Annex 5
Technical Notes

TECHNICAL NOTES
ON
THE BASIC DESIGN STUDY
ON
THE PROJECT
FOR
RURAL DRINKING WATER SUPPLY IN PERI-URBAN OF PHNOM PENH CITY
IN
THE KINGDOM OF CAMBODIA

Based on the Minutes of Discussions signed on October 3, 2001 between the Basic Design Study Team (hereinafter referred to as "the Team") of Japan International Cooperation Agency (hereinafter referred to as "JICA") and Department of Rural Water Supply, Ministry of Rural Development of the Kingdom of Cambodia, the consultant members of the Team had a series of discussions and conducted field surveys from September 26 to November 2, 2001.

As a result of the discussions and the surveys, both sides confirmed the technical conditions described on attached sheets.

Phnom Penh, October 26, 2001

Mr. Shinichiro Matsumoto
Chief Consultant,
JICA Basic Design Study Team for
the Project for Rural Drinking Water Supply
in Peri-Urban of Phnom Penh City

Dr. Mao Saray
Director,
Department of Rural Water Supply,
Ministry of Rural Development

ATTACHMENT

The both parties agreed upon and confirmed the following items.

1. Spaces and facilities of the workshop in the DRWS

The Cambodian side agreed that the spaces and facilities of the workshop in DRWS should be prepared by the Cambodian side in order to enable the implementation of the Project.

2. Modification of the numbers and specifications of the requested equipment

The Cambodian side requested the following modifications to the numbers and specifications of requested equipment.

1) One (1) unit of track-mounted fuel tank (4,000 L) should be added to efficiently serve the necessary fuel to each drilling site.
2) Number of water tank truck is reduced from two (2) units to one (1) unit.
3) Workshop equipment and tools should be deleted.

The equipment made in Japan should be procured for the Project due to the quality and applicability of after sales services by manufactures.

3. Name of Village

The both sides agreed that names of the projected villages shall be standardized, being the same as village name in the Population Census of Cambodia 1998.

4. Proposed Well Construction Sites

The both side agreed that 165 proposed well sites shall be selected for the Project as shown in **Annex-1**. The following five (5) villages in the services area of the World Bank Urban Water Supply Project shall be excluded from the Project. However, well construction sites shall be selected for the poor in these villages.

①Village No.47:Russey, ②Village No.48:Mean Chey, ③Village No.52:Phnom Penh Thmey, ④ Village No.54:Dey Thmey and ⑤Village No.59:Sleng Roleung

5. Evaluation of the Proposed Well Sites

The both sides agreed that the proposed well sites shall be evaluated by using evaluation criteria as shown in **Annex-2**.

6. Other Relevant Issues

Cambodian side requested the following technical assistance in the Project. The Team will convey the request to the Government of Japan.

1) Technical assistance for the database of existing well inventory.
2) Technical transfer for geophysical survey and borehole logging technology.
3) Technical assistance for capacity building of sustainable O&M system of handpump.

Annex-1: Proposed Well Construction Sites (Required Number of Handpump)

