Selection of Urban Water Supply Systems For Upgrading

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ABSTRACT

The Provincial Waterworks Authority of Thailand (PWA) is considering upgrading a number of their water supply schemes to improve the conditions of existing facilities and to maximize the system efficiency with minimum capital expenditures in order to postpone major investments.

The scope of the study was to review all water supply systems managed by PWA to ascertain the need for immediate action, the technical suitability and the cost effectiveness of upgrading and to set priorities among the systems proposed.

After preliminary screening, 39 systems were selected and ranked in accordance with established selection criteria. Specific recommendations were also given for future actions on the selected systems.

INTRODUCTION

The Provincial Waterworks Authority (PWA) is the main agency responsible for water supply in the urban and rural areas of Thailand, except metropolitan Bangkok. The PWA was established as a state enterprise in 1979 and has more than 5,000 employees. The agency operates 188 water supply systems serving a total of about 480,000 service connections. The water produced in 1987 was 273.5 million m^3, out of which 88.8 million m^3 were unaccounted for.

The PWA is considering upgrading a number of their water supply systems, to be selected on a national scale, in order to increase water sales at reduced costs, to improve the quality of service and, where possible, to postpone investment in major expansions of such systems.

The scope of the study was to review all the water supply systems managed by PWA, to ascertain the need for immediate action, the technical possibility of upgrading the systems, the cost effectiveness of the upgrading and to determine a scale for setting priorities among the proposed systems.

The rationale . . . is to improve . . . and to maximize the system efficiency with minimum capital expenditures.

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THE RATIONALE OF UPGRADING

The rationale behind the upgrading concept is to improve the conditions of the existing facilities and to maximize the system efficiency with minimum capital expenditures so that major investments can be conveniently delayed.

The upgrading of the water supply systems is based upon the experience gained by PWA in the UNDP sponsored Water Supply System Modification Programme carried out for some pilot plants [1]. This program brought about improvement in water quality and substantial increase of water treatment plant output.

Most of the water supply systems operated by the PWA were constructed between 1960 and 1980 and the majority of the water treatment facilities were designed based on standard modules of 40, 80 and 100 m^3/h. There are no established design criteria for the treatment processes in PWA, but criteria published in Europe and North America have been recommended by foreign consultants.

Plant output may be doubled without the addition of filters, providing proper flocculation and sedimentation as pre-treatment for filtration. The recommended maximum filtration rate for the modified filters was 7.5 m^3/h which is about twice the original design rate.

The upgrading of the system in this context is not, however, limited to the production facilities and includes

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other project components such as source, pumping system, transmission and distribution system that need improvement to cope with the increased production capacity of the system.

Doubling of the production capacity can be easily obtained through the modifications for the more recent units i.e. multiples of 80 and 100 m^3/h, due to the rather conservative original design and construction criteria but, for the smaller units of 40 and 50 m^3/h, it was assumed that the maximum increase in capacity should be limited to 50 percent only. However, this condition is unfavorable to many small waterworks which have only one water treatment plant and for which the existing demands far exceed the supply capabilities, even after the modifications.

SUITABILITY OF WATER SUPPLY SYSTEMS FOR UPGRADING

The identification of the water supply systems to be considered for upgrading was carried out as follows:

1. Data for all 188 waterworks, operated by PWA in 1988, was collected and analyzed. Data concerning production, costs and revenues for the period 1985 to 1988 was consolidated in a data base to be used for further evaluation.
2. All water supply systems that are already subject to improvements or major expansions in the near future were dropped and thus the number of waterworks to be further analyzed was reduced from 188 to 119.
3. The list of 119 waterworks was then analyzed by comparing the water demand in the service areas projected for 1995 with the production capacity of the same waterworks, with and without upgrading. From this analysis of water demand versus production capacity it was found that 79 systems are not suitable for upgrading, mainly due to one of the following reasons:
   - the systems have no potential for upgrading (i.e. the existing facilities are too old or were already upgraded) and/or
   - the existing production facilities have enough capacity to supply the forecast water demand (5 years span) without the need to upgrade the system or expand its production capacity.

In this way it was possible to further scale down the number of systems eligible for upgrading from 119 to 39.

RANKING OF THE SELECTED WATER SUPPLY SYSTEMS

The final list of 39 systems was scrutinized to confirm the upgrading potential and ranked in priority. A list of 12 criteria was identified and used to calibrate the suitability of the systems for upgrading and scores were assigned to each single criterion.

Scores were assigned to each single criterion.

