Appendix-5

Cost Estimation

Borne by the Recipient Country

Appendix 5 Cost Estimates Borne by RGC

Descriptions	US$ Base			Yen conversion		Riel conversion		Remarks
	Quantity	Unit cost	Sub-total	Y/$=121.79	Sub-total	R/$=3,800	Sub-total	
1. Land acquisition								
WTP site	10,000 m^2	7 $/m^2$	70,000	8,525,300		266,000,000		
Well sites	720 m^2	7 $/m^2$	5,040	613,822	9,139,122	19,152,000	285,152,000	9m by 10m/site, 8 sites
2. Dispatching of the Project Team	L.S.		5,000	608,950		19,000,000		MIME estimate
3. Employment for organization								<Quantity> Initial organization will be maneged by 33 staffs with 6 guards. <Unit Cost> Unit costs were referred to PPWSA' experience.
Director	1 person	400 $/person	400	48,716		1,520,000		
Deputy	3 person	300 $/person	900	109,611		3,420,000		
Section chief	4 person	200 $/person	800	97,432		3,040,000		
Staff	24 person	100 $/person	2,400	292,296		9,120,000		
Lab staff	1 person	150 $/person	150	18,269		570,000		
Guard	6 person	100 $/person	600	73,074	639,398	2,280,000	19,950,000	
4. Fencing works								
WTP	400 m	25	10,000	1,217,900		38,000,000		400m
well sites	304 m	25	7,600	925,604	2,143,504	28,880,000	66,880,000	38m/site, 8 sites
5. Primary power line	L.S.		70,000	8,525,300		266,000,000		MIME estimate
6. A/P commision fee	0.05 %		6,733	820,000		25,585,023		to Japan' costs
7. Replacement of house connections	500		2,791	339,916		10,605,800		
TTL			182,414	22,216,189		693,172,823		

Appendix-6

Other Relevant Data

6-1 Tourists and Visitors Projection in Siem Reap

6-2 Water Quality Examination

6-3 Groundwater Development Investigation

6-4 Job Descriptions and Necessary Qualifications

6-5 Distribution Pipeline Analysis

6-6 Groundwater Level and Land Settlement Monitoring Data

Appendix 6-1: Tourists and Visitors Projection in Siem Reap

Projection is made based on a data provided by the "Tourism Statistical Report" prepared by the Ministry of Tourism in 2002.

The Kingdom received 786,524 international visitors in year 2002, a 30 percent increase over year 2001. Out of the total international visitors, 453,148 or 58% of tourists visited Siem Reap and Cambodian visitors were 93,942 in 2002. Average stay of the international visitors in Cambodia was 5.8 days. The recorded occupancy rate of accommodation in 2002 was 50%.

In preparation of projection, the following are assumed:

1. The visitors' increase will be dependent on the capacity of accommodation (hotels) as well as transportation to Siem Reap.
2. A 30% increase rate will be kept in couple of years and gradually slow down from 30% in 2003 to 15% in 2004, and 7.5% in 2005 so that the estimated visitors' arrivals to Cambodia will reach at over 1.5 million or approximately full capacity of the present total capacity of accommodation. Then, in 2006 and afterwards, increase rate is assumed to be down at 2%.
3. Rate of visitors to Siem Reap against the total visitors to Cambodia is set at 58% yearly recorded in 2002
4. Average stay of visitors in Siem Reap will be 3 days, increased from 2 days estimated in the F/S in 2000 in view of the recent high increase rate of visitors.
5. Increase rate of Cambodian people to Siem Reap will be set in proportion to the GDP in Cambodia. The estimated GDP is set at 5% yearly in reference to the actual GDP growth rate in 2000 and 2001.
6. Daily numbers of visitors are calculated to be as 1/365 of yearly visitors.

As a result of the projection, visitors to Cambodia will reach at 1.709 million in the target year 2008. Out of that, 985 thousand of visitors will visit Siem Reap. While, yearly Cambodian visitors will be increased from 93,942 in 2002 to 125,891 in 2008. Thus, a yearly total of visitors is estimated over one million (1.111 million) which is equivalent to over 9 thousand visitors daily in 2008.

Tourists/Visitors Projection in Siem Reap

Year	Visitors arrival to Cambodia[1]	Increase ratio	Average length of stay	Hotel occupancy rate	Foreign visitors arrival to Siem Reap	Foreign visitors share to Sieam Reap	Cambodian visitors to Siem Reap	Cambodian visitors increase rate to Siem Reap	**TTL visitors to Siem Reap**	Average stay in Siem Reap	**Daily Nos of visitors**
			(days)								
1993	118,183	N/A	N/A	N/A							
1994	176,617	49.4%	N/A	N/A							
1995	219,680	24.4%	8	37.0%							
1996	260,489	18.6%	7.5	40.0%							
1997	218,843	-16.0%	6.4	30.0%							
1998	286,524	30.9%	5.2	30.0%							
1999	367,743	28.3%	5.5	44.0%							
2000	466,365	26.8%	5.5	45.0%						2	
2001	604,919	29.7%	5.5	48.0%						2	
2002	**786,524**	**30.0%**	**5.8**	**50.0%**	**453,148**	**58%**	**93,942**	**5.0%**	**547,090**	3	**4,497**
2003	1,022,649	30.0%	5.8		589,189	58%	98,639	5.0%	**687,828**	3	**5,653**
2004	1,329,444	15.0%	5.8		765,946	58%	103,571	5.0%	**869,517**	3	**7,147**
2005	1,528,861	7.5%	5.8		880,838	58%	108,750	5.0%	**989,588**	3	**8,134**
2006	1,643,525	2.0%	5.8		946,901	58%	114,187	5.0%	**1,061,088**	3	**8,721**
2007	1,676,396	2.0%	5.8		965,839	58%	119,896	5.0%	**1,085,735**	3	**8,924**
2008	**1,709,924**	**2.0%**	**5.8**		**985,156**	**58%**	**125,891**	**5.0%**	**1,111,047**	3	**9,132**
2009	1,744,122	2.0%	5.8		1,004,859	58%	132,186	5.0%	**1,137,045**	3	**9,346**
2010	1,779,005		5.8		1,024,956		138,795		**1,163,751**	3	**9,565**

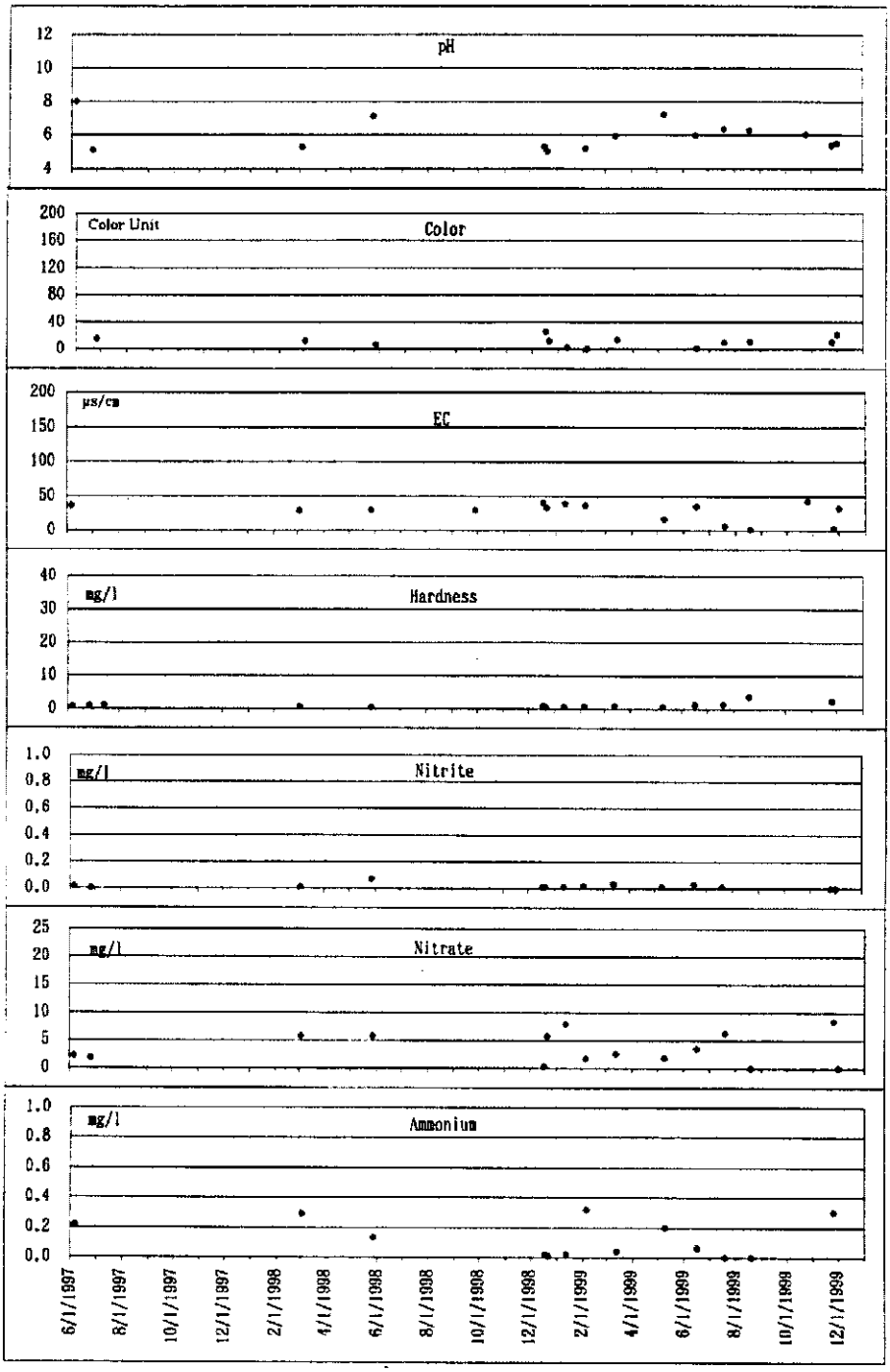
Notes:

1. Visitors increase ratio to Cambodia is assumed to be 30%, 15%, 7.5%, and 2% in year 2003, 2004, 2005, and afterwards, in reference to the existing hotel capacity in Cambodia. The visitors increase will be depend on the hotel capacity and transportation such as air flight. Therefore, The visitors arrivals to Cambodia will sharply reach at the 786,524 x 2 = approx. 1.6 million, the existing hotel capacity in the Project target year.
2. Based on the record in 2002, 58% of visitors to Cambodia visited Siem Reap.
3. Cambodian visitors to Siem Reap is assumed to grow at 5% annualy in reference to the GDP.
4. Average stay in Siem Reap Town is increased to 3 days from 2 days in FS based on interview from the hotels.

