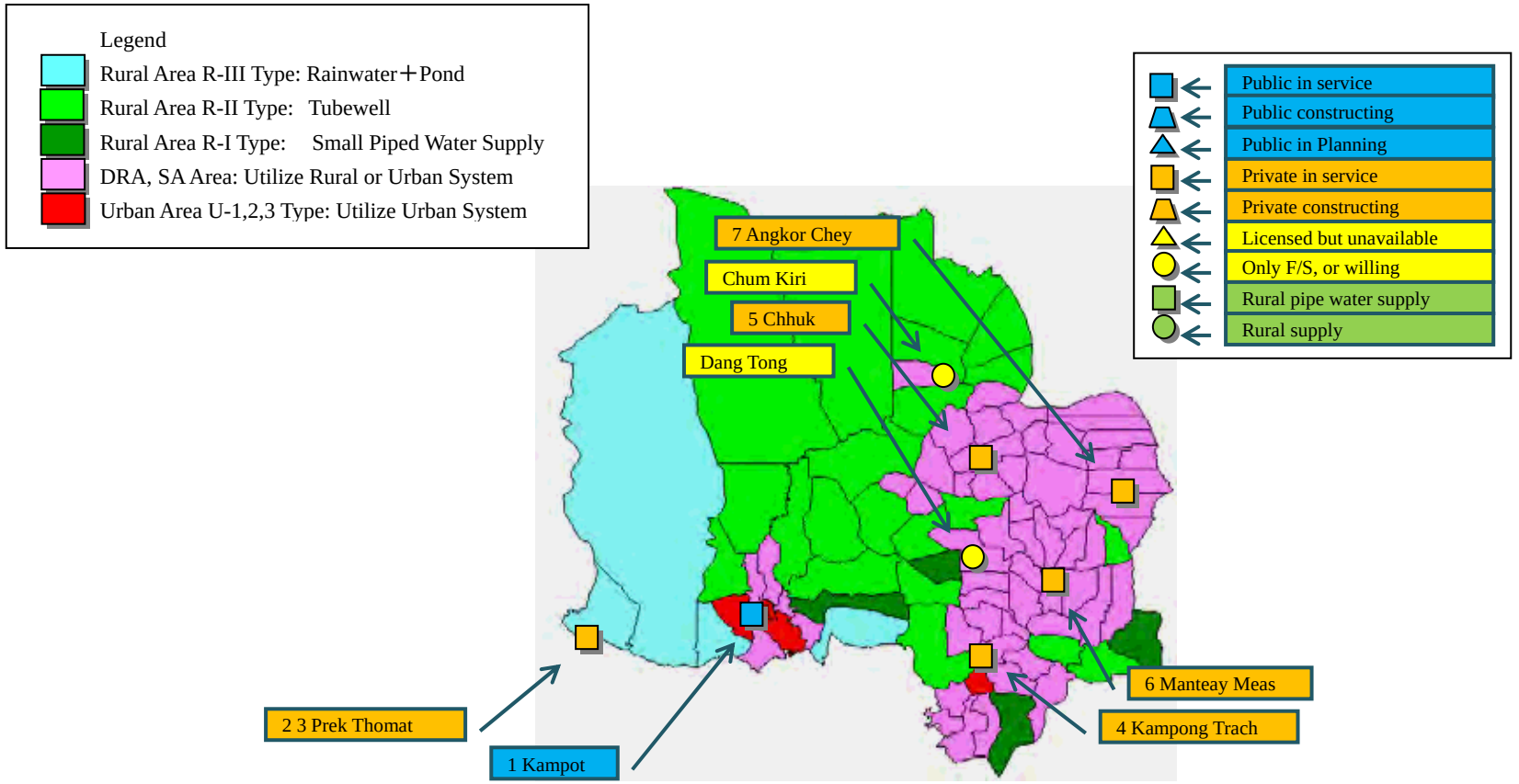
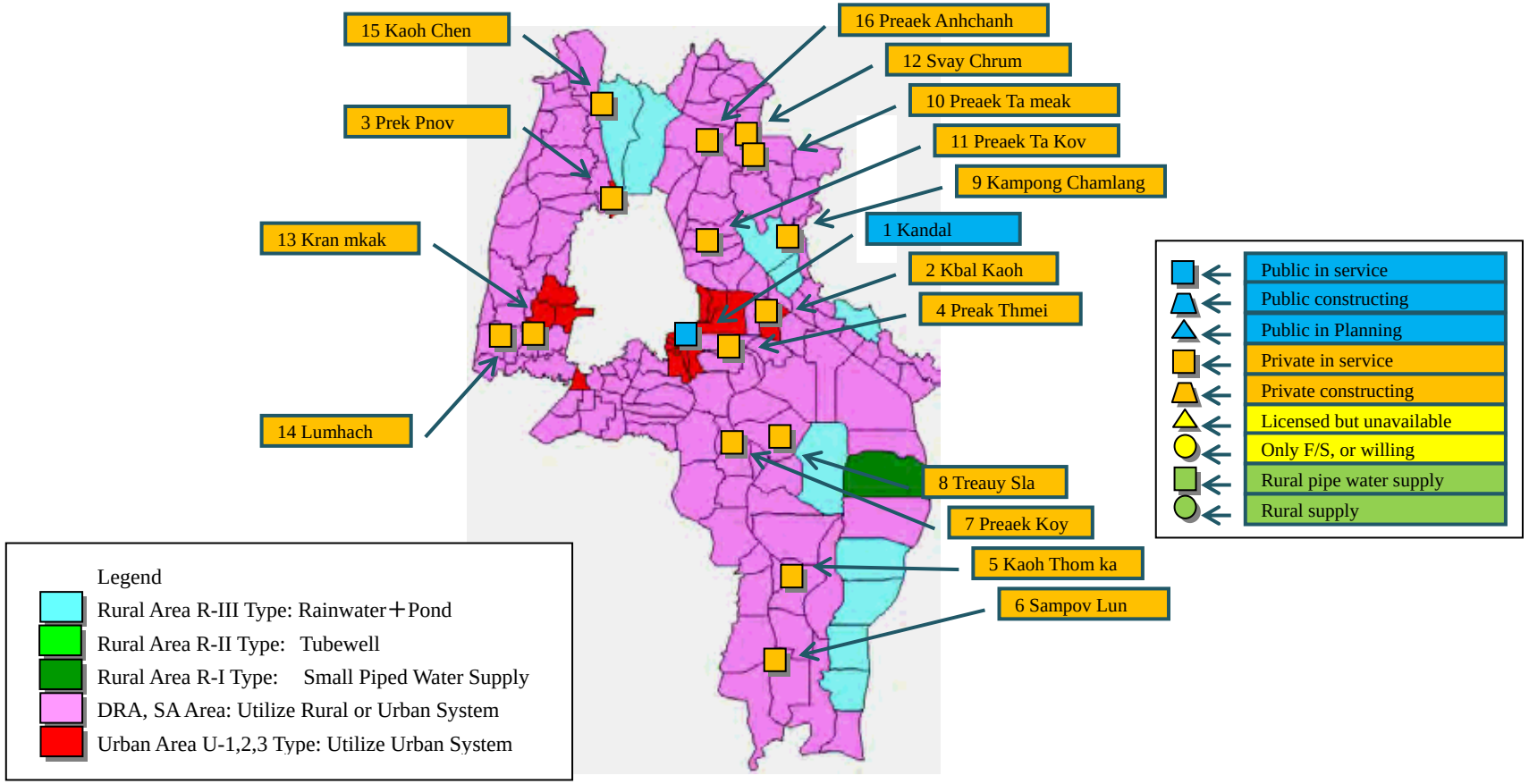


Figure 5.3.12 Proposed Water Supply Service System（Kampong Thom Province）



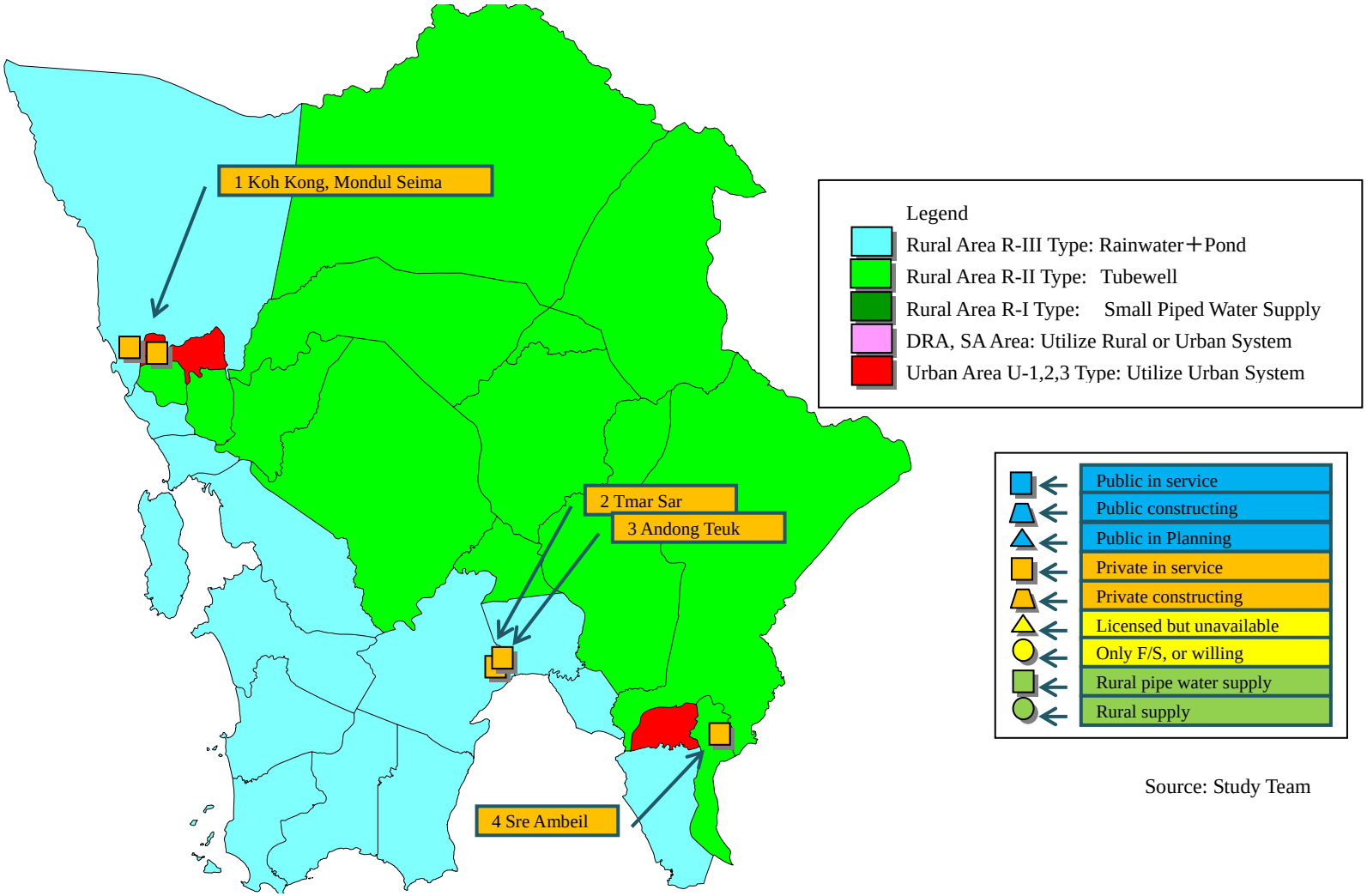
Source: Study Team

Figure 5.3.13 Proposed Water Supply Service System（Kampot Province）



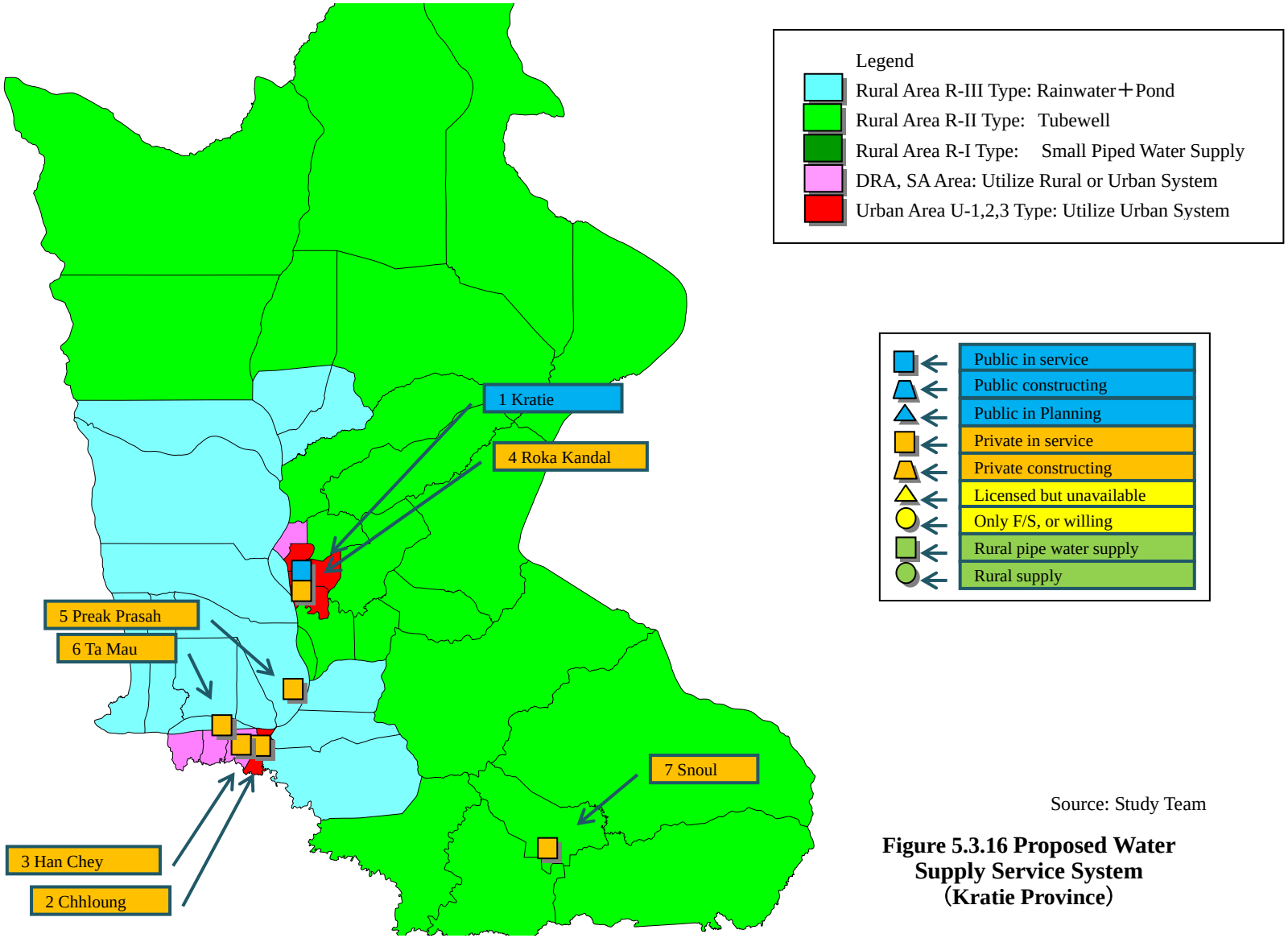
Source: Study Team

Figure 5.3.14 Proposed Water Supply Service System（Kandal Province）



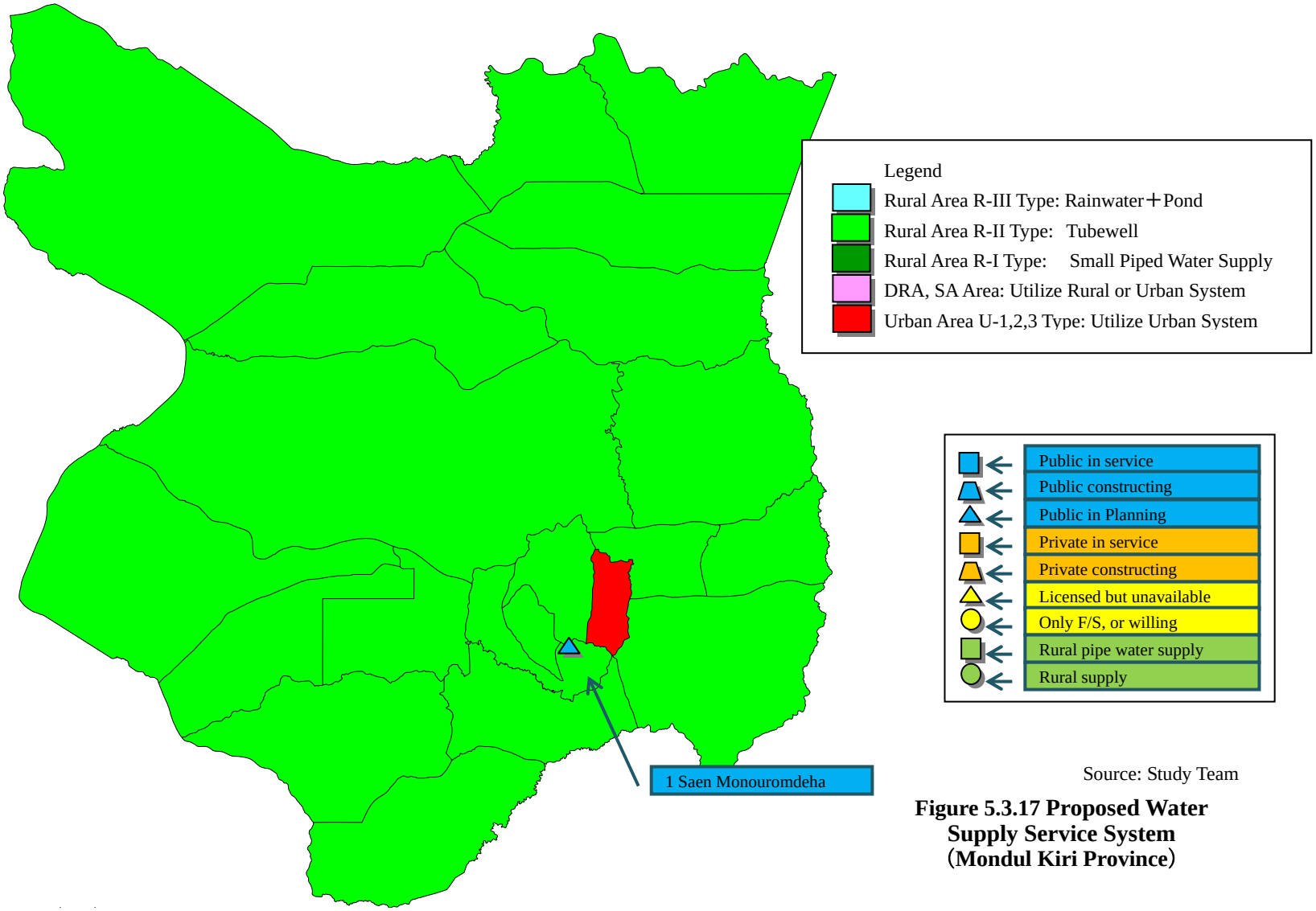
Source: Study Team

Figure 5.3.15 Proposed Water Supply Service System（Koh Kong Province）



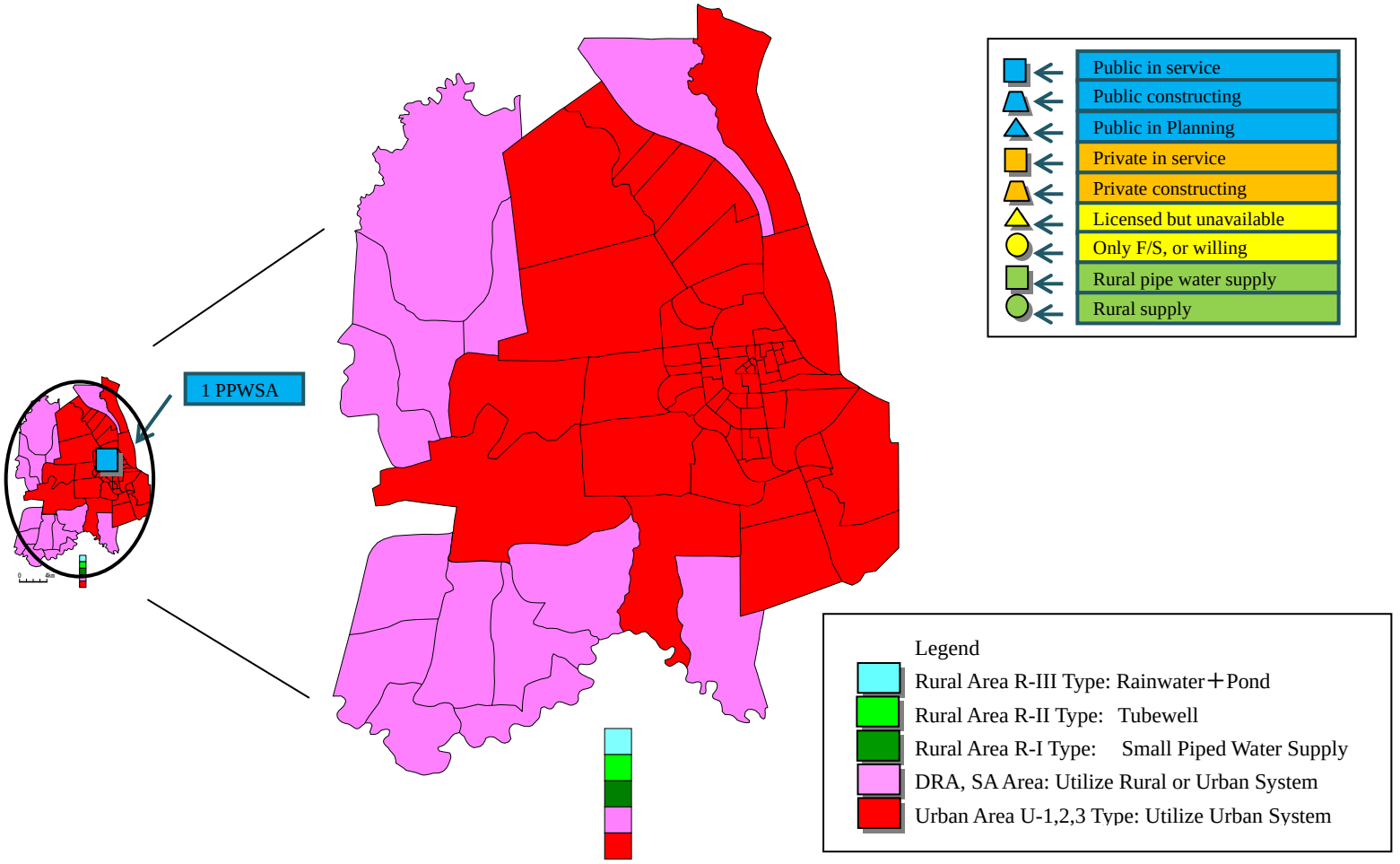
Source: Study Team

Figure 5.3.16 Proposed Water Supply Service System (Kratie Province)



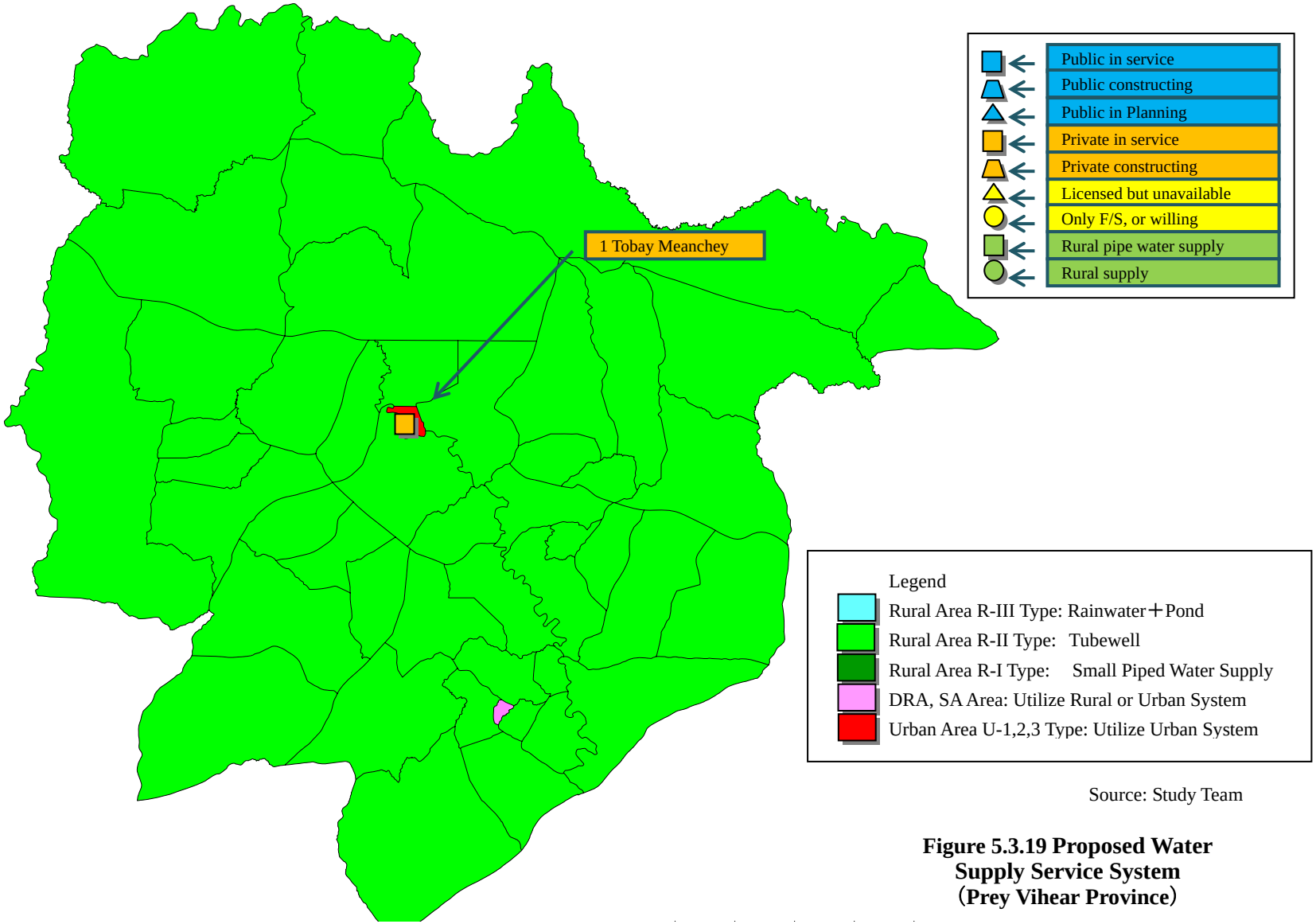
Source: Study Team

Figure 5.3.17 Proposed Water Supply Service System (Mondul Kiri Province)



