5.4 Institution and Organization

5.4.1 Institution and Legislation

(1) Present Status of the Waterworks

The Waterworks commenced its operation again on 28 July 1999 after settling the problem of electric charge between the Waterworks and electric company, after a long interval of out-of-operation since March 1995. According to the information of the Waterworks, estimated unaccounted-for-water ratio will reach some 70% which is obtained from the pump operation hours and consumer meter readings. Within the present limited staff and budget arrangement of the Waterworks, every endeavor has been carried out for their activities, but the results better than they expected were not obtained yet. The scale demerit originating from their small institution and organization has not been overcome so far.

After the re-operation of the plant, the newly registered customers have been increasing reliably. According to Waterworks records, the customer number newly registered was 113 on August 1999, and 189 on September 1999. The Waterworks is going to strengthen the employees from 9 in November 1999 to 15 in the near future to cope with the increasing management capacity. The organization of the Waterworks will have to be reformed together with the staff strengthening.

(2) Institution

The Waterworks is directly under the supervision and control of MIME Provincial Office in Siem Reap, and also MIME Headquarters in Phnom Penh especially for technical matters. However, the supervisory advice or counseling has not necessarily been given to the Waterworks with required timing because of insufficient staffing and budgetary reason of MIME.

At present, RGC has been encouraging with the recommendation of the World Bank and ADB that all waterworks in the country employ Private Sector Participation (PSP) system. The PSP system that the Government has been intending broadly implies an autonomous system and partial consignment together with privatization. Under such guideline of the Government, there are several towns such as Banteymeanchey, Kompong Speu, and Takeo which already reorganized their waterworks to the private units, and such as Phnom Penh which already became autonomous unit. As clearly mentioned in the previously issued report by IDA, the World Bank on April 1999, however, the background, process, legal framework, etc, of their PSP are ambiguous.

The Waterworks has problems for the operation and management. When necessity arose, MIME should help and advise all waterworks with their appropriate instruction and financial assistance, if necessary. MIME should have their strengthened staffing and organized system within the Ministry to meet such purposes. Instead of such systematized cooperation to be given to the waterworks, MIME has to supervise them all the time before they meet any problems with ceaseless inspection and management against all the waterworks in the country. MIME should set an independent department/section for supervisory advice timely in the Headquarters and main provincial offices.

When the waterworks intends to improve and/or expand the system by their own budget, MIME should make an institution to supply them government subsidy for their works. Where the institution for subsidy is established for the waterworks, the progress of the improvement and expansion will be accelerated and water supply must be pervading with the subsidy system. The subsidy rate for the works should be decided from the MIME budget available.

The waterworks side including of course the Waterworks in Siem Reap should strengthen and improve their activities and staff ability through training. In addition, strengthening their own institution as well is never given by others but should be obtained through their own endeavor.

For the Siem Reap Waterworks, the institution itself may be too small and weak to be improved by only their own activities. Especially for the on-the-job training execution, lack of trainers appropriate for instructor will be severe in the Waterworks. Where the Waterworks is too small as an institution, one of the solutions will be to associate with several other towns to make a joint undertaking/association for the training of employees concerned.

The joint undertaking/association of the waterworks be able to operate with allotting the charges to every member town as to the necessary expense. It is desirable that Phnom Penh Water Supply Authority and MIME will join with the Joint undertaking/association, because of their ample and long experience and staffing.

(3) Legislation

The Asian Development Bank (ADB) surveyed the water supply sector of Cambodia, and issued the study report named 'Institutional Support on the Water Supply Sector' on March 1998. The next year, the World Bank (IDA) reported 'Urban Water Supply Policy and Institutional Framework' on April 1999 after a long investigation of the sector concerned, and at present the World Bank has been studying the water sector of Cambodia consecutively. Recently, the World Bank re-

ported the preliminary papers to MIME on their study findings.

As pointed out by these reports, the present Cambodian situation seems having a lot of aspects to be improved. Because the Cambodia's legal system is in a state of transformation. The destruction of the entire system by the Khmer Rouge during the period of their control from 1975 till 1979 meant that a replacement system had to be developed almost from scratch.

The above ADB report said that 'the absence of adequate resources and the shortage of sufficiently qualified personnel have slowed the progress of this development.' Furthermore, 'Cambodia is almost exclusively governed by decrees and regulations of the Council of Ministers and of the Ministries with immediate supervisory responsibility over the issues in question. · · · · There is an absence of comprehensive and integrated water management legislation, and poor coordination of the related aspects which have been the subject of recent decrees and regulations.'

The matters to be improved at the national level of the water supply aspects will have gradually been revised by means of incessant activities of the staff concerned and recommendations of these related reports. In this report, therefore, the matters of the waterworks level will be discussed.

1) Prescriptive Supply Criteria of the Waterworks

The Waterworks has been supplying water to consumers based on the contract agreements which are signed and kept by the Waterworks and consumers, mutually, instead of the ordinance. The agreement form is prepared in advance by the Waterworks, and consumers are requested to submit the filled form to the Waterworks at the time when his house is connected with the service main of the Waterworks.

In the agreement form, the following are stated:

- The Waterworks supplies water to the contracted house.
- Water meter is a property of the Waterworks, and consumer has to pay meter charge.
- The consumer has to pay the water charge within the stipulated date .
- The consumer has to deposit money equivalent to a month charge for the Waterworks.
- The Waterworks has a right to disconnect the service pipe from the service main.
- The Waterworks may not supply water in case of emergency or accident.

This agreement form is not always clear about the Waterworks common duty, service level such as supply pressure and water quality. In addition, a judgment by which the Waterworks disconnects consumers who do not pay their charges seems to be entrusted to the Waterworks. However, re-connecting procedure is not defined yet in the document. These matters are also pointed out by the AFD Diagnosis Phase report issued on September 1999.

Influence of the Waterworks is generally enormous for the related society. If any accidents occur, an innumerable number of people will suffer from severe inconvenience to their life. If an accident causes hygienic problems, great social confusion will arise. As the activities of the Waterworks are required for infrastructure and maintaining all healthy condition of people, the water supply should not be controlled by an optional agreement, but strictly supervised by the government and law like ordinance on the waterworks.

In the following section, the ordinance of the waterworks will be stated.

2) Ordinance on the Waterworks

All of the activities to be taken by the Waterworks should be stated in the ordinance, and every action should be in accordance with the stipulation of this ordinance. The Waterworks has to be supervised and controlled by MIME, in which it is recommended that an independent section/department is established for that purposes.

In the ordinance, the following should be stated:

- Approval and inspection for the waterworks set-up and expansion by MIME
- Construction and supervision by qualified supervisor
- Inspection of all waterworks facilities by MIME prior to the operation
- Supply prescription on water charge and service level
- Structure and materials of service pipe system
- Qualified plumber and contractor
- Inspection for service pipe system
- Water quality and medical checkup for staff concerned
- Stoppage at emergency
- Incidentally necessary items

The ordinance stated here will be issued by the Government, and every related necessary regulatory matters should be made along with waterworks system. Otherwise, the Waterworks can issue the ordinance having full consent of MIME to do so.

The World Bank report says that 'there is no legal framework for regulating their (i.e. the waterworks) activities. It is not clear, for example, how tariffs will be revised or contractual disputes will be settled. This lacuna gets compounded by the lack of clear delineation of responsibility between MIME and the Governors. The absence of clear guidelines, and the presence of two centers of authority with overlapping jurisdictions' appears to exist in this Siem Reap area. The revision of water tariff and financial matters were requested to get approval of the Governor of Siem Reap.

Prior to issuing the ordinance of the waterworks, the clear delineation of legal framework must be requested.

5.4.2 Organization

Nowadays the Waterworks has been operated with two divisions of Administrative and Technical, consisting of 9 members in total. In the following sections, the organization and training aspects will be discussed:

(1) Present Status of the Waterworks

1) Administrative Matters

The Waterworks consists of two divisions, that is, Administration and Technique. The Administration Division is composed of Administration, Accounting, and Cashier Sections. The Technical Division is organized with Technical Unit, Distribution Network, and Production Sections. Every Division is controlled by Deputy Directors supervised by Director of the Waterworks . However, Administration Division chief, Deputy Director retired recently, and his position still remains unoccupied at present. Although the Waterworks expects to promote someone to this position from their own staff, an approval of the Ministry is not obtained yet.

Administrative Section covers general affairs, legal matters, personnel affairs, and record management. Accounting Section is for business accounting, store keeping, tender control, budget management, and billing and collection. Cashier Section is for collected money accounting.

Technical Section generally covers house connections, meter management, and leakage control. Distribution Network Section is for distribution planning, tendering, and ledger keeping. Production Section is for plant operation, quality control, disinfection, and distribution works.

The Waterworks asked consumers in writing whether they intend to connect with service main to get water in the beginning of July 1999, prior to starting the water supply service on 28 July 1999. As of the end of September 1999, 189 applications from consumers have already been collected, and the application submittals are increasing month by month. Big consumers such as hotels also are requesting their supply from the Waterworks system.

The Waterworks is going to strengthen its staffing to cope with the recent increasing management volume. Meanwhile, the shortage of repairing materials is quite sever and the Waterworks has been suffering from insufficiency of executing budget. The Waterworks has contrived to tide over such difficulties with their own ideas, especially for the pipe leakage repair works.

2) Technical Matters

(a) Plant Operation

After the re-operation of the Plant, it was found that the concentration of iron was about 3 ~ 11 mg/l in raw water obtained from two wells set in the premises of the water station. Although the existing iron removal facility was operated as instructed by the removal plant supplier, the concentration did not decrease as expected. The Waterworks therefore constructed an additional iron removal facility (spout type from nozzles) by their own budget, since the existing type of iron removal (horizontally spraying type) was out of order. As a result of the additional facility, the iron concentration became about 0.1 ~ 0.3 mg/l, and the treated water has been distributed through the pipelines to the consumers.

Operation hours of the wells are 4 hours from 5 ~ 6 am and 2 hours from 4 ~ 5 pm, and the total operation hours of the wells are about 6 hours a day for continuous 24 hour operation of the system because of the limited demands at present.

The obtained inspection results of the Study Team are shown below:

- Production meter should be installed at the beginning of distribution main to catch the production capacity.

- Disinfectant dosage is about 0.1 mg/l at the Plant. It should be increased, as many leakage repair works have been carried out along the distribution presently.
- Storage of chemicals should be kept with enough ventilation utilizing drain-boards under the chemical sacks in strage.

(b) Distribution System

Many leakings are found within the distribution system and the Waterworks has been repairing at present. The Study Team attended a repair work site situated at the pipeline along Siem Reap River, on 5 October 1999. In this case, the earth cover was about 70 cm.

The leaking pipe was ACP 150 mm set along a heavy traffic route. Adjacent to the site, two other repaired marks were found on the road. The earth covering seems too shallow for the asbestos cement pipe and traffic condition. The repairing was carried out with a steel bundle. As the outer shape of the pipe was not complete circle, the bundle and sheet rubber packing could not stop seepage around the pipe. The Waterworks was repairing the seepage with cement mortal paste.

On 6 October 1999 also, the Study Team had a chance to inspect the repair works conducted by the Waterworks beside Grand Hotel of Siem Reap. The leakage was from a valve spindle gland and adjacent ACP 100 mm distribution pipe with 75 cm earth covering. The leakage from the adjacent pipe had a past repair mark consisting of bandage with gum belt. As the leaking valve could not be repaired, the valve was replaced with another one. The leaking valve was from USA and replaced one from France. Because of different valve length and joint type, some part of the pipe was removed to meet the replaced valve length. PVC pipe and joints were utilized as adjuster materials.

The next day, 7 October 1999, the Study Team was present at the repair work of ACP pipe 100 mm along National Road No.6 near the water station. After excavation of the site, it was found the leaking was from the pipe just under a service pipe branch saddle. The earth covering of ACP was about 75 cm and the service pipe's was 60 cm. The repair was executed by replacement of damaged pipe.

On 8 October 1999, a pipe located only about 5 to 6 m east of the previous day's work-site had burst and water flushed out on the road. The Waterworks urgently started the repair works with their own workers and pipe materials. The pipe earth covering was about 85 cm from the road surface. About a 1 cm diameter hole in was found on the ACP 100 mm pipe. The holed pipe was replaced with PVC pipe and joints. Below the pipe, sand was set with compacting, and backfilled with excavated material.

The Study Teams inspection found the following:

- Earth covering depth (around 80 cm) seems shallow, considering the heavy traffic condition.
- Shortage of repairing materials/spare parts looks severe.
- Tools and machinery will be insufficient.
- Complete and updated pipe ledger should be prepared, in which necessary records and data are to be described.
- Staff training on pipe installation and repair work is highly requested.