District	Commune		Village	Population in 1998	Annual population growth rate	Population in 2005	Population surved by existing safe water supply facilities and other donor project	Design Population	DWSP	Required number of handpump		Beneficiary Population of 1 well
				①	②	③	④	⑤=③-④	⑥	⑦=⑤/⑥		
Dangkao	Chaom Chau	1	Prey Pring Khang	1,245	0.028	1,511	453	1,057	210	5.0	5	211.5
	Kakab	2	Kakab	508	0.028	616	0	616	210	2.9	3	205.4
		3	Trapaing Chrey	292	0.028	354	0	354	210	1.7	2	177.1
		4	Prey Sala	529	0.028	642	192	450	210	2.1	3	149.9
	Samaraong Kraom	5	Chamkar Sbeng	229	0.028	278	0	278	210	1.3	2	138.9
		6	Trapaing Thnong	599	0.028	727	0	727	210	3.5	4	181.7
		7	Kok Prech	304	0.028	369	0	369	210	1.8	2	184.4
		8	Tekak Panhor	368	0.028	446	0	446	210	2.1	3	148.8
		9	Sam Rong	453	0.028	550	0	550	210	2.6	3	183.2
		10	Chak Chrouk	333	0.028	404	0	404	210	1.9	2	202.0
		11	Ork Rumdoul	190	0.028	231	0	231	210	1.1	2	115.3
		12	Sre Reacheas	487	0.028	591	0	591	210	2.8	3	197.0
		13	Andong Taom	361	0.028	438	0	438	210	2.1	3	146.0
	Kouk Roka	14	Kab Srov Toch	664	0.028	806	0	806	210	3.8	4	201.4
		15	Kab Srov Thom	637	0.028	773	0	773	210	3.7	4	193.2
		16	Prey Thom	135	0.028	164	0	164	210	0.8	1	163.8
		17	Toul Sam Pauv	122	0.028	148	0	148	210	0.7	1	148.0
		18	Chum Rov	277	0.028	336	0	336	210	1.6	2	168.0
		19	Thlork	192	0.028	233	0	233	210	1.1	2	116.5
		20	Phlou Phaem	305	0.028	370	0	370	210	1.8	2	185.0
		21	Putrea	222	0.028	269	0	269	210	1.3	2	134.7
		22	Svay Chek	434	0.028	527	0	527	210	2.5	3	175.5
		23	Kok Rokar	261	0.028	317	0	317	210	1.5	2	158.3
		24	Angk Takov	164	0.028	199	0	199	210	0.9	1	199.0
		25	Trapaing Por	277	0.028	336	0	336	210	1.6	2	168.0
	P. Chheh Rotch	26	Koppluk	304	0.028	369	0	369	210	1.8	2	184.4
	Prey Veaeng	27	Prey Veng Keut	421	0.028	511	0	511	210	2.4	3	170.3
		28	Trapaing Svay	191	0.028	232	0	232	210	1.1	2	115.9
	Prey Sa	29	Piam	323	0.028	392	10	382	210	1.8	2	190.9
		30	Thor Tray	233	0.028	283	0	283	210	1.3	2	141.5
		31	Anlong Kong	502	0.028	609	0	609	210	2.9	3	203.0
		32	Prey Sa Keut	396	0.028	480	0	480	210	2.3	3	160.1
		33	Prey Thom	285	0.028	346	0	346	210	1.6	2	172.9
		34	Prey Tituy	315	0.028	382	0	382	210	1.8	2	191.1
		35	Momphey Boun	206	0.028	250	0	250	210	1.2	2	125.0
Dangkao	Cheung Aek	36	Prek Pranak	224	0.028	272	192	80	210	0.4	1	79.8
	Trapaing Krasang	37	Trapaing Tear	390	0.028	473	0	473	210	2.3	3	157.7
		38	Trapaing Andong	428	0.028	519	0	519	210	2.5	3	173.1
		39	Trapaing Karasang	455	0.028	552	0	552	210	2.6	3	184.0
		40	Khva	182	0.028	221	0	221	210	1.1	2	110.4
		41	Veal	306	0.028	371	0	371	210	1.8	2	185.6
		42	Prey Daun Ok	118	0.028	143	0	143	210	0.7	1	143.0
	Sak Sampov	43	Sam Bour	150	0.028	182	5	177	210	0.8	1	177.0
		44	Kraing Tapho	248	0.028	301	5	296	210	1.4	2	147.9
		45	Khvet	572	0.028	694	210	484	210	2.3	3	161.3
		46	Pou Rolumn	181	0.028	220	0	220	210	1.0	1	210.0
Mean Chey	S. Mean Chey	47	Russey	4,376	0.030	5,382	4,844	538	210	2.6	3	179.4
		48	Mean Chey	5,317	0.030	6,539	6,095	444	210	2.1	3	148.0
Ruessei Keo	Khmuonh	49	Khmuonh	1,134	0.028	1,376	0	1,376	210	6.6	7	210.0
		50	Sang Raong	511	0.028	620	0	620	210	3.0	3	210.0
		51	Bunlar Soet	1,268	0.028	1,538	197	1,341	210	6.4	7	191.6
	Phnom Penh Thmei	52	Phnom Penh Thmey	3,693	0.028	4,481	4,057	423	210	2.0	3	141.0
		53	Pong Peay	1,686	0.028	2,046	1,038	1,008	210	4.8	5	201.6
		54	Dey Thmey	1,964	0.028	2,383	2,145	238	210	1.1	2	119.1
		55	Roung Chak	1,723	0.028	2,090	1,463	627	210	3.0	3	209.0
		56	Bayab	2,266	0.028	2,749	222	2,527	210	12.0	12	210.6
		57	Kok Khleang ***	1,882	0.028	2,102	1,471	631	210	3.0	3	210.2
		58	Trapaing Svay	287	0.028	348	192	156	210	0.7	1	156.2
	Tuek Thla	59	Sleng Roleung	3,322	0.028	4,030	3,627	403	210	1.9	2	201.5
	Svay Pak	60	Lor Kambao	4,258	0.028	5,166	4,649	517	210	2.5	3	172.2
Total				49,705		60,284	31,068	29,216			165	

Source: General Population Census of Cambodia 1998/ National Institute of Statistics, Ministry of Planning
Population of Village No.57 is a order of socio-economic survey (2001)

Note: DWSP: Design water supply population per handpump

Annex-2 Evaluation Criteria for Well Construction Sites

Criteria	Evaluation Standard	Point
1. Socio-economic conditions in village level		
① Willingness to form VDC	A: yes (including VDCs already existing) D: no	A: 3 D: 0
② Willingness to form VWC	A: yes D: no	A: 3 D: 0
③ Willingness to offer free land	A: yes B: maybe D: no	A: 3 B: 2 D: 0
④ Prevalence of water-borne disease	A: very common B: common C: rare D: very rare	A: 3 B: 2 C: 1 D: 0
⑤ DRWS's priority	A: high priority B: middle priority C: low priority	A: 5 B: 3 C: 1
⑥ Potentiality of groundwater based on geophysical survey	A: high potential B: middle potential C: low potential	A: 5 B: 3 C: 1
⑦ Water quality of groundwater	A: good B: acceptable C: bad	A: 5 B: 3 C: 1
2. Socio-economic conditions in proposed well construction sites		
⑧ Willingness to form WPC	A: yes D: no	A: 3 D: 0
⑨ Willingness to pay water charge	A: over 1,000 Riel B: 500-1,000 Riel C: less than 500 Riel	A: 3 B: 2 C: 1
⑩ Access condition	A: good B: acceptable C: bad	A: 5 B: 3 C: 1
⑪ Voluntary participation in land/road preparation	A: yes D: no	A: 3 D: 0
⑫ Willingness to construct platform, if material is supplied by the Project	A: yes B: yes, but need technical assistance C: no	A: 3 B: 2 C: 1
⑬ Willingness to construct fence around the well	A: yes B: maybe D: no	A: 3 B: 2 D: 0
⑭ Existing drinking water supply facility in dry season	A: Lake/Pond/River/Water Seller B: Dug Well C: Handpump	A: 3 B: 2 C: 1
⑮ Distance to the drinking supply facility in dry season	A: over 200m (including 200m) B: 100-200m (including 100m)/ Water Seller C: less than 100m	A: 3 B: 2 C: 1