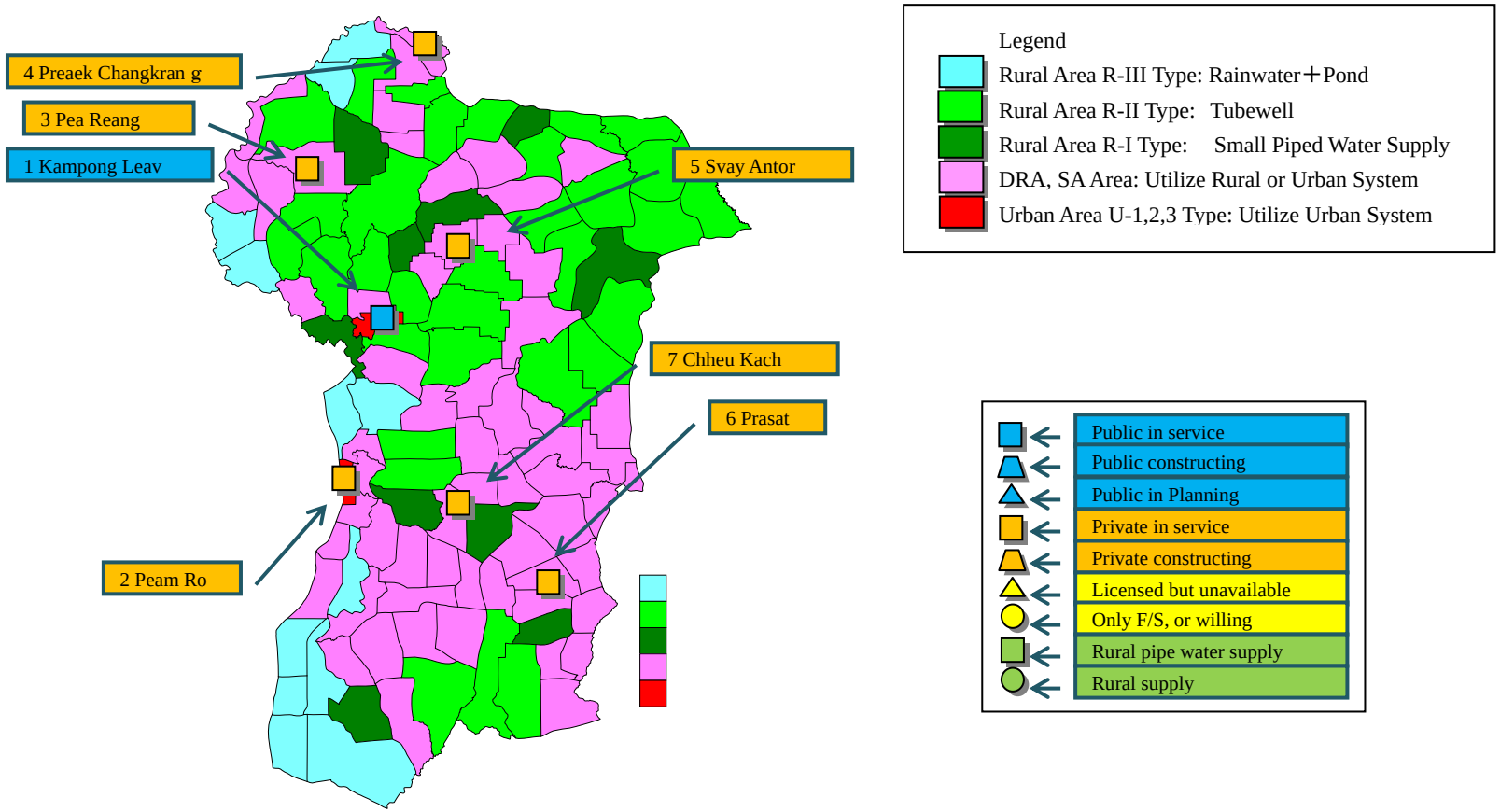
Source: Study Team

Figure 5.3.18 Proposed Water Supply Service System（Phnom Penh）



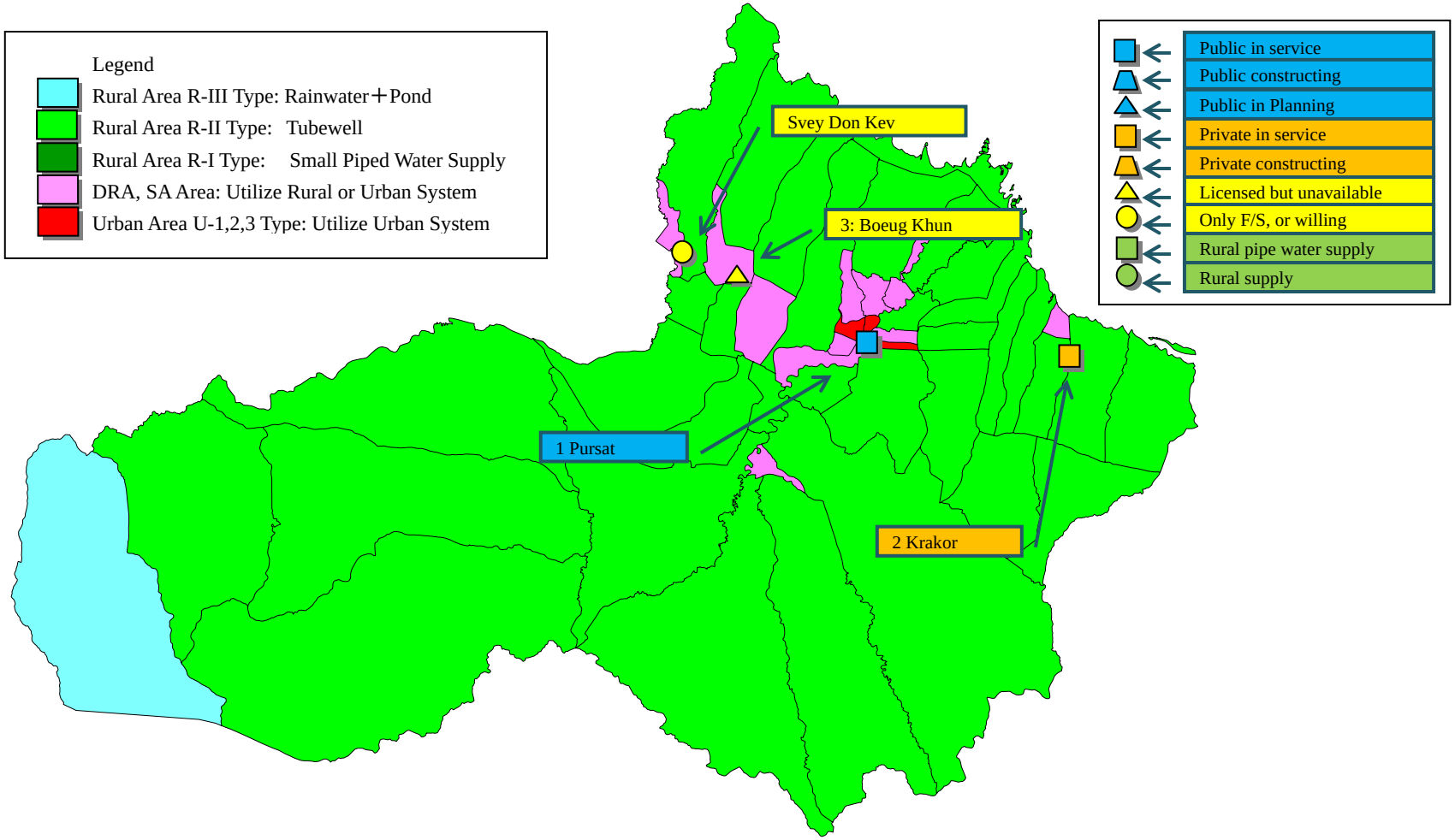
Source: Study Team

Figure 5.3.19 Proposed Water Supply Service System (Prey Vihear Province)



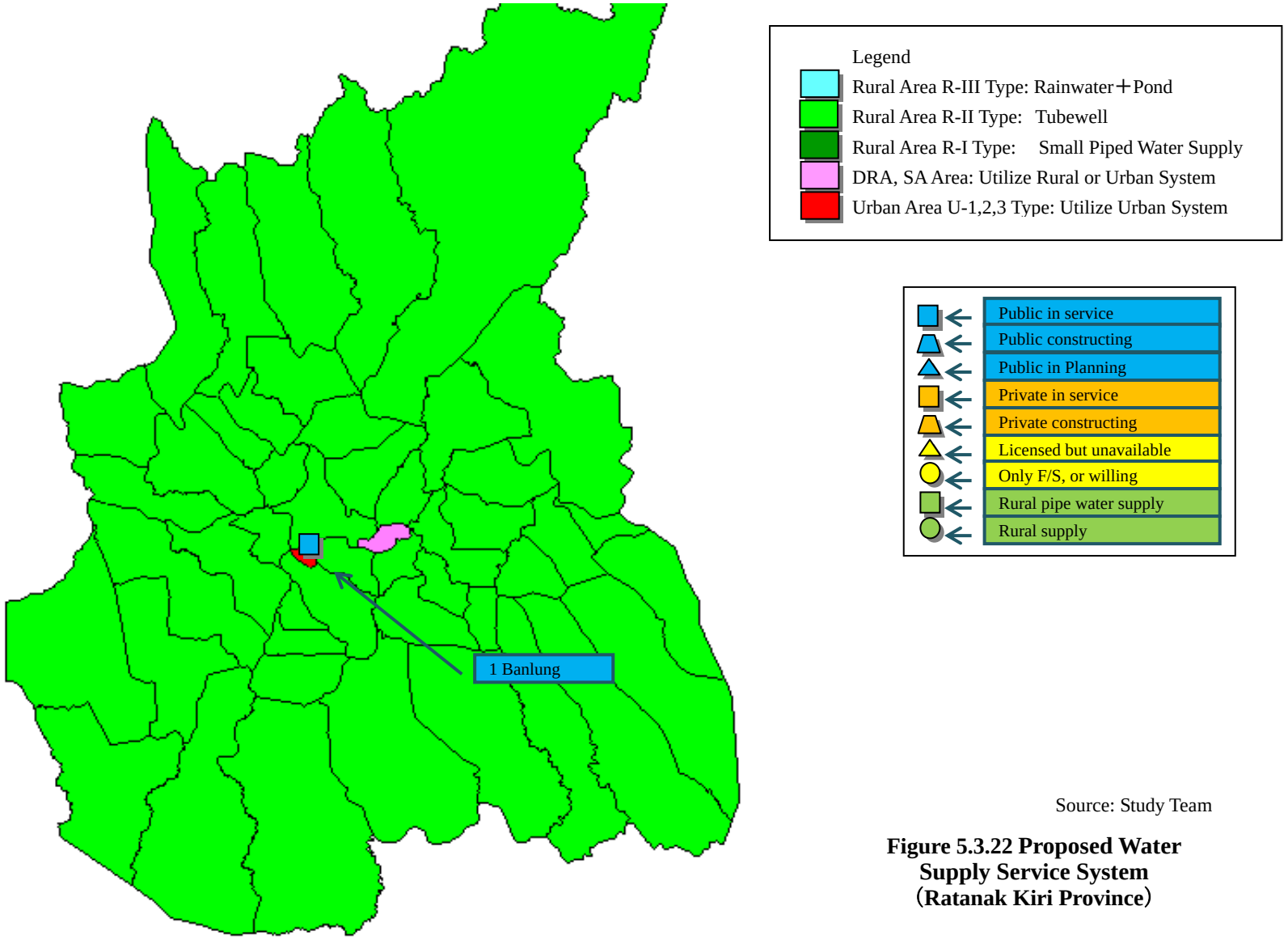
Source: Study Team

Figure 5.3.20 Proposed Water Supply Service System（Prey Veng Province）



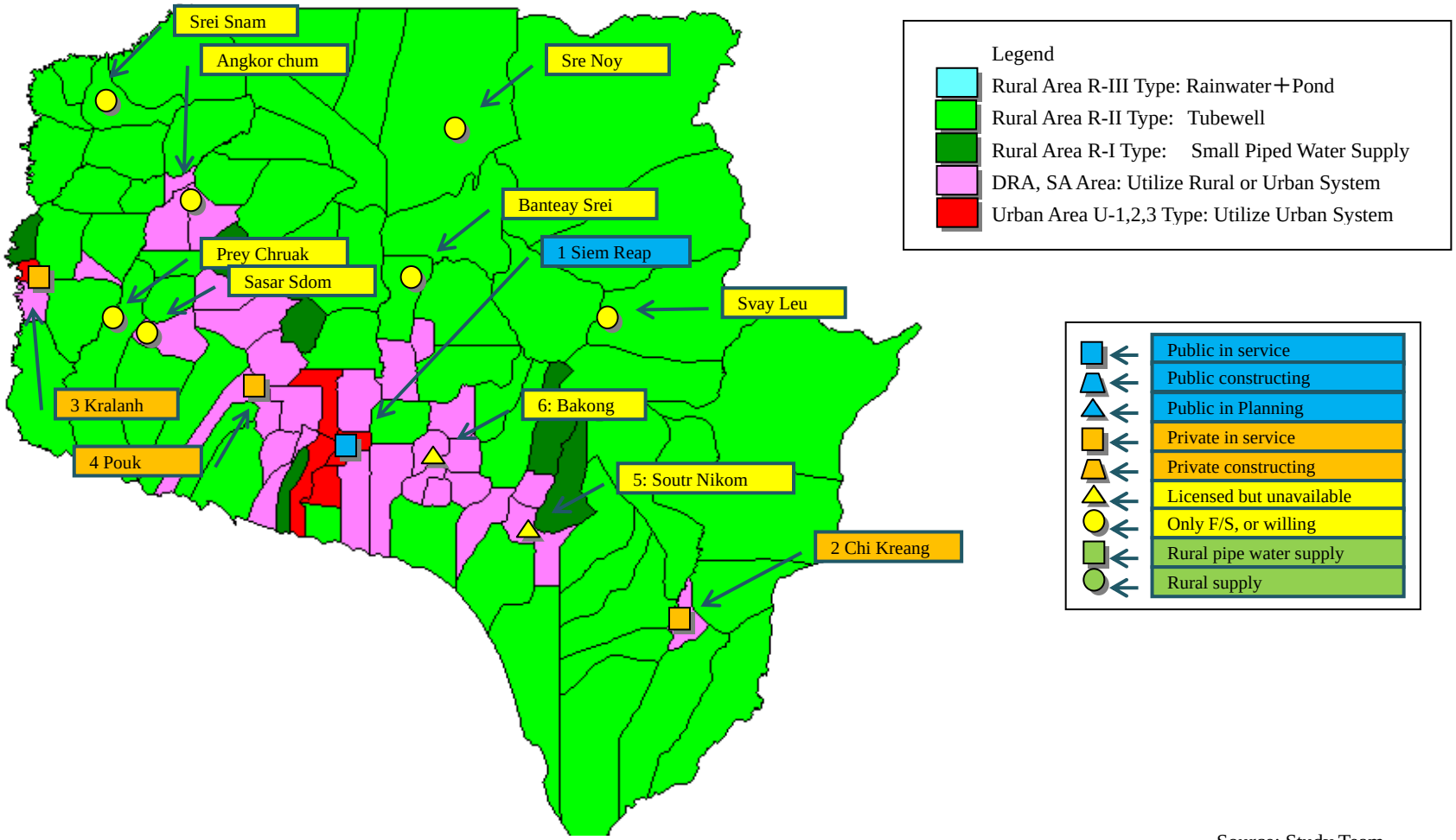
Source: Study Team

Figure 5.3.21 Proposed Water Supply Service System（Pursat Province）



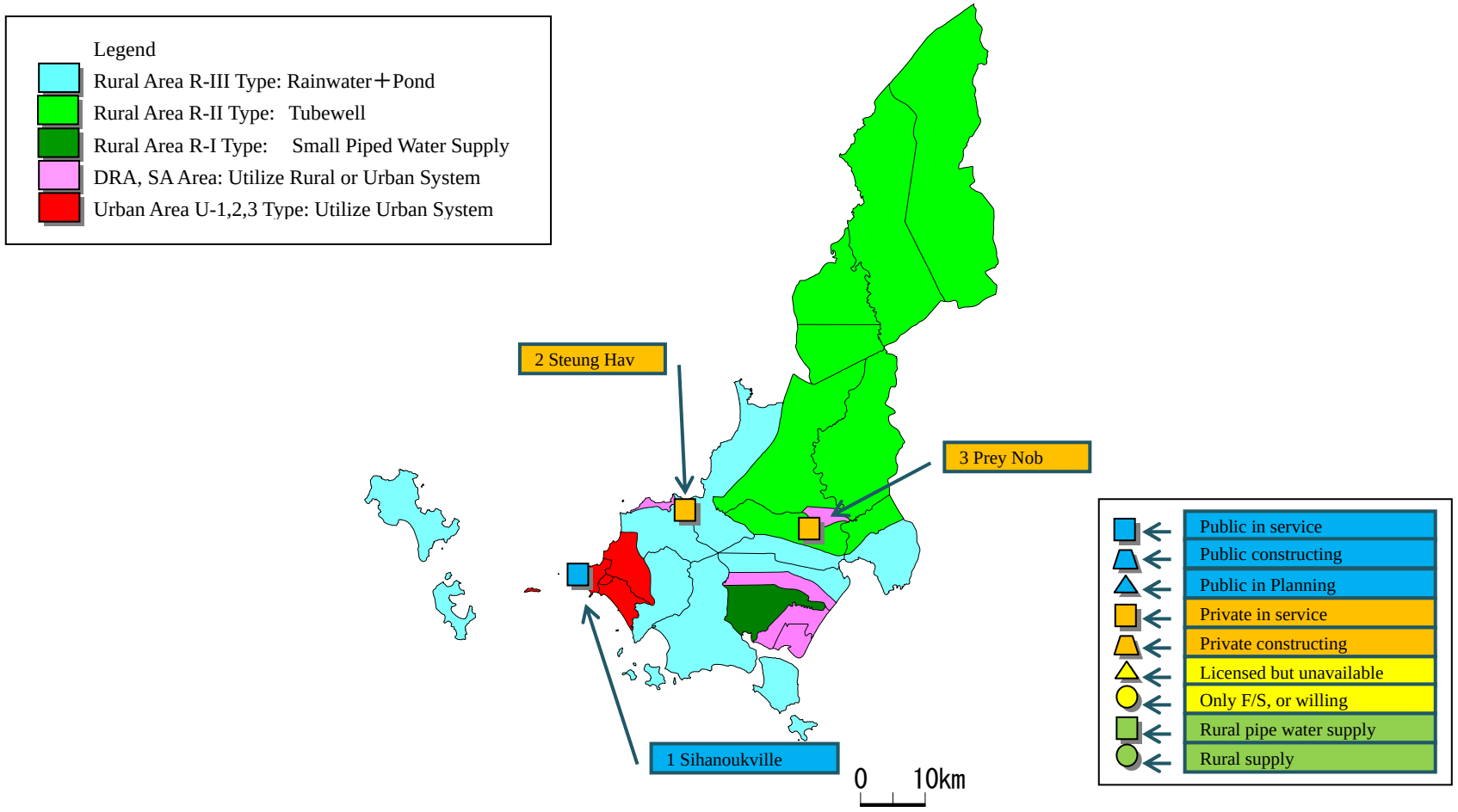
Source: Study Team

Figure 5.3.22 Proposed Water Supply Service System (Ratanak Kiri Province)



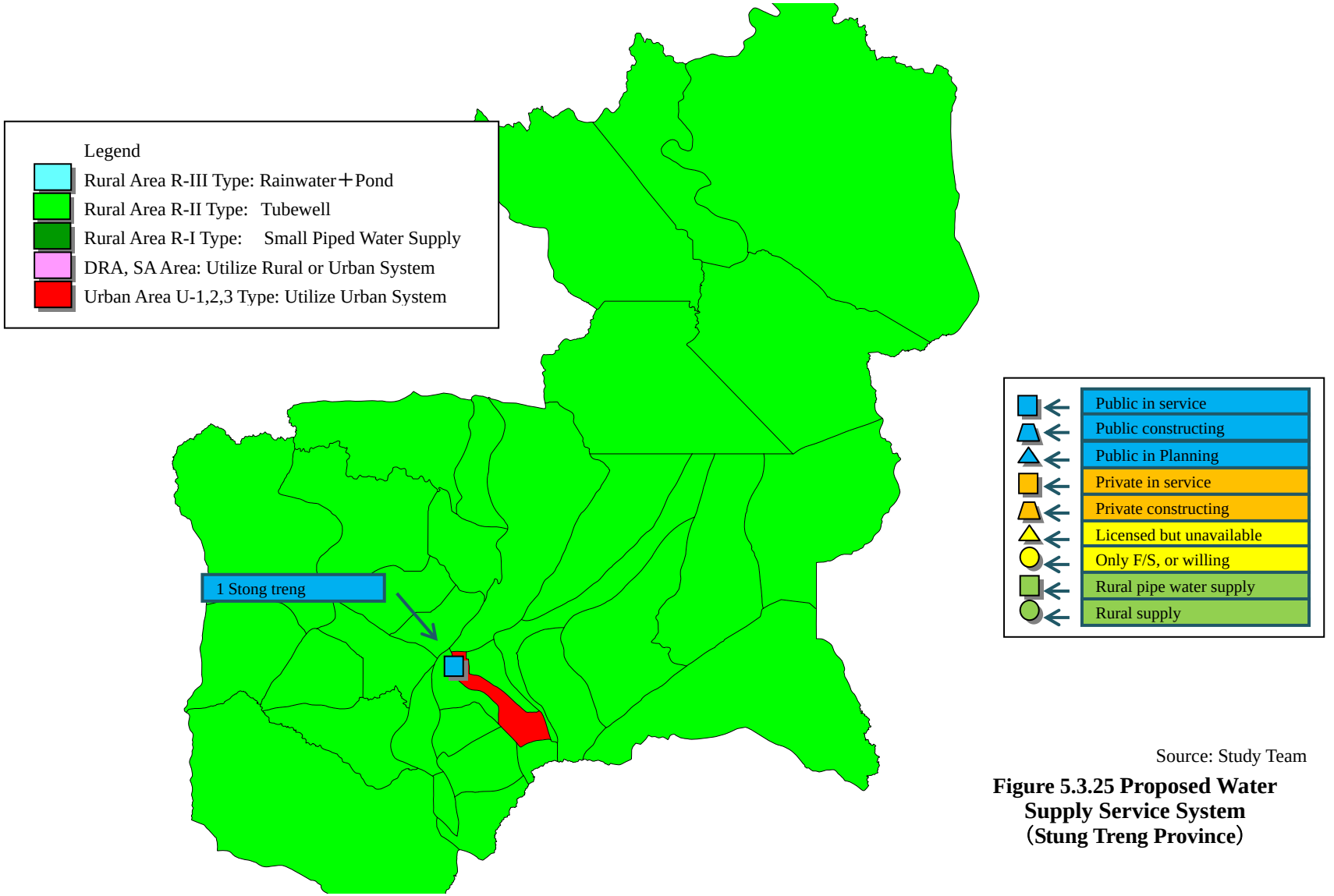
Source: Study Team

Figure 5.3.23 Proposed Water Supply Service System（Siem Reap Province）



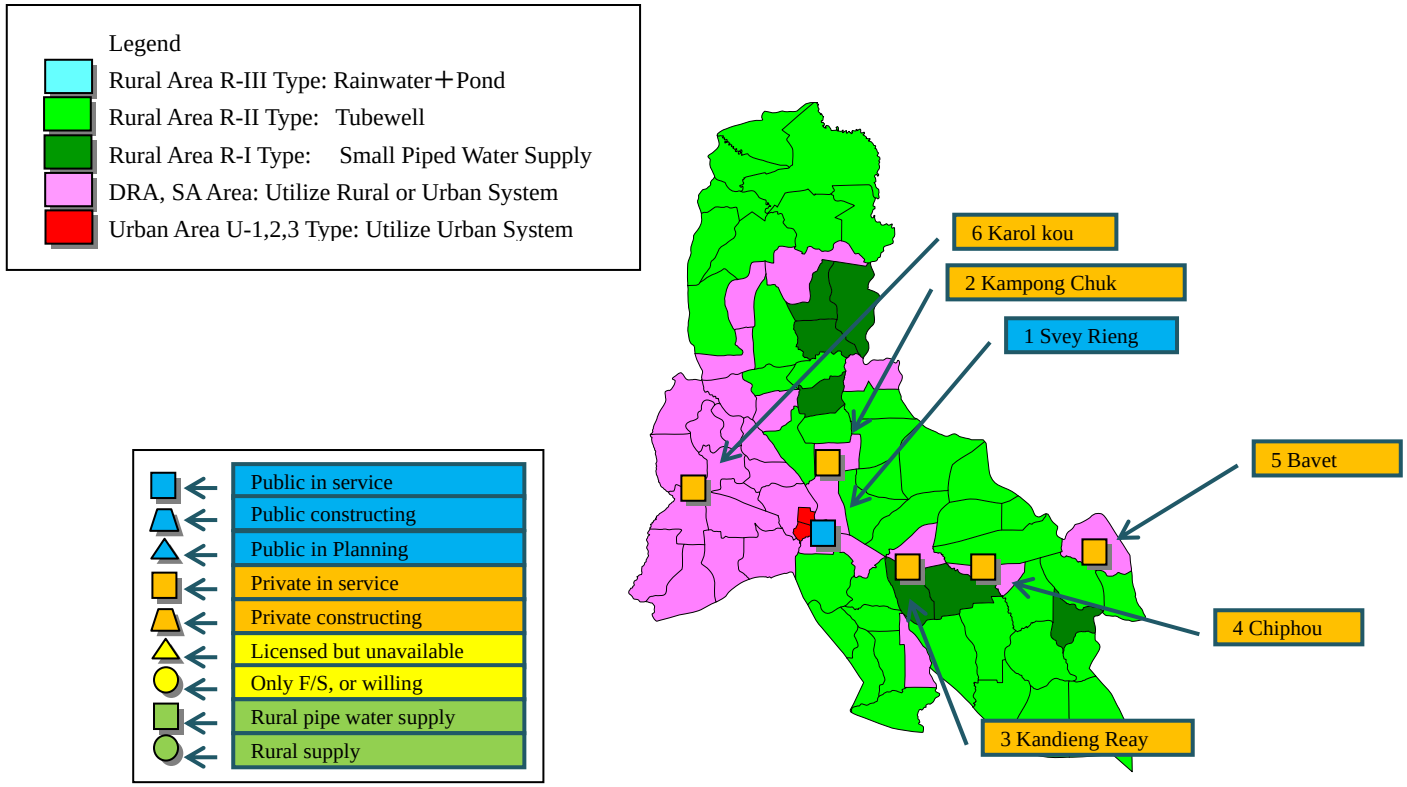
Source: Study Team

Figure 5.3.24 Proposed Water Supply Service System（Preah Sihanouk Province）



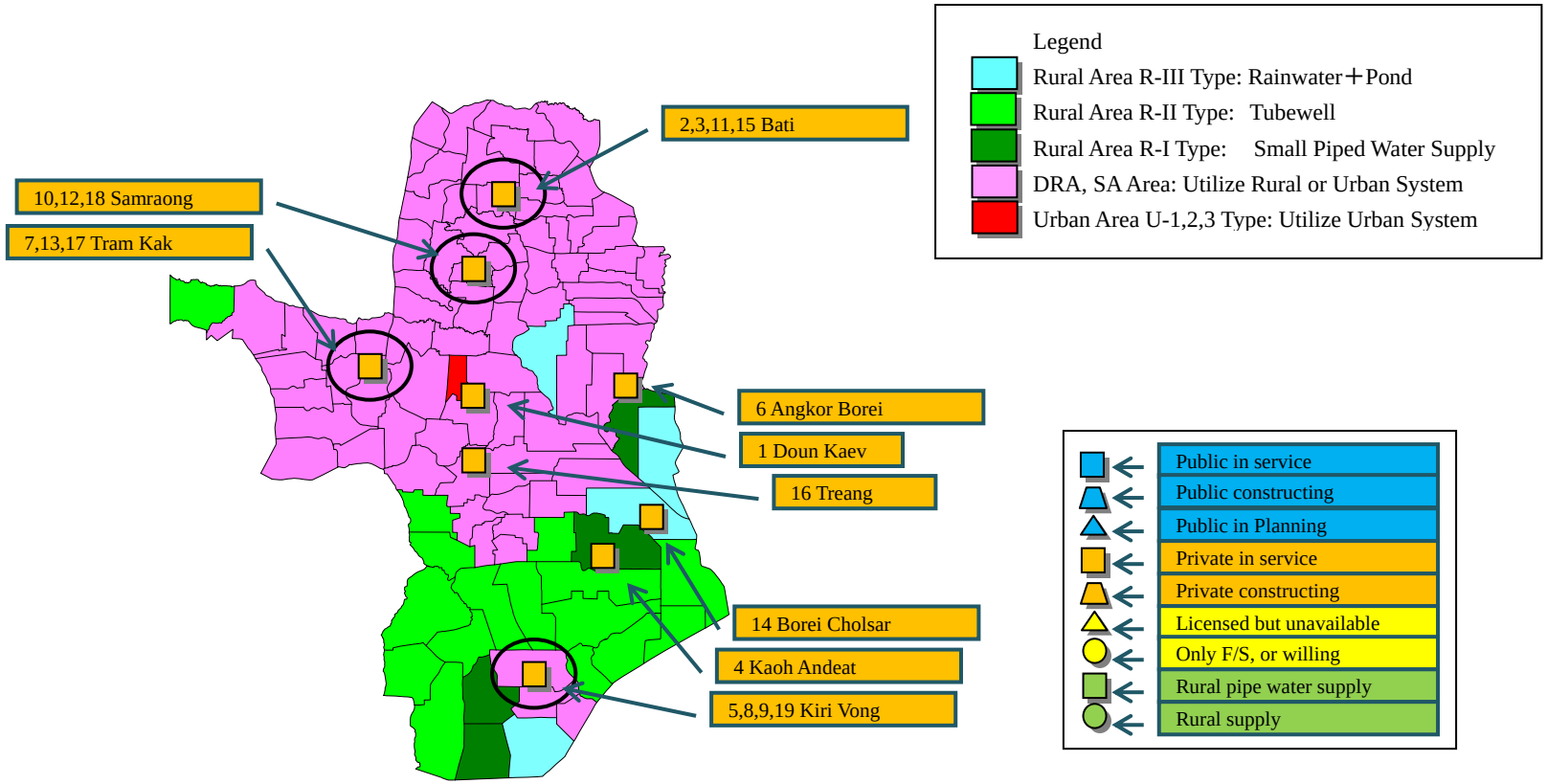
Source: Study Team

Figure 5.3.25 Proposed Water Supply Service System (Stung Treng Province)



