

**APPENDIX D**

**WATER SUPPLY**

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## 1. Service Population

No.1

### Debarwa

Year	1997	2005			2010			2015		
Zone,Village		Total Pop.	%	Supplied	Total Pop.	%	Supplied	Total Pop.	%	Supplied
Zone 1	1,884	3,701	0.90	3,331	5,078	1.00	5,078	6,719	1.00	6,719
Zone 2	1,551	3,047	0.90	2,742	4,180	1.00	4,180	5,532	1.00	5,532
Geza Lamza	1,396	2,742	0.70	1,920	3,762	0.85	3,198	4,979	1.00	4,979
Total	4,831	9,490	0.84	7,993	13,020	0.96	12,456	17,230	1.00	17,230
Projected Pop.		9,490			13,020			17,230		

### Mendefera

Year	1997	2005			2010			2015		
Zone,Village		Total Pop.	%	Supplied	Total Pop.	%	Supplied	Total Pop.	%	Supplied
Western zone										
5	1,398	2,227	0.60	1,336	2,857	0.80	2,286	3,629	1.00	3,629
6	2,005	3,194	0.70	2,236	4,097	0.85	3,483	5,204	1.00	5,204
7	4,089	6,513	0.80	5,211	8,356	0.90	7,520	10,614	1.00	10,614
8	2,275	3,624	0.70	2,537	4,650	0.80	3,720	5,906	1.00	5,906
Eastern zone										
1	2,743	4,370	0.70	3,059	5,606	0.85	4,765	7,121	1.00	7,121
2	2,934	4,674	0.70	3,272	5,996	0.85	5,096	7,616	1.00	7,616
4	2,192	3,491	0.60	2,095	4,479	0.75	3,359	5,689	1.00	5,689
Adi Bari	1,488	2,370	0.00	0	3,041	1.00	3,041	3,863	1.00	3,863
Adi Wegri	708	1,128	0.00	0	1,447	0.00	0	1,838	1.00	1,838
Adi Hare	539	859	0.00	0	1,101	0.00	0	1,399	1.00	1,399
Total	20,371	32,450	0.61	19,745	41,630	0.80	33,270	52,880	1.00	52,880
Projected Pop.		32,450			41,630			52,880		

### Adiquala

Year	1997	2005			2010			2015		
Zone,Village		Total Pop.	%	Supplied	Total Pop.	%	Supplied	Total Pop.	%	Supplied
Adiquala										
Zone 1	1,475	2,399	1.00	2,399	3,004	1.00	3,004	3,685	1.00	3,685
Zone 2	1,818	2,956	1.00	2,956	3,701	1.00	3,701	4,541	1.00	4,541
Zone 3	1,857	3,020	1.00	3,020	3,782	1.00	3,782	4,639	1.00	4,639
Zone 4	2,075	3,374	1.00	3,374	4,224	1.00	4,224	5,182	1.00	5,182
Geza Gebrai	335	545	0.00	0	682	1.00	682	837	1.00	837
Geza Azazi	334	543	0.00	0	680	1.00	680	834	1.00	834
Adi Arbaa	625	1,016	0.00	0	1,273	0.00	0	1,561	1.00	1,561
Geza Atat	87	141	0.00	0	177	1.00	177	217	1.00	217
Tekerakari	117	190	0.00	0	238	1.00	238	292	1.00	292
Adi Hihi	306	498	0.00	0	623	0.00	0	764	1.00	764
Adi Mini	201	327	0.00	0	409	0.00	0	502	1.00	502
Adi Shinfiio	258	420	0.00	0	525	0.00	0	644	1.00	644
Total	9,488	15,430	0.76	11,750	19,320	0.85	16,490	23,700	1.00	23,700
Projected Pop.		15,430			19,320			23,700		

## Dekemhare

No.2

Year	1997	2005			2010			2015		
Zone,Village		Total Pop.	%	Supplied	Total Pop.	%	Supplied	Total Pop.	%	Supplied
Zone 1										
1	3,163	5,016	0.60	3,009	6,425	0.80	5,140	8,155	1.00	8,155
2	3,168	5,024	0.90	4,522	6,436	1.00	6,436	8,168	1.00	8,168
3	1,746	2,768	0.70	1,938	3,546	0.85	3,015	4,501	1.00	4,501
4	1,024	1,623	0.90	1,461	2,080	1.00	2,080	2,639	1.00	2,639
5	776	1,230	1.00	1,230	1,576	1.00	1,576	2,000	1.00	2,000
Zone 2										
6	2,616	4,148	1.00	4,148	5,314	1.00	5,314	6,744	1.00	6,744
7	2,057	3,261	1.00	3,261	4,178	1.00	4,178	5,302	1.00	5,302
8	2,106	3,339	1.00	3,339	4,278	1.00	4,278	5,429	1.00	5,429
9	2,920	4,631	0.80	3,705	5,932	1.00	5,932	7,529	1.00	7,529
Hadamu	1,192	1,890	0.00	0	2,421	0.00	0	3,073	1.00	3,073
Metsalu	314	498	0.00	0	638	0.00	0	810	1.00	810
Amhare	593	940	0.00	0	1,205	0.00	0	1,529	1.00	1,529
Total	21,675	34,370	0.77	26,614	44,030	0.86	37,949	55,880	1.00	55,880
Projected Pop.		34,370			44,030			55,880		

## Segeneiti

Year	1997	2005			2010			2015		
Zone,Village		Total Pop.	%	Supplied	Total Pop.	%	Supplied	Total Pop.	%	Supplied
1	2,477	4,304	0.80	3,443	5,513	0.90	4,962	6,851	1.00	6,851
2	3,669	6,376	0.60	3,826	8,167	0.80	6,534	10,149	1.00	10,149
Total	6,146	10,680	0.68	7,269	13,680	0.84	11,495	17,000	1.00	17,000
Projected Pop.		10,680			13,680			17,000		

## Adi Keyih

Year	1997	2005			2010			2015		
Zone,Village		Total Pop.	%	Supplied	Total Pop.	%	Supplied	Total Pop.	%	Supplied
Zone 1	7,837	12,212	0.70	8,548	15,057	0.85	12,798	18,293	1.00	18,293
Zone 2	6,378	9,938	0.80	7,951	12,253	1.00	12,253	14,887	1.00	14,887
Total	14,215	22,150	0.74	16,499	27,310	0.92	25,052	33,180	1.00	33,180
Projected Pop.		22,150			27,310			33,180		

## Senafe

Year	1997	2005			2010			2015		
Zone,Village		Total Pop.	%	Supplied	Total Pop.	%	Supplied	Total Pop.	%	Supplied
Zone 1										
1	730	1,147	0.90	1,033	1,419	1.00	1,419	1,728	1.00	1,728
2	1,022	1,606	0.80	1,285	1,986	1.00	1,986	2,419	1.00	2,419
3	876	1,377	0.80	1,102	1,703	1.00	1,703	2,073	1.00	2,073
Zone 2										
4	3,549	5,578	0.70	3,905	6,898	0.90	6,208	8,398	1.00	8,398
5	1,971	3,099	1.00	3,099	3,832	1.00	3,832	4,666	1.00	4,666
6	2,366	3,719	1.00	3,719	4,598	1.00	4,598	5,599	1.00	5,599
Metera	1,178	1,852	0.80	1,481	2,290	0.90	2,061	2,788	1.00	2,788
Awle	590	927	0.00	0	1,147	0.00	0	1,396	1.00	1,396
Hahahile	0	0	0.00	0	0	0.00	0	0	1.00	0
Tisha	652	1,025	0.00	0	1,267	0.00	0	1,543	1.00	1,543
Afema	0	0	0.00	0	0	0.00	0	0	1.00	0
Total	12,934	20,330	0.77	15,623	25,140	0.87	21,807	30,610	1.00	30,610
Projected Pop.		20,330			25,140			30,610		

## Total

Target Year	1997	2005			2010			2015		
		Total Pop.	%	Supplied	Total Pop.	%	Supplied	Total Pop.	%	Supplied
Grand Total	89,660	144,900	0.73	105,491	184,130	0.86	158,518	230,480	1.00	230,480

## 2. Water Demand

Name of Town	Year	Population		%	Average Water Demand (m <sup>3</sup> /d)					Daily Max. (m <sup>3</sup> /d)	Hourly (m <sup>3</sup> /h)
		Whole	Supply area		Domestic	Industry	Others	Loss	Total		
Debarwa	2005	9,490	7,990	84.2	150	141	51	342	411	25.7	
	2010	13,020	12,460	95.7	247	81	94	629	754	47.2	
	2015	17,230	17,230	100.0	390	271	165	1,098	1,318	82.3	
Mendefera	2005	32,450	19,750	60.9	456	253	125	834	1,001	62.6	
	2010	41,630	33,270	79.9	979	314	285	1,902	2,283	142.7	
	2015	52,880	52,880	100.0	1,840	413	470	3,134	3,761	235.1	
Adiquala	2005	15,430	11,750	76.2	241	136	66	443	532	33.2	
	2010	19,320	16,490	85.4	389	170	99	658	789	49.3	
	2015	23,700	23,700	100.0	728	208	165	1,102	1,322	82.6	
Dekemhare	2005	34,370	26,610	77.4	615	320	165	1,100	1,320	82.5	
	2010	44,030	37,950	86.2	1,117	210	307	2,044	2,452	153.3	
	2015	55,880	55,880	100.0	1,945	1,050	620	4,135	4,962	310.1	
Segeneiti	2005	10,680	7,270	68.1	136	107	43	287	344	21.5	
	2010	13,680	11,500	84.1	228	138	65	431	517	32.3	
	2015	17,000	17,000	100.0	385	171	98	654	785	49.0	
Adi Keyih	2005	22,150	16,500	74.5	381	220	106	707	849	53.0	
	2010	27,310	25,050	91.7	737	271	178	1,186	1,424	89.0	
	2015	33,180	33,180	100.0	1,155	329	262	1,746	2,095	130.9	
Senafe	2005	20,330	15,620	76.8	321	174	87	582	698	43.6	
	2010	25,140	21,810	86.8	515	215	129	859	1,030	64.4	
	2015	30,610	30,610	100.0	940	261	212	1,414	1,697	106.0	
Total	2005	144,900	105,490	72.8	2,301	1,350	644	4,295	5,154	322.1	
	2010	184,130	158,530	86.1	4,214	605	1,733	7,708	9,250	578.1	
	2015	230,480	230,480	100.0	7,383	1,734	1,992	13,283	15,939	996.2	

## (1) Population

	Debarwa		Mendefera		Adiquala		Dekemhare		Segeneiti		Adi Keyih		Senafe	
	%	l/c/d	%	l/c/d	%	l/c/d	%	l/c/d	%	l/c/d	%	l/c/d	%	l/c/d
Water consumption														
1997														
H.C.	1.25	25	10.94	24.11	13.86	20.45	5.67	25.59	3	28.73	4.95	11.66	7.78	10.3
Y.C.			6.56	14.95	6.14	12.07	8.67	15.67	5	12.64	10.64	5.94	6.62	6.8
C.W.P.	41.7	8.56	29.2	10.13	63.6	14.31			90.5	16.45	13.94	8.79	83.8	8.04
Average		9.0		14.1		15.2		19.6		16.6		8.2		8.1
Population		4,831		20,371		9,488		21,675		6,146		14,215		12,934
Water Demand		44		287		144		425		102		117		105
2005														
H.C.	17	28	29	35	23	29	29	35	17	28	29	35	23	29
Y.C.	22	22	33	22	33	22	33	22	22	22	33	22	33	22
C.W.P.	61	15	38	15	44	15	38	15	61	15	38	15	44	15
Average		18.8		23.1		20.5		23.1		18.8		23.1		20.5
Population		7,990		19,750		11,750		26,610		7,270		16,500		15,620
Water Demand		150		456		241		615		136		381		321
2010														
H.C.	19	30	34	40	27	34	34	40	19	30	34	40	27	34
Y.C.	24	24	66	24	37	24	66	24	24	24	66	24	37	24
C.W.P.	56	15	0	15	37	15	0	15	56	15	0	15	37	15
Average		19.9		29.4		23.6		29.4		19.9		29.4		23.6
Population		12,460		33,270		16,490		37,950		11,500		25,050		21,810
Water Demand		247		979		389		1,117		228		737		515
2015														
H.C.	22	35	39	47	31	39	39	47	22	35	39	47	31	39
Y.C.	27	27	61	27	69	27	61	27	27	27	61	27	69	27
C.W.P.	51	15	0	15	0	15	0	15	51	15	0	15	0	15
Average		22.6		34.8		30.7		34.8		22.6		34.8		30.7
Population		17,230		52,880		23,700		55,880		17,000		33,180		30,610
Water Demand		390		1,840		728		1,945		385		1,155		940

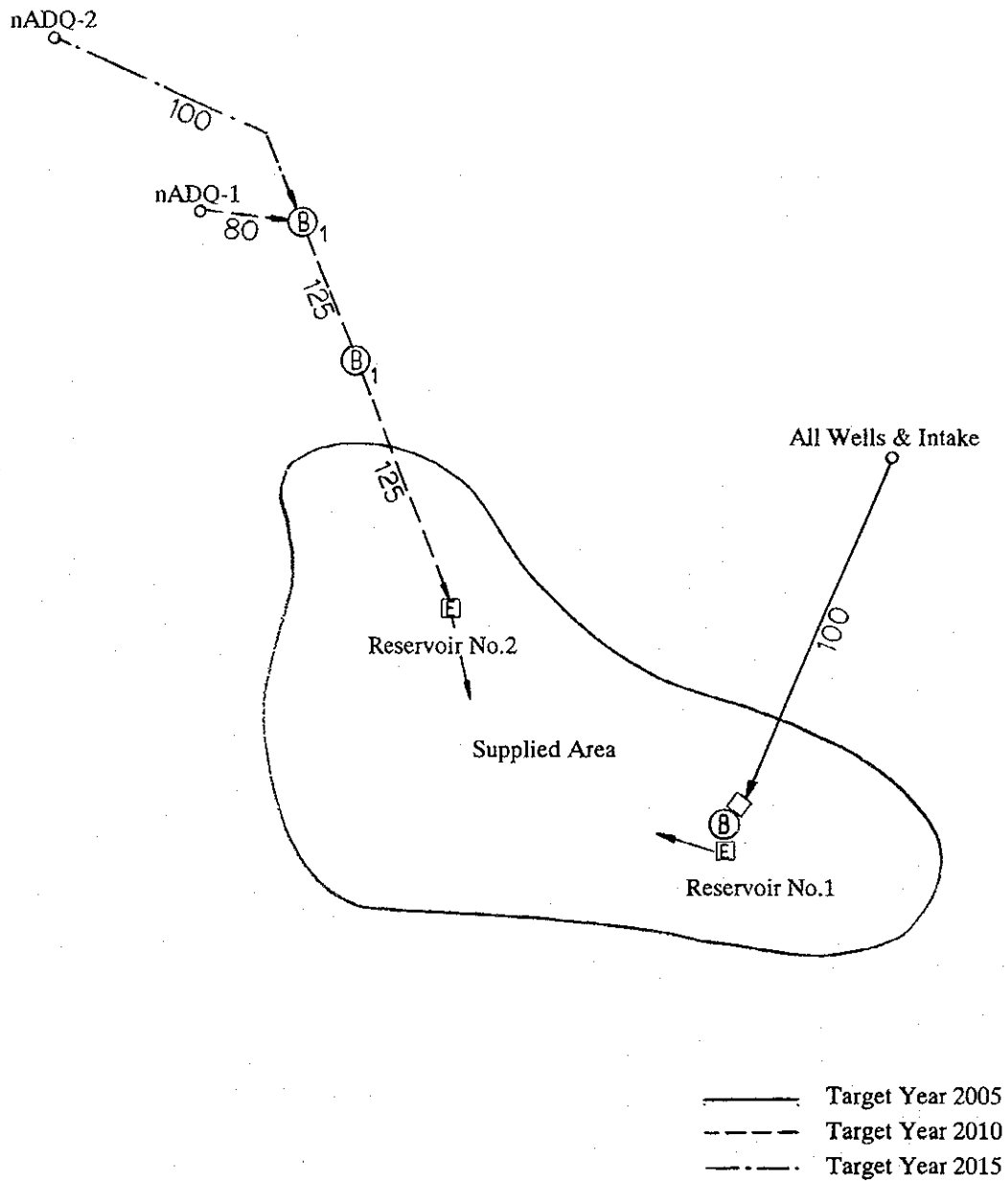
(2) Industry	unit	Water consum.	Debarwa	Mendefera	Adiquala	Dekemhare	Segeneiti	Adi Keyih	Senafe
Industry	ha	15,000	18.09			70			
Light Indus.		5,500		57					
				75					
Total			18.09			70.00			
Water Demand		2005							
		2010	81	314		210			
		2015	271	413		1,050			

