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 Shinfio	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 Tatal	89,660	144,900	0.73	105,491	184,130	0.86	158,518	230,480	1.00	230,480

Water Demand

Name of Town	Year	Population			Average Water Demand (m3/d)					Daily Max. (m3/d)	Hourly (m3/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	206	94	629	754	47.2
	2015	17,230	17,230	100.0	390	271	272	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	324	285	1,902	2,283	142.7
	2015	52,880	52,880	100.0	1,840	413	412	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	410	307	2,044	2,452	153.3
	2015	55,880	55,880	100.0	1,945	1,050	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	1,733	1,156	7,708	9,250	578.1
	2015	230,480	230,480	100.0	7,383	1,734	2,173	1,992	13,283	15,939	996.2

(1) Population

		Debarwa		Mendefera		Adiquala		Dekemhare		Segeneiti		Adi Keyih		Senafe	
Water consumption		%	l/c/d	%	l/c/d	%	l/c/d	%	l/c/d	%	l/c/d	%	l/c/d	%	l/c/d
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

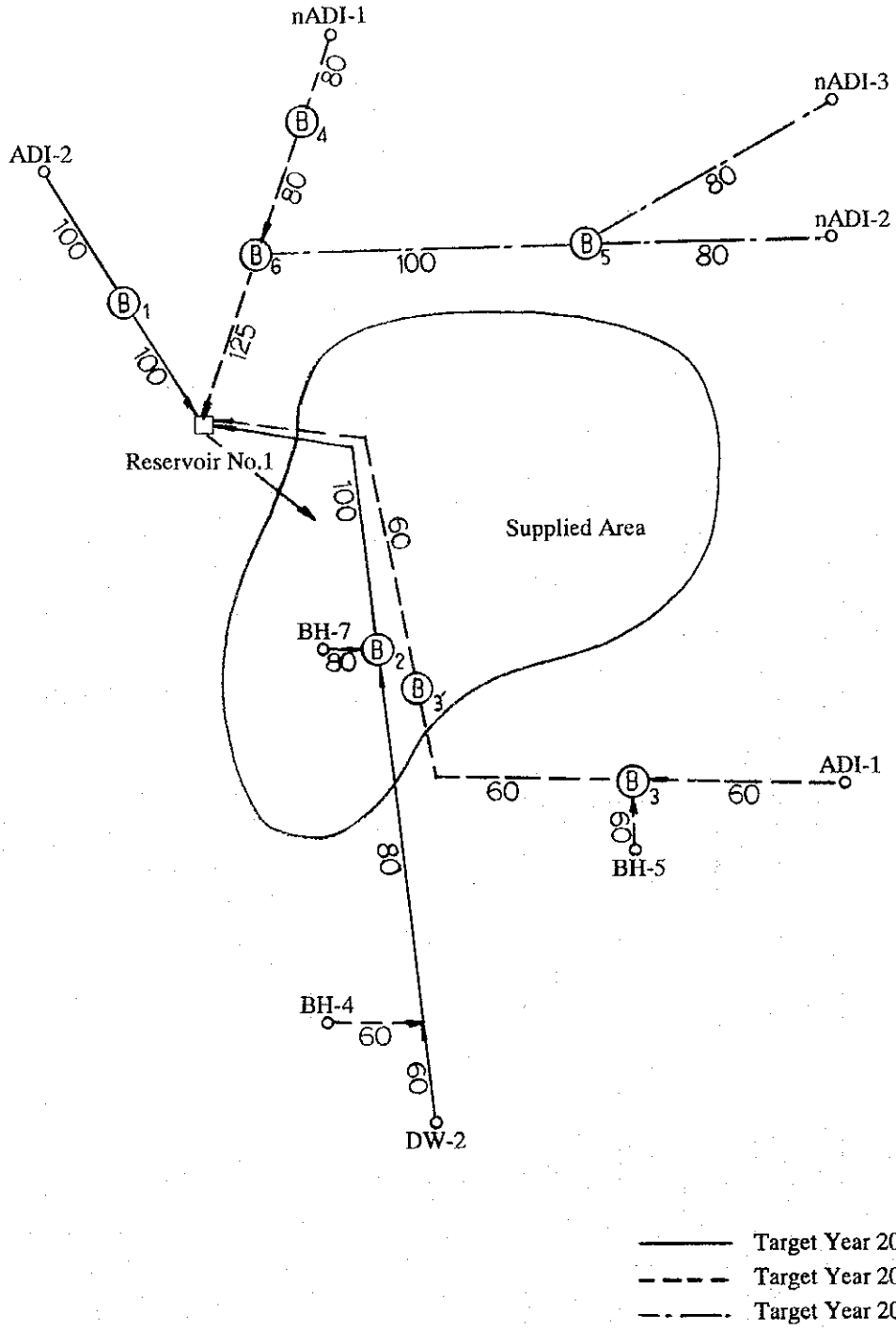
	unit	Water consum.	Debarwa	Mendefera	Adiquala	Dekemhare	Segeneiti	Adi Keyih	Senafe
Industry	ha	15,000	18.09			70			
Light Indus.		5,500		57					
				75					
Total			18.09			70.00			
Water Demand		2005							
		2010	81	314		210			
		2015	271	413		1,050			

(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

Adi Keyih



2.2 Hydraulic Calculation of Transmission Pipeline

Adi Keyhi	Target Year		2005				
	Well No.		ADI-2	DW-2	BH-7		
Condition	Symbol	Unit	24hr ope.	24hr ope.	24hr ope.		
Elevation of Intake	EL1	m	2219.71	2279.30	2359.00		
Ground water level		m	9.40	10.00	10.00		
Elevation of Reservoir	EL2	m	2398.00	2398.00	2398.00		
Water level		m	3.00	3.00	3.00		
Discharge	Q	m3/d	434	138			
Discharge	Q1	m3/s	0.0050	0.0016			
Pipe Diameter	D	mm	100	60			
Velocity	V	m/s	0.64	0.57			
Velocity Coefficient	C		110	110			
Pipe Length	L	m	2159	343			
Loss Head	h2	m	15.94	3.66			
Discharge	Q	m3/d		138	277		
Discharge	Q1	m3/s		0.0016	0.0032		
Pipe Diameter	D	mm		80	80		
Velocity	V	m/s		0.32	0.64		
Velocity Coefficient	C			110	110		
Pipe Length	L	m		1762	10		
Loss Head	h2	m		4.63	0.10		
Actual Head	h1	m	86.69	92.70	13.00		
Total Head	H	m	102.63	100.99	13.10		
Booster Pump			(BP No.1)	(BP No.2)			
Elevation of Booster P		m	2294.0	2359.0			
Discharge	Q	m3/d	434	415			
Discharge	Q1	m3/s	0.0050	0.0048			
Pipe Diameter	D	mm	100	100			
Velocity	V	m/s	0.64	0.61			
Velocity Coefficient	C		110	110			
Pipe Length	L	m	694	918			
Loss Head	h2	m	5.12	6.24			
Actual Head	h1	m	107.00	42.00			
Total Head	H	m	112.12	48.24			

- Pumps are operated 24 hours per day.