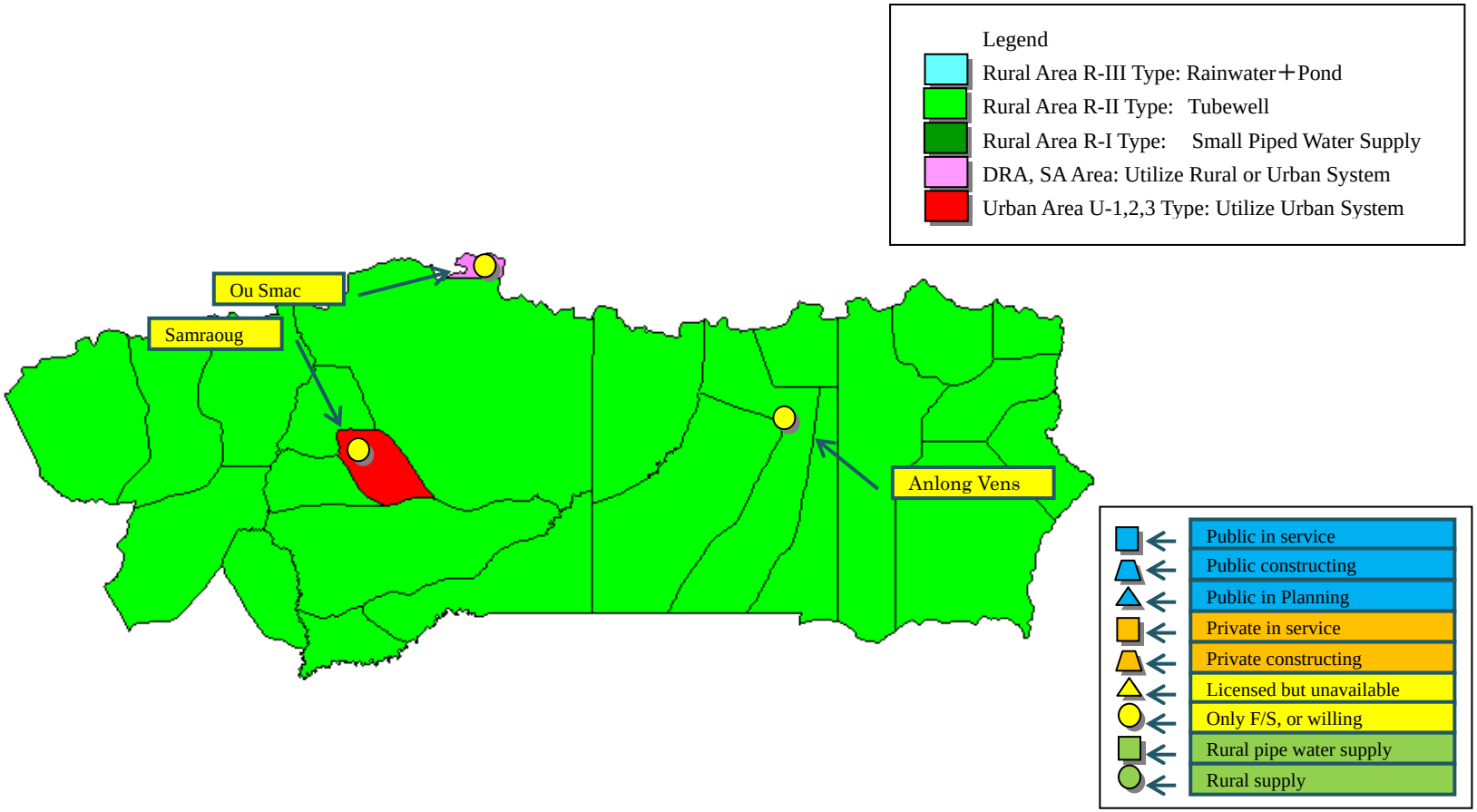
Source: Study Team

Figure 5.3.26 Proposed Water Supply Service System（Svay Rieng Province）



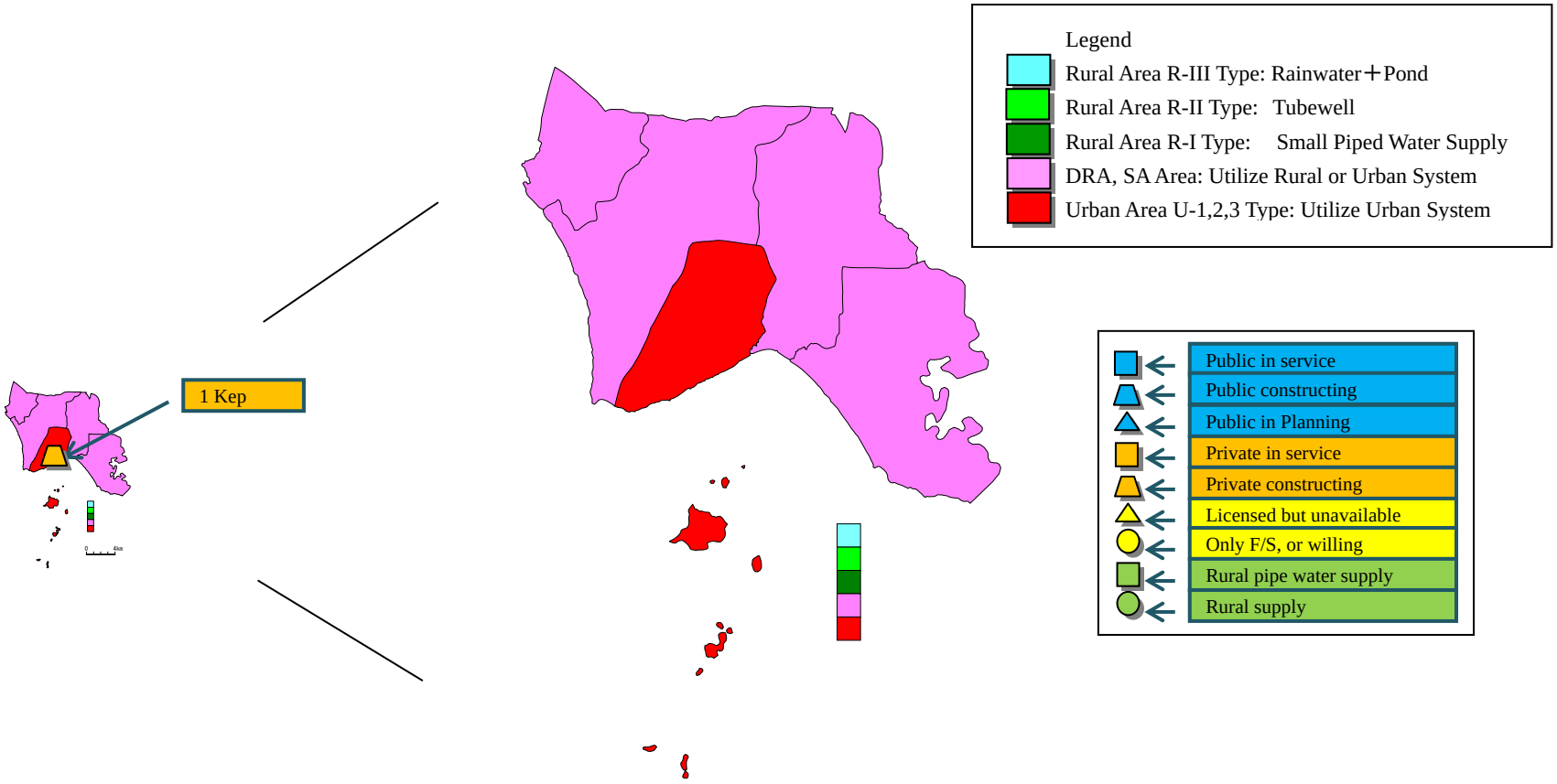
Source: Study Team

Figure 5.3.27 Proposed Water Supply Service System（Takeo Province）



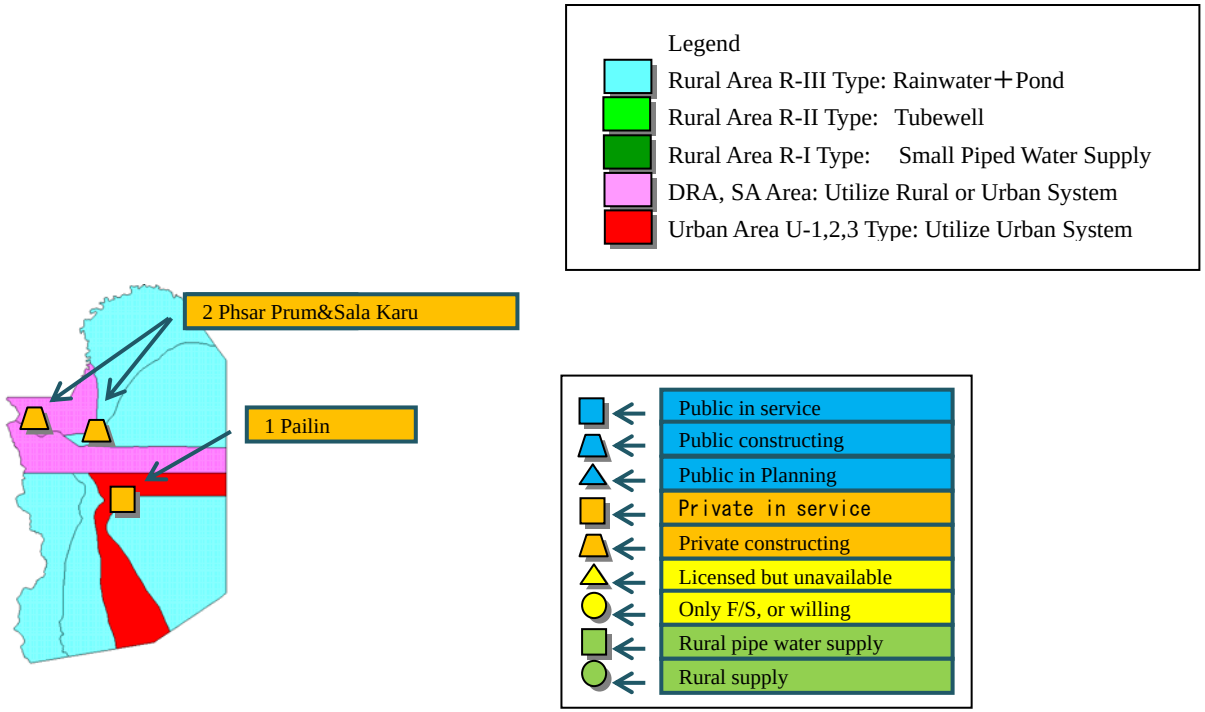
Source: Study Team

Figure 5.3.28 Proposed Water Supply Service System（Otdar Meanchey Province）



Source: Study Team

Figure 5.3.29 Proposed Water Supply Service System（Kep Province）



Source: Study Team

Figure 5.3.30 Proposed Water Supply Service System（Pailin Province）

5.4 Issues in Water Supply System Development

5.4.1 Issues

(1) Identify the areas where future water service stress generation is anticipated

In Cambodia, public system has been developed only specific areas such as provincial capital and important cities with high economical efficiency and other surrounding areas and small-scaled towns have been served by private system. Needless to mention, private system is one of the foundation for safe water supply, but they apt to eager on promotion in service area and water sales expansion but not to service quality upgrading. Aggressive support and proper regulation shall be applied to such private utility to let them voluntarily improve their supply water quality.

Many rural areas which are in transition to urban areas but not served by water supply system are found during the study. These areas are supposed to be suffered by high water service stress in the near future. As it usually takes 10 years to develop urban water supply system, field surveys shall be conducted as soon as possible to grasp the existing status for designing the optimum system.

(2) Evaluation of surface water intake

As water demand increase due to future economical development is quite sure in Cambodia, water source development mainly by dam constrictions is in process in many areas. However, in many cases, no comprehensive water use master plans covering whole catchment areas exist, and in some cases, constructions are conducted by quite obscure privatization contracts.

Surface water is introduced to most of urban system, but water level degradation, water quality deterioration and water supply shortage due to water demand increase are universal issues during dry season. Further, if deregulated water source development in upstream of water source is added, those existing problems may get aggravated seriously.

Water source securement is the most serious external risk beyond control. Though water source development is one of the countermeasures to solve water source shortage, confirmation of water use in whole catchment area and preparation of stake adjustment scheme to maintain water intake function is the top priority item. If water source shortage is unavoidable, water leakage reduction program shall be conducted in parallel to mitigate the adverse effect on water supply service.

(3) Clarification on the Nationwide Groundwater Development Potential

Groundwater has been thought of as the most suitable source of safe water in the Cambodian rural areas because of its economic efficiency and the relative ease of operation. However, there is a need to evaluate the groundwater potential in the entire country, and this has not yet been

carried out yet. The MRD and PDRD have received requests for this to be done, so that the proper strategy to develop sources of water supply can be implemented. Through groundwater potential evaluation, then the efficient and effective water supply program can be promoted.

(4) Dissemination of appropriate technology in the areas where groundwater development is difficult

As aforementioned, groundwater development is difficult along Mekong and Tonle Sap River, and in a part of the southern and the coastal area, due to water quality issues including high level of arsenic, iron and salinity. In these areas, there is no choice but to depend on surface water. But surface water needs treatment, and household treatment devices are commonly used in the rural areas. This is not sufficient, however, and water purifying capacity is low and difficult to process on a uniform scale if water comes from different sources.

There is a need to develop suitable water treatment technologies dependent on the characteristics of the locality and to disseminate these as widely as possible.

5.4.2 Points to Remember for Planned Water Supply Zone Map

The planned water supply zone map will show the direction of the most suitable water supply facility being planned in the urban and rural areas for the target year (2025) based on existing data and information. As for the semi-urban areas that will transit from rural to urban, these have been taken into consideration in the planned water supply map and have been regarded to be served by urban water supply in 2025. In the meantime, they will be covered by rural water supply system (R-I type and R-III type) until final transition to urban.

Chapter 6
Examination on Assistance Needs

Chapter 6 Examination on Assistance Needs

Note: The priority order of water supply service presented in this chapter does NOT reflect JICA's official viewpoint.

6.1 Examination in Priority Order

6.1.1 Criteria Setting

Using priority selection criteria, subjects in water supply sector extracted in the previous chapter shall be evaluated to ensure steady water service rate increase in urban and rural water supply. Criteria shall be considered for urban and rural areas, respectively. In this section, criteria in technical field, namely system development is to be examined. That of software field is to be studied in Section 6.3 "Examination of Assistance Needs".

(1) Urban Water Supply

The following items are proposed as national-wide criteria for selection of prioritized urban water supply projects to accelerate service ratio increase:

① Served population
② Un-served population
③ Urbanization potential
④ Urgency in water supply system development

The following are the detailed definition:

① Served population

Present served population in urban water supply can be estimated by utilizing the service population in 2008 as base data. The existing water supply system has high possibility in rapid and stable development with appropriate financial and technical assistant. Therefore, provinces with large number of service population shall be evaluated as those having high priority for development assistance.

② Un-served population

Provinces which have high population growth rate are supposed to have high demand on system capacity expansion and thus, such provinces shall be prioritized for urban water supply system development. The gap between served population in 2008 and service population forecast at 2025 shall be calculated to assume the un-served population in the future. **Table 6.1.1** shows the estimated un-served population in 2025.

③ Urbanization potential

Urbanization and water demand growth have close relationship. Infrastructure development needs shall be evaluated as well as future water demand growth. This criterion shall estimate

the infrastructure for development of industrial complex and tourism resources. Proposed sub-criteria to estimate the future urbanization potential are as follows:

- Road connection to Phnom Penh and other major cities.
- Power supply conditions

④ Urgency in water supply system development:

Negative trouble and problem in water supply system shall be evaluated as high priority for urgent remedy measures. Replacement, maintenance of deteriorated facilities and shortage of the water resources need quick action for stable water supply. Findings on system management confirmed during the field survey shall be examined to assess the urgency in water supply system development.

Table 6.1.1 Projection of Un-served Population in 2025

No	Province	Urban population projection			2008 Service Population	2025 Un-served population
		2008	Growth rate	2025		
1	Banteay Meanchey	181,396	2.55	278,313	62,960	215,353
2	Battambang	180,853		277,480	66,538	210,943
3	Kampong Cham	118,242		181,417	39,723	141,694
4	Kampong Chhnang	43,130		66,174	5,712	60,461
5	Kampong Speu	54,505		83,626	25,669	57,957
6	Kampong Thom	31,871		48,899	23,314	25,585
7	Kampot	48,274		74,066	29,144	44,923
8	Kandal	195,898		300,564	73,172	227,392
9	Koh Kong	36,053		55,316	8,311	47,005
10	Kratie	35,964		55,179	12,794	42,385
11	Mondul Kiri	4,859		7,455	0	7,455
12	Phnom Penh	1,242,992		1,907,105	974,549	932,557
13	Preah Vihear	10,679		16,385	2,364	14,021
14	Prey Veng	33,079		50,753	22,410	28,343
15	Pursat	25,650		39,354	21,424	17,931
16	Ratanak Kiri	19,317		29,638	2,834	26,803
17	Siem Reap	174,265		267,372	28,065	239,308
18	Preah Sihanouk	89,447		137,237	22,339	114,898
19	Stung Treng	17,022		26,117	7,697	18,420
20	Svay Rieng	17,029		26,127	10,821	15,306
21	Takeo	14,456		22,180	20,185	1,995
22	Otdar Meanchey	18,694		28,682	933	27,749
23	Kep	4,678		7,177	0	7,177
24	Pailin	15,674		24,048	5,336	18,713
Total		2,614,027		4,010,665	1,466,291	2,544,374

(2) Rural Water Supply

Criteria for prioritization of rural water supply facilities at provincial level are set up as described below in consideration of “Part 3: Rural Water Supply and Sanitation Policy, National

Policy on Water Supply and Sanitation" which prioritizes "poor, underserved communities and/or areas where there is high prevalence of water and sanitation-related disease".

① Poverty score
② Un-served population by protected water source
③ Mortality rate by diarrhea

① Poverty score

Assistance for water supply to poverty area is high prioritized.

② Un-served population

Numbers of un-served population is evaluated as high priority.

③ Mortality rate by diarrhea

Residents' health state is highly related to the supplied water quality. Rural water supply and sanitation policy employed these parameters to assess the service ratio in the target area objectively. They are "infant mortality rate", "mortality rate of children under 5 years old" and "mortality rate by diarrhea". "Mortality rate by diarrhea" is selected as the most reliable parameter having close causal relation with water-borne disease.

6.1.2 Examination on Priority Order

Weighted points by criteria items are shown in **Table 6.1.2** and **Table 6.1.3** respectively for urban system and rural system. Priority order is determined by total points.

Table 6.1.2 Criteria for Prioritization of Urban Water Supply Facilities at Provincial Level

Criteria Items	Ranking			Points		
	A	B	C	A	B	C
Served population in 2008 (Persons)	More than 50 thousand	50 to 20 thousand	Less than 20 thousand	3	2	1
Un-served population in 2025 (Persons)	More than 100 thousand	100 to 50 thousand	Less than 50 thousand	3	2	1
Urbanization Potential	High	Medium	Low	3	2	1
Urgency in system Development	High	Medium	Low	3	2	1

Table 6.1.3 Criteria for Prioritization of Rural Water Supply Facilities at Provincial Level

Criteria	Rank			Score		
	A	B	C	A	B	C
Poverty score	More than 35%	More than 20% and less than 35%	Less than 20%	3	2	1
Un-served population	More than 0.5 million	Less than 0.5 million people and more than 0.1 million	Less than 0.1 million	3	2	1
Mortality rate by diarrhea	More than 3	More than 1 and less than 3	Less than 1	3	2	1

(1) Urban Water Supply

Based on the grading points shown in **Table 6.1.2**, urban system development priority order was determined. **Table 6.1.4** shows the priority order and **Table 6.1.5** describes the respective scores. **Figure 6.1.1** illustrates the location map of provinces colored by priority rankings.

Table 6.1.4 Urban System Development Priority Order

Priority Order	Province Name
First Priority Group 7 Provinces	High Priority: Battambang, Banteay Meanchey, Kampong Cham, Preah Sihanouk (4 Provinces) Project is on progress: Phnom Penh, Siem Reap, Kandal (3 Provinces)
Second Priority Group 8 Provinces	High Priority: Kampong Chhnang, Kampong Speu, Kampong Thom, Kampot, Pursat, Prey Veng (6 Provinces) Project is on progress: Mondul Kiri, Ratanak Kiri (2 Provinces)
Third Priority Group 6 Provinces	Koh Kong, Kratie, Stung Treng, Svay Rieng, Takeo, Pailin (6 Provinces)
Fourth Priority Group 3 Provinces	Otdar Meanchey, Kep, Preah Vihear (3 Provinces)

Note: The priority order does NOT reflect JICA's official viewpoint

7 provinces evaluated as first priority group include national capital and large-scaled major cities. Phnom Penh is the national leader in both urban system development and management and the city is still expanding. Siem Reap located in the west, known as the center of Cambodian tourism transformed their own water utility SRWSA into a Government Corporation. Both Phnom Penh and Siem Reap are advanced in terms of urban water supply and high population/water demand growth is anticipated in these cities in the future. As these two provinces and Kandal province had started several projects or prepared new project studies, 4 provinces listed as "High Priority" group where no water supply projects have been implemented yet have higher priority than abovementioned 3 provinces. Among them, as two provinces of Battambang and Kampong Cham have large numbers of potential service population, advantageous project benefits are highly expected. Recently, Preah Sihanouk has been developing rapidly and high water demand has been rapidly growing. Banteay Meanchey is one of main center of transportation in Cambodia and therefore, the water demand growth is strongly expected. Since the operation of water supply is undertaken by public sector with fragile technology level, the efficient methodology of technical assistance shall be considered.

6 provinces considered as second priority group are middle-scaled local cities and future development is anticipated through the promotion of the agriculture and tourism industries. Consequently, high water demand growth is also expected.

