

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 Shinfo	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	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	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	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	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	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 ³ /d)					Daily Max. (m ³ /d)	Hourly (m ³ /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	206	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	410	307	2,044	2,452	153.3	
	2015	55,880	55,880	100.0	1,945	520	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	1,156	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

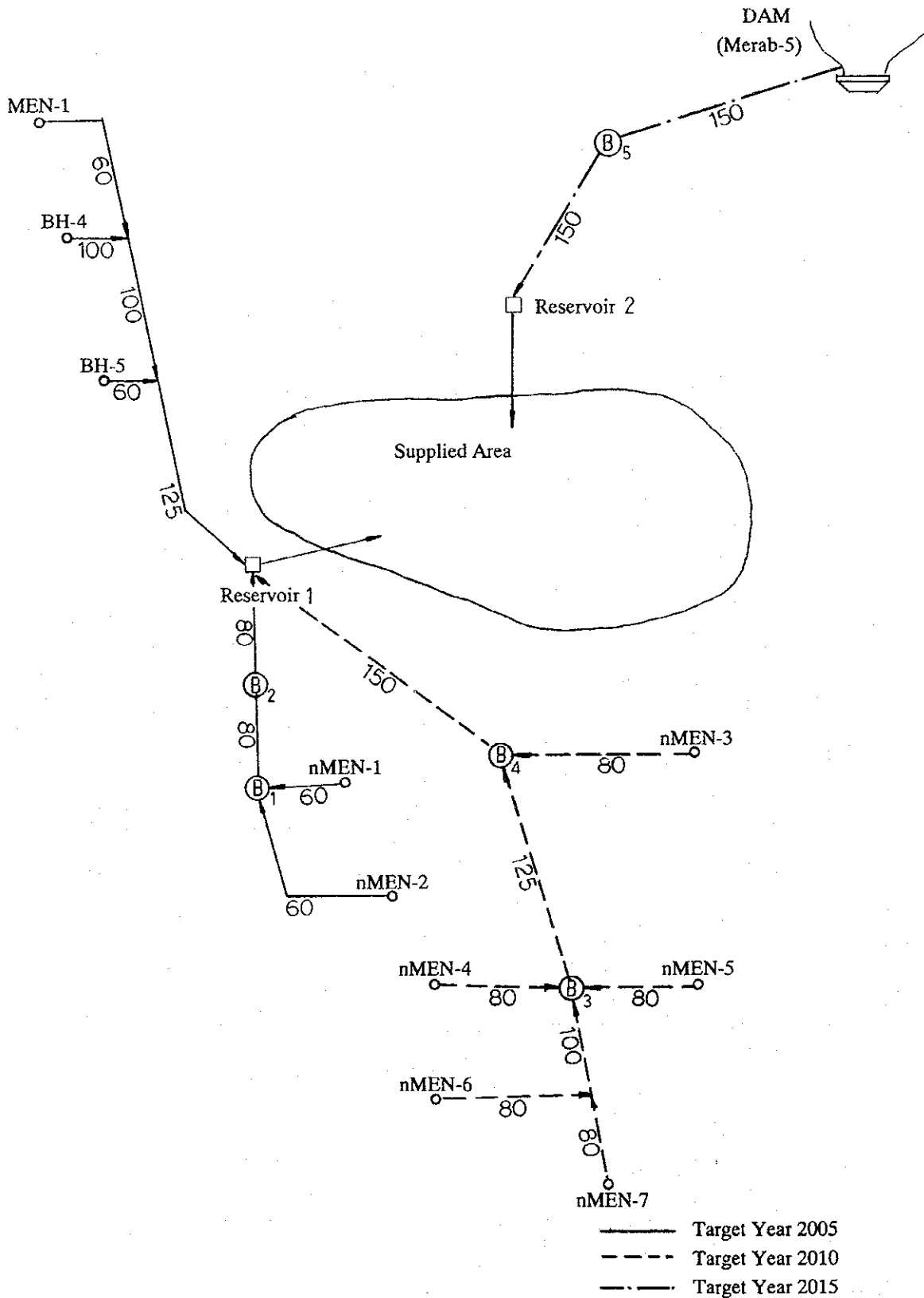
	Debarwa		Mendefera		Adiquala		Dekemhare		Segeneiti		Adi Keyih		Senafe	
	%	l/c/d	%	l/c/d	%	l/c/d	%	l/c/d	%	l/c/d	%	l/c/d	%	l/c/d
Water consumption														
1997														
H.C.	1.25	25	10.94	24.11	13.86	20.45	5.67	25.59	3	28.73	4.95	11.66	7.78	10.3
Y.C.			6.56	14.95	6.14	12.07	8.67	15.67	5	12.64	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	visiter	5	450	1,430	790	2,020	580	1,180	830
Mosque	visiter	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

Mendefera



2.2 Hydraulic Calculation of Transmission Pipeline

Mendefera	Target Year		2005				
	Well No.		MEN-1	BH-4	BH-5	nMEN-2	nMEN-1
Condition	Symbol	Unit	24hr ope.	24hr ope.	24hr ope.	24hr ope.	24hr ope.
Elevation of Intake	EL1	m	1942.43	1939.45	1932.20	1826	1852
Ground water level		m	18.60	11.00	11.00	10.00	10.00
Elevation of Reservoir	EL2	m	1983.00	1983.00	1983.00	1983.00	1983.00
Water level		m	3.50	3.50	3.50	3.50	3.50
Discharge	Q	m ³ /d	173	415		173	173
Discharge	Q1	m ³ /s	0.0020	0.0048		0.0020	0.0020
Pipe Diameter	D	mm	60	100		60	60
Velocity	V	m/s	0.71	0.61		0.71	0.71
Velocity Coefficient	C		110	110		110	110
Pipe Length	L	m	567	288		1600	100
Loss Head	h ₂	m	9.19	1.96		25.93	1.62
Actual Head	h ₁	m				42.50	16.50
Total Head	H	m				68.43	18.12
Booster Pump						(BP No.1)	
Elevation of Booster P		m				1855	
Discharge	Q	m ³ /d	588		138	346	
Discharge	Q1	m ³ /s	0.0068		0.0016	0.0040	
Pipe Diameter	D	mm	100		60	80	
Velocity	V	m/s	0.87		0.57	0.80	
Velocity Coefficient	C		110		110	110	
Pipe Length	L	m	336		400	2800	
Loss Head	h ₂	m	4.35		4.27	40.30	
Actual Head	h ₁	m				59.5	
Total Head	H	m				99.80	
Booster Pump						(BP No.2)	
Elevation of Booster P		m				1911	
Discharge	Q	m ³ /d	726			346	
Discharge	Q1	m ³ /s	0.0084			0.0040	
Pipe Diameter	D	mm	125			80	
Velocity	V	m/s	0.69			0.80	
Velocity Coefficient	C		110			110	
Pipe Length	L	m	1779			1777	
Loss Head	h ₂	m	11.48			25.57	
Actual Head	h ₁	m	62.67	58.05	65.30	75.50	
Total Head	H	m	87.69	75.84	81.04	101.07	

- Pumps are operated 24 hours per day.

- This transmission line is used in the year of 2010 and 2015.

Hydraulic Calculation of Transmission Line

Mendefera	Target Year		2010				
	Well No.		nMEN-7	nMEN-6	nMEN-5	nMEN-4	nMEN-3
Condition	Symbol	Unit	24hr ope.	24hr ope.	24hr ope.	24hr ope.	24hr ope.
Elevation of Intake	EL1	m	1765	1781	1790	1802	1850
Ground water level		m	15.00	15.00	15.00	15.00	15.00
Elevation of Reservoir	EL2	m	1983.00	1983.00	1983.00	1983.00	1983.00
Water level		m	3.50	3.50	3.50	3.50	3.50
Discharge	Q	m ³ /d	259	259			
Discharge	Q1	m ³ /s	0.0030	0.0030			
Pipe Diameter	D	mm	80	80			
Velocity	V	m/s	0.60	0.60			
Velocity Coefficient	C		110	110			
Pipe Length	L	m	1200	200			
Loss Head	h ₂	m	10.11	1.68			
Discharge	Q	m ³ /d	518		259	259	
Discharge	Q1	m ³ /s	0.0060		0.0030	0.0030	
Pipe Diameter	D	mm	100		80	80	
Velocity	V	m/s	0.76		0.60	0.60	
Velocity Coefficient	C		110		110	110	
Pipe Length	L	m	1600		800	500	
Loss Head	h ₂	m	16.39		6.74	4.21	
Actual Head	h ₁	m	63.50	47.50	38.50	26.50	
Total Head	H	m	89.99	65.57	45.24	30.71	
Booster Pump			(BP No.3)				
Elevation of Booster P		m	1810				
Discharge	Q	m ³ /d	1036				259
Discharge	Q1	m ³ /s	0.0120				0.0030
Pipe Diameter	D	mm	125				80
Velocity	V	m/s	0.98				0.60
Velocity Coefficient	C		110				110
Pipe Length	L	m	3800				1100
Loss Head	h ₂	m	47.33				9.26
Actual Head	h ₁	m	48.50				23.5
Total Head	H	m	95.83				32.76
Booster Pump			(BP No.4)				
Elevation of Booster P		m	1855				
Discharge	Q	m ³ /d	1295				
Discharge	Q1	m ³ /s	0.0150				
Pipe Diameter	D	mm	150				
Velocity	V	m/s	0.85				
Velocity Coefficient	C		110				
Pipe Length	L	m	2900				
Loss Head	h ₂	m	22.46				
Actual Head	h ₁	m	131.5				
Total Head	H	m	153.96				

*

- Pumps are operated 24 hours per day.
- " *" means that booster pumps shall be installed in the line.
- This transmission line is used in the year of 2015.

Hydraulic Calculation of Transmission Line

Mendefera	Target Year		2015			
	Well No.	nDam				
Condition	Symbol	Unit	24hr ope.			
Elevation of Intake	EL1	m	1780			
Ground water level		m	0.00			
Elevation of Reservoir	EL2	m	1995.00			
Water level		m	3.00			
Discharge	Q	m ³ /d	1478			
Discharge	Q1	m ³ /s	0.0171			
Pipe Diameter	D	mm	150			
Velocity	V	m/s	0.97			
Velocity Coefficient	C		110			
Pipe Length	L	m	34000			
Loss Head	h ₂	m	336.27			
Actual Head	h ₁	m	218.00			
Total Head	H	m	554.27			

*

- "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 ³ /s)	Pit Capacity		Dimension of Pump Pit			Additional Pump Pit			Remarks		
				Necessary (m ³)	Design (m ³)	Length (m)	Width (m)	High (m)	Actual (m ³)	Capacity (m ³)	Length (m)		Width (m)	High (m)
Mendefera	BP-1	2005	0.0040	7.2	15	3.0	2.5	2.0	15					
	BP-2	2005	0.0040	7.2	15	3.0	2.5	2.0	15					
	BP-3	2010	0.0120	21.6	25	5.0	2.5	2.0	25					
	BP-4	2010	0.0150	27.0	30	6.0	2.5	2.0	30					
	BP-5	2015	0.0171	30.8	35	7.0	2.5	2.0	35					
Adiquala	BP-1	2010	0.0032	5.8	15	3.0	2.5	2.0	15				15	
	BP-1	2015	0.0092	16.6	20	4.0	2.5	2.0	20	5	1.0	2.5	2.0	5
Dekemhare	BP-1	2005	0.0153	27.5	30	6.0	2.5	2.0	30				30	
	BP-1	2010	0.0241	43.4	45	9.0	2.5	2.0	45	15	3.0	2.5	2.0	15
Segeneiti	BP-2	2015	0.0291	52.4	55	7.5	3.0	2.5	56					
	BP-1	2005	0.0040	7.2	15	3.0	2.5	2.0	15					
	BP-1	2010	0.0044	7.9	15	3.0	2.5	2.0	15	0				
	BP-1	2015	0.0046	8.3	15	3.0	2.5	2.0	15	0				
	BP-1'	2010	0.0060	10.8	15	3.0	2.5	2.0	15					
Aadi Keyih	BP-1'	2015	0.0072	13.0	15	3.0	2.5	2.0	15	0				
	BP-2	2010	0.0016	2.9	15	3.0	2.5	2.0	15					
	BP-2	2015	0.0026	4.7	15	3.0	2.5	2.0	15	0				
	BP-1	2005	0.0050	9.0	15	3.0	2.5	2.0	15					
	BP-1	2010	0.0064	11.5	15	3.0	2.5	2.0	15	0				
Senafe	BP-2	2005	0.0048	8.6	15	3.0	2.5	2.0	15					
	BP-2	2010	0.0064	11.5	15	3.0	2.5	2.0	15	0				
	BP-3	2010	0.0020	3.6	15	3.0	2.5	2.0	15					
	BP-4'	2010	0.0024	4.3	15	3.0	2.5	2.0	15					
	BP-4	2010	0.0024	4.3	15	3.0	2.5	2.0	15					
Senafe	BP-5	2015	0.0073	13.1	15	3.0	2.5	2.0	15					
	BP-6	2015	0.0097	17.5	20	4.0	2.5	2.0	20					
	BP-1	2010	0.0048	8.6	15	3.0	2.5	2.0	15					
	BP-1	2015	0.0080	14.4	15	3.0	2.5	2.0	15	0				
	BP-2	2015	0.0034	6.1	15	3.0	2.5	2.0	15					
	BP-2	2015	0.0034	6.1	15	3.0	2.5	2.0	15					

