4.5 System Expansion Program on Siem Reap Water Supply

4.5.1 Introduction

Four alternative water sources were examined and compared in the previous section and groundwater was selected as the most suitable water source for Siem Reap water supply to meet water demand in the target year 2010.

Future water supply system using groundwater is discussed in this section together with preliminary cost estimates, and implementation schedule. Consideration on institutional development for the sound management of the Waterworks will be discussed in the following section.

Further detail information concerning the system expansion is shown in Annex 4.5.1.

4.5.2 Stagewised Development Policy

Service area, which is discussed in the previous section, will be expanded in the end of year 2006 to cover new housing area located in southeastern area. Along with this service area expansion, water demand will increase. In this Master Plan, stagewised development policy is introduced to meet such expansion of service area and increase of water demand. As shown on Figure 4.5.1, after the first implementation in year 2002 as Stage 1, system capacity will be increased again in year 2006 as Stage 2.

Increase of water supply capacity is as shown on Table 4.5.1.

Table 4.5.1 Increase of Supply Capacity

Stage	Incremental Capacity (m^3/day)	Total Supply Capacity (m^3/day)
Existing		1,440
Stage 1	8,000	9,440
Stage 2	4,000	12,000

At the end of the Stage 1, the existing system of which capacity is 1,440 m^3/day will be abandoned because of its life time. Therefore the total capacity of the Stage 2 will be 9,440 + 4,000 – 1,440 = 12,000 m^3/day

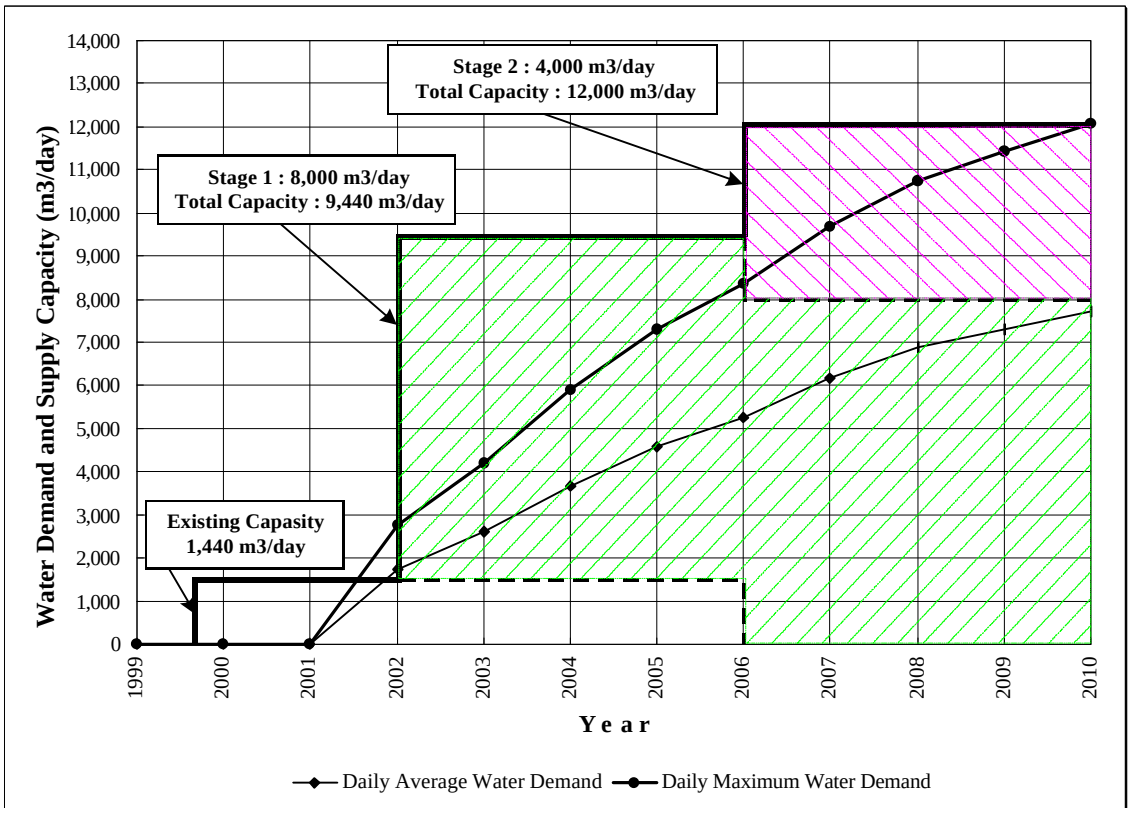

Figure 4.5.1 Stagewised Capacity Increase and Future Water Demand

4.5.3 Future Water Supply System

(1) System Flow

Future water supply system flow which will take groundwater as its source is as shown on Figure 4.5.2.