Appendix 6-2 Water Quality Examination Results

Water Quality Parameter (WHO 1998 Standard) / Sampling ID & Location		On-site Examination					Off-site Examination											
		potable meter			HACH 2000		Laboratory (PPWSA or Ministry of Environment)											
		Temp.	EC	pH	Fe	Mn	TH	Color	As	F	NO_2	NO_3	NH_4	Mg	Ca	Cl	SO_4	COD
		℃	μ S/cm	-	mg/L	mg/L	mg/L	TCU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
		-	-	-	0.3	0.5	-	15	0.01	1.5	3.0	50	1.5	-	-	250	250	-
WQ-01	Phnom Bok Hotel	24	220	5.0	0.25	0.01	4.4	4	0.000	0.04	0.000	0.10	0.00	4.4	0.0	8.5	0.0	7.61
WQ-02	Rama Hotel	24	220	5.4	**0.31**	0.12	4.4	3	0.000	0.08	0.001	0.10	0.01	4.4	0.0	7.0	1.0	11.42
WQ-03	Freedom Hotel	24	770	4.5	**0.57**	0.27	6.8	7	0.000	0.02	0.004	0.30	0.19	6.8	0.0	22.8	1.0	22.84
WQ-04	Siem Reap Town Hotel	22	490	6.1	**0.35**	0.02	4.4	5	0.000	0.00	0.003	0.20	0.04	2.4	2.0	11.5	2.0	30.46
WQ-05	Borei Angkor	24	450	4.6	**0.45**	0.03	4.0	5	0.000	0.02	0.002	0.10	0.09	4.0	0.0	14.5	1.0	34.27
WQ-06	Grand Hotel	23	250	4.8	**0.69**	0.04	4.2	8	0.000	0.00	0.001	0.20	0.03	4.2	0.0	7.5	1.0	53.31
WQ-07	Angkor Pich Hotel	24	270	4.8	**0.42**	0.02	4.0	8	0.000	0.00	0.002	0.40	0.08	4.0	0.0	8.0	3.0	15.23
WQ-08	Golden Angkor Hotel	23	500	4.5	**0.42**	0.01	4.4	6	0.000	0.02	0.002	0.20	0.10	4.4	0.0	14.5	1.0	19.04
WQ-09	Angkor Hotel	23	270	4.8	**0.43**	0.21	8.0	4	0.000	0.01	0.000	0.10	0.06	8.0	0.0	12.0	0.0	55.44
WQ-10	Prum Bayon Hotel	23	440	4.7	**0.57**	0.15	8.0	8	0.000	0.01	0.001	0.00	0.10	8.0	0.0	11.0	0.0	15.84
WQ-11	Hotel City Royal	24	320	4.5	**0.43**	0.10	16.0	10	0.000	0.00	0.000	0.10	0.07	16.0	0.0	8.5	0.0	11.88
WQ-12	Banteaysrey Hotel	24	350	4.7	**0.69**	0.03	8.0	10	0.000	0.03	0.000	0.00	0.08	8.0	0.0	14.0	0.0	23.76
WQ-13	APSARA Angkor Hotel	23	230	4.8	**0.35**	0.07	8.0	11	0.000	0.03	0.000	0.00	0.02	8.0	0.0	12.5	0.0	19.80
WQ-14	Hotel City Angkor	23	340	4.7	**0.59**	0.08	18.0	12	0.000	0.04	0.000	0.10	0.00	12.0	2.0	11.5	0.0	15.50
WQ-15	Princess Angkor Hotel	23	220	4.9	**0.42**	0.20	10.0	8	0.000	0.04	0.000	0.00	0.01	8.0	2.0	10.0	0.0	17.00
WQ-16	Nokon Phom Hotel	24	240	4.5	**0.65**	0.20	16.0	11	0.000	0.00	0.000	0.00	0.00	14.0	2.0	14.0	0.0	26.65
WQ-17	Angkor Reach Hotel	24	220	4.5	**0.53**	0.04	12.0	10	0.000	0.08	0.000	0.00	0.00	12.0	0.0	0.0	0.0	41.88
WQ-18	Test Well No. PP-99-02	24	220	4.8	**0.63**	0.01	4.0	14	0.000	0.04	0.000	0.20	0.04	2.6	0.0	11.5	1.0	15.23
WQ-19	House Construction Site	24	290	5.1	**0.47**	0.20	3.6	11	0.000	0.00	0.000	0.20	0.03	3.6	0.0	11.0	1.0	45.69
WQ-20	Test Well No. PP-99-01	25	390	5.0	**0.54**	0.25	2.6	14	0.000	0.01	0.002	0.40	0.08	4.0	0.0	14.0	3.0	15.00

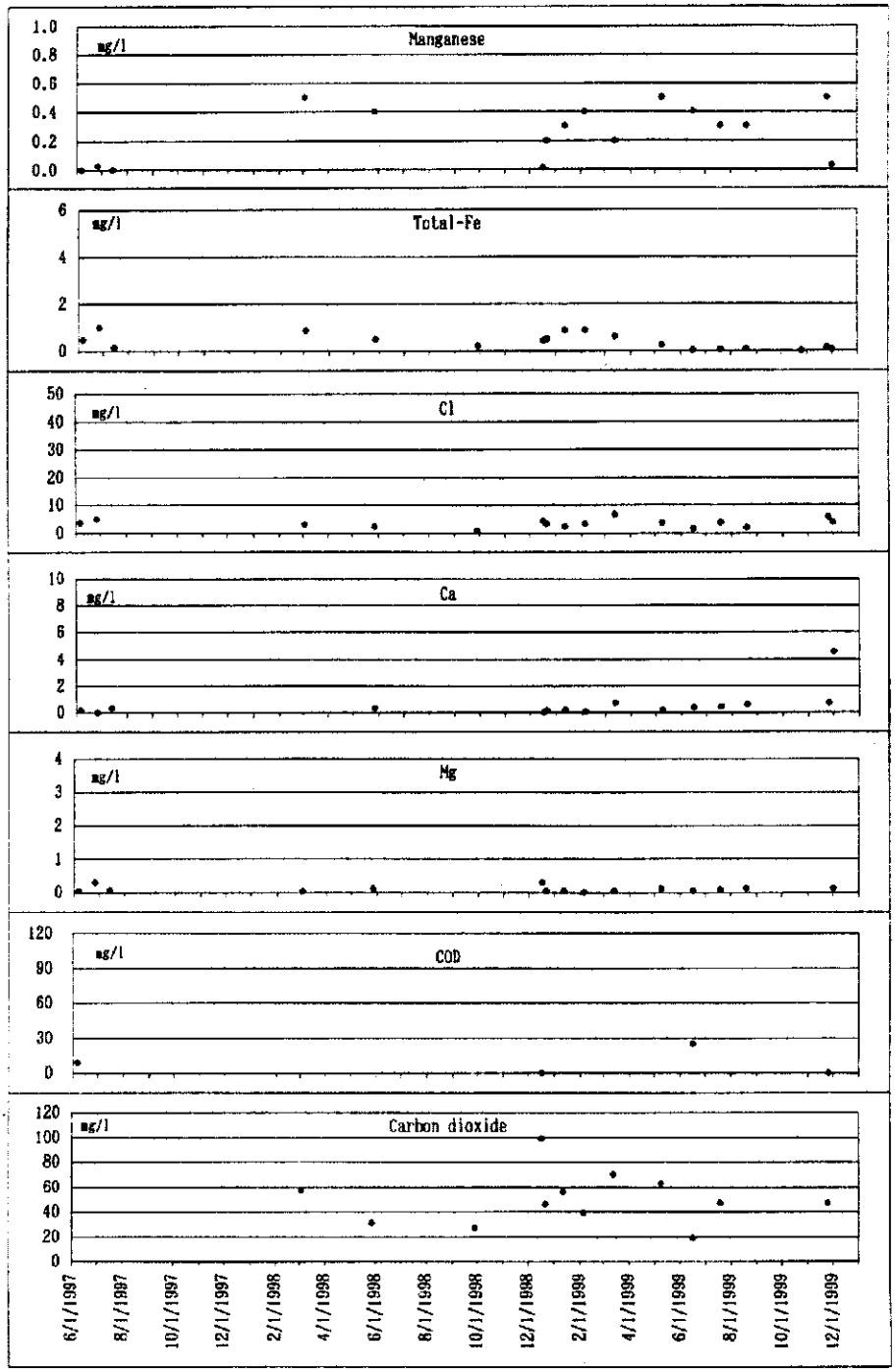
Note: Water samples were taken on 19 and 21 March 2003. Water samples were submitted to laboratories of PPWSA and MOE within same sampling-day.



The Study on Water Supply System for Siem Reap Region in Cambodia **Japan International Cooperation Agency**	**Figure 2.1** **Results After Data Screening (Groundwater from the Well No. WT4) (1/3)**

A2-1

Basic Design Study on the Project for Improvement of Water Supply System in Siem Reap Town
Appendix 6-2 Water Quality at WT-04; 1/2 (Source: M/P)



The Study on Water Supply System for Siem Reap Region in Cambodia	**Figure 2.1 Results After Data Screening (Groundwater from the Well No. WT4) (2/3)**
Japan International Cooperation Agency	

Basic Design Study on the Project for Improvement of Water Supply System in Siem Reap Town

Appendix 6-2

Water Quality at WT-04; 2/2 (Source: M/P)

Appendix 6-3 Groundwater Development Investigation

Part-1 Rehabilitation of Two Test Wells

(1) Background of Well Rehabilitation

Pumping tests were conducted during the first field survey at two existing test wells, namely PP-1 and PP-2. Unfortunately, the results indicated a significant decrease in the pumping rates at both test wells (see details under 2-2-2-5 (2) Pumping Test). Rehabilitation of the test wells was undertaken in the belief that the decrease in pumping rate was probably caused by increased resistance of the filtration layer in the annular space between the screen and the aquifer. The program of testing and rehabilitation are as follows:

- Completion (F/S) : December 1999
- Pumping Test (F/S) : December 1999
- Pumping Test (B/D Pre-rehabilitation) : March 2003
- Rehabilitation (B/D Third Field Survey) : July 2003
- Pumping Test (B/D Post-rehabilitation) : July 2003

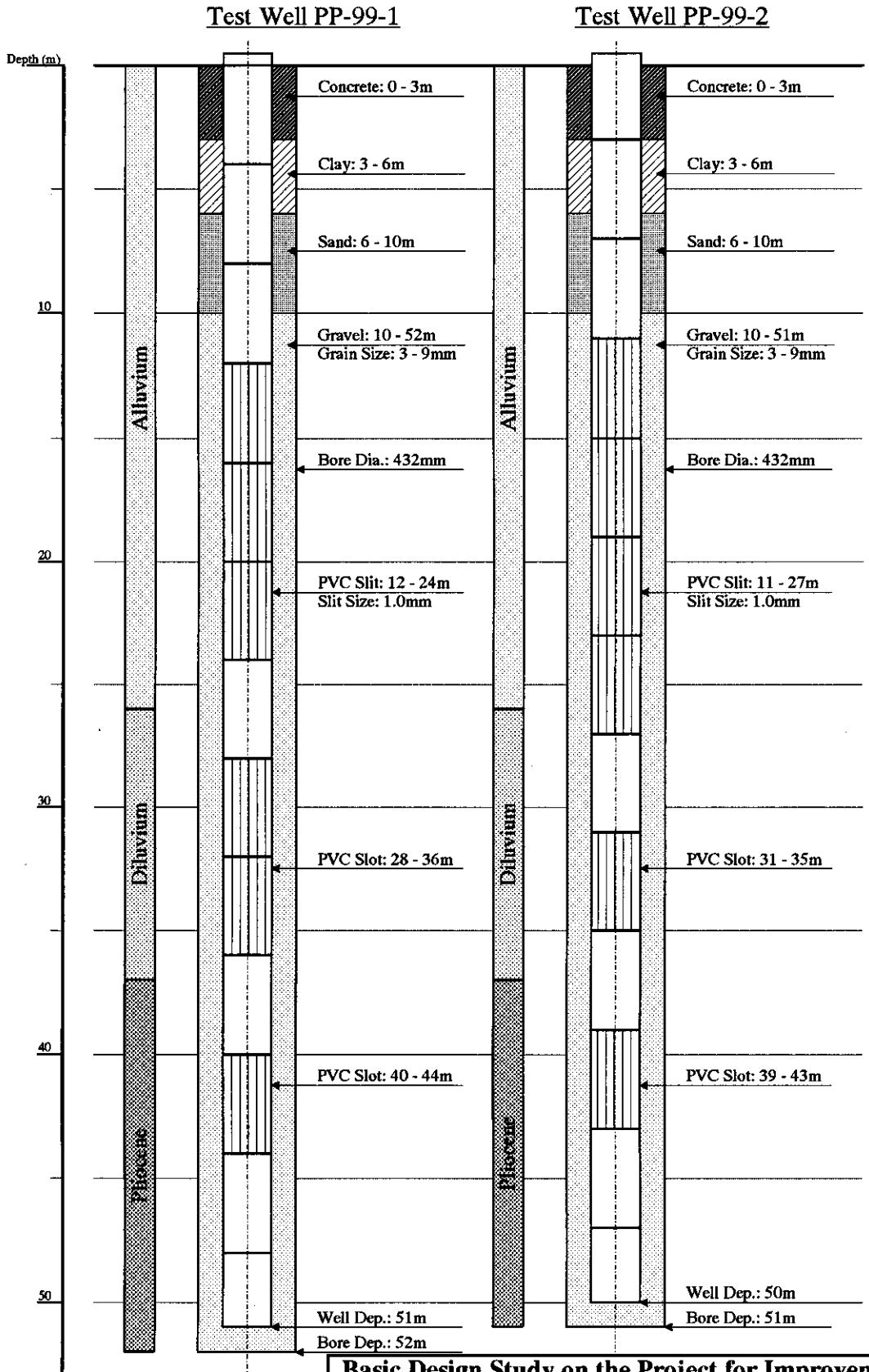
(2) Methodology and Specifications of Well Rehabilitation

The aim of the well rehabilitation was to remove the fine particles presumed to be present in the filtration layer. Rehabilitation methods adopted were physical washing and dredging, including repeat simple pumping tests on four occasions to verify the improvement achieved between each rehabilitation step. The specification and schedule of the rehabilitation exercise are shown in Table 6-3-1, the structures of the two test wells are shown in Figure 6-3-1.

