


## Appendix 6. Other relevant data

### 6 - 1 . Technical notes

TECHNICAL NOTES  
ON  
THE PREPARATORY SURVEY  
ON  
THE PROJECT FOR URGENT IMPROVEMENT OF WATER SUPPLY SYSTEM  
IN MANDALAY CITY  
IN THE REPUBLIC OF THE UNION OF MYANMAR

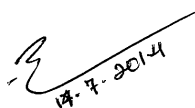
Based on the Minutes of Discussions (hereinafter referred to as "M/D") on the Preparatory Survey on the Project for Urgent Improvement of Water Supply System for Mandalay City (hereinafter referred to as "the Project") signed on 2nd May, 2014 between the Preparatory Survey Team (hereinafter referred to as "the Team") of Japan International Cooperation Agency (hereinafter referred to as "JICA") and Mandalay City Development Committee (hereinafter referred to as "MCDC"), of the Government of the Republic of Union of Myanmar, the consultant members of the Team had a series of discussions and conducted field surveys from 3<sup>rd</sup> May to 26<sup>th</sup> June, 2014. As a result of the discussions and the surveys, both sides confirmed the technical conditions described as per Attachments.

Mandalay, 14th July, 2014



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OKAGA Toshifumi  
Chief Consultant,  
JICA Preparatory Survey Team  
Project for Urgent Improvement of Water  
Supply System for Mandalay City



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U Tint Lwin  
Head of Department,  
Water and Sanitation Department  
Mandalay City Development Committee  
The Government of the Republic of  
Union of Myanmar

ATTACHMENT 1  
(Water Supply Plan)

MCDC and JICA Study Team confirmed the following technical issues on May 17, 2014:

MCDC: U Tint Lwin (Head of Department, Water and Sanitation  
JICA Survey Team: Toshifumi OKAGA (for Water Supply Plan)

*Jint Lwin*  
17.5.2014

*U Tint Lwin*

1. Service Area of Water Supply System in Pyi Gyi Tagon Township

The water supply candidate service areas are proposed 5 alternatives drawings based on the priority wards recommended by MCDC. Finally, it is determined depend upon the project cost of Japanese grant aid.

2. Population and Growth Rate of Pyi Gyi Tagon Township

The population (from year 2008 to 2011) of the Township over which MCDC has jurisdiction is based on the population data year 2012 (by General Administration Department of Mandalay Region) used by Water and Sanitation Dept. (WSD) with reference to the result of the follow-up study implemented by JICA year 2012. Accordingly the population year 2020 and 2025 is forecasted based on the said population data.

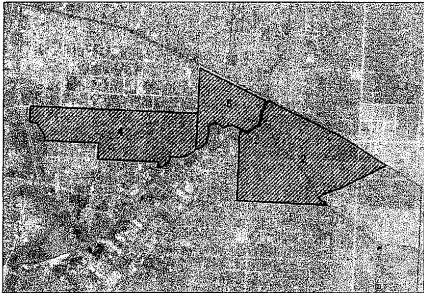
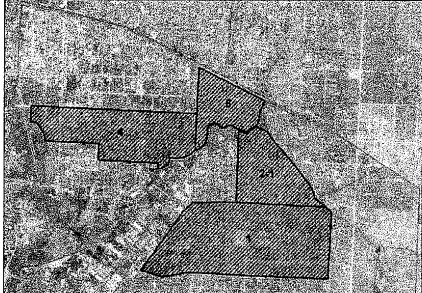
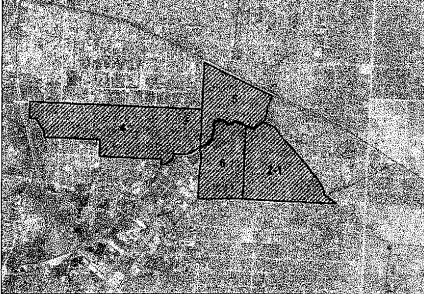
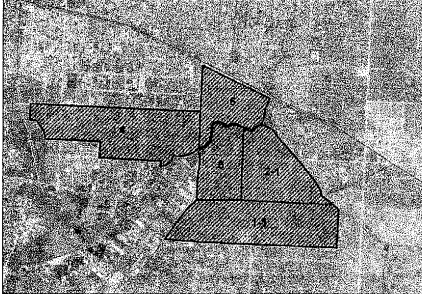
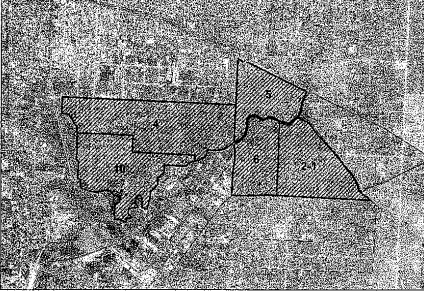
The detailed population data in Pyi Gyi Tagon is based on Planning for Water Supply in Pyi Gyi Tagon issued by WSD in April 2014. However, the total population is revised in order to accord data of General Administration Department.

The annual population growth rate is taken as 1.5 %. The Concept Plan Version 2040 by Department of Human Settlement and Housing Development (DHSHD) written in the Inception Report for Urban Services Improvement Project (2014) implemented by ADB assumes an annual average growth rate between 1.01 and 2.1% for 30 years commencing from 2011. This medium percentage is about 1.5 %. Meanwhile, according to the Statistic Year Book 2011, the annual population growth rate from year 2010 to 2011 is 1.1 %. Accordingly the annual population growth rate of 1.5 % is deemed to be adequate. Based on this growth rate, the population of each township is calculated.

Pyi Gyi Tagon is planned as total population of 154,741 year 2012 and annual

population growth rate of 1.5 %. But the population in a part of the ward (Sa, Thin Pan Kone) where water supply is conducted by ADB or MCDC is excluded from the plan. Based on these conditions, the population of each word and service areas are calculated and shown in the table below.