Hydraulic Calculation of Transmission Line

Adi Keyhi	Target Year		2010 (1)				
	Well No.		ADI-2	DW-2	BH-4	BH-7	
Condition	Symbol	Unit	24hr ope.	24hr ope.	24hr ope.	24hr ope.	
Elevation of Intake	EL1	m	2219.71	2279.30	2280.50	2359.00	
Ground water level		m	9.40	10.00	10.00	10.00	
Elevation of Reservoir	EL2	m	2398.00	2398.00	2398.00	2398.00	
Water level		m	3.00	3.00	3.00	3.00	
Discharge	Q	m3/d	553	138	138		
Discharge	Q1	m3/s	0.0064	0.0016	0.0016		
Pipe Diameter	D	mm	100	60	60		
Velocity	V	m/s	0.82	0.57	0.57		
Velocity Coefficient	C		110	110	110		
Pipe Length	L	m	2159	343	50		
Loss Head	h2	m	24.96	3.66	0.53		
Discharge	Q	m3/d		276		277	
Discharge	Q1	m3/s		0.0032		0.0032	
Pipe Diameter	D	mm		80		80	
Velocity	V	m/s		0.64		0.64	
Velocity Coefficient	C			110		110	
Pipe Length	L	m		1762		10	
Loss Head	h2	m		16.69		0.10	
Actual Head	h1	m	86.69	92.70	91.50	13.00	
Total Head	H	m	111.65	113.05	108.73	13.10	
Booster Pump			(BP No.1)	(BP No.2)			
Elevation of Booster P		m	2294.0	2359.0			
Discharge	Q	m3/d	553	553			
Discharge	Q1	m3/s	0.0064	0.0064			
Pipe Diameter	D	mm	100	100			
Velocity	V	m/s	0.82	0.82			
Velocity Coefficient	C		110	110			
Pipe Length	L	m	694	918			
Loss Head	h2	m	8.02	10.61			
Actual Head	h1	m	107.00	42.00			
Total Head	H	m	115.02	52.61			

- Pumps are operated 24 hours per day.

Hydraulic Calculation of Transmission Line

Adi Keyhi	Target Year		2010 (2)		
	Well No.		ADI-1	BH-5	nADI-1
Condition	Symbol	Unit	24hr ope.	24hr ope.	24hr ope.
Elevation of Intake	EL1	m	2255.80	2280.50	2150
Ground water level		m	3.10	10.00	10.00
Elevation of Reservoir	EL2	m	2398.00	2398.00	2398.00
Water level		m	3.00	3.00	3.00
Discharge	Q	m3/d	86	86	207
Discharge	Q1	m3/s	0.0010	0.0010	0.0024
Pipe Diameter	D	mm	60	60	80
Velocity	V	m/s	0.35	0.35	0.48
Velocity Coefficient	C		110	110	110
Pipe Length	L	m	498	250	4900
Loss Head	h2	m	2.21	1.11	27.26
Actual Head	h1	m	35.30	17.50	163.00
Total Head	H	m	37.51	18.61	190.26
					*
Booster Pump			(BP No.3)		(BP No.4)
Elevation of Booster P		m	2285.0		2300.0
Discharge	Q	m3/d	172		207
Discharge	Q1	m3/s	0.0020		0.0024
Pipe Diameter	D	mm	60		80
Velocity	V	m/s	0.70		0.48
Velocity Coefficient	C		110		110
Pipe Length	L	m	3162		800
Loss Head	h2	m	50.70		4.45
Discharge	Q	m3/d			
Discharge	Q1	m3/s			
Pipe Diameter	D	mm			
Velocity	V	m/s			
Velocity Coefficient	C				
Pipe Length	L	m			
Loss Head	h2	m			
Actual Head	h1	m	116.00		101.00
Total Head	H	m	166.70		105.45
			*		

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

Hydraulic Calculation of Transmission Line

Adi Keyhi	Target Year		2015 (1)				
	Well No.		ADI-2	DW-2	BH-4	BH-7	
Condition	Symbol	Unit	24hr ope.	24hr ope.	24hr ope.	24hr ope.	
Elevation of Intake	EL1	m	2219.71	2279.30	2280.50	2359.00	
Ground water level		m	9.40	10.00	10.00	10.00	
Elevation of Reservoir	EL2	m	2398.00	2398.00	2398.00	2398.00	
Water level		m	3.00	3.00	3.00	3.00	
Discharge	Q	m3/d	553	138	138		
Discharge	Q1	m3/s	0.0064	0.0016	0.0016		
Pipe Diameter	D	mm	100	60	60		
Velocity	V	m/s	0.82	0.57	0.57		
Velocity Coefficient	C		110	110	110		
Pipe Length	L	m	2159	343	50		
Loss Head	h2	m	24.96	3.66	0.53		
Discharge	Q	m3/d		276		277	
Discharge	Q1	m3/s		0.0032		0.0032	
Pipe Diameter	D	mm		80		80	
Velocity	V	m/s		0.64		0.64	
Velocity Coefficient	C			110		110	
Pipe Length	L	m		1762		10	
Loss Head	h2	m		16.69		0.10	
Actual Head	h1	m	86.69	92.70	91.50	13.00	
Total Head	H	m	111.65	113.05	108.73	13.10	
Booster Pump			(BP No.1)	(BP No.2)			
Elevation of Booster P		m	2294.0	2359.0			
Discharge	Q	m3/d	553	553			
Discharge	Q1	m3/s	0.0064	0.0064			
Pipe Diameter	D	mm	100	100			
Velocity	V	m/s	0.82	0.82			
Velocity Coefficient	C		110	110			
Pipe Length	L	m	694	918			
Loss Head	h2	m	8.02	10.61			
Actual Head	h1	m	107.00	42.00			
Total Head	H	m	115.02	52.61			

- Pumps are operated 24 hours per day.

Hydraulic Calculation of Transmission Line

Adi Keyhi	Target Year		2015 (2)				
	Well No.		ADI-1	BH-5	nADI-3	nADI-2	nADI-1
Condition	Symbol	Unit	24hr ope.	24hr ope.	24hr ope.	24hr ope.	24hr ope.
Elevation of Intake	EL1	m	2255.80	2280.50	2210	2165	2150
Ground water level		m	3.10	10.00	10.00	10.00	10.00
Elevation of Reservoir	EL2	m	2398.00	2398.00	2398.00	2398.00	2398.00
Water level		m	3.00	3.00	3.00	3.00	3.00
Discharge	Q	m3/d	86	86	277	355	
Discharge	Q1	m3/s	0.0010	0.0010	0.0032	0.0041	
Pipe Diameter	D	mm	60	60	80	80	
Velocity	V	m/s	0.35	0.35	0.64	0.82	
Velocity Coefficient	C		110	110	110	110	
Pipe Length	L	m	498	250	1700	600	
Loss Head	h2	m	2.21	1.11	16.21	9.06	
Actual Head	h1	m	35.30	17.50	23.00	68.00	
Total Head	H	m	37.51	18.61	39.21	77.06	
Booster Pump			(BP No.3)		(BP No.5)		
Elevation of Booster P		m	2285.0		2220.0		
Discharge	Q	m3/d	172		632		207
Discharge	Q1	m3/s	0.0020		0.0073		0.0024
Pipe Diameter	D	mm	60		100		80
Velocity	V	m/s	0.70		0.93		0.48
Velocity Coefficient	C		110		110		110
Pipe Length	L	m	3162		2700		4900
Loss Head	h2	m	50.70		39.95		27.26
Actual Head	h1	m			83.00		163.00
Total Head	H	m			122.95		190.26
							*
Booster Pump					(BP No.6)		
Elevation of Booster P		m			2300.0		
Discharge	Q	m3/d			839		
Discharge	Q1	m3/s			0.0097		
Pipe Diameter	D	mm			125		
Velocity	V	m/s			0.79		
Velocity Coefficient	C				110		
Pipe Length	L	m			800		
Loss Head	h2	m			6.74		
Actual Head	h1	m	116.00		101.00		
Total Head	H	m	166.70		107.74		
			*				

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

Capacity of Pump Pit

Name of Town	B.P. No.	Target Year	Max. Daily Consumption (m3/s)	Pit Capacity		Dimension of Pump Pit				Additional Pump Pit					Remarks
				Necessary (m3)	Design (m3)	Length (m)	Width (m)	High (m)	Actual (m3)	Capacity (m3)	Length (m)	Width (m)	High (m)	Actual (m3)	
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	
	BP-2	2015	0.0291	52.4	55	7.5	3.0	2.5	56						
Segeneiti	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						
	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					
Aadi Keyih	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					
	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						
	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						
Senafe	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						