Annex 6

Cost Estimation Borne by the Recipient Country

Annex 6 Cost Estimation Borne by the Recipient Country

1UD$= 122.85Yen

Phase	Subject	Item	Quantity		Unit Price (US$)	Amount (US$)	Amount (Yen)
Phase-1	D/D	Chief counterpart for Japanese team	3	M/M	25	75	
		Counterpart for cost estimation	3	M/M	20	60	
		Counterpart for geophysical survey (2 persons x 2.5M)	5	M/M	20	100	
		Counterpart for test boring (1person x 3M)	3	M/M	20	60	
		Fuel/expendable	1	LS	500	500	
		sub-total				795	97,666
	Soft Component	Counterpart for Community Development (2 persons x 19M)	36	M/M	20	720	
		Counterpart for O/M expert (1 person x 9 M)	9	M/M	20	180	
		sub-total				900	110,565
	Equipment Procurement	Arrangement of DRWS's workshop and motor pool	1	LS	500	500	
		Materials and labor cost	1	LS	500	500	
		sub-total				1,000	122,850
	Construction	Chief coordinator (1person x 13M)	13	M/M	30	390	
		Vice coordinator (1person x 13M)	13	M/M	25	325	
		Drilling crew (6 persons x 8M)	48	M/M	20	960	
		Pumping test crew (2persons x 3crew x 8.5M)	51	M/M	20	1,020	
		Handpump installation crew (2persons x 2crew x 8.5M)	34	M/M	20	680	
		Instructor for platform construction (1person x 7.1M)	7.1	M/M	20	142	
		Instructor for iron removal device (1person x 5M)	5	M/M	20	100	
		Fuel/expendable	1	LS	2,000	2,000	
		sub-total				5,617	690,048
	Workshop	Workshop crew (2persons x 8 M)	16	M/M	20	320	
		Fuel/expendable	1	LS	500	500	
		sub-total				820	100,737
	Rural road	Rehabilitation of rural road in flooding area	6	LS	500	3,000	368,550
	Commissions for Japanese foregn exchange bank		1	LS		6,407	784,800
Phase-2	D/D	Chief counterpart for Japanese team	3	M/M	25	75	
		Counterpart for cost estimation	3	M/M	20	60	
		Counterpart for geophysical survey (2 persons x 2.5M)	5	M/M	20	100	
		Fuel/expendable	1	LS	500	500	
		sub-total				735	90,295
	Soft Component	Counterpart for Community Development (2 persons x 11M)	22	M/M	20	440	
		Counterpart for O/M expert (1 person x 8 M)	8	M/M	20	160	
		sub-total				600	73,710
	Construction	Chief coordinator (1person x 13M)	13	M/M	30	390	
		Vice coordinator (1person x 13M)	13	M/M	25	325	
		Drilling crew (6 persons x 13M)	78	M/M	20	1,560	
		Pumping test crew (2persons x 3crew x 8M)	48	M/M	20	960	
		Handpump installation crew (2persons x 2crew x 8M)	32	M/M	20	640	
		Instructor for platform construction (1person x 6.7M)	6.7	M/M	20	134	
		Instructor for iron removal device (1person x 1M)	1	M/M	20	20	
		Fuel/expendable	1	LS	2,000	2,000	
		sub-total				6,029	740,663
	Workshop	Workshop crew (2persons x 13 M)	26	M/M	20	520	
		Fuel/expendable	1	LS	500	500	
		sub-total				1,020	125,307
	Rural road	Rehabilitation of rural road in flooding area	1	LS	2,000	2,000	245,700
	Commissions for Japanese foregn exchange bank		1	LS		3,684	452,600

Annex 7

Five Years Plan for Rural Water Supply Program (2001-2005)

MINISTRY OF
RURAL DEVELOPMENT

Department of Rural Water Supply

Five Years Plan for Rural Water Supply Program
2001-2005 by Technology
Target Number of Water Pont Sources

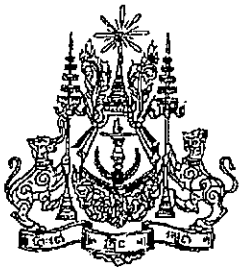
N	Technology	2001	2002	2003	2004	2005	Total
1	Hand-Dug Well	3500	3500	3700	3700	3700	18100
2	Dug-Drilled Well	1750	1750	2000	2000	2000	9500
3	Hand Pump Well	2000	2000	2000	2500	2500	11000
4	H.Pump Deep Well	1100	1100	1300	1300	1300	61001
5	Total	8350	8350	9000	9500	9500	44700

Rural Water Supply Investments by
Technology (US$.000's)

N	Technology	2001	2002	2003	3004	2005	Total
1	Hand-Dug Well	1,050	1,050	1,110	1,110	1,110	5,430
2	Dug-Drilled Well	1,137	1,137	1,300	1,300	1,300	6,175
3	Hand Pump Well	1,600	1,600	1,600	2,000	2,000	8,800
4	H.Pump Deep Well	1,760	1,760	2,080	2,080	2,080	9,760
5	Total	5,547	5,547	6,090	6,490	6,490	30,165