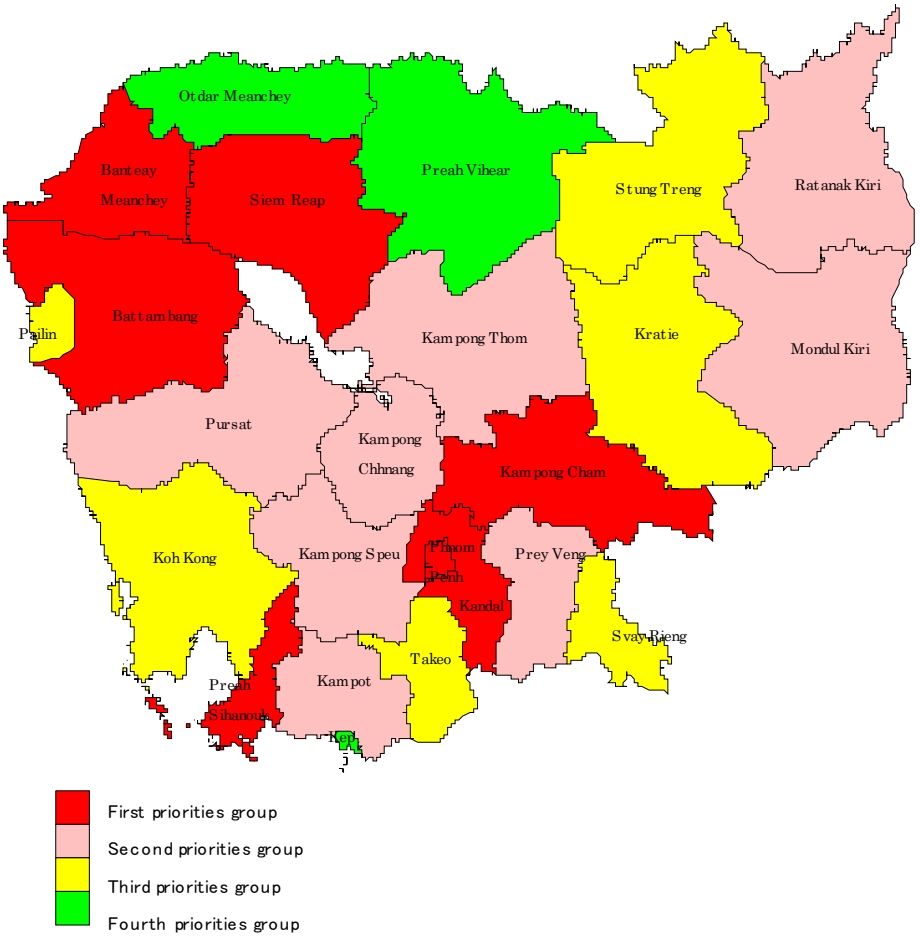


Figure 6.1.1 Urban System Development Priority Order by Province

Table 6.1.5 Result of Score Calculation for Prioritization for Urban Water Supply Facilities

No.	Province	Service population		Un-served population		Potential of urbanization		Urgency		Point	Rank
		Population	Score	Population	Score	Rank	Score	Rank	Score	Total	(1-24)
1	**Banteay Meanchey**	**62,960**	**3**	**215,353**	**5**	**A**	**3**	**B**	**2**	**13**	**3**
2	**Battambang**	**66,538**	**3**	**210,943**	**5**	**A**	**3**	**A**	**3**	**14**	**2**
3	**Kampong Cham**	**39,723**	**1**	**141,694**	**5**	**A**	**3**	**A**	**3**	**12**	**4**
4	Kampong Chhnang	5,712	1	60,461	3	A	3	A	3	10	8
5	Kampong Speu	25,669	1	57,957	3	A	3	B	2	9	9
6	Kampong Thom	23,314	1	25,585	1	A	3	A	3	8	10
7	Kampot	29,144	1	44,923	1	A	3	A	3	8	10
8	**Kandal**	**73,172**	**3**	**227,392**	**5**	**A**	**3**	**C**	**1**	**12**	**4**
9	Koh Kong	8,311	1	47,005	1	B	2	B	2	6	16
10	Kratie	12,794	1	42,385	1	B	2	B	2	6	16
11	Mondul Kiri	0	1	7,455	1	B	2	A	3	7	13
12	**Phnom Penh**	**974,549**	**5**	**932,557**	**5**	**A**	**3**	**B**	**2**	**15**	**1**
13	Preah Vihear	2,364	1	14,021	1	C	1	C	1	4	24
14	Prey Veng	22,410	1	28,343	1	B	2	A	3	7	13
15	Pursat	21,424	1	17,931	1	A	3	A	3	8	10
16	Ratanak Kiri	2,834	1	26,803	1	B	2	A	3	7	13
17	**Siem Reap**	**28,065**	**1**	**239,308**	**5**	**A**	**3**	**B**	**2**	**11**	**7**
18	**Preah Sihanouk**	**22,339**	**1**	**114,898**	**5**	**A**	**3**	**A**	**3**	**12**	**4**
19	Stung Treng	7,697	1	18,420	1	B	2	B	2	6	16
20	Svay Rieng	10,821	1	15,306	1	B	2	B	2	6	16
21	Takeo	20,185	1	1,995	1	B	2	B	2	6	16
22	Otdar Meanchey	933	1	27,749	1	C	1	B	2	5	22
23	Kep	0	1	7,177	1	B	2	C	1	5	22
24	Pailin	5,336	1	18,713	1	B	2	B	2	6	16

*1 "Census 2008" based estimation by Study Team

(2) Rural Water Supply

Acceding to criteria shown in **Table 6.1.3**, prioritizations for rural water supply facilities at provincial level are evaluated as shown in **Table 6.1.6**. **Table 6.1.7** shows the results of score calculation for each province and **Figure 6.1.2** shows the prioritization map for rural water facilities.

Table 6.1.6 Prioritizations for Rural Water Supply Facilities

Priorities	Province
First Priority Group	7 provinces：Kampong Cham, Mondul Kiri, Preah Vihear, Prey Veng, Ratanak Kiri, Stung Treng, Takeo
Second Priority Group	7 provinces : Battambang, Kampong Chhnang, Kampong Speu, Kampong Thom, Kandal, Kratie, Pursat
Third Priority Group	8 provinces : Banteay Meanchey, Kampot, Koh Kong, Siem Reap, Preah Sihanouk, Svay Rieng, Otdar Meanchey, Pailin
Fourth Priority Group	2 provinces：Kep, Phnom Penh

Among seven provinces selected as the first priority group, four provinces located in northeast Cambodia:, Mondul Kiri, Preah Vihear, Prey Veng, Ratanak Kiri, Stung Treng, are under development areas, as the provinces are currently developing basic infrastructure such as road and electricity. According to the result of the urban areas assessment in 2025 (refer to Chapter 5.4), most areas will still remain to be rural areas in 4 provinces, and the possibility of development for urban water supply services is low. Therefore, water supply facilities by tube well have high utility value over the long term and high effective as a rural water supply projects.

Two provinces located in central and southern Cambodia:, Kampong Cham and Takeo, on the other hand, have high un-served population, i.e., 500,000 or more residents still have no access to safe water, so the mortality rate by a water born diseases is high; therefore priority of these cities is high.

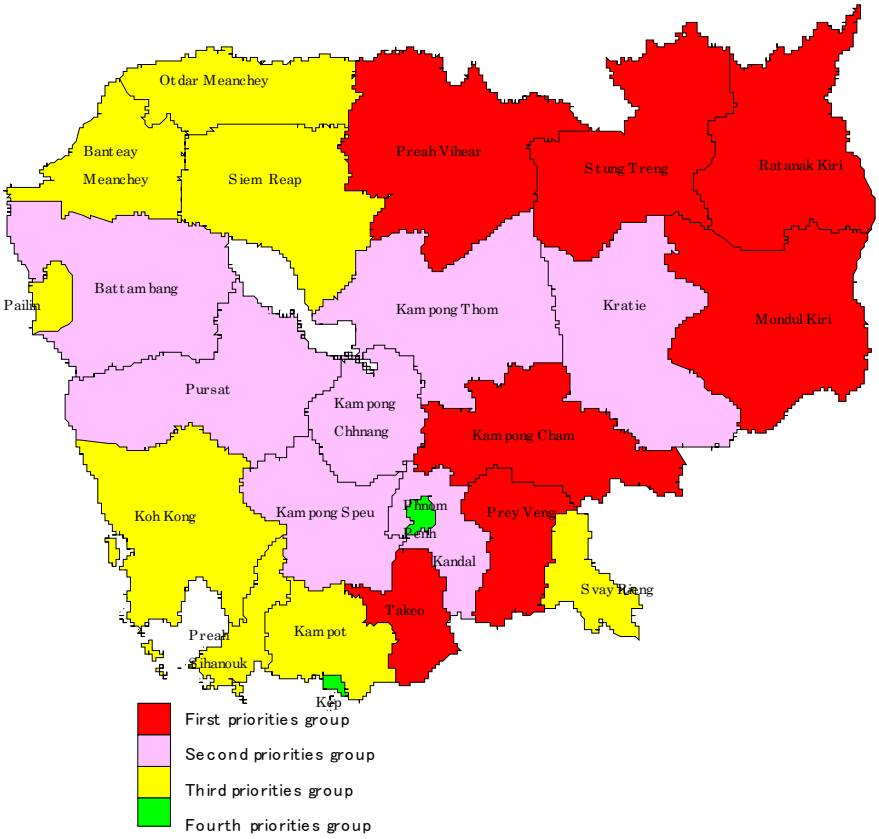


Figure 6.1.2 Rural System Development Priority Order by Province

Table 6.1.7 Result of Score Calculation for Prioritization for Rural Water Supply Facilities

No.	Province	Poverty *1 (2008)		Current un-beneficiery (Rural) *2 (2007)		Infant mortarity*3 (2005)		Mortarity under 5 *3 (2005)		Mortarity by diarrhoea (water origin disease) *2 (2007)		Point	Rank
		%	Score	Population	Score	% (対1,000人)	Score	(per 1,000 Person)	Score	Against province population (Per 10,000 person)	Score	Total (Max 17)	(1-24)
1	Banteay Meanchey	31.4	2	394,575	3	76	2	96	1	1.12	2	10	15
2	Battambang	29.6	2	589,054	5	97	2	116	2	0.60	1	12	8
3	Kampong Cham	25.8	2	996,245	5	94	2	111	2	1.08	2	13	1
4	Kampong Chhnang	32.4	2	256,352	3	87	2	101	2	1.46	2	11	12
5	Kampong Speu	32.2	2	413,774	3	107	3	122	2	2.02	2	12	8
6	Kampong Thom	34.4	2	474,002	3	87	2	106	2	1.38	2	11	12
7	Kampot	20.6	2	424,391	3	67	1	83	1	2.27	2	9	17
8	Kandal	17.4	1	710,194	5	85	2	101	2	1.11	2	12	8
9	Koh Kong	26.4	2	73,669	1	88	2	104	2	2.21	2	9	17
10	Kratie	38.6	3	187,779	3	84	2	116	2	1.57	2	12	8
11	Mondul Kiri	38.0	3	32,706	1	122	3	165	3	6.71	3	13	1
12	Phnom Penh	0.0	1	48,756	1	42	1	52	1	0.73	1	5	24
13	Preah Vihear	43.0	3	88,884	1	111	3	146	3	3.56	3	13	1
14	Prey Veng	27.4	2	132,205	3	121	3	143	3	1.54	2	13	1
15	Pursat	34.0	2	293,946	3	86	2	106	2	1.36	2	11	12
16	Ratanak Kiri	41.4	3	94,098	1	122	3	165	3	7.98	3	13	1
17	Siemreap	32.4	2	412,006	3	67	1	94	1	1.13	2	9	17
18	Preah Sihanouk	20.6	2	69,235	1	88	2	104	2	2.48	2	9	17
19	Stung Treng	42.4	3	73,180	1	111	3	146	3	3.40	3	13	1
20	Svay Rieng	23.6	2	32,795	1	92	2	110	2	2.30	2	9	17
21	Takeo	25.0	2	534,572	5	96	2	102	2	1.99	2	13	1
22	Otdar Meanchey	38.8	3	97,207	1	90	2	110	2	1.83	2	10	15
23	Kep	22.6	2	24,792	1	67	1	83	1	3.36	3	8	13
24	Pailin	31.0	2	43,105	1	97	2	116	2	1.42	2	9	17

*1 "Poverty and Select CMDGs Maps and Charts2003-2008September2009" based estimation by Study Team

*2 "Census 2008" based estimation by Study Team

*3 Cambodia Demographic and Health Survey 2005, December 2006 unit: per 1,000 live births

6.2 Potential in PPP Application to Project Execution

6.2.1 Outline of PPP and Experience in Cambodia

(1) Background of PPP application and outline

1) Background of PPP application

With the huge funding resources needed for water supply system construction and expansion, restricted public fund investment in Cambodia, and in light of human resource shortage in proper O&M of public systems, building of stable water supply systems in local towns and villages is quite difficult. PPP utilizing the funding ability and technology of private sector is regarded as one of the solutions and is considered to be an effective measure to increase service ratio if aggressively applied in local cities.

2) Outline of PPP

PPP, Public-Private-Partnership means project execution by private and public sectors in which private sector participates in providing public service in some forms. General concept of PPP is displayed in **Figure 6.2.1** referring to "Basic study on rural water supply development in Cambodia applying PPP scheme, JBIC".

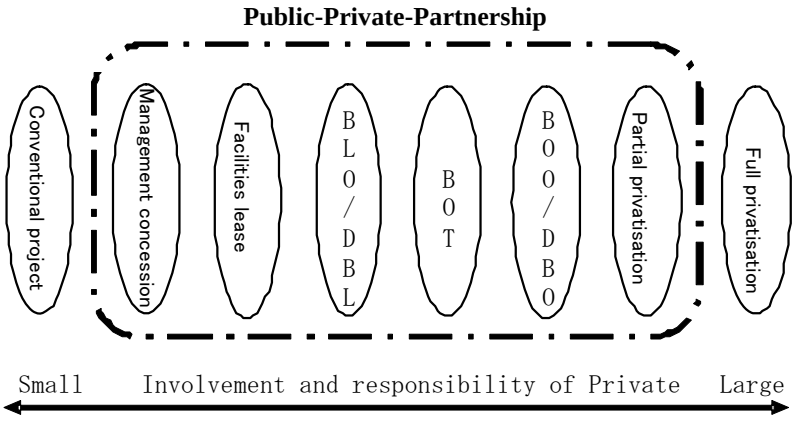


Figure 6.2.1 Concept of Project Execution by PPP

General identification of project execution methods shown in the figure is explained in **Table 6.2.1.**

Table 6.2.1 General Identification of Project Execution Methods by PPP

BOO (Build-Own-Operate) Method	Based on system development plan and facility design prepared by public sector, private sector build the facility, own and operate the facility
BOT (Build-Operate-Transfer) Method	Based on system development plan and facility design prepared by public sector, private sector build the facility, own the facility for certain period and transfer to public sector
DBO (Design-Build-Operate) Method	Basically same to BOO but private sector takes responsibility from facility design
OBA (Output-Based-Aid) Method	Assistant scheme by WB, private sector install house connection to low income group and WB pays work cost based on connection results

DBL (Design-Build-Lease) Method	Based on system development plan prepared by public sector, private sector design, build and lease and operate the facility
Entrust Operational Activities	Private sector undertake specific part of public service such as O&M of facilities built by public sector and water tariff collection

(2) Assistance method in water supply projects

Application of PPP to water supply projects is effective for a certain scale and it is not feasible for small-scaled rural system composed of narrow distribution network or scattered tube wells. Therefore, application of PPP shall be examined focusing on urban systems.

General project implementation method is facility building and O&M using internal funds, but as discussed beforehand, project implementation by administration is difficult in Cambodia. So, fund and technical support from foreign donor agencies or project implementation by private sector have been expected.

Urban water supply projects are managed by public sector and private sector and applicable assistance is proposed in **Table 6.2.2**, respectively.

Table 6.2.2 Applicable Assistance for Water Supply System

Project Classification	Assistance Methods
Public Project	➢ Direct assistance by Central Government ➢ Direct Support by Donor Agencies ➢ Assistance by partnership with private sector
Private Project	➢ Two-step-loan by Donor Agencies ➢ Assistance by partnership with private sector

(3) PPP application results in Cambodia

Table 6.2.3 displays past PPP application results for public system serves provincial capital and other cities:

Table 6.2.3 Application Results of PPP

PPP Methods	Province	Project Implementation Period	
		Commencement	Completion
OBA Method (WB, Grant)	Svay Rieng	2003	2010
	Prey Veng		
	Kampong Cham		
	Banteay Meanchey		
DBL Method (WB, Loan)	Svay Rieng	2003	2010
	Prey Veng		
	Kampong Cham		
	Banteay Meanchey		
DBO Method (AFD)	Local city in Takeo province	2001	2005
BOT Method (USAID)	Provincial capital of Takeo	Built in 1998 and 40 years operation	

Source: Potable Water Supply Department, MIME

6.2.2 Potentials of PPP Application to Water Supply Projects

(1) PPP Application Policy in Cambodia

In relatively large-scaled urban water supply projects, the capital of Takeo province was

implemented by BOT method. Further, PPP has potentials in new system establishment in provinces where the capital is not yet served and in expansion of existing capital system.
The action plan of MIME covering the period of 2009 to 2013 specified the policy of project promotion by private sector, such as application of BOT method, DBL method and OBA method.
The following are the proposed PPP application policy in this study:

- New construction or expansion of urban system: BOT/DBL method
- House connection aid for low income group: OBA method（Loan or Grant）

(2) Validity Examination of PPP Application
Aggressive application of PPP in Cambodia is effective in the following aspects:

- Aside from public system available only for limited areas, application of private system facilitates increase of nation-wide service rate
- Promote safe water access for low income group inhabiting in peri-urban area and this also works as poverty reduction program

Many small scale private water supply groups have been established in Cambodia and system expansion has also been progressive. Some of these are facing potential problem such as weak financial background, bankruptcy, low level operation and low water qualities. Delay of development of legal systems is a part of reasons for these circumstances. To implement assistance to such private water supply sector, followings are needed:

- Assist private sector to have close relationship with public sector
- Develop organization and institution structure for the public sector to supervise the private sector

(3) Proposed PPP Application Method
1) Applicable projects
In case of urban areas, the target water utilities for PPP projects are those successively and sustainably managed. Further, low income group area can be applicable area as this area has great possibility in contributing to water service ratio improvement. Otherwise, the public assistance to private sector is needed to facilitate the cooperation of private sector.

2) Proposed PPP methods and projects
As to project execution methods for urban water supply system either for new or expansion projects, application of BOT method, DBL method and OBA method which have been applied in several projects, is deemed to be effective.
Aside from assistance by PPP, the private sector can avail of Two Step Loans, tapping the fund offered by donor agencies through the central government. This method is considered applicable

for financing projects in second or third local cities by the private sector.

(4) Anticipated Subjects upon PPP Introduction and Solution

As aforementioned in the previous chapter, the following items shall be facilitated with the introduction of PPP:

- Align with public system development plan, avoid overlapping
- Promotion of market built up and diversifying financing
- Streamline licensing procedure in MIME, the supervisor agency
- Enhancement of MIME's supervision/instruction structure and law system to maintain stable water supply, water quality and water tariff under private sector management
- Execute management capacity development for directors in private sector
- Conduct technology transfer to private sector staff by skilled staff of PPWSA and SRWSA
- Unify the water source investigation data to promote nation-wide water service rate improvement
- Road and power supply facility development for stable operation of local private system

(5) Provinces having Potentials of PPP Application

① Provinces served by less matured public system

As to five or six provinces including Battambang, Pursat, Kampot which are evaluated as first priority group, private fund investment by allocation of part of fund to management right or stock of Government Corporation is possible. These scales of water sector can be advantage for private activities. However, collaboration between stakeholders is needed before privatization.

② Provinces served by non self-sustaining private system

Provinces including Banteay Meanchey, Kampong Speu and south-east provinces have high population density and many small-scaled private systems. Though water supply service is extensive, service quality is still low due to shortage of funds and technology and there is still room for private company participation.

Privatized water supply in Banteay Meanchey has been managed by low level technology and water quality is inferior. In case of assistance focusing on their facilities improvement, autonomies shall be kept and prompted to succeed stable operation. In consideration of enhancement on assistance to water supply utilities, executing aggressive improvement of water treatment facilities with expansion of distribution network will generate positive motivation for private fund investment for urban water supply system.

③ Provinces having needs for water supply service but not yet served

Provinces located near to the national border of Thailand such as Preah Vihear, Otdar Meanchey and north Siem Reap, have many communes where urban system has not been developed even if the need for water supply service is high.

Project execution is similar to private system foundation but large risk is anticipated. Likewise with the WB method, detailed F/S is absolutely imperative. In case of small scale rural water supply which can not apply the grant aid, assistance for investment environment development is strongly recommended.

6.3 Examination on Assistance Needs

6.3.1 Human Resource Development and Organizational Strengthening for Urban System

(1) Examination Manner

Based on the subjects and solutions developed in the previous chapter, assistance needs in urban system O&M, human resource development and organizational strengthening are examined according to the following policies. Implementation time scale of draft assistance needs is classified into short, medium and long term considering the benefit expression period and request of MIME.

Assistance Needs Classification	Short Term	Medium Term	Long Term
Have quick positive effect on the achievement of the CMDGs target	○		
Have instant result with respect to private system promotion	○		
Bring essential solutions for the existing issues	○	○	○
Builds/improves law system		○	

(2) Assistance Needs

Draft assistance needs proposed based on the study results are shown in **Table 6.3.1**.

Table 6.3.1 Draft Assistance Needs related to Organization and O&M of Urban System

Subjects	Draft Assistance Needs
A1-2：Lacking between MIME and DIME A1-3：Authority delegation A1-4：Negotiation between MIME and MRD on small-scaled system A1-6：Insufficient coordination among Donor Agencies A1-2-1：Shortage of management capacity A1-2-2 : Unbalanced investment to WTP and distribution network A2-1：Unavailability of water	**Assistance needs-1: Organization strengthening program for sustainable management** 【Objective】 Management capacity building and organization strengthening of urban water utility in central and provincial government 【Output】 ① Enhancement of staff's management capacity ② Development of law system related to urban water supply 【Contents】 ① Verify the management capacity of officers in central and provincial government and organize the improved points ② Study the assistance procedure of donor agencies for future application ③ Preparation works for law enforcement

Subjects	Draft Assistance Needs
related laws and regulations A2-4：Poor accountant system C1-2-3：Undeveloped fund procurement system C1-2-4：Water sales income improvement	
A1-5：Lack of governance by MOWRAM in water source development C2-2-1：Insufficient water source capacity and water quality deterioration C2-2-2：Imprudent development in upstream of water source	**Assistance needs-2: Formulation of water source management database** 【Objective】 Realize 24 hours water supply service by securing stable and safe water sources 【Output】 ① Unified management of water sources ② Proper and appropriate response to water shortage situations ③ Schematic water source development ④ Preservation of safe water sources 【Contents】 ① Consolidate and study the current water resource status ② Form the expert team with officers of the Ministry of Water Resource and related agencies to examine water resource and water quality conservation plan
A2-2：Expiration of water quality standard and fragile water quality inspection structure A3-1：Water quality aggravation in Tonle Sap River Basin	**Assistance needs-3: Capacity building program for water quality monitoring and water quality analysis** 【Objective】 Practice of proper and periodical water quality monitoring and building of observation system to preserve safe potable water 【Output】 ① Strengthen the water quality analysis capacity of provincial water quality inspection agencies (water works) ② Amelioration in agency management ③ Standardization of water quality monitoring procedure 【Contents】 ① Preparation of water quality monitoring manual ② Technology transfer in water quality analysis ③ Conduct OJT to agency staff ④ Building of operational management structure ⑤ Conduct periodical water quality monitoring

Subjects	Draft Assistance Needs
A1-1：Absence of Master Plan A3-3 : Adoption of the optimum water treatment methods B1-1-1：Un-served areas in urban water supply system B1-1-2：Inactive in-served area reduction program	**Assistance needs-4: Program for urban water supply system master plan establishment** 【Objective】 Urban system service rate improvement by schematic development in un-served area with high demand for water supply service 【Output】 ① Unified urban water supply system development plan ② Schematic and effective development plan for possible projects funded by donor agencies, private sector, etc ③ Service rate increase 【Contents】 ① Establishment of nation-wide urban water supply system development master plan
A2-3：Streamline license system B2-1-1：Obscure authority of DIME in private water supply system supervision B2-1-2：Shortage in supervisory capacity B2-1-3：Technical capacity shortage in private system B2-2-1：Obscure contract Contents	**Assistance needs-5: Private water supply system promotion program** 【Objective】 Facilitate the private sector participation in urban water supply projects to increase the service ratio 【Output】 ① Smooth project execution by private sector ② Stable and safe water supply service by application of proper technology and management ③ Appropriate instruction/supervision by MIME and DIME 【Contents】 ① Preparation of O&M manual for private system ② Human resource development to the staff of MIME and DIME in the field of water supply engineering and management 【Enforcement method】 Formulate the team comprised of Japanese experts in the fields of water supply, water quality, institutional system and financial analysis, local expert team and officers of MIME and DIME and execute the program
A3-2：Limited opportunity for communication and technical training for water supply engineers C1-1-1：Improper procurement and inventory control of	**Assistance needs-6: Program for appropriate technology introduction and engineering manual preparation** 【Objective】 Introduction of appropriate technology on water treatment, distribution network and work standardization by engineering manual

Subjects	Draft Assistance Needs
equipment and chemicals C1-1-2：Technical capacity shortage of staff C2-1-1：WTP functional issues C3-1-1：Distribution network capacity shortage C3-2-1：Water leakage from deteriorated pipes C3-2-2：Water leakage by inferior construction work	【Output】 ① Introduction of appropriate technology on water treatment and distribution network ② Preparation of engineering manual ③ Prescription of water supply service level 【Contents】 ① Trial water treatment by pilot project ② Preparation of engineering manual

Implementation time frame for the abovementioned draft assistance needs are shown below:

Table 6.3.2 Time Frame for Implementation of Assistance Needs

Assistance Needs Classification	Short Term	Medium Term	Long Term
Assistance needs-1: Organization strengthening program for sustainable management	○	○	
Assistance needs-2: Formulation of water source management database		○	○
Assistance needs-3: Capacity building program for water quality monitoring and water quality analysis		○	○
Assistance needs-4: Program for urban water supply system master plan establishment	○		
Assistance needs-5: Private water supply system promotion program	○		
Assistance needs-6: Program for appropriate technology introduction and engineering manual preparation	○	○	

6.3.2 Capacity Building for Organization, and System/O&M for Rural System

(1) Review method

a. Based on the issues and direction of solutions for rural water supply and sanitation described in chapter 5.2, action plans for capacity building, system and operation & maintenance for rural water supply and sanitation are developed as follows:

- In consideration of direction of solutions described in chapter 5.2.2, and needs by MRD and PDRD, draft assistance needs are made.
- Assistance needs are classified into a short, middle and long term in consideration of the appearance of effect of an achievement, and the needs of MRD.
- The classification of a time frame is based on the following policies.

Basic ideas of classification	Short term	Middle term	Long term
The needs are judged to obtain quick impact result in order to achieve the CMDGs goals.	✔		
The needs are judged to solve the issuers, which are detracted remarkably or may be detracted in present conditions if it is not implemented.	✔		
The needs are identified as a pilot program, and it can be developed toward middle and long term actions.	✔		
The needs are judged to shed light on the true nature of issues.	✔		
The needs are judged to be aimed at building and improving the legal system.		✔	✔

(2) Assistance needs

According to the above, assistance needs developed are shown in Table 6.3.3.