Capacity of Reservoir

No.1

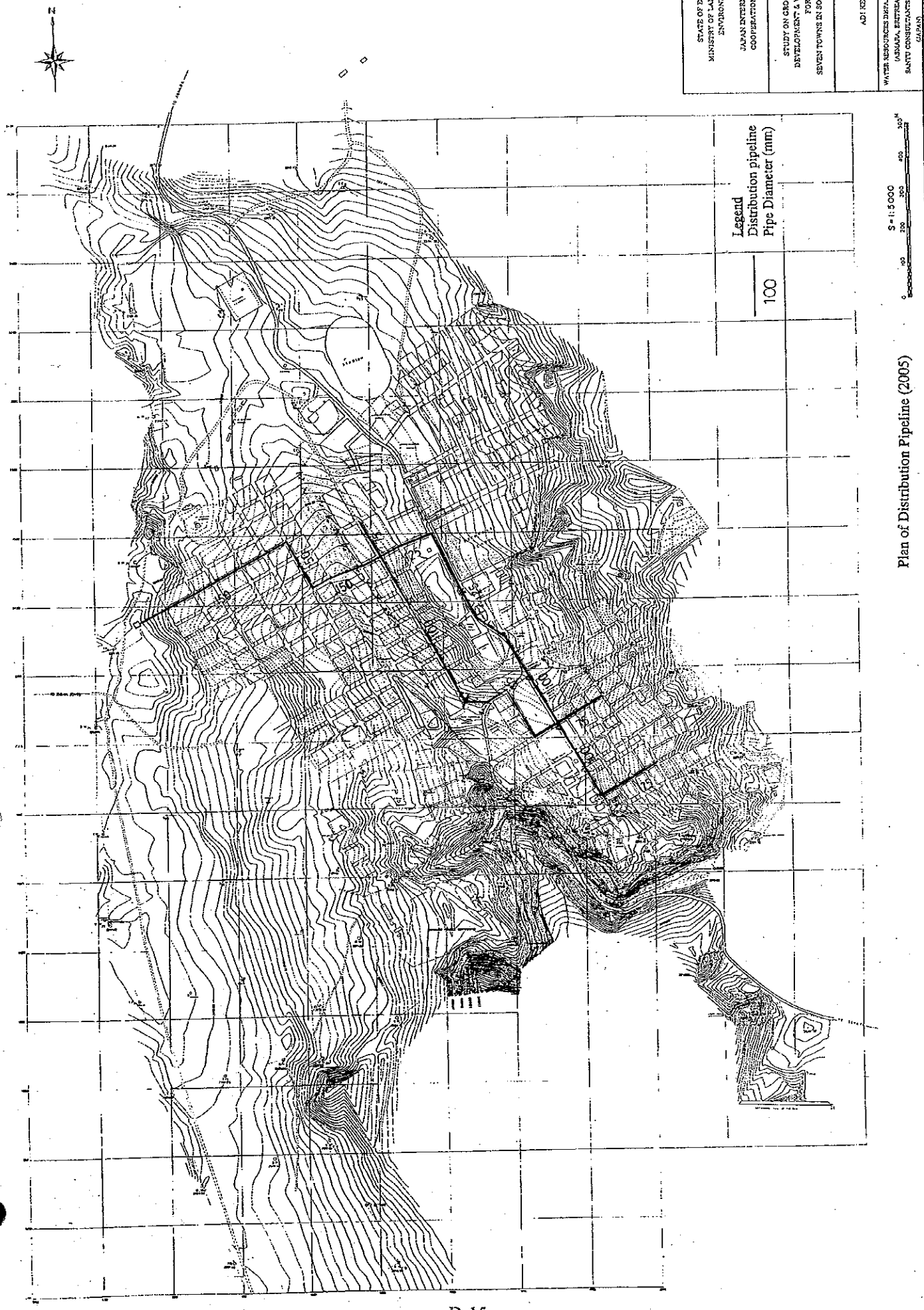
Name of Town	Rsv. No.	Target Year	Max. Daily Consumption (m3/d)	Reservoir Capacity		Dimension of Reservoir				Additional Reservoir					Remarks
				Necessary (m3)	Design (m3)	Length (m)	Width (m)	High (m)	Actual (m3)	Capacity (m3)	Length (m)	Width (m)	High (m)	Actual (m3)	
Debarwa	DB-1	2005	411	137	140	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						(Adi Wegri)
(2.9)	MD-4	2015	109	36	40	4.0	4.0	2.5	40						(Adi Hare)
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
	AQ-1'	2010	639	27	30	3.5	3.5	2.5	31	5	2.0	2.0	2.0	8	H=13m, Q=1hr
	AQ-1'	2015	843	35	35	4.0	4.0	2.5	40	5	2.0	2.0	2.0	8	H=13m, Q=1hr
(19.0)	AQ-2	2010	150	50	50	4.0	4.5	3.0	54					54	H=13m
(30.5)	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 & Shinfio
Dekemhare															
(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						H=12m, Q=1hr
(6.0)	DK-1'	2015	298	12	15	3.0	3.0	2.0	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

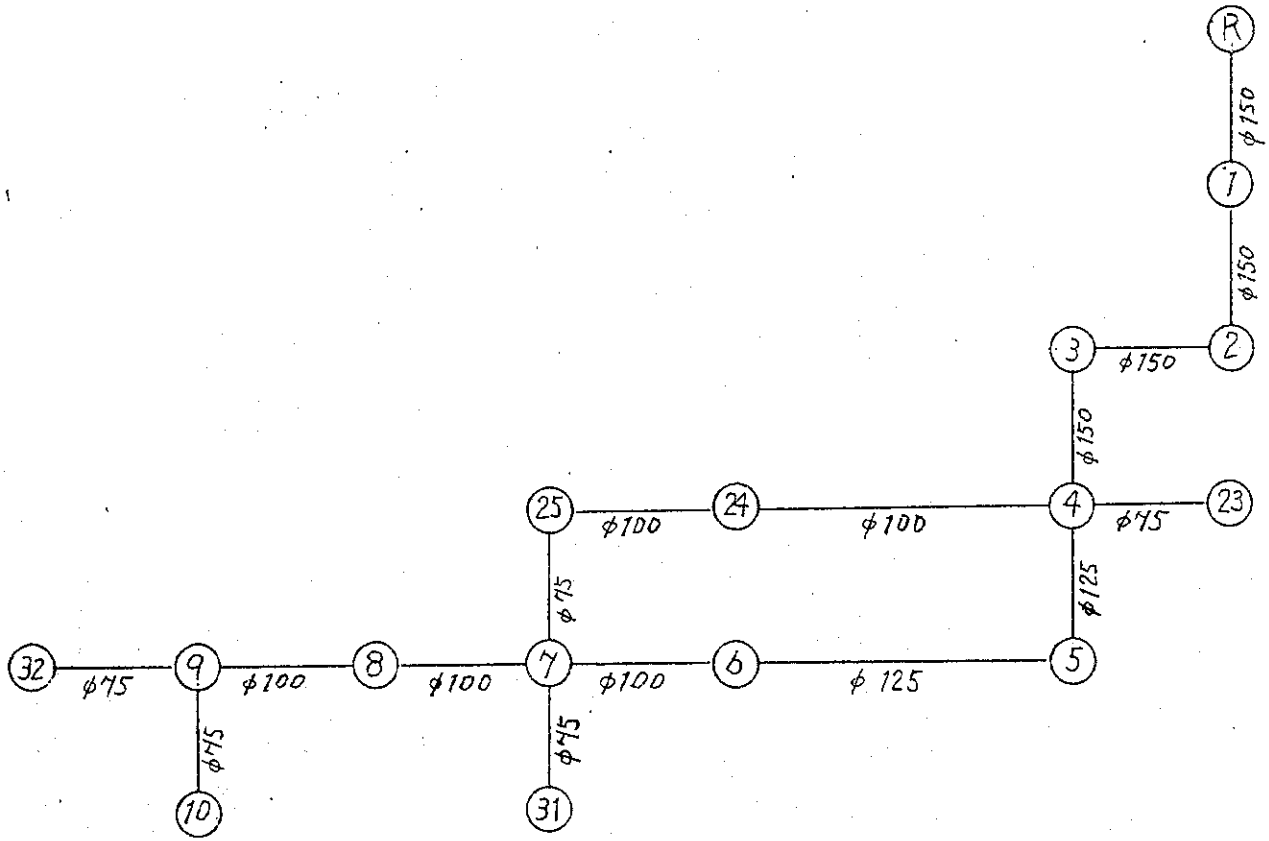
Name of Town	Rsv. No.	Target Year	Max. Daily Consumption (m3/d)	Reservoir Capacity		Dimension of Reservoir				Additional Reservoir					Remarks
				Necessary (m3)	Design (m3)	Length (m)	Width (m)	High (m)	Actual (m3)	Capacity (m3)	Length (m)	Width (m)	High (m)	Actual (m3)	
Segeneiti	SG-1	2005	344	115	120	7.0	7.0	2.5	123					123	
(74.0)	SG-1	2010	383	128	130	7.2	7.2	2.5	130	10	2.0	2.0	2.5	10	
(50.9)	SG-1	2015	400	133	140	7.5	7.5	2.5	141	10	2.0	2.0	2.5	10	
(26.0)	SG-2	2010	134	45	50	4.5	4.5	2.5	51					51	H=12.5m
(49.1)	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
Senafe	SN-1	2005	698	233	240				600						Existing
	SN-1	2010	1,030	343	350				600						
(81.4)	SN-1	2015	1,381	460	470				600						
(18.6)	SN-2	2015	316	105	110	6.5	6.5	2.6	110						Afema