2.4 Capacity of Reservoir

Capacity of Reservoir

No.1

Name of Town	Rsv. No.	Target Year	Max. Daily Consumption (m ³ /d)	Reservoir Capacity		Dimension of Reservoir			Additional Reservoir			Remarks		
				Necessary (m ³)	Design (m ³)	Length (m)	Width (m)	High (m)	Actual (m ³)	Capacity (m ³)	Length (m)		Width (m)	High (m)
Debarwa	DB-1	2005	411	137	140	7.0	7.0	3.0	147				147	
	DB-1	2010	754	251	260	9.6	9.0	3.0	259	120	5.5	7.0	3.0	116
	DB-1	2015	1,318	439	440	12.5	12.0	3.0	450	180	9.0	7.0	3.0	189
Mendefera	MD-1	2005	1,001	334	340	10.0	10.0	3.5	350					350
	MD-1	2010	2,283	761	770	15.0	15.0	3.5	788	430	12.5	10.0	3.5	438
	(80.0) MD-1	2015	3,009	1003	1010	17.0	17.0	3.5	1012	240	7.0	10.0	3.5	245
	(13.7) MD-2	2015	515	172	180	8.5	8.5	2.5	181					
(3.4) MD-3	2015	128	43	50	4.5	4.5	2.5	51						
	(2.9) MD-4	2015	109	36	40	4.0	4.0	2.5	40					
Adiquala	AQ-1	2005	532	177	180	7.5	8.0	3.0	180					180
	(81.0) AQ-1	2010	639	213	220	8.6	8.6	3.0	222	40	4.0	4.0	3.0	48
	(63.8) AQ-1	2015	843	281	290	10.0	10.0	3.0	300	70	4.5	5.0	3.0	68
	AQ-1'	2005	532	22	25	3.5	3.0	2.5	26					26 H=13m, Q=1hr
(19.0) AQ-2	2010	639	27	30	3.5	3.5	2.5	31	5	2.0	2.0	2.0	2.0	8 H=13m, Q=1hr
	(30.5) AQ-2	2015	843	35	35	4.0	4.0	2.5	40	5	2.0	2.0	2.0	8 H=13m, Q=1hr
(5.7) AQ-3	2015	150	50	50	4.0	4.5	3.0	54					54 H=13m	
Dekemhare	AQ-2	2015	403	134	140	7.0	7.0	3.0	147	90	5.5	5.5	3.0	91 H=13m
	(5.7) AQ-3	2015	75	25	30	3.5	3.5	2.5	31					Mini & Shimfio
	(84.2+15.8) DK-1	2005	1,320	440	440	8.5	15.0	3.5	446					446
	(88.8+11.2) DK-1	2010	2,452	817	820	16.0	15.0	3.5	840	380	7.5	15.0	3.5	394
(86.7+6.0) DK-1	2015	4,600	1533	1540	30.0	15.0	3.5	1575	720	14.0	15.0	3.5	735	
(15.8) DK-1'	2005	209	9	10	2.0	3.0	2.0	12					12 H=12m, Q=1hr	
(11.2) DK-1'	2010	275	11	15	3.0	3.0	2.0	18					18 H=12m, Q=1hr	
(6.0) DK-1'	2015	298	12	15	3.0	3.0	2.0	18					18 H=12m, Q=1hr	
(2.9) DK-2	2015	144	48	50	4.5	4.5	2.5	51					Hadamu	
(1.8) DK-3	2015	89	30	30	3.5	3.5	2.5	31					Metsalu	
(2.6) DK-4	2015	129	43	50	4.5	4.5	2.5	51					Amhare	

Capacity of Reservoir

No.2

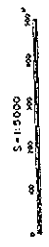
Name of Town	Rsv. No.	Target Year	Max. Daily Consumption (m ³ /d)	Reservoir Capacity		Dimension of Reservoir				Additional Reservoir				Remarks	
				Necessary (m ³)	Design (m ³)	Length (m)	Width (m)	High (m)	Actual (m ³)	Capacity (m ³)	Length (m)	Width (m)	High (m)		Actual (m ³)
Segenciti (74.0) (50.9) (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
Aadi Keyih	AD-1	2005	849	283	290	10.0	10.0	3.0	300					300	H=5.5m
	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
Sonafe	SN-1	2005	698	233	240				600						Existing
	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 BRITAIN MINISTRY OF LAND, WATER & ENVIRONMENT JAPAN INTERNATIONAL COOPERATION AGENCY	STUDY ON GROUNDWATER DEVELOPMENT AND SUPPLY FOR SEVEN TOWNS IN SOUTHERN LAOS	2005
VIENTIANE KHAMMOUN PROVINCE KHAMMOUN PROVINCE KHAMMOUN PROVINCE		2005
KHAMMOUN PROVINCE KHAMMOUN PROVINCE KHAMMOUN PROVINCE		2005

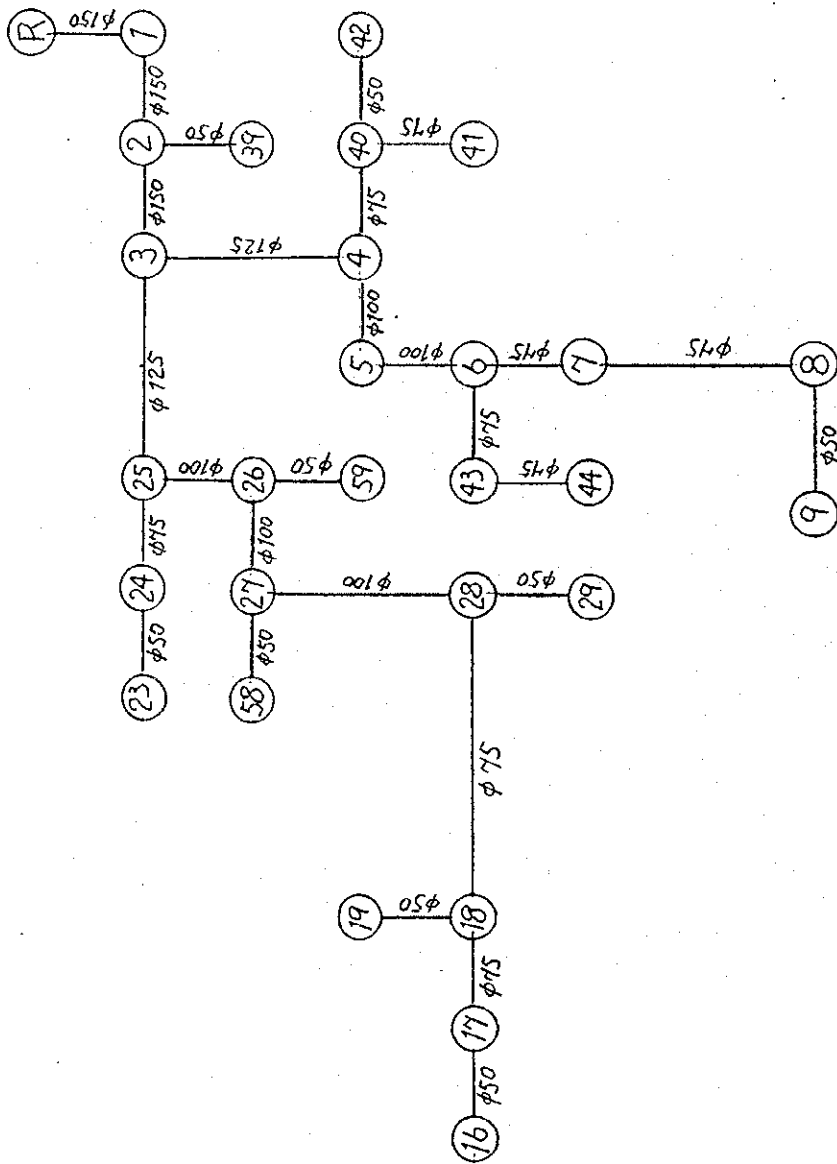
Legend
Distribution pipeline
Pipe Diameter (mm)

100



Plan of Distribution Pipeline (2005)