The ranking criteria and their maximum scores were as summarized in Table 1, which shows the minimum and the maximum scores and the corresponding values assigned to each parameter. Intermediate values and scores were also considered. For some parameters like the raw water quantity and quality, for which there are no numerical

Table 1. Criteria adopted for ranking

ITEM	CATEGORY	DESCRIPTION	SCORES	RANGE OF PARAMETER	
				Min. score	Max. score
1	Dimension	Size of town	0-4	<15,000 persons	>30,000 persons
2	Demand	Service ratio	0-4	<40%	>60%
3	Demand	Current system utilization	0-6	<90%	>150%
4	Demand	Postponement of major expansion	0-6	<3 years	>5 years
5	Efficiency	Unaccounted-for water	0-4	<20%	>40%
6	Efficiency	Raw water quantity	0-4	Depending upon specific problems	
7	Safety	Raw water quality	0-4	Depending upon specific problems	
8	Phys. Constraints	Distance of water source	0-6	<2 km	>12 km
9	Phys. Constraints	Need for temporary works	0-6	<1 WTP	>2 WTP
10	Profitability	O&M cost	0-4	<0.80*AVG	>1.2*AVG
11	Profitability	Average revenue	0-4	<0.80*AVG	>1.2*AVG
12	Financial	Average incremental cost of water	0-14	>20 B/m^3	<8 B/m^3
		Maximum score	**70**		

WTP = Water Treatment Plant

AVG = 1987 National Average

Table 2. Ranking of the systems and recommendations for upgrading.

Rank	Waterworks	Score	AIC (Baht/m³)	Priority	Remarks
1	Lampang	53	6.8	High	
2	Nan	49	9.8	High	
3	Sayasom	48	8.2	High	
4	Prachuab Khiri Khan	47	6.1	High	
5	Maha Sarakarm	47	10.9	High	
6	Roi Et	46	7.5	High	Needs expansion
7	Chantaburi	46	12.0	High	
8	Kalasin	45	7.2	High	Needs expansion
9	Satun	45	9.4	High	
10	Phi Chit	45	11.4	High	
11	Kui Buri	45	14.4	High	
12	Chai Badan	43	12.0	High	
13	Sukhothai	42	8.2	High	Needs expansion
14	Sri Saket	41	9.8	High	
15	Pak Phanang	41	13.9	High	
16	Aranyaprathet	40	8.8	High	Needs expansion
17	Nong Don-Phrap.	38	11.1	High	
18	Den Chai	37	13.4	High	
19	Lang Suan	37	13.6	High	
20	Nang Rong	35	11.6	High	
21	Lom Sak	35	11.7	High	
22	Bang Pakong	35	11.7	High	
23	Hin Kong-Nong Kae	35	12.4	High	
24	Sawankalok	34	10.1	High	Needs expansion
25	Nanphong	33	17.2	Medium	
26	Panom Sarakarm	32	33.6	Medium	
27	Kumphawapi	31	11.8	Medium	Needs expansion
28	Phanat Nikom	29	19.0	Medium	Needs expansion
29	Yanta Khao	28	20.7	Medium	Needs expansion
30	Nakhonsawan O. N.	27	19.0	Medium	Needs expansion
31	Phimai	27	32.5	Low	
32	Rong Kwang	27	38.8	Low	
33	Sri Koraphum	25	29.4	Low	
34	Khon Buri	23	16.3	Low	Needs expansion
35	Lam Plai Mat	23	24.2	Low	Needs expansion
36	Wattana Nakhon	20	28.1	Low	
37	Huai Yot	20	44.3	Low	
38	Phan	19	20.9	Low	Needs expansion
39	Chatturat	14	57.4	Low	

values shown in Table 1, the score assigned was inversely proportional to the effort required to increase the source capacity and to improve the water quality respectively. Where problems regarding raw water quantity and quality were serious, recommendations were made separately to PWA for immediate action.

A computer model was developed to calculate the inputs needed for ranking the systems (i.e. physical data, demand, capacity, investment and operating costs, water sales, etc.) and to determine the priorities in accordance with the scoring system.

The results of the ranking procedure are summarized in Table 2, which shows the values of the total score and the respective average incremental cost (AIC) of water due to the upgrading; the latter being the most important ranking parameter.

With reference to Table 2, the waterworks can be also grouped in three levels of priority as follows:

1. *High Priority Group.* This group includes systems having a total score higher than 33 and AIC lower than 15 Baht/m³. A total of 24 systems was found in this group.
2. *Medium Priority Group.* This group includes systems with total score between 27 and 33 and AIC between 15 and 22 Baht/m³; the latter values being comparable with those generally found for major expansion projects. Five systems were found in this group.
3. *Low Priority Group.* This group includes systems with total score below 27 and AIC values higher than 22 Baht/m³. These systems, although in need of some improvement, show limited benefits compared to the capital requirements for the upgrading. The main reason for this is that the upgrading of these systems is not as urgent as for other systems and therefore in most cases the upgrading could be delayed for a while and further investigation is needed to determine the most suitable project development.