Dewatering pump, pipe cutter, torque wrench, compactor, cart and so forth are required to carry out the work to an adequate level. To protect workers and traffic, guide board, removable fence, traffic light etc. are also necessary. To shorten the suspension time of water supply, sufficient preparation and prior working plan for the works are fervently requested. All location of line valve, drain valve and air release valve should be surveyed to effectively remove all water of pipelines.

(c) Service System

The First Survey The Study Team surveyed the meter reading records in the Waterworks with a meter-reader on 19 October 1999. In the reading records filed in order of divided block-number of the service area, Block No., Customer No., Name of Customer, Indicated Meter Reading Number for several months, etc, were registered for billing works. Originally, the number of connections was about 415 as of January 1999, and it became some 189 as of September 1999 after re-registration, although the number has been increasing month by month.

The service pipe branched from service main through branch saddle and stop valve is equipped with every service meter with protection cover made of steel plate. The meter cover was locked and the key was kept by the Waterworks.

The Study Team surveyed several meters selected at random from the records, and as far as they are concerned the maintenance of the meters looked in good condition and accuracy of the meters seems acceptable. On this day five meters were checked on the right bank of Siem Reap River. The meter accuracy was checked mutually by a water container and meter reading by the Study Team and counterpart of MIME Headquarters.

The Second Survey Following the first survey, on 20 October 1999 the second survey for meters was conducted with the same staff and same method. The survey was conducted on the left bank of Siem Reap River, the east area of Siem Ream, and the meters were chosen among the most big consumers and little ones.

The accuracy of meters was studied as in the same way as the previous day's way with the plastic water container and meter reading. Most meters showed acceptable indications and it seemed that the meters were treated with care. The selected big consuming houses belonged to restaurants or stores, while the little consuming ones were for private houses or houses which were at present not utilized for the time being. From these surveys, the following were found:

Found Matters

- When customers request the Waterworks their connection, they submit the request-form to the Waterworks. However, it is not necessary for drawings to be attached to the request ,forms. Therefore, there are no records in drawing-form.
- The meter ledger in which manufacturers' name, manufactured date, registered meter numbers, installed dates and places are recorded should be prepared for future maintenance and replacement.
- Under the direct rays of the sun, exposed PVC pipe should not be installed.

(2) Organization

1) Proposed Organization

When the Waterworks become a big organization, the customer service works should be separated from the administration section to clarify where the responsibility lies, and to split the increasing business capacity. Eventually, the Waterworks should be operated with three independent divisions as follows:

The Waterworks
- Administration and Finance Division
- Customer Service Division
- Technical Division

Every division chief should be appointed with qualified staff as deputy directors under the director of the Waterworks. These divisions are split into the following sections according to from their activities and responsibilities:

Administration and Finance Division
- Administrative Section
- Financial Section

Customer Service Division
- Technical Section
- Billing and Collection Section

Technical Division
- Planning and Designing Section
- Production Section
- Distribution Section

Every section will be strengthened with experienced staff. The production section will be increased with enough members for 24 hours continuous operation of production system. Considering such continuous system operation, the production section chief will be a experienced qualified engineer. The engineer will control 4 groups consisting of a technician or an assistant, alternately.

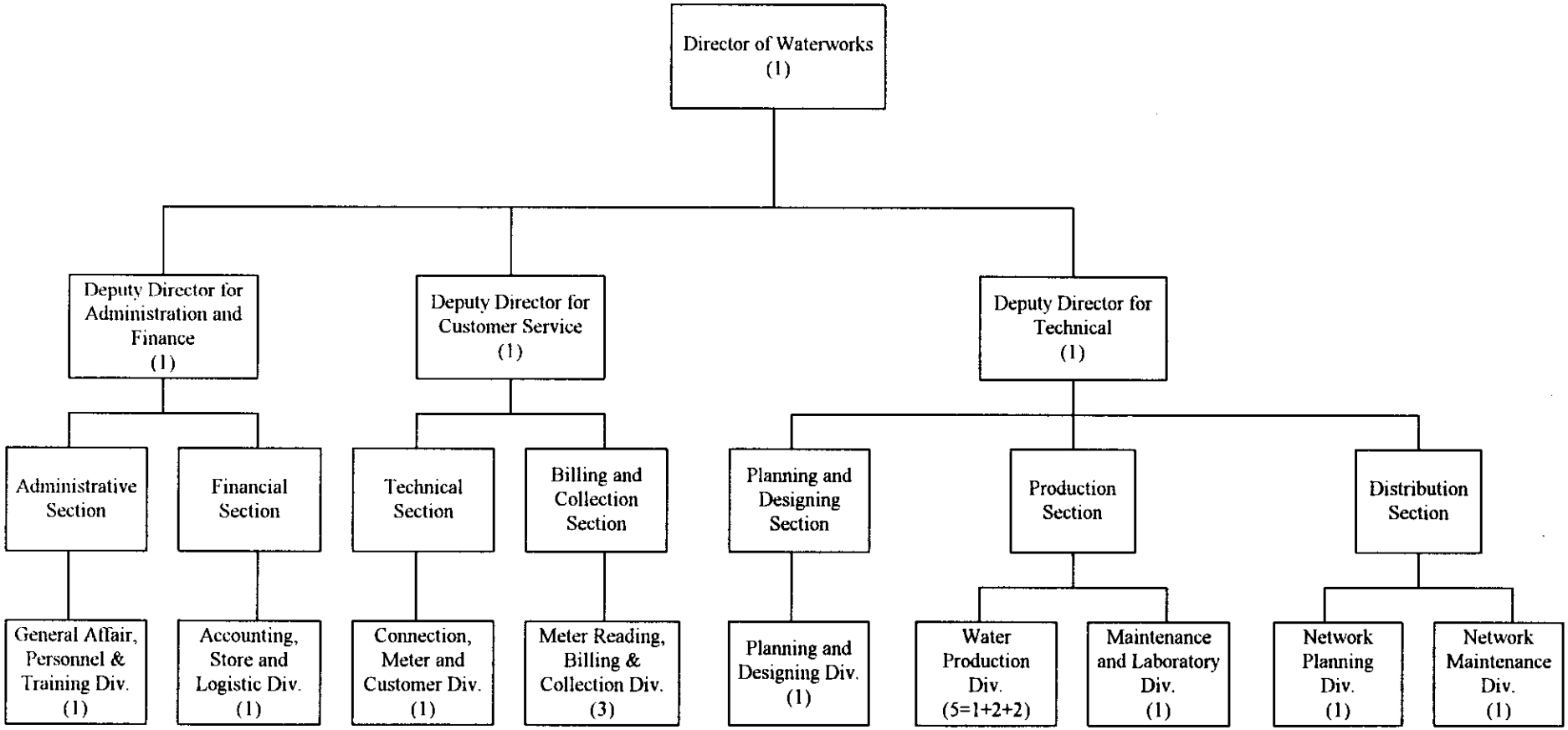
As the working hour of the one group is 8 hours a day (7 actual working hours + 1 hour rest = 8 actual portal-to-portal hours), three groups will be engage per day and one group will rest. The engineer will supervise these groups all day.

Production Section (1 Engineer)
- 2 Technicians
- 2 Assistants

Billing and collection section also will be strengthened according to the business increasing.

The total proposed organization of the Waterworks at the target year of Stage 1 (Well Capacity : 8,000 m^3/day in 2006) is as shown on Figure 5.4.1.

The employee numbers at present, in 2002, 2006, and 2010 are shown in the following table for reference. The year 2002 is the time when the total capacity become 9,440 m^3/day, and the year 2006 when the capacity become 13,440 m^3/day, 2010 is the target year of the Project. In the years 2002, 2006, and 2010, Billing and Collection Section, and Production Section will be strengthened. Every strengthened section will be necessary for being supervised by section chiefs who have experienced and qualified persons for the waterworks business.



(Note) Bracketed figures denote the number of employees.

The Study on Water Supply System for Siem Reap Region in Cambodia	**Figure 5.4.1 Organization Chart of the Waterworks for Stage 1, Year 2006**
Japan International Cooperation Agency	

Distribution of Personnel

Division/Section	Position	1999	2002	2006	2010
Waterworks	Director	1	1	1	1
Admi. & Fin. Div.	Dep. Director	1	1	1	1
Admi. Sec.	Clerk	1	1	1	1
Fina. Sec.	Clerk	1	1	1	1
Cust. Serv. Div.	Dep. Director		1	1	1
Tech. Sec.	Technician		1	1	1
Bil. & Col. Sec.	Asist. Technician	1	1	3	4
Tech. Div.	Dep. Director	1	1	1	1
Plan & Des. Sec.	Technician			1	1
Prod. Sec.	Engineer		1	1	1
(Production)	Technician		2	2	4
(Production)	Asist. Technician	1	2	2	4
(Laboratory)	Technician			1	1
Dist. Sec.					
(Net. Plan.)	Asist. Technician	1		1	1
(Net. Maint.)	Asist. Technician	1	1	1	2
Total		9	14	19	25

(Note) Position in 1999 is not always same as present because all positions are shown in the expanded form.

2) Details of the Activities

The director of the Waterworks will supervise all of his subordinates under the control of MIME Provincial Office in Siem Reap. Three deputy directors conduct their works in line with their business duty. Every activity of sections is described below:

(a) Administrative Section (Administration and Finance Division)

General affairs — Communication, correspondence, inquiry, questionnaire, response to questions, document arrangement, file management, record management, public opinion survey, campaign.

Legal matters — Communication, study and report, questionnaire, document arrangement, filing, dispute and mediation.

Personnel affairs	Recruitment, employment, position and salary promotion, rewards and penalties, health control and insurance, fringe benefit, family allowance, holiday and rest control, filing.
Training	Planning, framework making in cooperation with Planning and Designing Section, execution.
File management	All documents relating to Administrative Section will be kept for reference.

(b) Financial Section (Administration and Finance Division)

Budget execution	Preparation of yearly budget, execution of budget, revision of budget, preparation of balance sheet, reporting to superior offices.
Accounting	Payment and receipt management, bank accounting, water charge custody.
Logistics	Procurement and storage of goods, supply and distribution of materials, quality and quantity study of materials, spare parts keeping, ledger recording and filing.
Tendering	Tender arrangement, tender calling, opening, evaluation, contract.
File management	All documents relating to Financial Section will be kept for reference.

(c) Technical Section (Customer Service Division)

House connect.	Design of house connection, inspection and study of proposed house connection, supervision of installed service pipes, examination of qualified plumbers and contractors, survey of pipe materials to be installed.
Meter manage.	Service meter management, efficiency/performance test of service meters, installation, storage, changing, repair of meters, purchasing meters.
Leakage control	Leakage detection, repair, spare parts control, leakage reducing promotion and campaign.

File management	All documents relating to Technical Section will be kept for reference.

(d) Billing and Collection Section (Customer Service Division)

Meter reading	Reading, recording and report to customers, ledger filing, reporting something unusual to Technical Section.
Billing	Water charge calculation, bill preparation, arranging and reporting, total account and filing.
Bill collection	Visiting consumers for bill collection, transferring charge to Financial Section for custody.
File management	All documents relating to Billing and Collection Section will be kept for reference.

(e) Planning and Design Section (Technical Division)

Planning	Criteria of waterworks, design and planning standard preparation, system improvement and expansion works, cost estimation, tendering, contract, unit cost study.
Design	Preliminary study, planning of system, detailed design, cost estimation, cost study, collection of related data, study of new technology, improvement plan.
Spare parts	Study of spare parts, storing and ledger renewal, parts transfer slip and recording, purchase arrangement.
Drawing	CAD (Computer Aided Design system), review, filing, data storing, programming, software study
File management	All documents relating to Planning and Design Section will be kept for reference.

(f) Water Production Section (Technical Division)

O/M of system	Operation and maintenance for intake system, transmission system, reservoir and disinfection system, distribution system, study for new technology, CAD system and programming, software study.
Quality control	Sampling, laboratory test, filing, reporting, data collection, review of data, study of new technology.

Leakage control	Leakage detection, repair, spare parts control, leakage reducing promotion and campaign.
File management	All documents relating to Water Production Section will be kept for reference.

(g) Distribution Section (Technical Division)

Plan & design	Distribution planning and designing, tendering, tender evaluation, construction supervision, record keeping, drawing renewal, ledger keeping.
Drawing	CAD (Computer Aided Design system), review, filing, data storing, programming, software study
Leakage control	Leakage detection, repair, spare parts control, leakage reducing promotion and campaign.
File management	All documents relating to Distribution Section will be kept for reference.