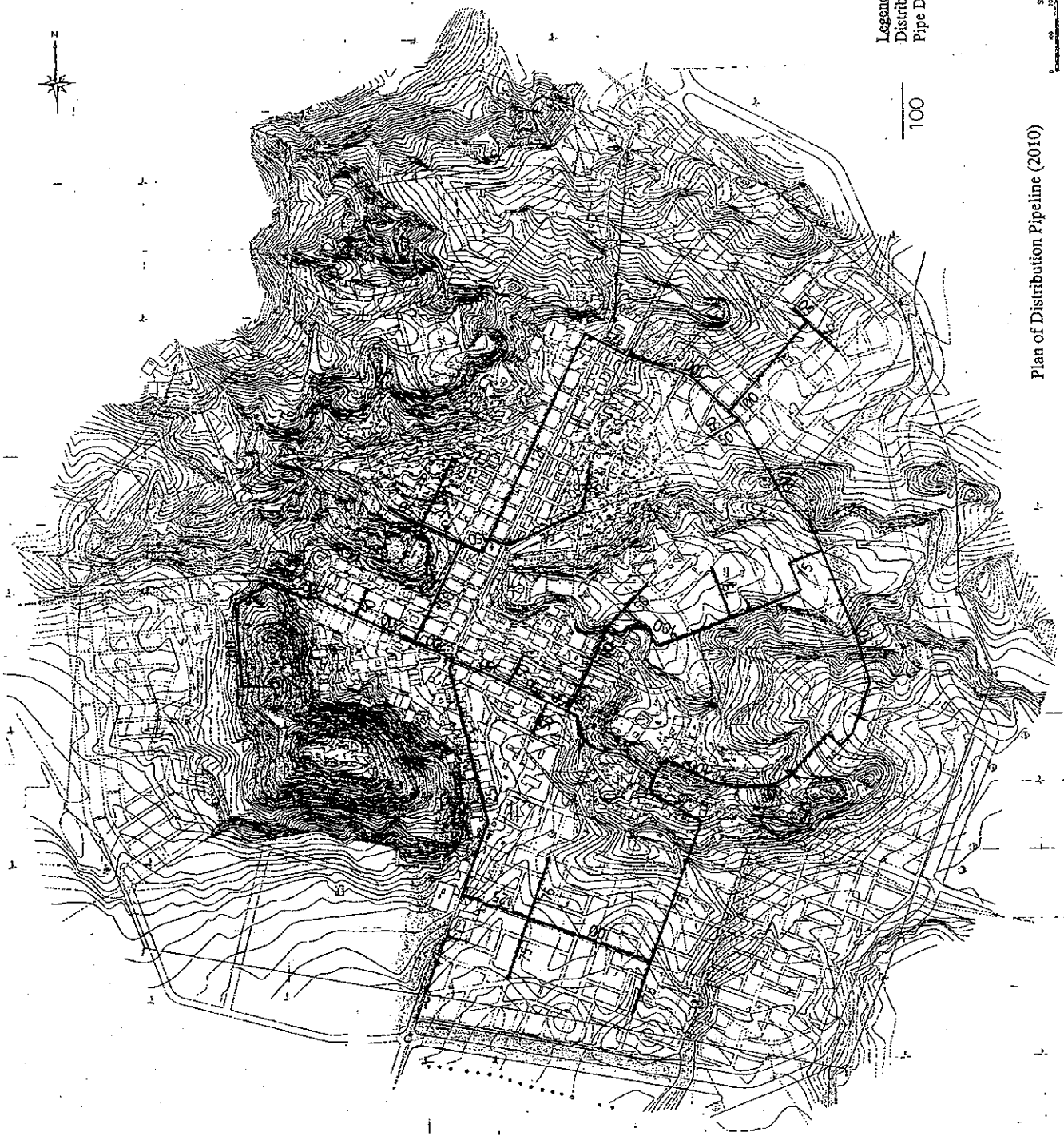


Node No.	Dynamic (WL.m)	Ground Elevation (EL.m)	Effective Head (m)	Area (ha)	Outflow Quantity (L/sec)
0	1983.000	1984.500	-1.500	-138.80	-17.39
1	1978.828	1943.400	35.428	0.00	0.00
2	1976.135	1933.000	43.135	0.00	0.00
3	1974.371	1927.900	46.471	6.40	0.80
4	1972.629	1933.500	39.129	0.00	0.00
5	1972.102	1932.000	40.102	5.60	0.70
6	1971.758	1933.700	38.058	0.00	0.00
7	1969.562	1937.900	31.662	3.50	0.44
8	1967.712	1943.000	24.712	8.40	1.05
9	1966.483	1938.000	28.483	7.10	0.89
39	1975.326	1934.400	40.926	0.00	0.00
25	1973.820	1927.100	46.720	0.00	0.00
26	1971.777	1923.700	48.077	0.00	0.00
27	1970.799	1922.300	48.499	0.00	0.00
28	1970.457	1923.000	47.457	0.00	0.00
18	1966.266	1935.400	30.866	0.00	0.00
17	1964.802	1934.000	30.802	8.00	1.00
16	1963.083	1930.100	32.983	7.70	0.96
24	1972.646	1925.000	47.646	10.10	1.27
23	1970.741	1917.000	53.741	4.70	0.59
59	1971.065	1927.400	43.665	6.60	0.83
58	1969.329	1920.300	49.029	9.60	1.20
19	1962.952	1927.000	42.568	7.40	0.93
40	1971.715	1930.000	32.952	9.30	1.17
41	1970.505	1940.000	31.715	0.00	0.00
42	1971.558	1941.300	30.005	16.20	2.03
43	1970.488	1936.500	30.258	2.80	0.35
44	1969.447	1934.600	33.988	6.60	0.83
			34.847	11.70	1.47

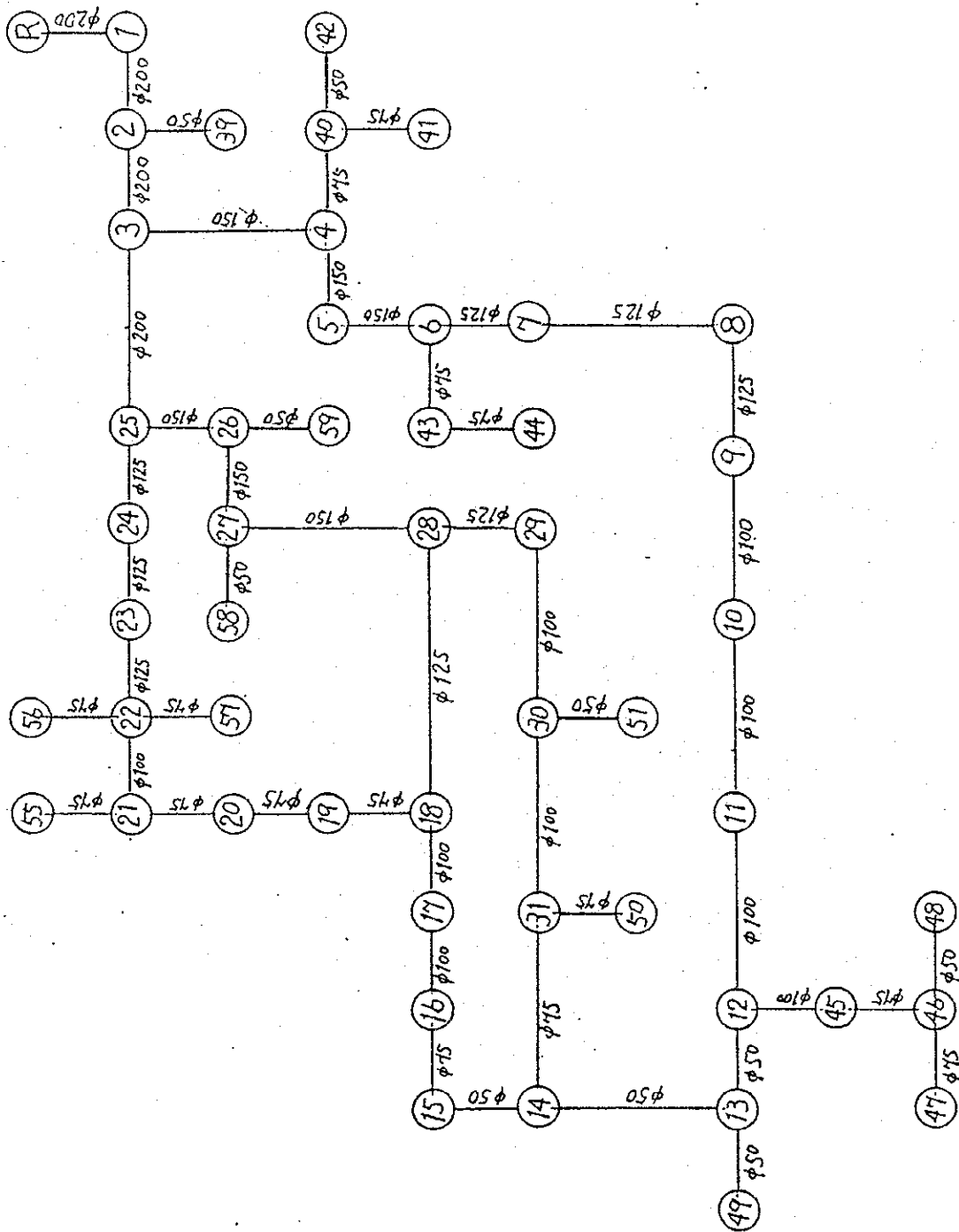
Pipe line	Pipe No.		Dia. (mm)	Length (m)	Flow Coefficient	Flow velocity (L/sec)	Flow velocity (m/sec)	Loss of Head (m)	Hydraulic Gradient (m/100m)	Head Loss Coefficient	Hydrostatic Water Hammer		Design Pressure (kg/sq.cm)	Pipe Material
	No.	From To									Head	Head		
1	0	1	150	418.00	110	17.3	0.981	4.172	9.981	0.03049	4.04	1.75	5.79	
2	1	2	150	270.00	110	17.3	0.981	2.693	9.975	0.03049	5.08	1.75	6.83	
3	2	3	150	195.00	110	16.4	0.930	1.764	9.047	0.03073	5.59	1.75	7.34	
4	3	4	125	322.00	110	7.7	0.628	1.741	5.407	0.03358	5.59	1.75	7.34	
5	4	5	100	64.00	110	5.4	0.685	0.528	8.247	0.03440	5.17	1.75	6.92	
6	5	6	100	54.00	110	4.7	0.596	0.343	6.357	0.03513	5.17	1.75	6.92	
7	6	7	75	297.00	110	2.4	0.539	2.197	7.397	0.03740	5.00	1.75	6.75	
8	7	8	75	365.00	110	1.9	0.440	1.850	5.067	0.03855	4.58	1.75	6.33	
9	8	9	50	143.00	110	0.9	0.453	1.229	8.594	0.04106	4.57	1.75	6.32	
10	2	39	50	94.00	110	0.9	0.453	0.809	8.605	0.04106	5.07	1.75	6.82	
11	3	25	125	97.00	110	7.9	0.645	0.551	5.678	0.03345	5.67	1.75	7.42	
12	25	26	100	198.00	110	6.1	0.774	2.043	10.319	0.03379	6.01	1.75	7.76	
13	26	27	100	124.00	110	5.3	0.669	0.978	7.883	0.03453	6.14	1.75	7.89	
14	27	28	100	170.00	110	4.1	0.516	0.342	4.883	0.03588	6.14	1.75	7.82	
15	28	18	75	341.00	110	3.1	0.709	4.192	12.292	0.03591	6.07	1.75	7.82	
16	18	17	75	282.00	110	2.0	0.445	1.464	5.190	0.03847	4.97	1.75	6.72	
17	17	16	50	172.00	110	1.0	0.491	1.719	9.996	0.04057	5.36	1.75	7.11	
18	25	24	75	252.00	110	1.9	0.420	1.174	4.658	0.03881	5.87	1.75	7.62	
19	24	23	50	476.00	110	0.6	0.300	1.905	4.002	0.04365	6.67	1.75	8.42	
20	26	59	50	95.00	110	0.8	0.420	0.711	7.489	0.04152	6.00	1.75	7.75	
21	27	58	50	98.00	110	1.2	0.612	1.470	15.002	0.03927	6.34	1.75	8.09	
22	28	29	50	96.00	110	0.9	0.472	0.889	19.265	0.04081	6.07	1.75	7.82	
23	18	19	50	234.00	110	1.2	0.593	3.314	14.162	0.03945	5.37	1.75	7.12	
24	4	40	75	130.00	110	2.3	0.525	0.915	7.035	0.03755	5.02	1.75	6.77	
25	40	41	75	220.00	110	2.0	0.460	1.210	5.501	0.03830	4.37	1.75	6.12	
26	40	42	50	102.00	110	0.4	0.179	0.157	1.537	0.04712	4.37	1.75	6.12	
27	6	43	75	184.00	110	2.3	0.519	1.270	6.902	0.03761	5.00	1.75	6.75	
28	43	44	75	346.00	110	1.5	0.332	1.041	3.009	0.04019	4.91	1.75	6.66	
合計														*
5739.00														*

2.6 Plan of Distribution Pipeline (2010)

STATE OF BIRMA MINISTRY OF LAND, WATER & ENVIRONMENT ASIAN INTERNATIONAL COOPERATION AGENCY	2010
STUDY ON GROUNDWATER DEVELOPMENT & WATER SUPPLY SEVEN TOWNS IN SOUTHERN REGION	MEMORANDUM Scale: 1:50,000 WATER RESOURCES DEPARTMENT, Yangon, Myanmar SAATCHI CONSULTANTS INC. (USA, INC)



Plan of Distribution Pipeline (2010)