Alternative Water Supply Target Areas

CASE I	CASE II
	
CASE III	CASE IV
	
CASE V	
	

Note: ward1: Sa Lone, ward 2: Thin Pan Kone, ward 4: Ga, ward 5: Ghagyi, ward6: Nga

*[Handwritten signature]*

**Case I Population served**

No.	Ward	Area (km2)	Population in 2012					Projected Population Served in 2012	Projected Population Served in 2020	Projected Population Served in 2025
			No. of Block	No. of House Hold	Population	Existing Population Served	Rate of Project service area			
1	Sa Lone	2.36	59	3,150	19,734	4,200				
2	Thin Pan Kone	2.87	78	4,480	25,399	250	100%	25,149	28,330	30,520
3	Ka	0.86	23	816	4,406	704	16%	3,702		
4	Ga	0.88	23	1,082	5,571		100%	5,571	6,276	6,761
5	Ghagyi	0.42	18	2,037	11,879		100%	11,879	13,382	14,416
6	Nga	0.56	11	622	3,343	2700	81%	643		
7	Sa Lain	1.08	83	2,921	14,923	704	5%	14,219		
8	Za	0.60	45	1,595	7,976					
9	Zha	10.18	422	2,120	10,651					
10	Ngwe Taw Kyi Kone	2.52	31	2,123	12,339					
11	Chan Mya Thar Yar	1.61	11	1,688	8,248					
12	Kha	0.10	24	994	5,010					
13	Tagon Tai	3.40	12	2,936	15,418					
14	Htain Kone	0.96	3	890	4,158					
15	Taung Myint	1.40	10	781	3,602					
16	Yar Taw	0.52	4	479	2,085					
	<b>Total</b>	<b>30.31</b>	<b>857</b>	<b>28,714</b>	<b>154,741</b>			<b>42,599</b>	<b>47,987</b>	<b>51,696</b>
					1.056			27.5%		

**Case II Population served**

No.	Ward	Area (km2)	Population in 2012					Projected Population Served in 2012	Projected Population Served in 2020	Projected Population Served in 2025
			No. of Block	No. of House Hold	Population	Existing Population Served	Rate of Project service area			
1	Sa Lone	2.36	59	3,150	19,734	4,200	95%	14,547	16,388	17,654
2	Thin Pan Kone	2.87	78	4,480	25,399	250	52%	16,259	18,316	19,732
3	Ka	0.86	23	816	4,406	704	16%	3,702		
4	Ga	0.88	23	1,082	5,571		100%	5,571	6,276	6,761
5	Ghagyi	0.42	18	2,037	11,879		100%	11,879	13,382	14,416
6	Nga	0.56	11	622	3,343	2700	81%	643		
7	Sa Lain	1.08	83	2,921	14,923	704	5%	14,219		
8	Za	0.60	45	1,595	7,976					
9	Zha	10.18	422	2,120	10,651					
10	Ngwe Taw Kyi Kone	2.52	31	2,123	12,339					
11	Chan Mya Thar Yar	1.61	11	1,688	8,248					
12	Kha	0.10	24	994	5,010					
13	Tagon Tai	3.40	12	2,936	15,418					
14	Htain Kone	0.96	3	890	4,158					
15	Taung Myint	1.40	10	781	3,602					
16	Yar Taw	0.52	4	479	2,085					
	<b>Total</b>	<b>30.31</b>	<b>857</b>	<b>28,714</b>	<b>154,741</b>			<b>48,257</b>	<b>54,361</b>	<b>58,562</b>
					1.056			31.2%		

**Case III Population served**

No.	Ward	Area (km2)	Population in 2012					Projected Population Served in 2020	Projected Population Served in 2025	
			No. of Block	No. of House Hold	Population	Existing Population Served	Rate of Project service area			
1	Sa Lone	2.36	59	3,150	19,734	4,200				
2	Thin Pan Kone	2.87	78	4,480	25,399	250	52%	16,259	18,316	19,732
3	Ka	0.86	23	816	4,406	704	16%	3,702		
4	Ga	0.88	23	1,082	5,571		100%	5,571	6,276	6,761
5	Ghagyi	0.42	18	2,037	11,879		100%	11,879	13,382	14,416
6	Nga	0.56	11	622	3,343		100%	3,343	3,765	4,056
7	Sa Lain	1.08	83	2,921	14,923	2700	18%	12,223		
8	Za	0.60	45	1,595	7,976	704	9%	7,272		
9	Zha	10.18	422	2,120	10,651					
10	Ngwe Taw Kyi Kone	2.52	31	2,123	12,339					
11	Chan Mya Thar Yar	1.61	11	1,688	8,248					
12	Kha	0.10	24	994	5,010					
13	Tagon Tai	3.40	12	2,936	15,418					
14	Htain Kone	0.96	3	890	4,158					
15	Taung Myint	1.40	10	781	3,602					
16	Yar Taw	0.52	4	479	2,085					
	<b>Total</b>	<b>30.31</b>	<b>857</b>	<b>28,714</b>	<b>154,741</b>			<b>37,052</b>	<b>37,973</b>	<b>40,908</b>
					1,056			23.9%		

**Case IV Population served**

No.	Ward	Area (km2)	Population in 2012					Projected Population Served in 2020	Projected Population Served in 2025	
			No. of Block	No. of House Hold	Population	Existing Population Served	Rate of Project service area			
1	Sa lone	2.36	59	3,150	19,734	2,800	70%	11,014	12,407	13,366
2	Thin Pan Kone	2.87	78	4,480	25,399	250	52%	12,958	14,597	15,725
3	Ka	0.86	23	816	4,406	704	16%	3,702		
4	Ga	0.88	23	1,082	5,571		100%	5,571	6,276	6,761
5	Ghagyi	0.42	18	2,037	11,879		100%	11,879	13,382	14,416
6	Nga	0.56	11	622	3,343		100%	3,343	3,765	4,056
7	Sa Lain	1.08	83	2,921	14,923	2700	18%	12,223		
8	Za	0.60	45	1,595	7,976	704	9%	7,272		
9	Zha	10.18	422	2,120	10,651					
10	Ngwe Taw Kyi Kone	2.52	31	2,123	12,339					
11	Chan Mya Thar Yar	1.61	11	1,688	8,248					
12	Kha	0.10	24	994	5,010					
13	Tagon Tai	3.40	12	2,936	15,418					
14	Htain Kone	0.96	3	890	4,158					
15	Taung Myint	1.40	10	781	3,602					
16	Yar Taw	0.52	4	479	2,085					
	<b>Total</b>	<b>30.31</b>	<b>857</b>	<b>28,714</b>	<b>154,741</b>			<b>44,764</b>	<b>50,426</b>	<b>54,323</b>
					1,056			28.9%		