(3) Number of Institutions	unit	Water consum.	Debarwa	Mendefera	Adiquala	Dekemhare	Segeneiti	Adi Keyih	Senafe
School	pupil	5	3,228	15,120	5,901	7,905	3,111	6,233	3,649
Hospital	bed	100	20	30	20	20	35	40	35
Clinic	bed	100	5	5		5	5	5	5
Hotel	shop	210	5	13	7	13	5	17	13
Bar, Tea shop	shop	210	68	79	20	103	16	72	63
Restaurant	shop	210	85	75	60	61	20	45	80
Church	visitor	5	450	1,430	790	2,020	580	1,180	830
Mosque	visitor	5	60	1,220	320	300	70	480	930
Office	person	5	570	1,641	1,005	1,812	690	990	738
Factory	site	1000	19	23	23	102	27	64	43
Water Demand		1997	76	159	83	202	62	141	110
(Others)		2005	141	253	136	320	107	220	174
		2010	206	324	170	410	138	271	215
		2015	272	412	208	520	171	329	261



## 2.1 Plan of Water Source and Transmission Pipelines

Adiquala



2.2 Hydraulic Calculation of Transmission Pipeline

**Hydraulic Calculation of Transmission Line**

Adiquala	Target Year		2005		2010		2015	
	Well No.	Unit	All Ex. & Intake	Intake	Intake	nADQ-1	nADQ-1	nADQ-2
	Symbol		24hr ope.	24hr ope.	24hr ope.	24hr ope.	24hr ope.	24hr ope.
Elevation of Intake	EL1	m	1815.25	1815.25	1815.25	1500	1500	1480
Ground water level		m	10.00	10.00	10.00	10.00	10.00	10.00
Elevation of Reservoir	EL2	m	1890.50	1890.50	1890.50	1908.00	1908.00	1908.00
Water level		m	3.00	3.00	3.00	3.00	3.00	3.00
Discharge	Q	m <sup>3</sup> /d	532	532	532	277	277	518
Discharge	Q1	m <sup>3</sup> /s	0.0062	0.0062	0.0062	0.0032	0.0032	0.0060
Pipe Diameter	D	mm	100	100	100	80	80	100
Velocity	V	m/s	0.78	0.78	0.78	0.64	0.64	0.76
Velocity Coefficient	C		110	110	110	110	110	110
Pipe Length	L	m	2851	2851	2851	100	100	1900
Loss Head	h2	m	30.68	30.68	30.68	0.95	0.95	19.46
Actual Head	h1	m				23.00	23.00	43.00
Total Head	H	m				23.00	23.95	62.46
Booster Pump								
Elevation of Booster P		m				(BP No.1)		(BP No.1)
Discharge	Q	m <sup>3</sup> /d				1510.00		1510.00
Discharge	Q1	m <sup>3</sup> /s				277		795
Pipe Diameter	D	mm				0.0032		0.0092
Velocity	V	m/s				125		125
Velocity Coefficient	C					0.26		0.75
Pipe Length	L	m				110		110
Loss Head	h2	m				5000		5000
Actual Head	h1	m	88.25	88.25	88.25	401.00		401.00
Total Head	H	m	118.93	118.93	118.93	406.43		439.16

"24 hrs ope." means that pumps are operated 24 hours per day.  
 - "\*" means that booster pumps shall be installed in the line.

### 2.3 Capacity of Pump Pit

#### Capacity of Pump Pit

Name of Town	B.P. No.	Target Year	Max. Daily Consumption (m <sup>3</sup> /s)	Pit Capacity		Dimension of Pump Pit			Additional Pump Pit				Remarks			
				Necessary (m <sup>3</sup> )	Design (m <sup>3</sup> )	Length (m)	Width (m)	High (m)	Actual (m <sup>3</sup> )	Capacity (m <sup>3</sup> )	Length (m)	Width (m)		High (m)	Actual (m <sup>3</sup> )	
Mendefera	BP-1	2005	0.0040	7.2	15	3.0	2.5	2.0								
	BP-2	2005	0.0040	7.2	15	3.0	2.5	2.0								
	BP-3	2010	0.0120	21.6	25	5.0	2.5	2.0								
	BP-4	2010	0.0150	27.0	30	6.0	2.5	2.0								
	BP-5	2015	0.0171	30.8	35	7.0	2.5	2.0								
Adiquala	BP-1	2010	0.0032	5.8	15	3.0	2.5	2.0							15	
	BP-1	2015	0.0092	16.6	20	4.0	2.5	2.0			1.0	2.5	2.0	5	2.0	5
Dekembhare	BP-1	2005	0.0153	27.5	30	6.0	2.5	2.0								30
	BP-1	2010	0.0241	43.4	45	9.0	2.5	2.0			3.0	2.5	2.0	15	2.0	15
	BP-2	2015	0.0291	52.4	55	7.5	3.0	2.5								
Segenciti	BP-1	2005	0.0040	7.2	15	3.0	2.5	2.0								
	BP-1	2010	0.0044	7.9	15	3.0	2.5	2.0								
	BP-1	2015	0.0046	8.3	15	3.0	2.5	2.0								
	BP-1'	2010	0.0060	10.8	15	3.0	2.5	2.0								
	BP-1'	2015	0.0072	13.0	15	3.0	2.5	2.0								
Aadi Keyih	BP-2	2010	0.0016	2.9	15	3.0	2.5	2.0								
	BP-2	2015	0.0026	4.7	15	3.0	2.5	2.0								
	BP-1	2005	0.0050	9.0	15	3.0	2.5	2.0								
	BP-1	2010	0.0064	11.5	15	3.0	2.5	2.0								
	BP-2	2005	0.0048	8.6	15	3.0	2.5	2.0								
	BP-2	2010	0.0064	11.5	15	3.0	2.5	2.0								
	BP-3	2010	0.0020	3.6	15	3.0	2.5	2.0								
	BP-4'	2010	0.0024	4.3	15	3.0	2.5	2.0								
Senafe	BP-4	2010	0.0024	4.3	15	3.0	2.5	2.0								
	BP-5	2015	0.0073	13.1	15	3.0	2.5	2.0								
	BP-6	2015	0.0097	17.5	20	4.0	2.5	2.0								
	BP-1	2010	0.0048	8.6	15	3.0	2.5	2.0								
	BP-1	2015	0.0080	14.4	15	3.0	2.5	2.0								
	BP-2	2015	0.0034	6.1	15	3.0	2.5	2.0								

2.4 Capacity of Reservoir

Capacity of Reservoir

No.1

Name of Town	Rsv. No.	Target Year	Max. Daily Consumption (m <sup>3</sup> /d)	Reservoir Capacity		Dimension of Reservoir			Additional Reservoir				Remarks			
				Necessary (m <sup>3</sup> )	Design (m <sup>3</sup> )	Length (m)	Width (m)	High (m)	Actual (m <sup>3</sup> )	Capacity (m <sup>3</sup> )	Length (m)	Width (m)		High (m)	Actual (m <sup>3</sup> )	
Debarwa	DB-1	2005	411	137	140	7.0	7.0	3.0						147		
	DB-1	2010	754	251	260	9.6	9.0	3.0						116		
	DB-1	2015	1,318	439	440	12.5	12.0	3.0						189		
Mendefera	MD-1	2005	1,001	334	340	10.0	10.0	3.5						350		
	MD-1	2010	2,283	761	770	15.0	15.0	3.5						438		
	(80.0)	2015	3,009	1003	1010	17.0	17.0	3.5						245		
	(13.7)	2015	515	172	180	8.5	8.5	2.5								
Adiquala	(3.4)	2015	128	43	50	4.5	4.5	2.5								
	(2.9)	2015	109	36	40	4.0	4.0	2.5								
	AQ-1	2005	532	177	180	7.5	8.0	3.0						180		
	(81.0)	2010	639	213	220	8.6	8.6	3.0						48		
	(63.8)	2015	843	281	290	10.0	10.0	3.0						68		
	AQ-1'	2005	532	22	25	3.5	3.0	2.5						26	H=13m, Q=1hr	
	AQ-1'	2010	639	27	30	3.5	3.5	2.5						8	H=13m, Q=1hr	
	AQ-1'	2015	843	35	35	4.0	4.0	2.5						8	H=13m, Q=1hr	
(19.0)	AQ-2	2010	150	50	50	4.0	4.5	3.0						54	H=13m	
	(30.5)	2015	403	134	140	7.0	7.0	3.0						91	H=13m	
	(5.7)	2015	75	25	30	3.5	3.5	2.5							Mini & Shinfio	
Dekemhare	(84.2+15.8)	2005	1,320	440	440	8.5	15.0	3.5						446		
	(88.8+11.2)	2010	2,452	817	820	16.0	15.0	3.5						394		
	(86.7+6.0)	2015	4,600	1533	1540	30.0	15.0	3.5						735		
	(15.8)	2005	209	9	10	2.0	3.0	2.0						12	H=12m, Q=1hr	
(11.2)	DK-1'	2010	275	11	15	3.0	3.0	2.0						18	H=12m, Q=1hr	
	(6.0)	2015	298	12	15	3.0	3.0	2.0						18	H=12m, Q=1hr	
(2.9)	2015	144	48	50	4.5	4.5	2.5								Hadamu	
(1.8)	2015	89	30	30	3.5	3.5	2.5								Metsalu	
(2.6)	2015	129	43	50	4.5	4.5	2.5								Ambhare	

Capacity of Reservoir

No.2

Name of Town	Rsv. No.	Target Year	Max. Daily Consumption (m <sup>3</sup> /d)	Reservoir Capacity		Dimension of Reservoir			Additional Reservoir				Remarks		
				Necessary (m <sup>3</sup> )	Design (m <sup>3</sup> )	Length (m)	Width (m)	High (m)	Actual (m <sup>3</sup> )	Capacity (m <sup>3</sup> )	Length (m)	Width (m)		High (m)	Actual (m <sup>3</sup> )
Segeneti (74.0) (50.9) (26.0) (49.1)	SG-1	2005	344	115	120	7.0	7.0	2.5	123					123	
	SG-1	2010	383	128	130	7.2	7.2	2.5	130	10	2.0	2.0	2.5	10	
	SG-1	2015	400	133	140	7.5	7.5	2.5	141	10	2.0	2.0	2.5	10	
	SG-2	2010	134	45	50	4.5	4.5	2.5	51					51	H=12.5m
	SG-2	2015	385	128	130	7.2	7.2	2.5	130	80	6.0	6.0	2.5	90	H=12.5m
	AD-1	2005	849	283	290	10.0	10.0	3.0	300					300	H=5.5m
Aadi Keyih	AD-1	2010	1,424	475	480	12.5	13.0	3.0	488	190	6.5	10.0	3.0	195	H=5.5m
	AD-1	2015	2,095	698	700	15.5	15.5	3.0	721	220	7.5	10.0	3.0	225	H=5.5m
															Existing
Senafe	SN-1	2005	698	233	240				600						
	SN-1	2010	1,030	343	350				600						
(81.4) (18.6)	SN-1	2015	1,381	460	470				600						
	SN-2	2015	316	105	110	6.5	6.5	2.6	110						Afema

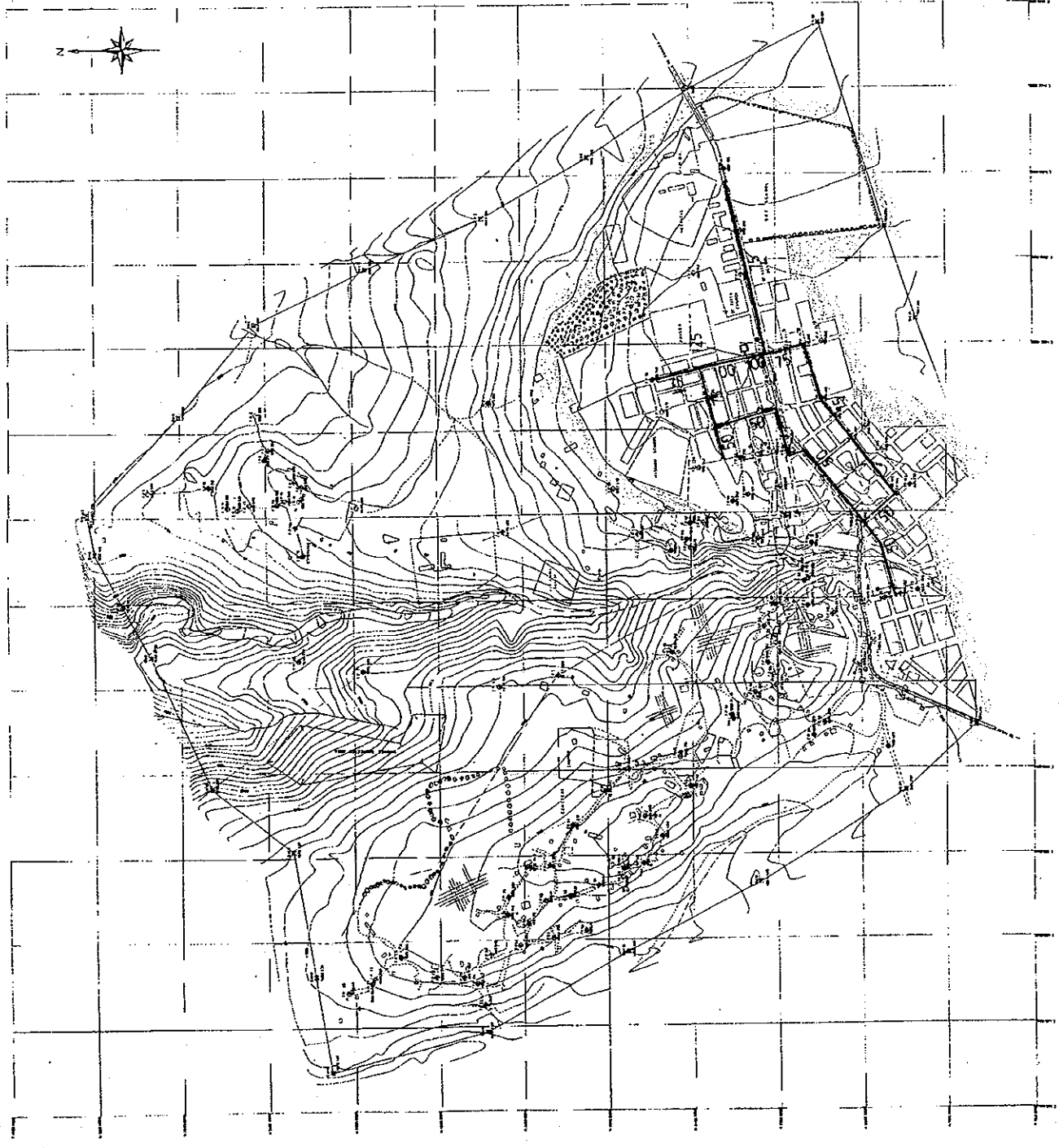
# 2.5 Plan of Distribution Pipeline (2005)

STATE OF ERITREA MINISTRY OF LAND, WATER & ENVIRONMENT	ADISUHALA	2005
JAPAN INTERNATIONAL COOPERATION AGENCY		
STUDY ON GROUNDWATER DEVELOPMENT & WATER SUPPLY FOR SEVEN TOWNS IN SOUTHERN REGION		
WATER RESOURCES DEPARTMENT (ADISUHALA, ERITREA)	Scale: 1:15,000	Drawing No.
SANTO CONSULTANTS INC.		JAPAN

Legend  
Distribution pipeline  
Pipe Diameter (mm)