2.5 Plan of Distribution Pipeline (2005)



Plan of Distribution Pipeline (2005)

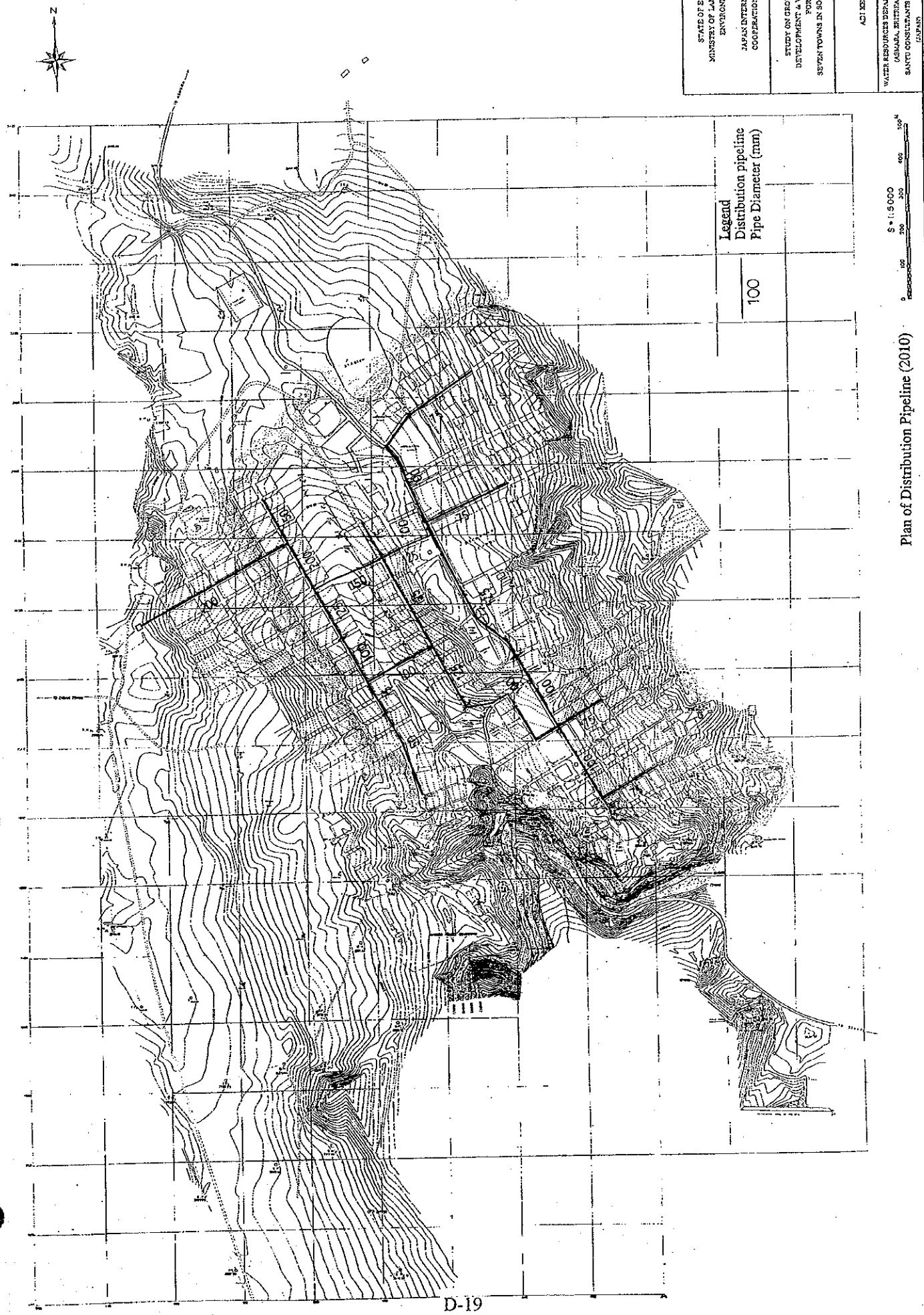
ADI KEYIN 2005



Node No.	Dynamic (WL.m)	Ground Elevation (EL.m)	Effective Head (m)	Area (ha)	Outflow Quantitiy (L/sec)
0	2398.000	2392.500	5.500	-72.50	-14.72
1	2396.158	2378.600	17.558	0.00	0.00
2	2394.364	2370.900	23.464	0.00	0.00
3	2393.269	2366.300	26.969	0.00	0.00
4	2391.684	2368.600	23.084	0.00	0.00
5	2390.762	2376.500	14.262	0.00	0.00
6	2388.315	2372.300	16.015	12.40	2.52
7	2386.260	2363.500	22.760	0.00	0.00
8	2385.646	2362.100	23.546	6.40	1.30
9	2385.139	2360.100	25.039	0.00	0.00
10	2383.668	2367.400	16.268	10.00	2.03
23	2390.343	2372.600	17.743	10.30	2.09
24	2389.897	2365.200	24.698	0.00	0.00
25	2388.607	2359.600	29.007	11.90	2.42
31	2383.637	2348.000	35.637	15.00	3.05
32	2385.005	2359.500	25.505	6.50	1.32