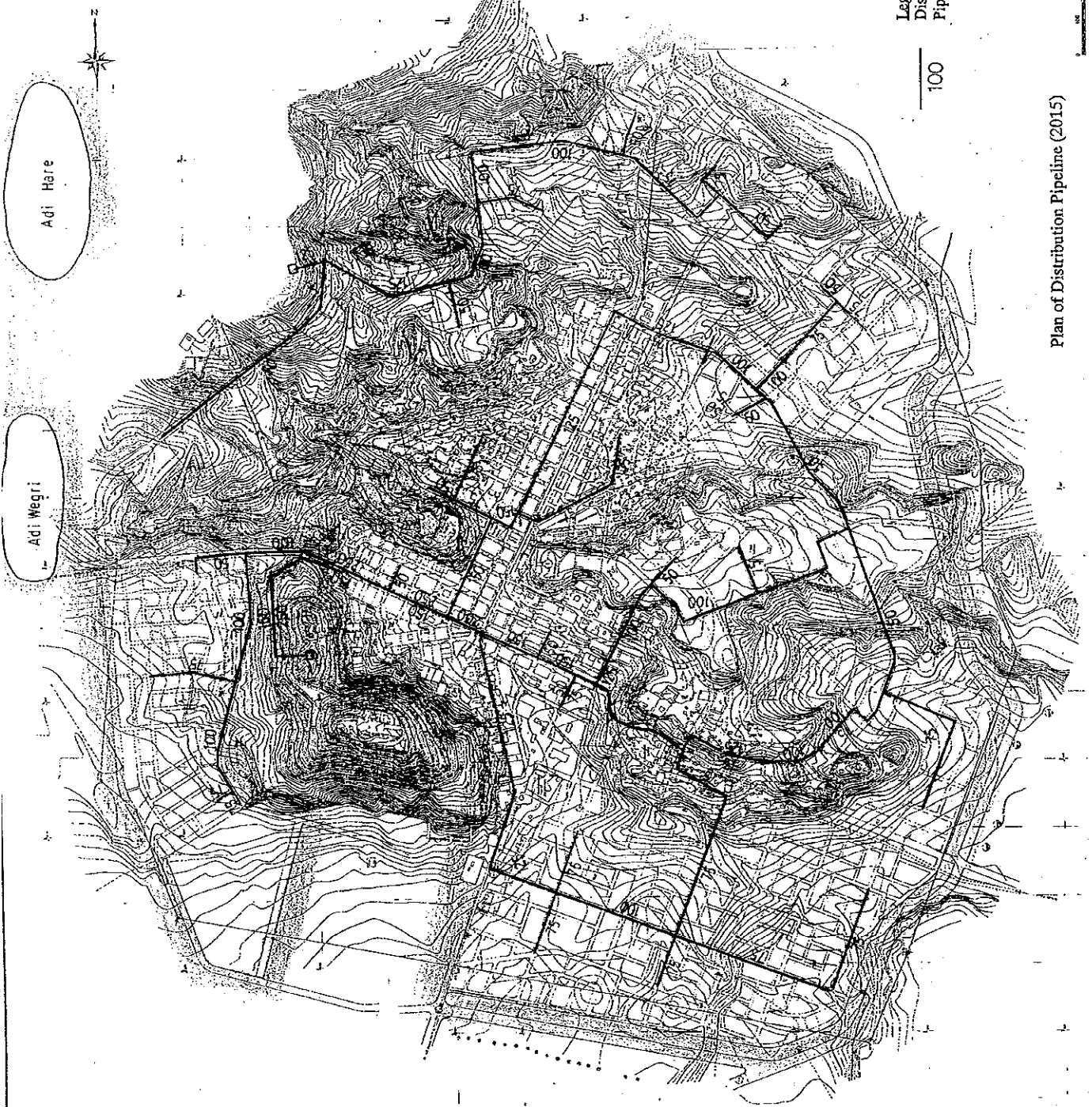
Node No.	Dynamic (WL.m)	Ground Elevation (EL.m)	Effective Head (m)	Area (ha)	Outflow Quantity (L/sec)
0	1983.000	1984.500	-1.500	-302.50	-39.64
1	1978.298	1943.400	34.898	0.00	0.00
2	1975.262	1933.000	42.262	0.00	0.00
3	1973.166	1927.900	45.266	6.40	0.84
4	1971.018	1933.500	37.518	0.00	0.00
5	1970.718	1932.000	38.718	5.60	0.73
6	1970.494	1933.700	36.794	0.00	0.00
7	1968.611	1937.900	30.711	3.50	0.46
8	1966.525	1943.000	23.525	8.40	1.10
9	1965.905	1938.000	27.905	7.10	0.93
10	1964.158	1932.000	32.158	5.40	0.71
11	1963.304	1929.000	34.304	4.60	0.60
12	1962.933	1928.600	34.333	0.00	0.00
13	1962.612	1928.600	34.012	0.00	0.00
14	1962.596	1946.600	15.996	19.40	2.54
15	1962.921	1919.700	43.221	18.70	2.45
16	1965.711	1930.100	35.611	7.70	1.01
17	1966.409	1934.000	32.409	8.00	1.05
18	1968.234	1935.400	32.834	0.00	0.00
19	1966.531	1930.000	36.531	9.30	1.22
20	1966.325	1918.500	47.825	19.20	2.52
21	1967.196	1912.200	54.996	0.00	0.00
22	1968.226	1913.100	55.126	0.00	0.00
23	1969.025	1917.000	52.025	4.70	0.62
24	1971.172	1925.000	46.172	10.10	1.32
25	1972.740	1927.100	45.640	0.00	0.00
26	1971.140	1923.700	47.440	0.00	0.00
27	1970.240	1922.300	47.940	0.00	0.00
28	1969.810	1923.000	46.810	0.00	0.00
29	1969.457	1927.000	42.457	7.40	0.97
30	1967.363	1952.500	14.863	0.00	0.00
31	1965.350	1950.000	15.350	0.00	0.00
39	1974.382	1934.400	39.982	7.10	0.93
40	1970.026	1940.000	30.026	0.00	0.00
41	1968.711	1940.500	28.211	16.20	2.12
42	1969.857	1941.300	28.557	2.80	0.37
43	1969.109	1936.500	32.609	6.60	0.86
44	1967.978	1934.600	33.378	11.70	1.53
45	1962.453	1927.700	34.753	10.50	1.38
46	1960.677	1930.600	30.077	0.00	0.00
47	1960.177	1927.800	32.377	13.00	1.70
48	1960.305	1931.700	28.605	5.40	0.71
49	1962.080	1929.700	32.380	5.90	0.77
50	1964.470	1953.300	11.170	15.40	2.02
51	1966.125	1954.200	11.926	8.10	1.06
55	1966.618	1909.300	57.318	12.00	1.57
56	1967.376	1912.200	55.177	13.50	1.77
57	1967.503	1917.500	50.003	12.60	1.65
58	1968.647	1920.300	48.347	9.60	1.26
59	1970.370	1927.400	42.970	6.60	0.86

Pipe line	Node No.		Dia. (mm)	Length (m)	Flow Coefficient	Flow 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.	No.											
1	0	1	200	418.00	110	39.4	1.254	4.702	11.250	0.02802	4.04	1.75	5.79
2	1	2	200	270.00	110	39.4	1.254	3.035	11.241	0.02803	5.08	1.75	6.83
3	2	3	200	195.00	110	38.5	1.224	2.096	10.751	0.02813	5.59	1.75	7.34
4	3	4	150	322.00	110	4.789	0.672	2.148	6.672	0.03149	5.59	1.75	6.93
5	4	5	150	64.00	110	11.5	0.651	0.299	4.677	0.03240	5.18	1.75	6.93
6	5	6	150	54.00	110	10.8	0.611	0.225	4.159	0.03270	5.18	1.75	6.76
7	6	7	125	297.00	110	8.4	0.684	1.882	6.338	0.03315	5.01	1.75	6.34
8	7	8	125	365.00	110	7.9	0.647	2.086	5.715	0.03343	4.59	1.75	6.33
9	8	9	125	143.00	110	6.8	0.558	0.621	4.340	0.03417	4.58	1.75	6.92
10	9	10	100	178.00	110	5.9	0.753	1.747	9.814	0.03393	5.17	1.75	6.92
11	10	11	100	110.00	110	5.2	0.664	0.854	7.766	0.03457	5.47	1.75	7.22
12	11	12	100	60.00	110	4.6	0.586	0.370	6.173	0.03521	5.51	1.75	7.26
13	12	13	50	44.00	110	0.8	0.415	0.322	7.308	0.04160	5.51	1.75	7.26
14	13	14	50	454.00	110	0.0	0.023	0.016	0.035	0.06378	5.51	1.75	7.26
15	14	15	50	519.00	110	-0.2	-0.110	-0.325	-0.05064	-0.03678	6.40	1.75	8.15
16	15	16	75	306.00	110	-2.7	-0.604	-2.790	-9.119	-0.03678	6.40	1.75	8.15
17	16	17	100	172.00	110	-3.7	-0.467	-0.698	-4.060	-0.03641	5.36	1.75	7.11
18	17	18	100	282.00	110	-4.7	-0.601	-1.825	-6.471	-0.03508	4.97	1.75	6.72
19	18	19	75	234.00	110	2.4	0.535	1.704	7.280	0.03745	5.37	1.75	8.27
20	19	20	75	108.00	110	1.1	0.259	0.205	1.899	0.04170	6.52	1.75	8.90
21	20	21	75	327.00	110	-1.4	-0.311	-0.871	-2.662	-0.04058	7.15	1.75	8.90
22	21	22	100	382.00	110	-2.9	-0.375	-1.030	-2.696	-0.03762	7.16	1.75	8.91
23	22	23	125	210.00	110	-6.4	-0.520	-0.799	-3.805	-0.03454	7.07	1.75	8.82
24	23	24	125	476.00	110	-7.0	-0.570	-2.147	-4.511	-0.03407	6.68	1.75	8.43
25	24	25	125	252.00	110	-8.3	-0.678	-1.568	-6.222	-0.03320	5.88	1.75	7.63
26	25	26	200	97.00	110	-23.7	-0.755	-0.426	-4.389	-0.03022	5.67	1.75	7.42
27	26	27	150	198.00	110	15.5	0.875	1.601	8.084	0.03101	6.01	1.75	7.76
28	27	28	150	124.00	110	14.6	0.826	0.900	7.257	0.03128	6.15	1.75	7.90
29	28	29	150	70.00	110	13.3	0.755	0.430	6.138	0.03170	6.15	1.75	7.90
30	29	30	100	341.00	110	7.1	0.577	1.576	4.621	0.03400	6.08	1.75	7.83
31	30	31	125	96.00	110	6.3	0.510	1.353	3.675	0.03463	6.08	1.75	7.83
32	31	32	100	262.00	110	5.3	0.574	2.094	7.992	0.03449	5.67	1.75	7.42
33	32	33	100	380.00	110	4.2	0.540	2.013	5.298	0.03564	3.37	3.37	6.75
34	33	34	175	404.00	110	2.3	0.516	2.754	6.817	0.03764	3.71	1.75	5.46
35	34	35	50	94.00	110	0.9	0.474	0.880	9.366	0.04078	5.07	1.75	6.82
36	35	36	75	130.00	110	2.1	0.480	0.992	7.630	0.03731	5.02	1.75	6.77
37	36	37	75	220.00	110	2.4	0.548	1.314	5.974	0.03804	4.37	1.75	6.12
38	37	38	50	102.00	110	0.4	0.186	0.169	1.654	0.04685	4.37	1.75	6.12
39	38	39	75	184.00	110	2.4	0.544	1.385	1.525	0.03735	5.00	1.75	6.75
40	39	40	75	346.00	110	1.5	0.347	1.131	3.269	0.03992	4.91	1.75	6.66
41	40	41	75	112.00	110	3.8	0.481	0.480	4.288	0.03625	5.61	1.75	7.36
42	41	42	75	236.00	110	2.4	0.544	1.776	7.524	0.03735	5.60	1.75	7.35
43	42	43	75	126.00	110	1.7	0.386	0.501	3.974	0.03930	5.59	1.75	7.34
44	43	44	50	66.00	110	0.8	0.361	0.372	5.637	0.04247	5.31	1.75	7.06
45	44	45	50	80.00	110	0.8	0.394	0.531	6.644	0.04192	5.51	1.75	7.26
46	45	46	75	162.00	110	2.0	0.456	0.880	5.433	0.04001	3.12	3.37	6.75
47	46	47	75	104.00	110	1.1	0.540	1.238	11.902	0.04001	3.12	3.37	6.75
48	47	48	75	168.00	110	1.6	0.357	0.578	3.441	0.03976	7.44	1.75	9.19
49	48	49	75	199.00	110	1.8	0.401	0.850	4.269	0.03908	7.15	1.75	8.90
50	49	50	75	192.00	110	1.7	0.374	0.723	3.764	0.03948	7.06	1.75	8.81