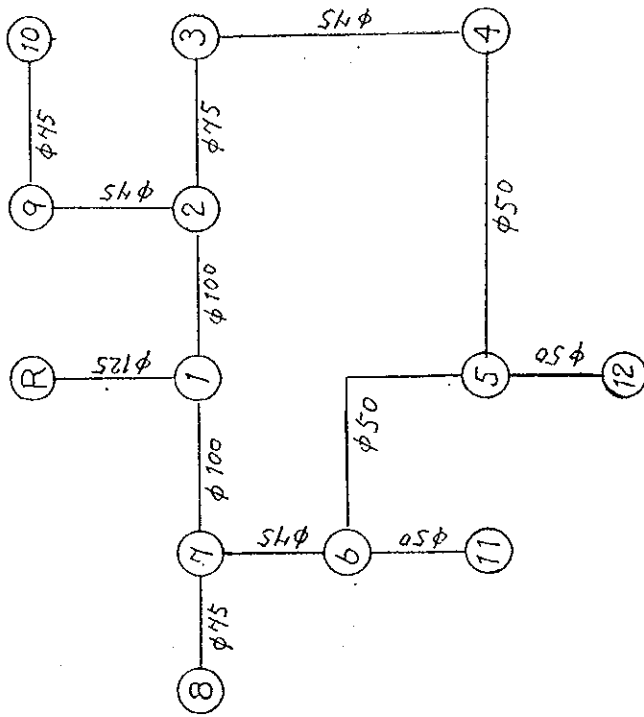
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S = 1:15,000  
0 100 200 300 400 500 M



Plan of Distribution Pipeline (2005)

ADIQUALA 2005



Node No.	Dynamic (WL.m)	Ground Elevation (EL.m)	Effective Head (m)	Area (ha)	Outflow Quantity (L/sec)
0	1903.500	1890.500	13.000	-75.50	-9.22
1	1903.389	1891.900	11.489	0.00	0.00
2	1902.949	1891.700	11.249	0.00	0.00
3	1901.938	1891.300	10.638	8.10	0.99
4	1899.673	1888.600	11.073	9.40	1.15
5	1898.847	1886.500	12.347	5.70	0.70
6	1901.960	1888.300	13.660	5.20	0.64
7	1902.642	1889.800	12.842	3.50	0.43
8	1901.616	1884.300	17.316	14.40	1.76
9	1901.253	1890.100	11.153	6.70	0.82
10	1900.867	1887.900	12.967	11.10	1.56
11	1901.408	1884.900	16.509	4.50	0.55
12	1896.030	1891.000	5.030	6.90	0.84



Pipe line	Node No.	Dia. (mm)	Length (m)	Flow Coefficient	Flow (L/sec)	velocity (m/sec)	Loss of Head (m)	Hydraulic Gradient (m/1000m)	Head Loss Coefficient	Hydrostatic Head	Water Hammer Head	Design Pressure (kg/sq:cm)	Pipe Material
No.	From	To	(mm)	(m)	(L/sec)	(m/sec)	(m)	(m/1000m)				(kg/sq:cm)	
1	0	1	125	15.00	110	9.1	0.743	0.111	0.03275	1.38	1.38	2.75	
2	1	2	100	58.00	110	5.1	0.655	0.440	0.03463	1.26	1.26	2.51	
3	2	3	75	90.00	110	3.0	0.676	1.011	0.03617	1.29	1.29	2.59	
4	3	4	75	426.00	110	2.0	0.451	2.265	0.03840	1.56	1.56	3.13	
5	4	5	50	106.00	110	0.8	0.429	0.825	0.04139	1.77	1.77	3.54	
6	5	6	50	570.00	110	-0.7	-0.355	-3.113	-0.04258	1.77	1.77	3.54	
7	6	7	75	143.00	110	-1.9	-0.425	-0.682	-0.03874	1.59	1.59	3.19	
8	7	1	100	154.00	110	-4.0	-0.515	-0.747	-0.03590	1.44	1.44	2.89	
9	7	8	75	243.00	110	1.8	0.398	1.026	0.03911	1.99	1.99	3.99	
10	2	9	75	276.00	110	2.2	0.488	1.696	0.03796	1.41	1.41	2.83	
11	9	10	75	148.00	110	1.4	0.307	0.385	0.04066	1.63	1.63	3.27	
12	6	11	50	156.00	110	0.6	0.280	0.552	0.04408	1.93	1.93	3.87	
13	5	12	50	362.00	110	0.8	0.429	2.817	0.04139	1.77	1.77	3.54	
* 合計													
												2747.00	

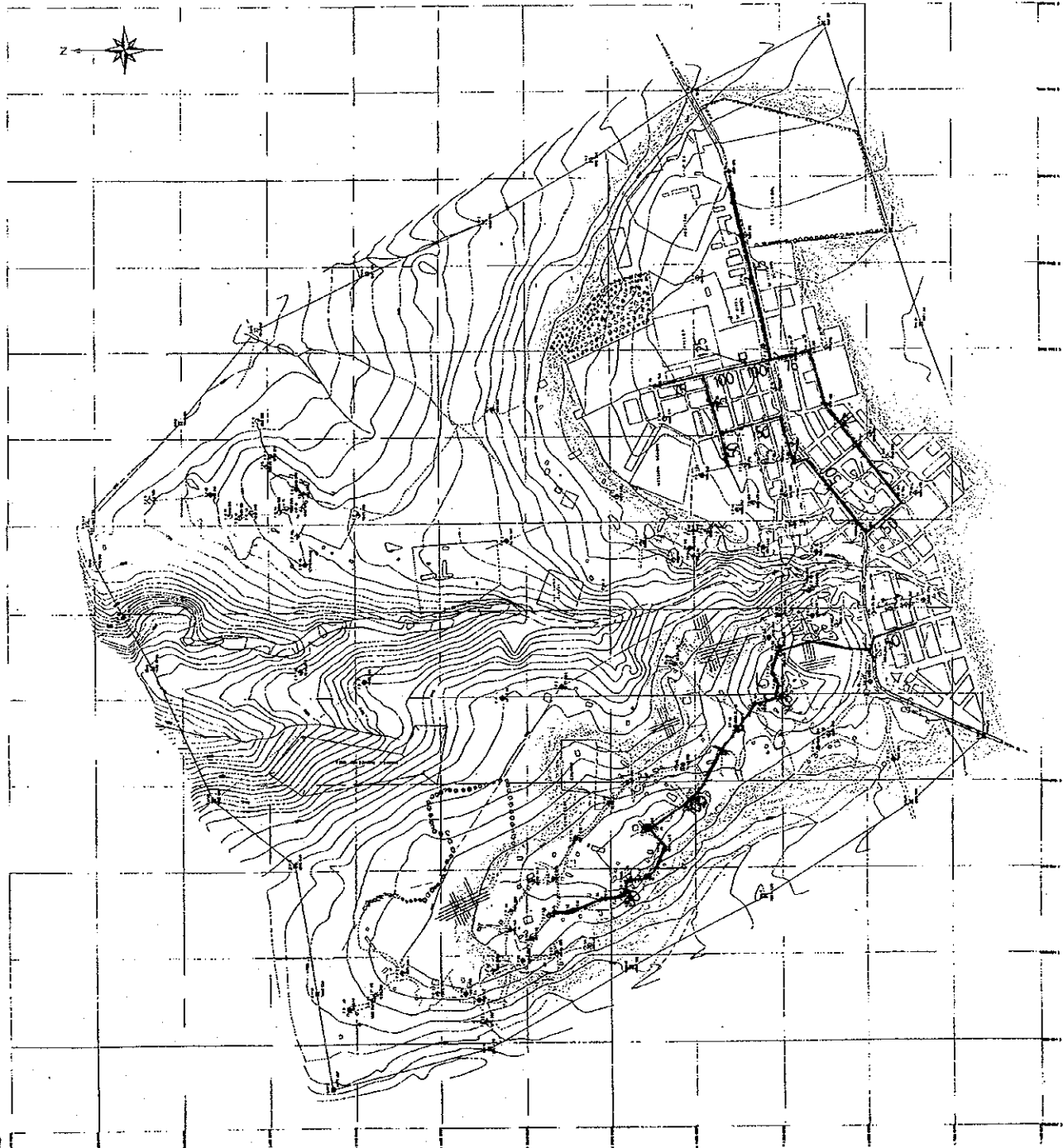
# 2.6 Plan of Distribution Pipeline (2010)

STATE OF ERITREA MINISTRY OF LAND, WATER & ENVIRONMENT	ADIGUALA
JAPAN INTERNATIONAL COOPERATION AGENCY	2010
STUDY ON GROUNDWATER DEVELOPMENT & WATER SUPPLY FOR SEVEN TOWNS IN SOUTHERN REGION	Scale: 1:5000 Drawing No.
	WATER RESOURCES DEPARTMENT (ASABABA, ERITREA) SANTO CONSULTANTS INC. JAPAN

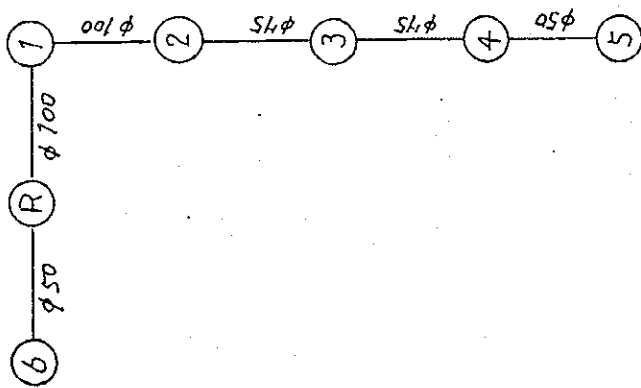
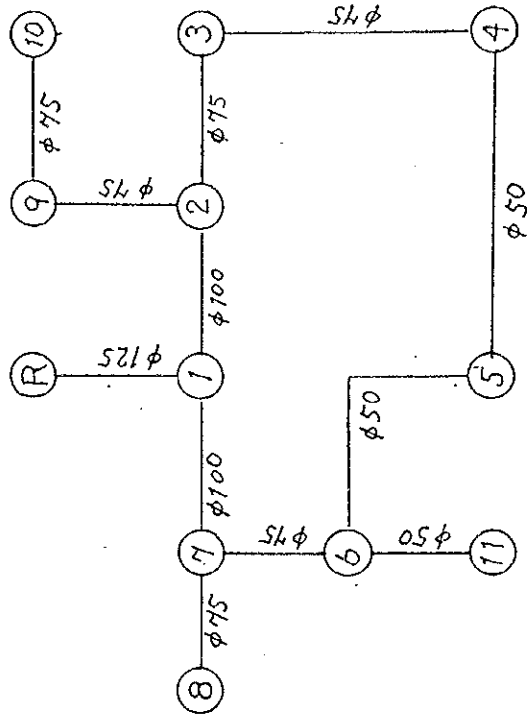
Legend  
Distribution pipeline  
Pipe Diameter (mm)  
100

S = 1:5000  
0 100 200 300 400 500m

Plan of Distribution Pipeline (2010)



ADIQUALA 2010



Node No.	Dynamic (W.L.m)	Ground Elevation (E.L.m)	Effective Head (m)	Area (ha)	Outflow Quantity (L/sec)
0	1903.500	1890.500	13.000	-68.60	-9.20
1	1903.389	1891.900	11.490	0.00	0.00
2	1902.968	1891.700	11.268	0.00	0.00
3	1902.154	1891.300	10.854	8.10	1.09
4	1900.698	1888.600	12.098	9.40	1.26
5	1900.571	1886.500	14.071	5.70	0.76
6	1902.004	1888.300	13.704	5.20	0.70
7	1902.607	1889.800	12.807	3.50	0.47
8	1901.385	1884.300	17.085	14.40	1.93
9	1900.942	1890.100	10.842	6.70	0.90
10	1900.483	1887.900	12.583	11.10	1.49
11	1901.348	1884.900	16.448	4.50	0.60

Pipe line	No.	From	To	Dia. (mm)	Length (m)	Flow Coefficient	Flow (L/sec)	velocity (m/sec)	Loss of Head (m)	Hydraulic Gradient (m/1000m)	Head Loss Coefficient	Hydrostatic Head	Water Hammer Head	Design Pressure (kg/sq.cm)	Pipe Material
1	0	1	2	125	15.00	110	9.1	0.743	0.111	7.373	0.03276	1.38	1.38	2.75	
2	1	2	3	100	58.00	110	5.0	0.640	0.421	7.265	0.03475	1.26	1.26	2.51	
3	2	3	4	75	90.00	110	2.7	0.601	0.814	9.047	0.03680	1.29	1.29	2.59	
4	3	4	5	75	426.00	110	1.6	0.355	1.456	3.418	0.03978	1.56	1.56	3.13	
5	4	5	6	50	106.00	110	0.3	0.156	0.127	1.198	0.04807	1.77	1.77	3.54	
6	5	6	7	50	570.00	110	-0.5	-0.233	-1.434	-2.515	-0.04530	1.77	1.77	3.54	
7	6	7	8	75	143.00	110	-1.8	-0.398	-0.602	-4.212	-0.03912	1.59	1.59	3.19	
8	7	8	9	100	154.00	110	-4.1	-0.528	-0.783	-5.083	-0.03576	1.44	1.44	2.89	
9	8	9	10	75	243.00	110	1.9	0.438	1.222	5.027	0.03857	1.99	1.99	3.99	
10	9	10	11	75	276.00	110	2.4	0.537	2.026	7.341	0.03742	1.41	1.41	3.83	
11	10	11	12	75	148.00	110	1.5	0.337	0.459	3.103	0.04009	1.63	1.63	3.27	
12	6	11		50	156.00	110	0.6	0.308	0.656	4.208	0.04347	1.93	1.93	3.87	
														合計	
														2385.00	

Node No.	Dynamic (WL.m)	Ground Elevation (EL.m)	Effective Head (m)	Area (ha)	Outflow Quantity (L/sec)
0	1908.000	1895.000	13.000	-33.50	-4.49
1	1907.649	1893.800	13.849	0.00	0.00
2	1907.171	1883.300	23.871	7.70	1.03
3	1906.374	1894.000	12.374	5.80	0.78
4	1905.041	1890.200	14.841	3.60	0.48
5	1903.284	1891.000	12.284	6.90	0.93
6	1901.209	1888.200	13.009	9.50	1.27

Pipe line	No.	From	To	Dia. (mm)	Length (m)	Flow Coefficient	Flow (L/sec)	velocity (m/sec)	Loss of Head (m)	Hydraulic Gradient (m/1000m)	Head Loss Coefficient	Hydrostatic Head	Water Hammer Head	Design Pressure (kg/sq.cm)	Pipe Material
	1	0	1	100	110.00	110	3.2	0.410	0.351	3.189	0.03712	1.49	1.49	2.99	
	2	1	2	100	151.00	110	3.2	0.409	0.479	3.169	0.03714	2.54	2.54	5.09	
	3	2	3	75	126.00	110	2.2	0.496	0.797	6.326	0.03787	2.54	2.54	5.09	
	4	3	4	75	476.00	110	1.4	0.319	1.333	2.800	0.04042	1.85	1.85	3.71	
	5	4	5	50	190.00	110	0.9	0.471	1.757	9.247	0.04082	1.85	1.85	3.71	
	6	0	6	50	406.00	110	1.3	0.649	6.791	16.726	0.03893	2.05	2.05	4.11	
														合計	
														1459.00	

# 2.7 Plan of Distribution Pipeline (2015)

STATES OF ERITREA  
MINISTRY OF LAND, WATER &  
ENVIRONMENT

JAPAN INTERNATIONAL  
COOPERATION AGENCY

STUDY ON GROUNDWATER  
DEVELOPMENT & WATER SUPPLY  
FOR  
SEVEN TOWNS IN SOUTHERN REGION

ADIGUALA 2015

WATER RESOURCES DEPARTMENT  
(ASAKA, ERITREA)  
SANTO CONSULTANTS INC.  
JAPAN

Legend  
Distribution pipeline  
Pipe Diameter (mm)

100

S = 1:5,000  
0 100 200 300 400 500 M

Plan of Distribution Pipeline (2015)