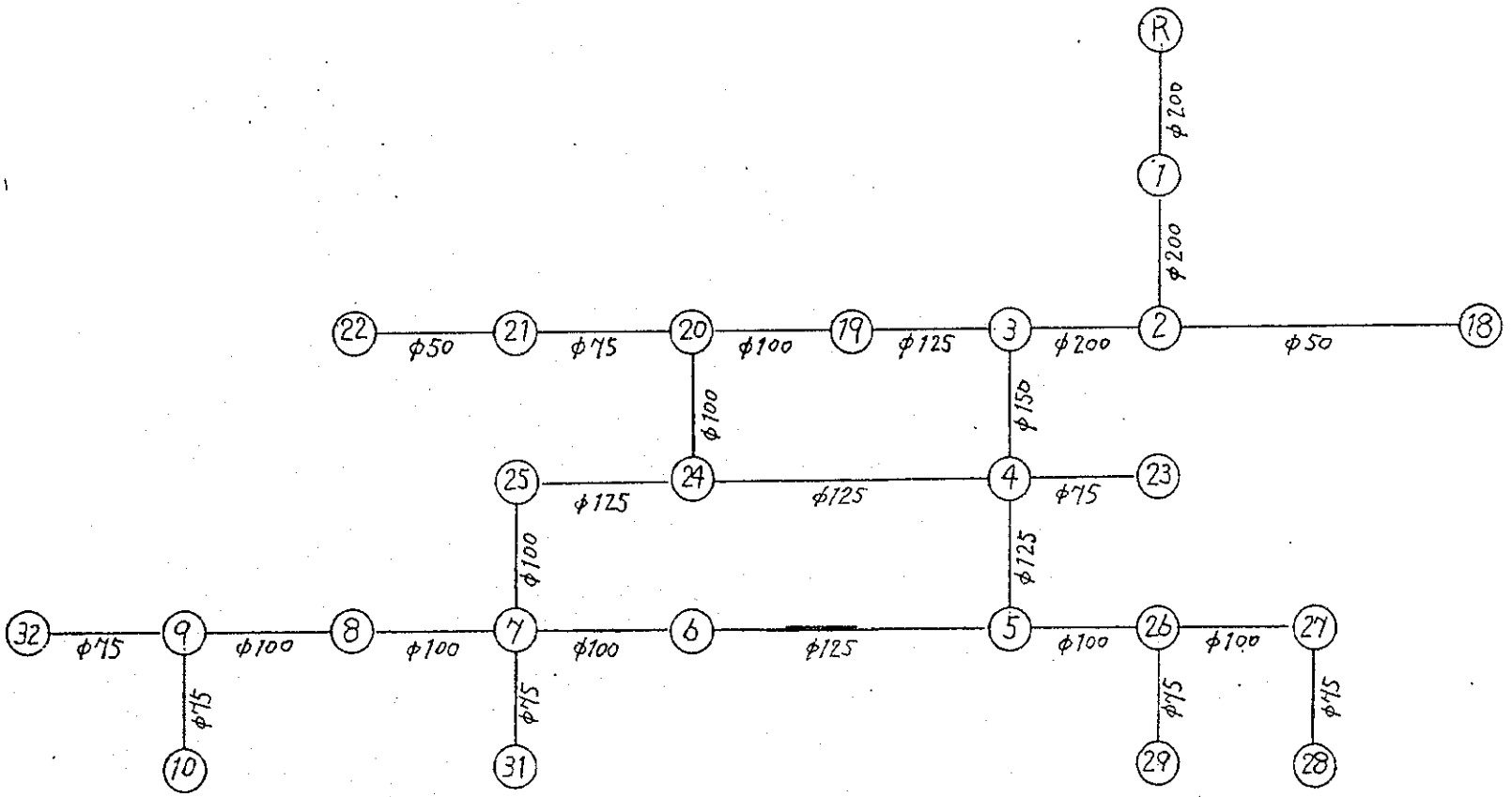
Pipe line No.	Node No. From	To	Dia. (mm)	Length (m)	Flow Coefficient	Flow (L/sec)	velocity (m/sec)	Loss of Head (m)	Hydraulic Gradient (m/1000m)	Head Loss Coefficient	Hydrostatic Head	Water Hummer Head	Design Pressure (kg/sq.cm)	Pipe Material
1	0	1	150	250.00	110	14.7	0.833	1.842	7.369	0.03124	2.02	2.02	4.03	
2	1	2	150	244.00	110	14.7	0.832	1.794	7.353	0.03125	2.79	2.79	5.58	
3	2	3	150	149.00	110	14.7	0.831	1.094	7.346	0.03125	3.25	3.25	6.49	
4	3	4	150	216.00	110	14.7	0.831	1.585	7.337	0.03125	3.25	3.25	6.49	
5	4	5	125	160.00	110	8.0	0.650	0.922	5.763	0.03341	3.02	3.02	6.03	
6	5	6	125	424.00	110	8.0	0.651	2.447	5.772	0.03340	2.65	2.65	5.29	
7	6	7	100	242.00	110	5.5	0.696	2.055	8.490	0.03432	3.52	1.75	5.27	
8	7	8	100	97.00	110	4.7	0.594	0.615	6.335	0.03514	3.66	1.75	5.41	
9	8	9	100	147.00	110	3.4	0.428	0.507	3.446	0.03689	3.86	1.75	5.61	
10	9	10	75	267.00	110	2.0	0.460	1.471	5.509	0.03829	3.86	1.75	5.61	
11	4	23	75	230.00	110	2.1	0.474	1.342	5.833	0.03812	3.01	3.01	6.03	
12	4	24	100	290.00	110	4.6	0.586	1.787	6.162	0.03521	3.36	3.36	6.71	
13	24	25	100	207.00	110	4.6	0.589	1.290	6.232	0.03518	3.91	1.75	5.66	
14	25	7	75	358.00	110	2.2	0.505	2.347	6.556	0.03776	3.91	1.75	5.66	
15	7	31	75	225.00	110	3.0	0.689	2.623	11.657	0.03606	5.07	1.75	6.82	
16	9	32	75	54.00	110	1.3	0.299	0.134	2.482	0.04081	3.92	1.75	5.67	
合計				3560.00										

2.6 Plan of Distribution Pipeline (2010)



Plan of Distribution Pipeline (2010)