Table 6.3.3 Daft Assistance Needs

Subjects	Draft assistance needs
A1-1：Sustainable implementation of operation and maintenance procedures A1-2：Establishment of supply chains A1-3：Creation of awareness of ownership among villagers A1-4：Development of technical manuals A2-1：Capacity development of personnel in the water supply and sanitation sector	**Assistance needs-1：Program for enhancement of sustainable operation and maintenance (O&M) system** 【Objective】: Sustainable O&M model by residents is established. 【Output】 (i) O&M system for piped water supply facilities operated by community is established. (ii) O&M system for tube well with hand pump operated by residents is established. (ii) O&M supporting system by PDRD is established. 【Contents】: (i) Establish management system for O&M fund (ii) Establish management system for O&M (iii) Prepare O&M manual (iv) Establish supply chains for spare parts of hand pump 【Target areas】: 23 provinces except Phnom Penh 【Implementation Arrangement】: The O&M system will be established through pilot projects first, then the output will be expanded to other provinces.
A3-1：Construction of an efficient and sustainable information management system	**Assistance needs-2：Program for establishment of data base for groundwater management** 【Objective】: Water supply development will become more efficient through extension of a

Subjects	Draft assistance needs
A3-2：Verification of the actual proportions of people with access to safe water and improved sanitation	systematic and unitary management system of well information. 【Output】 (iii) Groundwater management system is established. (iv) A groundwater observation monitoring system is established. (v) The groundwater information by MOWRAM, MRD, and PDRD is unified. 【Contents】: (i) Collection of inventory data of existing groundwater (as built documents, existing data base and new observation data) (ii) The design of a database (iii) Preparation of a GIS map (iv) Preparation of the groundwater data management manual 【Target areas】: 23 provinces except Phnom Penh
A1-3：Creation of awareness of ownership among villagers A1-6：Measures to promote devolution A2-1：Capacity development of personnel in the water supply and sanitation sector A3-3：Opportunities to improve capacity of PDRD staff	**Assistance needs-3：Program for capacity development of the local administration staff** 【Objective】: Based on the decentralization and deconcretization framework, the function of rural water supply and sanitation sector is transferred to a local organization, and capacity of each level of PDRD, DORD, a commune council, VDC, and WSUG is developed. 【Output】 (i) Capacity of PDRD, DORD and commune council for project cycle management will be improved. (ii) Provincial development projects are to be implemented actively and strategically by PRDC. (iii) The ownership of WSUG is enhanced. 【Contents】: (i) Verify the design process of a provincial development plan, and arrange improved points (ii) Specify the legal framework of WSUG (iii) Re-examine a commune investment plan, a provincial development plan, a rolling plan, and a provincial development investment plan. (iv) Carry out OJT for staff of provincial government. 【Target areas】: 23 provinces except Phnom Penh

Subjects	Draft assistance needs
A1-4：Development of technical manuals A1-7：Review of the water quality management system A3-1：Construction of an efficient and sustainable information management system A3-2：Verification of the actual proportions of people with access to safe water and improved sanitation	**Assistance needs-4：Program for building of water quality monitoring and an observation system** 【Objective】: In order to secure safe drinking water, water quality monitoring is carried out appropriately and a related observation system is built. 【Output】 (i) The capability of water quality analysis in related agencies such as water works by DIME in each province is improved. (ii) The management system by related agencies of water quality analysis is improved. (iii) The procedure of water quality monitoring is determined. 【Contents】: (i) Prepare water quality monitoring manual (ii) Provide OJT for staff of related agencies of water quality analysis (iii) Establish management system for water quality analysis (iv) Establish water quality monitoring system 【Target areas】: 23 provinces except Phnom Penh
A1-8：Integration of service level A1-4：Development of technical manuals B1-2-1：Diffusion of appropriate technology and securing of safe water sources	**Assistance needs-5：Development of appropriate technology and technical manuals** 【Objective】: Appropriate technology of the water treatment by surface water is developed, and standardization of the business by technical manuals is promoted. 【Output】 (i) Appropriate technology for water treatment is developed. (ii) Technical manuals are prepared. (iii) Service level of water supply facilities is stipulated. 【Contents】: (i) Trial of the appropriate water treatment technology through a pilot project (ii) Preparation of technical manuals (iii) Informed-choice manual for water supply facilities 【Target】: MRD
A2-1：Capacity development of personnel in the water supply and sanitation	**Assistance needs-6：Capacity building of water supply and sanitation** 【Objective】: The personnel training system for water and sanitation sector in Cambodia is improved.

Subjects	Draft assistance needs
sector A2-2：Human resource development in the water supply and sanitation sector A3-4：Active participation of the private sector A1-9：Improvement in quality control	【Output】 (i) National training center and provincial satellite training center are established. (ii) Training courses are developed. (iii) Water Suppliers Association is re-formed. (iv) Quality control system is established. 【Contents】: (i) Prepare a plan for establishment of a training center in cooperation with MIME. (ii) Develop training materials (iii) Train trainers (iv) Prepare a plan for reform of water suppliers association in cooperation with MIME 【Target areas】: 24 provinces
A3-5：Nationwide rural water supply master plan	**Assistance needs-7：Program for development of nationwide rural water supply master plan** 【Objective】: In order to achieve sector goal, implementation plan for rural water supply facilities is made and efficient and effective implementation is promoted. 【Output】 (i) Groundwater potential in whole Cambodia is identified. (ii) Sustainable groundwater development plan is made. (iii) Techniques for groundwater surveys and for planning are transferred to implementing agencies. 【Contents】: (i) Put the existing groundwater development data in order (ii) Field survey (iii) Examine groundwater potential (iv) Prepare groundwater development plan 【Target areas】: 16 provinces（except Kandal, Kompong Speu, Takeo, Prey Veng, Svay Rieng, Phnom Penh Peri-Urban, Kompong Cham and Kampong Kompong Chhnang)
A1-5：Poor availability of sanitation facilities	**Assistance needs-8：Program for improvement of hygiene awareness and environment** 【Objective】: Case rate of residents' water born disease is decreased through improvement of hygiene environment.

Subjects	Draft assistance needs
	【Output】 (i) National hygiene environmental improvement plan is made. (ii) A governmental financial support system to residents is improved. 【Contents】: (i) Prepare a hygiene environmental improvement plan (software, hard) (ii) Develop a governmental financial support system for construction of toilet for residents (iii) Implement a pilot project such as IEC activity, CLTS and toilet construction. Verify and improve the governmental financial support system. 【Target areas】: 23 provinces except Phnom Penh

Time frame for implementation of assistance needs descried above is shown in Table 6.3.4.

Table 6.3.4 Time Frame for Implementation of Assistance Needs

Assistance needs	Short term	Middle term	Long term
Needs-1：Program for enhancement of sustainable operation and maintenance (O&M) system	✔		
Needs-2：Program for establishment of data base for groundwater management	✔	✔	
Needs-3：Program for capacity development of the local administration staff		✔	✔
Needs-4：Program for building of water quality monitoring and an observation system		✔	✔
Needs-5：Development of appropriate technology and technical manuals	✔		
Needs-6：Capacity building of water supply and sanitation		✔	✔
Needs-7：Program for development of nationwide rural water supply master plan	✔	✔	
Needs-8：Program for improvement of hygiene awareness and environment	✔		

Chapter 7
Conclusion and Recommendations

Chapter 7 Conclusion and Recommendations

7.1 Study on Comprehensive Priority

Based on the results of the study in Chapter 6, the priority of provinces are as follows in terms of needs for system development, human resource development for organization and institution and operation and maintenance and programme for institutional development

(1) System Development

1) Urban water supply system

Table 7.1.1 Priority for Urban Water Supply System Development

Priority		Name of Provinces
First Priority Group	Top priority: 4 Provinces	Battambang, Kampong Cham, Preah Sihanouk, Banteay Meanchey
	On-going: 3 provinces	Phnom Penh, Kandal, Siem Reap
Second Priority Group	High priority: 6 Provinces	Kampong Chhnang, Kampong Speu, Kampong Thom, Kampot, Pursat, Prey Veng,
	On-going : 2 provinces	Mondul Kiri, Ratanak Kiri
Third Priority Group6 Provinces		Koh Kong, Kratie, Stung Treng, Svay Rieng, Takeo, Pailin
Fourth Priority Group3 Provinces		Otdar Meanchey, Kep, Preah Vihear

2) Rural water supply system

Table 7.1.2 Priority for Rural Water Supply System Development

Priority	Name of Provinces
First Priority Group	7 Provinces: Kampong Cham, Mondul Kiri, Preah Vihear, Prey Veng, Ratanak Kiri, Stung Treng, Takeo
Second Priority Group	7 Provinces: Battambang, Kampong Chhnang, Kampong Speu, Kampong Thom, Kandal, Kratie, Pursat
Third Priority Group	8 Provinces: Banteay Meanchey, Kampot, Koh Kong, Siem Reap, Preah Sihanouk, Svay Rieng, Otdar Meanchey, Pailin
Fourth Priority Group	2 Provinces: Kep, Phnom Penh

(2) Human Resource Development and Organization Strengthening Program

1) Urban water supply system

The timeframe of human resource development and organization strengthening program for urban water supply is shown below.

Table 7.1.3 Timeframe of Human Resource Development and Organization Strengthening Program for Urban Water Supply

Assistance Needs Classification	Short Term	Medium Term	Long Term
Assistance needs-1: Program for organization strengthening for sustainable management	○	○	
Assistance needs-2: Program for formulation of water source management database		○	○
Assistance needs-3: Program for capacity building of water quality monitoring and analysis		○	○
Assistance needs-4: Program for formulation of urban water supply system master plan	○		
Assistance needs-5: Program for private water supply system promotion	○	○	○
Assistance needs-6: Program for appropriate technology development and technical manual preparation	○	○	

2) Rural water supply system

Similarly, the timeframe of human resource development and organization strengthening program for rural water supply is shown below.

Table 7.1.4 Timeframe of Human Resource Development and Organization Strengthening Program for Rural Water Supply

Assistance Needs Classification	Short Term	Medium Term	Long Term
Assistance needs -1: Program for enhancement of sustainable operation and maintenance system	○		
Assistance needs -2: Program for establishment of for groundwater management database	○	○	
Assistance needs -3: Program for capability building of local administration staff		○	○
Assistance needs -4: Program for building of water quality monitoring and observation system		○	○
Assistance needs -5: Program of appropriate technology development and technical manual preparation	○		
Assistance needs -6: Program for capacity building of water supply and sanitation		○	○
Assistance needs -7: Program for formulation of nationwide rural water supply and sanitation master plan	○	○	
Assistance needs -8: Program for improvement of hygiene awareness and environment	○		

7.2 Conclusion and Recommendations

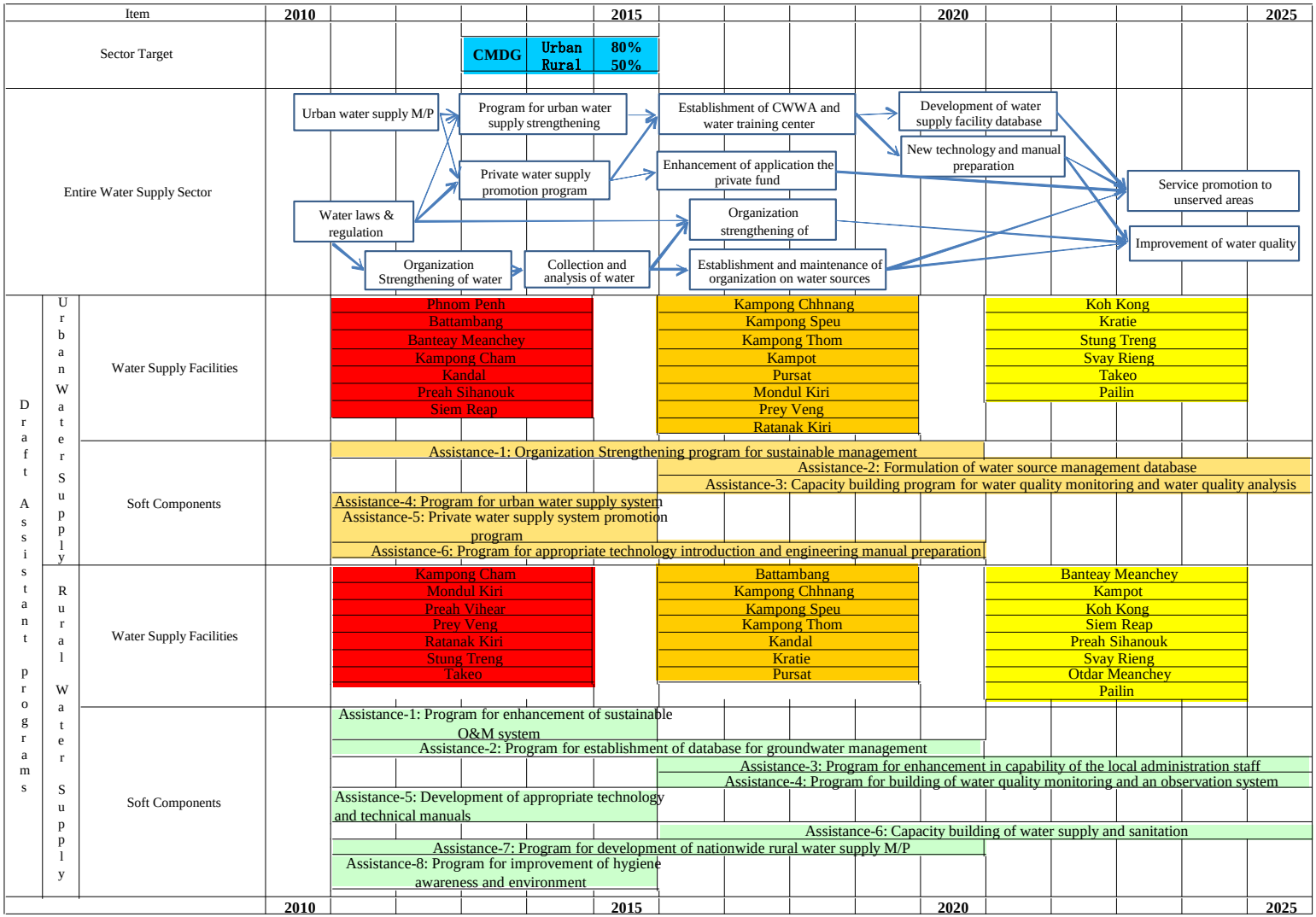
Consolidating the draft assistance needs by urban/rural water supply system development and soft component, the draft road map was prepared as shown in **Table 7.2.1**. Though actual project/program implementation period differs according to the scale and contents, a uniform period of four years is adopted herein.

Based on the draft road map, the following combinations are proposed as applicable assistance options by the donor agencies:

- Assistance program for technology transfer or human resource development for urban and rural water supply system in single province
- Assistance program for technology transfer or human resource development for urban and rural water supply system in plural provinces as one package
- Assistance program for both technology transfer and human resource development for urban or rural water supply system in single province

Hereafter, it is expected that the water supply service in which the people as much as possible can use safe and stable water will be provided by promoting the water supply system development under the donor's assistance based on this draft road map, achieving the water supply and sanitation coverage established in the Millennium Development Goals and by keeping proper and continuous system development thereafter.

Table 7.2.1 Road Map pf Assistance Needs Program by Urban and Rural Water Supply Sector



Appendices

A1. Urban Water Supply

A1.1 Water and Sanitation Law of the Kingdom of Cambodia

KINGDOM OF CAMBODIA
NATION RELIGION KING

WATER AND SANITATION LAW

OF

THE KINGDOM OF CAMBODIA

Unofficial Translation

2004

CHAPTER I

GENERAL PROVISIONS

ARTICLE 1:

The purpose of this Law is to govern and prepare a framework for, water supply and provide water supply and sanitation services, aiming at raising the people's living standards for the sake of society, economy and environment.

ARTICLE 2:

The scope of this Law shall cover all the management activities related to water supply and sanitation within the whole territory of the Kingdom of Cambodia.

ARTICLE 3:

"Water Supply Service" in this law shall refer to exploitation of treatment and distribution of water through pipeline network to the users.

"Sanitation Service" in this law shall refer to the exploitation of collection and transmission of sewerage discharged from domestic houses, public and private establishments to the treatment plant.

"Sewerage" in this law shall refer to wastewater and liquid contaminated by chemical impurities, oil etc. discharged from domestic houses, public and private establishments.

"User" in this law shall refer to a person or continued receiver, which buy or receive water supply and sanitation services for its own usage and do not provide or sell the services to the other.

"License" in this shall refer to the given permission for providing water supply and/or sanitation services.

"Licensee" in this law shall refer to person, who holds the legal and valid license issued by Water and Sanitation Authority.

ARTICLE 4:

This law aims to establish:

(a) The principles for operations in water supply and sanitation sector and all activities of the licensees in the provision of all water supply and sanitation services;

(b) The favorable conditions for investment in, and the commercial operation in the water supply and sanitation sector;

(c) The basis for regulation of the water supply and sanitation services throughout the Kingdom of Cambodia;

(d) The principles for:

  (i) Protection of the rights of consumers in order to receive water supply and sanitation services by ensuring the quality, durability and sufficiency at a reasonable price;

  (ii) Promotion of private ownership on the facilities for providing water supply and sanitation services;

  (iii) Promotion of competition wherever feasible within the water supply sanitation sector.

(e) Principles for granting the rights and obligations, and penalizing the suppliers and users of water and sanitation services and also the public and land owners in the connection with the facilities of water supply and sanitation;

(f) The Cambodian Water and Sanitation Authority for regulating the water supply and sanitation services.

CHAPTER II

FRAMEWORK OF WATER SUPPLY AND SANITATION SERVICES

ARTICLE 5:

The Ministry of Industry, Mines and Energy, in this law, shall be responsible for setting and administrating the government policies, strategies and planning in water supply and sanitation sector.

The Water and Sanitation Authority of Cambodia shall ensure that the provision of water supply and sanitation services and the use of these services shall be performed efficiently, qualitatively, sustainably and in a transparent and manner.

ARTICLE 6:

Ministry of Industry, Mines and Energy shall ensure the communication on a regular basis with the Authority and shall provide to the Authority the information on policies, strategies, planning of water supply and sanitation and its decision on:

- Investments in the rehabilitation and development of water supply and sanitation sector in short, medium and long terms;
- Restructuring of private sector participation and privatization of public utilities;
- Planning and agreements on the export and import of potable water;
- Subsidies to specific classes of customers and priorities regarding consumers of water supply and sanitation services;
- Promotion of efficiency in the provision of providing of water supply and sanitation services, and using of these services as well as the activities to save clean water and maintenance of sanitation.

ARTICLE 7:

Provider of each water supply and sanitation service is required to have a license issued by the Water and Sanitation Authority of Cambodia, and shall abide by provision of this law and those regulations setting in its license as well as the procedures of the Authority, and the requirements of the laws of the Kingdom of Cambodia.

While making decision on issuing licenses, the Authority shall take into account the government policies, strategies and planning in water supply and sanitation sector which aim to reduce the long and short run marginal cost of supplying water and sanitation services throughout the Kingdom of Cambodia, and decisions set out in Article 6 of this law, and shall ensure the public interest.

The Authority shall ensure that the licensees shall use the standard related to technical operation, safety and environment which is made and disseminated by Ministry of Industry, Mines and Energy.

CHAPTER III

ESTABLISHMENT OF THE WATER AND SANITATION AUTHORITY OF CAMBODIA

ARTICLE 8:

The Water and Sanitation Authority of Cambodia is a legal public entity, being granted the right from the Royal Government of Cambodia to be an autonomous agency to regulate the water supply and sanitation services, and to govern the relation between the delivery, receiving and usage of all water supply and sanitation services.

ARTICLE 9:

The Water and Sanitation Authority of Cambodia shall have the following duties:

(a) To issue, revise, suspend, revoke or deny the licenses for the water supply and/ or sanitation services as provided in Article 31 of this law;

(b) To approve tariff rates and other charges and terms and conditions of water supply and/or sanitation services of licensees, except where the Authority consider those rates or charges and terms and conditions are established pursuant to a competitive and market-based process;

(c) To order to implement guidance procedures and standards for investment programs by licensees;

(d) To review the financial activities and corporate organization structure of licensees to the extent that these activities and organization directly affect the operation of the water supply and sanitation sector and the efficiency of the provision of water supply and sanitation;

(e) To approve and enforce the performance standards for licensees;

(f) To evaluate and resolve consumer complaints and contract disputes involving licensees, to the extent that the complaints and disputes relate to the violation of the conditions of license;

(g) To approve and enforce a uniform system of accounts for all licensees;

(h) To prepare and publish reports of water supply and sanitation sector and relevant information received from licensees for the benefit of the Royal Government and the public interest;

(i) To prescribe fees applicable to licensees;

(j) To determine the procedures for informing the public about affairs within its duties, in order to ensure that the Water and Sanitation Authority of Cambodia complies with the principle of transparency as set forth in Article 5 of this law;

(k) To issue rules and regulations and to make appropriate orders, and to issue temporary and permanent injunction for water supply and sanitation services;

(l) To impose monetary penalty, disconnect water supply and sanitation services, suspend or revoke the license for the violations of this Law, standards and regulations of the Water and Sanitation Authority of Cambodia;

(m) To require the service providers and users of water supply and sanitation services to obey the rules relating to the security of water supply and sanitation, economy, environment and other Government policies;

(n) To require physical persons or legal entities connect and /or disconnect water supply and sanitation network in case effect on public health and safety.

(o) To perform any other function incidental or consequential to any of the duties as describes above; and

(p) To establish the terms and conditions of employment of the officers or employees including expert/advisers of Water and Sanitation Authority of Cambodia.

ARTICLE 10:

The Water and Sanitation Authority of Cambodia shall have a Secretariat and Departments. The Secretariat headed by one Executive Director shall be established for supporting the administrative and technical tasks and controlling the various expertise departments. The organization and functioning of the Secretariat shall be determined in the internal rule of the Authority.

ARTICLE 11:

The Water and Sanitation Authority of Cambodia shall consist of three members, including the Chairperson. The Chairman and members shall be designated and proposed by the Prime Minister and shall be appointed by the Royal KRET. Each member shall have a three-year term, which shall be staggered except for the initial term, as described in Article 72 of this law.

No member shall be appointed to serve on the Authority for more than two (2) terms. Within two (2) years after the completion of their term of office, neither the Chairman nor any member shall enter into the employment or have any advisory or consulting relationship with any Licensee.

ARTICLE 12:

An individual shall be eligible to serve as a Chairman or members of the Water and Sanitation Authority of Cambodia shall fulfill the following conditions:

- a Cambodian born citizen and a qualified voter in the Kingdom of Cambodia;
- who has never been convicted of a criminal sentence;
- who has university degree in engineering, law, economics, accountant, finance or engineering that related to the water supply and/or sanitation sector and has recognized by the competent institutions;
- who has professional experience of at least ten years; and
- who is a competent, neat and virtue person.

This designation for appointment is not based on political tendency.

ARTICLE 13:

The chairman and members shall have full time employment at the Authority and shall not have any other employment nor accept any payment for any other activities.

ARTICLE 14:

The chairman and members or officer or employee of the Authority shall not directly own any securities of, or have any economic interest in, or hold any position with any licensee or applicant for a license but shall not prevent any member or employee of the Authority from being a customer of any licensee.

Licensee or any person acting on behalf of licensee is prohibited to offer any gift or gratuity, different from that generally applicable to the public, to any member or employee of the Authority. Member or employee of the Authority is prohibited to accept, any gift or gratuity, different from that generally applicable to the public, from any Licensee or any person acting on behalf of any licensee.

During the chairman's or member's term, neither the chairman nor any member, nor his/her spouse nor children, shall enter into the employ of, seek to enter into the employ of, hold any official, advisory or consulting role with, own stock or bonds of, or have any pecuniary interest in any licensee under the law or with any person engaged in providing water supply and/or sanitation services or to associations of water users or any related undertaking activities.

ARTICLE 15:

The function of chairman and the members of the Authority are incompatible with those of civil servant, a member of Constitutional Council, a member of Senate, a member of National Assembly, a member of leader group of any political party, or an adviser of any Government Institution, or a member of the Royal Government.

When an individual having a position as stated above is appointed as a member of the Authority, the chairman and the members of the Authority shall temporarily resign or suspend from the above positions or membership, for the period of the office term.

ARTICLE 16:

The position of a member of the Authority shall fall vacant, when that member:

1- dies,

2- resigns,

3- retires,

4- is convicted by the criminal offence,

5- loses the right to vote,

6- is found to be mental or physical incapacity,

7- is found to have committed a serious violation of any provision stipulated in Article 13, 14 and 15,

8- is found to have seriously neglected and no responsibility in the performance of duties;

9- is found to have committed a grave misdemeanor in relation to his responsibilities; or

10- abandons the duties;

If a member is found to be in the case 5, 6, 7, 8, 9 or 10 of the article 16 the Prime Minister may decide to suspend the said member from duties and shall refer the case to the competent tribunal. In that case, the Prime Minister shall appoint temporary member to perform the job during the suspension period.

ARTICLE 17:

Whenever a vacancy in the Authority occurs prior to the expiration of a term, the Prime Minister shall designate new member to fulfill the former member's term. This new member shall be appointed by royal KRET. This replacement shall not count in the numbers of full term as stipulated in Article 11 of this law.

ARTICLE 18:

The salary allowances and other interests of members of Authority shall be determined by the Government. The chairman's position shall be equivalent to the rank of a Secretary of State, the position of other members shall be equivalent to Under Secretary of State.

The members of Authority shall retire when they attain the age of sixty (60). In case of retirement before the term expired, the Prime Minister may permit this member to continue the duties until the expired date of the term as necessary.

The chairman or other members may at any time request to resign their job by giving at least one (1) month written notice to the Prime Minister.

ARTICLE 19:

The chairman of Authority shall not be removed from the position of chairman of the Authority during the term except for the reasons given in Article 16 of this law.

ARTICLE 20:

The chairman of the Water and Sanitation Authority of Cambodia shall be responsible for:

- managing Water and Sanitation Authority of Cambodia
- presiding over the meeting of Authority; and
- ensuring the publishing and implementation of all Authority's decisions.

In addition, the Water and Sanitation Authority of Cambodia may delegate to the chairman any of its powers, duties or functions, except:

- the power to issue, reject, amend, or revoke licenses;
- the power to reject application or modification of a licenses;
- the power to set, approve, disapprove, or revise the water tariff of water and sanitation service charge or investment programs and conduct the receiving program for water and sanitation.
- the power to issue, revise, or repeal the Authority's regulations; or
- the power to decide on an appeal of the public.

Any aggrieved party or person may make appeals to the Authority in such cases within thirty (30) days of promulgation of the ruling.

The chairman of the Water and Sanitation Authority of Cambodia may designate in writing to one of the other members to fulfill the duties of the chairman in his/her absence.

ARTICLE 21:

The chairman of the Authority, in consultation with other members shall appoint all employees and shall hire other experts as may be necessary for the proper discharge of the Authority's duties. Employees and experts of the Authority shall abide by the Labor Law of Kingdom of Cambodia.

CHAPTER IV

FUNTIONING OF WATER AND SANITATION AUTHORTY OF CAMBODIA

ARTICLE 22:

The Water and Sanitation Authority of Cambodia shall adopt and declare the rules for controlling meeting between its members or employees and any party to establish a tariff, water supply and sanitation service charge and to grant a license. The rules shall determine the objective, the date and time, the place and the meeting proceeding for giving an opportunity to the interested persons to participate.

ARTICLE 23:

All members of the Water and Sanitation Authority of Cambodia shall have the right to vote on all matters requiring the decisions of the Authority. These decisions of the Authority will be based on the majority vote.

Two members shall constitute a quorum of the Water and Sanitation Authority of Cambodia to make decision.

All members of the Water and Sanitation Authority of Cambodia shall be given notice of the date and time, place and objective of the session in which the decision will be voted on.

ARTICLE 24:

The sessions of Water and Sanitation Authority of Cambodia for hearing of any complaint shall be public. The Authority's decisions, with its reasons, shall be published as soon as the decisions are made unless the Authority has the reasonable causes and decides to delay the publication. The Authority shall keep a record of all proceedings, orders, findings, and judgments, and to preserve all records, documents, and files of the Authority.

All orders, findings, judgments, records and other documents shall be open to public examination in the offices of the Authority; except provided that the Authority shall adopt appropriate rules to ensure confidential information received by Authority remains confidential, whenever Authority determines this confidentiality is necessary.

Except as otherwise expressly provided in this law, no outside authority or agency of the Government shall interfere in the decisions of the Authority.

ARTICLE 25:

Before promulgating any general order, or any rule or regulation, the Authority shall give reasonable notice of its contents and shall give an opportunity to interested legal persons and public to present their evidence their opinion. All such orders, rules, and regulations shall be available to the public.

Before the Authority make any finding, order, or judgment against any legal person or individual, the Authority shall give such legal person or individual reasonable notice of the time and place at which this legal person or individual has an opportunity to give evidence and opinion.

ARTICLE 26:

After the Authority issues a final decision, each affected institution and party shall have the right of appeal to the Court of the kingdom of Cambodia. This appeal shall be filed within three (3) months from the date of the final decision.

ARTICLE 27:

The Authority shall be jointly liable for the consequences resulting from the performance of functions by the members or employees of Authority pursuant to the provisions of this Law and any implementing Sub-Decrees and regulations.