TABLE 6-3-1 SPECIFICATION AND SCHEDULE OF REHABILITION

Description of Rehabilition		Schedule (July 2003)	
Work Process	Specification	PP-1*	PP-2
1 Test-1	4 steps x 30 minutes per step (2 hours)	18	9
2 Dredging	Air-lifting from the well bottom (until hit the bottom)	19	10
3 Jetting*	30 minutes per screen of each 1m length	19	10
4 Test-2	4 steps x 30 minutes per step (2 hours)	20	12
5 Sureging*	30 minutes per screen of each 1m length	21	14
6 Test-3	4 steps x 30 minutes per step (2 hours)	21	15
7 Intermittent Pumping	10 minutes pumping and 5 minutes recoery	22	16
8 Test-4	4 steps x 30 minutes per step (2 hours)	22	16
9 Dredging	Air-lifting from the well bottom (until hit the bottom)	22	17

Notes: Field works were done by 2 shifts. Jetting is pressurization method and Surging is reversed



Basic Design Study on the Project for Improvement of Water Supply System in Siem Reap Town

Figure 6-3-1
Test Well Structures (PP-1 & PP-2)

(3) Evaluation of Well Rehabilitation Effect

The rehabilitation effect is defined by the index of Specific Capacity (Q/sw; discharge divided by drawdown). Data for the four simple step drawdown tests are shown in Table 6-3-2, the related Q - sw graphs are shown in Figures 6-3-2 and 6-3-3.

TABLE 6-3-2 COMPARISON OF SIMPLE STEP DRAWDOWN TESTS

Period after	Test Well PP-1			Test Well PP-2		
	Q m^3/day	sw m	Sp.Cap. m^3/day/m	Q m^3/day	sw m	Sp.Cap. m^3/day/m
Dredging	128	0.83	154	318	2.61	122
	180	1.24	145	390	3.31	118
	240	1.94	124	450	4.02	112
	264	2.30	15	482	4.66	103
Jetting	408	3.76	109	175	0.99	176
	485	4.41	110	346	2.04	170
	562	5.26	107	486	3.02	161
	666	6.51	102	514	3.41	151
Surging	418	4.59	91	212	0.88	240
	473	5.67	83	360	1.81	199
	529	6.82	78	529	3.02	174
	562	7.57	74	600	4.13	145
Intermittent Pumping	374	2.85	131	268	0.86	312
	486	4.04	120	449	1.87	240
	580	5.14	113	580	2.90	200
	681	6.39	107	691	3.91	177

Note: Flow rate was measured by volumetric method.

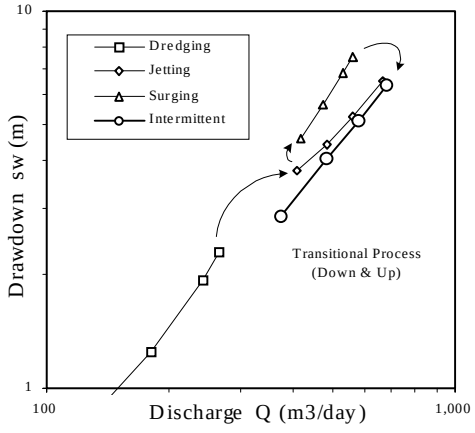


Figure 6-3-2 Q – sw Graph (PP-1)

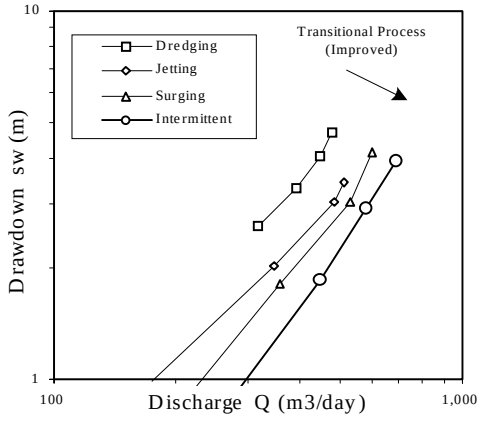


Figure 6-3-3 Q – sw Graph (PP-2)

The rehabilitation result for the two wells at a drawdown of 5m can be summarized as follows:

<Test Well PP-1>

Jetting : increased by 21% from pre-rehabilitation condition

Surging : decreased by 1% from pre-rehabilitation condition and by 18% from previous step

Intermittent Pumping : increased by 28% from pre-rehabilitation condition and by 29% from previous step

<Test Well PP-2>

Jetting : increased by 26% from pre-rehabilitation condition

Surging : increased by 31% from pre-rehabilitation condition and by4% from previous step

Intermittent Pumping : increased by 63% from pre-rehabilitation condition and by 24% from previous step

During the rehabilitation a large quantity of fine sand was discharged from the wells. At well PP-1, the well casing and concrete base sank 7cm during jetting and the ground level subsided by 1.2m as a result of surging. It is believed that the filtration layer was not properly developed during the original well construction and as a result the pumping performace was lower than that experienced pre-rehabilitation. On the other hand, the surrounding ground subsided 10cm during the implementation of the rehabilitation works and the overall well capacity increased significantly from 350 to 640m^3/day.

Part-2 Construction of New Test Well

(1) Background of New Test Well Construction

According to the results from electric prospecting carried out during the first field survey, the thickness of the Quaternary system was confirmed to be very thin in the area of the water treatment plant (WTP). Since the most economical arrangement is to construct the production wells close to the WTP, and since the potential of the Pliocene series which underlaid the Quaternary system had not been confirmed in the earlier feasibility study, a new test well PP-3 was constructed and tested during the third field survey.

(2) Location of Test Well PP-3

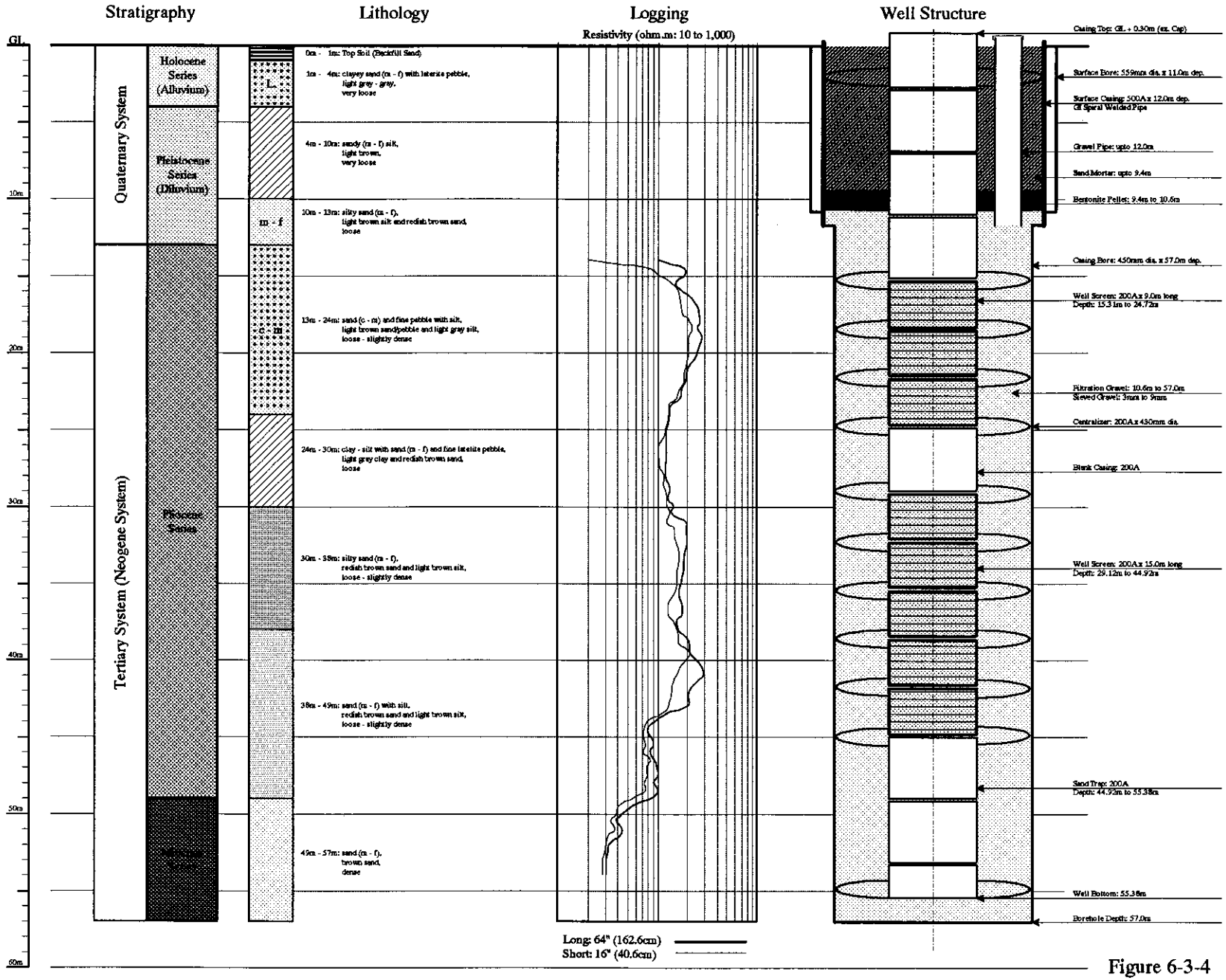
The distribution area of the Pliocene series is located near the WTP along the provincial road leading to West Baray Reservoir. The team selected the site for the test well at the junction of the provincial and national roads, because: (a) the well field is along the national road and (b) access is easier than at other potential sites in the rainy season.

The road system is currently being expanded and the eventual production well needs to be more than 13m (expansion of 9m + shoulder of 2m + open space of 2m from fence) from the present shoulder of the national road. The actual distance from the shoulder to test well PP-3 was 13.7m.

(3) Stratigraphy and Well Structure

The bottom depths of the Quaternary and Pliocene seriess are 13m and 49m respectively. These measurements agreed closely with the electric prospecting results of 11m and 50m. The upper portion of the Pliocene series was confirmed to be a good aquifer of coarse sand with pebbles, as encountered at both test wells PP-1 and PP-2, and at the observation well WT-4.

The well screens were designed to be 24m long, representing 67% of the formarion thickness (36m) from the logging data and observation of soil samples. The well completion record is shown in Figure 6-3-4.



APPEND-52

Materials

Surface Casing: GI 500A, Spiral Welded, 7.9t
Welding by LB-52
Gravel Pipe: GI 65A, Schedule 20
Threaded Coupling

Blank Casing: uPVC 200A, 13.5 Mpa, 4.0m/pc
uPVC Coupling by Solvent Cement
uPVC Threaded Adapter (Male & Female)
Well Screen: SUS304 200A, Wire, Slot 1.0mm, 3.0m/pc
Threaded Coupling (Male & Female) at both ends

Centralizer: SUS304 200A x 430mm, Lantern
Bottom & Cap: uPVC 200A with Plate by Welding

Step Drawdown Test

Pump: Submersible Motor, 7.5kW x 80A
Riser Pipe: GI 80A with Threaded Coupling
Discharge: Flow Meter & Volumetric (Dram Can 55gal.)
Measuring Point: GL + 0.65m)
SWL: MP - 1.37m
Date of Test: 28 July 2003

Step	Q (m3/day)	sw (m)	Q/sw (m3/day/m)
1	492	1.48	332
2	653	2.11	309
3	805	2.76	292
4	937	3.38	277
5	1,092	4.17	262

Water Quality

Sampling Date: 28 July 2003
Analysis Date: 28 July 2003
Kit: Meter (EC, pH), Pack (Fe, Mn, Si), Labo. (Aik.)