5.4.3 Training

(1) Items of Training

The training will be one of fundamentally important matters for improvement and promotion of the staff abilities. As for the training conducted within every working place so far, on-the-job training has mainly been employed in the Waterworks also, as occasions required. However, the capacity of the Waterworks is to be improved by means of the present Project execution and it is expected that the employees will be increased with the capacity strengthening in both administrative and technical fields. To get effective results of the training, more systematic training is required. To meet such purpose, the training classified from the contents, methods, timing, and so on will be described below:

- Training for every split business hierarchy
- Training for practical business/subjects
- Training for specified items
- Training by dispatching/sending to other places or by invitation of lecturer
- Training within workshop/working place (on-the-job training)
- Support for self-study

The following explanations are offered for those classification.

1) Training for Every Split Business Hierarchy

More effective results of training may be got from a hierarchically classified training in some cases. The business hierarchy is classified for the sake of convenience as shown below. The undermentioned explanation will be shown classification-wise.

Class		Position
Executive	:	Department chief, Division chief, and so forth
Supervisor	:	Assist. Div. chief, section chief, and engineer
Usual Staff	:	Clerk, Assist. clerk, Technician, Assist. Technician
Recruited Staff	:	Newly employed staff, and freshmen from School

(a) For Executives

From the standpoint of appropriately coping with social and economic variation, and managing subordinates, broad viewpoint for managing sense should be brushed up, and sensitivity picking up public reaction will be one of desirable feeling for superlative staff. In addition, executives of the Waterworks have to keep keen and flexible sensibility for all consumers as well.

① Administrative and Managerial Planning

- Administration and management of waterworks
- Legislation and institution
- Principle of private sector participation
- Finance and accounting of waterworks
- Project planning of waterworks
- Operation and management of waterworks

② Administrative Management

- Public relations and public hearing
- Water rate and accounted-for-water
- New technology for waterworks
- Waterworks and environmental problems
- Emergency measures and action for disaster

③ Personnel Management

- Guidance and evaluation of personnel
- Promotion and elevation of rank
- Salary system and post/position
- Recruitment and employment
- Education and guidance for employees

(b) For Supervisors

The supervisors,(meaning a position/class corresponding to the sub-/deputy executive) they have to manage their subordinates and waterworks under supervision of the executives. Therefore, the activities to be done by the so-called 'supervisors' will be much similar to the activities of the executives, and at the same time their own activities as mainstay of the Waterworks should be carried out. Their training items are:

① Administrative and Managerial Planning
② Administrative Management
③ Personnel Management

These matters for executives are correspondingly applied to Supervisors from their responsibilities.

④ Budget and settlement of accounts

- Operation and maintenance cost
- Management of waterworks
- Budget planning/monitoring and execution
- Settlement of accounts and reporting

⑤ Waterworks Operation

- Legislation and execution
- Contract and budgetary execution
- Property management of waterworks
- Documentation management

The 'Usual Staff' denotes members who practically work under instructions of their superior officials, supervisors and executives. The Usual Staff are divided into two classes, that is, technical and clerical.

(c) For Usual Staff (Technical)

① General Matters of Waterworks

- Waterworks engineering
- Hydraulics
- Civil structures
- Design and construction
- Repairs and supervision
- Operation and management of waterworks
- Water quality analysis and record filing
- Spare parts and inventory management
- Ledger and records of facilities
- Countermeasures for emergency

② Computer Operation Study

- Rudiments of personal computer, network, word-processor
- Rudiments and application of Excel/Lotus matrix
- Rudiments and application of data-base
- Personal computer and office automation

(d) For Usual Staff (Clerical)

① General Matters of Waterworks

- Outline of waterworks
- Operation and management of waterworks
- Spare parts and inventory management
- Ledger and records of facilities
- Countermeasures for emergency

② Administrative Management

③ Personnel Management

Above matters for executives are correspondingly applied to Usual Staff.

④ Budget and settlement of accounts

- Operation and maintenance cost
- Management of waterworks
- Budget planning/monitoring and execution
- Settlement of accounts and reporting

⑤ Waterworks Operation

- Legislation and execution
- Contract and budgetary execution
- Property management of waterworks
- Documentation management

⑥ Computer Operation Study

- Rudiments and application of Excel/Lotus matrix
- Rudiments of personal computer, network, word-processor
- Rudiments and application of data-base
- Personal computer and office automation

(e) Recruited Staff

For the newly employed staff for the Waterworks, the most urgently necessary matters are to get accustomed to the working place and jobs to be done, and secondly to master the mission of the Waterworks. The courses to foster the moral sense against illegal actions like corruption will be added to the training.

① General Matters of Waterworks

- Outline of waterworks
- Operation and management of waterworks
- Ledger and records of facilities
- Countermeasure for emergency
- To perform their duty and do away with corrupt practices.

② Computer Operation Study

- Rudiments of personal computer, network, word-processor
- Rudiments and application of Excel/Lotus matrix
- Rudiments and application of data-base
- Personal computer and office automation

2) Training for Practical Business/Subjects

The following subjects will be matters to come across daily and ordinarily along the routine works of every staff. Therefore, they must be considering how to solve the matters and how to study more minutely. These subjects should be instructed by experienced persons.

① Technical Matters on Water Supply

- Well and water production
- Water quality and water processing
- Distribution and network, and maintenance
- Leakage reduction
- Service facilities and house connection

② Managerial and Administrative Matters on Water Supply

- Customer services, public relations
- Water rate and connection charge
- Administration and management
- Legislation and regulation
- Institution and governmental support (Training, Guidance, Counseling etc.)
- Inventory management
- Ledger preparation and updating
- Recruitment, employment, payment system, and promotion and salary increasing

③ Practical Matters to Conduct Routing Works

- Technical matters to be solved/improved
- Clerical matters to be solved/improved
- Managerial and administrative matters to be solved/improved

3) Training for Specified Items

In this training, more specific items than the previous section 2) will be selected and trained. All items will be collected from every members' requests prior to the training preparation, and training items will be decided. Therefore, some items may not always be considered necessary because of too particularly specified items. For instance, 'handling of chlorine gas' must be quite important for a gas operator, and if mishandling by him occurred, serious accident might arise. However, the handling will be not interesting and bor-

ing item for general clerical staff, even though it must be indispensable. The selection of items and trainees should take care of expected trainer and place where the training will be carried out. Several samples for the specified items are shown below. The shown samples are quoted from 'Training Program (1999) of Tokyo Metropolitan Waterworks'.

For General Affairs Department

- Financial and accounting affairs for local public enterprise
- Newly employed staff for local public enterprise
- Seminar on public relations
- Training course on clerical works for local loan/bond
- Study for mainstay staff of waterworks
- Guideline on operation and maintenance of waterworks

For Management Planning Department

- Seminar on study for company history
- Study on river engineering
- Introduction for network
- Technique of LAN (Local Area Network)
- Outline for management and introducing of Win. NT Workstation
- Management and apply of Windows NT ver. 4.0
- Explanation on methodology of cost estimation

For Accounting Department

- Contract and specification
- Cost estimation of maintenance and repair works
- Detail of registry business
- Seminar on ISO-9000s management

For Purification Department

- Study on water analyses
- Operation of analytical equipment and machinery
- Study on electric corrosion and protection
- Seminar on practice for factory automation

For Construction Department

- Practical method of pipe-driving work
- Study for robot on construction works
- Study on N-value of earth-bearing force
- Study on aerial photo survey

4) Training by Dispatching/Sending to Other Places or Invitation of Lecturer(s)

To send the Waterworks staff to other cities/towns for training will be quite applicable to staff training, because the staff can meet different experiences. Where lecturer can be invited for the Waterworks training, many staff will have a chance to attend the lecture. For overseas training, it may be possible to apply ODA from other countries.

- At/by other provincial towns
- At/by Phnom Penh Water Supply Authority
- At the National Waterworks Technology Training Institute, Bangkok
- At Overseas

5) Training within Workshop (On-the-Job Training)

On-the-job training which has been employed so far is very popular in every field, because of its practicality and applicability. This type of training will have been applied henceforward in the Waterworks.

- Technical matters for staff engaging in technical field
- Clerical matters for staff engaging in clerical field
- Managerial and administrative matters for all staff

6) Support for Self-Study/-Education

For every staff, ceaseless study for every field has been requested. To promote the self study condition and willingness, support for the self-study is highly demanded. One of the most effective and reliable measures for the self-study promotion will be to pay expenses for the study and/or to compensate award for getting official qualification. The compensated amount, timing, study contents, and so forth should be surveyed with the system itself.

As for the contents of the self-study, it can be judged from the personal qualification. But every qualification does not always have official status like Doctor or Bachelor. To stimulate every staff willingness for self-study and

to give many chances to all staff, one solution may be that the study level keeps a comparatively low barrier for the time being.

(2) Opportunity and Period of Training

Providing opportunity for the training to as many as staff possible will lead not only to an activated Waterworks but to the improvement of the staff ability. The training must continuously be conducted for a certain period to get a purpose, although its period will depend on the selected items. The training can be broken down a of ways; from the period, contents/items, timing to be employed, and so on. In this Report the training is broken down into the falling training period:

- consecutive full-day course
- consecutive half-day course
- consecutive 2 ~ 3 days a week course (for several months)

(a) Consecutive Full-Day Course

Full-day training will be held within a concentrated period. The training period will be a week, or a half month, or maybe a month or so. A merit of this way course is the training is concentrated. It is applicable for cost-consuming training like invited lecturer or hotel-utilized training including overseas. The concentrated mamer may be the most effective way for the trainees to lean the . On the other hand, it is costly, and the business related to the trainees must be completely stopped because of their absence. As the training must be continued for a certain period of course, it also may become boring.

(b) Consecutive Half-Day Course

The advantage of this course is that it is not necessary for the trainee to case his jobs at all, and the business will never be interrupted by the training. In this way the trainee can experience both job and training in the same day, so it may be effective for newly recruited staff training, or actual site training by invited instructors.

(c) Consecutive 2 ~ 3 Days a Week Course (for Several Months)

This way may possibly be not enough for only 2 or 3 days training. In that case, the period can be extended according to the training items and level. This course has the same advantage as the (b) course in that the trainees can still work at their jobs during the course. But there are longer gaps between

working period and training period. As the trainees concentrate on their jobs during the work period and on training during the training period. The concentricity for training may be rather inferior compared to the other courses.

To make every training course effective, it is recommended that a test related to the training material is carried out for all trainees after the course. According to the test results, if a kind of written recognition and/or awards are given to the trainees who passed the examination, they will become a certain and effective incentives for all employees.

5.5 Cost estimation and Implementation Plan

5.5.1 Cost Estimation

(1) Basis of Cost Estimation

1) Price Level

Base year for the cost estimation is 1999, with an exchange rate of 1 US$=3,800 Riel or 1 US$=120 Yen, and all costs presented in this section are shown in US Dollar.

2) Unit Cost

Unit costs in this cost estimation are collected from the Provincial Department of Industry, Mines and Energy (PDIME), Electricity de Siem Reap, Phnom Penh Water Supply Authority (PPWSA), as well as recent similar projects of JICA in Cambodia.

(2) Project Costs

Project costs in this Study are divided into two categories, as follows, and are estimated separately.

- Construction costs, and
- Other related costs such as land acquisition cost, engineering service and administrative costs, physical and price contingencies.

1) Construction Costs

Construction costs for the Project are estimated respectively for well facilities, distribution center, and distribution pipelines and house connections.

A survey concerning unit costs of labor, materials, and equipment in Siem Reap and Phnom Penh was carried out. Based on the results of the survey, construction costs are estimated as about 11.32 million US$ as shown in Table 5.5.1. Total construction costs for Stage 1 is slightly different from the costs, which were shown in the Master Plan. Necessities of the establishment of the meter district zone and inclusion of material costs for house connection replacement relating to the existing pipe replacement are identified during the Feasibility Study and these costs are additionally included in Stage 1 construction cost.

Scope of Stage 1 Project includes construction of 10 wells. Two wells out of these 10 wells were already constructed during this Study as pilot wells and these two wells will be used as production wells under Stage 1.

However, as discussed in the previous section, two monitoring wells will be required to monitor groundwater behavior. Therefore, construction costs of totally 10 wells, 8 production wells and 2 monitoring wells, are included in these cost estimates.

It should be noted that material and installation costs for new house connections that will increase in future are excluded in these estimates, which are supposed to be paid by new customers. However, the costs for re-installation of house connections by the replacement of existing pipelines are included in the construction costs as mentioned above.

The detailed cost estimates with breakdown are shown in Annex 5.5.1.