Rural Water Supply Technologies
Selection and Specification

N	Technology	Unit Cost $	Users/Well	Remarks
1	Hand-Dug Well	300	40	
2	Dug-Drilled Well	650	60	
3	Hand Pump Well	800	100	
4	H.Pump Deep Well	1600	120	



MINISTRY OF RURAL DEVELOPMENT

Department of Rural Water Supply

Estimated Resource Requirement for Universal Access to Water Supply in Rural Areas, 2001-2005

	Province	Total Pop. to be covered by 2005 in 000's	Total number of water points required	Remarks
1	Banteay Meanchey	240	3000	
2	Battambang	320	4000	
3	Kampot	280	3500	
4	Kandal	280	3500	
5	Koh Kong	120	1500	
6	Kg. Cham	320	4000	
7	Kg. Chhnang	120	1500	
8	Kg. Speu	200	2500	
9	Kg. Thom	120	1500	
10	Kratie	120	1500	
11	Mondulkiri	16	200	
12	Phnom Penh	240	3000	
13	Preah Vihear	40	500	
14	Prey Veng	0	0	
15	Pursath	120	1500	
16	Rattanakiri	80	1000	
17	Siem Reap	240	3000	
18	Sihanuk ville	80	1000	
19	Stung Treng	40	500	
20	Svay Rieng	200	2500	
21	Takeo	320	4000	
22	Odormeanchey	40	500	
23	Kep	20	250	
24	Pailin	20	250	
25	Total	3576	44700	

Ministry of Rural Development
Department of Rural Development
Rural Water Supply Program
Rural Water Supply Coverage by Provinces

N	Province	Total pop.	Total water points	Total pop. accessed water	Pop. needs water	Water points required	Remarks
1	Banteay Meanchey	577,300	3677	294,160	283,140	3,539	
2	Battam Bang	791,958	1791	143,280	648,678	8,108	
3	Kampot	527,904	445	35,600	492,304	61,538	
4	Kandal	1,073,586	2754	220,320	853,266	10,665	
5	Koh Kong	131,912	24	1,920	129,992	1,624	
6	Kg. Cham	1,607,913	9916	793,280	814,633	10,182	
7	Kg. Chhnang	416,999	1974	157,920	259,079	3,238	
8	Kg. Speu	598,101	2602	208,160	389,941	4,874	
9	Kg. Thom	568,454	4762	380,960	187,494	2,343	
10	Kratie	262,945	723	57,840	205,105	2,563	
11	Mondulkiri	32,392	0	0	32,392	404	
12	Phnom Penh	997,986	3061	244,880	753,106	9,413	
13	Preah Vihear	119,160	179	14,320	104,840	1,310	
14	Prey Veng	945,129	23684	945,129	0	0	
15	Pursath	360,291	1819	145,520	214,771	2,684	
16	Rattanakiri	94,188	0	0	94,188	1,177	
17	Siem Reap	695,485	3925	314,000	381,485	4,768	
18	Sihanuk Ville	155,376	52	4,160	151,216	1,890	
18	Stung Treng	80,978	173	13,840	67,138	839	
20	Svay Reang	479,710	9226	738,080	258,370	3,229	
21	Takeo	789,710	2350	188,000	601,710	7,521	
22	Odormeanchey	68,836	0	0	68,536	856	
23	Kep	28,677	108	8,640	20,037	250	
24	Pailin	22,844	21	1,680	21,164	264	
25	**Total**	**11,427,834**	**345,912**	**4,911,689**	**7,032,585**	**143,279**	

Annex 8

Results of Resistivity Survey and Water Quality Analysis

1. Hydrogeology in Peri-urban

Topography of Peri-urban area is almost flat, the range of elevation is from 8 to 15 meter; it is gradually inclining from northwest to the southeast. Tonle Sap, Mekong and Bassac river flow from the north to the south on the east side of the survey area. And Thnaiot river flows from the west to the east on the south side of this area. In the south side of Peri-urban area, a flood frequently occurs in the end of rainy season.

The bedrock of this area is sedimentary rock (Sandstone, Shale) of Paleozoic to Mesozoic or granite. A part of the bedrock is covered with Tertiary basalt. And these are covered with the Quaternary sediment. According to ESCAP (1993) the tectonic line that cuts Cambodia in the direction from the northwest to southeast is assumed. This line goes along the river of Tonle Sap in the east side of Phnom Penh city. According to USGS (1977) Bassac fault is assumed in this survey area.

The Quaternary sediment is assumed almost consisting of clay or silt. Because the porosity of clay or silt is too small, this layer has low permeability. Therefore, if the water of well is used, the phenomenon that water level does not recover occurs because the ground water does not be supplied from surroundings. So we will plan deep wells as the probability of the appearance of the sand or gravel layers in the Quaternary sediment become high. If we guess that the bedrock is shallow, we will get the ground water from the fissure of the bedrock.

We show the figure of the geological section from USGS (1977).