Electric Conductivity	240	μS (m.mho/cm)
pH	7.2	-
Ferrite	0.2	mg/L
Mnganese	<0.1	mg/L
Silica	10	mg/L
Alkalinity	8	mg/L

Construction Schedule

Rig: Tone Top-300 (NS 500 Mud Pump)/ Track Mount
Drag Bit 22"
Drag Bit 17-1/2"
Drill Color 6" x 6m
Drill Pipe 3-1/2" ODF

12 July 2003: Drilling 22" x 11m
13 July 2003: Surface Casing 500A x 12m
16 July 2003: Drilling 17-1/2" x 57m
17 July 2003: Logging, Well Casings, Gravel Pack
27 July 2003: Well Development
29 July 2003: Pump Base

Figure 6-3-4 Completion Records (Test Well PP-3)

Part-3 Estimation of Total Intake Amount

Planned intake amount was estimated to add the water amount for operation and maintenance (O/M) of WTP to maximum water supply amount (8,000m^3/day). Additional water amount will be consumed for water treatment process. Minimal requirement water for O/M is summed up 570m^3/day with condition below. It is estimated at 7.2% of maximum daily water supply amount.

- Drainage from Oxidation Tank: 30m^3/day
- Cleaning Water for Filtration Tank: 520m^3/day (surface cleaning 95m^3/day + backwashing 425m^3/day)
- Water Supply to WTP: 20m^3/day
- Others (over-flow, etc.): 0m^3/day

For water supply planning, common rate of O/M water is 10% of maximum daily water supply amount. In this regard, necessary intake amount of raw water source is estimated at 8,800m^3/day.

Appendix 6-4 Job Description & Necessary Qualifications

Proposed job descriptions for the Siem Reap Water Supply System

Job Position	No. of staff	Job descriptions	Qualification
Management			
Director of the Waterworks	1	- Supervising all activities of the waterworks - Have responsibility of all activities by the waterworks - Formulate corporate plan	- University Graduate or more - Experience of manage some organization with more than 30 personnel - Prefer to have more than 3 years experience of water supply system as senior manager or chief engineer
Administration and Finance Division			
Deputy Director for Administration and Finance	1	- Manage administration and financial activities - Conduct communication, correspondence, inquiry, questionnaires, response to question	- University graduate or more - Prefer to have working experience as manager of administration section for more than 5 years in public or private company of more than 30 employees
General Affair/ Legal Affair	1	- General affairs including communication, correspondence, inquiry, questionnaires, response to questions for assist to the Deputy Director for Administration and Finance - Legal matters with communication and reporting to authorities concerned, manage of official and contract documents.	- High school graduate or more - Knowledge and working experience of legal affairs - Prefer to have working experience in general affair/legal affair section of public or private company for more than 3 years
Personnel and Training	1	- Personnel affairs including recruitment, rewards and penalties, holidays and rest control, and payroll - Human resources development matters including training planning and arrangement of training	- High school graduate or more - Prefer to have working experience of human resources management/human resources development section in public or private company for more than 3 years
Accounting Section			
Accountant and section chief	1	- Formulate budget planning and cost management - Manage accounting including book keeping, ledgers management, financial reporting, and other financial activities - Manage general ledger - Manage payment and account payable ledger	- College graduate or more - Prefer to have working experience as chief accountant in public or private company for more than 3 years
Treasurer	1	- Manage income cash - Manage account receivable ledger - Assist accountant	- Collage graduate or more - Have knowledge of accounting - Prefer to have working experience in accounting section of public or private company for more than 3 years

continued

Customer Services Division			
Deputy Director for Customer Services	1	- Manage customer service activities	- University graduate - Prefer to have working experiences as section chief of customer services of utility service company for more than 3 years
Customer services	2	- Accept application of new connection and arrange the new house connection - Manage customer ledgers - Accept customer complains and arrange the investigation - Conduct other customer relation including PR (Public Relations), coordination of campaign and public hygiene education	- Not required specific qualification - Prefer to have training experience of computer operation or secretary, or business administration in college or high school
Meter reading and collection	4	- Meter reading (reporting consumption) - Distribution of water bill to customer - Bill collection	- Not required specific qualification
Billing and Computer Section			
Billing and computer section chief	1	- Manage computer system (hardware, software and data) - Manage data input for water consumption and collection of customers by key punchers - Analysis of customer consumption behavior by computer - Prepare water bill by computer - Prepare monthly performance report - Provide necessary information using computer for management	- Technical school (computer) graduate or more - Knowledge and experience of system operation/management - Prefer to have knowledge and experience of programming and system development - Prefer to have working experience as computer section chief for more than 3 years
Computer operator/key puncher	2	- Data input of water consumption - Data input of collection - Data input of others including performance data - Check of data - Operating computer system	- Not required specific qualification - Prefer to have training experience of computer operation and/or capability to manipulate MS-Word, EXCEL, MS-ACCESS and others
Engineering Division			
Deputy Director for Engineering	1	- Manage water production, distribution and quality control activities - Manage planning of network expansion - Manage civil works for house connection, leakage repair and network expansion	- University graduate (engineering including civil engineering, hydro engineering) - Prefer to have working experience as chief engineer or senior engineer in water supply system for more than 3 years
Planning section chief	1	- Planning of waterworks (preliminary and detail design of expansion works) - Cost analysis and cost estimating for expansion works - Prepare tender documents - Maintain pipeline network ledger	- Technical collage graduate or more - Prefer to have working experience as planner of utility company for more than 3 years

continued

Production Section			
Production section chief	1	- Manage water intake, deep well facility and purification plan	- University graduate (engineering including civil engineering, hydro engineering) - Prefer to have working experience as chief engineer or manager of purification plant for more than 3 years
Purification plant operator	16 one team 4 member X four teams 3 shifts	- Operate intake from deep wells - Operate purification plant - Monitoring and maintain deep wells, intake facilities and purification plant - Receive and manage emergency accidents during night - Maintenance and repair facilities and equipments for water intake, purification and booster - Patrolling for monitoring water supply system	- Not required specific qualification - Prefer to have working experience as operator of purification plant
Laboratory	1	- Conduct quality management of supply water - Conduct sampling tests of raw water and tap water	- University graduate (chemistry) - Prefer to have working experience as chemical engineer of water supply system or other chemical industry
Distribution Division			
Distribution Division Chief	1	- Manage water distribution system - Manage civil works for expansion of network - Manage civil work for new house connection - Manage civil works for disconnection - Manage detection of leakage and leakage repair - Manage detection of illegal water use	- University graduate (engineering including civil engineering, hydro engineering) - Prefer to have working experience as chief civil engineer of water supply system or chemical plant, or utility company
Distribution operator	3	- Monitoring water distribution - Supervising civil works for expansion of network by contractor - Supervising civil work for new house connection by constructor - Conduct disconnection - Detection of leakage and leakage repair - Stock control of materials for production, construction and repair - Detection of illegal water use	- Not required specific qualification - Prefer to have working experience as civil engineer or plumber

Appendix 6-5 Distribution Pipeline Analysis

1. Pipeline Route Indicators

Pipe No.			Length	Diameter	Flow	Velocity	Hydraulic Grade	Head Loss
ID	from	to	m	nominal	cu.m/s	m/s	‰	m
1	1	2	74	200	1,323	0.5	2.0	0.1
2	2	56	100	150	927	0.6	4.1	0.4
3	2	3	311	100	295	0.4	3.5	1.1
4	3	4	141	100	181	0.3	1.5	0.2
5	4	12	148	150	-144	-0.1	-0.1	0.0
6	10	12	170	100	383	0.6	5.8	1.0
7	10	11	92	100	113	0.2	0.6	0.1
8	9	10	325	150	603	0.4	1.9	0.6
9	1	9	64	200	-1,467	-0.5	-2.4	-0.1
10	9	19	92	450	-3,725	-0.3	-0.3	0.0
11	19	319	20	250	-265	-0.1	0.0	0.0
12	20	319	217	150	-663	-0.4	-2.2	-0.5
13	20	55	313	150	373	0.2	0.8	0.2
14	20	21	495	100	100	0.1	0.5	0.2
15	21	22	64	100	-31	-0.1	-0.1	0.0
16	22	23	318	100	-89	-0.1	-0.4	-0.1
17	19	24	99	250	-251	-0.1	0.0	0.0
18	24	25	85	250	-185	0.0	0.0	0.0
19	25	26	120	250	-104	0.0	0.0	0.0
20	26	27	113	250	-131	0.0	0.0	0.0
21	27	45	265	150	-348	-0.2	-0.7	-0.2
22	27	28	92	250	189	0.0	0.0	0.0
23	28	43	438	150	-373	-0.2	-0.8	-0.3
24	44	45	166	150	421	0.3	0.9	0.2
25	44	46	127	150	-507	-0.3	-1.3	-0.2
26	46	47	113	150	-546	-0.4	-1.5	-0.2
27	47	49	92	150	-938	-0.6	-4.2	-0.4
28	49	51	88	150	-968	-0.6	-4.5	-0.4
29	53	351	336	150	-96	-0.1	-0.1	0.0
30	51	52	166	250	3,268	0.8	3.5	0.6
31	19	52	254	250	-3,243	-0.8	-3.5	-0.9
32	24	50	262	100	-92	-0.1	-0.4	-0.1
33	25	48	265	100	-116	-0.2	-0.6	-0.2
34	47	48	163	100	276	0.4	3.1	0.5
35	48	50	92	100	119	0.2	0.7	0.1
36	45	48	237	100	28	0.0	0.1	0.0
37	28	29	85	200	507	0.2	0.3	0.0
38	29	30	269	200	454	0.2	0.3	0.1
39	30	31	95	75	207	0.5	7.5	0.7
40	31	36	92	75	-12	0.0	0.0	0.0
41	30	36	106	75	194	0.5	6.7	0.7
42	31	32	85	75	166	0.4	5.0	0.4
43	36	37	85	75	129	0.3	3.1	0.3
44	32	37	95	150	-574	-0.4	-1.7	-0.2
45	37	38	113	75	125	0.3	3.0	0.3
46	33	38	88	75	-113	-0.3	-2.5	-0.2
47	38	41	180	75	-145	-0.4	-3.9	-0.7
48	33	34	92	75	52	0.1	0.6	0.1
49	38	39	88	75	103	0.3	2.1	0.2
50	34	39	92	75	-68	-0.2	-1.0	-0.1