Table 5.5.1 Summary of Construction Cost Estimation for Stage 1

Description	Unit	Stage 1 (2006) Quantity	Cost (US$1,000)
1. Well Facilities			
1) Wells (φ450 mm × H 50 m, Q 800 m^3/d)	well	10 *	
2) Submergible Pumps	set	10	
3) Connecting Pipelines DIP φ150 mm ～ φ 250 mm	m	4,600	
4) Generator Houses (50 m^2 × 2 houses)	m^2	100	
5) Generator (3P 75 KVA/W Fuel Tank)	set	4	
6) Well Houses (25 m^2 × 10 houses)	m^2	250	
Subtotal			2,428
2. Distribution Center			
1) Receiving Well (H 3 m × Area 14 m^2)	m^3	42	
2) Chlorinator House (W 7 m × L 15 m)	m^2	105	
3) Clear Water Reservoir (W15m×L25m×H3.5m×3 basins)	m^3	2,625	
4) Generator House (150 m^2 × 1 houses)	m^2	150	
5) Generator (3P 150 KVA/W Fuel Tank)	set	4	
6) Instrumentation System etc.	LS	1	
7) Pump Station (240 m^2 × 1 houses)	m^2	240	
8) Distribution Pumps	set	7	
Subtotal			2,666
3. Distribution Pipelines and House Connections			
1) New Distribution Pipelines (φ500 – 75 mm)	m	17,025	
2) Replacement of Existing Pipelines (φ400 – 100 mm)	m	6,310	
3) District Meters	unit	6	
4) Service Mains (φ75 – 50 mm)	m	6,200	
5) House Connections for Replacement of Existing Pipelines	unit	254	
Subtotal			6,225
Total		11,319	

* : 10 wells (8 production wells + 2 monitoring wells)

2) Related Costs

For the implementation of the Project, there are other related costs such as land acquisition cost, engineering service and administrative costs, physical and price contingencies besides the construction costs. In addition, cost allocation of foreign and local currency portions is also carried out.

Land acquisition Cost

No costs will be involved for the lands of well facilities and transmission lines, because these facilities and pipelines will be constructed in the road shoulder where the Government owns. The land acquisition cost for distribution center site is estimated based on the unit price of the land and space required.

The costs of engineering service and administrative costs, physical and price contingencies are estimated as a percentage of the construction costs.

Administration Cost

Administration cost which will be paid by Cambodian Government for the implementation of the Project is estimated to be 2% of the construction costs.

Engineering Service Cost

The cost of engineering service, which includes detailed design, soil investigation and field survey, and construction supervision, is commonly estimated at about 10% of the construction costs. The percentage for engineering service cost is varied by local conditions and the size of the project, with higher percentages for smaller projects. Taking account of the scale of this Project, the engineering service cost is estimated to be 15% of the construction costs.

Physical Contingency

Ten percent of the sum of the construction costs, administration cost and the engineering service cost has been added to finance unforeseen expenditure, such as unanticipated rock excavation or site dewatering.

Price Contingency

Considering the inflation rates in Cambodia in the past five years, 10% of the sum of all above costs has been added to include costs inflation during construction period.

The estimated project costs including the related costs as well as cost allocation of foreign and local currency are summarized in Table 5.5.2.

Table 5.5.2 Estimated Project Cost

(Unit: US$1,000)

	Description	Foreign Currency	Local Currency	Total of Stage 1 (Year 2006)
A	Construction Cost	10,685	635	11,320
B	Land Acquisition Cost	0	250	250
C	Administration Cost (2% of A)	0	226	226
D	Engineering Services (15% of A)	1,698	0	1,698
E	Physical Contingency (10% of A+C+D)	1,238	86	1,324
F	Price Contingency (10% of A to E)	1,362	120	1,482
	Total	14,982	1,317	16,300

2) Operation and Maintenance Costs

Power Costs

Considering that public electric power in Siem Reap is currently not stable, not reliable and not guaranteed for future power requirement, own generator system is proposed for the Project which are necessary to supply electricity for well pumps, distribution pumps and lighting, etc.

Annual power costs are divides into two categories as follows.

- Annual fuel cost
- Annual maintenance cost of generator

Annual fuel cost is estimated based on the unit price of fuel and annual consumed electric power of all pumps and lighting, etc., while annual maintenance cost of generator is estimated to be 10% of its initial investment.

Estimated annual power costs of new and existing water supply systems from year 2002 to year 2006 are shown in Table 5.5.3.

Chemical Costs

Required chemicals will be chlorine gas for disinfection and lime for pH control. It is planned that the dosages of chlorine gas and lime will be 4.0 mg/l and 20.0 mg/l, respectively. Annual chemical costs are estimated based on the unit price of chemicals and annual average water supply. Estimated chemical costs of new and existing water supply systems from year 2002 to year 2006 are shown in Table 5.5.3.

Personnel Cost

According to the results of organization study, the total number of employees in year 2006 will be 19, therefore, annual personnel cost is estimated based on the number and salaries of employees. Estimated personnel costs of new and existing water supply systems from year 2002 to year 2006 are shown in Table 5.5.3.

3) Maintenance Costs

Maintenance costs comprise of all expenditures which will be required to keep the system in good condition after it is placed on line. It includes the costs for required materials and equipment such as spare parts, tools, leakage detection equipment, office and laboratory equipment, chemicals for water quality testing, etc., as well as training costs. Maintenance costs in this Project are estimated to be 1% of the construction costs, although actual maintenance costs will be tend to increase as the facilities become older.

Operation and maintenance costs (including not only the new system but also existing facilities) of system from year 2002 to year 2006 (Stage 1) are estimated as shown Table 5.5.3.

Table 5.5.3 Estimated Annual Operation and Maintenance Costs

Description	Unit	2002	2003	2004	2005	2006
Power Cost	US$/year	121,090	135,645	154,857	166,436	186,855
Chemicals Cost	US$/year	5,436	8,122	11,262	14,011	16,080
Personnel Cost	US$/year	39,000	41,400	42,600	45,000	47,400
Maintenance Cost	US$/year	113,196	113,196	113,196	113,196	113,196
Total	US$/year	**278,722**	**298,363**	**321,915**	**338,643**	**363,531**
Unit Power Cost	US$/$m^3$	0.162	0.120	0.098	0.084	0.082
Unit Chemicals Cost	US$/$m^3$	0.007	0.007	0.007	0.007	0.007
Unit Personnel Cost	US$/$m^3$	0.052	0.037	0.027	0.023	0.021
Unit Maintenance Cost	US$/$m^3$	0.152	0.100	0.072	0.057	0.050
Total	US$/$m^3$	**0.373**	**0.264**	**0.204**	**0.171**	**0.160**

5.5.2 Implementation Plan

The proposed implementation schedule including budgetary arrangement, detailed design, tendering and construction, as well as training and institutional development, etc, is summarized in the Figure 5.5.1.

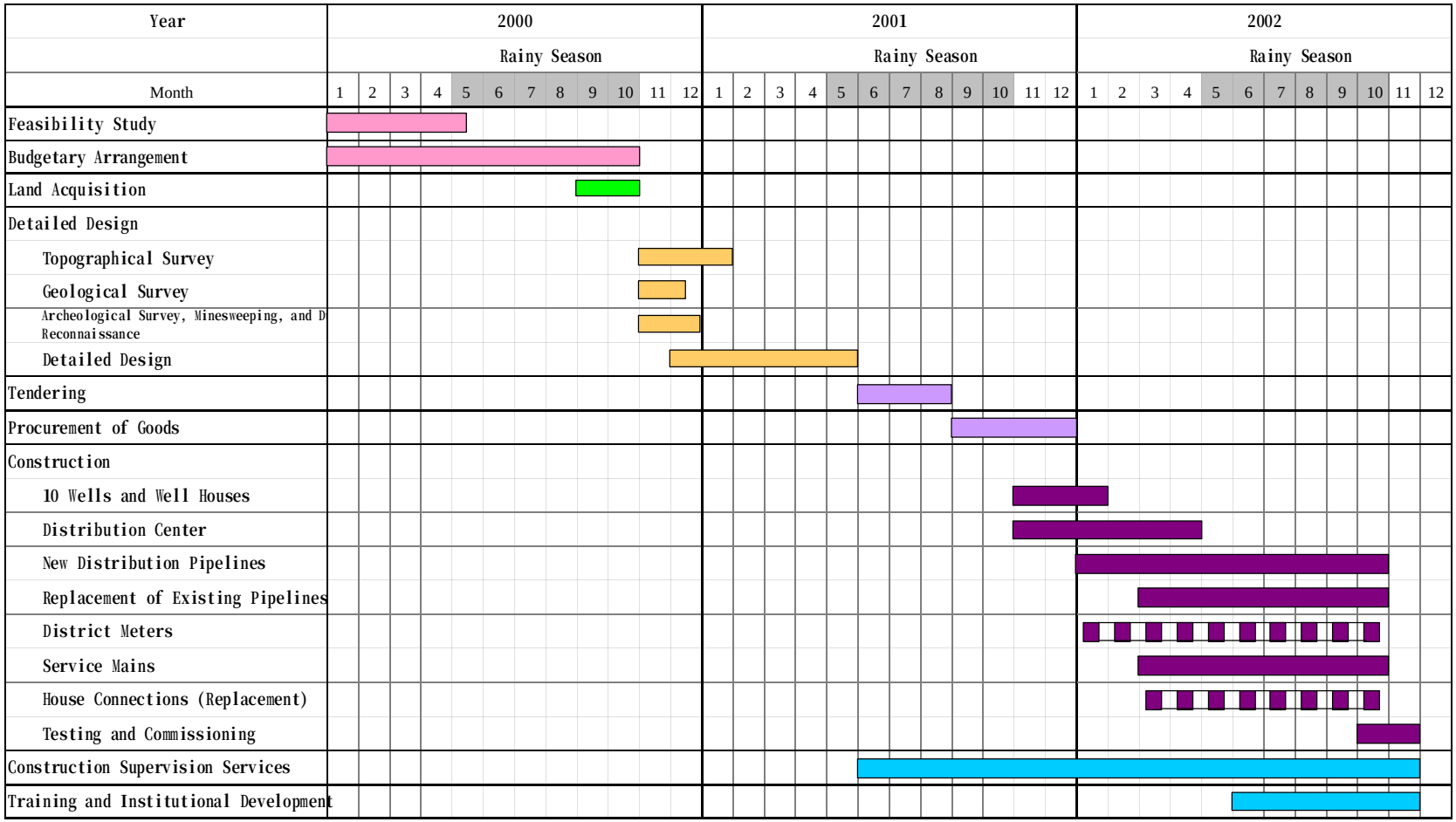
Project costs (construction costs and related costs) disbursement for Stage 1 is also carried out considering the implementation schedule of the Project, and the results are shown as Table 5.5.4.

Table 5.5.4 Project Costs Disbursement for Stage 1

(Unit: US$1,000)

Year	Annual Disbursement	Ratio
2000	591	3.6%
2001	7,759	47.6%
2002	7,950	48.8%
Total	16,300	100%

Considering the situation in Siem Reap and Cambodia, archeological survey, minesweeping, and dud reconnaissance will be required for the location of the distribution center. The survey should be done under the cooperation of UNESCO and APSARA during the detailed design stage just after the land acquisition.



The Study on Water Supply System for Siem Reap Region in Cambodia

Japan International Cooperation Agency

Figure 5.5.1
Implementation Schedule for Stage 1

5.6 Financial and Economic Analysis

5.6.1 Introduction

In this section, the viability of the project from the socio-economic viewpoints is examined. The project evaluation in this feasibility study is conducted from two points of view: (1) economic aspect and (2) financial aspect. The economic evaluation is to examine the project from the economic point of view, that is, viability of social investment in the national economy. The financial evaluation is to inspect the project from the financial point of view, that is, tests of earning capacity and fund management. In addition, the financial simulation of the project is conducted through a financial analysis model. On the basis of the results of the simulation, some points to notice on management are discussed in the analysis.

5.6.2 Financial Analysis

(1) Overview of Financial Analysis

The project proposed in this feasibility study is an urgent scheme, which was formulated as Stage 1 of the water supply system formulated in the master plan. The financial analysis aims at working out a successful financial plan for the project. The fundamentals of the analysis are based on the following preconditions.

1) The tariff structure approved in July 1999 by MIME was expected to fully recover costs of water production by the new plant system supported by French Government. This tariff is also applied to the financial analysis.
2) The project in this feasibility study is expected to have long-term financial sustainability.
3) Establishment of a new organization for operation and maintenance ensures the long-term financial viability of the managing entity by means of ensuring full cost recovery.
4) The management of the system improves its performance efficiency through reduction of water losses, commercial practices and good working incentive.

The financial simulation is based on a financial analysis model. It shows financial simulations under various financial conditions and assumptions. Through these simulations, the model suggests the relation between the new water tariff including the new installation charges and the financial management conditions that were adopted by this feasibility study. In order to assess the financial implications and long-term viability, all-important elements of the project will be elucidated as results of the simulations, as well.