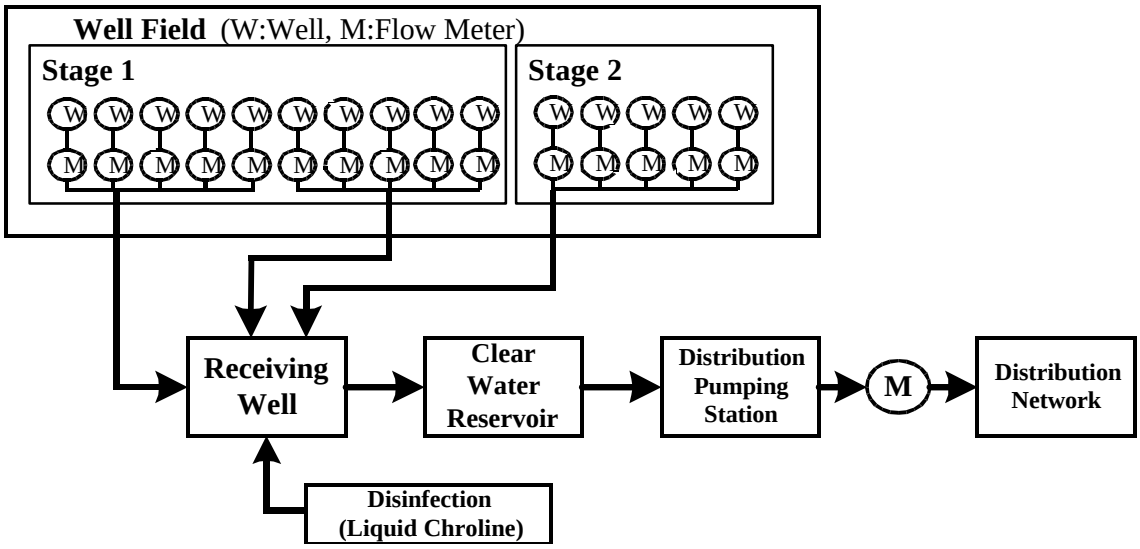

Figure 4.5.2 Water Supply System Flow

Groundwater abstracted from each well will be sent to a receiving well through a connecting pipeline. Liquid chlorine will be dosed for disinfection in the receiving well. Disinfected groundwater will be stored in the clear water reservoir to buffer hourly peak water demand. Water will be pumped to distribution network, after measurement by the main water meter. Method of water distribution is direct pumping and new/additional elevated tank will not be constructed.

Water production facilities such as wells, receiving well, clear water reservoir, and disinfection facilities will be designed based on the Daily Maximum Water Demand. Distribution system such as distribution pumping station and distribution network will be designed based on the Hourly Maximum Water Demand.

(2) Production facilities

1) Well Field

Plan of the well field is shown in Figure 4.5.3. As shown in the figure, 10 wells constructed under Stage 1 will be located along the National Road No. 6. Additional 5 wells constructed under Stage 2 will be located along the branch road from the National Road No. 6 to the West Baray. Area required for each well is about 50 m^2.

Each well will have a capacity of 800 m^3/day. Depth of each well will be 50 meters. Drilling diameter will be 430 mm. Within the drilling bore, a pipe of smaller diameter (220 mm, outer) will be installed up to the depth of 47 m. The main portion of this pipe is the PVC screen pipe. Total length of the screen will be 25 meters. This screen will have a 4% opening ratio with a slit width of 1 mm. Length of each vertical slit will be 100 mm. On both sides of this screen (top and bottom) PVC casing pipes will be placed. Casing pipe should follow VP200 (JIS K 6741) or equivalent standard to ensure required quality. On the top, this pipe will be closed by casing cap while it will be closed in the bottom by bottom plug. Provision will be kept for water flowing pipes in the casing cap. For structural strength, a concrete base will be constructed on the top. For smooth operation of the screen, a gravel pack of 40 m deep will be placed around the pipe within the drilling hole. The diameter of the gravel can vary between 3 and 7 mm. Provision will also be made to keep the well straight in the borehole by introducing centralizer. Details of the proposed well are shown in Figure 4.5.4.