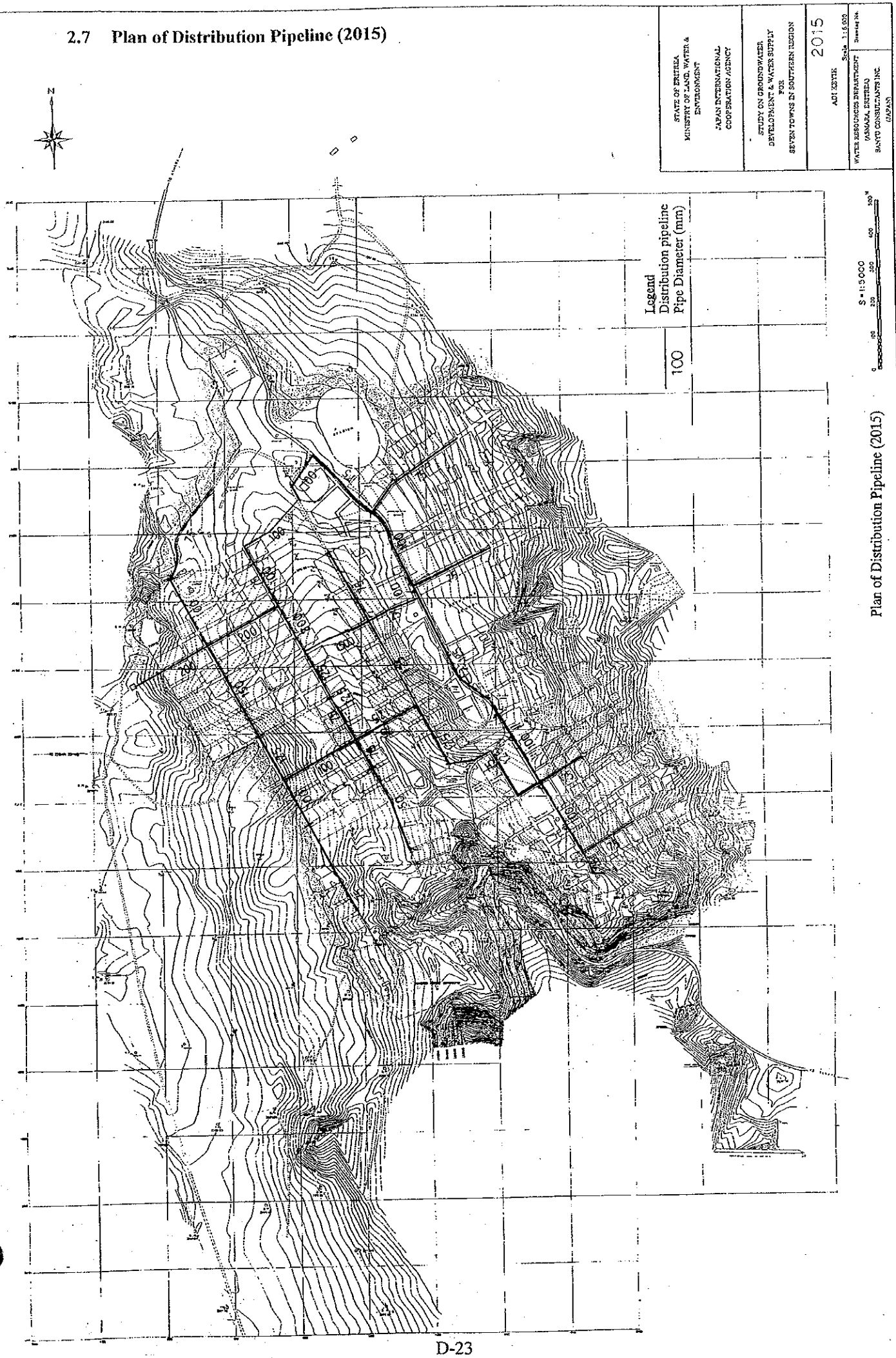
ADI KEYIN 2010



Node No.	Dynamic (WL.m)	Ground Elevation (EL.m)	Effective Head (m)	Area (ha)	Outflow Quantitiy (L/sec)
0	2398.000	2392.500	5.500	-120.70	-24.72
1	2396.810	2378.600	18.210	0.00	0.00
2	2395.650	2370.900	24.750	0.00	0.00
3	2394.987	2366.300	28.687	0.00	0.00
19	2394.288	2360.900	33.388	7.70	1.58
20	2393.066	2360.000	33.066	0.00	0.00
24	2392.432	2365.200	27.232	0.00	0.00
25	2391.479	2359.600	31.879	11.90	2.44
7	2389.241	2363.500	25.741	0.00	0.00
8	2388.616	2362.100	26.516	6.40	1.31
9	2388.100	2360.100	28.000	0.00	0.00
10	2386.606	2367.400	19.206	10.00	2.05
18	2394.542	2375.500	19.042	4.00	0.82
4	2392.908	2368.600	24.308	0.00	0.00
23	2391.546	2372.600	18.946	10.30	2.11
5	2391.276	2376.500	14.776	0.00	0.00
26	2387.104	2377.000	10.104	0.00	0.00
27	2386.033	2376.600	9.433	7.10	1.45
28	2383.660	2364.800	18.860	11.20	2.29
29	2386.489	2368.700	17.789	7.10	1.45
6	2389.980	2372.300	17.680	12.40	2.54
21	2392.369	2360.700	31.669	5.60	1.15
22	2388.829	2359.200	29.629	5.50	1.13
31	2386.569	2348.000	38.569	15.00	3.07
32	2387.964	2359.500	28.464	6.50	1.33

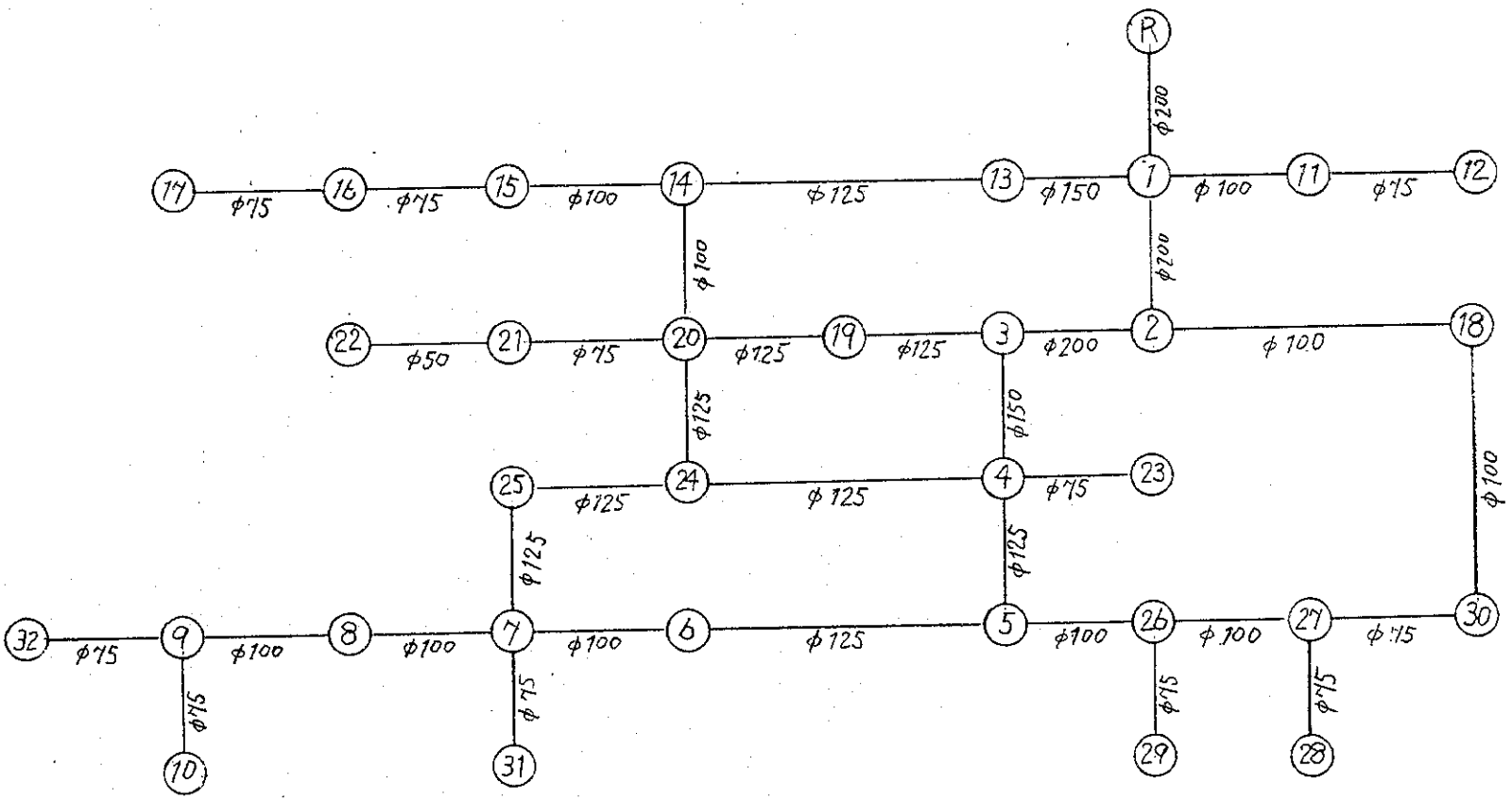
Pipe line	Node No.		Dia.	Length	Flow Coefficient	Flow	velocity	Loss of Head	Hydraulic Gradient	Head Loss Coefficient	Hydrostatic Head	Water Hummer Head	Design Pressure	Pipe Material
No.	From	To	(mm)	(m)		(L/sec)	(m/sec)	(m)	(m/1000m)				(kg/sq.cm)	
1	0	1	200	250.00	110	24.8	0.788	1.190	4.760	0.03002	2.02	2.02	4.04	
2	1	2	200	244.00	110	24.7	0.788	1.160	4.753	0.03002	2.79	2.79	5.58	
3	2	3	200	149.00	110	23.9	0.761	0.664	4.455	0.03018	3.25	3.25	6.50	
4	3	19	125	159.00	110	6.9	0.561	0.698	4.391	0.03414	3.79	1.75	5.54	
5	19	20	100	152.00	110	5.3	0.676	1.223	8.044	0.03447	3.87	1.75	5.62	
6	20	24	100	222.00	110	3.0	0.386	0.634	2.854	0.03745	3.87	1.75	5.62	
7	24	25	125	207.00	110	7.1	0.576	0.953	4.604	0.03401	3.92	1.75	5.67	
8	25	7	100	358.00	110	4.6	0.590	2.238	6.251	0.03517	3.91	1.75	5.66	
9	7	8	100	97.00	110	4.7	0.600	0.625	6.441	0.03509	3.66	1.75	5.41	
10	8	9	100	147.00	110	3.4	0.432	0.516	3.509	0.03684	3.86	1.75	5.61	
11	9	10	75	267.00	110	2.0	0.464	1.495	5.598	0.03824	3.86	1.75	5.61	
12	2	18	50	150.00	110	0.8	0.417	1.108	7.388	0.04156	2.78	2.78	5.57	
13	3	4	150	216.00	110	17.0	0.962	2.079	9.624	0.03058	3.25	3.25	6.49	
14	4	24	125	290.00	110	4.0	0.330	0.476	1.640	0.03694	3.36	3.36	6.71	
15	4	23	75	230.00	110	2.1	0.478	1.361	5.919	0.03807	3.01	3.01	6.03	
16	4	5	125	160.00	110	10.9	0.885	1.632	10.197	0.03192	3.02	3.02	6.03	
17	5	26	100	540.00	110	5.2	0.662	4.172	7.727	0.03458	2.22	2.22	4.45	
18	26	27	100	254.00	110	3.7	0.477	1.070	4.214	0.03630	2.21	2.21	4.43	
19	27	28	75	344.00	110	2.3	0.519	2.373	6.899	0.03761	3.39	3.39	6.79	
20	26	29	75	207.00	110	1.5	0.330	0.615	2.972	0.04023	3.00	3.00	6.01	
21	5	6	125	424.00	110	5.7	0.462	1.296	3.056	0.03515	2.65	2.65	5.29	
22	6	7	100	242.00	110	3.1	0.401	0.740	3.056	0.03725	3.52	1.75	5.27	
23	20	21	75	102.00	110	2.3	0.516	0.696	6.826	0.03764	3.87	1.75	5.62	
24	21	22	50	266.00	110	1.1	0.574	3.540	13.309	0.03965	3.95	1.75	5.70	
25	7	31	75	225.00	110	3.1	0.696	2.672	11.876	0.03601	5.07	1.75	6.82	
26	9	32	75	54.00	110	1.3	0.302	0.136	2.527	0.04075	3.92	1.75	5.67	
合計				5956.00										