The financial model follows conventional accounting principles and standards like normal commercial enterprises. The accounting for the project is done on an accrual basis, and standard commercial procedures, which are utilized for the accounting of revenue and expense as well as fixed assets and debt obligations. The project is set to start its construction work in 2000 and its operation in 2002, although the existing plant is supplying water to consumers without a break. Thus, the simulations of the financial analysis are set to start in 2000. The financial conditions of the existing water supply system is involved as an initial financial precondition for the financial simulation. In the financial simulation, however, the existing system is set to be involved into the new system in 2002 when the project is inaugurated.

(2) Financial Viability

The project in the feasibility study was evaluated in the same manner as done in the master plan. The financial viability was examined by means of a financial main factor of "FIRR" in addition to "B/C" and "NPV". If the viability were not good to implement from the point of financial view, its constraints would be identified and analyzed, and some countermeasures would be discussed in this analysis.

The financial evaluation results were 0.33 of B/C, US$ -10.98 million of NPV, and -2.7% of FIRR. The figures of B/C and NPV were discounted at 10%. These figures mean that the project is not viable from the financial viewpoint. This is because the total revenues at current prices for the evaluation period are less than the total costs at current prices. In other words, the total revenues are too small as compared with the total costs to manage the project.

Against this negative condition, some countermeasures are proposed for making the project viable from the financial viewpoint. According to these financial analyses, the countermeasures were considered as follows.

Case 1: The revenue of water sales is increased by means of raising water-tariff to 3.3 times more than the present one.

Case 2: More than 86% of the initial investment is covered by subsidy of the government or foreign donors.

Case 3: Combination of the following measures: (a) covering more than 68% of investment costs by subsidy and (b) raising the water-tariff to 50% more than the present one.

The respective cases above are considered as special cases among various countermeasures. Figure 5.6.1 shows the range of the countermeasure cases in terms of financial procurement and water charge, for which the project could be viable. The area hatched in the figure indicates the effective combination of financial source and water charge. The case 3 above is one of the special cases in the areas hatched, as shown in the figure.

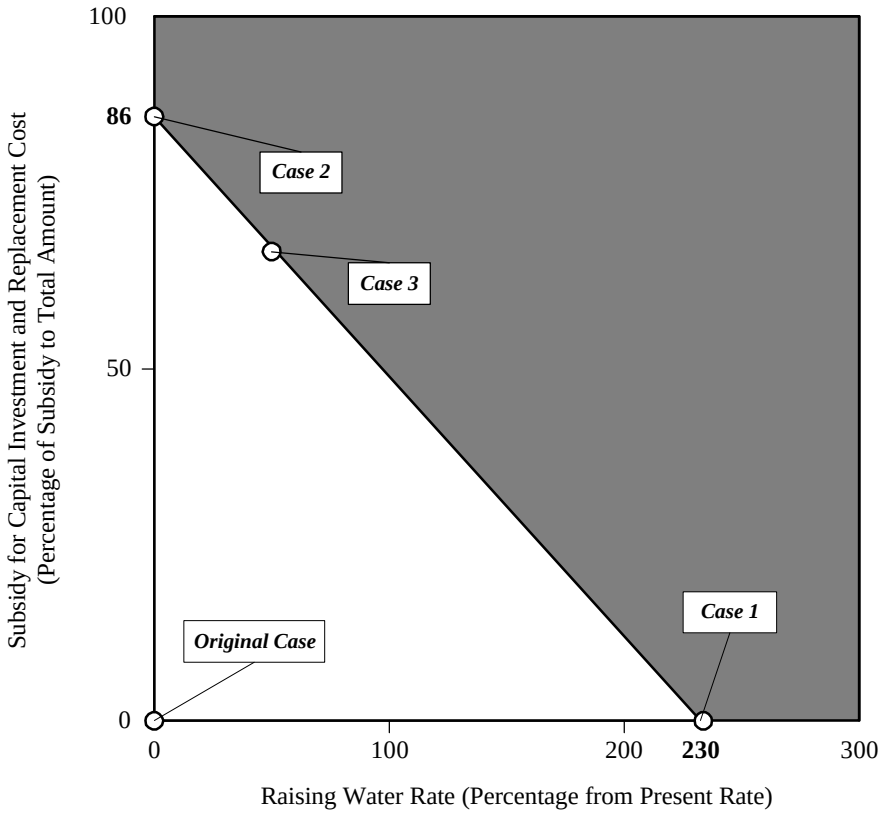


Figure 5.6.1 Effective Countermeasures for Making the Project Viable

In the case that the initial investment costs are covered entirely by grant from foreign countries, the project would be also viable from the financial point of view. This case is also included in the viable area in the figure above. In the case, the project might be viable even if the tariff of water went down to 60% of the present one. However, if the tariff were cut down to 60% of the present one, a cash position could be very difficult during an initial stage of the management.

In these countermeasures, the tariff was considered as one set of domestic and big consumers. However, a combination of the tariff can be changed in different ways. For example, the ratio between domestic and big consumers could be changed as a way.

For example, the balance between the rates of small and big consumers is discussed under the following case.

(1) 50% higher than the present tariff

(2) Keep the domestic rate at the present one.

In this case, the tariff rate for big consumer has to be raised to US$ 0.80 per m^3 or 2.2 times the present one. This case corresponds to the Case 3, mentioned above.

The following case corresponds to the Case 1 above.

(1) 3.3 times higher than the present tariff.

(2) Keep the domestic rate at the present one.

In this case, the tariff rate for big consumer has to be raised to US$ 2.40 per m^3 or 6.5 times the present one.

This relation is illustrated in Figure 5.6.2. The tariffs' variations between small and big consumers are made in various ways. This selection is considered as policy matter. Thus, final decision will be made by the undertaker himself.

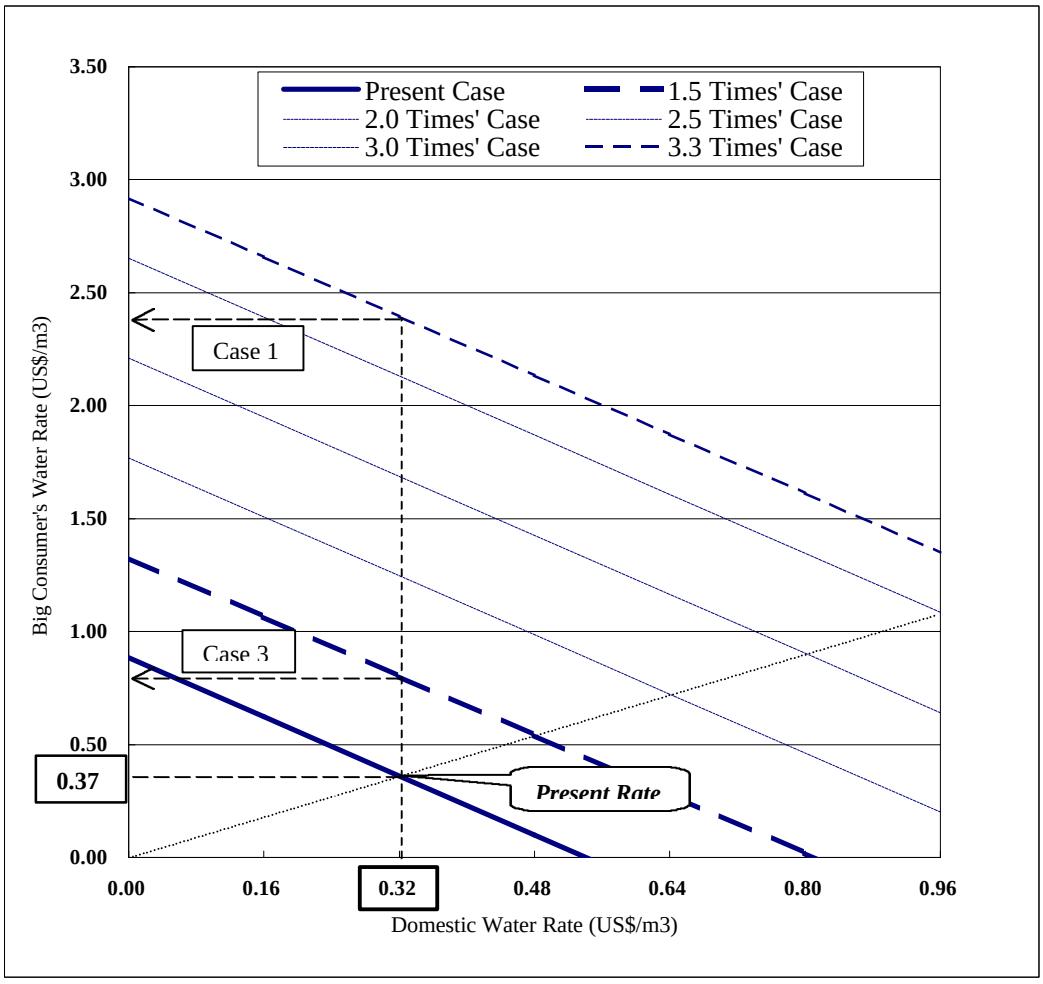


Figure 5.6.2 Relation Between Domestic and Big Consumer's Tariff

(3) Financial Simulation

1) Selection of Financial Simulation Cases

For recommendable financial plans, a financial simulation was done applying a financial analysis model. In the model, the management of the water supply services is simulated as a financially autonomous entity.

Through this analysis, the financial and management problems were identified for the project and the timing of fund requirement was analyzed for the water supply entity. To solve the problems, the Study Team referred to existing financial and administrative conditions.

Among various countermeasures discussed in the previous section, the following financial plans are adopted for financial simulation.

Financial Plan 1: The finance for initial investment is procured (a) 30% of the total investment costs from loan of international financial organization and (b) 70% from grant of foreign countries and central governments. In addition, the tariff is set at 50% higher than the present rate.

Financial Plan 2: The finance for initial investment is procured from grant of foreign countries and central governments. The tariff is set at the present one because of avoiding difficulty of cash situation at the initial stage of the management, although the analysis said that the a half of the present rate would make the project management feasible. This condition may promote to invest in Stage 2 implementation.

2) Conditions and Assumptions of Financial Simulation

In the financial simulation, the water volumes used by the consumers and the expenditures for operation and maintenance as well as capital investment are given conditions. These expenditures are provided by the cost estimators. Besides these data, the following major conditions and assumptions are set-up for the financial simulation. The detailed conditions and assumptions are described in the supporting report, Annex 4.7.1.

- Projection period: 11 years, from 2000 as the start year of construction works of the project through 2010. Simulations were also done up to 2030 to check the cash balance and break-even point.
- Prices and cost escalation: Projections of both revenues and expenditures were made without escalation to simplify and to make the simulation clearly understandable.
- Assumptions about accounting and tax: Grants from foreign countries are internalized as a part of equity of the waterworks entity. The facilities established on the basis of the grants are treated as depreciable assets in the accounting system without reduction entry of these

facilities. The water supply entity, i.e., the PDIME is exempt from income taxes currently and even in the future as far as the entity is not privatized.

(4) Analysis of Financial Simulation

In the financial plan 1, the waterworks will continue a net loss, although their operating results record net gains. In the target year 2006 of the project, the total revenue is expected to be US$ 1.102 million, which comprises the US$ 0.976 million of water sales amount, US$ 0.126 million of installation charge. On the other hand, the operating expenses amount to US$ 0.447 million in the same year. Then the net operating profit becomes US$ 0.655 million. However, the depreciation (US$ 0.991 million) and interest (US$ 0.308 million) of loan are estimated at US$ 1.299 million, so the income before tax results in a deficit of US$ 0.645 million. The accumulated deficit aggregated to US$ 3.371 million in 2006. Since the amount of net loss decreases year by year, the cash balance is expected to return to black in 17th year (2018). After that, the accumulated deficit will reduce and return to break-even at 24th year (2025).

In the beginning stage, the waterworks will face a cash flow crisis from 2002 to 2004. During this period, the waterworks has to request short-time cash loan of the government. After that, the management will have no problems in terms of cash situation, since the financial sources are procured from internal finance.

In the financial plan 2 as well, the waterworks will continue a net loss, although their operating results record net gains. In the target year 2006 of the project, the total revenue is expected to be US$ 0.741 million, which comprises the US$ 0.651 million of water sales amount, US$ 0.084 million of installation charge and US$ 7,000 of deposit's interest. On the other hand, the operating expenses amount to US$ 0.447 million in the same year. Then the net operating profit becomes US$ 0.294 million. However, the depreciation is estimated at US$ 0.991, so the income before tax results in a deficit of US$ 0.697. The accumulated deficit aggregated to US$ 3.282 million in 2006. After 2007, the same trend of the management will be expected as that of the financial plan 1. Consequently, the simulation makes it clear that the cash position of the plan 2 is much more positive than that of plan 1 during the starting period and especially after 2007, the end of grace period of the loan in the plan 1. The cash balance is expected to return to black in 17th year (2018) and the accumulated deficit will reduce and return to break-even in 27th year (2028).