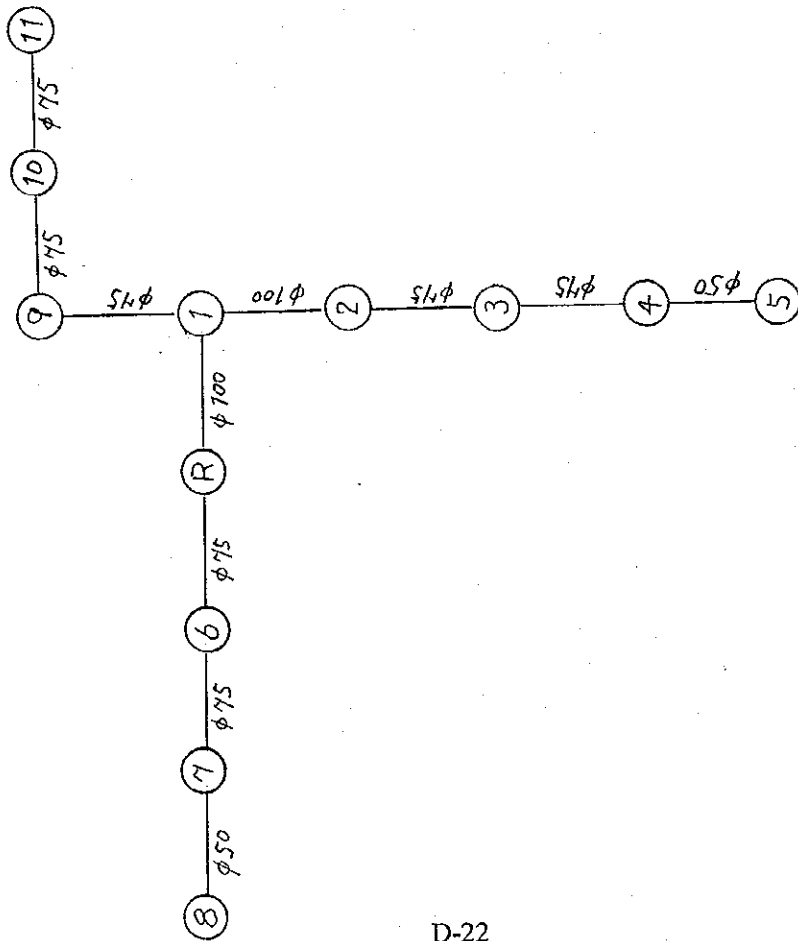
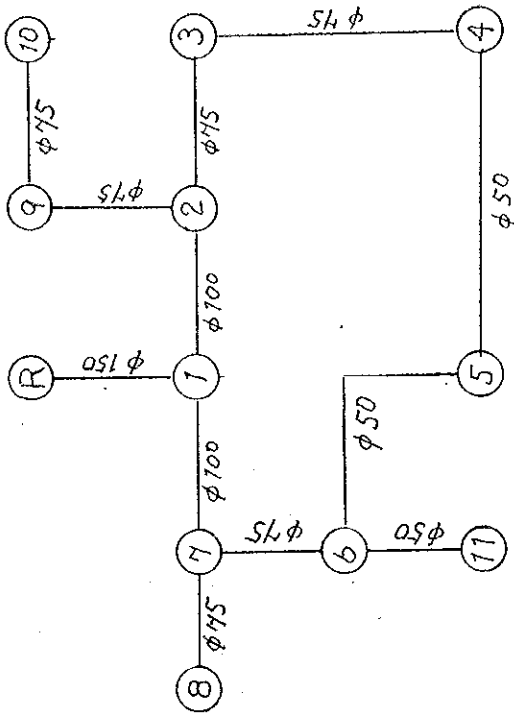


Adi Shinfio

Adi Mini



# ADIQUALA 2015



Node No.	Dynamic (WL.m)	Ground Elevation (EL.m)	Effective Head (m)	Area (ha)	Outflow Quantity (L/sec)
0	1903.500	1890.500	13.000	-68.60	-10.73
1	1903.438	1891.900	11.538	0.00	0.00
2	1902.873	1891.700	11.173	0.00	0.00
3	1901.789	1891.300	10.489	8.10	1.27
4	1899.856	1888.600	11.256	9.40	1.47
5	1899.688	1886.500	13.188	5.70	0.89
6	1901.592	1888.300	13.292	5.20	0.81
7	1902.397	1889.800	12.597	3.50	0.55
8	1900.776	1884.300	16.476	14.40	2.25
9	1900.141	1890.100	10.041	6.70	1.05
10	1899.531	1887.900	11.631	11.10	1.74
11	1900.721	1884.900	15.821	4.50	0.70



Node No.	Dynamic (WL.m)	Ground Elevation (EL.m)	Effective Head (m)	Area (ha)	Outflow Quantity (L/sec)
0	1908.000	1895.000	13.000	-58.90	-9.21
1	1906.862	1893.800	13.062	0.00	0.00
2	1906.223	1883.300	22.923	7.70	1.20
3	1905.165	1894.000	11.165	5.80	0.91
4	1903.396	1890.200	13.196	3.60	0.56
5	1901.060	1891.000	10.060	6.90	1.08
6	1903.024	1888.200	14.824	9.50	1.49
7	1901.909	1883.200	18.709	6.30	0.99
8	1900.948	1885.300	15.648	4.20	0.66
9	1900.948	1869.600	31.348	3.60	0.56
10	1899.282	1862.800	36.482	2.80	0.44
11	1899.075	1863.000	36.075	8.50	1.33

Pipe line	No.	Node No.	Dia. (mm)	Length (m)	Flow Coefficient	Flow (L/sec)	velocity (m/sec)	Loss of Head (m)	Hydraulic Gradient (m/1000m)	Head Loss Coefficient	Hydrostatic Water Hammer Head	Design Pressure (kg/sq.cm)	Pipe Material
	From	To											
1	0	1	100	110.00	110	6.1	0.775	1.138	10.345	0.03378	1.49	2.99	*
2	1	2	100	151.00	110	3.8	0.478	0.639	4.230	0.03629	2.54	5.09	*
3	2	3	75	126.00	110	2.6	0.578	1.059	8.402	0.03702	2.54	5.09	*
4	3	4	75	476.00	110	1.6	0.372	1.769	3.717	0.03952	1.85	3.71	*
5	4	5	50	190.00	110	1.1	0.549	2.336	12.293	0.03990	1.85	3.71	*
6	0	6	75	406.00	110	3.1	0.708	4.976	12.256	0.03592	2.05	4.11	*
7	6	7	75	300.00	110	1.6	0.372	1.115	3.716	0.03952	2.55	5.11	*
8	7	8	50	196.00	110	0.7	0.335	0.961	4.904	0.04295	2.55	5.11	*
9	1	9	75	834.00	110	2.3	0.527	5.914	7.091	0.03753	3.91	7.82	*
10	9	10	75	392.00	110	1.8	0.400	1.666	4.251	0.03909	4.59	9.18	*
11	10	11	75	82.00	110	1.3	0.302	0.207	2.522	0.04076	4.59	9.18	*
合計				3263.00									*

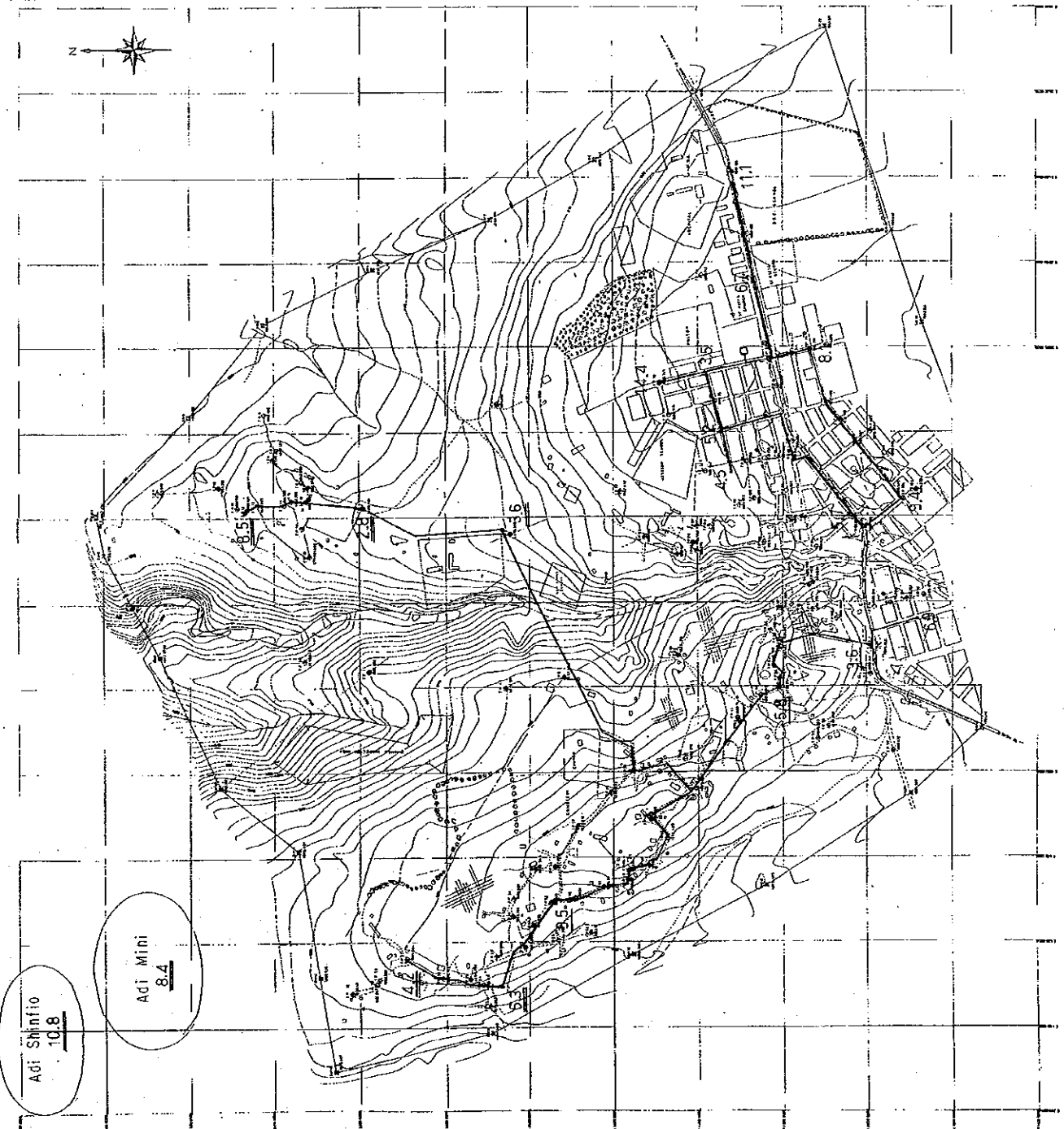
STATE OF EMBRIA MINISTRY OF LAND, WATER & ENVIRONMENT	Scale 1:15,000
JAPAN INTERNATIONAL COOPERATION AGENCY	Drawn No.
STUDY ON GROUNDWATER DEVELOPMENT & WATER SUPPLY FOR SEVEN TOWNS IN SOUTHERN REGION	SATSU CONSULTANTS INC. OSAKA JAPAN

Legend  
Distribution pipeline  
Supplied area (ha)

120

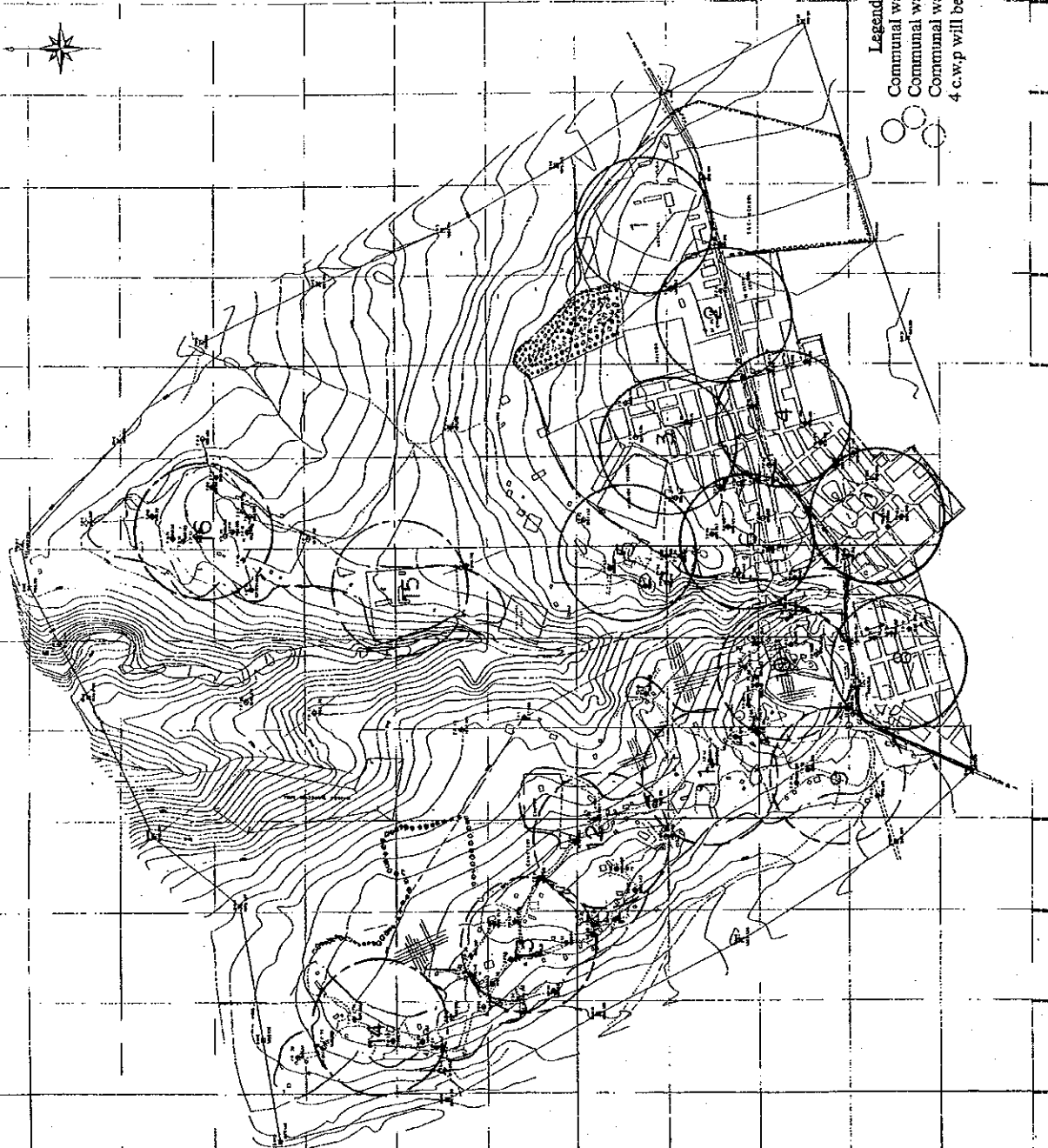
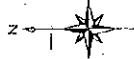


Supplied Points and its Area

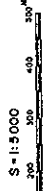


## 2.8 Location of Proposed Communal Water Point

STATE OF ESTERIA MINISTRY OF LAND, WATER & ENVIRONMENT	STUDY ON GROUNDWATER DEVELOPMENT & WATER SUPPLY FOR SEVEN TOWNS IN SOUTHERN REGION
JAPAN INTERNATIONAL COOPERATION AGENCY	
ADICICALA	Scale 1:15,000
WATER RESOURCES DEPARTMENT OSAKA, JAPAN	Sheet No. 1
SANTO CONSULTING INC. OSAKA	



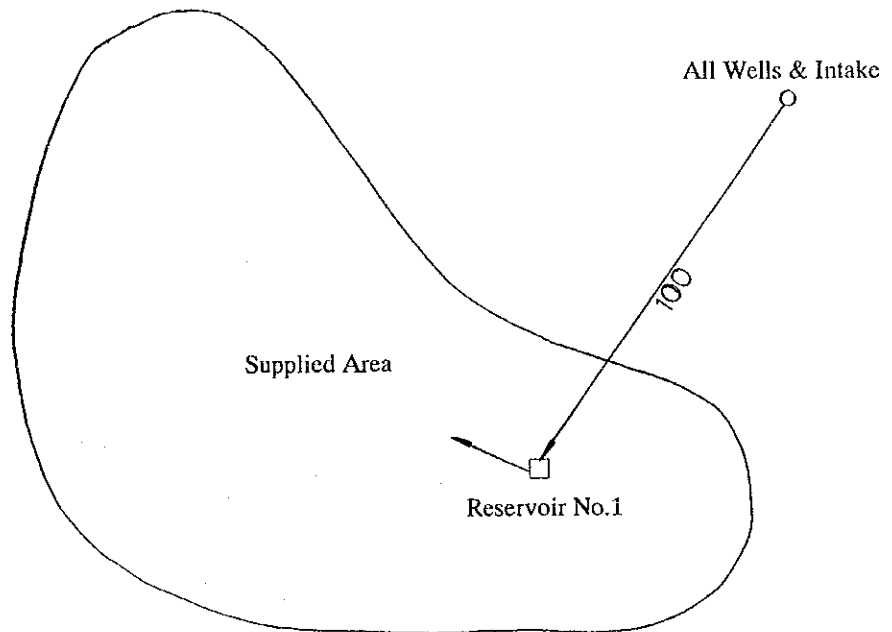
**Legend**  
 Communal water points for 2005 (No. 1 - 8)  
 Communal water points for 2010 (No. 9 - 13)  
 Communal water points for 2015 (No. 14 - 16)  
 4 c.w.p will be added for 2 villages in 2015.