2.7 Plan of Distribution Pipeline (2015)



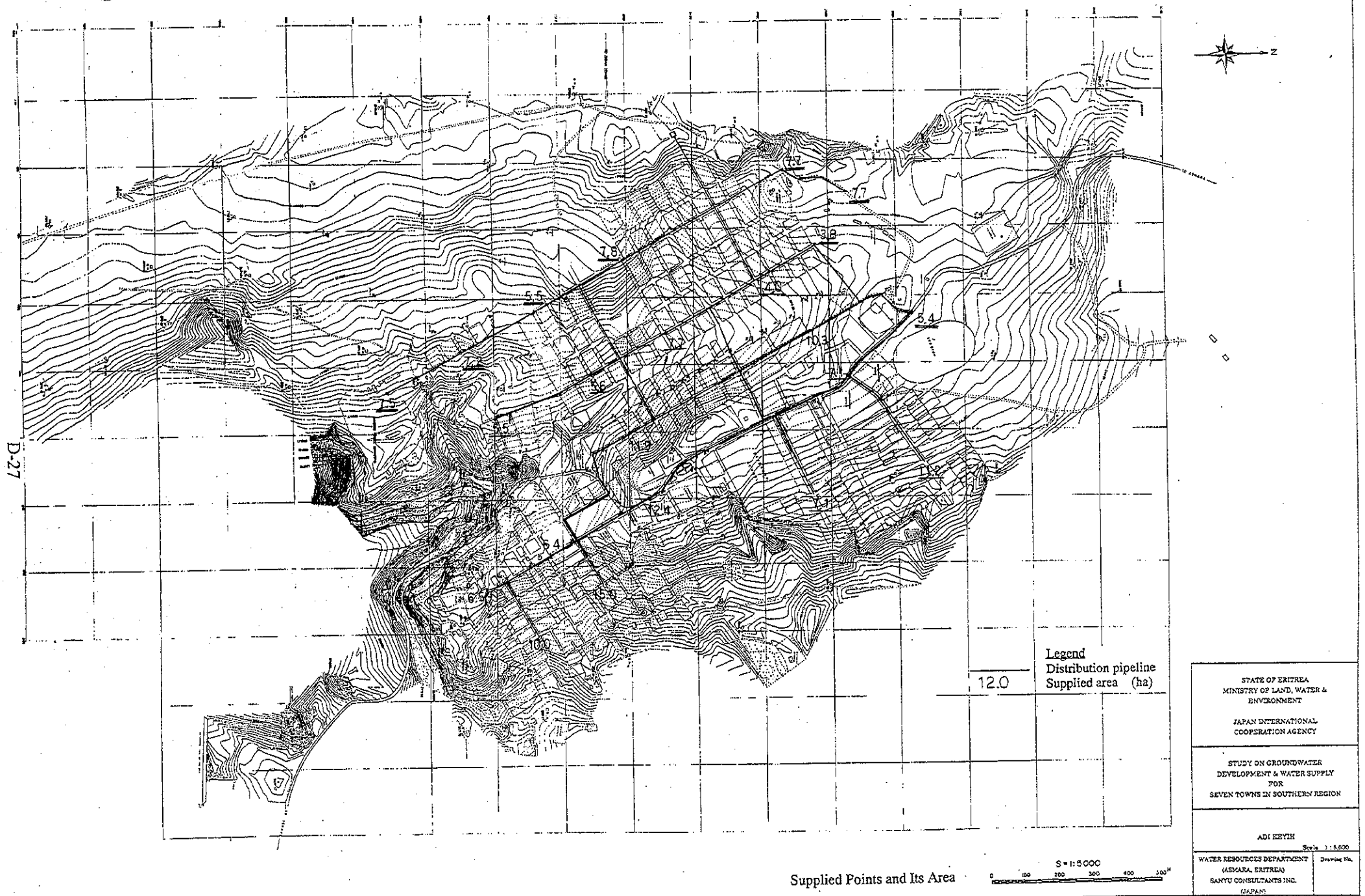
Plan of Distribution Pipeline (2015)