Table 5.6.1 shows management indicators of the respective financial plans. The figures in the table are the indicators in the year 2006, the target year of the project. As a reference, some indicators of waterworks in Japan are tabulated in the same table. Japanese indicators were calculated on the basis of management data from

180 waterworks, which are located in middle-scale towns having populations between 30,000 and 50,000. However, the management conditions in Japan are quite different from those in Cambodia, so the figures of Japanese waterworks should be considered only for reference.

In 2006, the waterworks are still run at a loss, so the management indicators in line 7 to 9 result in negative figures. Although the income statements show loss in 2006, the financial situation is not bad, since the internal finance based on depreciation functions well for financial management.

A fixed ratio of the financial plan 1 looks much harder than that of the financial plan 2. Even for the financial plan 1, however, a Ratio of Fixed Assets to Long-term Capital is smaller than 100%, so there would be little problems on the management.

Labor productivity seems to be worse as compared with the Japanese case. In the financial plan 1, a labor cost yields the total revenue of about 23 times the labor cost. In the financial plan 2, it was only 15 times. These figures are far smaller than the Japanese case of 71 times.

Table 5.6.1 Management Indicators of Respective Financial Plans: 2006

	Indicator	Financial Plan 1[*1]	Financial Plan 2[*1]	Reference[*2]
1.	Turnover Ratio of Working Capital (per year)	1.54	0.75	1.17
2.	Current Ratio	1.74	4.15	4.71
3.	Capital Adequacy Ratio	0.64	0.98	0.45
4.	Debt Service Coverage	1.60	-[*3]	-
5.	Fixed Ratio	148.2%	94.4%	191.8%
6.	Ratio of Fixed Assets to Long-term Capital	97.6%	94.4%	89.1%
7.	Return on Revenues	-66.0%	-107.1%	9.5%
8.	Return on Assets	-4.8%	-5.1%	1.7%
9.	Return on Equity	-7.6%	-5.2%	3.7%
10.	Labor Productivity	23.2	15.5	71.3

Note: *1 Indicators in 2006, when the services of the waterworks become to matured stage.
*2 Indicators of Waterworks in Japan, which serve middle-scale towns having population between 30,000 and 50,000. The information is quoted from "Management Indicators of Waterworks Business, 1991, Japan Society of Waterworks".
*3 No interests and principle repayments because the investment was covered by grants.

(5) Financial Issues of Water Consumers

As discussed in the master plan study, the water charge of family accounted for 1.4% of the total household expenditure. The annual amount of the water charge was estimated at around 67,600 Riels on average, since the monthly amount was reported as 5,631 Riels. The annual total expenditure was also estimated at

4,839,000 Riels on average.

As of September 1999, the tariff of domestic use is 1,200 Riels per m^3. Under this tariff, a water charge of a household is estimated to account for 4.2% on average, as discussed in the master plan. The tariff is three times the survey result of 1.4% mentioned above. Whereas, the financial plan 1 proposed that the tariff is set up to 50% higher than that of the present. Then, the annual charge is calculated as 369,300 Riels per household. This accounts for 6.3% of the annual family income of 5,855,000 Riels in 1999.

On the other hand, the financial plan 2 proposed that the tariff is set up as the present tariff. Then, the annual amount of water charge accounts for 4.2% of the annual family income.

Incidentally, the World Bank report of "Investing in Development, 1985" insisted that the price of the minimum block of water is commonly set at 3 to 5 percent of household income, which experience suggests is affordable. The rates of 4.2% in the financial plan 2 seems to be within the block. To cover lower-income people in the water supply services, however, the waterworks have to make endeavors to reduce the tariff as much as possible.

The installation charges are heavy burden for a new connection of water supply services. A new connection of household has to pay for US$ 137 for connection installations plus 12,000 Riels of security deposit at the time of application. This charging amount exceeds the average monthly household income, i.e., US$ 128 in 1999. In particular, the connection charge of US$ 137 seems to be serious for the new connection. Thus, it would be recommendable that a system of lending and/or subsiding to new connection fee is established with some regulations such as loan program in accordance with household income. The system could make lower-income families accessible to the water supply system more easily than the present.

5.6.3 Economic Analysis

(1) Overview of Economic Analysis

The methodology of economic evaluation is the same as done in the master plan. In the feasibility study, the respective experts estimate the costs with discretion and more precisely than those in the master plan. Then, the project could be evaluated more accurately. In spite of that, some uncertainty still exists in the estimation. In particular, a case with long implementation period and increment of future water demand growth has risks in terms of judgment on project viability. In this context, the sensitivity test is introduced in the certain aspects.

(2) Assumptions for Economic Evaluation

Preconditions and assumptions for economic evaluation in the feasibility study are the same as set-up in the master plan. The costs and benefits are estimated on the basis of economic values instead of market values, which were applied for financial analysis. The economic values are converted from the financial values basically applying conversion factors. For the economic evaluation, the following criteria and assumptions are applied to calculate economic values and evaluation indicators.

Schedule and evaluation period of the project are set as follows. Basic conditions and assumptions are also set in the same manner as done in the master plan.

1)	Base Year:	The year 2000
2)	Construction Period:	Two years in real terms from 2000 to 2002
3)	Economic Life and Evaluation Period:	30 years after the completion
4)	Timing of Benefits Accruing:	After the completion of the project. The matured benefit is attained in 2006 of Stage 1's target. After 2007, the full capacity of the plant is utilized for the beneficiaries in the service area.
5)	Price Level:	Cost and benefit of the project are set in 1999
6)	Opportunity Cost of Capital:	10% per annum
7)	Standard Conversion Factor	90% of financial value
8)	Shadow Wage	Skilled worker: 100% of legislated wage Unskilled worker: 60% of legislated wage
9)	Value of Land for Plant	Negligible small

(3) Estimate of Economic Benefits

Unit economic benefit has already been estimated in the master plan. It was figured out as follows: US$ 0.80 per m^3 for domestic use and US$ 1.16 per m^3 for hotels and non-residential use. The total benefits were calculated as a product of unit benefits of the respective categories and total consumption volumes of the corresponding categories. Finally, the total economic benefits were estimated at US$ 0.612 million in 2002 and US$ 1.835 million in 2006. The details are shown in Table 5.6.2.

Table 5.6.2 Estimate of Economic Benefits

Item	2002	2006	2010*1
I. Water Demand (1000 m^3/Year)			
Domestic Demand	341	1,117	1,454
Non-residential Demand*2	292	809	890
Total	633	1,926	2,344
II. Benefit (US$1000/Year)			
Domestic Demand	273	894	1,165
Non-residential Demand	339	941	1,036
Total	612	1,835	2,201

Note: *1 Although the full water demand will not covered by the system, 83% (1/1.2) of the total demand is assumed to be covered by the system.
*2 Special use is included in this category in economic analysis.

(4) Economic Costs

The cost estimate of the project was already described in Section 5.5. The estimate, however, was enumerated in market prices. In economic evaluation, the financial value has to be converted into economic value. The total economic cost of the project was calculated at US$ 14.4 million. It was broken down as follows:

Foreign portion : US$ 13.6 million or 94% of the total cost, and

Local portion : US$ 0.80 million or 6%.

In addition to these main works, the connection works to the respective consumers are estimated at US$ 0.87 million in economic value.

The construction costs are disbursed in compliance with the construction schedule of three years. Then, the disbursement of economic construction costs is as follows:

US$ 0.285 million in 2000,

US$ 6.985 million in 2001 and

US$ 7.155 million in 2002.

In the disbursement schedule, the replacement costs of the equipments are appropriated every 15 years. These replacement costs were estimated in economic terms as US$ 1.731 million in 2017. In addition, the connection work costs are distributed between 2002 and 2010.

The O&M cost is annually required during the economic life of the project. The O&M unit cost in economic terms was estimated at US$ 0.334 per m^3 in 2002 and went down to US$ 0.142 per m^3 in 2006. After 2007, the plant will be operated in full capacity to meet water demand, so the O&M unit cost is estimated at US$ 0.102 per m^3 in economic terms.

(5) Economic Efficiency

The evaluation factors were 9.2% of EIRR, 0.94 of B/C and only US$ -0.92 million of NPV. The EIRR was slightly lower than the opportunity cost of capital of 10% in spite of the fact that the EIRR of the master plan was 10.5%. This is because the facilities designed in the feasibility study include a part of prior investment. In the future, thus, the EIRR is expected to be over 10% after the Stage 2 is implemented.

(6) Sensitivity Test

A case with long implementation period and increment of future water demand growth has risks in terms of judgment on project viability. It is customary, therefore, to test the results of economic analysis for sensitivity to variations in certain important inputs. The test is made for the variations in ±10% of the cost and benefit with respect to evaluation factors of the project. Then, there are nine cases under these variations. The results are shown in Table 5.6.3.

The cases, which the EIRR exceeds 10%, were the following conditions among the nine cases: (i) 10% decrease of cost; (ii) 10% increase of benefit; and (iii) condition fulfilling both (i) and (ii). All other cases were less than 10% of EIRR. Figure 5.6.3 shows the project viable range of cost and benefit variation from the original estimate. Accordingly, the estimates of cost and benefit should be reconsidered with prudence at the implementation stage.

Table 5.6.3 Results of Sensitivity Test

	Cost	Benefit	EIRR (%)	B/C	NPV (US$1000)
1.	Original Case	-	9.2	0.94	-922
2.	-	10% Decrease	7.9	0.84	-2,294
3.	-	10% Increase	10.4	1.03	449
4.	10% Increase	-	8.1	0.85	-2,323
5.		10% Decrease	6.9	0.94	-3,695
6.		10% Increase	9.2	0.94	-952
7.	10% Decrease	-	10.5	1.04	479
8.		10% Decrease	9.1	0.93	-892
9.		10% Increase	11.7	1.14	1,851

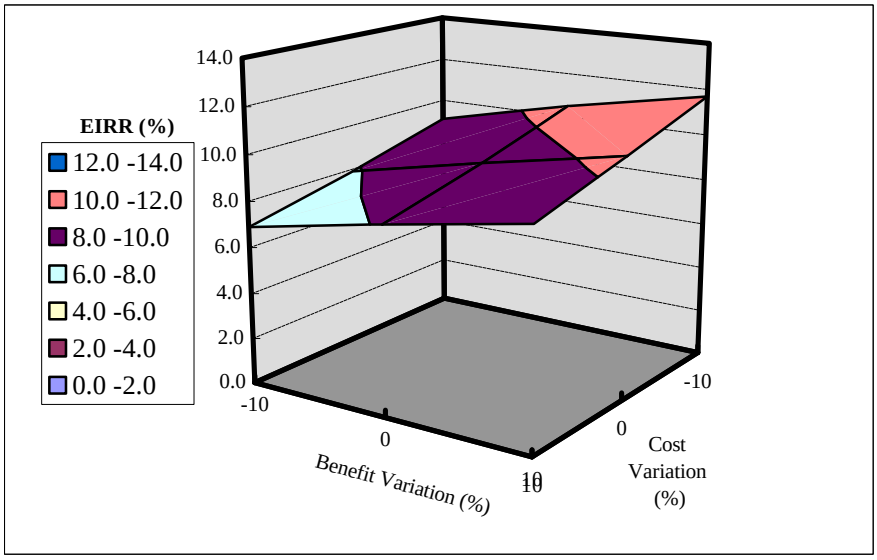


Figure 5.6.3 Project Viable Range of Cost and Benefit Variation from Original Estimate

5.7 Environmental Considerations

5.7.1 Introduction

In order to support sustainable development in developing countries, it is of great importance to give sufficient consideration to the environment in the planning and implementation of development programs. This involves studying of whether a development project will have serious environmental impacts on the project site and its surrounding areas, and establishing necessary measures for avoiding or alleviating any adverse environmental impacts.

For the present Study, an environmental investigation was conducted during the initial phase of the Study. This investigation was regarded as a preparatory stage for the Initial Environmental Examination (IEE). The IEE had been carried out in Master Plan Phase on the selected alternative project to determine the environmental impacts that may be created by the Project based on existing information and data, and judgement and experience. Based on IEE the scope of Environmental Impact Assessment (EIA) was also prepared. This section focuses on the EIA. However, EIA is restricted to the selected priority project only. An outline of the mitigation plan is also proposed.

5.7.2 IEE and Scope of EIA

An IEE was conducted in the Phase II: Master Plan of the study focusing on determination of 1) Existing environmental conditions and problems of the study area in accordance with their relevance to urban water supply planning, and 2) Potential environmental impacts and mitigation measures. This made possible to incorporate environmental concerns related to water supply, in the formulation of a development strategy for water supply in the Siem Reap Region. Important factors to be considered from the environmental point of view for Feasibility Study in Phase III of this study was also determined.