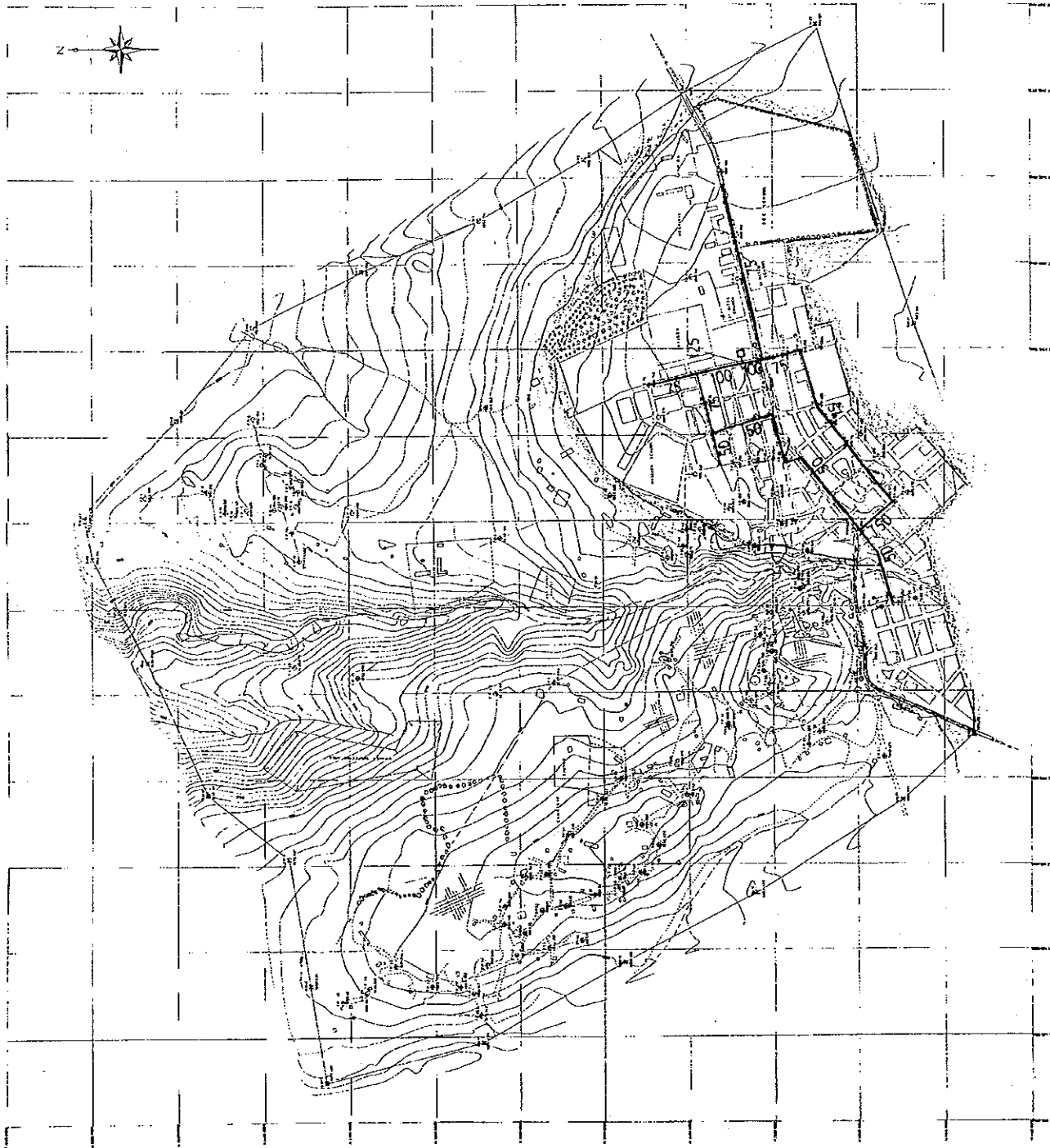
Location of Proposed Communal Water Point

## 2.9 Plan of Water Source and Transmission Pipeline (2005)

Adiquala







Legend  
 Distribution pipeline  
 Pipe Diameter (mm)

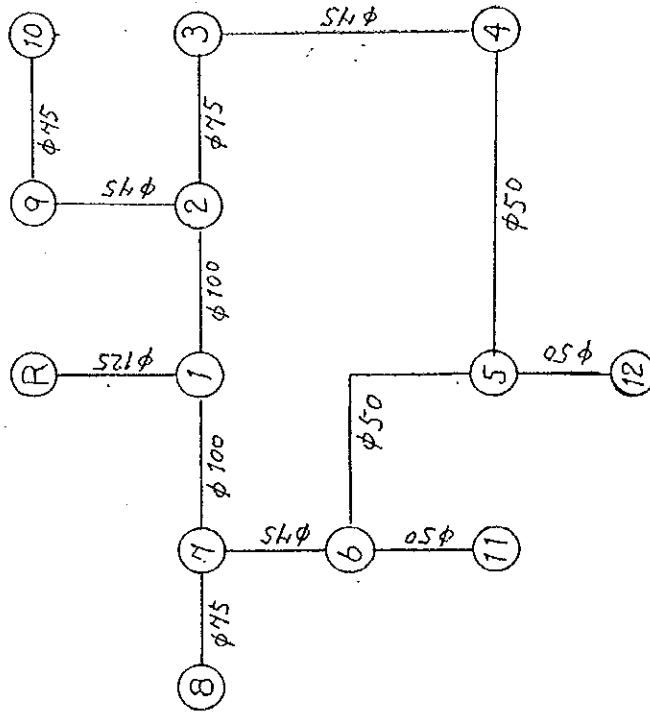
100

S = 1:5000  
 0 100 200 300 400 500 M

Plan of Distribution Pipeline (2005)

STATE OF ERETRIA MINISTRY OF LAND, WATER & ENVIRONMENT	2005
JAPAN INTERNATIONAL COOPERATION AGENCY	
STUDY ON GROUNDWATER DEVELOPMENT & WATER SUPPLY FOR SEVEN TOWNS IN SOUTHERN REGION	ADIGUALLA
WATER RESOURCES DEPARTMENT (ASHAKA, ERETRIA)	Scale: 1:5,000
SANTO CONSULTANTS INC. JAPAN	Drawing No.

ADIQUALA 2010 (2005area)



Node No.	Dynamic (WL.m)	Ground Elevation (EL.m)	Effective Head (m)	Area (ha)	Outflow Quantity (L/sec)
0	1903.500	1890.500	13.000	-75.50	-10.13
1	1903.368	1891.900	11.469	0.00	0.00
2	1902.843	1891.700	11.143	0.00	0.00
3	1901.641	1891.300	10.341	8.10	1.09
4	1898.949	1888.600	10.349	9.40	1.26
5	1897.966	1886.500	11.466	5.70	0.76
6	1901.663	1888.300	13.363	5.20	0.70
7	1902.476	1889.800	12.676	3.50	0.47
8	1901.256	1884.300	16.956	14.40	1.93
9	1900.811	1890.100	10.711	6.70	0.90
10	1900.353	1887.900	12.453	11.10	1.49
11	1901.008	1884.900	16.108	4.50	0.60
12	1894.614	1891.000	3.614	6.90	0.93

Pipe line	Pipe No.	Node No.	Dia. (mm)	Length (m)	Flow Coefficient	Flow (L/sec)	velocity (m/sec)	Loss of Head (m)	Hydraulic Gradient (m/1000m)	Head Loss Coefficient	Hydrostatic Head	Water Hammer Head	Design Pressure (kg/sq.cm)	Pipe Material													
															No.	From	To	(kg/sq.cm)									
1	0	1	125	15.00	110	10.0	0.816	0.132	8.773	0.03230	1.38	1.38	2.75														
2	1	2	100	58.00	110	5.7	0.721	0.526	9.063	0.03414	1.26	1.26	2.51														
3	2	3	175	90.00	110	3.3	0.742	1.202	13.352	0.03567	1.29	1.29	2.59														
4	3	4	75	426.00	110	2.2	0.495	2.692	6.319	0.03787	1.56	1.56	3.13														
5	4	5	50	106.00	110	0.9	0.472	0.983	9.275	0.04081	1.77	1.77	3.54														
6	5	6	50	570.00	110	-0.8	-0.389	-3.697	-6.486	-0.04200	1.77	1.77	3.54														
7	6	7	75	143.00	110	-2.1	-0.468	-0.813	-5.689	-0.03819	1.59	1.59	3.19														
8	7	1	100	154.00	110	-4.4	-0.566	-0.892	-5.793	-0.03539	1.44	1.44	2.89														
9	7	8	75	243.00	110	1.9	0.438	1.221	5.023	0.03857	1.99	1.99	3.99														
10	2	9	75	276.00	110	2.4	0.538	2.031	7.360	0.03741	1.41	1.41	2.83														
11	9	10	75	148.00	110	1.5	0.337	0.459	3.100	0.04009	1.63	1.63	3.27														
12	6	11	50	156.00	110	0.6	0.308	0.655	4.197	0.04348	1.93	1.93	3.87														
13	5	12	50	362.00	110	0.9	0.471	3.352	9.259	0.04082	1.77	1.77	3.54														
合計																											
														2747.00													

## 2.10 Target Years for Pipeline

The pipe diameters of the transmission line and main distribution line are enlarged to meet the water demand in the target year. The diameter of the various case and target year calculated and shown in this tables and figures.

### 1) Transmission Pipeline

The table A was estimated the following conditions.

- (a) Pipelines shown in the table are adopted that wells connected this pipelines have enough capacity to cover the future water demand or additional wells are planned to be connected to this pipelines.
- (b) Pipe diameter is determined according to the pump operation hour and the water demand of each target year.
- (c) Pipe diameter is also selected to consider the minimum velocity and the future water demand.
- (d) Life times are 50 years in pipeline and 15 years in pump.
- (e) The sum per year consists of the pipeline construction cost, pump installation cost and these operation and maintenance cost.

#### - Debarwa

The case of pipe diameter of 100mm and 24hr pump operation of the target year 2005 is not cheapest in the target year 2005, but it is the same diameter of the target year 2010 and is economical in the target year 2010. This case must be planned a new pipe at the target year 2015 because the pipe diameter of 100mm can not be enough to cover the water demand of the target year 2015.

#### - Adiquala

The case of All Ex. & Intake that is pipe diameter of 100mm and 24hr pump operation of the target year 2005 is economical in the target year 2005, and it is the same diameter of the target year 2010 and 2015. The reason is that this case is not necessary of the booster pump.

The case of nADQ-1 that is pipe diameter of 125mm and 24hr pump operation in the target year 2010 is the same mentioned above.

#### - Dekemhare

Case-II of the target year 2005 is economical in the target year 2005, and it is the same diameter of the target year 2010 and 2015. The difference is only the booster pumps.

#### - Segeneiti

The case of pipe diameter of 100mm and 24hr pump operation of the target year 2005 is economical in the target year 2005, and it is the same diameter of the target year 2010 and 2015. The difference is only the booster pumps.

- Adi Keyih

The case of ADI-2 that is pipe diameter of 100mm of the target year 2005 is can be used the water demand of the target year 2010 and 2015.

Case II of DW-2 and BH-7 of the target year 2005 is not economical in the target year 2005, but it is the same diameter of the target year 2010 and 2015.

As mentioned above, the diameters of the transmission pipeline planned for the water demand of the target year 2010 are economical to use the water demand of the target year 2005 totally.

2) Main Distribution Pipeline

The table B was estimated the following conditions.

(f) Pipe diameter is determined according to the water demand of each target year.

(g) Pipe length is restricted within the are of the target year of 2005.

This table shows that the pipe diameters are enlarged according to the water demand, and its cost is also increased 22.2% in 2010 and 43.5% in 2015 against the target year 2005 on the average.

Therefore, the diameters of the transmission pipeline and main distribution pipeline are planned for the water demand in the target year 2010 under the project. The transmission pipeline and main distribution pipeline in the target year 2015 will be equipped with another one line to meet the water demand in the target year 2015. The reasons to employ these diameters are a) it is difficult to expand the facilities to meet the water demand, b) the facilities covering the water demand in the target year 2010 is nearly 20 % increase from those in 2005, and is cheaper than construction of another one line (refer to Appendix D), c) the facilities covering water demand in the final target year 2015 are nearly 40 % increase from those in 2005, and the final future plan is still unclear at present.

Transmission Pipeline

Table A

Name of Town	Well No.	Pipelines							Total Length (m)	Cost (NkF)	Cost/Year (NkF)	Pumps		Cost/Year (NkF)	O&M cost (NkF)	Total Cost (NkF)	Total Cost (%)		
		Diameter Unit Price	60	80	100	125	150	200				Cost (NkF)	Booster Pump Cost (NkF)					Well Pump Cost (NkF)	
Debarwa	2005	DEB-1	442.41	521.87	583.63	645.92	661.27	806.43	690	360,090	7,202	148,693	7.5	9,913	39,420	56,535	100.0		
		DEB-1	0	0	690	0	0	0	690	402,705	8,054	148,693	7.5	9,913	39,420	57,387	101.5		
		DEB-1	0	0	690	0	0	0	690	402,705	8,054	149,864	7.5	9,991	39,420	57,465	101.6		
		DEB-1	0	0	690	0	0	0	690	402,705	8,054	151,193	11.0	10,080	57,816	75,950	134.3		
	2010	DEB-1	0	1,380	0	0	0	0	1,380	720,181	14,404	285,364	15.0	19,024	78,840	112,268	198.6		
		DEB-1	0	1,380	0	0	0	0	1,380	720,181	14,404	289,257	15.0	19,284	78,840	112,927	199.0		
		DEB-1	0	1,380	0	0	690	0	690	445,685	8,914	176,838	15.0	11,789	78,840	99,543	176.1		
		DEB-1	0	1,380	0	1,380	0	0	1,380	805,409	16,108	299,728	15.0	19,982	78,840	114,930	203.3		
2015	DEB-1	0	2,070	0	0	0	0	2,070	1,090,271	21,605	433,885	22.5	28,926	118,260	168,791	298.6			
	DEB-1	0	2,070	0	0	0	0	2,070	1,090,271	21,605	433,885	22.5	28,926	118,260	168,791	298.6			
	DEB-1	0	2,070	0	0	0	0	2,070	1,090,271	21,605	433,885	22.5	28,926	118,260	168,791	298.6			
	DEB-1	0	2,070	0	0	0	0	2,070	1,090,271	21,605	433,885	22.5	28,926	118,260	168,791	298.6			
Adiguila	2005	All Ex.		2,851					2,851	1,487,851	29,757	149,864	7.5	82,104	97,236	142,458	100.0		
		All Ex.		2,851					2,851	1,663,929	33,279	172,851	11.0	11,523	57,816	102,618	72.0		
		All Ex.		2,851					2,851	1,663,929	33,279	151,193	11.0	10,980	57,816	102,618	72.0		
		All Ex.		2,851					2,851	1,663,929	33,279	172,851	11.0	11,523	57,816	102,618	72.0		
	2010	nADQ-1		5,100					5,100	2,661,537	53,231	100,913	1.5	384,566	44,000	31,032	239,148	323,411	100.0
		nADQ-1		100		5,000			5,100	2,970,337	59,407	100,913	1.5	358,053	30,000	30,589	165,564	255,568	79.0
		nADQ-1		100		5,000			5,100	2,661,537	53,231	144,628	7.5	420,797	60,000	37,695	354,780	445,708	137.8
		nADQ-1		100		5,000			5,100	3,281,767	65,636	100,913	1.5	460,302	74,000	37,414	396,828	499,878	154.6
	2015	nADQ-1		628		948			628	4,940,401	98,808	397,811	17.2	177,285	18,500	38,340	187,639	324,767	100.0
		BH-14,DEK-1,DEK-2		628		948		3,941	6,191	5,873,624	117,472	360,297	11.4	134,516	15,000	32,988	138,758	289,218	89.0
		BH-14,DEK-1,DEK-2		628		948		0	6,191	5,873,624	117,472	390,135	15.2	217,629	30,000	40,518	237,571	395,561	121.8
		BH-14,DEK-1,DEK-2		628		948		0	6,191	5,873,624	117,472	390,135	15.2	217,629	30,000	40,518	237,571	395,561	121.8
Segeneiti	2005	SEG-2		5,253				5,253	2,741,393	54,828	159,909	7.5	177,138	16,500	22,470	126,144	203,441	100.0	
		SEG-2		1,085	4,168			5,253	2,998,799	59,976	159,909	7.5	91,142	11,000	16,737	97,236	173,948	85.5	
	2010	SEG-2		1,085	4,168			5,253	2,998,799	59,976	167,297	11.0	186,851	22,000	23,596	173,448	257,020	126.3	
		SEG-2		1,085	4,168			5,253	2,998,799	59,976	152,095	11.0	184,467	18,500	22,437	155,052	237,465	116.7	
	2015	SEG-2		1,085	4,168			5,253	2,998,799	59,976	176,838	11.0	196,841	22,500	24,879	176,076	260,931	128.3	
		SEG-2		1,085	4,168			5,253	2,998,799	59,976	176,838	11.0	196,841	22,500	24,879	176,076	260,931	128.3	
Adi Keyih	2005	ADI-2		2,853				2,853	1,665,096	33,302	167,297	11.0	103,123	15,000	18,028	136,856	187,966	100.0	
		ADI-2		2,853				2,853	1,665,096	33,302	172,851	11.0	103,883	15,000	18,449	136,656	188,407	100.2	
	2010	ADI-2		2,853				2,853	1,665,096	33,302	172,851	11.0	103,883	15,000	18,449	136,656	188,407	100.2	
		ADI-2		2,853				2,853	1,665,096	33,302	172,851	11.0	103,883	15,000	18,449	136,656	188,407	100.2	
	2015	DW-2,BH-7		2,105	928			3,033	1,415,566	28,311	211,795	5.2	82,104	5,500	19,593	56,239	104,144	100.0	
		DW-2,BH-7		343	1,772	918		3,033	1,612,273	32,245	211,748	5.2	82,104	5,500	18,590	58,239	108,075	103.8	
2010	DW-2,BH-7		343	1,772	918		3,033	1,612,273	32,245	211,795	5.2	85,997	11,000	19,853	85,147	137,245	131.8		
	DW-2,BH-7		343	1,772	918		3,033	1,612,273	32,245	211,795	5.2	85,997	11,000	19,853	85,147	137,245	131.8		