**Case V Population served**

No.	Ward	Area (km2)	Population in 2012						Projected Population Served in 2020	Projected Population Served in 2025
			No. of Block	No. of House Hold	Population	Existing Population Served	Rate of Project service area	Projected Population Served in 2012		
1	Sa lone	2.36	59	3,150	19,734	2,800	14%	0	0	0
2	Thin Pan Kone	2.87	78	4,480	25,399	250	52%	12,958	14,597	15,725
3	Ka	0.86	23	816	4,406	704	16%	3,702		
4	Ga	0.88	23	1,082	5,571	0	100%	5,571	6,276	6,761
5	Ghagyi	0.42	18	2,037	11,879	0	100%	11,879	13,382	14,416
6	Nga	0.56	11	622	3,343	0	100%	3,343	3,765	4,056
7	Sa Lain	1.08	83	2,921	14,923		0	0	0	0
8	Za	0.60	45	1,595	7,976		0	0	0	0
9	Zha	10.18	422	2,120	10,651		0	0	0	0
10	Ngwe Taw Kyi Kone	2.52	31	2,123	12,339	0	100%	12,339	13,900	14,975
11	Chan Mya Thar Yar	1.61	11	1,688	8,248	2700	33%	5,548	0	0
12	Kha	0.10	24	994	5,010	704	14%	4,306	0	0
13	Tagon Tai	3.40	12	2,936	15,418		0	0	0	0
14	Htain Kone	0.96	3	890	4,158		0	0	0	0
15	Taung Myint	1.40	10	781	3,602		0	0	0	0
16	Yar Taw	0.52	4	479	2,085		0	0	0	0
	<b>Total</b>	<b>30.31</b>	<b>857</b>	<b>28,714</b>	<b>154,741</b>	<b>7,158</b>	<b>4.6%</b>	<b>46,089</b>	<b>51,919</b>	<b>55,932</b>
					1,056			29.8%		

3. Unit Water Demand (L/c/d)

The unit water demand is shown in the below table.

	Descriptions	Unit	Notes
1.	Domestic water use	130 L/c/d	WSD
2.	Non domestic water	10% of domestic use	Site investigation
3.	Leakage water	10% of total distribution	Design criteria
4.	Factor of daily maximum	1.1	Same as YCDC
5.	Factor of hourly maximum	1.5	Same as YCDC

4. Water flow capacity calculation

Based on above design criteria, flow capacity of each case (service area) is calculated as follow,

Case I

Unit Water Demand and Design Criteria				Water Flow Capacity		
No.	Description	Unit	Notes	Year 2020	Year 2025	
No.	Unit water demand	L/c/d	Note	47,987	51,696	Population
1	Domestic use	130	DWS data	6,238	6,720	m3/d
2	Nondomestic use	13	Domestic use x 10%	624	672	m3/d
3	Leakage	16	10%, $(130+13) \times (1/(1-0.1)-1)$	695	821	m3/d
	total	159		7,557	8,214	m3/d
4	Factor of Daily maximum	1.1		<b>8,312</b>	9,035	m3/d
5	Factor of hourly maximum	1.5		520	<b>565</b>	m3/h

CaseII

Unit Water Demand and Design Criteria				Water Flow Capacity		
No.	Description	Unit	Notes	Year 2020	Year 2025	
	Unit water demand	L/c/d	Note	54,361	58,562	Population
1	Domestic use	130	DWS data	7,067	8,336	m3/d
2	Nondomestic use	13	Domestic use x 10%	707	834	m3/d
3	Leakage	16	10%, $(130+13) \times (1/(1-0.1)-1)$	864	1,019	m3/d
	total	159		8,637	10,189	m3/d
4	Daily maximum (m3/d)	1.1		<b>9,501</b>	11,207	m3/d
5	Hourly maximum (m3/h)	1.5		594	<b>700</b>	m3/h

CaseIII

Design Criteria				Water Flow Capacity		
No.	Description	Unit	Notes	Year 2020	Year 2025	
	Unit water demand	L/c/d	Note	37,973	40,908	Population
1	Domestic use	130	DWS data	4,937	5,318	m3/d
2	Nondomestic use	13	Domestic use x 10%	494	532	m3/d
3	Leakage	16	10%, $(130+13) \times (1/(1-0.1)-1)$	603	650	m3/d
	total	159		6,034	6,500	m3/d
4	Daily maximum (m3/d)	1.1		<b>6,637</b>	7,150	m3/d
5	Hourly maximum (m3/h)	1.5		415	447	m3/h

CaseIV

Unit Water Demand and Design Criteria				Water Flow Capacity		
No.	Description	Unit	Notes	Year 2020	Year 2025	
	Unit water demand	L/c/d	Note	50,426	54,323	Population
1	Domestic use	130	DWS data	6,555	7,062	m3/d
2	Nondomestic use	13	Domestic use x 10%	656	706	m3/d
3	Leakage	16	10%, $(130+13) \times (1/(1-0.1)-1)$	801	863	m3/d
	total	15.9		8,012	8,631	m3/d
4	Daily maximum (m3/d)	1.1		<b>8,813</b>	9,494	m3/d
5	Hourly maximum (m3/h)	1.5		551	593	m3/h

Case V

Unit Water Demand and Design Criteria				Water Flow Capacity		
No.	Description	Unit	Notes	Year 2020	Year 2025	
	Unit water demand	L/c/d	Note	51,919	55,932	Population
1	Domestic use	130	DWS data	6,750	7,271	m3/d
2	Nondomestic use	13	Domestic use x 10%	675	727	m3/d
3	Leakage	15.9	10%, $(130+13) \times (1/(1-0.1)-1)$	825	889	m3/d
	total	159		8,249	8,887	m3/d
4	Daily maximum (m3/d)	1.1		<b>9,074</b>	9,776	m3/d
5	Hourly maximum (m3/h)	1.5		567	611	m3/h



ATTACHMENT 2  
(Undertakings of Service Pipe and Water Meter)

MCDC and JICA Study Team confirmed the following technical issues on May 29, 2014:

MCDC: U Tint Lwin (Head of Department, Water and Sanitation)  
JICA Study Team: Atsuo Ohno (for Operation and Maintenance)

*Ohno*  
29.5.2014  
大野敦生

1. Options for Undertakings of Service Pipe and Water Meter by the Project

It is confirmed that the following two options are considered as the possible options.

From the standpoint of the project effectiveness and the soundness for the poor, Option 1 could be better.

MCDC expresses their preference on Option ① rather than Option ②.

It is finally determined depending upon further consideration.

Option	Service pipe		Water meter		Connection Fee
	Procurement	Installation Works	Procurement	Installation Works	
①	J	J	J	J	Official permission
②	J	M	J	M	Official permission Labor work costs

J --- Japanese Side, M --- Myanmar Side

2. Connection Fee

The burden of connection fee of Option ① could be cheaper than that of Option ② for new customer. While, the exemption of the full charge of new connection fee is also possible as necessary, according to MCDC.