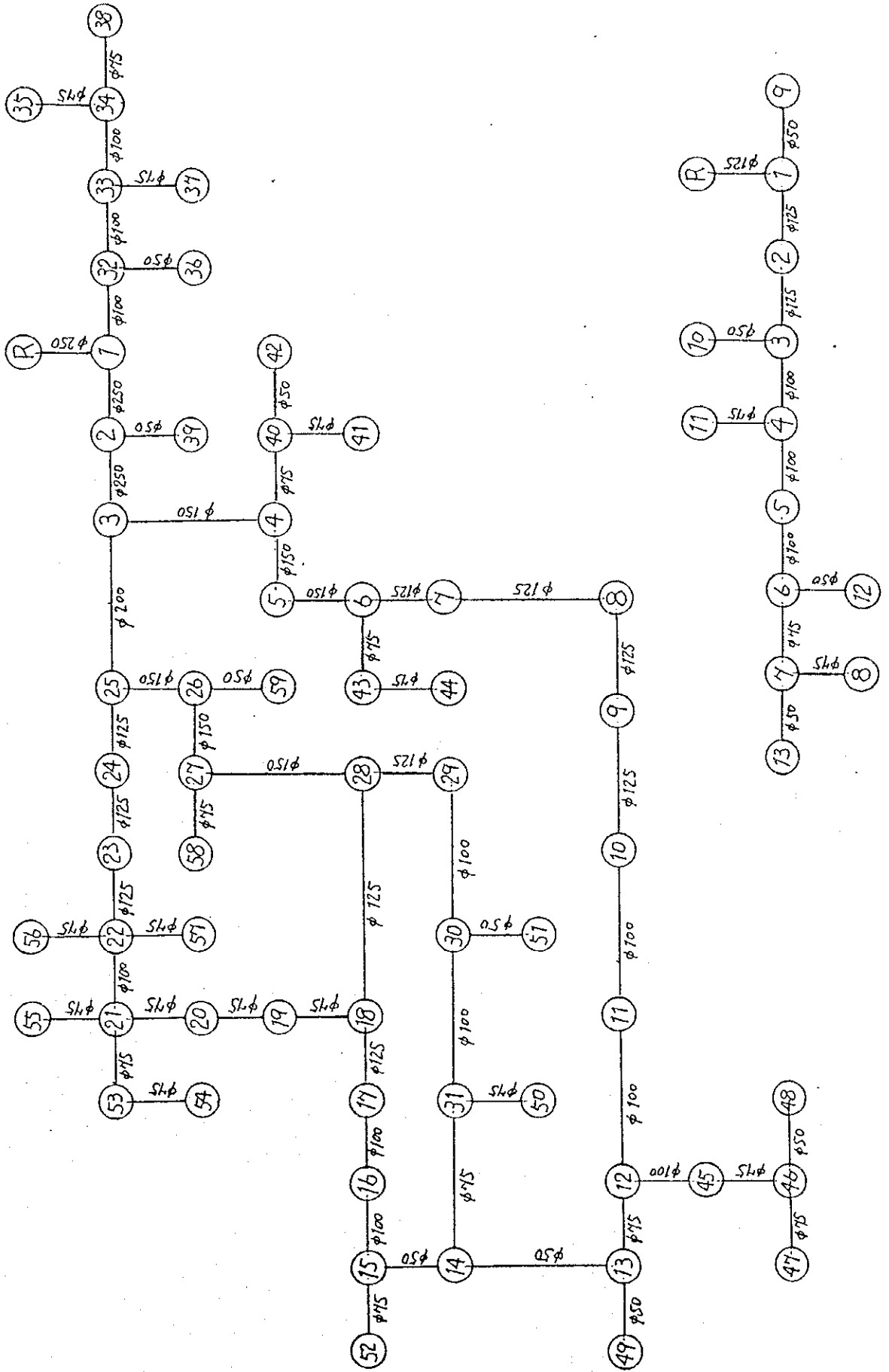
Pipe line	No.	From	To	Dia. (mm)	Length (m)	Flow Coefficient	Flow (L/sec)	velocity (m/sec)	Loss of Head (m)	Hydraulic Gradient (m/1000m)	Head Loss Coefficient	Hydrostatic Head	Water Hammer Head	Design Pressure (kg/sq.cm)	Pipe Material
	51	27	58	50	98.00	110	1.3	0.639	1.593	16.255	0.03902	6.34	1.75	8.09	
	52	26	59	50	95.00	110	0.9	0.439	0.770	8.105	0.04125	6.00	1.75	7.75	
	合計				10928.00										

2.7 Plan of Distribution Pipeline (2015)

STATE OF BINTARA MINISTRY OF LAND, WATER & ENVIRONMENT	2015
JAPAN INTERNATIONAL COOPERATION AGENCY	WATER RESOURCES DEPARTMENT (ASAHARA, EXTERNAL) Drawing No. SANTU CONSULTANTS INC. 222222
STUDY ON GROUNDWATER DEVELOPMENT & WATER SUPPLY FOR SEVERAL TOWNS IN SOUTHERN REGION	



MENDEFERA 2015



Node No.	Dynamic (WL.m)	Ground Elevation (EL.m)	Effective Head (m)	Area (ha)	Outflow Quantity (L/sec)
0	1983.000	1984.500	-1.500	-376.90	-52.22
1	1980.365	1943.400	36.965	0.00	0.00
2	1979.004	1933.000	46.004	0.00	0.00
3	1978.057	1927.900	50.157	6.40	0.89
4	1975.557	1933.500	42.057	0.00	0.00
5	1975.204	1932.000	43.204	5.60	0.78
6	1974.937	1933.700	41.237	0.00	0.00
7	1972.653	1937.900	34.753	3.50	0.48
8	1970.109	1943.000	27.109	8.40	1.16
9	1969.340	1938.000	31.340	7.10	0.98
10	1968.599	1932.000	36.599	5.40	0.75
11	1967.510	1929.000	38.510	4.60	0.64
12	1967.030	1928.600	38.429	0.00	0.00
13	1966.926	1928.600	38.326	0.00	0.00
14	1965.725	1946.600	19.125	19.40	2.69
15	1965.675	1919.700	45.975	18.70	2.59
16	1967.588	1930.100	37.488	7.70	1.07
17	1969.162	1934.000	35.162	8.00	1.11
18	1970.371	1935.400	34.971	0.00	0.00
19	1967.649	1930.000	37.649	9.30	1.29
20	1967.194	1918.500	48.694	19.20	2.66
21	1967.592	1912.200	55.392	0.00	0.00
22	1970.167	1913.100	57.067	0.00	0.00
23	1971.516	1917.000	54.516	4.70	0.65
24	1975.017	1925.000	50.017	10.10	1.40
25	1977.434	1927.100	50.334	0.00	0.00
26	1975.177	1923.700	51.477	0.00	0.00
27	1973.891	1922.300	51.591	0.00	0.00
28	1973.268	1923.000	50.268	0.00	0.00
29	1972.889	1927.000	45.889	7.40	1.03
30	1970.651	1952.500	18.151	0.00	0.00
31	1968.520	1950.000	18.520	0.00	0.00
32	1978.645	1943.000	35.645	0.00	0.00
33	1976.100	1939.700	36.400	0.00	0.00
34	1975.006	1929.400	45.606	0.00	0.00
35	1974.776	1928.000	46.776	13.30	1.84
36	1975.479	1935.800	39.679	8.70	1.21
37	1975.317	1928.700	46.617	10.60	1.47
38	1974.620	1926.700	47.920	10.10	1.40
39	1978.018	1934.400	43.618	7.10	0.98
40	1974.484	1940.000	34.484	0.00	0.00
41	1973.027	1940.500	32.527	16.20	2.24
42	1974.298	1941.300	32.998	2.80	0.39
43	1973.401	1936.500	36.901	6.60	0.91
44	1972.147	1934.600	37.547	11.70	1.62
45	1966.499	1927.700	38.799	10.50	1.45
46	1964.533	1930.600	33.933	0.00	0.00
47	1963.979	1927.800	36.178	13.00	1.80
48	1964.121	1931.700	32.421	5.40	0.75
49	1966.337	1929.700	36.637	5.90	0.82

Node No.	Dynamic (WL.m)	Ground Elevation (EL.m)	Effective Head (m)	Area (ha)	Outflow Quantity (L/sec)
50	1967.543	1953.300	14.243	15.40	2.13
51	1969.285	1954.200	15.085	8.10	1.12
52	1962.639	1913.000	49.639	15.40	2.13
53	1964.306	1906.800	57.506	3.70	0.51
54	1962.945	1910.200	52.745	12.60	1.75
55	1966.946	1909.300	57.646	12.00	1.66
56	1969.222	1912.200	57.022	13.50	1.87
57	1969.365	1917.500	51.865	12.60	1.75
58	1973.648	1920.300	53.348	9.60	1.33
59	1974.316	1927.400	46.916	6.60	0.91

Pipe line	Node No.	Dia.	Length	Flow Coefficient	Flow	velocity	Loss of Head	Hydraulic Gradient	Head Loss Coefficient	Hydrostatic Water Hammer Head	Design Pressure	Pipe Material
No.	From	To	(m)	(L/sec)	(m/sec)	(m)	(m/1000m)	(m/1000m)	(kg/sq.cm)			
1	0	1	418.00	51.8	1.056	2.635	6.304	0.03770	4.04	1.75	5.79	
2	1	2	270.00	45.9	0.936	1.361	5.040	0.05820	5.08	1.75	6.83	
3	2	3	250.00	45.0	0.917	0.947	4.858	0.02828	5.59	1.75	7.34	
4	3	4	150.00	15.0	0.856	2.500	7.762	0.03111	5.59	1.75	7.34	
5	4	5	322.00	12.6	0.713	0.354	5.524	0.03197	5.18	1.75	6.93	
6	5	6	64.00	11.9	0.671	0.267	4.946	0.03225	5.18	1.75	6.93	
7	6	7	54.00	9.3	0.670	2.284	7.689	0.03265	5.01	1.75	6.76	
8	7	8	297.00	8.8	0.720	2.544	6.970	0.03290	4.59	1.75	6.34	
9	8	9	365.00	7.7	0.626	0.769	5.375	0.03359	4.58	1.75	6.33	
10	9	10	143.00	6.7	0.545	0.741	4.163	0.03429	5.18	1.75	6.93	
11	10	11	178.00	5.9	0.757	1.089	9.901	0.03390	5.47	1.75	7.22	
12	11	12	110.00	5.3	0.675	0.481	8.012	0.03448	5.51	1.75	7.26	
13	12	13	60.00	1.3	0.291	0.104	2.358	0.04098	5.51	1.75	7.26	
14	13	14	44.00	0.5	0.240	1.201	2.645	0.04512	5.51	1.75	7.26	
15	14	15	454.00	0.5	0.240	1.201	2.645	0.04512	5.51	1.75	7.26	
16	15	16	519.00	0.1	0.040	0.050	0.040	0.03878	6.40	1.75	8.15	
17	16	17	306.00	4.6	0.590	-1.914	-6.254	-0.03517	6.41	1.75	8.16	
18	17	18	172.00	5.7	0.725	-1.574	-9.151	-0.03412	5.36	1.75	7.11	
19	18	19	282.00	6.8	0.554	-1.208	-4.285	-0.03421	4.98	1.75	6.73	
20	19	20	234.00	3.0	0.689	2.722	11.631	0.03607	5.37	1.75	7.12	
21	20	21	108.00	1.8	0.398	0.455	4.216	0.03912	6.52	1.75	8.27	
22	21	22	327.00	0.9	0.204	0.398	-1.218	-0.04321	7.15	1.75	8.90	
23	22	23	100.00	4.8	0.615	-2.578	-6.740	-0.03496	7.16	1.75	8.91	
24	23	24	210.00	8.5	0.689	-1.349	-6.423	-0.03312	7.07	1.75	8.82	
25	24	25	476.00	9.1	0.742	-3.502	-7.357	-0.03276	6.68	1.75	8.43	
26	25	26	252.00	10.5	0.856	-2.417	-9.589	-0.03207	6.88	1.75	7.63	
27	26	27	97.00	-29.1	0.927	-0.623	-6.423	-0.02931	5.67	1.75	7.42	
28	27	28	198.00	18.6	1.054	2.257	11.401	0.03017	6.01	1.75	7.76	
29	28	29	124.00	17.7	1.001	1.285	10.364	0.03040	6.15	1.75	7.90	
30	29	30	70.00	16.3	0.923	0.624	8.911	0.03077	6.15	1.75	7.90	
31	30	31	341.00	9.8	0.802	2.897	8.495	0.03239	6.08	1.75	7.83	
32	31	32	96.00	6.5	0.599	0.378	3.942	0.03444	6.08	1.75	7.83	
33	32	33	262.00	5.5	0.699	2.238	8.542	0.03431	5.67	1.75	7.42	
34	33	34	380.00	4.4	0.557	2.131	5.608	0.03548	5.67	1.75	7.42	
35	34	35	404.00	2.3	0.520	2.795	6.919	0.03760	3.71	1.75	5.46	
36	35	36	178.00	5.9	0.747	1.720	9.665	0.03397	4.07	1.75	5.82	
37	36	37	396.00	4.7	0.599	2.544	6.425	0.03510	4.41	1.75	6.16	
38	37	38	341.00	3.2	0.412	1.094	3.210	0.03710	5.44	1.75	7.19	
39	38	39	50.00	1.2	0.413	0.230	4.600	0.03885	5.57	1.75	7.32	
40	39	40	210.00	1.8	0.613	3.166	15.074	0.03926	4.79	1.75	6.54	
41	40	41	260.00	1.5	0.332	0.783	3.010	0.04019	5.50	1.75	7.25	
42	41	42	140.00	1.0	0.316	0.386	2.755	0.04047	5.70	1.75	7.45	
43	42	43	94.00	1.0	0.505	0.987	10.495	0.04041	5.02	1.75	6.82	
44	43	44	130.00	2.5	0.572	1.073	8.254	0.03707	5.02	1.75	6.77	
45	44	45	220.00	2.2	0.508	1.457	6.623	0.03773	4.37	1.75	6.12	
46	45	46	102.00	0.4	0.196	0.187	1.829	0.04647	4.37	1.75	6.12	
47	46	47	184.00	2.5	0.576	1.536	8.347	0.03704	5.00	1.75	6.75	
48	47	48	346.00	1.6	0.367	1.253	3.623	0.03960	4.91	1.75	6.66	
49	48	49	112.00	4.0	0.508	0.530	4.735	0.03596	5.61	1.75	7.36	
50	49	50	236.00	2.5	0.575	1.966	8.330	0.03704	5.60	1.75	7.35	
	46	47	126.00	1.8	0.408	0.555	4.404	0.03898	5.59	1.75	7.34	