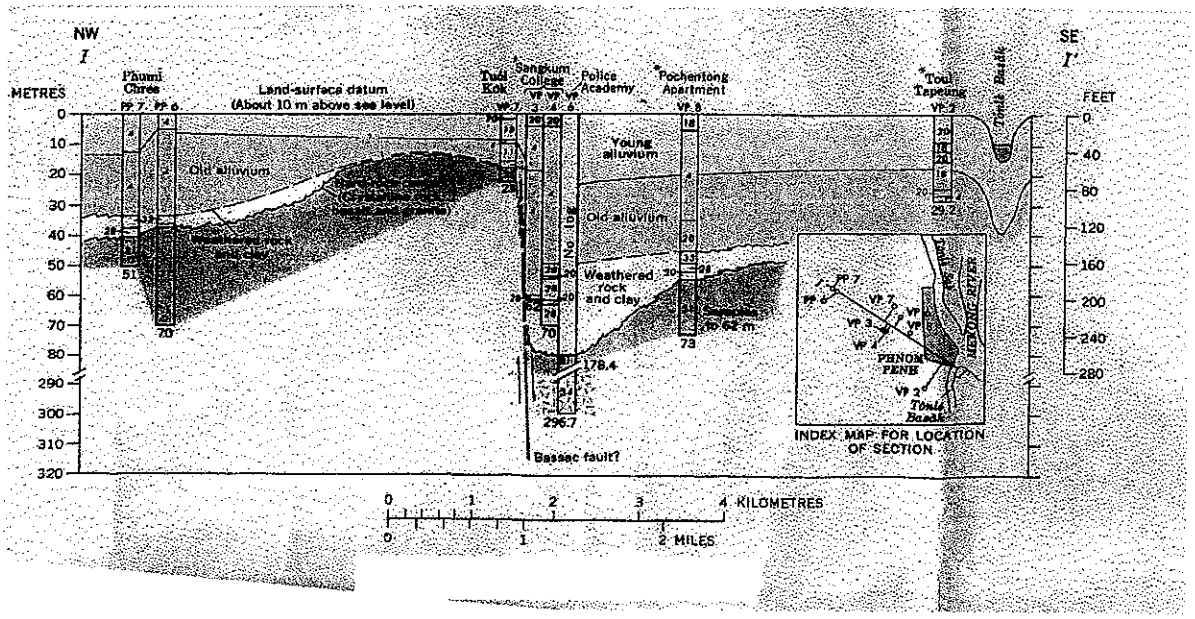


Fig-1. Geological section from USGS (1977)

The resistivity structure in this survey area is generally composed the three layers; resistivity changes high – Low – high to the deeper from the result of our survey. The resistivity of surface layer varies widely in each survey point because this is reflected the local difference such as a rice field or a roads. The resistivity of middle layer is lower than 10 Ωm in a whole

area, this layer is assumed to be the Quaternary sediment consisting of clay or silt. The lower part of the layer has almost high resistivity, this is considered to bedrock. However, the north-western part of the survey area has lower resistivity than 20Ωm.

According to the existing data, the bedrock is assumed sedimentary rock like sandstone or shale. However, there is a part indicated very high resistivity, this is considered to distributing igneous rock such as granite. And low resistivity bedrock is assumed basalt.

By the way, the surface depth of the bedrock is recognized that a deeper part exists in the center of the survey area toward the north and south.

The survey area is classified into the following three areas from the depth and resistivity of bedrock.

1. The area has shallow bedrock depth and high resistivity bedrock : Area A
2. The area has deeper bedrock depth and high resistivity bedrock : Area B
3. The area has shallower bedrock depth and low resisivity bedrock : Area C

2. Evaluation of possibility for groundwater development

We estimate the condition of groundwater in each area and the idea of setting for drilling depth as follows.

1. Area A

   As the bedrock depth is shallow, it is difficult to get enough water from the Quaternary sediment. Therefore, we consider trying to get water from the weathered layer and the fissure in the bedrock. But generally, it is low possibility to get the fissure zone in the bedrock. Consequently, we try to drill till the depth of 60m every point in this area.

2. Area B

   The reason of deep bedrock surface is considered to crustal movement such as folding or fault or to existing old river. It has higher possibility to existing groundwater than that in the area of shallow bedrock. We expect to get groundwater from sand and gravel layers in the Quaternary sediment or the weathered zone of bedrock. Drilling depth is extended from surface of bedrock to 20 m into bedrock.

3. Area C

   We estimate that the bedrock is relatively shallow and the bedrock is basalt. The basalt layer continues to deeper than 200m according to the result of resistivity survey. Fracture zone of basalt layer can be aquifer, however, we considered that there are several lava layers and it is not clear where is aquifer. Consequently, we try to drill to the depth of 120m at every point in this area.

When we considered the drilling depth, we carried out arrangement and analysis of drilling data obtained from DRWS (124 data in our area). These data include both of successful wells

and abandoned wells. We classified these data into each area, and tried to calculate the success rates. In this result, the success rates were 75% in area A, 78% in area B and 65% in area C. The average of the depths of existing wells is about 33m. There is no deep well over 50m depth in area A and B, however, there are five deep wells in area C. There are three successful wells in these deep wells, and the success rate becomes 60%. However, the data shows that even the abandoned well had much water in the pumping test. We thought that these wells abandoned after drilling by some troubles. This means the aquifer exists in this area. Consequently, we considered that we would be able to raise the success rate by drilling more deeply. We set the success rates of each area like a following table.