In case of ②, it is confirmed that it is necessary to consider subsidy for new customer's connection fee, especially for the poor household. The reduction of the connection fee could be one of the options

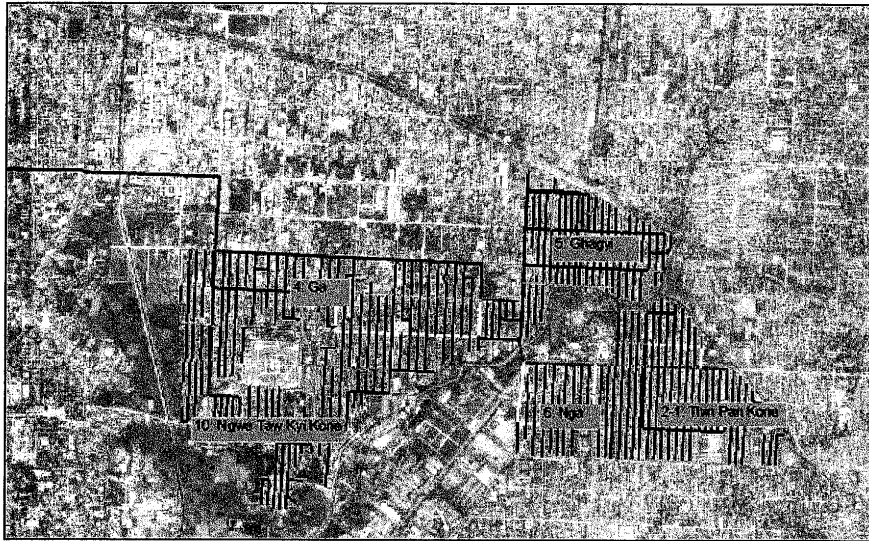
3. Identification of the Poor

It is difficult to identify the poor household because there is no complete statistics for all household income.

In case of subsidy provision for connection fee, MCDC proposed that all supply areas by the Project should be targeted, because all wards are relatively poor

areas. Also, if only some wards are selected for subsidy provision, severe customer complaints could be occurred according to MCDC.

#### Water Supply Target Areas




Note: ward1: Sa Lone, ward 2: Thin Pan Kone, ward 4: Ga, ward 5: Ghagyi, ward6: Nga, ward 10: Ngwe Taw Kyi Kone

ATTACHMENT 3  
(Water Supply Facility)

MCDC and JICA Study Team confirmed the following technical issues on June 12, 2014:

MCDC: U Tint Lwin (Head of Department, Water and Sanitation)

JICA Survey Team: Masashi KAWAMURA (Water Supply Facility)

 2014. 6. 12  
河村正

1. Target water supply area

MCDC and JICA Survey Team confirmed that the target water supply area was CASE V in which ward 4, 5, 6, 10 and western side of ward 2 are included. The water supply in ward 3, 11, 12 and eastern side of ward 2 will be considered by using existing pipeline and MCDC's own budget. On the other hand, the water supply in southern area of Pyi Gyi Tagon Township other than the target water supply area in the Project will be considered, when the future Project for new water supply system using surface water is implemented by using other fund.

2. Exclusion of the existing water supply area

According to the result of field survey and discussion with MCDC, we confirmed that there is the existing water supply system which has pipe network and house connections. Therefore, the water supply area for the existing water supply system is excluded from the target water supply area of the Grant Aid Project. The followings are the detail of the existing water supply system.

Items	Detail
Name of system	MCDC 7976
Location	Between Min Ye Kyaw Swar Rd. and Bo Ba Htoo Rd. From 58 <sup>th</sup> St., 6 streets to east direction
Facility	Deep well, elevated tank with capacity of 450 m <sup>3</sup> , pipe network
Population served	250 persons

3. Pipe material

Pipe materials for the proposed pipelines are defined as below.

Transmission pipeline (From wells to service reservoir): Ductile iron pipe

Distribution pipeline:

More than 200mm: Ductile iron pipe



100mm and 150mm: PVC (Polyvinyl chloride pipe)  
Less than 50mm: PE (Polyethylene pipe)

4. Gate Valve, Air Valve and Fire Hydrant

In the proposed distribution pipeline, gate valves, air valves and fire hydrants will be installed. The each location of gate valves and air valves will be selected based on pipe layout and topographic condition. In order to carry out firefighting appropriately, the locations of fire hydrants will be selected.

5. Pipe laying method

In the proposed pipeline, there are railway and national road; namely "Mandalay-Yangon road". When the proposed pipeline crosses railway and national road, following methods are applied.

- Railway: Pipe jacking method
- National road (Mandalay-Yangon road): Open cut (night work)

6. Water pressure in the end of the distribution pipeline

In the proposed water supply system, we confirm that we secure enough water pressure to supply treated water to the individual house with enough water pressure. The residual water pressure is set as mentioned below.

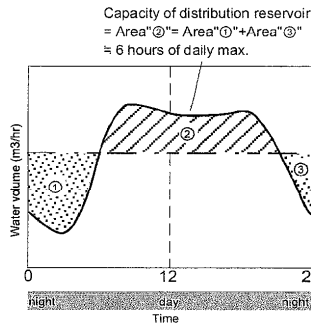
- Minimum dynamic water pressure: more than 0.15 Mpa

7. Distribution system

In principle, distribution system from the reservoir to service area is recommended by gravity flow. However, the gravity flow system is not possible to adopt due to topographic conditions in Pyi Gyi Tagon Township and the booster pump system is applied.

8. Capacity of the proposed service reservoir

The distribution reservoir has the function of regulating the fluctuation in daily consumption especially hourly maximum water demand. According to the water consumption pattern in Figure 1, the consumption during day time is high compared to night time. Therefore, the reservoir tank charges water in the night time in order to prepare for peak consumption. The storage water in the reservoir can be equal to demand in the peak consumption time. The capacity needs to have storage for 6 hours of daily maximum water.



**Figure 1 Pattern of Daily Water Consumption**

It also facilitates the water supply for certain duration in case of emergency such as occurrence of facilities failure or in case of suspension of intake facilities due to some unavoidable reasons.