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 Water Hammer		Design Pressure (kg/sq.cm)	Pipe Material												
	From	To									Head	Head														
51	46	48	50	66.00	110	0.7	0.381	0.412	6.244	0.04212	5.31	1.75	7.06													
52	13	49	50	80.00	110	0.8	0.417	0.589	7.361	0.04157	5.51	1.75	7.26													
53	31	50	75	162.00	110	2.1	0.483	0.977	6.031	0.03801	3.37	3.37	6.75													
54	30	51	50	104.00	110	1.1	0.570	1.366	13.139	0.03969	3.12	3.12	6.24													
55	15	52	75	506.00	110	2.1	0.482	3.035	5.999	0.03803	7.07	1.75	8.82													
56	21	53	75	490.00	110	2.3	0.511	3.286	6.707	0.03769	7.69	1.75	9.44													
57	53	54	75	327.00	110	1.7	0.395	1.361	4.161	0.03916	7.69	1.75	9.44													
58	21	55	75	168.00	110	1.7	0.379	0.646	3.847	0.03941	7.44	1.75	9.19													
59	22	56	75	199.00	110	1.9	0.424	0.944	4.745	0.03875	7.15	1.75	8.90													
60	22	57	75	192.00	110	1.7	0.396	0.802	4.178	0.03915	7.06	1.75	8.81													
61	27	58	75	98.00	110	1.3	0.299	0.244	2.486	0.04081	6.34	1.75	8.09													
62	26	59	50	95.00	110	0.9	0.466	0.861	9.059	0.04089	6.00	1.75	7.75													
合計													13826.00													

Node No.	Dynamic (WL.m)	Ground Elevation (EL.m)	Effective Head (m)	Area (ha)	Outflow Quantity (L/sec)
0	1995.000	1995.000	0.000	-64.50	-8.94
1	1994.150	1986.100	8.050	0.00	0.00
2	1993.028	1982.700	10.328	5.70	0.79
3	1992.238	1968.200	24.038	0.00	0.00
4	1989.262	1953.600	35.662	0.00	0.00
5	1986.854	1949.200	37.654	5.40	0.75
6	1986.086	1947.100	38.986	0.00	0.00
7	1981.979	1937.000	44.979	0.00	0.00
8	1981.178	1944.500	36.678	13.00	1.80
9	1981.829	1951.500	30.329	9.20	1.27
10	1991.197	1970.000	21.197	5.90	0.82
11	1988.274	1949.500	38.974	13.20	1.83
12	1985.425	1952.400	33.025	4.30	0.60
13	1977.812	1933.700	44.112	7.80	1.08

Pipe line	Pipe 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.	To												
1	0	1	125	120.00	110	8.9	0.727	0.850	7.086	0.03286	0.97	0.97	1.93	*
2	1	2	125	211.00	110	7.6	0.622	1.122	5.318	0.03362	1.31	1.31	2.61	*
3	2	3	125	182.00	110	6.8	0.558	0.790	4.340	0.03417	2.76	2.76	5.51	*
4	3	4	100	292.00	110	6.0	0.768	2.976	10.192	0.03382	4.21	1.75	5.96	*
5	4	5	100	460.00	110	4.2	0.536	2.408	5.235	0.03568	4.66	1.75	6.41	*
6	5	6	100	210.00	110	3.5	0.442	0.768	3.655	0.03672	4.86	1.75	6.61	*
7	6	7	75	390.00	110	2.9	0.652	4.107	10.530	0.03636	5.87	1.75	7.62	*
8	7	8	75	182.00	110	1.8	0.407	0.801	4.403	0.03898	5.87	1.75	7.62	*
9	1	9	50	736.00	110	1.3	0.649	12.321	16.741	0.03893	4.42	1.75	6.17	*
10	3	10	50	142.00	110	0.8	0.416	1.041	7.329	0.04159	2.75	2.75	5.51	*
11	4	11	75	218.00	110	1.8	0.414	0.987	4.529	0.03890	4.64	1.75	6.39	*
12	6	12	50	162.00	110	0.6	0.303	0.661	4.080	0.04358	4.86	1.75	6.61	*
13	7	13	50	338.00	110	1.1	0.550	4.167	12.329	0.03989	6.20	1.75	7.95	*
合計														
3643.00														

Abi Hare
150

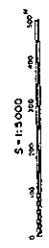
Adi Wegri
150



Legend
Distribution pipeline
Supplied area (ha)

120

Supplied Points and Its Area



S = 1:2,000

STATE OF ESTERIA MINISTRY OF LAND, WATER & ENVIRONMENT	MEMBERSHIP
JAPANESE NATIONAL CORPORATION AGENCY	Scale: 1:2,000
STUDY ON GROUNDWATER DEVELOPMENT & WATER SUPPLY FOR SEVEN TOWNS IN GOVTOWN REGION	WATER RESOURCE DEPARTMENT Survey No.
	LAND CONSULTANTS INC. DATE: 200

2.8 Location of Proposed Communal Water Point

STATE OF ETHIOPIA MINISTRY OF LAND, WATER & ENVIRONMENT	YERUHA WATER & POWER DEVELOPMENT AGENCY
JAPAN INTERNATIONAL COOPERATION AGENCY	WATER & POWER DEVELOPMENT AGENCY JAMAAL, ETHIOPIA
STUDY ON PROPOSED WATER DEVELOPMENT WATER SUPPLY SEVEN TOWNS IN SOUTHERN REGION	PROJECT No. 111/005 Phase 1a



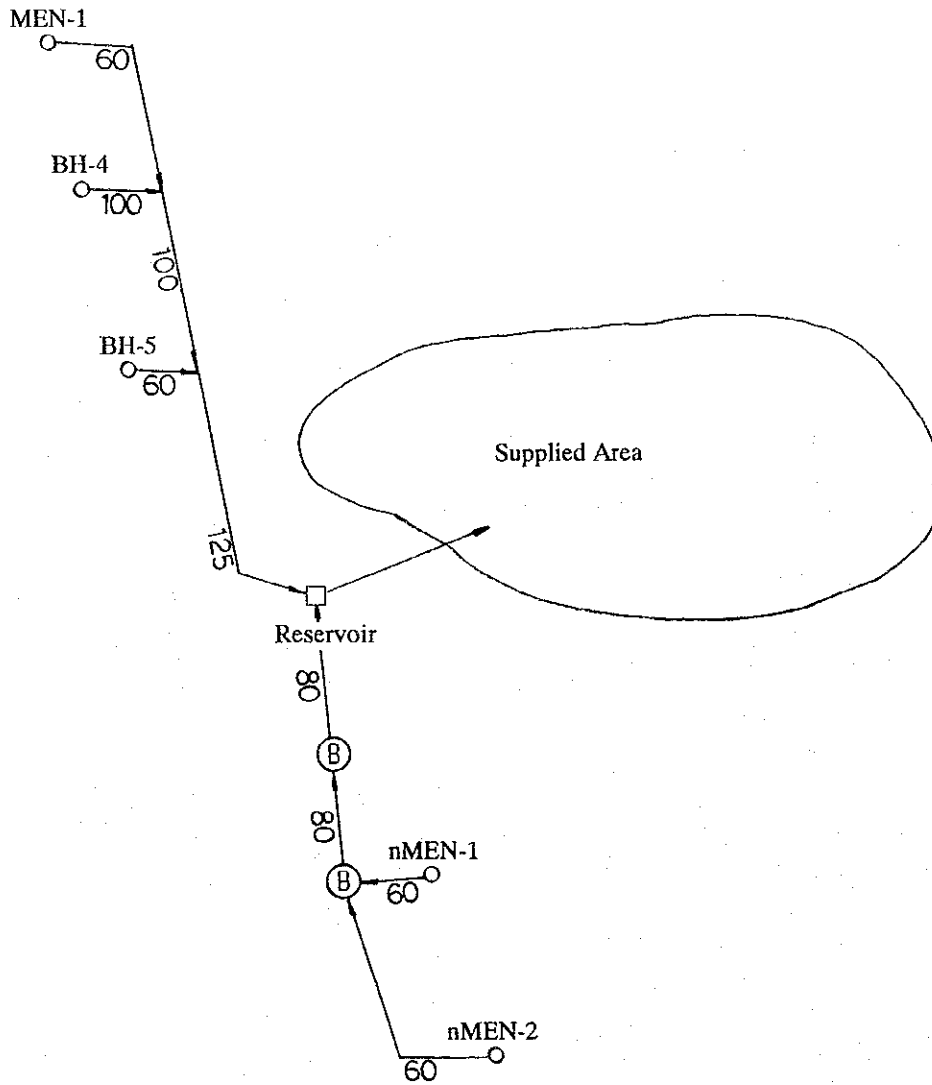
- Legend**
- Communal water points for 2005 (No. 1 - 13)
 - Communal water points for 2010 (No. 14 - 26)
 - Communal water points for 2015 (No. 27 - 41)
 - 4 c.w.p will be added for 2 villages in 2015.

S = 1:10,000

Location of Proposed Communal Water Point

2.9 Plan of Water Source and Transmission Pipeline (2005)

Mendefera



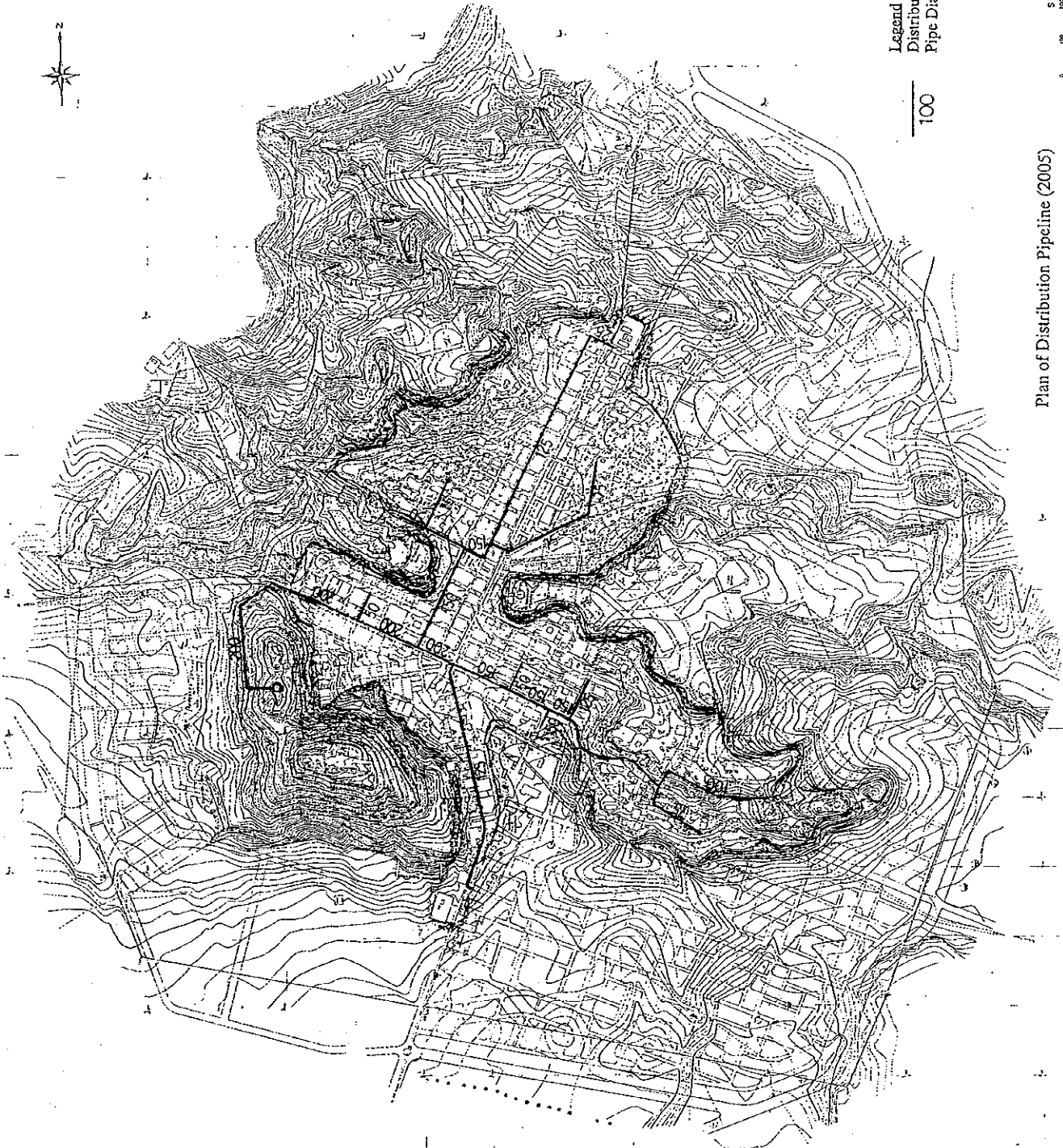
STATE OF ESTERIA MINISTRY OF LAND, WATER & ENVIRONMENT JAPAN INTERNATIONAL COOPERATION AGENCY	STUDY ON GROUNDWATER DEVELOPMENT & WATER SUPPLY FOR SEVEN TOWNS IN SOUTHERN REGION	2005 MENDIPELA
WATER RESOURCES DEPARTMENT OSAKA, ESTERIA MITSUBISHI ENGINEERS & ARCHITECTS P.C. (JAPAN)		Scale: 1:1,000 Drawing No.