Table Criteria of groundwater development possibility

Area	Bedrock depth	Drilling depth	Note	Success rate
A	Shallower than 40m	60m	It is possible to get water from fissure zone in bedrock or the Quaternary sediment. However it is needed to consider the drilling point very well	85%
B	40～120m	100m (average)	It is possible to get water from the Quaternary sediment or weathered layer of bedrock.	90%
C	Deeper than 40 ～50m	120m	It is possible to get water from fissure zone in bedrock (basalt). However it is needed to consider the drilling point very well	80%

List of evaluation for groundwater development

Vill. No.	District	Commune	Village Name	No. of drilling well	Bedrock depth (m)	Bedrock resistivity (Ω·m)	Geologic Area	Depth of existing well (m)	Water table of existing well (m)	Success rate	Evaluation
1	DANGKAO	Cham Chau	Prey Pring Khang	5	30	10	C	34	10	80%	1
2		Kakab	Kakab	3	30	10	C	31~36	6~7	80%	1
3			Trapaing Chrey	2	30	10	C	28	9	80%	1
4			Prey Sala	3	35	25	C			80%	1
5		Samarang Kraom	Chamkar Sbeng	2	35	10	C	76~80	8~9	80%	1
6			Trapaing Thnong	4	50	5	C	80~90	8~9	80%	1
7			Kok Prech	2	50	5	C			80%	1
8			Tekak Panhor	3	50	10	C			80%	1
9			Sam Rong	3	50	36	C			80%	1
10			Chak Chrouk	2	40	10	C			80%	1
11			Ork Rumdoul	2	40	10	C			80%	1
12			Sre Reacheas	3	30	5	C			80%	1
13			Andong Taom	3	30	10	C			80%	1
14		Kouk Rokar	Kab Srov Toch	4	20	150	A	32		85%	3
15			Kab Srov Thom	4	90	120	B	31~34		90%	5
16			Prey Thom	1	120	100	B			90%	5
17			Toul Sam Pauv	1	105	600	B			90%	5
18			Chum Rov	2	35	5	C			80%	1
19			Thlork	2	110	50	B			90%	5
20			Phlou Phaem	2	70	10	C			80%	1
21			Putrea	2	30	30	C	27		80%	1
22			Svay Chek	3	30	30	C			80%	1
23			Kok Rokar	2	35	5	C			80%	1
24			Angk Takov	1	70	5	C	80	7	80%	1
25			Trapaing Por	2	105	200	B			90%	5
26		P. Chheh Rotch	Koppluk	2	25	100	A	30	6	85%	3
27		Prey Venn	Prey Veng Keut	3	40	190	B	28~30	5	90%	5
28			Tapaing Svay	2	60	20	B	28	9	90%	5
29		Prey Sar	Piam	2	100	150	B			90%	5
30			Thor Tray	2	100	150	B			90%	5
31			Anlong Kong	3	70	150	B			90%	5
32			Prey Sa Keut	3	90	80	B			90%	5
33			Prey Thom	2	30	30	A	27		85%	3
34			Prey Tituy	2	95	120	B	35	10	90%	5
35			Momphey Boun	2	30	130	A			85%	3
36		Cheung Aek	Prek Pranak	1	100	80	B			90%	5
37		Trapaing Karasang	Trapaing Tear	3	60	10	B			90%	5
38			Trapaing Andong	3	65	105	B			90%	5
39			Trapaing Karasang	3	20	175	A	30~33		85%	3
40			Khva	2	55	105	B			90%	5
41			Veal	2	55	10	C			80%	1
42			Prey Daun OK	1	30	20	C	55	8	80%	1
43		Sak Sampov	Sam Bour	1	40	250	B			90%	5
44			Kraing Tapho	2	70	150	B	31	10	90%	5
45			Khvet	3	110	190	B			90%	5
46			Pou Rolumn	1	110	80	B			90%	5
47	MEAN CHEY	S. Mean Chey	Russey	3	30	80	A	21~37	5~7	85%	3
48			Mean Chey	3	35	110	A			85%	3
49	RUESSEI KEO	Khmouonh	Khmuonh	7	35	140	A	54		85%	3
50			Sang Raong	3	60	100	B	31	6	90%	5
51			Bunlar Soet	7	60	300	B			90%	5
52		Phnom Penh Thmei	Phnom Penh Thmey	3	30	840	A			85%	3
53			Pong Peay	5	85	280	B			90%	5
54			Dey Thmey	2	105	45	B			90%	5
55			Roung Chak	3	25	270	A	20~28	4~5	85%	3
56			Bayab	12	20	130	A	24	7	85%	3
57			Kok Khleang	3	85	300	B			90%	5
58			Trapaing Svay	1	50	95	B			90%	5
59		Toek Thla	Sleng Roleung	2	100	1800	B	22~40	4~14	90%	5
60		Svay Park	Lor Kambao	3	75	50	B			90%	5
Total				165							