Note: Refered to Figure 2.18 Proposed Distribution Network

Pipe No.			Length	Diameter	Flow	Velocity	Hydraulic Grade	Head Loss
ID	from	to	m	nominal	cu.m/s	m/s	‰	m
51	39	40	57	75	-57	-0.1	-0.7	0.0
52	34	35	92	75	70	0.2	1.0	0.1
53	35	40	155	100	-181	-0.3	-1.4	-0.2
54	40	41	170	100	-352	-0.5	-4.9	-0.8
55	41	42	219	150	-569	-0.4	-1.7	-0.4
56	42	43	92	150	-1,275	-0.8	-7.4	-0.7
57	35	54	304	75	60	0.2	0.8	0.2
58	4	5	244	100	113	0.2	0.6	0.1
59	5	6	131	100	52	0.1	0.1	0.0
60	6	7	85	100	-17	0.0	0.0	0.0
61	7	8	99	100	-58	-0.1	-0.2	0.0
62	12	13	226	100	133	0.2	0.8	0.2
63	13	14	78	100	60	0.1	0.2	0.0
64	13	15	134	100	12	0.0	0.0	0.0
65	6	15	127	100	8	0.0	0.0	0.0
66	15	16	99	100	-81	-0.1	-0.3	0.0
67	7	16	152	100	-62	-0.1	-0.2	0.0
68	16	17	120	100	-246	-0.4	-2.5	-0.3
69	8	17	205	100	-189	-0.3	-1.6	-0.3
70	17	18	110	100	183	0.3	1.5	0.2
71	100	101	4,050	500	9,636	0.6	0.9	3.6
72	101	102	1,000	450	6,994	0.5	0.8	0.8
73	102	103	1,000	400	6,932	0.6	1.4	1.4
74	103	104	1,000	400	6,859	0.6	1.4	1.4
75	104	105	400	350	6,747	0.8	2.6	1.1
76	105	106	300	350	6,636	0.8	2.5	0.8
77	106	107	330	300	4,619	0.8	2.8	0.9
78	51	107	80	300	-4,306	-0.7	-2.4	-0.2
79	106	108	750	250	1,888	0.5	1.3	1.0
80	107	109	640	100	164	0.2	1.2	0.8
81	108	109	230	200	1,707	0.6	3.1	0.7
82	43	109	180	200	-1,683	-0.6	-3.0	-0.6
83	35	110	290	75	58	0.1	0.7	0.2
84	110	111	550	75	-1	0.0	0.0	0.0
85	35	111	540	75	41	0.1	0.4	0.2
86	18	112	600	75	60	0.2	0.8	0.5
87	18	113	200	75	63	0.2	0.8	0.2
88	8	114	540	75	67	0.2	0.9	0.5
89	17	32	95	150	-688	-0.5	-2.4	-0.2
90	4	115	250	75	107	0.3	2.2	0.6
91	21	55	200	100	0	0.0	0.0	0.0
92	55	116	360	150	226	0.1	0.3	0.1
93	116	117	470	150	122	0.1	0.1	0.1
94	117	118	390	100	0	0.0	0.0	0.0
95	21	118	630	100	69	0.1	0.3	0.1
96	9	309	20	150	1,550	1.0	10.6	0.2
97	56	120	330	150	642	0.4	2.1	0.7
98	120	121	370	150	488	0.3	1.3	0.5
99	121	122	300	150	370	0.2	0.8	0.2
100	122	123	240	150	218	0.1	0.3	0.1

Pipe No.			Length	Diameter	Flow	Velocity	Hydraulic Grade	Head Loss
ID	from	to	m	nominal	cu.m/s	m/s	‰	m
101	123	124	430	150	114	0.1	0.1	0.0
102	43	44	191	150	-46	0.0	0.0	0.0
103	101	301	20	250	2,621	0.6	2.3	0.1
104	301	302	1,000	250	2,559	0.6	2.2	2.2
105	302	303	1,000	250	2,445	0.6	2.1	2.1
106	303	304	1,000	250	2,334	0.6	1.9	1.9
107	304	305	400	250	1,592	0.4	0.9	0.4
108	304	501	1,000	150	555	0.4	1.6	1.6
109	501	502	1,000	150	354	0.2	0.7	0.7
110	305	306	300	250	1,463	0.3	0.8	0.2
111	306	307	300	200	1,358	0.5	2.0	0.6
112	307	351	80	200	1,210	0.5	1.7	0.1
113	351	352	166	200	972	0.4	1.1	0.2
114	319	352	254	200	-950	-0.3	-1.1	-0.3
115	23	309	360	100	-147	-0.2	-1.0	-0.3
116	309	401	64	200	1,301	0.5	1.9	0.1
117	401	402	74	200	1,200	0.4	1.6	0.1
118	356	402	100	150	-957	-0.6	-4.3	-0.4
119	119	402	280	75	-99	-0.3	-1.9	-0.5
120	320	356	330	150	-587	-0.4	-1.8	-0.6
121	320	321	370	150	472	0.3	1.2	0.4
122	321	322	300	150	321	0.2	0.6	0.2
123	322	323	240	150	215	0.1	0.3	0.1
124	323	324	430	150	109	0.1	0.1	0.0
125	42	503	180	150	632	0.4	2.0	0.4
126	37	503	180	150	-631	-0.4	-2.0	-0.4
127	41	503	120	75	-1	0.0	0.0	0.0
128	54	504	300	75	30	0.1	0.2	0.1

2. Network Connection Indicators

Pipeline Connection No. in Fig.		Ground Level masl	Supply Amount cu.m/day	Dynamic Water Level masl	Dynamic Head m	Static Head m
1	1	14.5	143.9	32.2	17.7	29.5
2	2	14.8	101.4	32.0	17.2	29.2
3	3	14.0	113.3	30.9	16.9	30.0
4	4	13.7	105.1	30.7	17.0	30.3
5	5	13.8	60.8	30.6	16.8	30.2
6	6	13.7	60.8	30.6	16.9	30.3
7	7	13.6	103.3	30.6	17.0	30.4
8	8	13.5	64.0	30.6	17.1	30.5
9	9	14.5	104.5	32.3	17.8	29.5
10	10	14.3	106.9	31.7	17.4	29.7
11	11	14.3	113.3	31.7	17.4	29.7
12	12	14.0	105.1	30.8	16.8	30.0
13	13	13.9	60.8	30.6	16.7	30.1
14	14	13.9	60.8	30.6	16.6	30.1
15	15	13.9	102.7	30.6	16.7	30.1
16	16	13.9	102.7	30.6	16.7	30.1
17	17	13.9	69.0	30.9	17.0	30.1
18	18	13.5	60.2	30.7	17.2	30.5
19	19	14.1	33.8	32.4	18.3	29.9
20	20	14.1	189.0	31.9	17.8	29.9
21	21	14.5	61.8	31.6	17.1	29.5
22	22	14.5	58.7	31.6	17.1	29.5
23	23	14.9	57.1	31.8	16.9	29.1
24	24	14.2	26.9	32.4	18.2	29.8
25	25	13.9	35.6	32.4	18.5	30.1
26	26	13.9	26.9	32.4	18.5	30.1
27	27	13.9	26.9	32.4	18.5	30.1
28	28	14.0	56.0	32.4	18.4	30.0
29	29	14.0	52.6	32.3	18.3	30.0
30	30	14.1	53.0	32.3	18.2	29.9
31	31	14.1	52.6	31.6	17.4	29.9
32	32	14.2	52.6	31.1	16.9	29.8
33	33	14.2	61.7	30.7	16.5	29.8
34	34	14.1	49.9	30.7	16.6	29.9
35	35	13.9	92.6	30.6	16.7	30.1
36	36	14.1	52.6	31.6	17.5	29.9
37	37	14.1	61.2	31.3	17.2	29.9
38	38	14.1	53.0	30.9	16.9	29.9
39	39	14.1	92.3	30.8	16.7	29.9
40	40	14.1	113.3	30.8	16.7	29.9
41	41	14.1	73.9	31.6	17.6	29.9
42	42	14.1	73.4	32.0	17.9	29.9
43	43	14.1	80.8	32.7	18.6	29.9
44	44	14.1	39.4	32.7	18.6	29.9
45	45	13.9	44.4	32.5	18.6	30.1
46	46	14.0	39.2	32.9	18.9	30.0
47	47	13.9	115.4	33.0	19.1	30.1
48	48	14.5	69.4	32.5	18.0	29.5
49	49	13.6	30.5	33.4	19.8	30.4
50	50	14.2	26.9	32.5	18.3	29.8
51	51	13.4	69.0	33.8	20.4	30.6
52	52	14.1	25.1	33.2	19.1	29.9
53	53	14.3	96.1	32.8	18.5	29.7

Pipeline Connection No. in Fig.		Ground Level masl	Supply Amount cu.m/day	Dynamic Water Level masl	Dynamic Head m	Static Head m
54	54	13.8	30.1	30.4	16.6	30.2
55	55	14.6	146.8	31.6	17.0	29.4
56	56	14.6	284.5	31.6	17.0	29.4
57	101	14.0	20.3	40.4	26.4	30.0
58	102	14.0	62.6	39.6	25.6	30.0
59	103	14.0	72.8	38.1	24.1	30.0
60	104	13.9	111.6	36.7	22.8	30.1
61	105	13.9	111.6	35.7	21.8	30.1
62	106	13.8	128.5	34.9	21.1	30.2
63	107	13.7	148.3	34.0	20.3	30.3
64	108	13.5	181.2	34.0	20.5	30.5
65	109	13.5	188.4	33.3	19.8	30.5
66	110	13.2	59.9	30.4	17.2	30.8
67	111	12.7	39.5	30.4	17.7	31.3
68	112	13.0	60.2	30.3	17.3	31.0
69	113	12.9	63.4	30.6	17.7	31.1
70	114	12.6	67.0	30.1	17.5	31.4
71	115	13.0	107.6	30.2	17.2	31.0
72	116	15.0	104.3	31.5	16.5	29.0
73	117	15.8	121.8	31.5	15.7	28.2
74	118	15.1	70.6	31.5	16.4	28.9
75	119	13.4	99.6	31.3	17.9	30.6
76	120	14.6	153.7	30.9	16.3	29.4
77	121	14.6	118.6	30.5	15.9	29.4
78	122	14.8	151.6	30.3	15.4	29.2
79	123	14.8	104.0	30.2	15.4	29.2
80	124	15.0	114.6	30.1	15.2	29.0
81	301	14.0	62.6	40.4	26.4	30.0
82	302	14.0	113.9	38.1	24.1	30.0
83	303	14.0	111.2	36.0	22.1	30.0
84	304	13.9	186.6	34.2	20.3	30.1
85	305	13.9	129.1	33.8	19.9	30.1
86	306	13.8	104.8	33.6	19.8	30.2
87	307	13.7	148.3	32.9	19.2	30.3
88	309	14.5	101.4	32.1	17.6	29.5
89	319	14.1	22.0	32.4	18.3	29.9
90	320	14.6	115.4	30.9	16.3	29.4
91	321	14.6	150.6	30.4	15.8	29.4
92	322	14.8	106.0	30.3	15.4	29.2
93	323	14.8	106.0	30.2	15.4	29.2
94	324	15.0	109.6	30.1	15.2	29.0
95	351	13.4	142.0	32.8	19.4	30.6
96	352	14.1	22.0	32.6	18.5	29.9
97	356	14.6	369.5	31.4	16.8	29.4
98	401	14.5	101.4	32.0	17.5	29.5
99	402	14.8	143.9	31.9	17.1	29.2
100	501	15.8	201.0	32.6	16.8	28.2
101	502	15.8	354.0	31.9	16.1	28.2
102	503	14.1	0.0	31.6	17.6	29.9
103	504	13.8	30.1	30.3	16.5	30.2

Appendix 6-6 Groundwater Level & Land Settlement Monitoring Data

Conditions of Graphic Monitoring Data at each Station

Monitoring Station		Equipment Installed	Aquifer Depth		Data Period (2003)		Figure	
ID	Location		shallow	deep	from	to	No.	Interval
WT-03	NW-side of West Baray	Water Table	20-32m	-	12 Aug.	14 Aug.	*Fig. 1-1*	hourly
					12 Aug.	8 Oct.	*Fig. 1-2*	daily
WT-04	W-side of Well Field	Water Table	13-25m	-	11 Aug.	13 Aug.	*Fig. 2-1*	hourly
					11 Aug.	9 Oct.	*Fig. 2-2*	daily
WT-05	SRWSS (Town Proper)	Water Table	-	42-54m	13 Aug.	15 Aug.	*Fig. 3-1*	hourly
					13 Aug.	9 Oct.	*Fig. 3-2*	daily
WT-06	NE-side of Angkor Tom	Water Table	13-25m	-	10 Aug.	12 Aug.	*Fig. 4-1*	hourly
					10 Aug.	30 Sep.	*Fig. 4-2*	daily
WT-07	E-side of Angkor Tom	Water Table	-	44-56m	25 Aug.	27 Aug.	*Fig. 5-1*	hourly
					10 Aug.	2 Sep.	*Fig. 5-2*	daily
WT-08	Hotel Zone	Water Table	-	67-79m	16 Aug.	18 Aug.	*Fig. 6-1*	hourly
					16 Aug.	9 Oct.	*Fig. 6-2*	daily
LTa-1&2	SOS (N-side of Town)	Water Table	LTa-2 27-35m	LTa-1 64-72m	10 Aug.	12 Aug.	*Fig. 7-1*	hourly
					10 Aug.	9 Oct.	*Fig. 7-2*	daily
		Land Table			10 Aug.	12 Aug.	*Fig. 7-3*	hourly
					10 Aug.	9 Oct.	*Fig. 7-4*	daily
LTb-1&2	W-side of Angkor Wat	Water Table	LTb-2 32-40m	LTb-1 65-73m	15 Aug.	17 Aug.	*Fig. 8-1*	hourly
					15 Aug.	29 Sep.	*Fig. 8-2*	daily
		Land Table			15 Aug.	17 Aug.	*Fig. 8-3*	hourly
					15 Aug.	29 Sep.	*Fig. 8-4*	daily

Remark: Graphic figures show the hourly/daily fluctuations of water/land tables at each monitoring station.