Since there is no Cambodian Law available for environmental screening, principally JICA format was applied making reference to ADB and WB guidelines. The Project is a water supply project involving groundwater development. So JICA guidelines for both groundwater development and water supply were applied for the Project. The result of the screening is given in Table 4.8.1. There are 23 items considered involving social environment, natural environment and pollution aspects.

The Project will significantly improve the public heath condition. Beneficiaries are presently depending on shallow wells for the domestic water supply. Since there is no wastewater disposal system available in the town, organic and fecal pollution of the well water is highly possible. As stated in the previous reports, water-related disease constitutes a major health problem in Siem Reap. In addition, the Project will contribute to the public health for the section of population depending on surface water for their water supply. A house or yard supply will reduce the water fetching and storing time thereby contributing in more economic time availability. Hotels can also save a great amount of energy for independent water withdrawal and treatment.

A number of negative impacts were anticipated due to implementation of the Project. In the screening process as shown in Table 4.8.1, all negative impacts were classified into three categories, major negative impacts, notable negative impacts, and minor negative impacts.

The possible major negative impacts can be the excessive lowering of groundwater table and more than expected land subsidence.

The notable negative impacts may occur due to resettlement and land acquisition and generation of wastewater.

There are some minor negative impacts, but these are either temporary or with insignificant impact. During the construction of pipelines, some traffic jams and accidents are possible. During the construction, generation of construction waste will occur. Also some change in underground water flow and hydrological pattern is possible. During the construction, air, water, soil and noise pollution is expected from the drilling rigs, generators, pumps and other construction vehicles.

There were two aspects of impacts, which are not possible to ascertain in IEE. One of them was impact on economic activities and the other was impact on cultural property.

Based on IEE, scope for EIA was also prepared in the M/P stage. Through the scoping process, the priority fields or items of the EIA were identified. The matrix of the scoping is given in Table 4.8.2. The matrix shows that six items were scoped for EIA in the feasibility study stage.

In the EIA process, detail investigation and analysis were conducted only on these six items scoped for EIA in M/P stage. In addition, future anticipated water quality was also reviewed.

5.7.3 Environmental Impact Assessment (EIA)

(1) Groundwater Level

A possible major negative impact anticipated in the IEE due to implementation of the Project is the excessive lowering of groundwater table by overdraft. Excessive lowering of groundwater table may reduce the yield of other wells operating nearby and may ultimately reduce the yield of the wells under the Project if the recharge is less than abstraction. However, since groundwater is not used for irrigation near the proposed well field, there is no impact on agricultural practice. The allowable limit for the groundwater level drawdown was set as 0.3m in Angkor area. Continuous monitoring has to be done to check these allowable limits. The step-wise implementation selected in the M/P is preferable so as to allow evaluating the impacts. All deep wells and most of the shallow wells should stop groundwater withdrawal in the town area. Some recommendations in this regard are made in M/P study and also in Section 5.8.3.

Another possible impact is the degradation of water quality caused by groundwater abstraction. Since the capacity of the proposed well field is lower than the calculated yield, this possibility is fairly low. However, water quality should be monitored continuously throughout the life span and detail study should be done before implementation of Stage 2 project.

Two pilot wells are constructed in the proposed well fields. After the completion of the pumping tests and soil characteristic tests, relation between drawdown and yield was studied. Results from the additional computer simulation also helped to anticipate expected lowering of the groundwater level after the implementation of the Priority Project. In the additional computer simulation, it was found that there would be concentrated drawdown near each well. Although maximum average drawdown in 100m X 100m mesh having a well is around 5 meter, there is little impact in the surrounding meshes not having wells.

(2) Land Subsidence

Another possible major negative impact is more than expected land subsidence. Land subsidence is caused by consolidation and contraction of clay layers due to the lowering of groundwater. Land subsidence may bring about the transformation and functional disorder of various structures, and the spread of flood damage area caused by the decrease in drainage capacity. These phenomena will raise the urban development cost. An impartial and non-differential settlement is much less damaging than a partial and differential settlement. An excessive land subsidence may cause structural damage to buildings, airport and Angkor heritage. Based on the results from the pilot well operation, a computer simulation was conducted in the feasibility study stage to estimate land subsidence near Angkor

heritage and the nature of the subsidence, if any. The result showed that there will be no significant land subsidence around the heritage area. However, continuous monitoring should be done to conceive succession for land subsidence.

The maximum allowable limit for the land subsidence in Angkor area is set at 1 mm. In case the land subsidence tends to be higher than this limit, proper remedial measure should be taken. The advantage of the stepwise development should be fully tapped. After the implementation of the Priority Project (10 wells), continuous monitoring should be carried out. Further study should be done before the implementation of the Stage 2 Project (additional 5 wells). Stage 2 Project should be implemented only after confirming allowable land subsidence. One of the other possible options can be an artificial recharge of groundwater subject to further study. Surface water from West Baray may be used for recharge. The location of the recharge zone can be northeastern side of the well field to act as a barrier between well field and Angkor area.

(3) Resettlement / Land Acquisition

This is an impact caused by the transfer of the rights of residence and land ownership. The land requirement for the Project includes one plot of 10,000 m^2 land area and 15 plots of 50 m^2 land area. All pipelines will be placed under the road so no permanent land acquisition is necessary. As indicated in the IEE, there is no resettlement problem anticipated in the Project. The land requirement required for the Priority Project includes one plot of 10,000 m^2 land area for the distribution station and 10 plots of 50 m^2 land area for the well houses along the National Road No. 6.

At present, the width of the paved surface of the National Road No. 6 is 6 m. The right-of-way is 50 m. There is a 22-m shoulder on each side of the paved road. According to the plan, the paved surface will become 10 m in future with 20-m shoulder on each side. This government land is under jurisdiction of the Ministry of Transport and Public Works. The Department of Electric Supply now uses some portion of land for their transformers. Steps should be taken in selecting well locations so that well-houses can be located in this public land. An agreement should be made with the Ministry of Transport in this regard. As per the existing system, MIME has to request the Ministry of Transport and Public Works in consultation with Land Title Office and Provincial Governor's Office in order to obtain permission for the construction of wells. MIME may have to pay a nominal fee to the Taxation office. However, an important project like water supply might be exempted from this taxation. Situation is similar in case of the road towards West Baray. A canal of about 10-m wide is running by the western side of the road. This canal is within the shoulder width. Proposed five wells in Stage 2 project will be constructed in the eastern side of the road within the

shoulder area.

The 10,000 m^2 of land area required for disinfection and distribution facilities cannot be obtained from this public land. Land acquisition from the private owners is required. The location for this facility should be selected in such a way that impact remains minimum. In the vicinity of the proposed distribution station, major land use is paddy cultivation and small housing and business. The location should be selected within paddy cultivation land to eliminate the impact of resettlement. Proper compensation should be paid for land acquisition.

Powered by a Royal Decree, Government can easily acquire private land required for public facilities. According to that law, Government can either rehabilitate or pay logically. As convention, a committee is prepared by the Land Title Office to fix the land price of the plot to be acquired. Government would pay this compensation to the landowners. During the extension of Siem Reap Airport, Government paid 4 US$/$m^2$ as a compensation. It is reported that the land price around the proposed Distribution Station is in between 20 and 25 US$ per square meter.

There are possibilities that living standard of the persons whose land would be acquired might get deteriorated due to poor compensation system. Proper compensation system must be maintained in the land acquisition process. Since the land for the proposed disinfection and distribution facility is mostly occupied by paddy cultivation, without proper compensation, this may cause loss of economic earning capability. An option of providing similar cultivatable land should also be examined. Another option could be to train these farmers for other kind of jobs and provide suitable jobs.

(4) Wastewater Generation

Any water supply project increases the domestic wastewater. If not disposed properly, benefits from safe water supply may disappear and may constitute a threat to public health. The maximum water supply volume in 2010 is 13,440 m^3/day. Considering a typical tropical country value of 80% for the conversion to wastewater, the maximum amount of wastewater generation in 2010 is 10,752 m^3/day. Per capita BOD load depends on geographic location, climate, social and food habit, personal hygiene, local custom, and economic properness. A BOD load generation value of 40 gm/capita/day can be estimated for Siem Reap Town for the persons served with water supply facility. A BOD generation of 20 gm/capita/day should be considered for persons not connected with water supply. For a target service area population of 53,151 in 2010 and a target service ratio of 75%, the total domestic wastewater pollution load is estimated as 1,860 kg-BOD/day. Considering a tourist BOD generation of 70 gm/capita/day for persons

with water supply service and 50 gm/capita/day for persons not served with water supply service, the tourist wastewater pollution load is estimated as 335 kg-BOD/day. This estimation is made with a total number of foreigners per day as 4,856 and a service ratio of 95%. Without considering industrial waste and leachate from solid waste, the total pollution potential in 2010 is 2,195 kg-BOD/day. With an ideal situation of total collection system, the pollution load of the wastewater is estimated as around 205 mg/l.

Proper arrangement for wastewater disposal is essential to get maximum health benefit from a water supply project. A future wastewater disposal plan was proposed briefly in Section 4.8.3.

(5) Economic Activity

Easy access to water does, in one hand, benefit the economy by reduced mortality and increase of economic time. On the other hand, water tariff may put some pressure on personal economic condition. Also, persons involved in shallow well digging and maintenance may have to change their profession. In the EIA study both factors were evaluated.

1) Water Tariff

Determination of impact on this item is closely related with the economic analysis performed in M/P study as presented Section 4.7.4. All estimations are based on the assumptions considered in the economic evaluation under M/P study.

One of the important main goals of water supply project is to improve public health and well-being. In particular, the urban poor should receive benefit from the project. They rely on contaminated groundwater or polluted streams, rivers and lakes in the project site. Besides these basic benefits, the water supply project gives various advantages to the people and the regional economy in and around the project areas. The following Table 5.7.1 lists the benefits accruing from the water supply project.

Table 5.7.1 Benefits Accruing from the Water Supply Project

(1)	Improvement of Public Health	(a) Elimination of poor quality water source
		(b) Reduction of water related diseases
		(c) Reduction of medical expenses
(2)	Enhancement of Amenity and Well-being	(a) Elimination of equipment for procuring water source
		(b) Time-savings associated with procuring water source
		(c) Energy-savings associated with boiling water for disinfection
		(d) Reduction of absence from work because of water related illness
(3)	Social Issues Related to Water Supply	(a) Effective use of alternative water resources
		(b) Efficient operation of water supply equipment
		(c) Stimulation of the project investment to regional economy
		(d) Prevention of urban disaster by means of fire hydrant
		(e) Improvement of degree of freedom for urban planning
		(f) Increase of land values

Among these benefits, benefits under the items (1) and (2) are considered as direct benefits, which the proposed project directly brings to the beneficiaries. Benefits under the item (3) are considered as indirect benefits.

The benefits listed up in the table above are furthermore classified into two categories. They are quantifiable or tangible, and non-quantifiable or intangible. To indicate evaluation indicators for economic evaluation, only tangible benefits are quantified as project benefit. In the economic evaluation under M/P study, the following benefits are chosen as tangible benefit, and they are grouped into three components.

(A)Benefits of (2a), (2b) and (2c) .....Water source saving benefit for residents

(B)Benefits of (1b) & (1c) and (2d) ...Public health improvement benefit for residents

(C)Benefit of (2a) .....Water source saving benefit for hotels and other big water consumers

Benefits are classified into two main categories, i.e., (a) domestic water for residential use and (b) water for hotel business. For the EIA purpose, only domestic portion will be critically analyzed.

The benefits of residents is assumed as a sum of (i) water source saving benefit, (ii) public health improvement benefit and (iii) other intangible direct benefits. Here, other intangible direct benefits are assumed as 10% of the sum of benefit (i) and (ii).

The water source saving benefit is estimated based on how the people in the project areas procure water source at present. According to the detail calculation explained in Section 4.7.4, the total water source costs are estimated between 1.20 US$ and 0.31 US$ per m^3 of water. After making

weighted average for different types of water sources and adjusting for economic cost value, water source value becomes 0.57 US$/m^3 of water in economic terms.

In addition to water source saving benefit, the public health improvement benefit was estimated as reduction of medical expenses by beneficiaries and at the same time reduction of labor opportunity losses due to illness. The amounts of these losses are estimated on the basis of economic evaluation made in M/P study. The medical annual expenses were estimated at around 108,000 Riels per household in 1999. The annual labor losses were estimated at around 30,000 Riels per household. Then, the total annual losses due to ill conditions were estimated at 138,000 Riels or equivalent 36 US$ per household. The losses were re-calculated at 0.17 US$/m^{3}of water, because a household consumes 208 m^3 per year. Finally, it was converted to 0.16 US$/m^3 per year in economic terms.