ARTICLE 28:

The Authority shall determine the salary, and other remuneration of its officers and employees.

The Authority shall establish a budget of its operating expenses for each financial year that sets forth all the Authority's expected revenues and expenses. The budget shall clearly state the proposed license fees for the financial year, together with the method of calculating the license fees, and the salaries and other remunerations entitlements to be paid to each of the members and senior staff of the Authority. The Authority shall submit this budget to the Government for review and approval.

ARTICLE 29:

The Authority shall have an autonomous budget for their operation. This budget shall come through fees paid to the Authority by applicants and licenses. The fees shall be determined by the Authority. This fee is called the license fee.

The license fees shall be deposited in an account of a state bank of the Kingdom of Cambodia. Only the Authority shall the right to use this fund.

The maximum license fees shall be determined by Sub-Degree.

Any balance funds in the Authority account at the end of the year shall be carried forward to the next year budget.

In case that surplus or shortfall in annual budget of the Authority as stated above shall be adjusted through the license fees a t the next year budget.

In case that shortfall in budget cannot be met even after maximum readjustment, the Authority is still unable to meet its operation expenses and repayment loan with interest, the Authority shall request to be the Royal Government for reviewing and approving the new maximum license fees.

The financial and accounting operation of the Authority shall be performed in accordance with the public accounting system.

ARTICLE 30:

The Authority shall prepare its annual financial statement not later than one month after the end of each financial year.

Each annual financial statement, together with the accounting books of the Authority and related records shall be audited by auditor and inspected by the National Audit Authority.

Within 1 (one) month after auditing, the Authority shall submit all reports to the Prime Minister for approval, and shall publish the approved report to the public.

CHAPTER V

TYPE OF LICENSES

ARTICLE 31:

The licenses under empowerment of Water and Sanitation Authority of Cambodia as stipulated in Article 9 (a) of the law shall be as follows:

1- Water Supply Service License

2- Water Treatment License

3- Water Distribution License

4- Sanitation Service License

5- Wastewater Discharge Collection License

6- Sewerage Treatment License

7- Consolidate License

The provision of water supply and sanitation services under any type of license as stated above shall be operated in form of company registered according to the rule in force. The provision of water supply and sanitation services under of type license as stated above may be operated inform of an individual, provided that this provision of services shall be in the small size as determined by Water and Sanitation Authority.

ARTICLE 32:

The Water Supply Service Licensee shall have the right to treat water and distribute in a franchise service area. The right of Water Supply Service License under this law is to own, operate and manage or control the treatment facilities and distribution of water supply for sale to consumer and not solely for own consumption.

The granting of Water Supply Service License shall be for the purpose of promoting the safe, reliable, and economic efficient operation of water supply system.

The validity of Water Supply Service License shall generally be for the expected useful life of the efficient distribution and treatment facilities. The Water Supply Service License can be revoked under the provisions of this law.

ARTICLE 33:

The Water Treatment License shall be provided to who operate the water treatment services for water production bulk sale to distributors.

The validity of Water Treatment License shall generally be for the expected useful life of the efficient generation facility. The Water Treatment License can be revoked under this law.

ARTICLE 34:

The Water Distribution Licensee shall have the right to provide the water distribution services in any determined service area. The right to provide the water distribution services under this law is the right of ownership and operation and managing or controlling to the water distribution for supplying and selling water to customers that have the specified purpose and ensure the public interest.

The Water Distribution License shall prescribe the regulation on conditions to ensure that the operation of water treatment system, transmission system and distribution system under its dispatch control is in safe, reliable and efficient condition.

The validity of Water Distribution License shall generally be for the expected useful life of the efficient distribution facilities. The Water Distribution License can be revoked under the provisions of this law.

ARTICLE 35:

The Sanitation Service Licensee shall have the right to collect, discharge and treat sewerage in a franchise area. The right to provide sanitation service in this law is the right of ownership, operation and managing facilities to collect, discharge and treat sewerage for insure of the safe, reliable, and economic efficient operation.

The validity of Sanitation Service License shall be generally for the expected useful life of the efficient service facilities. The Sanitation Service License can be revoked under the provisions of this law.

ARTICLE 36:

The Sewerage Discharge Collection Licensee shall have the right to collect and discharge in the determined service area. The right to provide sewerage discharge collection service in this law is the right of ownership, operation and managing or controlling facilities to collect discharge sewerage to ensure the safe, reliable, and economic efficient operation.

The validity of Sewerage Discharge Collection License shall generally be for the expected useful life of particular services facilities. The Sewerage Discharge Collection License can be revoked under the provisions of this law.

ARTICLE 37:

The Sewerage Treatment License shall be provided to who operate sewerage treatment service to treat sewerage only.

The validity of Sewerage Treatment License shall generally be for the expected useful life of particular sewerage treatment facilities. The Sewerage Treatment License can be revoked under the provisions of this law.

ARTICLE 38:

The Consolidate License is a license, which may be the combination of some or all type of licenses stated in paragraph 1 to 6 of Article 31 of this law.

In issuing Consolidate Licenses, the Authority shall consider long term planning, including the objectives of Government policy encouraging water supply and sanitation services to all people in Kingdom of Cambodia.

CHAPTER VI

LICENSING OF WATER SUPPLY AND SANITATION UTILITIES

ARTICLE 39:

No person may operate as water supply and/or sanitation services except he/she have performed under and in accordance with the terms of a valid license issued by the Authority.

Licenses shall be issued only to legal entity or person whose competence satisfies the requirement of Authority to operate as water supply and sanitation service and to satisfy the service obligation and conditions included in the license.

Licensees shall not be required to provide water supply and sanitation services, the cost of which can not be recovered through water supply and sanitation tariffs, except to the extent specific funds are provided to subsidize consumers and the licensee is agreeable to this arrangement.

ARTICLE 40:

Each license must comply with all conditions set forth in its license, the rules and regulations adopted by the Authority, and the laws of the Kingdom of Cambodia. Licensees shall use the resources and provide treatment, transmission or distribution services, as applicable, at least cost and in accordance with prudent utility practices.

In accordance with Authority regulations, each Licensee shall submit to the Authority with a copy to Ministry of Industry, Mines and Energy make available to the public:

(i)- An annual summary report of Licensee's activities for the past year;

(ii)- Annual work plan for following year describing the Licensee's anticipated activities;

(iii)- Tariffs, other charges and conditions decided and determined by the Authority;

(iv)- Such other reports, statement and information as the Authority regulation, determines to be necessary and appropriate.

Each Licensee shall submit to the Authority for reviewing and approval the reports, statements, and information that the Authority, by regulation, deems necessary for the safe and reliable operation of the transmission pipes and connection facilities.

ARTICLE 41:

Before issuing of any License or reinstating of a suspended License, the Authority may require a bond or other form of financial security necessary to ensure satisfaction of service obligations pursuant to this Law and the conditions of the License, including the payment of License Fees.

ARTICLE 42:

The Authority shall establish the conditions on the issuing, amendment, suspension, revocation or denying of licenses and its application procedures in according to this law.

The Authority shall insure fair, transparency and no discrimination to issue, amend, suspend, revoke or deny the license according to this law, Sub-Decree and other orders.

ARTICLE 43:

The licensee shall not rent, sell or deposit as lien its license to any other person. The license can assign or transfer its license to any other person only with the special approval of Authority. Only the Royal Government may transfer the licenses held by the state or by the state owned companies to another person as part of water and sanitation sector reform.

For the purpose of this law and in the public interest, the Authority may approve, disapprove or restrict the following activities of licensees:

- Conducting a business merger or reorganization or a major acquisition or sale of assets or securities; or
- Expanding the licensee's business activities.

CHAPTER VII

TARIFFS

ARTICLE 44:

The Authority shall determine and review the tariff rates, charges and service terms and conditions of the licensee. With ninety (90) days from the receiving date of any application by licensees requesting the Authority to determine or revise their tariff, the Authority shall approve, revise or disapprove this request.

The Authority shall determine the effective date for new tariff or the revised tariff not later than ninety (90) days as stipulated above.

ARTICLE 45:

The Authority shall establish procedures and models for submitting the tariff applications for approval in accordance with the provisions of this Law.

The Authority shall establish the rules for licensees regarding:

- Evidentiary requirements for tariff applications, including audited financial information;
- Time frames for tariff applications and decisions;
- Procedures for consumers and other interested parties to comment on tariff applications; and
- Procedures for the Authority to obtain additional information from the applicant as necessary to evaluate tariff applications.

ARTICLE 46:

The Water and Sanitation Authority must determine the tariffs for:

1- Protect consumers against monopolistic prices;

2- Provide licensees with an opportunity to recover their costs but this cost recover shall be the proper expenditure according to the business standard which is determined by Sub-Decree.

3- Encourage the efficiency of operations and internal management of licensees by allowing to increase their financial returns according to the result of the minimizing its service costs; provided that the licensee meets all requirements of its license concerning the supply and quality of service;

4- Encourage the economic efficiency of water supply and sanitation sector by reflecting short run and long run marginal costs and by sending accurate price signals regarding the abundance or shortage of the supply of water and sanitation services;

5- Take into account the cost and other appropriate differences between categories of customers and types of service, any subsidies provided by the Government to subsidize any customer or category of customers; provided that no Government policy shall prevent a licensee from exercising any rights granted in its license to disconnect any public or private consumer for failure to meet its payment obligations under any contract or approved terms and conditions of service.

Allocations of the revenue required to cover the cost of licenses fees shall be assigned so that costs are recovered from each customer category in proportion to the costs of serving that category.

Different tariffs may be established for each customer category to reflect the quantity of peak, average, or overall usage of water supply and sanitation services at different times, seasons, the types of services purchased or other similar factors. Lower rates for low usage or poor residential and urban customers may be established to ensure the availability of water supply and sanitation to these customers. Performance-based tariffs may, including revenue indexing, price indexing, and other innovative tariff methodologies may also be used if the Water and Sanitation Authority found that the use of such methodologies is in the interest of licensees and consumers.

CHAPTER VIII

OTHER REGULATIONS ON THE WATER SUPPLY AND SANITATION SERVICES

ARTICLE 47:

The Water and Sanitation Authority shall establish procedures and standards to obtain information from licensees regarding the investment program to expand additional water supply systems and sanitation services.

ARTICLE 48:

The Water and Sanitation Authority shall require each licensee to ensure and certify that metering equipment and meter testing facilities comply with all applicable standards. Licensees shall measure the quantity of water only by the metering equipment, which has been tested by meter test facilities certified by the Authority.

Any metering equipment and meter testing facilities may be inspected by the Authority from time to time to ensure continuing compliance with applicable standards and requirements as approved by the Authority.

Licensees and consumers of water shall give access to the Water and Sanitation Authority and its employees to inspect and test meters and meter test equipment to verify the accuracy of measurement of supplies without prior notice.

ARTICLE 49:

Licensees shall:

1- Install the metering equipment in the most practical location where the licensee can easily to read the meter and the consumer can preserve the equipment;

2- Have the right to test, replace and modernize metering equipment, the cost of which shall be borne by the licensee;

3- At the request of a consumer, inspect and recalibrate the metering equipment and, if necessary, install a temporary meter if the installed equipment needs to be removed and repaired.

All charges for this testing, calibrating, inspection and replacement shall be approved by the Water and Sanitation Authority.

ARTICLE 50:

Consumers:

1- Shall report to licensee any observed malfunctions and facilitate the inspection, repair or replacement of that equipment by licensees upon giving reasonable notice; and

2- May have their own metering equipment, provided that it satisfies all the prescribed standards and requirements.

ARTICLE 51:

All licensees shall use a uniform system of account established by the Water and Sanitation Authority for financial and economic reporting to the Authority.

The Water and Sanitation Authority shall use the financial and economic reports provided by licensees and its own analysis as the basis for calculating tariffs.

ARTICLE 52:

After receiving not less than twenty-four (24) hours notice before operation, consumers must allow the authorized representative of a licensee to enter into their premises or property for the purpose of inspection, repair and maintenance of meters and water supply facilities, including legal disconnection of service or installation of water supply facilities and equipment.

ARTICLE 53:

A licensee may arrange, construct, or install, such water supply and sanitation facilities and equipment as are necessary for the licensee to satisfy its water supply and sanitation services responsibilities under this Law.

The licensee shall take reasonable efforts through negotiations and conciliation with the owners of the lands and by paying appropriate compensation to acquire necessary rights of entry, rights of way, and/or easements.

In the event that licensee is unable to obtain such rights through reasonable efforts as stated above, the Water and Sanitation Authority, upon request by the licensee, shall intervene to the relevant authority to settle these issues in the public interest.

ARTICLE 54:

Licensee shall responsible for all actions performed by their employees on the operation of its water supply and sanitation services.

CHAPTER IX

ANTI-PILFERAGE

ARTICLE 55:

It is hereby declared unlawful activities as below:

(a) Destroy, damage or interfere with any water supply and/or sanitation infrastructures of licensees;

(b) Store or discharge sewerage that effect on environment and/or public health;

(c) Prevent, obstruct and interfere with the survey, works, and construction of access road and water mains and distribution network of water or sewerage and any related necessary works of licensees;

(d) Tap, make, or cause to be made any connection with water lines without prior Authority or consent from the licensees;

(e) Tamper, install or use tampered water meters, sticks, magnets, reversing water meters, shortening of vane wheels and other devices to steal water or interfere with accurate registry or metering of water usage, or otherwise result in its diversion in a manner whereby water is stolen or wasted;

(f) Use or receive the direct benefit of activities mentioned in (d) and (e);

(g) Steal or pilfer water meters, main lines, pipes and related or ancillary facilities;

(h) Steal water for profit or resale;

ARTICLE 56:

The presence of any of the following circumstances shall constitute prima facie evidence of theft, pilferage, or of any unlawful acts enumerated in Article 55 hereof:

(a) The unauthorized tapping to the water main or distribution pipe or without permission of licensees;

(b) The connection before water meters;

(c) The presence of tampered or fake seals on the meters;

(d) Destruction of the meter protection and other metering accessories;

(e) Abnormal imprints, traces or marks found in the meter assembly.

The prima facie shall not apply to tenants who have occupied the house or dwelling for thirty (60) days or less.

Inspection of tampered water meters shall be done in the presence of the registered water consumer.

CHAPTER X

ENFORCEMENT OF THE AUTHORITY

ARTICLE 57:

The Authority shall be competent to file the complaint in the court of the Kingdom of Cambodia for any violation of this law or Sub-Decree related and violations of the regulations, orders, judgments and licenses issued by the Authority.

ARTICLE 58:

The Authority shall determine the procedures for imposing sanctions and penalties. The nature of penalties issued by the Authority which it may impose for specified license violations as well as procedures governing the revocation of licenses and the conditions which shall apply for the continued operation of the facilities covered by licenses.

ARTICLE 59:

The Authority shall determine the procedures including the issuing instruction and the receiving instruction procedures for governing the termination by licensee of water supply and sanitation services for non-payment. The instruction shall also determine the penalties through payments of interests, charges for disconnection or reconnection and such other

means as appropriate to ensure that licensees can fully recover all costs associated with payment of arrears, and that the arrangements are fair to consumers.

ARTICLE 60:

Any licensee or consumer that is party to a dispute regarding the supply water and sanitation services, under an Authority approved tariff or under a contract, may refer the dispute to the Authority for resolution; provided that the related license requires such dispute to be referred to the Authority.

Any interested person may file to the Authority a written complaint against a licensee alleging a violation of any provision of this law. The Authority shall investigate this complaint and determine whether there may have been a breach of this law. If the Authority determines that there is a violation, then the Authority shall provide the licensee with written notice of this complaint and give an opportunity to the licensee to respond in written. In either case, the Authority shall advise the complainant within fifteen (15) days after receipt of the complaint.

CHAPTER 10

ADMINISTRATION

ARTICLE 61:

Terminations and orders issued by the Water and Sanitation Authority of Cambodia shall be published and thereupon shall be effective. The Water and Sanitation Authority of Cambodia may amend its decisions and regulations published as the Authority may deem appropriate. The amendments shall be effective upon publication.

ARTICLE 62:

The Water and Sanitation Authority of Cambodia may investigate any facts, natures, actions or matters which it may find necessary or proper to determine whether any person has violated or is about to violate any provision of this law or any implementing Sub-Decree, regulation, order or judgment of the Authority.

ARTICLE 63:

All orders, regulations, judgments and determinations of the Authority together with the related written explanation, shall be submitted to the interested parties with a copy to be sent to the Royal Government. In addition, all orders, regulations, judgments and determinations shall be made available to the public, free of charge, at the offices of the Authority. The Authority shall require the licensee to make available for the public inspection of all their licenses and approved tariff, other charges, and terms and conditions as the Authority may require in accordance with the public interest.

CHAPTER 11

PENALTIES, SANCTION AND FINES

ARTICLE 64:

Licensees and/or their employees, who violate once per day for each day against any provision of this law, shall be fined in obstacle ranging from 40,000 Riels (Forty Thousand Riels) up to 400,000 Riels (Four Hundred Thousand Riels).

In the case that the violation still continues, the Authority may issue the determination notice to stop and take other legal measures;

ARTICLE 65:

In the case of the licensee's material failure to comply with the conditions of its license, the Authority has the power to suspend or revoke its license and submit the case to the court.

If the Authority found that it is in public interest not to revoke the license, the Authority may in lieu of revocation impose sanctions as stated under article 64 above until the availability of new licensee to replace the existing one.

ARTICLE 66:

The licensees, who have the intention to steal/cheat by noting the quantity of water supply more the consumers' real quantity of water use, shall be fined in obstacle ranging from once to three times of the price of water stolen/cheated in addition to the sanctions as determined under Article 64 of this law without prejudice of the compensation for other damages.

ARTICLE 67:

Monetary Penalties in obstacle ranging from 400,000 Riels (Four Hundred Thousand Riels) up to 4,000,000 Riels (Four Million Riels) per day for every day shall be imposed on any person found to be providing water supply services without having obtaining the necessary license.

In case of sanitation, monetary Penalties in obstacle ranging from 40,000 Riels (Forty Thousand Riels) up to 400,000 Riels (Four Hundred Thousand Riels) per day for every day shall be imposed on any person found to be providing sanitation services without having obtaining the necessary license.

ARTICLE 68:

Monetary Penalties in obstacle ranging from once to three times of the price of water calculated based on the average price of the water used over the previous three months before having committed the offense or calculated based on connected water equipment, without prejudice of the compensation for other damages, shall be imposed to any person, who steals water by illegal connection, destroying or tampering the meter or by other methods. The offender shall also pay for water which has been stolen calculated based on the average consumption above but not more than twelve (12) months.

ARTICLE 69:

Theft, tampering of, or causing willful damage to the water supply/sanitation installation, facilities or equipment of licensee is a criminal offense and shall be punished by imprisonment from one (1) to three (30) years or fine from 4,000,000 Riels (Four Million

Riels) up to 40,000,000 Riels (Forty Million Riels) or both punishments, without prejudice of the compensation of other damages.

ARTICLE 70:

All employees of the Authority, who violates this law, will face administrative action punishment, without prejudice of other criminal sentences.

CHAPTER XIII

TRANSITIONAL PROVISIONS

ARTICLE 71:

The Water and Sanitation Authority of Cambodia is established as of the effective date of this Law.

ARTICLE 72:

By no later than three (3) months after the effective date of this law the Prime Minister shall appoint the Chairman of the Authority with a three (3) years term and two (2) other members with two (2) years term for the first member and one (1) year term for the second member.

ARTICLE 73:

The Royal Government shall provide the initial fund to the Authority for its operation upon the appointment of the Chairman. The Authority shall deposit this fund in a separate account for its use.

ARTICLE 74:

The Ministry of Industry, Mines and Energy shall transfer the functions and duties defined in this law in an orderly manner to the Authority as soon as the Authority is fully operational.

ARTICLE 75:

All existing suppliers of water supply and sanitation services shall apply for a license with the Authority within six (6) months after receiving the announcement of the Authority.

ARTICLE 76:

The Authority shall not issue any other or regulation abridging or expanding, without the mutual consent of the parties, the rights or obligations provided under a contract in existence at the effective date of this law including the right to recover rates or charges under such contract.

ARTICLE 77:

After the effective date of this law, the Authority shall issue the regulation in relation to operation of own generation facilities that affect the environment.

CHAPTER XIV

FINAL PROVISIONS

ARTICLE 78:

Any provisions that contradict this Law shall consider null and void.

ARTICLE 79:

This law shall be promulgated as urgent.

Phnom Penh, 200
King of Cambodia
Signed by

Reported and Requested for
The signature of His Majesty the King of Cambodia
Prime Minister
Signed by

Reported to the Prime Minister
Minister of Industry, Mines and Energy
Signed by

A1. Urban Water Supply

A1.2 Drinking Water Quality Standards

KINGDOM OF CAMBODIA
NATION RELIGION KING

MINISTRY OF INDUSTRY, MINES AND ENERGY

Drinking Water Quality Standards

January, 2004

Drinking Water Quality Standards

Preface

The Task Force on Drinking Water Quality Standards prepared these standards with guidance from the World Health Organization and the Advisory Panel of specialists. The standards were based on the latest WHO drinking water quality guidelines (2003) and those of other countries with particular adaptation to the water quality problems in Cambodia. Several local and international agencies provided guidance and data on the important parameters and frequency to be monitored. The DWS was reviewed through an inter-ministerial and inter-agency consultation among the sectors from water authorities, rural development, health, environment, water resources, private, academe, and NGO last June 12-13, 2003. A seminar-workshop to initiate the process of developing drinking water standards was also held on June 24-25, 2002.

Table of Contents **Page Number**

1. Introduction

The Royal Government of Cambodia has established a comprehensive policy on National Water Supply and Sanitation, covering both urban and rural water supplies. Based on this policy and to ensure access to safe drinking water to all people, it required the Drinking Water Quality Standard (DWS) for Cambodia. These standards are developed by an inter-ministerial process initiated by Ministry of Industry, Mines and Energy and concerned ministries with support from the World Health Organization.

Drinking water should be clean and clear with pleasant taste and odor. The public will assess drinking water quality using these aesthetic indicators but actually the safety of water is determined by microbiological, physical, and chemical quality. It should be safe so that it does not contain suspended matter, harmful chemical substances, and disease-causing microorganisms. Microbiological quality is most important and is a priority for monitoring.

Using a risk-based approach and taking into consideration local environmental, social, economic and cultural conditions, the Drinking Water Quality Standards (DWS) were developed to make sure that the people are protected from water-related and water-borne diseases in Cambodia. In general, the greatest microbial risks are associated with ingestion of water that is contaminated with human and animal excreta.

The aim of these standards are to ensure that drinking water will be safe in the future, that there are no health risks to the public, to serve as a basis for the design and planning of water supply treatment, and to provide a benchmark for assessing long-term trends in the performance of the water supply system. They should be used along with sanitary surveys and barriers to prevent contamination of water supplies.

United Nations Committee on Economic, Cultural and Social Rights, 2002
"Water is fundamental for life and health. The human right to water is indispensable for leading a healthy life in human dignity. Water, like health, is an essential element for achieving other human rights, especially the rights to adequate food and nutrition, housing and education. "

2. Definition of terms

Terms	Definition
Coliforms, fecal	Subgroup of coliform bacteria associated with fecal contamination from warm-blooded animals. Can ferment lactose at 44.5 °C during analysis. Also known as thermotolerant coliforms.
Coliforms, total	Both fecal and non-fecal bacteria from humans, animals, and decayed organic matter that are able to ferment lactose at either 35 or 37°C within 24-48 hours.
Disinfecting	Treatment of water to inactivate disease-causing microorganisms using chlorine, chlorine dioxide, chloramines, ultraviolet radiation, ozone, or other disinfectant. Boiling is popular at household level.
Disinfection by-products (DBPs)	Carcinogenic DBPs are formed by the reaction of excess disinfectant chlorine with organic substances found in water, especially surface water.
Drinking water	Water that is suitable for human consumption such as drinking and cooking.
Escherichia coli (E. coli)	Indicator of pathogenic bacteria found in human intestines
Grab sample	A one-time sample collected using a dipper or bottle and represents the concentration of water at that particular time and place.
Groundwater	Any water found beneath the surface of the ground in rock crevices and in the pores of geologic materials.
Helminth	Worm found in the intestines especially in children
Inorganic parameters	Non-carbon based chemicals such as arsenic, cadmium, iron
mg/L (ppm)	Milligram per liter - concentration at which one thousandth of a gram (1/1000) is found in a volume of one liter; it is approximately equal to the unit parts per million (ppm) in very dilute solutions.
µg/L (ppb)	Microgram per liter – mg/L divided by 1000, approximately equal to the unit parts per billion (ppb) in very dilute solutions
Monitoring	Routine collection of water samples for analysis to determine water quality, usually done by water supplier.
Nephelometric Turbidity Unit (NTU)	A measure of the turbidity (cloudiness) of water as measured by a nephelometer
Organic parameters	Carbon-based chemicals such as pesticides
Pathogens	Disease-causing microorganisms such as bacteria, protozoa, algae, helminths and viruses found in water
Pesticides	Agricultural chemicals used to eradicate or control pests such as insects, weeds, snails, rodents, and mites.
pH	A measure of acidity (low pH) or alkalinity (high pH) of water with a neutral value of 7.
Physical parameters	Characteristics of water that can be detected by the senses

	including taste, odor, color and turbidity.
Raw water	Untreated, undisinfected surface water or groundwater
Residual Chlorine	Excess chlorine in treated water, usually between 0.2 to 0.5 mg/L, which indicates sufficiency of chlorination and an assurance of protection from pathogens.
Sanitary inspection	Onsite inspection of a community or facility to identify the hazards associated with water supply. Usually includes water sampling and analysis.
Sanitary survey	An evaluation of the physical environment to identify existing and potential sources of health hazards and environmental contamination that may affect water supply and community health.
Surface water	Freshwater on the Earth's surface, such as stream, river, lake, pond, or reservoir.
Surveillance	Process of checking if monitoring of drinking water supplies conforms to the standards. Usually conducted by government authority and may include sanitary inspection, water monitoring, data processing, and report.
Thermotolerant coliforms	Also known as fecal coliforms, which can grow at 44-45 °C. Indicator of fecal contamination as well as efficiency of water treatment and bacterial removal.
Trihalomethanes (THM)	The main DBPs produced in highest concentrations. Formed by reaction of excessive chlorine in water with naturally occurring organic substances.
True Color Unit (TCU)	Measure of color of filtered water sample that could come from iron or dissolved organic substances, also quoted in Hazen unit.
Turbidity	Characteristics of cloudiness of water. The amount of solid particles that are suspended in water that can cause scattering of light. Low turbidity is essential for effective disinfection.
Virus	Smallest of all infectious agents especially those that multiply in the human intestine and excreted in the feces.
Water quality	A description of the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose, such as for drinking.
Water quality standard	A level for a water constituent which does not result in significant health risk and which ensures acceptability of the water to consumers.
Well (water)	A tube well or dug hole put down for the purpose of withdrawing water from the ground. Sometimes fitted with a pump (could be manual or motorized).

3. General clauses

3.1 Mandate

The relevant government regulatory agencies shall make sure that all drinking waters delivered to the population will comply with these standards. The drinking water quality standards shall be referred hereto as DWS.

The DWS will be reviewed every 5 years in order to accommodate changes in knowledge of the risk posed by various chemical and microbial constituents of water as well as the capacity to respond to water quality risks.