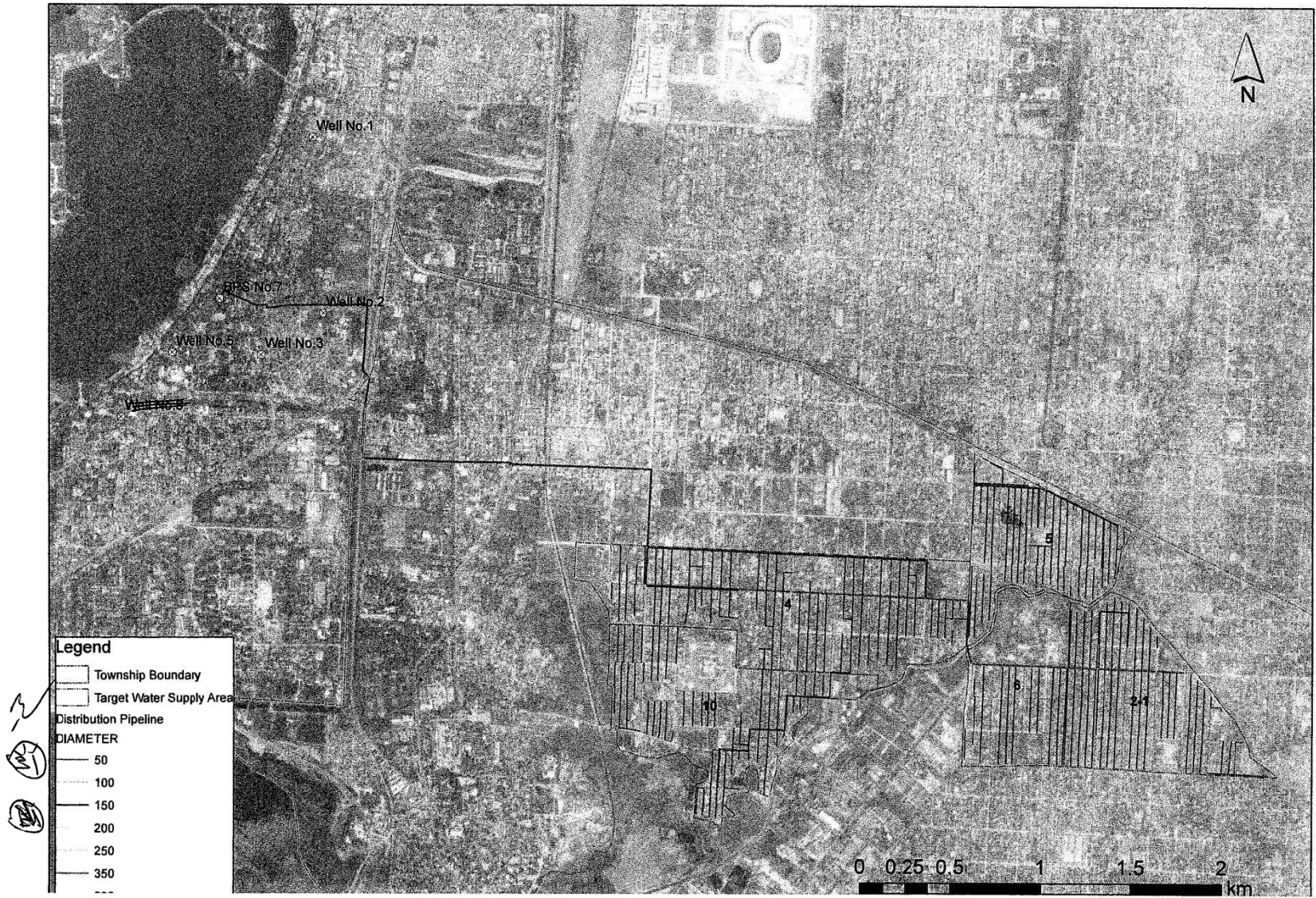
Therefore, it is better to have some allowance in the capacity. Taking this into consideration, the retention time or capacity of each reservoir is to have storage for 8 hours of daily maximum water in the design.

9. Setting of DMA (District Metering System)

The whole distribution network in the target area in Pyi Gyi Tagon Township is divided into the DMAs from the viewpoint of administrative district boundaries, topography and geography. According to the result of population forecast in 2020, the range of population in 5 wards is from approx. 4,000 to 15,000. If it is converted to number of house connections, it will be from approx. 700 to 2,700. As for a scale of DMA, according to Non-Revenue Water Control in World Bank Project or other similar Project, about 2,000 house connections per DMA are recommended. Therefore, it results 5 DMAs in the target water supply area in Pyi Gyi Tagon Township.

10. Monitoring System

In order to understand Non-Revenue water and secure the safety water, water flow, water pressure and residual chlorine shall be monitored in each DMA. In the Project, water flow meters, pressure transmitters and residual chlorine gauges are installed in the inlet of each DMA, and the central monitoring station monitors residual chlorine, pressure and flow data.



ATTACHMENT 4  
(Disinfection Facilities)

MCDC and JICA Study Team confirmed the following technical issues on June 13th, 2014;

MCDC: U Tint Lwin (Head of Department, Water and Sanitation)

JICA Survey Team: Norio TANAKA (Disinfection Facility)

15.6.2014  
田中規夫

1. Selection of Chlorine Disinfectant

There are eleven main distribution facilities, i.e. service reservoirs, water treatment plants and elevated tanks, which require installation of disinfection facilities, in Mandalay City. Disinfection facility has been installed in the site of No.8 WTP and will be installed in the site of No.4 WTP under technical cooperation of Japan. Electrochlorination system, which produces sodium hypochlorite on the site, is adapted for these facilities. Therefore, the same system is selected for this Project owing to the advantages in unifying chlorine disinfectant for procurement of chemical, operation and maintenance.

2. Targeted Existing Facilities

Nine exiting distribution facilities except for No.4 WTP and No.8 WTP are targeted in this Project. Targeted existing facilities are as below.

- No.1 Pump Station & Service Reservoir
- No.2 Pump Station & Service Reservoir
- No.3 Pump Station & Service Reservoir
- No.5 Pump Station & Service Reservoir
- No.6 Pump Station & Service Reservoir
- No.7 Pump Station & Service Reservoir
- Mandalay Hill Service Reservoir (\*1)
- No.1 Elevated Tank
- No.2 Elevated Tank

\*1: Mandalay hill service reservoir receives water from two resources. One is groundwater from No. 28, No. 29 and No. 33 wells and the other is treated water from No.8 WTP. Treated water from No.8 WTP will be disinfected in No.8 WTP. Hence, groundwater from the wells is targeted in this Project. Disinfection facility will be installed in the site of No. 28 well in order to make possible to operate disinfection facility with the wells.

### 3. Centralized System

It results in increases of workload for operation and maintenance of the facilities to install electrochlorination system at every site of nine main distribution facilities, at the same time that it increases initial investment and operating cost. Therefore, the concept of centralized production of sodium hypochlorite by choosing key stations from nine main distribution facilities is adapted. In this concept, the other main distribution facilities are planned to use sodium hypochlorite transported from these key stations. No.1 Pump Station & Service Reservoir and No.7 Pump Station & Service Reservoir are selected as the key stations.

### 4. Targeted Residual Chlorine

Water quality standard for water supply in Myanmar does not regulate minimum requirement on residual chlorine. WHO guideline recommends securing not less than 0.5 mg/l of free residual chlorine after chlorination. Hence, targeted residual chlorine of distribution water is set not less than 0.5mg/l at the outlet of distribution facilities.

### 5. Chlorine Injection Rate

Chlorine demand of water distributed by each targeted existing facility has been estimated from experimental trial in order to set chlorine injection rates. Chlorine demand of water is not more than 0.5mg/l (results: 0.2-0.4mg/l). Targeted residual chlorine is set not less than 0.5mg/l at the outlet of distribution facilities. Hence, chlorine injection rate is set for the design purpose as shown below.