Legend
 Distribution pipeline
 Pipe Diameter (mm)

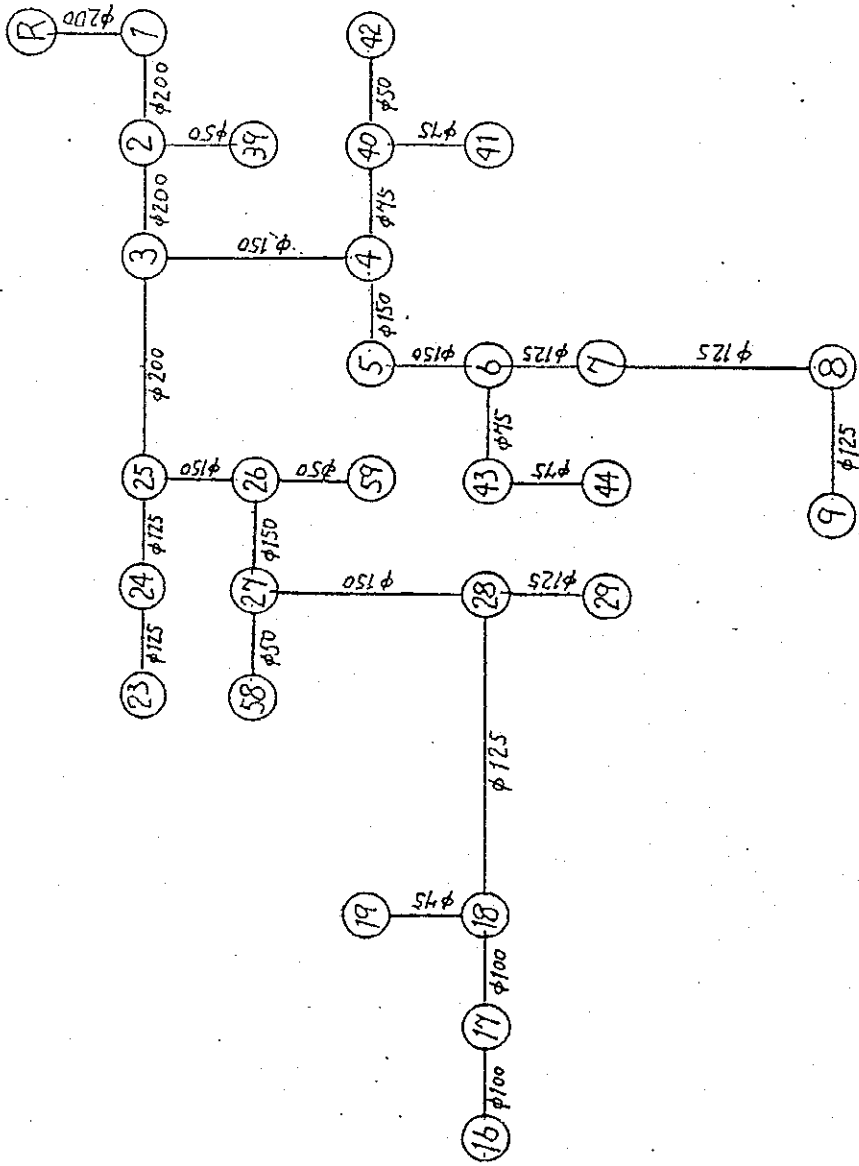
100

S = 1:5,000
 0 100 200 300 400 500 600 700 800 900 1000

Plan of Distribution Pipeline (2005)



MENDEFERA 2010 (2005area)



Node No.	Dynamic (WL.m)	Ground Elevation (EL.m)	Effective Head (m)	Area (ha)	Outflow Quantity (L/sec)
0	1983.000	1984.500	-1.500	-138.80	-18.19
1	1981.949	1943.400	38.550	0.00	0.00
2	1981.272	1933.000	48.272	0.00	0.00
3	1980.828	1927.900	52.928	6.40	0.84
4	1980.111	1933.500	46.611	0.00	0.00
5	1980.035	1932.000	48.035	5.60	0.73
6	1979.986	1933.700	46.286	0.00	0.00
7	1979.803	1937.900	41.903	3.50	0.46
8	1979.654	1943.000	36.654	8.40	1.10
9	1979.638	1938.000	41.638	7.10	0.93
39	1980.392	1934.400	45.992	0.00	0.00
25	1980.769	1927.100	53.668	0.00	0.00
26	1980.462	1923.700	56.762	0.00	0.00
27	1980.317	1922.300	58.017	0.00	0.00
28	1980.264	1923.000	57.264	0.00	0.00
18	1979.884	1935.400	44.484	0.00	0.00
17	1979.492	1934.000	45.492	8.00	1.05
16	1979.428	1930.100	49.328	7.70	1.01
24	1980.660	1925.000	55.660	10.10	1.32
23	1980.637	1917.000	63.637	4.70	0.62
59	1979.685	1927.400	52.285	6.60	0.86
58	1978.716	1920.300	58.416	9.60	1.26
29	1980.253	1927.000	53.253	7.40	0.97
19	1979.585	1930.000	49.385	9.30	1.22
40	1979.317	1940.000	39.117	0.00	0.00
41	1977.802	1940.500	37.302	16.20	2.12
42	1978.947	1941.300	37.646	2.80	0.37
43	1978.599	1936.500	42.099	6.60	0.86
44	1977.466	1934.600	42.866	11.70	1.53

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 Water Hammer Head	Design Pressure (kg/sq.cm)	Pipe Material
No.	From	To	(m)	(L/sec)	(m/sec)	(m)	(m/1000m)	(m/1000m)	(kg/sq.cm)	(kg/sq.cm)	(kg/sq.cm)	
1	0	1	418.00	110	17.5	0.558	1.051	2.513	0.03159	4.04	1.75	5.79
2	1	2	270.00	110	17.5	0.558	0.677	2.508	0.03160	5.08	1.75	6.83
3	2	3	200.00	110	16.6	0.530	0.444	2.279	0.03184	5.59	1.75	7.34
4	3	4	150.00	110	7.7	0.436	0.717	2.228	0.03438	5.59	1.75	6.93
5	4	5	64.00	110	5.5	0.310	0.049	1.183	0.03616	5.18	1.75	6.93
6	5	6	54.00	110	4.8	0.270	0.182	0.614	0.03996	5.01	1.75	6.76
7	6	7	297.00	110	2.4	0.194	0.150	0.410	0.04127	4.59	1.75	6.34
8	7	8	365.00	110	1.9	0.156	0.015	0.106	0.04600	4.58	1.75	6.33
9	8	9	143.00	110	0.9	0.075	0.881	9.368	0.04078	5.07	1.75	6.82
10	2	39	94.00	110	0.9	0.474	0.059	0.612	0.03538	5.67	1.75	7.42
11	3	25	97.00	110	8.2	0.260	0.306	1.546	0.03540	6.01	1.75	7.76
12	25	26	198.00	110	6.3	0.358	0.145	1.170	0.03620	6.15	1.75	7.90
13	26	27	124.00	110	5.4	0.308	0.054	0.767	0.03744	6.15	1.75	7.90
14	27	28	70.00	110	4.3	0.245	0.380	1.114	0.03810	6.08	1.75	7.83
15	28	18	341.00	110	3.3	0.262	0.392	1.390	0.03967	4.97	1.75	6.72
16	18	17	282.00	110	2.1	0.128	0.063	0.368	0.04412	5.36	1.75	7.11
17	17	16	172.00	110	1.0	0.160	0.109	0.431	0.04111	5.88	1.75	7.63
18	25	24	252.00	110	2.0	0.049	0.023	0.431	0.04894	6.68	1.75	8.43
19	24	23	476.00	110	0.6	0.049	0.777	8.180	0.04122	6.00	1.75	7.75
20	26	59	95.00	110	0.9	0.441	1.602	16.345	0.03900	6.34	1.75	8.09
21	27	58	50.00	110	1.3	0.641	0.010	0.107	0.04596	6.08	1.75	7.83
22	28	29	98.00	110	0.9	0.075	0.499	2.134	0.04131	5.37	1.75	7.12
23	18	19	234.00	110	1.2	0.276	0.994	7.643	0.03730	5.02	1.75	6.77
24	4	40	130.00	110	2.4	0.549	1.314	5.975	0.03804	4.37	1.75	6.12
25	40	41	220.00	110	2.1	0.480	0.170	1.671	0.04681	4.37	1.75	6.12
26	40	42	102.00	110	0.4	0.187	1.386	7.534	0.03734	5.00	1.75	6.75
27	6	43	184.00	110	2.4	0.547	1.133	3.275	0.03992	4.91	1.75	6.75
28	43	44	346.00	110	1.5	0.347	1.133	3.275	0.03992	4.91	1.75	6.66
合計												
5739.00												

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.