3.2 Scope of the DWS

The DWS are applicable as the minimum requirement to all sources of drinking water in both urban and rural areas, public or private water supply regardless of its source including groundwater, surface water, rainwater, intended for human consumption. There are separate standards for bottled/packaged water of non-mineral, natural mineral waters and other beverages from the Industrial Standard of Cambodia (ISC) based on Codex Alimentarius.

3.3 The point of use (POU)

The DWS shall be applied in water treatment plants, in the distribution network, at the tap, and in community sources. Samples shall be taken from all these points at specified frequency.

4. Table of parameters and concentrations (TPC)

In the selection of the parameters and their concentrations, the following were considered in Cambodia: resources, water quality, epidemiological data, industrial activity, pesticides usage and imports, cultural habits, and climate. The drinking water quality standards are in Tables 1 to 5. In Table 1 are indicators of microbial contamination of water to indicate presence of from bacteria, protozoa, viruses and helminths. Table 2 provides inorganic constituents such as heavy metals of health significance. Table 3 lists the organic constituents of health significance to drinking water while Table 4 contains the physical and chemical quality that may rise to consumer complaints if exceeded. Table 5 provides the priority parameters to be monitored in small water supplies. The maximum values of the standards shall not be exceeded to assure protection of the public drinking water.

It should be noted that some of the DWS differ from WHO guideline values. These differences were carefully noted and debated during the development of these Standards. In particular, the Arsenic standard of 50 ppb is higher than the WHO guideline value of 10 µg/l. The higher level of 50 µg/l was selected in recognition of several key facts: 1) it

will be very difficult and costly to monitor and enforce a standard of 10 μg/l in Cambodia at the present time; 2) the potential health risk of ingesting water with arsenic levels between 10 and 50 μg/l is low relative to the risk posed by water with bacteriological contamination, and more attention should be placed on monitoring and enforcing the latter standard in Cambodia; and 3) other countries in the region are using 50 ppb as their standard. It was concluded that while 10 μg/l may be a desirable long-term goal for arsenic in drinking water, it was an impracticable level to use in Cambodia at the present time.

All water supply systems should be tested for water quality parameters set out in Tables 1 through 4 prior to commissioning to ensure compliance with DWS. Small water supply systems (those serving less than 100 people or delivering less than 10 m^3/day) should be tested for priority parameters set out in Table 5

Table 1 Bacteriological quality for drinking water

Parameter	Maximum Value
Thermotolerant (Fecal) Coliforms or E. coli	0 per 100 mL
Total coliforms	0 per 100 mL

Table 2 Inorganic constituents of health significance in drinking water

Parameter	Maximum Value* mg/L, (ppm)
Arsenic	0.05
Barium	0.7
Cadmium	0.003
Chromium	0.05
Cyanide	0.07
Fluoride	1.5
Lead	0.01
Mercury	0.001
Nickel	0.02
Nitrate as NO_3^-	50
Nitrite as NO_2^-	3
Selenium	0.01

* For very low concentrations, laboratory results are reported in μg/L or ppb. Note the conversion: 1 mg/L (ppm) = 1000 μg/L (ppb)

Table 3 Organic constituents of health significance to drinking water

Parameter*	Maximum Value** µg/L (ppb)
Polychlorinated biphenyls (PCBs)	0.5
Benzene	10
Disinfection-by-product	
Trihalomethanes	250
Pesticides	
2,4 D	30
Aldrin and Dieldrin	0.3
Carbofuran	10
Chlordane	0.2
DDT	20
Dichlorvos	1
Dimethoate	6
Endosulfan	30
Endrin	0.6
Glyphosate	10
Heptachlor	0.3
Hexaclorobenzene	1
Methyl parathion	0.3
Mevinphos	5
Monocrotophos	1
Paraquat	30
Parathion	10
Permethrin	20

*Routine monitoring for organic constituents (Table 3) is not required unless there is a potential for contamination of water supplies.

**For very low concentration, laboratory results are reported in µg/L or ppb. Note the conversion: 1 mg/L (ppm) = 1000 µg/L (ppb)

Table 4 Physical and chemical quality: aesthetic quality

Parameter	Maximum Value, mg/L
Taste	Acceptable
Odor	Acceptable
Color	5 TCU
Turbidity	5 NTU
Residual chlorine	0.2-0.5
pH	6.5 – 8.5 (no unit)
Aluminum	0.2
Ammonia	1.5
Chloride	250
Copper	1
Hardness*	300
Hydrogen Sulfide	0.05
Iron	0.3
Manganese	0.1
Sodium	200
Sulfate	250
Total dissolved solids**	800
Zinc	3

* Hardness is expressed as mg/L $CaCO_3$

**Conductivity (µS/cm) can also be measured and it is roughly equivalent to twice the TDS value.

Table 5 Priority parameters in small water supplies

Parameter*	Maximum Value
pH	6.5-8.5
Turbidity	5 NTU
Arsenic	0.05 mg/L
Iron	0.3 mg/L
Total Dissolved Solids (TDS)	800 mg/L
Thermotolerant Coliforms or *E. coli*	0 per 100 mL

*Additional parameters such as conductivity can be monitored but these are the minimum requirements.

5. Timing and frequency of sampling

The most important technique for ensuring that drinking water does not contain contaminants at concentrations to affect health is monitoring. However, monitoring is costly and the resources required such as personnel, portable equipment, transport, and laboratory should be considered with care.

Inspectorates within the relevant government agencies shall be established to implement the DWS and to carry out the sanitary surveys. The frequencies of sampling for water analysis and visits to water systems for sanitary inspections will depend on:

a) Type of source water (groundwater or surface water)
b) Quality of the source water
c) Number of water sources
d) Treatment the water receives
e) Risks of contamination in various parts of the system
f) Particular type of system
g) Previous history of water quality
h) Size of the population supplied with water.

Grab samples for chemical and physical parameters shall be taken from the source water (lake, pond, river, reservoir, well or spring) and from the distribution system[1]. The distribution system samples shall be taken at the point leaving the system and at the tap. Additional sampling locations may be identified if deemed necessary.

Results of monitoring shall be made known to both the operator of the water supply system and the consumers. When the water analysis showed values exceeding the standards, efforts should be made to find the source of the problem for control and to carry out re-sampling to verify the results.

Due to higher risks to human health compared with aesthetic parameters, the microbiological parameters should have a higher frequency of sampling. Table 6 below shows the various sampling frequency to be followed in these standards while Table 7 presents the minimum frequency and number of samples for microbiological analysis. Residual chlorine, turbidity, pH, and color should be analyzed immediately onsite.

Table 6 Frequency of sampling and analysis of parameters in a water distribution system

Parameter	Frequency
Color, pH, residual chlorine, turbidity, total dissolved solids*	Daily
Arsenic, iron, manganese, nitrates, chloride, sulfate, hardness, aluminum	Quarterly
Inorganic constituents (Table 2)	Once a year
Organic constituents and pesticides (Table 3)	Every 3 years

* Can be measured with conductivity (μS/cm)

[1] Detailed sampling procedures can be found in Volume 3 of the WHO drinking water quality guidelines.

Table 7 Minimum sampling frequencies for microbiological analysis

Population Served	Frequency of sampling	Number of Samples
Less than 5000	Monthly	1 sample
5000 – 100 000	Every two weeks	1 sample per 5 000 people
More than 100 000	Weekly	1 sample per 10 000 people plus additional 10 samples

6. Methods of sampling

6.1 Methods of sampling for bacteriological quality

The sample should be representative of the water under examination. Contamination during collection and before examination should be avoided.

The tap should be cleaned and free from attachments and fully opened with water allowed to run to waste for a sufficient time to permit the flushing/clearing of the service lines. Flaming of the tap is not necessary. Taps with a history of previous contamination may be disinfected with hypochlorite solution (NaOCl 100 mg/L). No samples shall be taken from leaking taps.

Sterilized glass bottles, provided with either ground glass stoppers or plastic screw-caps, should be used for collection of samples. A paper or a thin aluminum foil cover should protect both the stopper and neck of the bottle. For waters that have been chlorinated, bottles containing 0.1 mL of a 3% solution of sodium thiosulfate for every 100 mL of water sample should be used.

The bottle should be kept unopened until it is ready for filling. It should be filled without rinsing and ample space (at least 2.5 cm) must be left for mixing samples. The stopper or cap should be replaced with a protective cover for additional protection.]

6.2 Methods of sampling for physical and chemical analysis

The actual collection of the water sample is a matter of considerable importance. Refer to Table 8 for additional guidance. The following procedures should be observed for sampling:

a) Collect samples from wells only after the well has been pumped sufficiently to ensure that the sample represents the quality of the groundwater that feeds the well. Sometimes it will be necessary to pump at a specified rate to achieve a characteristic drawdown as part of the sample record. New wells will require sufficient utilization and abstraction before sampling. Collect samples from open shallow wells by taking a composite sample(s).

b) When samples are collected from a river or stream, it is best to take a composite sample from three depths (top, middle and bottom). In this way the sample becomes representative. If only a grab or catch sample can be collected, it is best to take in the middle of the stream and at mid-depth.

c) When sampling lakes and reservoirs, which are naturally subjected to considerable variations from normal causes, the choice of location, depth, and frequency of sampling will depend on the local conditions and the purpose of the investigations.

d) Before samples are collected from distribution systems, flush the lines sufficiently to ensure that the sample is representative of the supply, taking into account the diameter and length of the pipe to be flushed and the velocity of flow.

6.3 Sample Size

A one (1) liter sample should suffice for most physical and chemical analyses but it could vary depending on the requirement of the laboratory. However, no attempt should be made to use the sample for microbiological and microscopic examinations because the methods of collection and handling are quite different.

6.4 Sample containers

In all cases, the container should be chosen so that it will not contaminate the sample.

a) Chemically resistant glass (Pyrex), polyethylene, or hard rubber is suitable material for containers. For samples containing organics, avoid plastic containers except those made of fluorinated polymers such as polyfluoroethylene (PTFE). Glass containers generally are preferred for volatile organics. Sample containers must be carefully cleaned to remove all extraneous surface dirt, thoroughly rinsed with distilled water and drained before use. For glass bottles, rinsing with chromic acid cleaning solution is necessary. An alternative method is with the use of alkaline permanganate solution followed by an oxalic acid solution. For polyethylene bottles, detergents or concentrated hydrochloric acid can be used.

b) Stoppers, caps and plugs should be chosen to resist the attack of material contained in the vessel or container. Cork stoppers wrapped with a relatively inert metal foil are suitable for many samples, or polytetraflouroethylene (PTFE).

c) The sample containers should be such that when filled with the desired amount of sample, space roughly equivalent to 1 percent of the volumetric capacity of the containers is available for expansion of the liquid.

d) The stoppers closing the sample containers must be fixed in place by wire, tape, or cord to prevent leakage during transit.

e) Sample containers must be properly labeled. A gummed label, or a cardboard or tag securely affixed to the container should be provided with the following information: date and time of sampling, source of sample, point of sampling (designed in sufficient detail to enable anyone to collect a second sample from the identical spot from which the first sample was taken), sampled by (name of collector).

6.5 Sample handling and storage

In general, the shorter the time lapse between collection of a sample and its analysis, the more reliable will be the analytical results.

a) For certain constituents and physical values, immediate analysis in the field is required in order to obtain dependable results, because the composition of the sample may change before it arrives at the laboratory.

b) Changes caused by the growth of organisms may be greatly retarded by keeping the sample in the dark and at a low temperature until it can be analyzed.

c) It is necessary to keep the samples cool or refrigerated. Storage at low temperature ($4^{o}C$) in a cooler is the best way to preserve most samples.

d) Add chemical preservatives to samples only as specified in the analytical methods. Suitable preservative that will not affect the results of the analyses to be made must be selected (See Table 8).

7. Approved analytical methods for analysis

7.1 Field testing using portable kits

Reputable field equipment are acceptable to use in water quality testing but should be supported by the use of sanitary surveys and risk assessment. There are field kits using membrane filtration for bacteriological analysis and are capable of monitoring thermotolerant coliforms (fecal). Presence/absence tests for microbiological quality can also be used especially in small water supplies. Priority parameters such as residual chlorine (where chlorination was used), turbidity, pH, color, conductivity, and total dissolved solids should be analyzed onsite using field test kits. Portable kits for arsenic analysis are also popular. Residual chlorine and pH should be analyzed at the same time since pH should be less than 8 for disinfection to be effective.

In sampling the source of water located in a remote place where transport of samples back to a laboratory is not possible within the time allocation for sample preservation, it is better to carry out onsite analysis. Within reasonable level of confidence, portable kits for both microbiological and physico-chemical analysis can be used.

7.2 Laboratory analysis

The analyses and tests must be carried out in accordance with Industrial Standard of Cambodia Volume II on drinking water testing. In addition, laboratory analysis of parameters should conform with the standard methods found in any of the following references: *Water Quality Series* from the International Organization for Standardization (ISO), *Standard Methods for the examination of water and wastewater* from the American Public Health Association; *Report 71* from the British Public Health Service and the *Methods for chemical analysis of water and wastes* from the US Environmental Protection Agency. Recommendations for sampling, preservation and analysis of selected parameters are listed in Table 8. When collecting chlorinated samples for laboratory analyses, add sodium thiosulfate to the sample and transport the sample at controlled conditions preferably in a cooler at – 4°C.

For community-managed schemes, sanitary surveys should be accompanied by analysis of pH, turbidity, conductivity, and total dissolved solids (TDS) using simple field equipment. Changes in these parameters, plus the sanitary survey data, can act as substitute indicators for other changes in water quality. A low pH could indicate chemical contamination, high turbidity could indicate microbial pollution or ineffective disinfection, and high TDS could indicate soluble metals and ions present in the water. This information could alert community members for further investigation and remedial action.

Table 8 Recommendation for sampling, preservation and method of analysis of samples for selected parameters

Parameter	Container plastic/ glass	Mode of preservation	Holding time rec/req	Minimum sample (ml)	Method of analysis
Coliforms	G	Refrigerate	6 h	100	Membrane filtration/MPN
Color (true)	P, G	Refrigerate	48 h/48 h	500	Visual comparator/platinum -cobalt method
Turbidity	P, G	Analyze same day; store in dark up to 24 h, refrigerate	24 h/48 h	-	Nephelometric
Aluminum					AAS/ICP
pH	P,G	Analyze immediately	2 h/stat	-	Electrode
Hardness	P, G	Add HNO_3 to pH<2	6 months/6 months	100	EDTA titration
Chlorine, residual	P, G	Analyze immediately	0.5 h/stat	500	DPD
Cyanide	P, G	Add NaOH to pH>12; Refrigerate in dark	24 h/14 d; 24 h if sulfide present	500	Ion Specific Electrode
Ammonia	P, G	Analyze asap or add H_2SO_4 to pH<2; Refrigerate	7 d/28 d	500	Indophenol Phenate
Nitrate	P, G	Analyze asap or refrigerate sample	48 h/48 h (28 d for chlorinated	100	Colorimetric IC
Nitrite	P, G	Analyze asap or refrigerate	None/48 h	100	Colorimetric IC
Nitrate+Nitrite	P, G	Add H_2SO_4 to pH>2, Refrigerate	Non/48 h	200	Colorimetric IC
Organics	P, G	Add H_2SO_4 to pH>2, Refrigerate	28 d	500	GC
Chloride	P, G	Refrigerate	1 week	-	IC
Fluoride	P	Non required	28 d/28 d	300	IC
Metals	P(A), G(A)	For dissolved metals filter immediately, add HNO_3 to pH<2	6 months/6 months	- 100	AAS ICP
Solid, total dissolved					Gravimetric
Sulfate	P, G	Refrigerate	28 d/28 d	-	IC
Arsenic	P,G			-	AAS
Selenium Mercury				100	ICP

Source : APHA *Standard Methods for the Examination of Water and Wastewater, 1999*

P - Plastic (polyethylene or equivalent)

G - Glass

P(A) - Rinsed with 1 + 1 HNO_3

G(A)	-	Rinsed with 1 + 1 HNO_3
Rec/Req	-	Recommended/required
Stat	-	No storage allowed; analyze immediately
asap	-	As soon as possible
AAS	-	Atomic Absorption Spectrophotometer
IC	-	Ion Chromatograph
GC	-	Gas Chromatograph
ICP	-	Inductively Coupled Plasma Mass Spectroscopy
DPD	-	N,N-diethyl-*p*-phenylenediamine

NOTE: If samples cannot be returned to the laboratory in less than 6 hours and holding time exceeds this limit, the final reported data should indicate the actual holding time.

8. Sanitary surveys

A sanitary survey is an on-site review of the water source, facilities, equipment, operation and maintenance of a public water system to evaluate whether it is producing and distributing safe drinking water. During an inspection, records, operation and maintenance practices are reviewed. Guidance can be obtained on the proper conduct of sanitary surveys from Volume 3 of WHO Drinking Water Quality Guidelines (2003).

The frequency for carrying out sanitary surveys varies between 6 months to 2 years depending on the size of the facility and the source of water, as shown in Table 9 below. Surface water should be inspected more frequently than groundwater since it is more vulnerable to contamination and exhibits more variation in water quality.

Table 9 Frequency of Sanitary Inspection

	Frequency of inspection by source of water	
Location	**Groundwater**	**Surface Water**
Cities	Every year	Every 6 months
Towns	Every 2 years	Every year
Rural areas	Every 3 years	Every 2 years

9. General requirements

In implementing the DWS, there are requirements that need to be followed by the stakeholders involved in water. These are the following:

a) The water service is obliged to disinfect water regardless of whether the source is surface or ground water.
b) The water supplier should at all times protect water sources and watersheds.
c) The water treatment facilities should be operated and maintained by certified or trained operators.
d) The water service should make sure to disinfect mains and distribution networks every time repairs have been completed.

e) The water service should monitor the quality of the chemicals used in water treatment with a fixed frequency.
f) The water service shall submit reports of monitoring to the DWS central database.

10. Good water practice recommendations

Applying good practice means to manage the quality of water from the source to consumer. Specific treatment of water include disinfection and associated conditions (e.g., concentration of disinfectant, contact time, pH and turbidity), reduction of risk of contamination, use of materials and chemicals, removal of organic substances prior to disinfection to reduce the formation of disinfection by-products, the need to always have positive pressure in the distribution network and so on. If all these best practices are followed, then the quality of water is safeguarded.

An urban water system is by definition a four-stage barrier to prevent any contamination of water: the storage reservoir; chemical treatment (coagulation, flocculation, and sedimentation); filtration; and the final disinfection. If these stages are properly managed, then the quality of the water should be secured in the long term. Sampling and analysis should be the last steps after making sure the barriers are in place.

11. Information, record keeping and reporting

The objectives of a drinking water quality surveillance or control program are to detect anomalies in the production of drinking water with the intention of solving the problem. To do this would require an organized system of record keeping that could be used for such decision-making. Existing databases currently found in Cambodia can be the foundation for a drinking water quality database.

A database of water quality monitoring data over time and in different locations should be established, initially in a spreadsheet format until sophisticated enough to be in a geographic information system (GIS) format that could be overlaid with thematic maps. As an important part of every surveillance and control, record keeping and its availability to the public should be assured to better appreciate monitoring efforts.

12. Surveillance and control programs

The principal objective of surveillance is to identify public health risks so that action may be taken promptly to prevent public health problems. Surveillance requires a systematic program of surveys that combine analysis, sanitary inspection, and institutional and community aspects. Surveillance contributes to the protection of public health by promoting improvement of the quality, quantity, coverage, cost, and continuity of water supplies. The most common and widespread health risk associated with drinking-water is microbial contamination so this is given the highest priority for monitoring and surveillance. When the standard is exceeded, this should be a signal to investigate the cause with a view to taking remedial action; and to consult with, and seek advice from the responsible authority.

Inspectorates at relevant agencies at the national and local level should implement these standards and will have the following responsibilities:

a) Implement the drinking water quality surveillance program according to the national guidelines
b) Implement and maintain a drinking water quality surveillance program
c) Analyze the information presented by the water service.
d) Have the proper laboratories facilities to develop their surveillance activities
e) Assess systematically the human health risk by monitoring the water source, the physical characteristics of the water systems (sanitary inspections), and the drinking water quality history and trends.
f) Audit the drinking water quality control programs.
g) Inform the public about drinking water quality and associated risks.
h) Maintain records on drinking water quality characteristics.
i) Maintain open resources for the public to express their complaints and concerns
j) Inform the water service of anomalies detected in the water system and demand the needed corrective actions.
k) Approve the sampling programs as presented by the water service.

References

World Health Organization (2003) Guidelines for Drinking Water Quality, Third Edition.

Codex Alimentarius Committee (2001) General Standard For Bottled/Packaged Drinking Waters (Other Than Natural Mineral Waters) CODEX STAN 227-2001

International Program on Chemical Safety (2000). Summary of Toxicological Evaluations Performed by the Joint FAO/WHO Meeting on Pesticide Residues.

APHA (2000) Standard Methods for the examination of water and wastewater American Public Health Association.

Industrial Standard of Cambodia CSX 008-2002 Volume II on Drinking Water Quality. Department of Standards, Ministry of Industry, Mines and Energy, 2002.

Cambodia Drinking Water Quality Assessment. Ministry of Rural Development and the Ministry of Industry, Mines and Energy supported by the World Health Organization in cooperation with, 2001.

National Policy on Water Supply and Sanitation of the Kingdom of Cambodia, Coordinating Committee for Development of Water Supply and Sanitation Sector, 2003.

National Water Sector Profile of the Kingdom of Cambodia. Ministry of Water Resources and Meteorology supported by the Asian Development Bank, 2001.

National Poverty Reduction Strategy for Cambodia for 2003-2005. Council for Social Development, 2002.

Ministry of Industry, Mines and Energy (2001) Provincial City Water Supply in Cambodia supported by Japan International Cooperation Agency.

Cambodia Demographic and Health Survey, 2000.

Drinking Water Guidelines and Standards from the following countries:
Australia, Bangladesh, Canada, China, France, Japan, Lao PDR, Malaysia, New Zealand, Philippines, Singapore, Thailand, UK, USA, Vietnam

A1. Urban Water Supply

A1.3 Memorandum between MIME&MRD
（Small Scale Water Supply System）

Appendix A1.3 Notice on Water Supply Service

Introduction

To provide Water Supply Service and Sanitation Service to users in whole country is under the responsibility of the Royal Government of Cambodia. Especially MIME and MRD are directly responsible for above work.

The government has clearly identified the National Policy on Water Supply and Sanitation Service including jurisdictional division of provincial towns, urban and rural areas, namely:

- MIME is responsible for Water Supply and Sanitation Service Distribution in provincial towns and urban areas
- While, MRD is responsible for those in rural areas

However, service jurisdiction between these ministries is unclear in some areas. For instance, in area having small-scaled urban areas and rural areas, service jurisdiction becomes complicated.

Objectives

According to the needs in water supply and sanitary facility development, MRD received finance from ADB to construct groundwater tube wells, small scaled water supply system and household latrines.

MOU (Memorandum of Understanding) was established to facilitate effective project implementation by both Ministries.

Agreement between MIME and MRD

According to the National Policy in Water Supply and Sanitation and needs in Water Supply and Sanitary facility development in rural community, both Ministries has agreed on their designated responsibilities:

1. MRD is mainly in charge of rural community water supply system development. To ensure sustainable service and project benefit, proper system O&M and residents' awareness toward system ownership is indispensable.
2. MIME is mainly in charge of water supply in business and commercial use. Projects shall be quality -effective and have high cost-transparency.
3. MIME and MRD shall share relevant information on their water supply service distribution

The followings are the duties of these two Ministries:

Duty of MIME

1. Provide technical assistance for piped water supply system to be managed by provincial towns
2. Promote private participation

Duty of MRD

1. Facilitate water supply project financed by foreign donor agencies. Support local authorities and commune council in tender documents preparation and material procurement processing.

2. Provide technical assistance in system planning, technical drawing preparation, cost estimation and system O&M services
3. Make necessary response to the Project Implementing Agencies, such as Cambodian Government, National Organizations and International Agencies

The MOU will enter into effective after the date of Agreement. If any party wants to revise the said agreement, he shall inform to the other parties at least 60 days in advance.

Phnom Pehn, 01 Feb. 2005
MRD
Deputy Prime-Minster and Minister
Leu Laysreng

Phnom Pehn, 01 Feb. 2005
MIME
Minister
Suey Sem

A2. Rural Water Supply
A2.1 Village Interview Survey

Village Interview Survey

1. Summary of survey

1.1 Objective of survey

This village interview survey was conducted to understand the present status of water supply and sanitation at villages of 24 provinces around the country.

1.2 Targeted villages

As shown below, a total of 55 households of 38 villages located near the province capital were selected as the survey target in consultation with PDRD since conflicts might arise near the national border as well as the time period available for the survey was limited.

No.	Province	District	Commune	Village	No. of HH
1	Banteay Meanchey	Preah Net Preah	Bos Sbor	Bos Sbor	2
2			Teuk Cho	Kokei	1
3				Tuol Kei	1
4	Battambang	Banan	Baydamram	Sdao	2
5		Sangke	Voatamem	Kawpong Chhlanag	2
6	Kampong Cham	Kampong Siem	Kralar	Trapeang Tros	1
7			O Svay	Trapeang Kok	1
8	Kampong Chhnang	Rolea Bea	Sre Tamey	Prey Moan	2
9			Andon Sway	Char Thmey	2
10	Kampong Speu	Phnom Srouch	Moha Sang	Sambour	2
11				Tuol Serei	2
12	Kampong Thom	Kampong Svay	Kampong Svay	So Chey	2
13	Kampot	Teuk Chhou	Thmey	Thmey	2
14				Kor Chen Leng	2
15	Kandal	Kandal Stanp	Tbeng	Ang Khlor	1
16	Koh Kong	Koh Kong	Tatai Kroam	Anlong Vak	2
17	Kratie	Kratie town	Krakor	Toul Monorom	1
18		Chetrak Borey	Da	Stung Svay	1
19	Mondol Kiri	Ou Reang	Dak Dam	PO Treing	1
20			Sen Monorom	Po Hem	1
21	Phnom Penh	Son Sok	Khmoagn	Son Sok No.6	1
22	Preah Vihear	Preah Vihear Town	Pal Hal	Pheara kech	1
23	Prey Veng	Svay Anton	Damrey Poum	Trapeang Pring	1
24	Pursat	Bakan	Me Teuk	Kdat	2
25			Boeng Kana	Roung	2
26	Ratanak Kiri	Kaurs Mom	Trapeang Chres	Phum IV	1
27		O Chum	O Chum	Tharon Svay	1
28	Siem Riep	Pouk	Lvea	Kork Sramor	2
29	Preah Sihanouk	Prey Noup	Ream	Ream	2
30	Stung Traeng	Seream	Kam Phon	Katot	1
31			Sam Kuy	Sam Kuy	1
32	Svay Rieng	***	***	Svay Ta Phlon	1
33	Takeo	Tring	Ang Khnor	Trapeang Prey	1
34	Otdar Meanchey	Samroang	Samroang	Chhueb	2
35	Kep	Dam Nakch	Pom Teak	Phnom Leav	1
36	Pailin	Pailin	Tuol Lvea	Tuol Lvea	1
37				Tuol Sralao	1
38			Ou Tavao	Pauum Dambang	2
	Total No. of household surveyed				55

2. Results of survey

The results of this hearing survey are explained in the following sections. Although the survey was conducted on 55 households, not all of these households responded to every question. Therefore, the number of the samples below somewhat varies.