Average Chlorine Injection Rate	Maximum Chlorine Injection Rate
1.0 - 1.5 mg/l	2.0 mg/l

Average chlorine injection rate should be optimized monitoring free residual chlorine at the end of distribution networks. Maximum chlorine injection rate is set 2.0mg/l considering the margin and seasonal fluctuation of water quality. Furthermore, production equipment is planned to have 120% of required capacity for maximum chlorine injection rate considering safety factor.



### 6. Facilities Planning

Chlorination facilities are installed at the location shown below in the site of the targeted existing distribution facilities.

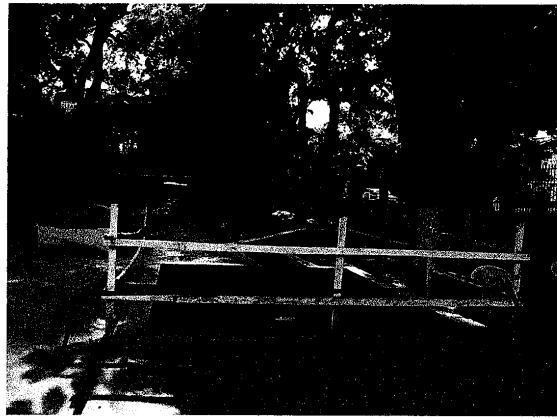


6.1 No.1 Pump Station & Service Reservoir

Production and injection equipment of sodium hypochlorite will be installed at the existing rooms of No.1 Pump Station shown below. Underground tanks for making saturated salt solution will be constructed at the space shown below.

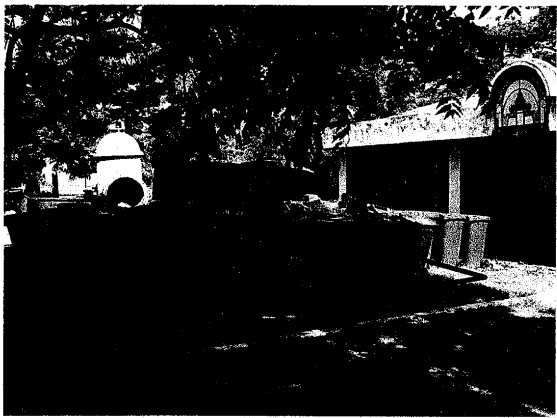
	<p>Existing room: 10.7*11.2m Production equipment of sodium hypochlorite</p>
	<p>Existing room: 7.4*11.2m Injection equipment of sodium hypochlorite (tanks and pumps) (including repair works of existing basement)</p>



	<p>Underground tank size: approx. 3m x 9m</p> <p>Salt storage tank</p> <p>Salt dissolution tank</p> <p>Saturated salt solution pumps (including removal of existing concrete structure)</p>
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6.2 No.2 Pump Station & Service Reservoir

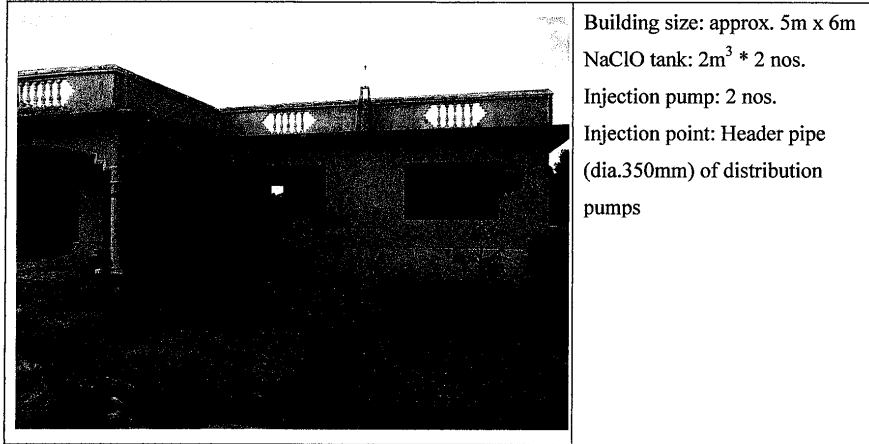
The building for injection equipment of sodium hypochlorite will be constructed at the space shown below.

	<p>Building size: approx. 6m x 7m</p> <p>NaClO tank: 6m<sup>3</sup> * 2 nos.</p> <p>Injection pump: 2 nos.</p> <p>Injection point: Header pipe (dia.400mm) of distribution pumps</p>
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6.3 No.3 Pump Station & Service Reservoir

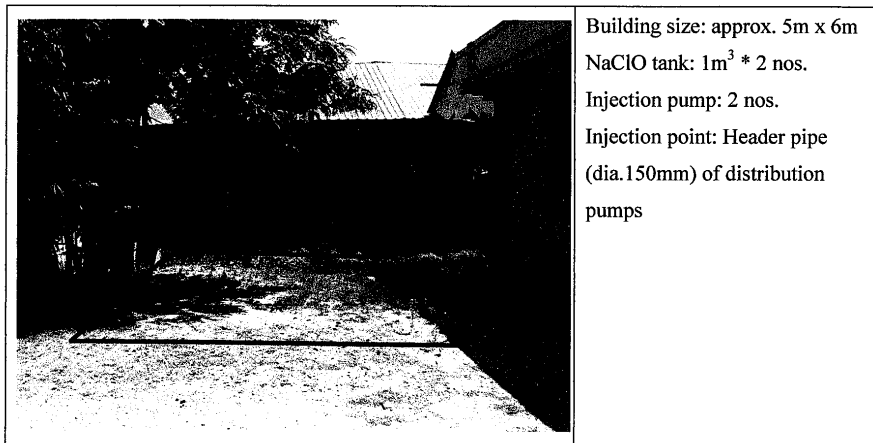
The building for injection equipment of sodium hypochlorite will be constructed at the space shown below.

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6.4 No.5 Pump Station & Service Reservoir

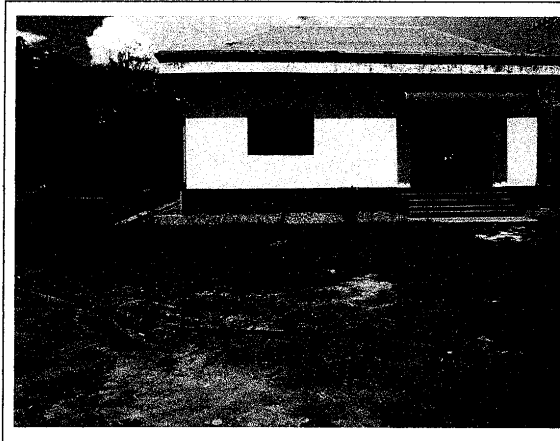
The building for injection equipment of sodium hypochlorite will be constructed at the space shown below.