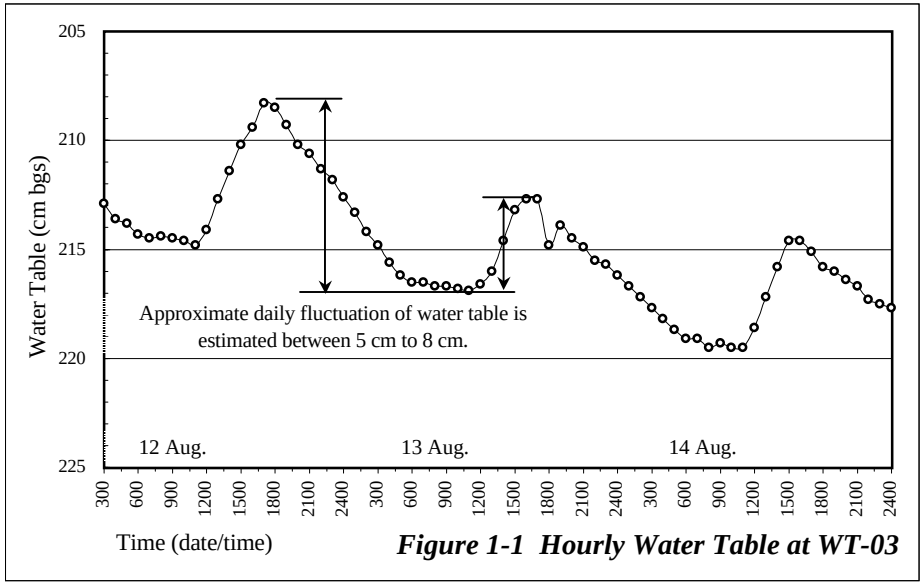


Figure 1-1 Hourly Water Table at WT-03

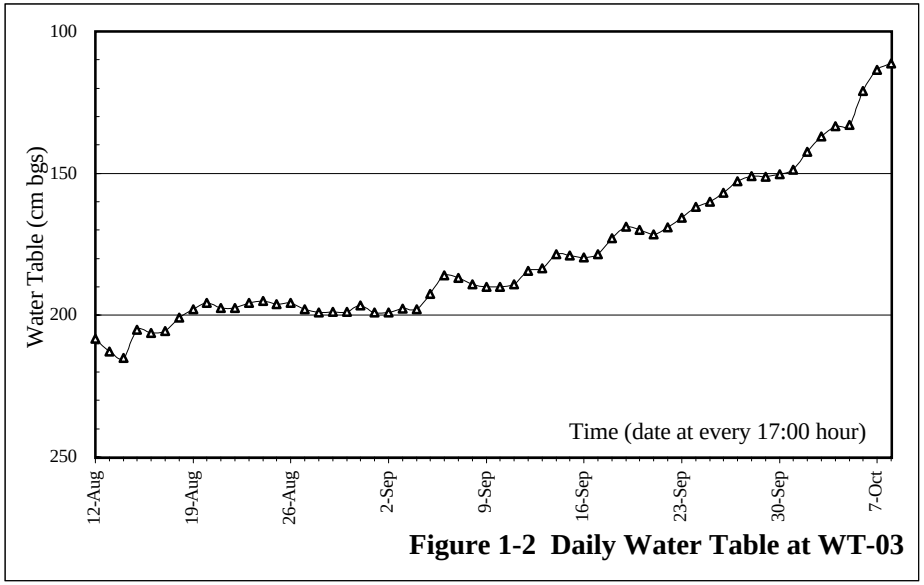


Figure 1-2 Daily Water Table at WT-03

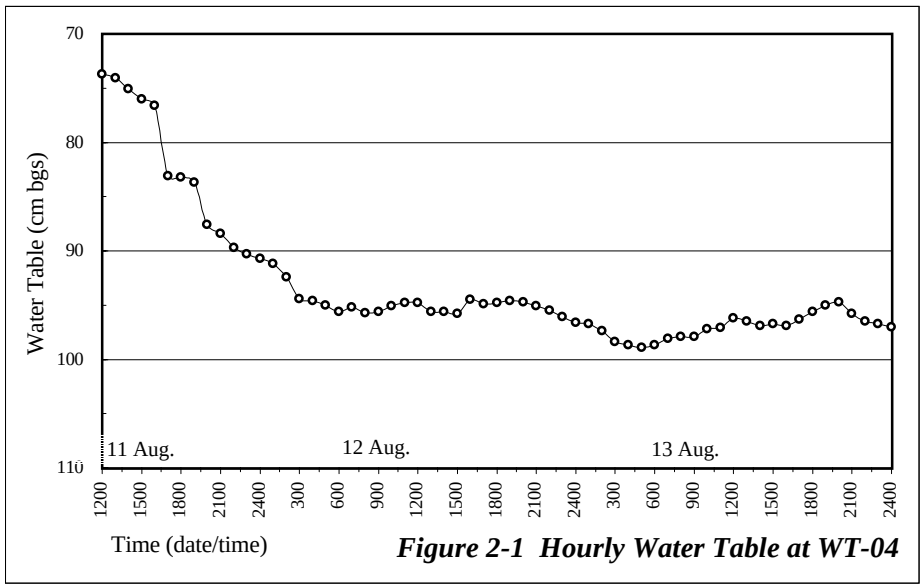


Figure 2-1 Hourly Water Table at WT-04

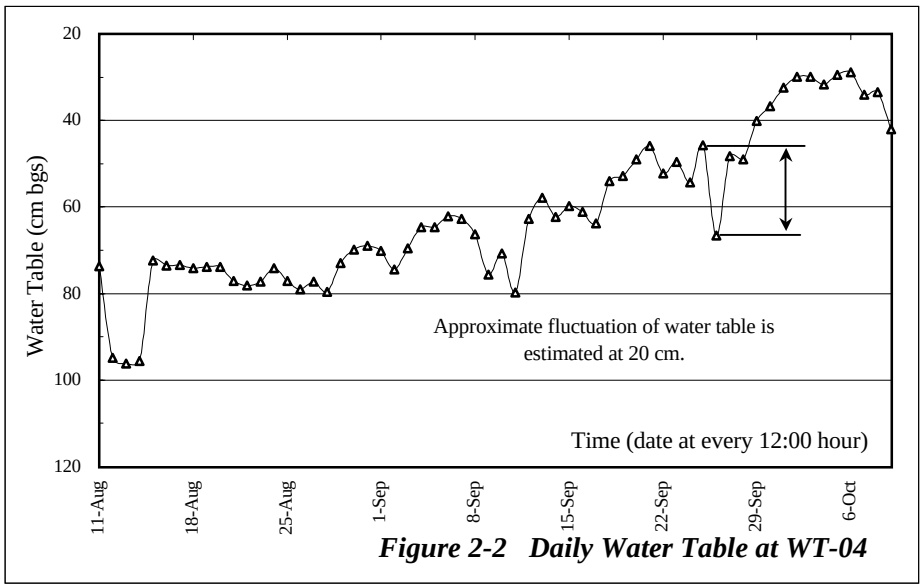


Figure 2-2 Daily Water Table at WT-04

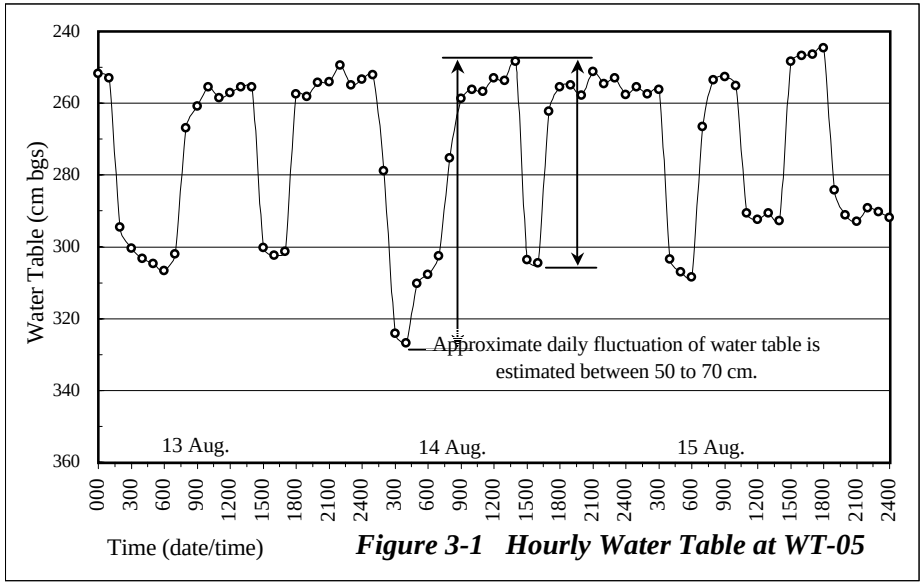


Figure 3-1 Hourly Water Table at WT-05

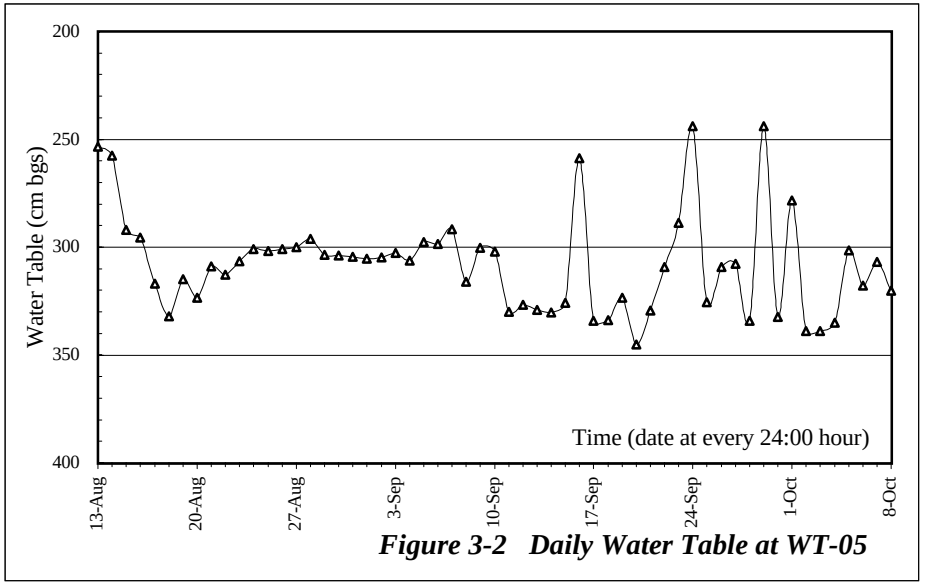


Figure 3-2 Daily Water Table at WT-05

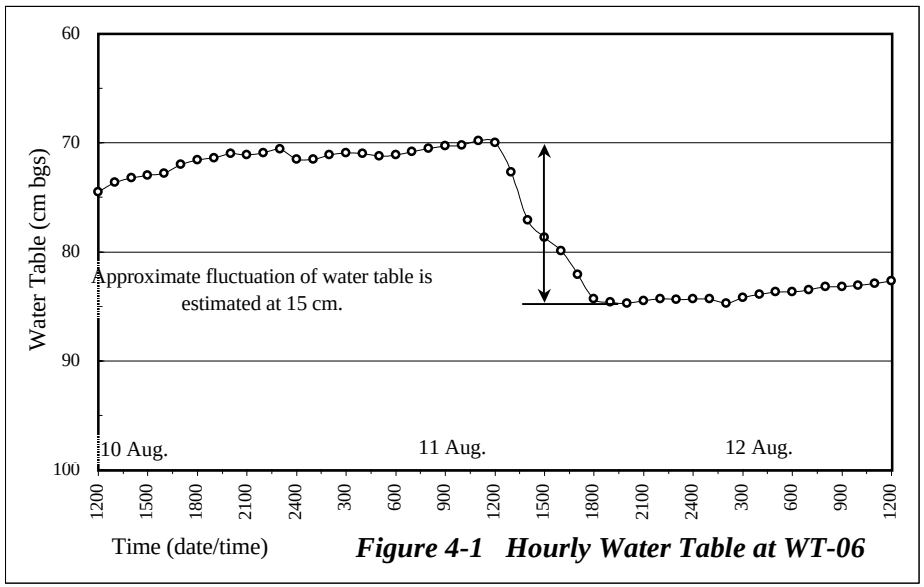


Figure 4-1 Hourly Water Table at WT-06

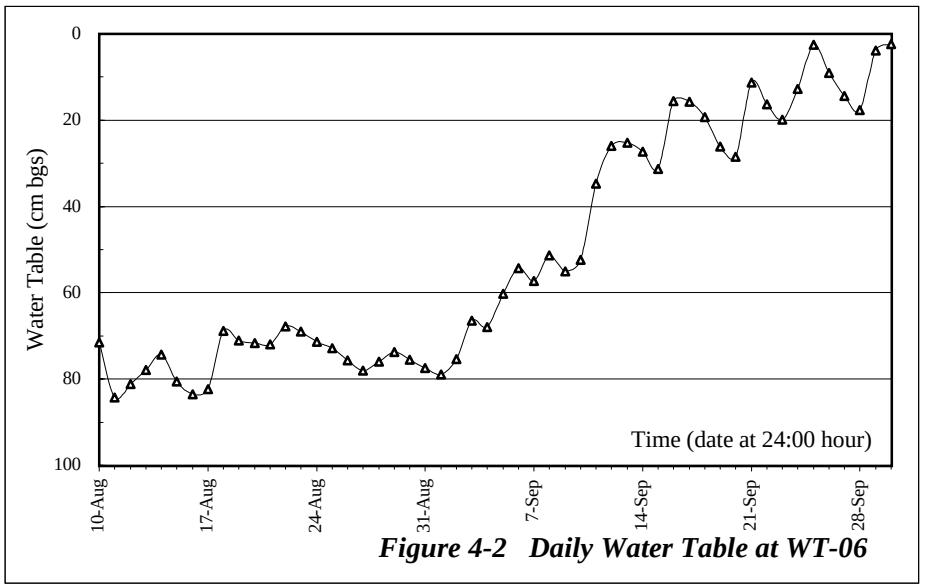


Figure 4-2 Daily Water Table at WT-06

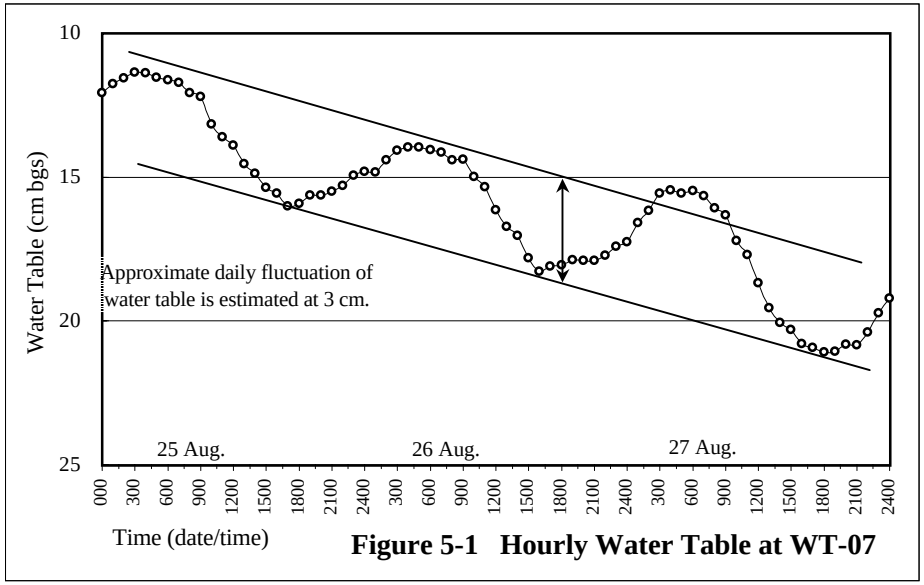


Figure 5-1 Hourly Water Table at WT-07

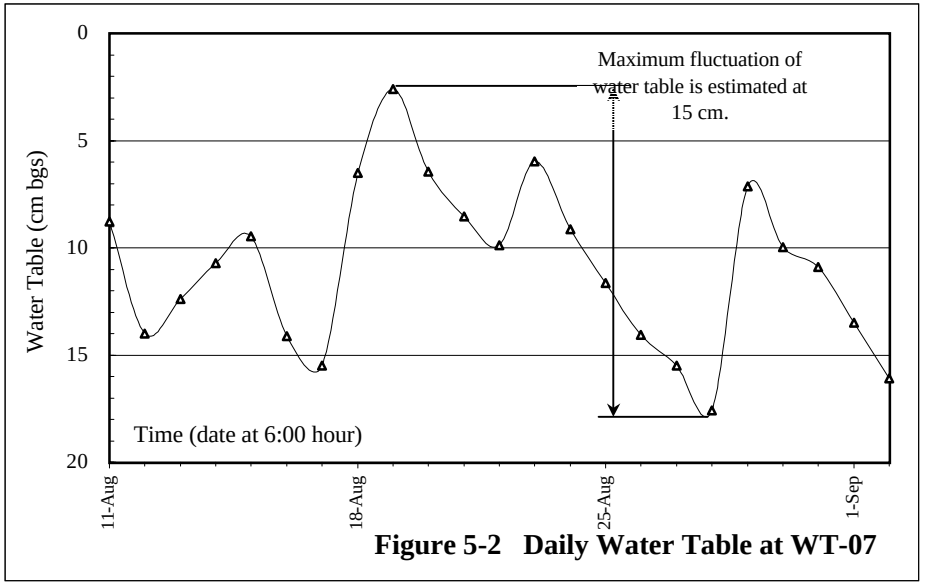


Figure 5-2 Daily Water Table at WT-07

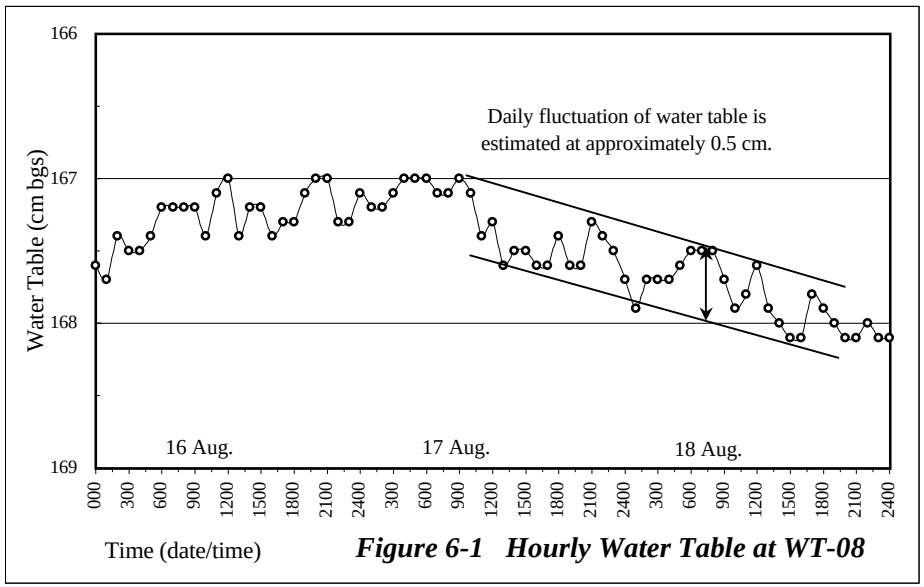


Figure 6-1 Hourly Water Table at WT-08

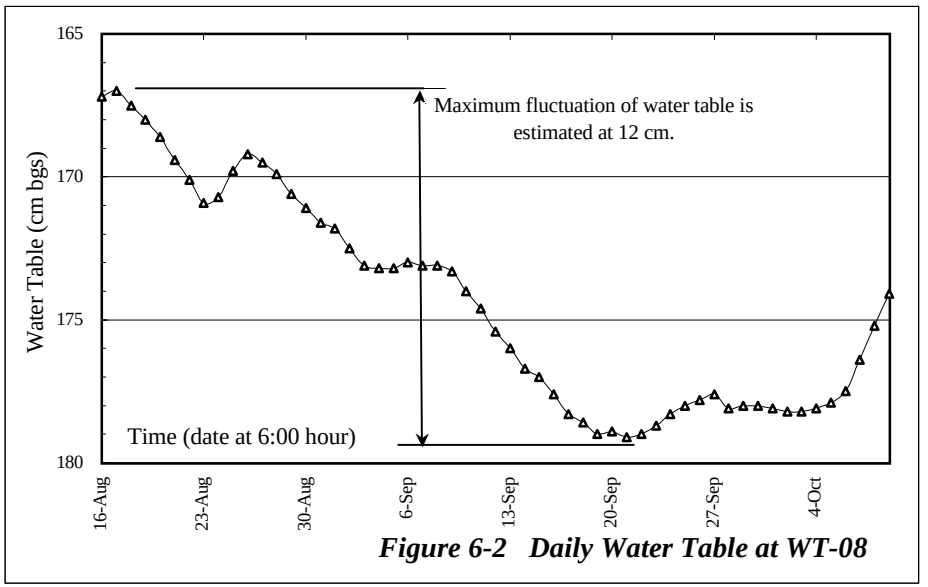


Figure 6-2 Daily Water Table at WT-08