Table B

Distribution Pipeline

Pipe Diameter	(mm)	50	75	100	125	150	200	250	300	Total		
Unit Price	(Nkf)	133.75	183.28	229.77	274.61	365.34	625.80	926.50	1,119.32	(Nkf)	(%)	
<b>Debarwa</b>												
2005	Length	(m)	3,531	983	365						4,879	
	Cost	(Nkf)	472,271	180,164	83,866	0	0	0	0	0	736,302	100.0
2010	Length	(m)	3,001	1,513		365					4,879	
	Cost	(Nkf)	401,384	277,303	0	100,233	0	0	0	0	778,919	105.8
2015	Length	(m)	1,696	1,258	582	978	365				4,879	
	Cost	(Nkf)	226,840	230,566	133,726	268,569	133,349	0	0	0	993,050	134.9
<b>Mendefera</b>												
2005	Length	(m)	1,510	2,417	510	419	883				5,739	
	Cost	(Nkf)	201,963	442,988	117,183	115,062	322,595	0	0	0	1,199,790	100.0
2010	Length	(m)	389	1,114	454	1,970	832	980			5,739	
	Cost	(Nkf)	52,029	204,174	104,316	540,982	303,963	613,284	0	0	1,818,747	151.6
2015	Length	(m)	291	1,212	172	2,252	832	97	883		5,739	
	Cost	(Nkf)	38,921	222,135	39,520	618,422	303,963	60,703	818,100	0	2,101,764	175.2
<b>Adiguala</b>												
2005	Length	(m)	1,194	1,326	212	15					2,747	
	Cost	(Nkf)	159,698	243,029	48,711	4,119	0	0	0	0	455,557	100.0
2010	Length	(m)	1,194	1,326	212	15					2,747	
	Cost	(Nkf)	159,698	243,029	48,711	4,119	0	0	0	0	455,557	100.0
2015	Length	(m)	1,194	1,326	212	0	15				2,747	
	Cost	(Nkf)	159,698	243,029	48,711	0	5,480	0	0	0	456,918	100.3
<b>Dekemhare</b>												
2005	Length	(m)	1,485	2,901	2,133	630	205	133			7,487	
	Cost	(Nkf)	198,619	531,695	490,099	173,004	74,895	83,231	0	0	1,551,544	100.0
2010	Length	(m)	849	1,275	2,599	1,486	940	205	133		7,487	
	Cost	(Nkf)	113,554	233,682	597,172	408,070	343,420	128,289	123,225	0	1,947,412	125.5
2015	Length	(m)	647	1,191	1,447	774	1,884	1,206	134	204	7,487	
	Cost	(Nkf)	86,536	218,286	332,477	212,548	688,301	754,715	124,151	228,341	2,645,356	170.5
<b>Segeneiti</b>												
2005	Length	(m)	2,008	1,186		531					3,725	
	Cost	(Nkf)	268,570	217,370	0	145,818	0	0	0	0	631,758	100.0
2010	Length	(m)	2,008	954	232	531					3,725	
	Cost	(Nkf)	268,570	174,849	53,307	145,818	0	0	0	0	642,544	101.7
2015	Length	(m)	2,008	954	232	531					3,725	
	Cost	(Nkf)	268,570	174,849	53,307	145,818	0	0	0	0	642,544	101.7
<b>Adi Keyih</b>												
2005	Length	(m)		1,134	983	584	859				3,560	
	Cost	(Nkf)	0	207,840	225,864	160,372	313,827	0	0	0	907,903	100.0
2010	Length	(m)	0	776	844	1,081	216	643			3,560	
	Cost	(Nkf)	0	142,225	193,926	296,853	78,913	402,389	0	0	1,114,307	122.7
2015	Length	(m)	0	776	486	1,439	216	643			3,560	
	Cost	(Nkf)	0	142,225	111,668	395,164	78,913	402,389	0	0	1,130,360	124.5
<b>Senafe</b>												
2005	Length	(m)	1,216	1,356	632	198	120				3,522	
	Cost	(Nkf)	162,640	248,528	145,215	54,373	43,841	0	0	0	654,596	100.0
2010	Length	(m)	906	774	1,270	254	318				3,522	
	Cost	(Nkf)	121,178	141,859	291,808	69,751	116,178	0	0	0	740,773	113.2
2015	Length	(m)	616	747	1,105	586	348	120			3,522	
	Cost	(Nkf)	82,390	136,910	253,896	160,921	127,138	75,096	0	0	836,352	127.8
Total Length		(m)	25,743	26,499	14,682	14,639	8,033	4,027	1,150	204	94,977	
Tatao Cost	2005	(Nkf)									6,137,449	100.0
	2010	(Nkf)									7,498,259	122.2
	2015	(Nkf)									8,806,343	143.5



**APPENDIX E**

**SANITATION**

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**Table 4.1 Adiquala Water Supply and Consumption Pattern**

	Domestic water consumption by private house water connection		Commercial water consumption by private connection		Gov't establishments water consumption by private water connection		Domestic water consumption by public water connection
	m <sup>3</sup>	No. of customers	m <sup>3</sup>	No. of Customers	m <sup>3</sup>	No. of customers	m <sup>3</sup>
Jan-Feb/95	3815	197	1902	33	1853	13	3206
Mar.-Apr.	3315	201	879	34	1566	13	3468
May-Jun.	2721	199	714	34	1255	13	3695
July-Aug.	3182	198	861	34	1811	13	996
Sep.-Oct.	358	204	665	21	2121	13	1987
Nov.-Dec.	3575	211	662	20	1762	13	2648
<b>Total</b>	<b>23,763</b> <b>43%</b>		<b>5,683</b> <b>10%</b>		<b>10,368</b> <b>19%</b>		<b>16,000</b> <b>28%</b>
Jan-Feb/96	3055	212	663	25	3238	10	2320
Mar.-Apr.	4065	213	764	25	2718	10	3153
May-Jun.	2802	204	625	26	1061	15	338
July-Aug.	2405	209	364	22	929	12	1120
Sep.-Oct.	2957	212	738	24	978	12	2340
Nov.-Dec.	1777	213	440	22	748	15	2600
<b>Total</b>	<b>17,061</b> <b>41%</b>		<b>3,588</b> <b>8%</b>		<b>9,672</b> <b>23%</b>		<b>11,871</b> <b>28%</b>

Continue .....

**Table 4.1 Adiquala Water Supply and Consumption Pattern**

	Domestic water consumption by private house water connection		Commercial water consumption by private connection		Gov't establishments water consumption by private water connection		Domestic water consumption by public water connection
	m <sup>3</sup>	No. of customers	m <sup>3</sup>	No. of Customers	m <sup>3</sup>	No. of customers	m <sup>3</sup>
Jan-Feb/97							3140
Mar.-Apr.	5815	215	1522	25	3940	16	3140
May-Jun.	2955	220	554	27	1939	16	2880
July-Aug.	2748	225	694	26	1814	16	1360
<b>Total</b>	<b>11,518</b> <b>35%</b>		<b>2,770</b> <b>9%</b>		<b>7,693</b> <b>24%</b>		<b>10,520</b> <b>32%</b>

Source:- Adequala WSS

**Table 4.2 Domestic Water Consumption by Source of Water Supply**

Source of water supply	Household users, %	Ave. volume of water consumption m <sup>3</sup> /hld/mon		Ave. expenditure for Water Nfa/m <sup>3</sup>	Ave. income Nfa/mon
		m <sup>3</sup> /hld/mon	l/c/d		
Municipality supply					
House connection	32.7	3	20.45	12	949
Yard connection	14.5	1.77	12.07	2.65	645
Communal Water point	36.4	2.1	14.31	10.5	593
Private well	1.80	-	-	-	600
Public well	10.9	1.56	10.64	7.80	291
River/spring	0	-	-	-	-
Water tanker	0	-	-	-	-
Water vender	23.6	2.33	15.88	23.30	962
Rain water	92.7	1.12	7.63	-	773

*Source: Socio-economic survey conducted by JICA Study Team Nov. 1997*

**Table 4.3 Distance of Water Points from Households**

Type of water point	Average distance from household			
	< 99m 0%	100-199 m 15%	200-399 m 25%	>400 m 60%
Communal water point				
Public well	<200 m 16.7%	200-499 m 33.3%	500-999 50%	

*Source: Socio-economic survey conducted by JICA Study Team Nov. 1997*

**Table 4.4 Toilet Condition and Related Behaviors**

Type of latrines used	Septic tank/cesspool 23.65	Dry pit 12.7%	Community toilet 0%	Open field 63.6%		
Condition of septic tank/cesspool and pit latrine	Clean squatting hole 80%	Clean slab 70%	Well fitting lid 15%	Good ventilation 70%	No flies 85%	Not filled up 75%
Households satisfied with the existing latrines used	41.8%	Average distance of latrine from the nearest water source				125m
Affordable preferences of unsatisfied households	Septic tank/cesspool 76.7%	Dry pit 0%	Community toilet 23.3%	Open field 0%		
Households favoring credit system for latrine construction	55.8%	Ave. of maximum repayment a household afford				33Nfa/mon
Type of anal cleansing material used	Stone 21.8%	Water 20%	Paper 81.8%	Twig 3.6%	Leaves 0%	Nothing 0%

Source: Socio-economic survey conducted by JICA Study Team Nov. 1997

**Table 4.5 Conditions of Waste Disposal**

Solid waste disposal	Open field 32.7%	Open pit 1.8%	Covered in pit 0%	Burn 1.8%	Municipality truck 63.3%
Waste water disposal	Open field 94.5%	Pit 1.8%	Gardening 0%	Drainage system 3.6%	
Animal waste disposal	Used as fuel 70%	Used as fertilizer 20%	Thrown in a pit 0%	Open field 10%	
Infant excreta disposal	Open field 0%	Popo and thrown to the field 44.4%		Popo and put in the toilet 55.6%	

Source: Socio-economic survey conducted by JICA Study Team Nov. 1997

**Table 4.6 Adiquala Schools Present Water and Latrine Facilities Conditions.**

Name of School	Water supply facility		Latrine facility	
	Availability	Remark	Availability	Remark
Adiquala junior & secondary school	Yes	From town supply	Yes, but not functional	Two super-structurally good toilets with number of latrines in it for girls and boys, but being filled with stone, are out of function. The third pit latrine is under construction.
Adiquala elementary school	No	Never had	No	Never had
Swiznile mission elementary & junior school	Yes	From town supply and rain water harvesting. 450m <sup>3</sup> & 950m <sup>3</sup> cisterns are available for rain water collection.	Yes	Four units of latrine, 2 for female and 2 for male are available. Good condition.
Missionary kindergarten school	Yes	From town supply	Yes, but temporary	The present one is a pit latrine but they have plans to make a new one.



**Table 4.7 Cases of Water and Poor Sanitation Related Diseases in Adiquala**

Description of Disease	1995	1996	1997
<b>Water-borne &amp; washed diseases</b>			
Typhoid			4
Hepatitis	13	10	18
Diarrhoea	758	406	276
Amebic Dysentery	251	191	224
Giardiasis	136	150	171
Shigellosis	33	191	92
<b>Bacterial skin srosis</b>			
Scabies	140	57	38
Fungal infection (skin disease)	933	649	381
Trachoma	78	25	4
Asthma	93	96	59
Rickettsial Typhus			
<b>Water basis</b>			
Schistosomiasis		36	26
<b>Total</b>	<b>2,435</b> <b>45%</b>	<b>5,105</b> <b>34%</b>	<b>2,570</b> <b>32%</b>
<b>Water related insect vector</b>			
<b>Malaria</b>	<b>3,291</b> <b>61%</b>	<b>3,269</b> <b>60%</b>	<b>1,277</b> <b>24%</b>

*Source: Adiquala Mini-Hospital*

**Table 4.8 Conditions of Health**

Water related disease cases in the last six months	Ave. number of cases	Ave. number of cases by type of diseases				
	1person/hhd	Diarrhea 1 person 1.5 %	Dysentery 2 person 4.7 %	Malaria 8 person 16.3%	Warms 1 person 4.8 %	Scabies 0 person 0 %
Ave. medical cost	Diarrhea 30 Nfa/case	Dysentery 53 Nfa/case	Malaria 36.38 Nfa/case	Warms 38 Nfa/case	Scabies 0 Nfa/case	
Type of treatment	Self-administered traditional medicine 14.5%	Self-administered modern medicine 1.80%	Consult traditional healer 0%	Consult physician 92.7%		
Infants health condition	Households with infant 5.5%	Infants death in the last 10 years 1.3 persons/household	Child immunization 89.2%			

Source: Socio-economic survey conducted by JICA Study Team Nov. 1997

**Table 4.9 Hand washing behavior**

	Hand washing method					
	with water and soap	With water & ash	with water & mud	with water only	with other material	nothing
After defecation	85.5%	0%	0%	14.5%	0%	0%
Before cooking	69.1%	0%	0%	30.9%	0%	0%
Before eating	67.3%	0%	0%	32.7%	0%	0%
After disposal of children stool	55.9%	0%	0%	0%	0%	0%
After handling animal dung	37.0%	0%	0%	0%	0%	0%

Source: Socio-economic survey conducted by JICA Study Team Nov. 1997

**Table 4.10 Food handling**

Placing utensil	on shelf 61.1%	on floor 1.9%	Over the table 37%	Other 0%	
Storage of left over food	Covered 85.2%	Open to flies 0%	No leftover food 7.4%	Thrown away 7.4%	Other 0%
Washing raw food before eating	Washing vegetable 100%	Washing meat 100%	Washing fruit 73.5%		