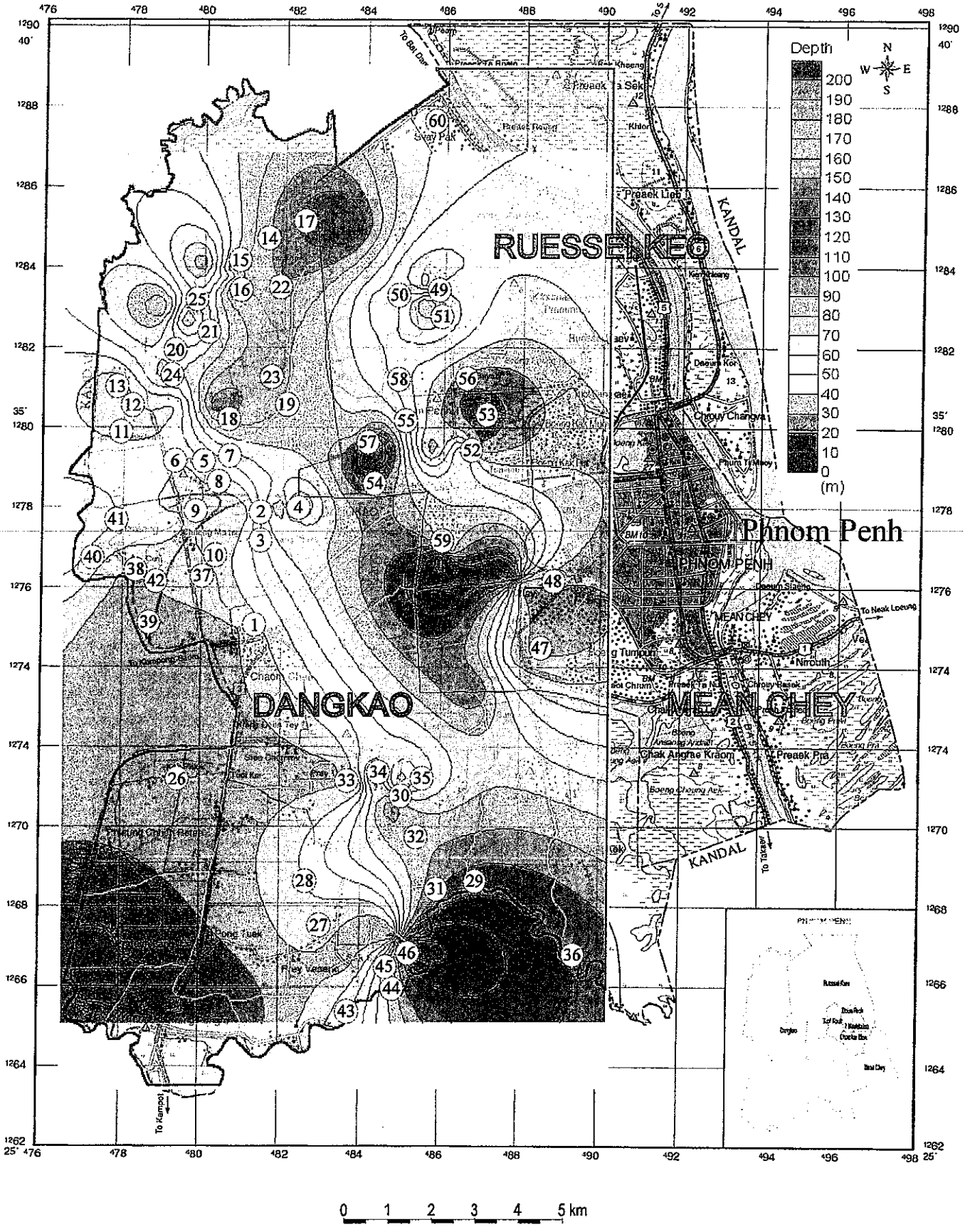


Fig.- Estimated Bedrock Depth Distribution

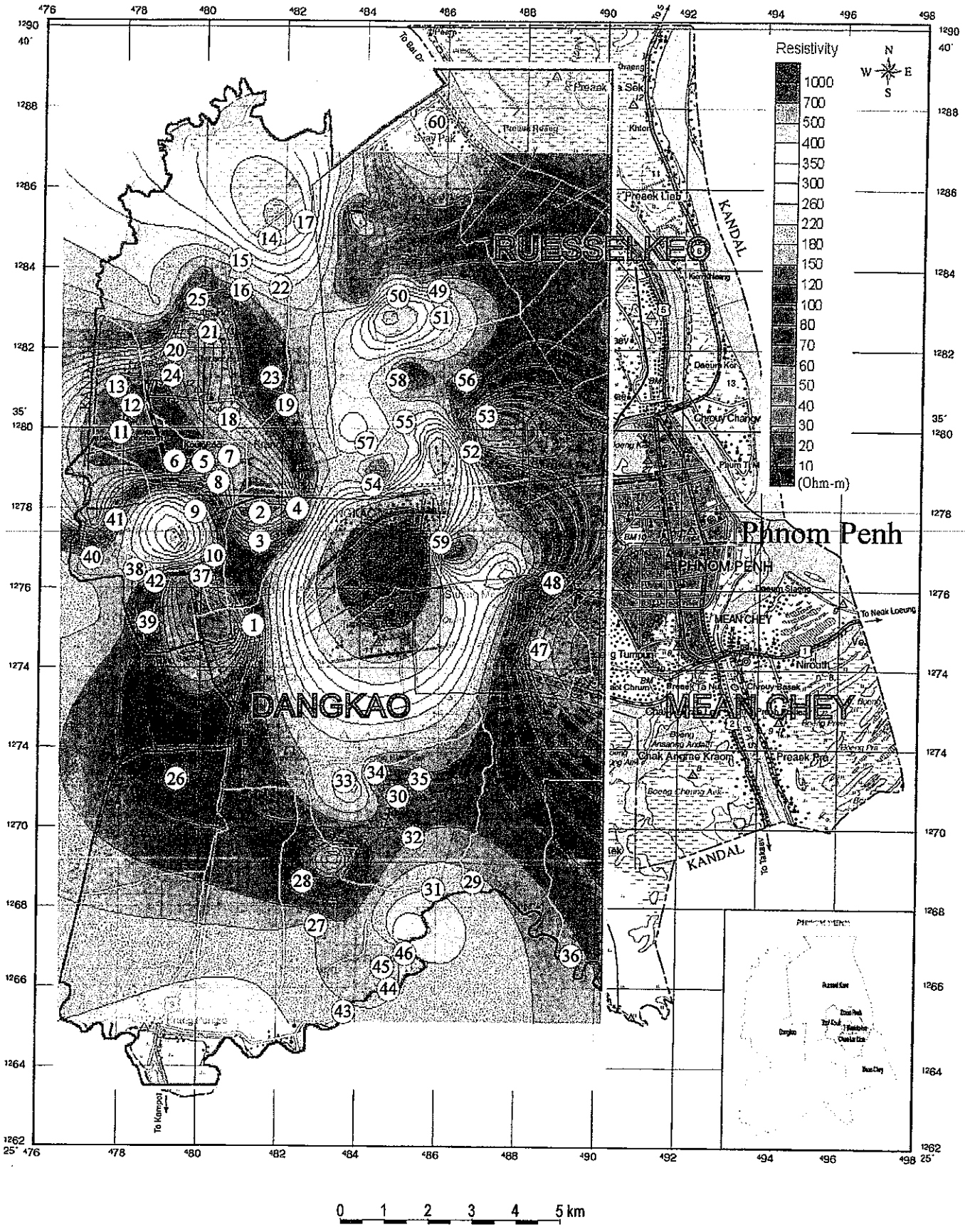


Fig.- Estimated Bedrock Resistivity Distribution

Ministry of Environment

Department of Environmental Pollution Control
Environmental Quality Research And Laboratory Office

ANALYSIS REPORT

We received thirty samples , each approximately 1000ml from the study team of Pacific Consultants International The samples were contained in the plastic bottles and marked as shown below.
On analysis , the following results were obtained :

N	Sampling Points	Turbidity (NTU)	Alkalinity (mg/l)	COD_{Cr} (mg/l)	Hardness $CaCO_3$ (mg/l)	Fluoride (mg/l)	Total Iron (mg/l)	Manganese (mg/l)	Arsenic (mg/l)	Chloride (mg/l)
		Nephelometric Method	Titration Method	Reflux Method	Photometer Method	Photometer Method	AAS Method	AAS Method	Kit	Kit (Digital)
1	PP Tmei(52)	2	570.4	11.76	130	0.85	0.09	0.03	0.0085	22.22
2	Poung Peay(53)	0.7	496.0	19.60	135	0.75	0.04	0.00	0.00	73.95
3	Ba yab(56)	17.1	535.68	7.84	115	0.60	3.09	0.14	0.00	74.75
4	Lor Kaboa(60)	10.30	530.72	15.68	240	1.35	2.93	0.73	0.35	5.81
5	Russei(47)-1	13.1	689.44	7.76	40	0.95	0.76	0.03	0.00	32.96
6	Russei(47)-2	0.8	734.08	19.40	140	1.20	0.52	0.88	0.00	460.50

7	Russei(47)-3	0.6	505.92	11.64	25	4.00	0.35	0.08	0.00	13..48
8	Mean Chey(48)-1	0.4	575.36	15.52	130	0.60	0.40	0.11	0.00	73.55
9	Mean Chey(48)-2	0.5	535.68	19.40	115	1.00	0.52	0.14	0.00	25.17
10	Mean Chey(48)-3	0.4	525.76	7.76	150	0.85	3.37	0.31	0.00	85.75
11	Kab Srov Touch(14)-1	81.7	32.73	47.04	70	0.90	4.43	5.77	0.00	0.737