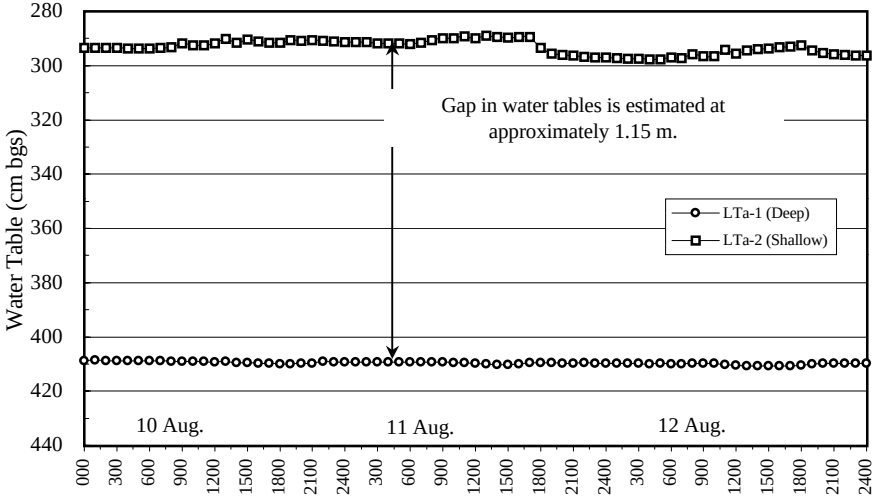


Figure 7-1 Hourly Water Table at LTa-1&2

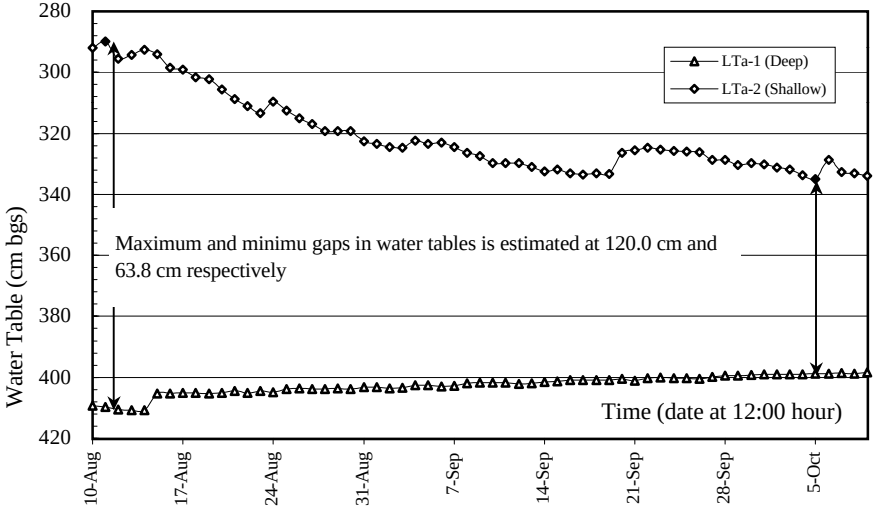


Figure 7-2 Daily Water Table at LTa-1&2

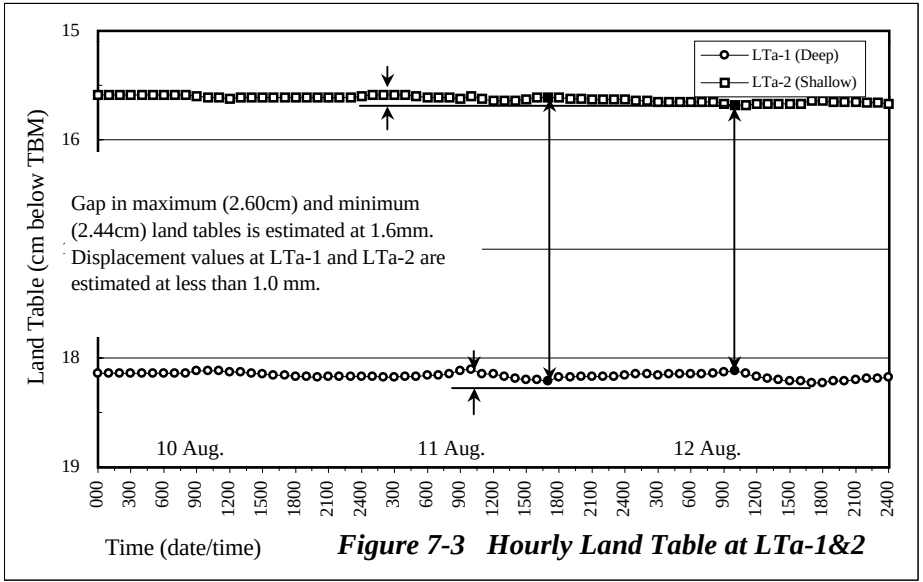


Figure 7-3 Hourly Land Table at LTa-1&2

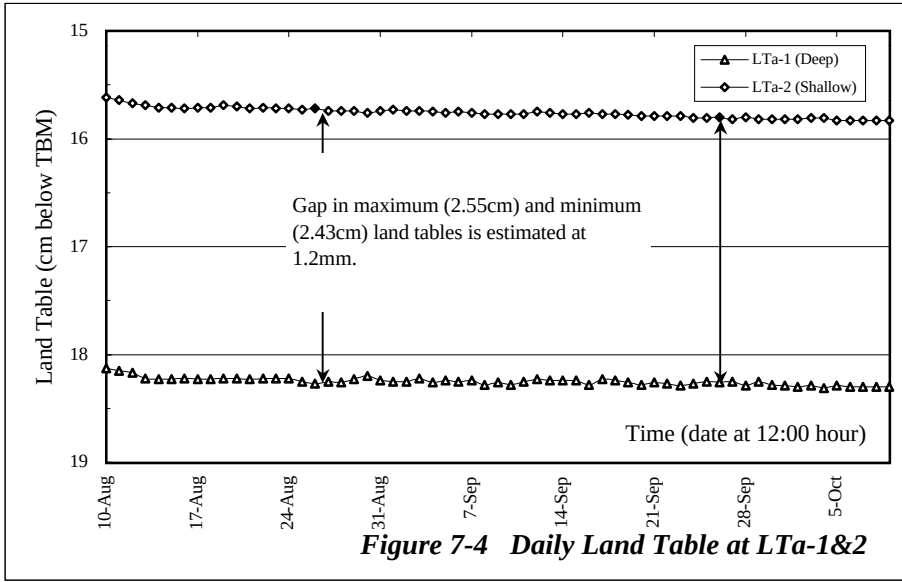


Figure 7-4 Daily Land Table at LTa-1&2

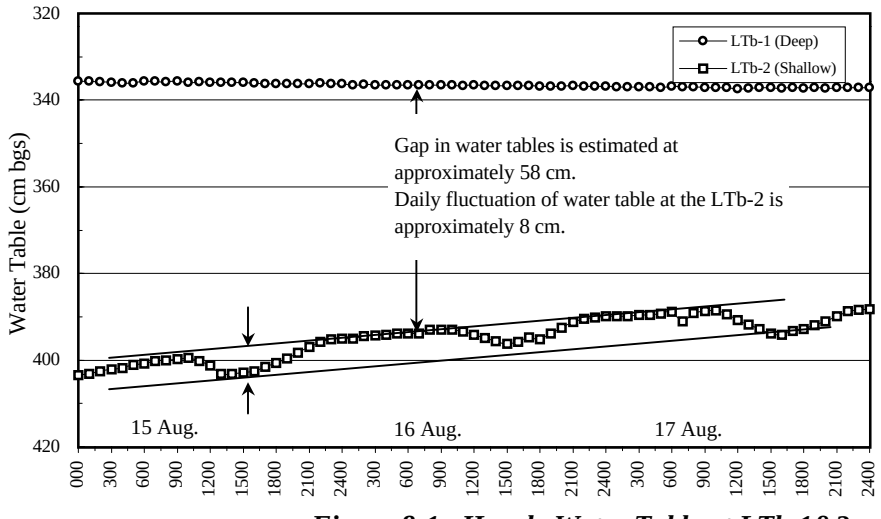


Figure 8-1 Hourly Water Table at LTb-1&2

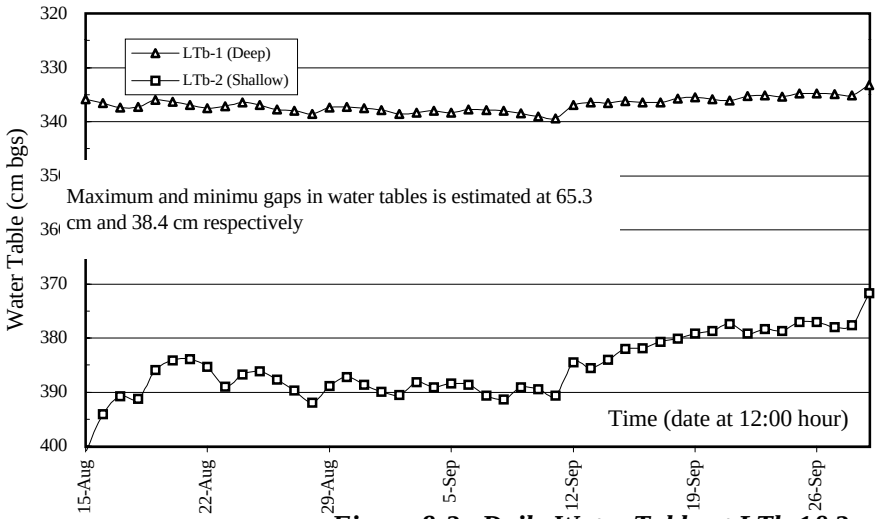


Figure 8-2 Daily Water Table at LTb-1&2

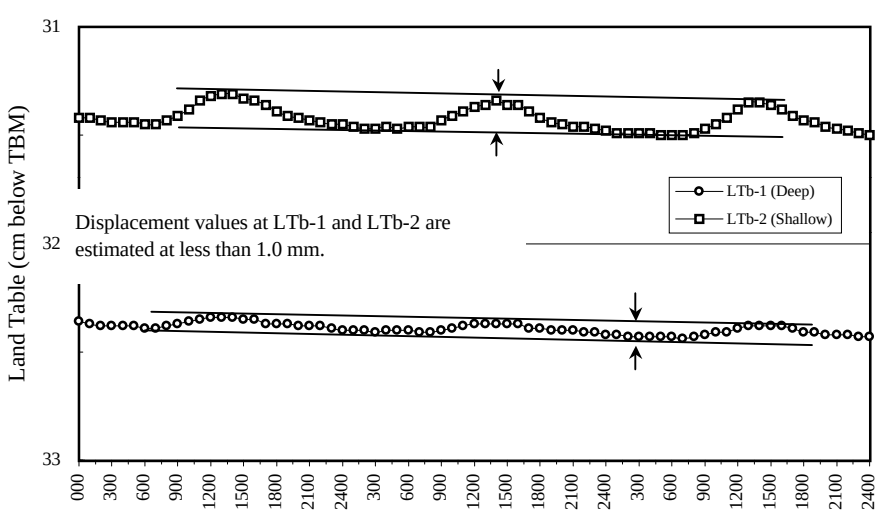


Figure 8-3 Hourly Land Table at LTb-1&2

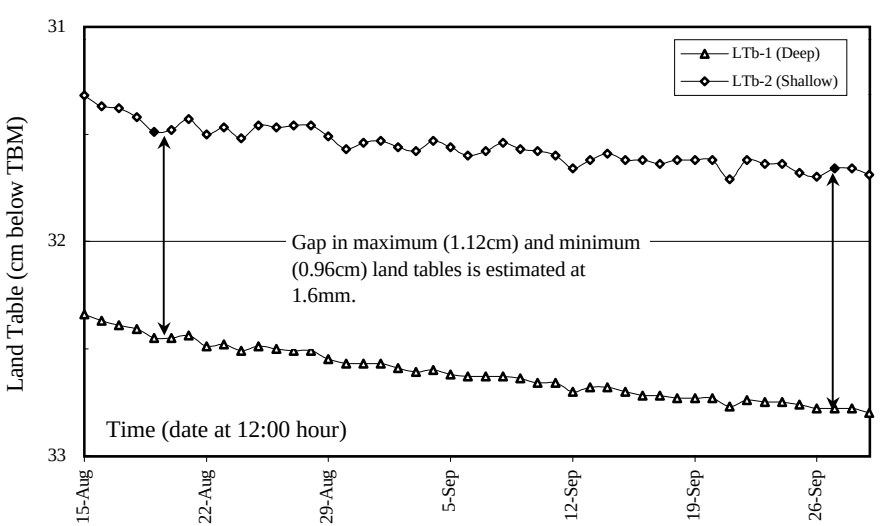


Figure 8-4 Daily Land Table at LTb-1&2

Appendix-7

References

Appendix 7 References

as of November 2003

ID	Title of Data/Information	Form	Collected	Made by Expert	Made by JICA	Text	Publishing Organization of Data/Information
C-1	Second Five Year Socioeconomic Development Plan, 2001 - 2005	book	○				National Economic Growth and Poverty Reduction Strategy, Ministry of Planning
C-2	General Population Census of Cambodia 1998 (Analysis of Census Results, Report 6, Population Projections 2001 - 2021)	book	○				National Institute of Statistics, Ministry of Planning
C-3	National Health Statistics Report 2000	book	○				Department of Planning and Health Information, Ministry of Health
	National Health Statistics Report 2001	book	○				
C-4	List of Guest Houses in SRP, Dec. 2002 Restaurant in SRP, Dec. 2002 List of Travel Agencies in SRP, Feb. 2003	copy	○				Tourism Industry and Planning Development Bureau, Ministry of Tourism
C-5	Tables of Monthly Exchange Rate Real/US$, from Oct. 2002 to Feb. 2003	copy	○				Department of Exchange, National Bank of Cambodia
C-6	Meteorological Data of Rainfall (1998 to 2002), Evaporation (1996 to 2000) and Temperature (1990 to 2002)	copy	○				Meteorological Station in Siem Reap, Ministry of Meteorology
C-7	Cambodia Statistical Data Book 2000	book	○				National Institute of Statistics, Ministry of Planning