Accordingly, the water cost of domestic use in Siem Reap Town was estimated as at least 0.73 US$/m^3, which includes not only visible portion but also invisible portion. In this study, it was assumed from the economic point of view that the total benefit might be 10% more than the estimated value, taking intangible direct benefits into consideration. Thus, it resulted in 0.8 US$/m^3.

The present domestic water tariff is 1,200 Riels/m^3, which is around 0.3 US$/m^3. Even anticipating slight increase in water tariff, domestic economic benefit is higher than the cost. Thus, no negative impact is anticipated for the water tariff.

2) Change of profession

Different groups of people are now related with the well construction business. These include persons involved with drilling and persons involved with supplying the materials.

All of the deep wells and shallow well with mechanical lifting are constructed by some specialist companies. However, most of the open shallow wells are constructed by the owner with additional hired labors. There are about 10 well drilling companies in Siem Reap. These companies drill both open wells and tube wells. Out of average 100 wells constructed by each company, only 10 to 20% are open wells. It is reported by the companies that at present, they receive orders mostly from outside of the town center. One of the reasons is that most of the houses in the town center already have wells. Each company has only few specialist technicians (around five persons). On the other hand, they employ around 10 to 20

labors in each company. The average salary of the technicians and labors are 30,000 Riels and 10,000 Riels per day, respectively. It takes about half to one day to construct a well of 30 m deep under ideal condition. These firms do not pay any tax for their activities.

There are about 10 shops in Siem Reap Town selling well construction materials. However, none of these are dedicated sellers of well construction materials only. Most of the components are imported from Thailand. There are a number of places where the concrete rings for open wells are constructed. In all cases, the owners reported that most of the buyers are from the outside of town center.

Since the major market for the well construction activities is now outside the town center, introduction of piped water supply system will not create any significant impacts on these peoples.

3) Conclusion

Both from the household economy and well related activities, it can be inferred that there is no negative impact for the item 'economic activity' from the Project.

(6) Cultural Values

With the easy water availability, tourism potential will increase. This may put extra pressure on the precious cultural property of Angkor heritage although increase in tourism will benefit the local economy.

A series of studies concerning tourism development at Angkor has been carried out over the past few years. These studies point unanimously to the necessity of making a harmony between the protection of the cultural and environmental heritage of Angkor on the one hand, and tourism development on the other.

Based on a study by UNESCO ZEMP team (1993) for the environmental capacity that the Angkor Heritage can withstand, APSARA-UNESCO study (1996) concluded that 5,250 visitors in town per night is the most optimistic case with present infrastructure. This Study estimates 4,856 visitors in town per night in 2010, which is less than APSARA safe limiting value with present infrastructure. However, Cambodian authority is giving high priority to restrict tourist acceptance capacity within the heritage area. So, it can be concluded that there is no negative impact on the item 'cultural values' from the Project.

(7) Future Water Quality

Area adjacent to the proposed well field is mainly agricultural area. According to the Department of Agriculture, there is no risk of contamination from the irrigation excess.

In this area, most of the fertilizers used are organic in nature. Compost is also used extensively. The Agriculture Department reported that only three kinds of artificial fertilizers are used in the area, namely, Urea, 16-20-00 (N:P:K), and 18-46-00 (N:P:K). Their uses are limited. Typical application amounts are reported to be 30 kg/ha of Urea and 50 kg/ha of (N:P:K) for the paddy cultivation.

Pesticides are used in few cases. FAO is overseeing an Integrated Pest Management (IPM) in Siem Reap. The common pesticides are Azodrin, Endrin and Phosdrin. Typical application rate is reported as 0.5 to 1.0 liter/ha for paddy cultivation. There is no reported case of herbicide use.

Yield of rice in the area is 1.2 to 1.5 ton/ha. There are two to three harvest of paddy per year in the area.

From the low coverage of artificial fertilizer and pesticide, and low level of application amount, there is no risk from agricultural waste. However, IPM should be continued to practice in the area.

Possible degradation of water quality due to over abstraction of groundwater is discussed before.

5.8 Conclusions and Recommendations

5.8.1 Conclusions

(1) Technical Evaluation

After implementation of the Stage 1 Project, service area will be 345 ha and served population will be 25,500 people in 2006. No special technologies are required for the construction works of the proposed water supply facilities. The proposed groundwater based water supply system requires simple operation and maintenance skill. From the results of pumping and quality tests of pilot wells, quality and quantity are confirmed as suitable as a water source.

From the technical point of view, this project is evaluated as viable.

(2) Financial Evaluation

Under the conditions that 30% of the total investment costs is procured from loan of financial organization and 70% from grant of foreign countries and central governments, the water tariff is set to 50% higher than the present rate (Financial Plan 1), the cash balance is expected to return to the black in 17th year (2018). After that the accumulated deficit will reduce and return to break-even in 24th year (2025).

In the case that the entire finance for initial investment is procured as grant from foreign countries and central governments, the water tariff is set at the present water rate (Financial Plan 2), the cash balance will return to the black in 17th year (2018), and the accumulated deficit will return to break-even in 27th year (2028).

From the financial point of view, these two financial plans make this project viable. Considering the water tariff, the Financial Plan 2 is recommended.

(3) Environmental Evaluation

Groundwater abstraction may cause the land subsidence. From the results of the pumping tests and groundwater simulation, it is confirmed that the planned groundwater abstraction will not cause any serious land subsidence problem (simulation result: land subsidence is less than 1 mm) around the Angkor heritage area.

(4) Overall Evaluation

Considering the technical, Financial and environmental evaluations, the Stage 1 project is judged as a feasible project.

After the implementation of Stage 1, people will be able to access the safe water easily. Water born diseases will be decreased. Tourist-related infrastructure will also be improved.

5.8.2 Recommendations

(1) Review of Master Plan in Future

The present Master Plan has the time horizon set at the year 2010. For the development of future water supply related infrastructure, a review of the Master Plan is essential. This can ensure the compatible consideration of various changing factors. Siem Reap Town is a dynamic city and because of its potential as a major tourist attraction, the urban development can be vigorous. The revised Master Plan should consider all related factors and draw the outline for a later date. It is recommended to start this review of the Master Plan from 2006, in order to give ample time for the M/P review study, and subsequent feasibility study, design and implementation so that additional infrastructure for water supply will be ready before 2010.

As explained in Chapter 4, the present Project is divided into two stages. It is expected that the Stage 1 implementation will be completed in the early part of 2006. It is recommended that further confirmation of groundwater potential should be conducted before the implementation of the Stage 2. In that stage, evaluation of the first stage operation, groundwater level in the well field, impact to Angkor heritage and other related factors can be taken into consideration. Considering the requirement of water demand, it is recommended to start Stage 2 development in 2005 in order give enough time for design and construction so that the facilities can be ready for operation by the end of 2006.

(2) Continuous Monitoring

As explained in the previous chapters, groundwater monitoring should be conducted through the entire service period of the Project. The main objective is to ensure the safety of the famous Angkor Heritage. Various types of monitoring are proposed by the Study Team.

Level monitoring of existing shallow wells: In the present Study, around 100 existing wells are demarcated for level survey. It is proposed to continue this survey at least once every 3 months. This will give the actual situation of groundwater level during the operation of the water supply facilities.

Level monitoring in well field: It is highly recommended to monitor continuously the water level and drawdown in the well field. This will enable to check whether the drawdown in the well field is within the maximum allowable limit of 2 meters.

Level monitoring in the existing monitoring stations: For the present JICA Study, a number of groundwater level monitoring stations are established with automatic data loggers powered with solar panel for smooth uninterrupted service. It is recommended to continue operation of these stations during the operation of the

water supply system. These stations can monitor continuously the fluctuations of groundwater level. It will give a total picture of the impact of groundwater withdrawal and also serve as a base line data for Stage 2 feasibility study and future review of the master plan. The station near the Angkor Wat will also provide the check that the groundwater drawdown in Angkor area is within the acceptable limit of 0.3 m.

Land subsidence monitoring: Two of the monitoring stations set by the Study Team are equipped with land subsidence monitoring facilities. These are also capable of continuous monitoring. These stations will facilitate to cope with any unexpected situation.

Quality monitoring: Water quality at the well field should also be monitored routinely. It is possible that the water quality may degrade because of groundwater flow. Prompt action can be taken based on these water quality data.

Construction of Additional Monitoring Wells

Two wells, one for ground water level monitoring and one for land subsidence monitoring should be constructed. The location is the airport for groundwater level and the army camp between the well field and Angkor heritage. These additional monitoring wells should be installed with the automatic recording system as already constructed in this study.

Organization for monitoring: All types of monitoring proposed here should be responsibilities of the Waterworks. Data collection, interpretation and water quality test facilities should be established within PDIME. A training and technology transfer is undergoing in these aspects within the scope of present Study. Continuation of these services is recommended.

(3) Regulation for Restriction of Groundwater Usage

At present, the major source of water in Siem Reap Town is groundwater. For domestic purposes mainly shallow wells are used with either manual withdrawal or in few instances, mechanical withdrawal. However, hotels and other enterprises use deep wells with mechanical withdrawal. To ensure the renewability of the groundwater resources, this use has to be restricted after the operation of the Project. A legal framework is required for the proper reinforcement. A stepwise approach is most suitable to implement.

Hotel zone is very near to Angkor heritage and their water demand is rather high. So no wells should be allowed within the proposed hotel zone. The hotel zone will be provided with bulk water supply from the well field as soon as hotels are constructed.

In order to achieve final target of total eradication of existing wells, public awareness is essential. The present users have to be educated to realize that the unregulated groundwater withdrawal may pose a risk to Angkor Heritage. They should be encouraged to hookup with the public water supply system.

As for legal procedures, a two step implementation is proposed. Various combinations of this strategy is shown in the following:

Options	First Step	Second Step
User type	Stop commercial use	Stop domestic use
Well depth	Stop deep wells	Stop shallow wells
Withdrawal	Stop mechanical withdraw	Stop manual withdraw

For the first option, commercial uses should be curtailed first because these users like hotels withdraw substantial amount of water while domestic users use water for drinking and other household purpose. Also the control of commercial use will be easy. For the second option, steps can be taken to stop all deep wells first since they withdraw more water. Shallow wells are mostly used for domestic and small commercial purpose. A third option can also be selected from withdrawal amount and ease of regulation point of view. In this option, all pumps should be banned in first step.

Since it will be difficult to enforce total stoppage instantly, a user charge can also be introduced. Under this system, user have to pay an user fee if he/she wants to continue the use once that use type is proposed to stop.

(4) Public Relation and Education on Hygienic Life

In order to get maximum benefit from the water supply system, public awareness is a precondition. People have to be informed on the importance of safe water, personal hygiene and relation with the water related diseases.

Hygiene education should be included in the curricula of school education. Also, hospitals and public health clinics can play a vital role in information dissipation. A coordinated approach on the parts of NGOs is also very effective. Finally, programs in mass media can help in achieving the objectives.

(5) Sanitation and Wastewater Control System

Total benefit from a water supply project can not be obtained completely without a proper wastewater and drainage management system. A future wastewater disposal plan is proposed in Section 4.8.3. Immediate attention should be given in order to implement those plans.

The authority should act readily to materialize the proposals put forward under the immediate step in Section 4.8.3. For the other strategies, detail investigation is recommended. A master plan study on wastewater and drainage should start as early as possible followed by a feasibility study for the prioritized projects in order to facilitate quick implementation of the facilities required.

(6) Action Required for Project Implementation

- **Coordination with Central Government**

MIME is recommended to request the cooperation of Central Government for external funding arrangement.

- **Coordination with Local Provincial Government**

Cooperation of the local provincial government is required for smooth project implementation. MIME is recommended to explain scope of the project and role of the local provincial government not only for the project implementation but also for the sound management of the Waterworks after inauguration of the new system.

- **Arrangement for Acquisition of Land Space Required**

Land space will be required for well field and receiving well/clear water reservoir. These land spaces should be procured before commencement of civil work. MIME is recommended to make necessary actions for the land acquisition with cooperation of the local provincial government.

- **Archeological Survey in the Distribution Center**

It is necessary to survey whether a heritage exists or not in the planned distribution center of the 1 ha area and/or the pipe line route. Therefore, various archeological surveys are requested to carry out timely in the next stage under the cooperation of UNESCO/APSARA and NGOs.

- **Coordination with Phnom Penh Water Supply Authority (PPWSA)**

Siem Reap Waterworks may need assistance from PPWSA in many aspects such as technical and managerial. It is strongly recommended to keep close relation with PPWSA.