2.1 Target of hearing survey

(1) Size of household

The average size of the 55 households was 5.5 people.

Table 1. Size of households

No. of HH collected answer	Total family member	Ave.
55	303 person	5.5 person

2.2 Household property

(1) Size of land property

The average area of land property of 55 households was 1.18ha.

Table 2. Area of land property

No. of HH collected answer	Total land area	Ave.
55	64.80 ha	1.18 ha

2.3 Water source

(1) Distance to water source

The distance from the living place to water source was 85.07m during the rainy season and 176.07m during the dry season. Water can be sourced from a well or surface water located in the neighborhood during the rainy season. But these water sources dry up in the dry season and it is clear that people are forced to fetch water from faraway sources.

Table 3. Distance to water source

Rainy season			Dry season		
No. of HH collected answer	Total distance to water source	Ave.	No. of HH collected answer	Total distance to water source	Ave.
43	3,658.00 m	85.07 m	42	7,395.00 m	176.07 m

(2) Access time to water source

Access time from living place to water source is 2.40 minutes during the rainy season and 3.05 minutes

during the dry season. As mentioned above, water sources dry up in the dry season and it is clear that people have to fetch water from faraway sources.

Table 4. Access time to water source

Rainy season			Dry season		
No. of HH collected answer	Total min. to access water	Ave.	No. of HH collected answer	Total min. to access water	Ave.
42	101.00 min	2.40 min	40	122.00 min	3.05 min

(3) Time spent to fetch water

Time spent to fetch water is 11.59 minutes during the rainy season and 13.25 minutes during the dry season. It is inferred that, when compared with the dry season, the rainy season is cooler and as a result water demand is lower.

Table 5. Time spent to fetch water (per day)

Rainy season			Dry season		
No. of HH collected answer	Total min. to fetch water	Ave.	No. of HH collected answer	Total min. to fetch water	Ave.
41	475.00 min	11.59 min	40	530.00 min	13.25 min

(4) The number of times water is fetched and its amount

The number of times water is fetched is 4.32 during the rainy season and 4.46 during the dry season. As mentioned above, it is inferred that the rainy season is cooler than the dry season and as a result water demand is lower.

Table 6. The number of times water is fetched (per day)

Rainy season			Dry season		
No. of HH collected answer	Total time to access water source	Ave.	No. of HH collected answer	Total time to access water source	Ave.
41	177.00 times	4.32 times	37	165.00 times	4.46 times

Meanwhile, the amount of water fetched (the number of times water is fetched in a 20-liter bucket) is 10.40 during the rainy season and 10.23 during the dry season. Normally water demand should be stronger in the dry season. The survey result indicates that water sources dry up in the dry season and people cannot obtain enough water in the dry season.

Table 7. Amount of water fetched (per day)

Rainy season			Dry season		
No. of HH collected answer	Total time to fetch water by buckets	Ave.	No. of HH collected answer	Total time to fetch water by buckets	Ave.
47	488.67 times	10.40 times	41	419.50 times	10.23 times

(5) Intended use of water

Intended use of water is not largely different between the dry and rainy seasons. The largest purpose of water use is livestock, which is followed by bathing, washing and toilet.

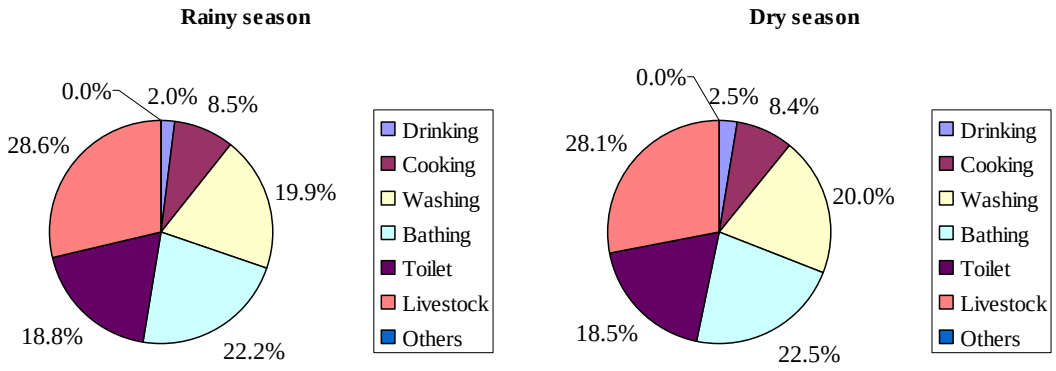


Chart 1. Intended use of water

(6) Evaluation of and satisfaction with water quality

The survey results on the taste, smell, and clearness of water sources used by village people is shown in the following tables. It is clear that water quality tends to deteriorate somewhat in the rainy season. The result, however, largely depends on village people's subjective answer and it can be judged the water quality does not change so much.

Table 8. Evaluation of water quality (taste)

	Rainy season	Dry season
Good	86.3%	84.4%
Salty	0.0%	0.0%
Iron	0.0%	0.0%
Others	13.7%	15.6%

Table 9. Evaluation of water quality (smell)

	Rainy season	Dry season
Not smell	78.4%	82.2%
Little smell	17.6%	13.3%
Smell	3.9%	4.4%

Table 10. Evaluation of water quality (clearness)

	Rainy season	Dry season
Clear	78.4%	77.8%
Little muddy	2.0%	0.0%
Not clear	19.6%	22.2%

Table 11. Satisfaction with water quality

Rainy season	Satisfy	Not satisfy
Taste	84.0%	16.0%
Smell	84.0%	16.0%
Clearness	86.3%	13.7%
Dry season	Satisfy	Not satisfy
Taste	86.4%	13.6%
Smell	86.4%	13.6%
Clearness	84.4%	15.6%

(7) Water fee

For water use, people pay 2,957 riel ($1.5) on average during the rainy season and 4,789 riel ($2.4) during the dry season. The result indicates that during the rainy season water can be obtained easily from surface water and some people do not use water from supply facilities. In addition, water pricing varies depending on village (facility) and in some villages water is supplied free of charge, while in other villages people need to pay 50,000 riel ($12.5) for water during the rainy season.

Table 12. Water fee (per month)

Rainy season				
No. of HH collected answer	Total cost for water	Ave.	Min.	Max.
23	68,000 R	2,957 R	0 R	30,000 R
Dry season				
No. of HH collected answer	Total cost for water	Ave.	Min.	Max.
19	91,000 R	4,789 R	0 R	50,000 R

2.4 Economic statistics related to water supply

(1) Annual income

The average annual income of 51 households was 3,130,000 riel ($782.50).

Table 13. Annual income

No. of HH collected answer	Total income in a year	Ave. (Riel)	Ave. (USD)
51	159,630,000 R	3,130,000 R	782.50 USD

(2) Water-related expenditure

Each household's expenditure related to water (water fee, water transport, medical treatment for water-related disease, etc.) is shown in the table below. The majority of the expenditure is for medical treatment for water-related disease. Payment of water fee is 6.133 riel ($1.53) during the rainy season and 10,471 riel ($2.62) during the dry season. If constructed, water supply facilities can contribute to reduction of water-related illness, which in turn can curb households' water-related expenditure.

Table 14. Water-related expenditure (per month)

Rainy season	No. of HH collected answer	Total monthly expenditure	Ave. (Riel)	Ave. (USD)	Ratio
Water fee	15	92,000.00 R	6,133 R	1.53 USD	4.2%
Water transport	15	0.00 R	0 R	0.00 USD	0.0%
Medical treatment for water related diseases	15	2,070,000.00 R	138,000 R	34.50 USD	95.6%
Others	15	4,000.00 R	267 R	0.07 USD	0.2%
Total	15	2,166,000.00 R	144,400 R	36.10 USD	
Dry season	No. of HH collected answer	Total monthly expenditure	Ave. (Riel)	Ave. (USD)	Ratio
Water fee	17	178,000.00 R	10,471 R	2.62 USD	14.1%
Water transport	17	0.00 R	0 R	0.00 USD	0.0%
Medical treatment for water related diseases	17	1,080,000.00 R	63,529 R	15.88 USD	85.6%
Others	17	4,000.00 R	235 R	0.06 USD	0.3%
Total	17	1,262,000.00 R	74,235 R	18.56 USD	

(3) Willingness to pay

Each household's willingness to pay for new water facilities is 20,145 riel ($5.04). This figure is 2 to 3 times the water-related expenditure (amount of actual payment) shown above. It can be judged that village people have a strong demand for safe water.

Table 15. Willingness to pay (per month)

No. of HH collected answer	Total amount willing to pay	Ave. (Riel)	Ave. (USD)
31	624,500 R	20,145 R	5.04 USD

2.5 Sanitation

(1) Hand-washing before meals

98% of households answered that they wash hands before meal. The number of households that answered they wash hands sometimes before meals was larger than those that wash hands always before meals. The result indicates that health education has not fully permeated among village people.

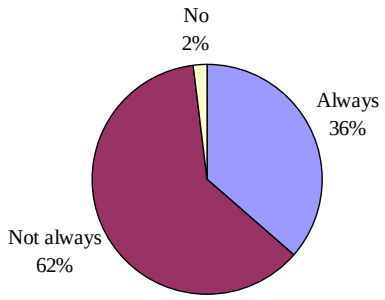


Chart 2. Rate of hand-washing before meals

(2) Hand-washing before food preparation

88% of households answered that they wash hands before preparing food. The number of households that answered they wash hands sometimes was larger than those that wash hands always. The result indicates that health education has not fully permeated among village people.

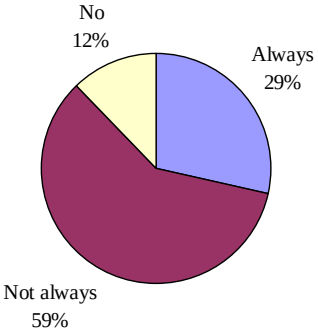


Chart 3. Hand-washing before food preparation

(3) Hand-washing after using lavatory

94% of households answered that they wash hands after using the lavatory, which is fewer than those that wash hands before meals. It is acceptable that a larger number of households wash hands always after using the lavatory than those that wash sometimes.

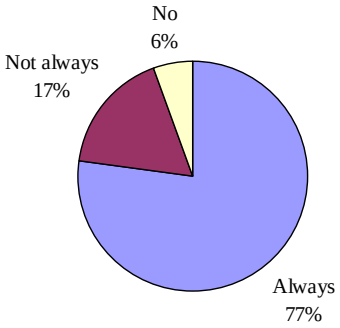


Chart 4. Rate of hand-washing after lavatory

(4) Hand-washing related to child-raising

100% of households answered that they wash hands both after taking care of children's lavatory needs and before feeding children. However, 17% and 37% of households answered that they do not wash hands

always on these occasions, respectively, meaning there is room for improvement.

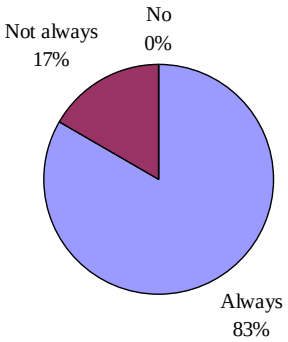


Chart 5. Rate of hand-washing after taking care of children's lavatory needs

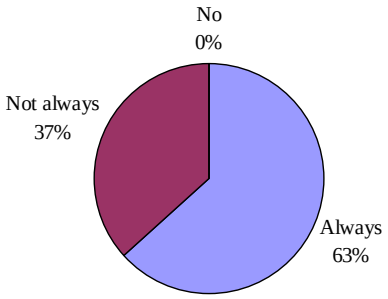


Chart 6. Rate of hand-washing before feeding children

(5) Water-related illness

Diverse water-related illness occurs among village people at the rates shown below. Both in the rainy and dry seasons, diarrhea occurs most often followed by typhoid and malaria. Since there is no large difference in occurrence of such illness between seasons, it is expected that water-related illness occurs not because of water quality but because of living environment (hygiene environment).

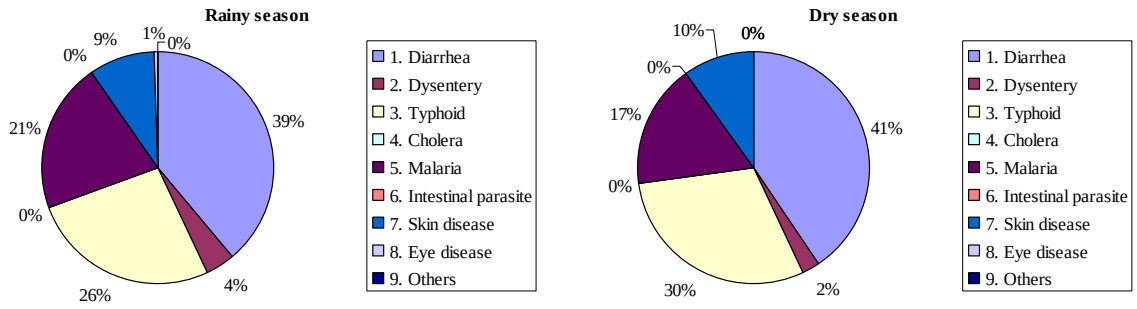


Chart 7. Rate of occurrence of water-related illness

3. Conclusion and recommendation

3.1 Improvement of hygiene environment

Even when water supply facilities are constructed, they will contribute little if people do not understand how to use water effectively and if a clean environment is not maintained. It has been found that the basic hand-washing practice is not a habit before meals and after using the lavatory. Occurrence of water-related illness often depends on factors such as water quality or how far a hygienic environment is developed. It can be improved, however, if hand-washing is made a habit among the people. It is judged, therefore, that in order to improve the current hygiene situation, the top priority is to change village people's minds.

3.2 Administration and maintenance of water supply facilities

In villages, there are not enough safe water sources and many village people hope that new water supply facilities will be constructed. Currently, there are a number of households making payment to existing water supply facilities for water use (water fee). And it is considered that village people may not be reluctant to pay as well as there is a sufficient base to encourage them to pay administration and maintenance expenses (water fee). In some provinces, however, deep wells cannot be used as a water source because of the presence of arsenic and salt in underground water, and people are forced to depend on water supply facilities that supply processed surface water. In this case, the administration and maintenance cost (water fee) can be higher than normal hand-pump wells and as a result, it is necessary to make people understand that charge for administration and maintenance is indispensable, by fully informing them of the importance of safe water.

A3. Field Survey Photos in 24 Provinces

Appendix A3: Field Survey Photos

1. Banteay Meanchey Province

Photo 1-1

Private WTP sreves area located next to the provincial capital. Stationed operator is available.

Photo 1-2

Receiving well of the same WTP. Raw water is taken from the pond located nearby through the exposed piping for coagulated sedimentation.

Photo 1-3

Sedimantatiopn basin of the same WTP. Typical pattern of privated system.

Photo 1-4

In plent piping of the same WTP. Pipe is thin and fragile PVC.

Photo 1-5

Private system constructed by WB assistance. Raw groundwater is treated by irob removal device and water quality is excellent.

Photo 1-6

Piping of small-scaled rural water supply system. Water dsource is pond located nearby and pipe was exposed.

2. Battambang Province

Photo 2-1

Receiving well of WTP serves the provincial capital. Water source is Sangkat River flowing through the center of the capital. Low river water level and water quality deterioration during dry season is remarkable.

Photo 2-2

Rapid filter comprised of vertical baffled coagulation tank and horizontal flow sedimatation tank. Treatment efficiency is insufficient due to poor raw water quality

Photo 2-3

Water quality analysis laboratotry. Fully equipped with testing devices and tools but this lady engineer only can operate them.

Photo 2-4

Water source of rural water supply system. If river water level is lowered like this, water cannot taken from intake well, pipe is directly laid on river bed

Photo 2-5

As water supply system is not fully covered the area, kids are fetching water from the school.

Photo 2-6

Rain water storage tank is rural water supply system. During the dry season, rain water is only available water source. 3 L/capita/day

3. Kampong Cham Province

Photo 3-1

WTP serves the provincial capital. Managed by DIME and well-operated.

Photo 3-2

Water level meter of groundwater tubewell, water source of WTP. Water depth is only 0.38m and it affects intake pump operation.

Photo 3-3

Chroline disinfection system (Chroline Gas Cylinder)

Photo 3-4

Field survey in village near to the provincial capital. Interview to groundwater users.

Photo 3-5

Groundwater for domestic use.

Photo 3-6

Concrete stand of handpump. Pump was removede due to malfunctioning. Villagers are using another pumps.

4. Kampong Chhnang Province

Photo 4-1

Intake facility of provincial capital WTP. Intake pipe is inducted beneath the derrick and pump is installed in the concrete room. Poor raw water quality

Photo 4-2

Rapid coagulated sedimentation method is employed as treatment method but as this method needs high operation skill, treatment efficiency is poor

Photo 4-3

Solid alum in bamboo basket. They pour water to dissolve it.

Photo 4-4

Tubewell constructed within the school premises supported by the World Bank.

Photo 4-5

Iron removal unit for groundwater.

Photo 4-6

Traditional shallow wells are exploited as domestic use. Water is red due to high Iron content.

5. Kampong Speu Province

Photo 5-1

The provincial capital is served by private system. View of WTP.

Photo 5-2

River water is water source. Raw water is pumped by engine pump during daytime and by electric pump duting nighttime.

Photo 5-3

Though raw water quality is poor, coagulated sedimentation efficiency is excellent.

Photo 5-4

Bleaching powder is used as disinfection. Chemicals are well-storaged.

Photo 5-5

Many broken handpumps are observed in rural area.

Photo 5-6

Breakage condition is various. Villagers cannot repair them due to lack of spareparts.

6. Kampong Thom Province

Photo 6-1

View of WTP. Provincial water HQ is located in secound floor of Admini9stratiuon Building

Photo 6-2

Raw water source river. Two intake pipes are installed to cope with the seasonal water level fluctuation. Pipe for rainy season is exposed.

Photo 6-3

Baffled coagulation tank and horizontal flow sedimentation basin.

Photo 6-4

Treated water quality was inferior due to malfunction of flush mixer.

Photo 6-5

Material warehouse of rural water supply system.

Photo 6-6

Sample of rural water supply system with quite simple oxidation device.

7. Kampot Province

Photo 7-1

Raw water source river and aqueduct.

Photo 7-2

Baffled flocculator

Photo 7-3

Laboratory is fully equipped and staffs are receiving training by JICA.

Photo 7-4

Private system. Water intake and treatment is suspended during dry season.

Photo 7-5

Resident pumping domestic water into container.

Photo 7-6

Rainwater tank in rural area. Many tanks were observed during field survey.

8. Kandal Province

Photo 8-1

View of private WTP.

Photo 8-2

Water treatment facility of private WTP.

Photo 8-3

Elevated reservoir of private WTP.

9. Koh Kong Province

Photo 9-1

Private WTP serves the provincial capital. Capacity and function is equivalent to public WTP.

Photo 9-2

Water source is pond located in a distance. Due to sedimentation effect, raw water quality is stable.

Photo 9-3

Thailand-type baffled flocculator.

Photo 9-4

Piping work of private system. Batt welding connection of PE pipe.

Photo 9-5

Fishing villages located far from national roads. Villagers use boats for daily life.

Photo 9-6

Traditional shallow well. Groundwater development has not yet started.

10. Kratie Province

Photo 10-1

Provincial capital WTP managed by DIME. Periodical cleaning of filter. During cleaning work, groundwater is utilized.

Photo 10-2

Elevated reservoir constructed in 1960.

Photo 10-3

Generator, heavily deteriorated.

Photo 10-4

Handpump privately installed. Well-maintained.

Photo 10-5

Upper portion of handpump was removed due to malfunctioning. Residents are buying water from another wells.

Photo 10-6

Handpump pumping groundwater with high iron content. Residents are not using this.

11. Mondul Kiri Province

Photo 11-1

Proposed construction site for provincial capital WTP.

Photo 11-2

Raw water source lake for the proposed WTP. Construction site is seen at the back.

Photo 11-3

Traditional shallow well.

Photo 11-4

Groundwater taken from the shallow well.

Photo 11-5

Public toilet

Photo 11-6

Malfunctioning handpump. No water coming out.

12. Phnom Penh Province

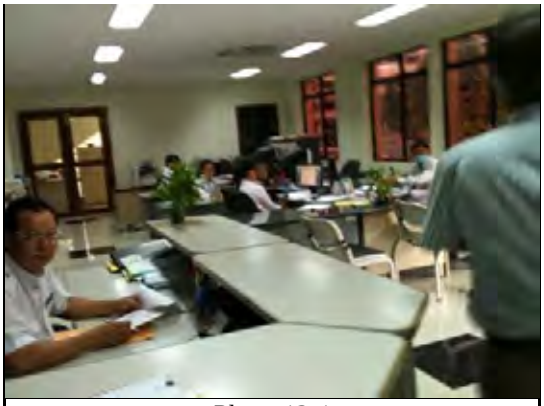


Photo 12-1

Planning division of Phnom Penh Water Supply Authority.

Photo 12-2

View of No.1 WTP. Well-managed but as raw water quality is inferior, treated water quality is not so good.

Photo 12-3

Stock yard in WTP. Pipe material is DCIP and PE pipe.

Photo 12-4

No. 3 WTP taking raw water from Mekong River. Raw water quality is drastically good compared by Tonle Sap River.

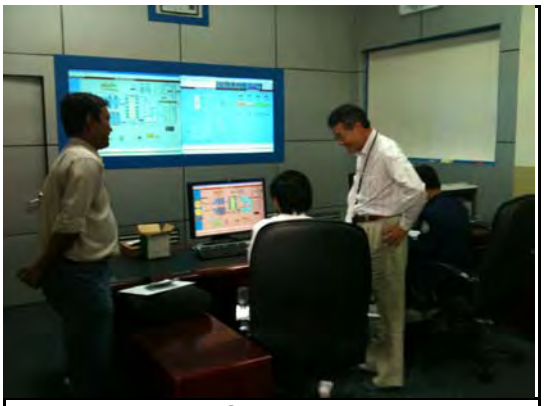


Photo 12-5

Control room of No. 3 WTP with newest equipment.

Photo 12-6

Water bill counter of PPWSA. Monthly payment.

13. Preah Vihear Province

Photo 13-1

View of private provincial capital WTP, partially expanded.

Photo 13-2

Raw water intake facility.

Photo 13-3

View of water treatment facilities.

Photo 13-4

Hand pump used by villagers.

Photo 13-5

Interview survey to village handpump users.

Photo 13-6

Well-maintained village public toilet.

14. Prey Veng Province

Photo 14-1

Groundwater pump of provincila capital WTP managed by DIME.. They are digging the pump house ground to cope with groundwater table lowering.

Photo 14-2

Heavily deteriorated groundwater pump of said WTP.

Photo 14-3

Generator equipment of WTP. Have not been operated since 1995.

Photo 14-4

Private handpump in village.

Photo 14-5

Public handpump in village.

Photo 14-6

Simplified filter constructed next to the said public pump but broken.

15. Pursat Province

Photo 15-1

View of provincial capital WTP, well-cleaned.

Photo 15-2

View of first field survey. Water treatment is not totally functioned.

Photo 15-3

View of second field survey. This time water treatment is properly functioned.

Photo 15-4

Raw water source is river. Two intake pipe are installed I different level to cope with seasonal river water level fluctuation.

Photo 15-5

Water treatment ility of rural water supply system by coagulated sedimentation method. Raw water is taken from pond.

Photo 15-6

Pond water is fetched by children for domestic use.

16. Ratanak Kiri Province

Photo 16-1

View of provincial capital WTP managed by DIME.

Photo 16-2

Two distribution pipes of WTP. Left one is for groundwater and right one is for lake water. In case of groundwater shortage, untreated lake water is supplied.

Photo 16-3

Water meyter and valve installed on main distribution pipe.

Photo 16-4

Stream water is used by villagers.

Photo 16-5

Well drilled next to thye said stream.

Photo 16-6

Handpump without handle and traditional shallow well in village.

17. Siem Reap Province

Photo 17-1

Ex-WTP site with SRWSA office and water bill counter.

Photo 17-2

Water source is groundwater. Well drilled next to the reservoir located near to WTP.

Photo 17-3

Receiving well of WTP. Groundwater is pumped and sent here.

Photo 17-4

SRWSA drilled well by their own budget within premise of WTP to cope with the increasing water demand.

Photo 17-5

All wells in village have billboard to appeal to the tourists visiting Angkor Wat.

Photo 17-6

Elevated reservoir of private system located far from the provincial capital.

18. Preah Sihanouk Province

Photo 18-1

WTP is constructed on hill viewing town.

Photo 18-2

Provincial capital WTP employs rapid coagulated sedimentation method. Though raw water quality is bad, WTP is well-operated.

Photo 18-3

Part of pump equipment is ex-Soviet Union made.

Photo 18-4

One of private WTP built on the top of the hill.

Photo 18-5

Another private WTP. Raw water is unsed to be taken by own dam but it has already depleted. Raw water is fetched from other source located far away.

Photo 18-6

Filter is clogged and water is overflowing.

19. Stung Treng Province

Photo 19-1

View of provincial capital WTP built in 1960.

Photo 19-2

Water treatment facility.

Photo 19-3

Movable raw water intake facility to deal with the seasonal river water level fluctuation.

Photo 19-4

Road in front of WTP became unregulated dumping site.

Photo 19-5

Handpump and filtration device in village. Both of them are functioning.

Photo 19-6

Filtration device built next to handpump.

20. Svay Rieng Province

Photo 20-1

Provincial capital WTP inagurated in 2006. Two units of sand filter is installed.

Photo 20-2

Clearwater reservoir and distribution pumping station.

Photo 20-3

Laboratory of WTP. Seldom used.

Photo 20-4

Rainwater storage bowl in village.

Photo 20-5

Handpump installed in village school.

Photo 20-6

Private handpump in village.

21. Takeo Province

Photo 21-1

Raw water intake facility of provincial capital WTP entrustedc to private company. Raw water is pond water.

Photo 21-2

Water treatment facility of WTP.

Photo 21-3

Chrolination disinfection tank.

Photo 21-4

Elevated reservoir.

Photo 21-5

Villagers are fetching water by the container from the reservoir located sevearl km away.

Photo 21-6

Village pond totally dried up.

22. Otdar Meanchey Province

Photo 22-1

Office buiding of PDRD. They performed the detailed presentation.

Photo 22-2

No water supply system is available in this province, hotels are using lake water.

Photo 22-3

Lakes are artificially built in cenreal area of provincial capital for water source.

Photo 22-4

Surrounding area of lake became park.

Photo 22-5

Handpump in village.

Photo 22-6

Handpump

23. Kep Province

Photo 23-1

Construction site of water dam for provincial capital urban water supply system.

Photo 23-2

Proposed WTP construction site located downstream of water dam.

Photo 23-3

Handpump cconstructed within the premise of PDRD office in provincial capital.

Photo 23-4

Domestic water used by villagers.

Photo 23-5

Malfunctioning handpump in village.

Photo 23-6

Private toilet in village.

24. Pailin Province

Photo 24-1

Rural water supply system constructed by support of Italian Government. Slow sand filter is employed as water treatment method.

Photo 24-2

Raw water is surface water. As village is located in mountainous area, water is clear.

Photo 24-3

Each household is equipped with water meter and faucet.

Photo 24-4

Another private WTP. It looks like coagulated sedimentation tank but treatment efficency is doubtful.

Photo 24-5

It looks like chlorinated compound but color is turned into yellow.

Photo 24-6

Public well. Basically laundry is prohibited here.