Table A Transmission Pipeline

Name of Town	Well No.	Diameter Unit Price						Pipelines						Cost			Pumps			Total Cost		Total Cost (%)
		60	80	100	125	150	200	Total Length (m)	Cost (Nkrf)	Cost/Year (Nkrf)	Well Pump Cost (Nkrf)	Well Pump (Kw)	Booster Pump Cost (Nkrf)	Booster Pump (Kw)	Cost/Year (Nkrf)	O&M cost (Nkrf)	Total Cost (Nkrf)	Total Cost (%)				
Deberwa	2005 DEB-1	442.41	521.87	593.63	645.92	661.27	806.43	690	360,090	7,202	148,693	7.5			9,913	39,420	56,535	100.0				
	2005 DEB-1		0	690	0	0	0	690	402,705	8,054	148,693	7.5			9,913	39,420	57,387	101.5				
	2010 DEB-1		0	0	690	0	0	690	402,705	8,054	149,664	7.5			9,991	39,420	57,465	101.6				
	2010 DEB-1		0	0	690	0	0	690	402,705	8,054	151,193	11.0			10,000	57,816	75,550	134.3				
	2010 DEB-1		0	1,380	0	0	0	1,380	720,181	14,404	285,364	15.0			19,024	78,840	112,268	198.6				
	2015 DEB-1		0	1,380	0	0	0	1,380	720,181	14,404	289,257	15.0			19,204	78,840	112,527	176.1				
2015	DEB-1		0	0	0	690	0	690	445,685	8,914	176,838	15.0			11,789	78,840	99,543	203.3				
	DEB-1		0	1,380	0	0	1,380	805,409	16,108	299,728	15.0			19,982	78,840	114,930	203.3					
	DEB-1		0	2,070	0	0	2,070	1,080,271	21,605	433,885	22.5			28,926	118,260	168,791	298.6					
Adiquala	2005 All Ex.		2,851					2,851	1,487,851	29,757	149,864	7.5	82,104	11.0	15,465	97,236	142,458	100.0				
	2005 All Ex.			2,851				2,851	1,663,929	33,279	172,851	11.0			11,523	57,816	102,618	72.0				
	2010 All Ex.			2,851				2,851	1,663,929	33,279	151,193	11.0	108,380	11.0	17,305	115,632	166,215	116.7				
	2010 All Ex.			2,851				2,851	1,663,929	33,279	172,851	11.0			11,523	57,816	102,618	72.0				
	2015 nADO-1		5,100					5,100	2,661,537	53,231	100,913	1.5	364,566	44.0	31,032	239,148	323,411	100.0				
	2015 nADO-1		100		5,000			5,100	2,970,337	59,407	100,913	1.5	358,053	30.0	30,598	165,564	255,568	79.0				
2015	nADO-1		5,100					5,100	2,661,537	53,231	144,628	7.5	420,797	60.0	37,695	354,780	445,706	137.8				
	nADO-1		100					5,100	3,281,787	65,656	100,913	1.5	460,302	74.0	37,414	396,828	499,878	154.6				
	nADO-1							5,000														
Dekemhare	2005 BH-14,DEK-1,DEK-2		628	948	2,250	3,941		7,767	4,940,401	98,808	397,811	17.2	177,285	18.5	38,340	187,639	324,787	100.0				
	2010 BH-14,DEK-1,DEK-2		628	948		6,191		7,767	5,873,624	117,472	360,297	11.4	134,516	15.0	32,988	138,758	289,218	89.0				
	2010 BH-14,DEK-1,DEK-2		628	948		0	6,191	7,767	5,873,624	117,472	390,135	15.2	217,829	30.0	40,518	237,571	395,561	121.8				
	2015 BH-14,DEK-1,DEK-2		628	948		0	6,191	7,767	5,873,624	117,472	390,135	15.2	217,829	30.0	40,518	237,571	395,561	121.8				
Segoneiti	2005 SEG-2		5,253					5,253	2,741,383	54,828	159,909	7.5	177,138	16.5	22,470	126,144	203,441	100.0				
	2005 SEG-2		1,085	4,168				5,253	2,998,799	59,976	159,909	7.5	91,142	11.0	16,737	97,236	173,949	85.5				
	2010 SEG-2		1,085	4,168				5,253	2,998,799	59,976	167,297	11.0	186,651	22.0	23,596	173,448	257,020	126.3				
	2010 SEG-2		0	1,085	4,168			5,253	2,998,799	59,976	152,095	11.0	184,467	18.5	22,437	155,052	237,465	116.7				
	2015 SEG-2		0	1,085	4,168			5,253	2,998,799	59,976	176,838	11.0	196,341	22.5	24,979	176,076	260,931	128.3				
Adi Kevih	2005 ADI-2			2,853				2,853	1,665,096	33,302	167,297	11.0	103,123	15.0	18,028	136,656	187,986	100.0				
	2010 ADI-2			2,853				2,853	1,665,096	33,302	172,851	11.0	103,883	15.0	18,449	136,656	188,407	100.2				
	2015 ADI-2			2,853				3,033	1,665,096	33,302	172,851	11.0	103,883	15.0	18,449	136,656	188,407	100.2				
	2005 DW-2,BH-7		2,105	928				3,033	1,612,273	32,245	211,795	5.2	82,104	5.5	19,593	56,239	104,144	100.0				
	2010 DW-2,BH-7		343	1,772	918			3,033	1,612,273	32,245	211,795	5.2	82,104	5.5	19,593	56,239	108,075	103.8				
	2015 DW-2,BH-7		343	1,772	918			3,033	1,612,273	32,245	211,795	5.2	85,997	11.0	19,853	85,147	137,245	131.8				
2015	DW-2,BH-7		343	1,772	918			3,033	1,612,273	32,245	211,795	5.2	85,997	11.0	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	11.0	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)	(%)	
Debarwa												
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
Mendefera												
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
Adiquala												
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
Dekemhare												
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
Segeneiti												
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
Adi Keyih												
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
Senafe												
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

List of Tables

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Table 4.1 Mendefera Water Supply and Consumption Pattern

	Domestic water consumption by private water connection		Commercial water consumption by private connection		Gov't establishments water consumption by private water connection		Domestic water consumption by:	
	M ³	No. of Customers	m ³	No. of customers	m ³	No. of Customers	Public m ³	Tanker m ³
Jan-Feb/95	3848	431	1884	88	2513	23	879	5599
Mar.-Apr.	4428	425	2175	92	2897	23	999	6760
May-Jun.	4322	418	1981	100	2485	23	917	6845
July-Aug.	3460	431	1511	104	1360	23	540	2310
Sep.-Oct.	4545	435	1763	107	1793	23	634	4936
Nov.-Dec.	4299	445	1898	106	2114	28	662	4392
Total	24,902 29%		11,212 13%		13,162 16%		4,631 6%	30,842 36%
Jan-Feb/96	7717	448	3655	106	2983	28	1354	5683
Mar.-Apr.	9453	449	3843	109	3720	28	1562	6704
May-Jun.	7398	447	3641	109	3776	30	1519	6901
July-Aug.	5874	449	2108	109	3401	30	632	2279
Sep.-Oct.	7744	451	2972	108	3612	31	873	4988
Nov.-Dec.	6235	453	3015	112	3210	32	891	4585
Total	44,421 36%		19,234 16%		20,702 17%		6,831 6%	31,140 25%

Continue

Table 4.1 Mendefera Water Supply and Consumption Pattern

	Domestic water consumption by private water connection		Commercial water consumption by private connection		Gov't establishments water consumption by private water connection		Domestic water consumption by :	
	M ³	No. of Customers	m ³	No. of customers	m ³	No. of Customers	Public m ³	Tanker m ³
Jan-Feb/97	7286	482	3902	112	6430	32	1376	6940
Mar.-Apr.	9631	506	4924	114	2644	33	1628	8236
May-Jun.	8316	521	4431	115	2383	36	1114	8352
July-Aug.	6879	528	3074	117	1680	36	617	4832
Sept.- Oct.	7114	535	4123	118	1945	38	787	5149
Total	39,226 34%		20,454 18%		15,082 13%		5,520 5%	33,509 29%

Source: WSS of Mendefera

Table 4.2 Domestic Water Consumption by Source of Water Supply

Source of water supply	Household users, %	Ave. volume of water consumption		Ave. expenditure for Water, Nfa/m ³	Ave. income Nfa/mon
		m ³ /hld/mon	l/c/d		
Municipality supply		m ³ /hld/mon	l/c/d		
House connection	20.0	4	24.11	13	1176
Yard connection	12.0	2.48	14.95	6.72	836.11
Communal Water point	14.7	1.68	10.13	8.35	432.8
Private well	0	-		-	-
Public well	1.3	0.88	5.30	4.40	425
River/spring	0	-	-	-	-
Water tanker	53.3	2.72	16.39	20.40	706
Water vender	0.7	0.16	0.96	1.20	600
Rain water	92.7	1.67	10.07	-	-

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	100-199 m	200-399 m	>400 m
Communal water point	36.4%	22.7%	36.4%	4.5%
Public well	<200 m 0%	200-499 m 100%	500-999 0%	

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

Table 4.4 Toilet Condition and Related Behaviors

Type of latrines used	Flush latrine 40.7%	Dry pit 9.3%	Community toilet 4%		Open field 46%	
Condition of septic tank/cesspool and pit latrine	Clean squatting hole 72%	Clean slab 72%	Well fitting lid 1.3%	Good ventilation 72%	No flies 86.7%	Not filled up 90.7%
Households satisfied with the existing latrines used	46.60%		Average distance of latrine from the nearest water source		70m	
Affordable preferences of unsatisfied households	Septic tank/cesspool 53.2%		Dry pit 8.9%	Community toilet 34.2%	Open field 0%	
Households favoring credit system for latrine construction	58.4%		Ave. of maximum repayment a household afford		27Nfa/mon	
Type of anal cleansing material used	Stone 14%	Water 29.3%	Paper 86%	Twig 1.3%	Leaves 0.7%	Nothing 0.7%

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

Table 4.5 Conditions of Waste disposal

Solid waste disposal	Open field 4.7%	Open pit 0%	Covered in pit 0%	Burn 0%	Municipality truck 95.3%
Waste water disposal	Open field 57.3%	Pit 7.3%	Gardening 0%	Drainage system 34%	
Animal waste disposal	Used as fuel 80%	Used as fertilizer 10%	Thrown in a pit 0%	Open field 10%	
Infant excreta disposal	Open field 4.8%	Popo and thrown to the field 45.2%		Popo and put in the toilet 50%	

Table 4.6 Mendefera Schools, Present Water and Latrine Facilities

Name of school	Water supply facility		Latrine facility	
	Availability	Remark	Availability	Remark
Saint George junior and secondary school.	Yes	From Mai Tekela, drilled and motorized school well pumped to 4 m ³ reservoir with five taps. Only two taps are working	Yes, but not functional	One pit latrine and one flushed latrines are filled with stone and are out of order.
Mendefera middle school	No	ready to make connections from Saint George's supply line.	Yes, pit latrine with 10 No. units.	New school functional in 1996-97 but with very dirty latrines with no-one to clean them. Already a lot of stones have collected in the latrines.
Adi Ugri elementary school.	No	There is pipeline but water never reach the school. Students bring water by shift to water garden.	Yes, but not functional.	Lack of proper utilization & management.
Fikrekalsi elementary school.	No	Students bring water by shift to water garden.	Yes pit latrine, but out of order.	Mis-management
Mendefera elementary school.	No	There is pipeline but water doesn't reach and the pipeline is not maintained.	Yes pit latrine, but out of function.	Mis-management
Dej. Abdela Gonafer	No		No	

Table 4.7 Cases of Water and Poor Sanitation Related Diseases in Mendefera.

Description of Disease	1995	1996	1997
Water borne & washed diseases			
Typhoid	77	35	15
Hepatitis	5	5	1
Diarrhoea	635	526	488
Amebic Dysentery	565	572	350
Shigellosis	189	90	47
Bacterial skin srosis	1208	856	871
Scabies	435	98	65
Fungal infection (skin disease)	163	14	33
Trachoma	32	141	5
Asthma	159	202	99
Rickettsial Typhus			1
Water basis			
Schistosomiasis	52	58	34
Total	3,520 21%	2,597 16%	2,009 12%
Water related insect vector			
Malaria	2,154 13%	1,361 8%	951 6%

Source: Mendefera 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/hld	Diarrhea 8 person 12.3 %	Dysentery 7 person 16.3 %	Malaria 10 person 20.4%	Warms 0 person 0 %	Scabies 0 person 0 %
Ave. medical cost	Diarrhea 19.86 Nfa/case	Dysentery 19.17 Nfa/case	Malaria 56.60 Nfa/case	Warms 0 Nfa/case	Scabies 0 Nfa/case	
Type of treatment	Self-administered traditional medicine 8.7%	Self-administered modern medicine 3.3%	Consult traditional healer 0%	Consult physician 96%		
Infants health condition	Households with infant 14.7%	Infants death in the last 10 years 1.41 persons/household	Child immunization 100%			

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	74%	0%	0.7%	22.7%	0%	2%
Before cooking	46%	0%	0.7%	53.3%	0%	0%
Before eating	43.3%	0%	0.7%	55.3%	0%	0%
After disposal of children stool	61.5%	0%	0%	3.3%	0%	1.1%
After handling animal dung	11.3%	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 80.0%	on floor 2.7%	over the table 17.3%	Other 0%	
Storage of left over food	Covered 86.7%	Open to flies 1.3%	No leftover food 2%	Thrown away 10%	Other 0%
Washing raw food before eating	Washing vegetable 100%	Washing meat 50%	Washing fruit 41.3%		

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 80.3%		
Participation in community sanitation work 95.3%	Areas of involvement			
	Cash contribution 2%	Material contribution 12%	Labor contribution 84%	Not willing 2%

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