*Source: Socio-economic survey conducted by JICA Study Team Nov. 1997*

**Table 4.11. Households perception of health and Hygiene**

ORS preparation knowledge 87.3%	Participation on health/hygiene education session 52.7%	Satisfaction on health/hygiene education session 60.0%		
Participation in community sanitation work 91.7%	Areas of involvement			
	Cash contribution 3.6%	Material contribution 9.1%	Labor contribution 85.5%	Not willing 1.8%

*Source: Socio-economic survey conducted by JICA Study Team Nov. 1997*

**APPENDIX F**  
**COST ESTIMATION**

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# 1. Water Supply

Table 1.1 Bill of Quantity

Facility	Item Description	Unit	Year		
			2005	2010	2015
Intake Facility	New borehole	sets	1	1	1
	Existing borehole	sets			
	Observation borehole	sets			
	Dam	sets			
	(Sub-total)	sets	1	1	1
Well Pump Facility	Submersible pump		All In., 0.372m <sup>3</sup> /min 118.9m, 1set	nADQ-1, 0.192m <sup>3</sup> /min 24.0m, 1set	nADQ-2, 0.360m <sup>3</sup> /min 62.5m, 1set
	(Sub-total)	sets	1	1	1
Transmission Pipeline	DCIP 200mm	m			
	ditto 150mm	m			
	ditto 125mm	m		5,000.0	
	ditto 100mm	m	2,851.0		1,900.0
	ditto 80mm	m		100.0	
	ditto 60mm	m			
	(Sub-total)	m	2,851.0	5,100.0	1,900.0
Booster Pump Facility	Centrifugal pump		BP.1, 0.372m <sup>3</sup> /min 16.0m, 1set	BP.1, 0.192m <sup>3</sup> /min 101.6m, 4set	BP.1, 0.552m <sup>3</sup> /min 109.8m, 4set
	(Sub-total)	sets	1	4	4
Pump Pit	Made of RC			20m <sup>3</sup> , 4set	
	(Sub-total)	sets	0	4	0
Reservoir	Made of RC		180m <sup>3</sup>	40m <sup>3</sup>	70m <sup>3</sup> 30m <sup>3</sup>
	Made of FRP		35m <sup>3</sup> , h=13m	50m <sup>3</sup> , h=13m	90m <sup>3</sup> , h=13m
	Existing				
	(Sub-total)	sets	2	2	3
Distribution Pipeline	PVC 300mm	m			
	ditto 250mm	m			
	ditto 200mm	m			
	ditto 150mm	m			
	ditto 125mm	m	15.0		
	ditto 100mm	m	212.0		
	ditto 75mm	m	1,326.0	602.0	1,623.0
	ditto 50mm	m	12,744.0	4,531.0	1,567.0
	(Sub-total)	m	14,297.0	5,133.0	3,190.0
Control House	sets	2	5	1	
Communal Water Point	sets	8	5	7	
Individual Connection	sets	935	439	561	
Tempolaty Road	Width 3.0m	m	300	5,000	2,000

Table 1.2 (1) Project Cost (2005)

(Nakfa)

Description		Unit	Quantity	Unit Cost		Cost		Total
Item	Dimension			Local C.	Foreign C.	Local C.	Foreign C.	
<b>1. Construction Cost</b>								
Intake facility	Shallow well	set	1	249,339.57	51,472.20	249,340	51,472	300,812
	Exsiting well	set		9,275.43	85,317.49	0	0	
	Observation well	set		0.00	0.00			
	Dam	set						
	(sub total)	set	1			249,340	51,472	
Submersible pump	All In., 0.372m3/min 118.9m	set	1	10,703.31	222,645.30	10,703	222,645	233,349
	(sub total)		1			10,703	222,645	
Transmission pipeline	D C I P 200mm	m		245.85	842.83	0	0	2,246,316
	150mm	m		221.01	671.71	0	0	
	125mm	m		214.20	657.79	0	0	
	100mm	m	2,851	207.31	580.60	591,029	1,655,287	
	80mm	m		204.69	499.83	0	0	
	60mm	m		203.85	393.40	0	0	
	(sub total)	m	2,851			591,029	1,655,287	
Booster pump	BP.1, 0.372m3/min 16.0m	set	1	1,860.75	87,742.83	1,861	87,743	89,604
	(sub total)		1			1,861	87,743	
Pump pit	Rein forced Concrete	sets						0
	(sub total)					0	0	
Reservoir	RC 180m3	sets	1	406,427.65	202,988.87	406,428	202,989	1,797,378
	F R P 35m3, h=13m	sets	1	61,958.94	1,126,002.18	61,959	1,126,002	
	(sub total)		2			468,387	1,328,991	
Distribution pipeline	P V C 300mm	m		289.52	1,221.56	0	0	2,700,449
	250mm	m		249.89	1,000.89	0	0	
	200mm	m		222.67	622.16	0	0	
	150mm	m		181.05	312.16	0	0	
	125mm	m	15	167.54	203.19	2,513	3,048	
	100mm	m	212	154.76	155.42	32,810	32,949	
	75mm	m	1,326	140.33	107.09	186,081	142,006	
	50mm	m	12,744	126.50	54.06	1,612,052	688,990	
(sub total)	m	14,297			1,833,456	866,993		
Control house	Type A	sets	1	137,822.18	9,992.65	137,822	9,993	413,302
	Type B	sets		195,386.85	10,232.97	0	0	
	Type C	sets		196,861.35	10,530.98	0	0	
	Type D	sets	1	254,523.76	10,963.56	254,524	10,964	
	(sub total)	sets	2			392,346	20,956	
Comunal water point		sets	8	18,019.46	6,866.40	144,156	54,931	199,087
Individual connection		set	935	0.00	0.00	0	0	0
Temporary Road	width3.0m	m	300	297.00	0.00	89,100	0	89,100
Sub-Total						3,780,377	4,289,019	8,069,396
<b>2. Engineering Fee</b>							806,940	806,940
<b>3. Administration Cost</b>						161,388		161,388
<b>4. Physical Contingency</b>						394,177	509,596	903,772
Total						4,335,942	5,605,554	9,941,496
<b>5. Price Contingency</b>						828,234	1,070,751	1,898,985
Grand Total						5,164,176	6,676,305	11,840,481

Table 1.2 (2) Project Cost (2010)

(Nakfa)

Item	Description Dimension	Unit	Quantity	Unit Cost		Cost		Total
				Local C.	Foreign C.	Local C.	Foreign C.	
<b>1. Construction Cost</b>								
Intake facility	New well	set	1	13,229.04	273,277.16	13,229	273,277	286,506
	Exsiting well	set		9,275.43	85,317.49	0	0	
	Observation well	set		0.00	0.00			
	Dam	set						
	(sub total)	set	1			13,229	273,277	
Submersible pump	nADQ-1, 0.192m3/min 24.0m	set	1	10,505.05	125,727.49	10,505	125,727	136,233
	(sub total)		1			10,505	125,727	
Transmission pipeline	D C I P 200mm	m		245.85	842.83	0	0	4,430,437
	150mm	m		221.01	671.71	0	0	
	125mm	m	5,000	214.20	657.79	1,071,023	3,288,963	
	100mm	m		207.31	580.60	0	0	
	80mm	m	100	204.69	499.83	20,469	49,983	
	60mm	m		203.85	393.40	0	0	
	(sub total)	m	5,100			1,091,491	3,338,946	
Booster pump	BP.1, 0.192m3/min 101.6m	set	4	1,897.86	118,944.89	7,591	475,780	483,371
	(sub total)		4			7,591	475,780	
Pump pit	RC 20m3	sets	4	73,376.21	48,868.40	293,505	195,474	488,978
	(sub total)		4			293,505	195,474	
Reservoir	RC 40m3	sets	1	195,893.96	153,789.73	195,894	153,790	1,792,703
	FRP 50m3,h=13m	sets	1	75,868.47	#####	75,868	1,367,151	
	(sub total)		2			271,762	1,520,941	
Distribution pipeline	PVC 300mm	m		289.52	1,221.56	0	0	967,063
	250mm	m		249.89	1,000.89	0	0	
	200mm	m		222.67	622.16	0	0	
	150mm	m		181.05	312.16	0	0	
	125mm	m	0	167.54	203.19	0	0	
	100mm	m	0	154.76	155.42	0	0	
	75mm	m	602	140.33	107.09	84,480	64,470	
	50mm	m	4,531	126.50	54.06	573,149	244,963	
	(sub total)	m	5,133			657,629	309,434	
Control house	Type A	sets	0	137,822.18	9,992.65	0	0	1,093,284
	Type B	sets	1	195,386.85	10,232.97	195,387	10,233	
	Type C	sets	3	196,861.35	10,530.98	590,584	31,593	
	Type D	sets	1	254,523.76	10,963.56	254,524	10,964	
	(sub total)	sets	5			1,040,495	52,789	
Comunal water point		sets	5	18,019.46	6,866.40	90,097	34,332	124,429
Individual connection		set	439	0.00	0.00	0	0	0
Temporary Road	width3.0m	m	5,000	297.00	0.00	1,485,000	0	1,485,000
Sub-Total						4,961,305	6,326,699	11,288,004
<b>2. Engineering Fee</b>							1,128,800	1,128,800
<b>3. Administration Cost</b>						225,760		225,760
<b>4. Physical Contingency</b>						518,707	745,550	1,264,256
Total						5,705,772	8,201,050	13,906,821
<b>5. Price Contingency</b>						2,873,599	4,130,297	7,003,896
Grand Total						8,579,371	12,331,347	20,910,717



**Table 1.2 (3) Project Cost (2015)**

(Nakfa)

Description		Unit	Quantity	Unit Cost		Cost		
Item	Dimension			Local C.	Foreign C.	Local C.	Foreign C.	Total
<b>1. Construction Cost</b>								
Intake facility	New well	set	1	13,229.04	273,277.16	13,229	273,277	286,506
	Exsiting well	set		9,275.43	85,317.49	0	0	
	Observation well	set		0.00	0.00	0	0	
	Dam	set						
	(sub total)	set	1			13,229	273,277	
Submersible pump	nADQ-2, 0.360m3/min 62.5m	set	1	10,625.18	191,691.43	10,625	191,691	202,317
	(sub total)		1			10,625	191,691	
Transmission pipeline	D C I P 200mm	m		245.85	842.83	0	0	1,497,019
	150mm	m		221.01	671.71	0	0	
	125mm	m		214.20	657.79	0	0	
	100mm	m	1,900	207.31	580.60	393,881	1,103,138	
	80mm	m		204.69	499.83	0	0	
	60mm	m		203.85	393.40	0	0	
	(sub total)	m	1,900			393,881	1,103,138	
Booster pump	B.P.1, 0.552m3/min 109.8m	set	4	2,385.27	152,966.56	9,541	611,866	621,407
	(sub total)		4			9,541	611,866	
Pump pit	Rein forced Concrete	sets						0
	(sub total)					0	0	
Reservoir	RC 70m3	sets	1	251,491.62	167,082.91	251,492	167,083	2,685,978
	30m3		1	170,139.19	147,359.88	170,139	147,360	
	F R P 90m3,h=13m	sets	1	102,663.54	1,847,241.14	102,664	1,847,241	
	(sub total)		3			524,294	2,161,684	
Distribution pipeline	P V C 300mm	m		289.52	1,221.56	0	0	684,508
	250mm	m		249.89	1,000.89	0	0	
	200mm	m		222.67	622.16	0	0	
	150mm	m		181.05	312.16	0	0	
	125mm	m		167.54	203.19	0	0	
	100mm	m		154.76	155.42	0	0	
	75mm	m	1,623	140.33	107.09	227,760	173,813	
	50mm	m	1,567	126.50	54.06	198,218	84,718	
	(sub total)	m	3,190			425,977	258,531	
Control house	Type A	sets	1	137,822.18	9,992.65	137,822	9,993	147,815
	Type B	sets		195,386.85	10,232.97	0	0	
	Type C	sets		196,861.35	10,530.98	0	0	
	Type D	sets	0	254,523.76	10,963.56	0	0	
	(sub total)	sets	1			137,822	9,993	
Comunal water point		sets	7	18,019.46	6,866.40	126,136	48,065	174,201
Individual connection		set	561	0.00	0.00	0	0	0
Temporary Road	width3.0m	m	2,000	297.00	0.00	594,000	0	594,000
Sub-Total						2,235,507	4,658,245	6,893,751
2. Engineering Fee							689,375	689,375
3. Administration Cost						137,875		137,875
4. Physical Contingency						237,338	534,762	772,100
Total						2,610,720	5,882,382	8,493,102
5. Price Contingency						2,642,562	5,954,126	8,596,688
Grand Total						5,253,282	11,836,508	17,089,789

**Table 1.3 O&M Cost****(Nakfa)**

Description	2005	2010	2015
1. Personnel cost	234,099	336,517	528,544
2. Electricity & fuel cost	97,131	328,920	707,878
3. Chemical cost	9,016	13,371	22,403
4. Repairing cost	46,158	111,650	154,096
5. Miscellaneous cost	38,640	79,046	141,292
Total	425,044	869,504	1,554,213

## 2. Sanitation

Table 2.1 Bill of Quantity for School and Public Latrine

### SUMMARY

#### A. SUPERSTRUCTURE

1 EXCAVATION AND EARTHWORK	6905,00
----------------------------	---------

#### B. SUPERSTRUCTURE

1 BRICKWORKS	7060,00
--------------	---------

2 CARPENTARY AND JOINERY	6140,00
--------------------------	---------

3 METAL WORKS	5200,00
---------------	---------

4 PLASTERING	2038,00
--------------	---------

5 PAINTING	1660,00
------------	---------

6 SANITARY INSTALLATION	14998,00
-------------------------	----------

7 SEPTIC TANK	30724,56
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<b>TOTAL</b>	<b>74 725,56</b>
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Table 2.1 (1) Bill of Quantity for School and Public Latrine

ITEM	DESCRIPTION	UNIT	QTY.	U.PRICE Nakfa	TOTAL P. Nakfa
<b>A. SUBSTRUCTURE</b>					
<b>1. EXCAVATION &amp; EARTHWORKS</b>					
1.1	Clear off site to remove top soil to an average depth of 20cm.	m2	50	4	200
1.2	Excavate for trench foundation in ordinary soil to a depth not exceeding 75cm from the stripped ground level.	m3	39	25	975
1.3	Return fill around foundation with good, dry excavated material from site and well ram in layers every 25cm interval.	m3	26	22	572
1.4	Cartaway surplus excavated material to a distance not exceeding 5km from the compound.	m3	13	25	325
1.5	25cm thick basaltic or equivalent stone hardcore and blinded with crushed stone.	m2	179	27	4833
					-
<b>TOTAL CARRIED TO SUMMARY .....</b>					<b>6905,00</b>
					=
<b>B. SUPERSTRUCTURE</b>					
<b>2. BRICK WORKS</b>					
2.1	20cm thick hollow concrete wall bedded on compo-mortar 1:2:9 mix both sides left for plastering.	m2	47	110	5170
2.2	Ditto, but 10cm thick brick wall	m2	27	70	1890
					-
<b>TOTAL CARRIED TO SUMMARY .....</b>					<b>7060,00</b>
					=
<b>3. CARPENTRY AND JOINERY</b>					
3.1	Eucalyptus post for roofing, as shown on the section of section the drawing.	m	34	25	850
3.2	5x3cm zigba wood perlin, on which the C.I.S. is going to be fixed.	m	59	30	1770
3.3	Supply and fix 0.3mm thick C.I.S roofing, to be fixed to the perlin price including lap; roof ridges and washers	m2	44	80	3520
					-
<b>TOTAL CARRIED TO SUMMARY .....</b>					<b>6140,00</b>
					=