12	Kab Srov Thom(15)-1	27.1	699.63	38.80	125	0.00	5.9	0.36	0.00	115.20
13	Prey Tea-1	28.6	59.52	11.47	310	0.85	1.07	0.29	0.00	11.41
14	Prey Tea-2	36.9	196.41	19.12	70	0.3	0.84	0.18	0.00	105.95
15	Trapeangsampoar -1	45.9	813.44	22.94	25	0.75	7.44	0.18	0.00	120.75
16	Trapeangsampoar -2	8.2	137.39	38.24	55	2.20	4.69	0.36	0.00	308.00
17	Prey Chisak(i)	142.1	193.44	34.41	75	0.05	1.81	0.32	0.00	81.25
18	Trapeangkrasaing (39)-1(Cin Kamp)	8.9	783.68	45.88	50	1.50	11.66	0.79	0.00	244.9
19	Near 44 (KamReang)-1	6.5	312.48	38.08	195	0.80	0.65	0.27	0.00	55.74
20	Near 44 (KamReang)-2	22.8	342.4	7.61	20	6.00	1.60	0.06	0.00	119.35
21	Ang Takov (Near N-19)	21.8	739.04	19.04	25	1.30	3.13	0.09	0.001	113.05
22	Village N-4 (Prey Sala-1)	0.7	481.12	11.42	110	5.00	0.17	0.13	0.00	346.5
23	Trapaing Svay-1 (N-058)	0.5	540.64	15.23	75	0.90	0.10	0.04	0.00	21.27
24	Near 44 (Kam Reang-3N-6)	36.8	39.68	15.84	420	0.80	2.14	1.69	0.00	408.25

25	Near 44 (Kam Reang-4N-6)	10.2	177.07	11.88	125	1.45	0.71	0.77	0.00	272.00
26	Near27(Pong Tuek)	10.0	158.72	19.80	50	13.00	0.55	0.06	0.00	47.00
27	Voat Sleang Near~~58~~ 27	2.4	124.49	23.76	90	0.50	0.48	0.52	0.00	119.35
28	Prey Rogeang Near 26	3.4	625.60	141.84	200	1.45	0.34	2.52	0.00	11.92
29	Tuolkei Near 26-1	62.9	664.64	35.46	300	0.45	1.82	0.53	0.00	330.25
30	Pearkar Near-32	100.5	55.20	43.31	110	0.50	6.47	0.19	0.00	35.81

Department Director

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Laboratory Manager

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