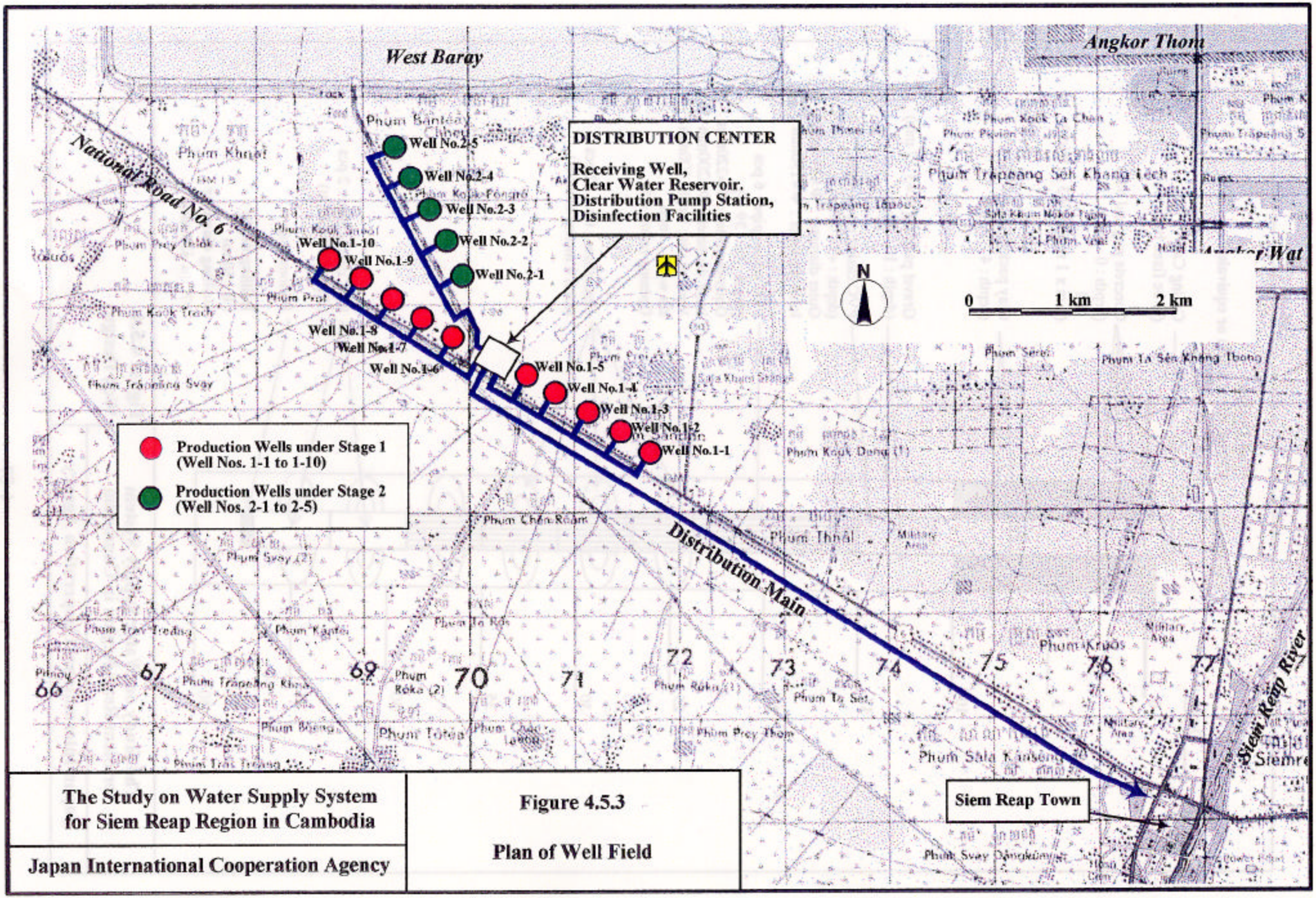

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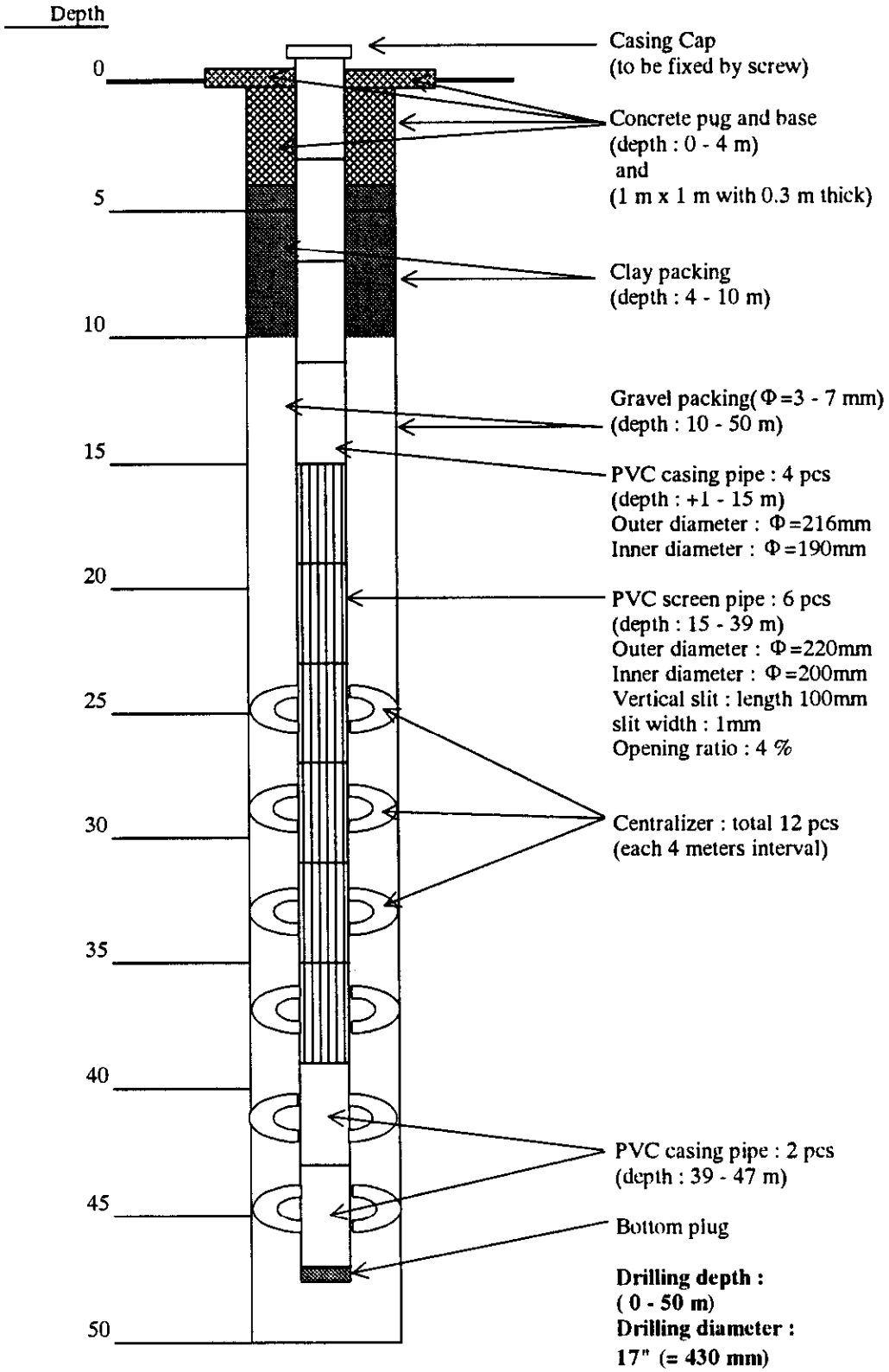
Figure 4.5.3

Plan of Well Field

Well Design

Casing pipe : VP200(JIS K 6741) or equivalent



The Study on Water Supply System for Siem Reap Region in Cambodia	**Figure 4.5.4 Well Design**
Japan International Cooperation Agency	

2) Well Connecting Pipe

Every five wells are connected by one connecting pipe of which total length is 6.9 km and diameter is 150 mm to 250 mm. Ductile Cast Iron Pipe (DIP) will be recommended for the material of the connecting pipe because of its reliability and easy installation work specially in the rainy season.

3) Receiving Well

From three units of wells, each unit consisting of five wells, water will be conveyed to the receiving well. Purpose of the receiving well is to regulate the water flow and to dose and mix chlorine solution for disinfection.

Capacity of the receiving well is 42 m^3 (effective depth 3 m, area 14 m^2) and this is equivalent to 5 minutes of Stage 2 production capacity, 12,000 m^3/day. The receiving well which has capacity of the Stage 2 will be constructed under Stage 1.