6.5 No.6 Pump Station & Service Reservoir

The building for injection equipment of sodium hypochlorite will be constructed at the space shown below.





Building size: approx. 5m x 6m  
 NaClO tank: 2m<sup>3</sup> \* 2 nos.  
 Injection pump: 2 nos.  
 Injection point: Header pipe  
 (dia.200mm) of distribution  
 pumps

6.6 No.7 Pump Station & Service Reservoir

Disinfection facility including production and injection equipment of sodium hypochlorite will be installed in the same building planned for new distribution pumps. The existing system will be injected from new building. Also, production equipment will produce sodium hypochlorite for No.2, No.3, No.5, No.6 Pump Station & Service Reservoir, No.28 Well and No.1, No.2 Elevated Tank.

6.7 No. 28 Well

The building for injection equipment of sodium hypochlorite will be constructed at the space shown below.

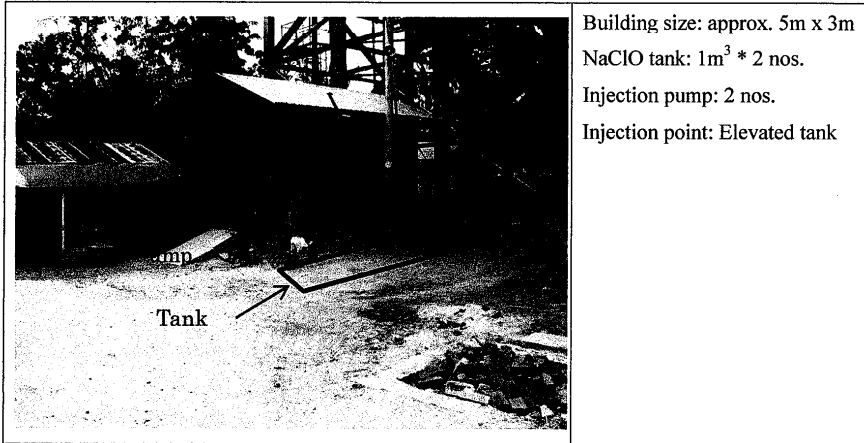


Building size: approx. 6m x 6m  
 NaClO tank: 5m<sup>3</sup> \* 2 nos.  
 Injection pump: 2 nos.  
 Injection point: transmission  
 pipe (dia. 200mm) to Mandalay  
 Hill service reservoir

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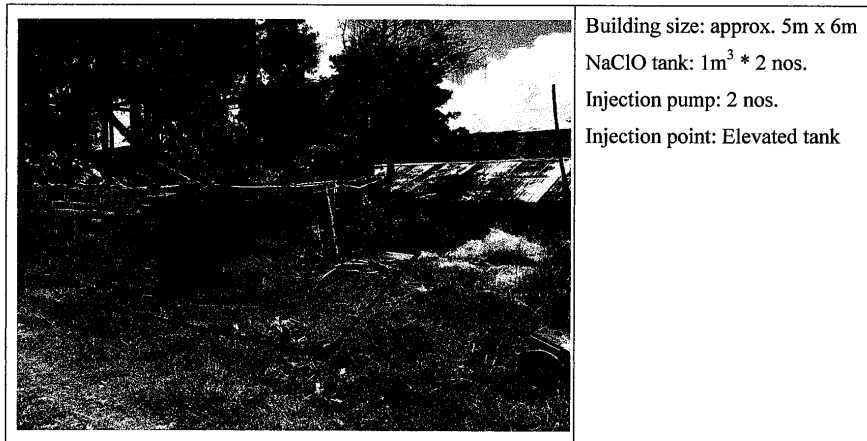
6.8 No.1 Elevated Tank

Injection equipment will be installed at the space shown below. Injection pump will be installed in the existing small house. Tanks will be installed in new building.



6.9 No.2 Elevated Tank

The building for injection equipment of sodium hypochlorite will be constructed at the space shown below.



7. Transportation of Sodium Hypochlorite



Sodium hypochlorite which is produced at the key stations is transferred to the other main distribution facilities. Tanks will be procured in this Project. You are kindly requested to arrange trucks to carry these tanks filled with sodium hypochlorite.

#### 8. Commissioning and Trainings

The following commissioning and OJT trainings will be implemented by the Contractor.

- Inspection on quality of equipment and installation
- Trial operation
- Preparation of operating and maintenance manual
- Trainings on operation and maintenance of equipment
- Trainings on trouble shooting

#### 9. Spare Parts

Adequate amount of spare parts for electrochlorination system is included in the Contract to secure sustainability of operation.



ATTACHMENT 5  
(Groundwater Development)

MCDC and JICA Study Team confirmed the following technical issues on June 20, 2014;

MCDC: U Tint Iwin (Head of Department, Water and Sanitation

JICA Study Team: Mitsuyoshi SAITO (for Groundwater Development)

*U Tint Iwin*  
19.6.2014  
*Mitsuyoshi SAITO*

1. Quantity of new well

The planned daily maximum water supply is estimated approximately 9,000 m<sup>3</sup>/day in the water supply target area, and then total quantity of new wells are three in consideration of the pumping capacity, 3,000 m<sup>3</sup>/day for each well. However, in the case if the capacity is less than 3,000 m<sup>3</sup>/day, quantity of well should be increased. Though it was planned 5 new wells of 12 inch diameter in the initial plan, the new wells should be planned to acquire the pumping capacity of approximately 9,000 m<sup>3</sup>/day in the detailed design plan.

2. Location of new well site

The locations of 5 candidates' well sites are shown in figure 1. They are No.1, No.2, No.3, No.5 and No.9. Final well sites should be selected from them in consideration of the pumping capacity which will be obtained by pumping test at test well, well interference, land-use approval, etc.

3. Land-use approval of new well site

The location, land owner, and land administrator of 5 candidates' well sites are shown in the table 1. MCDC should be gotten participator's approval for 5 well sites by October, and the evidence of them should be acquired before the beginning of detailed design plan.

4. Well structure

Basically well structure should be referenced the Test Well's structure is shown in figure 2 and final structure should be decided by the geological section and geophysical logging data of each well.