Table 2.1 (2) Bill of Quantity for School and Public Latrine

ITEM	DESCRIPTION	UNIT	QTY.	U.PRICE Nakfa	TOTAL P. Nakfa
<b>4. METAL WORKS</b>					
4,1	Metal doors and windows constructed in accordance to detail drawing, including one coat of anti-rust and three coats of oil paint:-				
	<b>Doors</b>				
	a) Type D1 size: 60 x 170	No	10	400	4000
	b) Type D2 size: 100 x 200	No	2	600	1200
					<b>5200,00</b>
<b>5. PLASTERING</b>					
5,1	Apply three coats of plaster in compo-mortar (1:2:9) mix up to fine finish to all internal walls of the latrine units.	m2	61	28	1708
5,2	Ditto but to external wall of the front faces.	m2	11	30	330
					<b>2038,00</b>
<b>6. PAINTING</b>					
6,1	Apply in three coats of oil paint to internal plastered wall surfaces of the latrine units.	m2	61	20	1220
6,2	Ditto but plastic emulsion paint to external wall surfaces.	m2	11	40	440
					<b>1660,00</b>
	<b>TOTAL CARRIED TO SUMMARY .....</b>				<b>=</b>
<b>7. SANITARY INSTALLATION</b>					
7,1	Supply and install Galvanized steel water supply pipes for cold water distribution from supply line, elevated tanker to all sanitary fixtures according to where shown on the drawings. Complete with the necessary connecting pieces such as bends, unions, nipples, tee, elbow, etc. shall include all the necessary assistance to the installation works, such as chiselling of walls, slabs, floors, etc. and closing them with concrete to normal condition where required. The installation shall be tested at a pressure of 1bar at the expense of the contractor.				
	Dia. ND 15mm (1/2")	ml	13	25	325
	Dia. ND 20mm (3/4")	ml	21	28	588

Table 2.1 (3) Bill of Quantity for School and Public Latrine

ITEM	DESCRIPTION	UNIT	QTY.	U.PRICE Nakfa	TOTAL P. Nakfa
7,2	Supply and install, on water supply lines, gate valves, made of bronze or brass parts complete with rubber gaskets, hand weels unions and other accessories.				
	Dia. ND 15mm	pcs	18	25	450
	Dia. ND 20mm	pcs	2	30	
7,3	Supply and install soil waste and vent pipes in horizontal branches and vertical stacks made of UPVC pipes and fittings. Fittings should include bends, branches, tees, clearout reducers, etc. Unit price shall include all the necessary assistance work to the installation, such as chiselling of walls, slabs, floors, etc. and closing them with concrete. All pipes entering manhole shall be trapped.				
	Dia. ND 50mm	ml	17	55	935
	Dia. ND 100mm	ml	26	95	2470
7,4	Supply and fix on terminals of ventilation pipes, vent caps (cows), with weathering PP states, sealing gaps b/n the girth of the vent pipe and hole in the roof material.				
	Dia. ND 100mm	pcs	2	65	130
7,5	Supply and fix white vitreous Turkish type W.C. unit with trap and complete with fixing device.	pcs	10	700	7000
7,6	Construct sanitary manholes on domestic sewer lines in 200mm HCB wall plastered from the inside with cement mortar (1:3) on a base of mass concrete slab 100mm thick with proper slope for smooth flow, with reinforced concrete cover.				
	600 x 600mm	pcs	2	800	1600
7,8	Supply and install fiber-glass elevated tank of capacity 1 with vent pipe 25mm, drain pipe and gate valve of diam. 50mm and manhole 60x60cm. cover shall be provided.	pcs	1	1500	1500
					14998,00
	<b>8. SEPTIC TANK</b>				
	<b>Excavation &amp; earthworks</b>				
8,1	Clear off site to remove top soil to an average depth of 20cm.	m2	16	4	64
8,2	Bulk excavation for under ground reservoir excavated in ordinary soil to a depth not exceeding 150cm from the stripped ground level.	m3	109	20	2180
8,3	Return fill around reservoir with good, dry excavated material from site and well ram in layers every 30cm interval.	m3	78	22	1716

Table 2.1 (4) Bill of Quantity for School and Public Latrine

ITEM	DESCRIPTION	UNIT	QTY.	U.PRICE Nakfa	TOTAL P. Nakfa
8,5	Cartaway surplus excavated material to a distance not exceeding 5km from the compound.	m3	31	25	775
8,6	25 cm thick basaltic or equivalent stone hardcore and blinded with crushed stone.	m2	36	27	972
	<b>Concrete works</b>				
	Reinforced concrete in c-25,360kg cement/m3 filled in to formworks and vibrated around rod reinforcem. steel reinforcement and formworks measured separately.				
8,7	In floor slab	m3	4	65	260
8,8	In roof slab	m3	5	100	500
	<b>Steel works</b>				
	Steel reinforcements according to drawing. Price includes cutting ,bending ,placing in position and tying wires.				
8,9	a) Dia.8mm deformed bar	Kg	71	7	511
8,10	b) Dia.12mm deformed bar	Kg	111	7	801
	<b>Formworks</b>				
	Provide cut and fix in position sawn zigba form works :				
8,11	a) Roof slab	m2	25	65	1625
	<b>Walls</b>				
8,12	50 cm thick in trachetic or equivalent stone wall bedded in cement mortar 1:3.	m3	55	290	15950
	<b>Finishing</b>				
8,13	Apply three coats of plastic in cement-mortar (1:3) mix up to	m2	110	37	4070
8,14	Provide and install steel manhole cover of 10mm thick and (60x60)cm size.	pcs	2	500	1000
8,15	Provide and install inlet and outlet pipes with all necessary fittings.	Ls	1	300	300
	<b>TOTAL CARRIED TO SUMMARY</b>				<b>30724,56</b>
					=

Table 2.2 Bill of Quantity for Household Flush Latrine

**SUMMARY**

**A. SUPERSTRUCTURE**

1 EXCAVATION AND EARTHWORK 551,60

**B. SUPERSTRUCTURE**

1 BRICKWORKS 690,20

2 CARPENTARY AND JOINERY 440,00

3 METAL WORKS 400,00

4 PLASTERING 276,08

5 PAINTING 197,20

6 SANITARY INSTALLATION 1975,00

7 SEPTIC TANK 5764,28

**TOTAL 10 294,36**



Table 2.2 (1) Bill of Quantity for Household Flush Latrine

ITEM	DESCRIPTION	UNIT	QTY.	U.PRICE Nakfa	TOTAL P. Nakfa
<b><u>A. SUBSTRUCTURE</u></b>					
<b><u>1. EXCAVATION &amp; EARTHWORKS</u></b>					
1.1	Clear off site to remove top soil to an average depth of 20cm.	m2	9,60	4	38
1.2	Excavate for trench foundation in ordinary soil to a depth not exceeding 75cm from the stripped ground level.	m3	9,60	25	240
1.3	Return fill around foundation with good, dry excavated material from site and well ram in layers every 25cm interval.	m3	6,40	22	141
1.4	Cartaway surplus excavated material to a distance not exceeding 5km from the compound.	m3	4,00	25	100
1.5	25cm thick basaltic or equivalent stone hardcore and blinded with crushed stone.	m2	1,20	27	32
<b>TOTAL CARRIED TO SUMMARY .....</b>					<b>551,60</b>
<b><u>B. SUPERSTRUCTURE</u></b>					
<b><u>2. BRICK WORKS</u></b>					
2.1	10cm thick hollow concrete wall bedded on compo-mortar 1:2:9 mix both sides left for plastering.	m2	9,86	70	690
<b>TOTAL CARRIED TO SUMMARY .....</b>					<b>690,20</b>
<b><u>3. CARPENTRY AND JOINERY</u></b>					
3.1	Eucalyptus post for roofing, as shown on the section of the drawing.	m	8,00	25	200
3.2	5x3cm zigba wood perlin, on which the C.I.S. is going to be fixed.	m	8,00	30	240
3.3	Supply and fix 0.3mm thick C.I.S roofing, to be fixed to the perlin price including laps, roof ridges and washers.	m2	1,80	80	144
<b>TOTAL CARRIED TO SUMMARY .....</b>					<b>440,00</b>

Table 2.2 (2) Bill of Quantity for Household Flush Latrine

ITEM	DESCRIPTION	UNIT	QTY.	U.PRICE Nakfa	TOTAL P. Nakfa
<b>4. METAL WORKS</b>					
4,1	Metal doors and windows constructed in accordance to detail drawing, including one coat of anti-rust and three coats of oil paint:-				
	<b>Doors</b>				
	a) Type D1 size: 60 x 170	No	1,00	400	400
					400,00
<b>5. PLASTERING</b>					
5,1	Apply three coats of plaster in compo-mortar (1:2:9) mix up to fine finish to all internal walls of the latrine units.	m2	9,86	28	276
					276,08
<b>6. PAINTING</b>					
6,1	Apply in three coats of oil paint to internal plastered wall surfaces of the latrine units.	m2	9,86	20	197
					197,20
	<b>TOTAL CARRIED TO SUMMARY .....</b>				
<b>7. SANITARY INSTALLATION</b>					
7,1	Supply and install Galvanized steel water supply pipes for cold water distribution from supply line, elevated tanker to all sanitary fixtures according to where shown on the drawings. Complete with the necessary connecting pieces such as bends, unions, nipples, tee, elbow, etc. shall include all the necessary assistance to the installation works, such as chiselling of walls, slabs, floors, etc. and closing them with concrete to normal condition where required. The installation shall be tested at a pressure of 1bar at the expense of the contractor.				
	Dia. ND 15mm (1/2")	ml	4,00	25	100
7,2	Supply and install, on water supply lines, gate valves, made of bronze or brass parts complete with rubber gaskets, hand weels unions and other accessories.				
	Dia. ND 15mm	pcs	1,00	25	25

Table 2.2 (3) Bill of Quantity for Household Flush Latrine

ITEM	DESCRIPTION	UNIT	QTY.	U.PRICE Nakfa	TOTAL P. Nakfa
7,3	Supply and install soil waste and vent pipes in horizontal branches and vertical stacks made of UPVC pipes and fittings. Fittings should include bends, branches, tees, clearout reducers, etc. Unit price shall include all the necessary assistance work to the installation, such as chiselling of walls, slabs, floors, etc. and closing them with concrete. All pipes entering manhole shall be trapped.  Dia. ND 100mm	mi	3,00	95	285
7,4	Supply and fix on terminals of ventilation pipes, vent caps (cowls), with weathering PP states, sealing gaps b/n the girth of the vent pipe and hole in the roof material.  Dia. ND 100mm	pcs	1,00	65	65
7,5	Supply and fix white vitreous Turkish type W.C. unit with trap and complete with fixing device.	pcs	1,00	700	700
7,6	Construct sanitary manholes on domestic sewer lines in 200mm HCB wall plastered from the inside with cement mortar (1:3) on a base of mass concrete slab 100mm thick with proper slope for smooth flow, with reinforced concrete cover.  600 x 600mm	pcs	1,00	800	800
					1975,00
<b>8. SEPTIC TANK</b>					
<b><u>Excavation &amp; earthworks</u></b>					
8,1	Clear off site to remove top soil to an average depth of 20cm.	m2	5,33	4	21
8,2	Bulk excavation for under ground reservoir excavated in ordinary soil to a depth not exceeding 150cm from the stripped ground level.	m3	36,33	20	727
8,3	Return fill around reservoir with good, dry excavated material from site and well ram in layers every 30cm interval.	m3	26,00	22	572
8,5	Cartaway surplus excavated material to a distance not exceeding 5km from the compound.	m3	10,30	25	258
8,6	25 cm thick basaltic or equivalent stone hardcore and blinded with crushed stone.	m2	12,00	27	324

Table 2.2 (4) Bill of Quantity for Household Flush Latrine

ITEM	DESCRIPTION	UNIT	QTY.	U.PRICE Nakfa	TOTAL P. Nakfa
	<b>Concrete works</b>				
	Reinforced concrete in c-25,360kg cement/m3 filled in to formworks and vibrated around rod reinforcem. steel reinforcement and formworks measured separately.				
8,7	In floor slab	m3	1,30	65	85
8,8	In roof slab	m3	1,70	100	170
	<b>Steel works</b>				
	Steel reinforcements according to drawing. Price includes cutting ,bending ,placing in position and tying wires.				
8,9	a) Dia.8mm deformed bar	Kg	23,70	7	171
8,10	b) Dia.12mm deformed bar	Kg	37,10	7	267
	<b>Formworks</b>				
	Provide cut and fix in position sawn zigba form works :				
8,11	a) Roof slab	m2	2,70	65	176
	<b>Walls</b>				
8,12	50 cm thick in trachetic or equivalent stone wall bedded in cement mortar 1:3.	m3	6,00	290	1740
	<b>Finishing</b>				
8,13	Apply three coats of plastic in cement-mortar (1:3) mix up to	m2	12,30	37	455
8,14	Provide and install steel manhole cover of 10mm thick and (60x60)cm size.	pcs	1,00	500	500
8,15	Provide and install inlet and outlet pipes with all necessary fittings.	Ls	1,00	300	300
	<b>TOTAL CARRIED TO SUMMARY</b>				<b>5764,28</b>

Table 2.3 Bill of Quantity for Double PIT VIP Latrine

Material expenses for double pit VIP

Item No.	Description	Unit	Quantity	Unit rate Nfa	Total mount Nfa
1	Hollow block (20x20x10)	pcs	210	1,5	315
2	Stone	m3	7	20	140
3	Cement	quintel	4	70	280
4	Sand	m3	3,5	40	140
5	Reinforcement bar dia. 10mm	kg	31	6	186
6	Galvanized sheet metal vent pipe w	pcs	2	25	50
7	Door made with GSM complete with wire mesh and lock	pcs	1	110	110
8	Corrugated iron sheet roof	pcs	1	100	100
9	Wooden post for roof support	pcs	1	70	70
				<b>Total</b>	<b>1391</b>

Labour expenses for double pit VIP

Item No.	Description	Unit rate Nfa	Total mount Nfa
1	Pit cover slab	ls	60
2	Door	ls	40
3	Masonry work	ls	100
4	Digging pit-8m3	10/m3	80
<b>Total labour expense</b>			<b>280</b>

Total labour and material cost of Double pit VIP latrine = Nfa 1671/-

**Table 2.4 Cost Estimation of Latrine**

Item No.	Description	Qty	1998 price Nfa	Total price Nfa	Inflated price Nfa	Total price Nfa
1	School Latrine – PFL					
	- Year 2000 – 2005	3	74,725.56	224,177	83,961.64	251,885
	- Year 2005 – 2010	1	74,725.56	74,726	112,359.61	112,360
	- Year 2010 – 2015	1	74,725.56	74,726	150,362.51	150,363
2	Public latrine – CFL					
	- Year 2000 – 2005	3	74,725.56	224,177	83,961.64	251,885
	- Year 2005 – 2010	1	74,725.56	74,726	112,359.61	112,360
	- Year 2010 – 2015	1	74,725.56	74,726	150,362.51	150,363
3	Household latrine					
	- CFL – Year 2005	710	10,500.00	7,455,000	11,728.65	8,327,342
	- CFL – Year 2010	333	10,500.00	3,496,500	15,695.58	5,226,628
	- CFL – Year 2015	429	10,500.00	4,504,500	21,004.23	9,010,815
	- PFL – Year 2005	611	10,438.46	6,377,899	11,797.80	7,208,456
	- PFL – Year 2010	390	10,438.46	4,070,999	15,788.12	6,157,367
	- PFL – Year 2015	1,297	10,438.46	13,538,086	21,128.06	27,403,094
	- VIP – Year 2005	543	1,671.00	907,353	1,877.54	1,019,504
	- VIP – Year 2010	172	1,671.00	287,412	2,512.57	432,162
	- VIP – Year 2015	268	1,671.00	447,828	3,362.38	901,118

**Table 2.5 Cost Estimation of Public Facility**

Item No.	Description	Qty	1998 price Nfa	Total price Nfa	Inflated price Nfa	Total price Nfa
1	Refuse truck (compactor)					
	- Year 2000-2005	1	1,027,586	1,027,586	1,134,596	1,134,596
	- Year 2005-2010	1	1,027,586	1,027,586	1,545,109	1,545,109
	- Year 2010-2015	2	1,027,586	2,055,172	2,067,705	4,135,410
2	Vacuum truck (3,000 lit.)					
	- Year 2000-2005	-	924,828	-	1,039,137	-
	- Year 2005-2010	1	924,828	924,828	1,390,599	1,390,599
	- Year 2010-2015	1	924,828	924,828	1,860,936	1,860,936
3	Refuse collecting bins					
	- Year 2000-2005	100	500	50,000	562	56,200
	- Year 2005-2010	100	500	50,000	752	56,200
	- Year 2010-2015	100	500	50,000	1006	56,200
4	Refuse collecting container (8m <sup>3</sup> )					
	- Year 2000-2005	-	59,086	-	66,392	2,221,200
	- Year 2005-2010	25	59,086	1,477,150	88,848	2,221,200
	- Year 2010-2015	25	59,086	1,477,150	118,899	