4) Disinfection Facilities

The disinfection of water supply system is almost universally accomplished by the use of chlorine gas or chlorine compounds (hypochlorites). The decision to use either chlorine gas or hypochlorites should be based on several factors.

In the existing New French System, Siem Reap Waterworks use chlorine gas as a disinfectant. Therefore, staff of the waterworks are familiar with using the chlorine gas. In Phnom Pen Water Supply Authority (PPWSA), they also use chlorine gas and alum are supplied by Malaysian supplier.

Considering this situation, chlorine gas is recommended as a disinfectant for the new system. Chlorine gas will be fed by solution-feed chlorinators. Two sets of chlorinators will be installed under the Stage 1 and another one set will be added under the Stage 2. Chlorinators will be installed in the Chlorinator House and the house will also have a space for storage of the gas cylinder.

5) Clear Water Reservoir

Clear water reservoir will be constructed to balance the fluctuating demand from the distribution system against the output from the wells, and to act as a safeguard for the continuance of the supply should there be any breakdown at the source or on the main trunk distribution pipelines.

Detention time of the reservoir is recommended to be about 8 hours. The clear water reservoir will consist from three basins and two of them will be

constructed under the Stage 1 and the other will be constructed under the Stage 2. Area of clear water reservoir is 375 m^2 with a depth of 3.5 m.

Land space required for the distribution center which will accommodate the receiving well, disinfection facilities, clear water reservoir, and distribution pumping station will be about 1 ha.

(3) Distribution Facilities

1) Distribution Pumping Station

Distribution pumping station will be constructed to store distribution pumps which will transmit water to distribution system in Siem Reap Town area through distribution trunk main.

Flow of transmitting water will be controlled by a number of operating pumps. Therefore, capacity of each pump will be planned rather small. Total number of pumps is 8 for the project. Power of these distribution pumps will be supplied by in-plant generators. Current situation of public electric supply is not stable and reliable and capacity of the public supply will not be enough for the future power requirement.

2) Proposed Distribution Network

From the distribution pumping station, water will be transmitted to the city through distribution trunk main which will be installed along the National Road No. 6. Length of distribution main is 7,450 m with a diameter of 500 mm. Hotels which are located along the National Road No. 6 will be supplied from branches on the trunk main.

According to the future land use plan, new hotel development project will take place in the northeast part of the city. Water supply system for the new hotel development area will be a separated system from the city water supply. Water for the new hotel development area will be available at the branch on the northern end of the distribution network and water will be supplied by bulk. Transmission pipeline from this branch to the new hotel area will be installed by hotel developers.

Future distribution network is established taking account of,

- future land use plan,
- future service area,
- future water demand, and

- topographic condition.

Planned future distribution network is checked by computer network analysis. Network analysis is conducted based on the following conditions.

- C-value for new pipe is 120 and 110 for existing pipeline.
- Hourly peak factor is 1.2. (The peak factor is not applied for bulk water supply for the new hotel development area)
- Minimum residual pressure should be more than 15 m.
- In the case that existing pipe is not enough for future distribution, the existing pipe will be replaced by the new pipe and the existing pipe will be abandoned.

In addition to these conditions, existing pipe replacement is also taken into account. Existing pipelines to be replaced are discussed and selected in the previous section and those selected pipelines to be replaced are included in the network analysis and required pipe diameter is confirmed. Detail results of network analysis are shown in Annex 4.5.1.

Proposed future distribution network which was confirmed by its capacity and rationality is shown on Figure 4.5.5 and network diagram which shows pipe diameter and length is shown on Figure 4.5.6. As shown on these figures, most of the new pipeline will be installed under the Stage 1, additional pipeline will be installed under the Stage 2 to cover newly expanded service area. Service area is separated by the Siem Reap River and eastern and western service area will be connected by two new pipe bridge.

Length of the proposed distribution network is as shown in Table 4.5.2.

As shown on Table 4.5.2 and Figures 4.5.5 and 4.5.6, diameters of selected existing pipelines for the replacement are calculated and confirmed. Total length and diameter range for the pipe replacement will be 6.3 km and 400 mm to 100 mm. Remaining existing pipelines which will not be replaced under the Stage 1 will be totally 5.8 km. It should be noted that this does not mean the remaining pipelines are in good condition. Remaining pipelines were also installed from the 1960's and they should also be repaired or replaced gradually after completion of the Stage 1 by the Waterworks using own fund or donor's assistance.