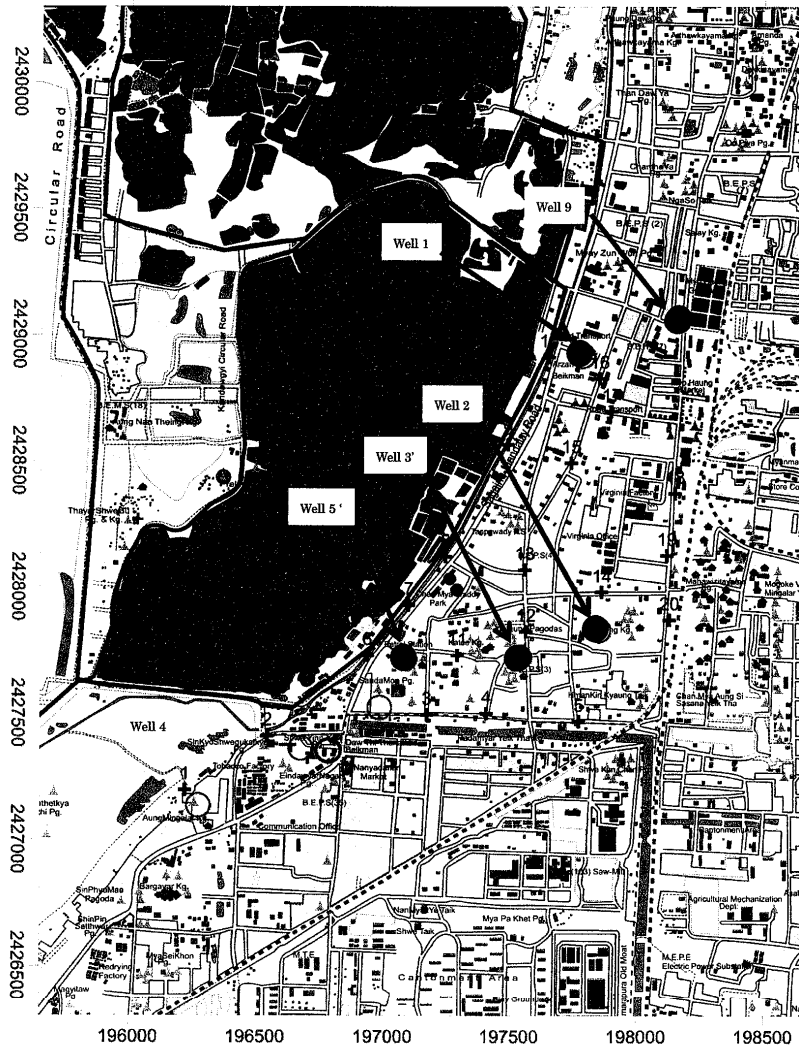


Figure 1 Well location map

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Table 1 Candidate Well Sites Information

Well No.	Location	Landowner	Administrator	Approval	Evidence
1	Next to Martyr memorial	Dept. of Play Ground and Garden, MCDC	Dept. of Play Ground and Garden, MCDC	Approved	None
2	Play ground Next to transformer station	Dept. of Play Ground and Garden?, MCDC	Dept. of Play Ground and Garden?, MCDC	Applied to dept. of City Planning and Land Administration, MCDC	None
3'	In front of Yinn Taw, Su Taung Pyae Pagoda & Aung Myay Bon San Ka Toe Kyaung, side by KOICA well	Pagoda and Monastery ?	Dept. of City Planning and Land Administration ?, MCDC	Applied to dept. of City Planning and Land Administration, MCDC	None
5'	Behind New day gas station, near Sanda Mon Pagoda	Sanda Mon Monastery	Dept. of City Planning and Land Administration, MCDC	Applied to dept. of City Planning and Land Administration, MCDC	None
9	Park in front of BEHS(7)	Dept. of Play Ground and Garden, MCDC	Dept. of Play Ground and Garden, MCDC	Send the letter to Committee from DWS and waiting the replay	None

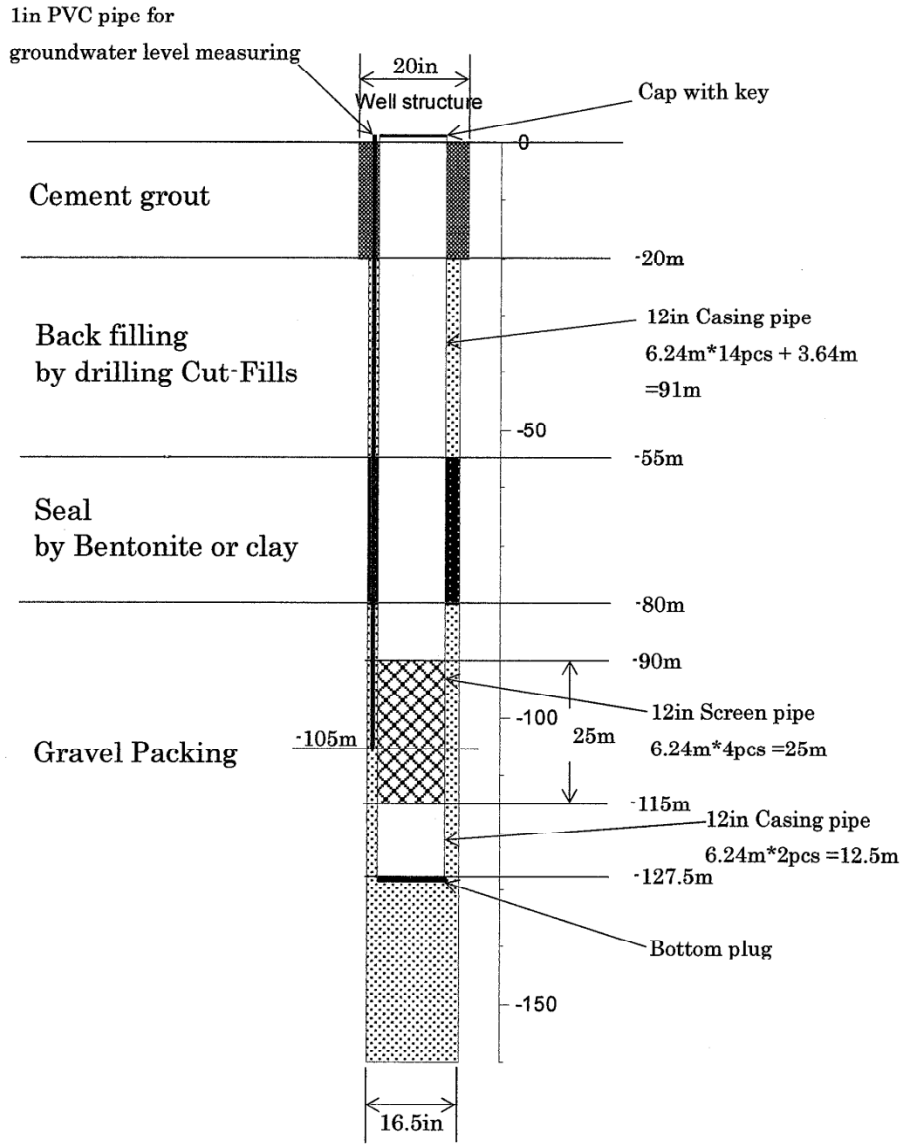


Figure 2 Well structure

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