ADI KEYIN 2015

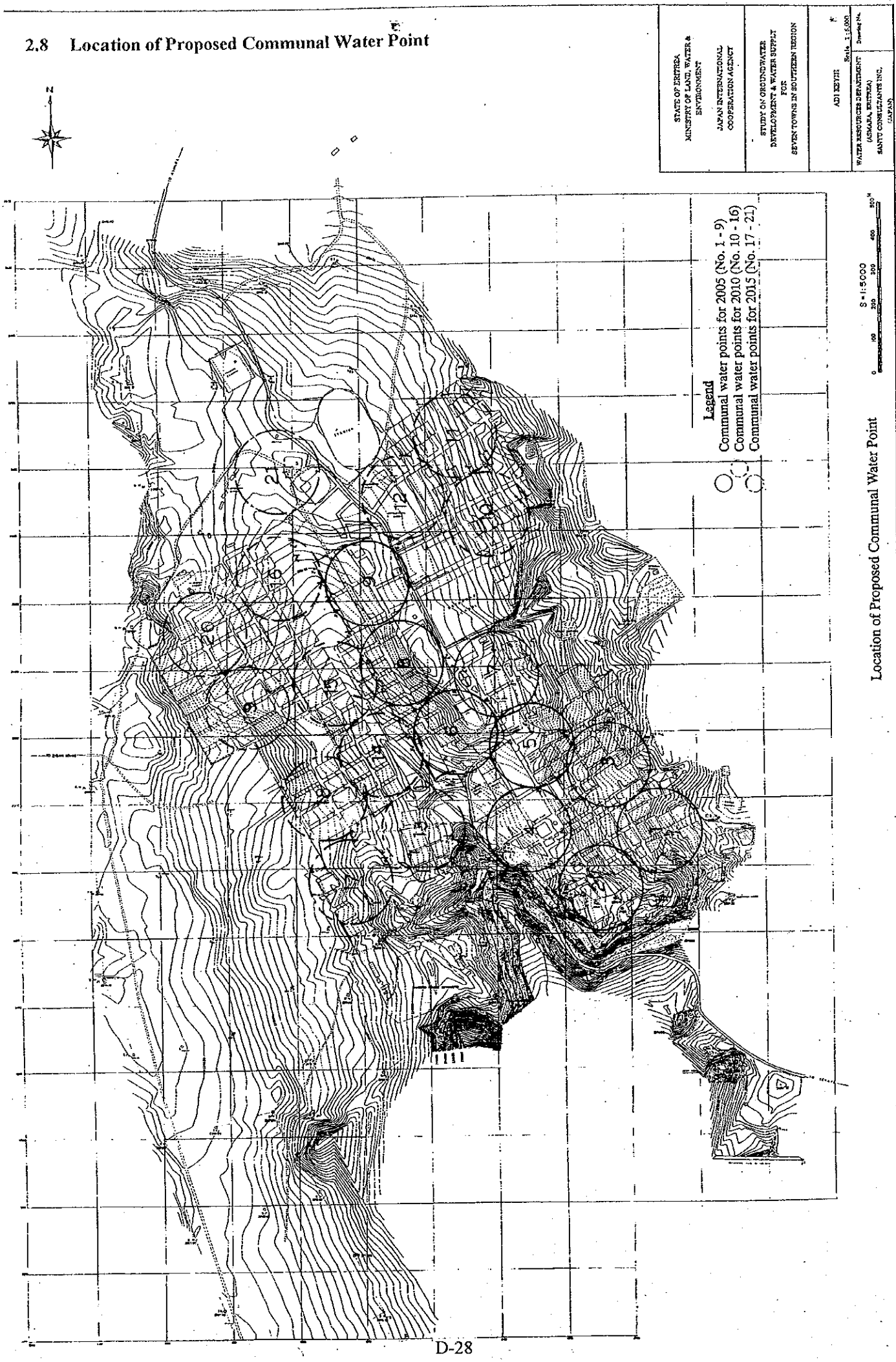


Node No.	Dynamic (WL.m)	Ground Elevation (EL.m)	Effective Head (m)	Area (ha)	Outflow Quantitiy (L/sec)
0	2398.000	2392.500	5.500	-173.30	-36.36
1	2395.583	2378.600	16.983	0.00	0.00
2	2394.484	2370.900	23.584	0.00	0.00
3	2394.028	2366.300	27.728	0.00	0.00
4	2392.708	2368.600	24.108	0.00	0.00
5	2391.683	2376.500	15.183	0.00	0.00
6	2390.652	2372.300	18.352	12.40	2.60
7	2390.204	2363.500	26.704	0.00	0.00
8	2389.551	2362.100	27.451	6.40	1.34
9	2389.011	2360.100	28.911	0.00	0.00
10	2387.448	2367.400	20.049	10.00	2.10
11	2394.858	2384.300	10.558	7.70	1.62
12	2393.822	2380.400	13.422	7.70	1.62
13	2394.658	2379.000	15.658	7.80	1.64
14	2393.894	2378.000	15.894	0.00	0.00
15	2393.091	2371.100	21.991	5.50	1.15
16	2389.652	2365.300	24.352	7.20	1.51
17	2388.759	2362.500	26.259	7.50	1.57
18	2393.570	2375.500	18.070	7.80	1.64
19	2393.445	2360.900	32.545	7.70	1.62
20	2393.124	2360.000	33.124	0.00	0.00
21	2392.398	2360.700	31.698	5.60	1.17
22	2388.694	2359.200	29.494	5.50	1.15
23	2391.281	2372.600	18.680	10.30	2.16
24	2392.490	2365.200	27.290	0.00	0.00
25	2391.269	2359.600	31.669	11.90	2.50
26	2391.542	2377.000	14.542	0.00	0.00
27	2391.211	2376.600	14.611	7.10	1.49
28	2388.730	2364.800	23.930	11.20	2.35
29	2390.898	2368.700	22.198	7.10	1.49
30	2392.420	2377.700	14.720	5.40	1.13
31	2387.412	2348.000	39.412	15.00	3.15
32	2388.868	2359.500	29.368	6.50	1.36

Pipe line	Node No.		Dia.	Length	Flow Coefficient	Flow	velocity	Loss of Head	Hydraulic Gradient	Head Loss Coefficient	Hydrostatic Head	Water Hummer Head	Design Pressure	Pipe Material
No.	From	To	(mm)	(m)		(L/sec)	(m/sec)	(m)	(m/1000m)				(kg/sq.cm)	
1	0	1	200	250.00	110	36.3	1.156	2.417	9.669	0.02837	2.02	2.02	4.04	
2	1	2	200	244.00	110	24.0	0.765	1.099	4.504	0.03015	2.79	2.79	5.58	
3	2	3	200	149.00	110	19.5	0.621	0.456	3.061	0.03110	3.25	3.25	6.50	
4	3	4	150	216.00	110	13.3	0.752	1.319	6.108	0.03171	3.25	3.25	6.49	
5	4	5	125	160.00	110	8.4	0.688	1.025	6.409	0.03313	3.02	3.02	6.03	
6	5	6	125	424.00	110	5.0	0.408	1.031	2.432	0.03579	2.65	2.65	5.29	
7	6	7	100	242.00	110	2.4	0.306	0.448	1.849	0.03877	3.52	1.75	5.27	
8	7	8	100	97.00	110	4.8	0.614	0.653	6.735	0.03496	3.66	1.75	5.41	
9	8	9	100	147.00	110	3.5	0.443	0.540	3.675	0.03670	3.86	1.75	5.61	
10	9	10	75	267.00	110	2.1	0.475	1.562	5.851	0.03811	3.86	1.75	5.61	
11	1	11	100	230.00	110	3.2	0.408	0.725	3.152	0.03715	2.01	2.01	4.03	
12	11	12	75	287.00	110	1.6	0.366	1.036	3.611	0.03961	1.83	1.83	3.67	
13	1	13	150	310.00	110	9.0	0.511	0.925	2.984	0.03358	2.02	2.02	4.03	
14	13	14	125	152.00	110	7.4	0.604	0.764	5.027	0.03377	2.08	2.08	4.15	
15	14	15	100	152.00	110	4.2	0.539	0.802	5.278	0.03565	2.76	2.76	5.53	
16	15	16	75	288.00	110	3.1	0.698	3.440	11.943	0.03599	3.34	3.34	6.69	
17	16	17	75	260.00	110	1.6	0.356	0.892	3.432	0.03977	3.62	1.75	5.37	
18	2	18	100	150.00	110	4.6	0.582	0.914	6.095	0.03524	2.79	2.79	5.57	
19	3	19	125	159.00	110	6.3	0.509	0.583	3.668	0.03464	3.79	1.75	5.54	
20	19	20	125	152.00	110	4.6	0.378	0.321	2.112	0.03620	3.88	1.75	5.63	
21	20	21	75	102.00	110	2.3	0.528	0.725	7.111	0.03752	3.87	1.75	5.62	
22	21	22	50	266.00	110	1.2	0.588	3.705	13.927	0.03951	3.95	1.75	5.70	
23	4	23	75	230.00	110	2.2	0.491	1.428	6.209	0.03793	3.01	3.01	6.03	
24	4	24	125	290.00	110	2.7	0.217	0.218	0.753	0.03932	3.36	3.36	6.71	
25	24	25	125	207.00	110	8.1	0.658	1.221	5.899	0.03335	3.92	1.75	5.67	
26	5	26	100	40.00	110	3.4	0.434	0.141	3.534	0.03682	2.22	2.22	4.45	
27	26	27	100	254.00	110	2.0	0.253	0.331	1.301	0.03988	2.21	2.21	4.43	
28	27	28	75	344.00	110	2.3	0.532	2.481	7.212	0.03747	3.39	3.39	6.79	
29	26	29	75	207.00	110	1.5	0.338	0.644	3.110	0.04008	3.00	3.00	6.01	
30	27	30	75	262.00	110	-1.8	-0.418	-1.209	-4.615	-0.03884	2.21	2.21	4.43	
31	7	31	75	225.00	110	3.1	0.713	2.792	12.409	0.03588	5.07	1.75	6.82	
32	9	32	75	54.00	110	1.4	0.309	0.142	2.636	0.04062	3.92	1.75	5.67	
33	14	20	100	250.00	110	3.2	0.403	0.770	3.080	0.03722	3.87	1.75	5.62	
34	18	30	100	417.00	110	3.0	0.379	1.149	2.756	0.03756	2.32	2.32	4.65	
35	20	24	125	222.00	110	5.5	0.445	0.633	2.853	0.03534	3.88	1.75	5.63	
36	25	7	125	358.00	110	5.6	0.455	1.065	2.974	0.03522	3.92	1.75	5.67	
合計				8064.00										

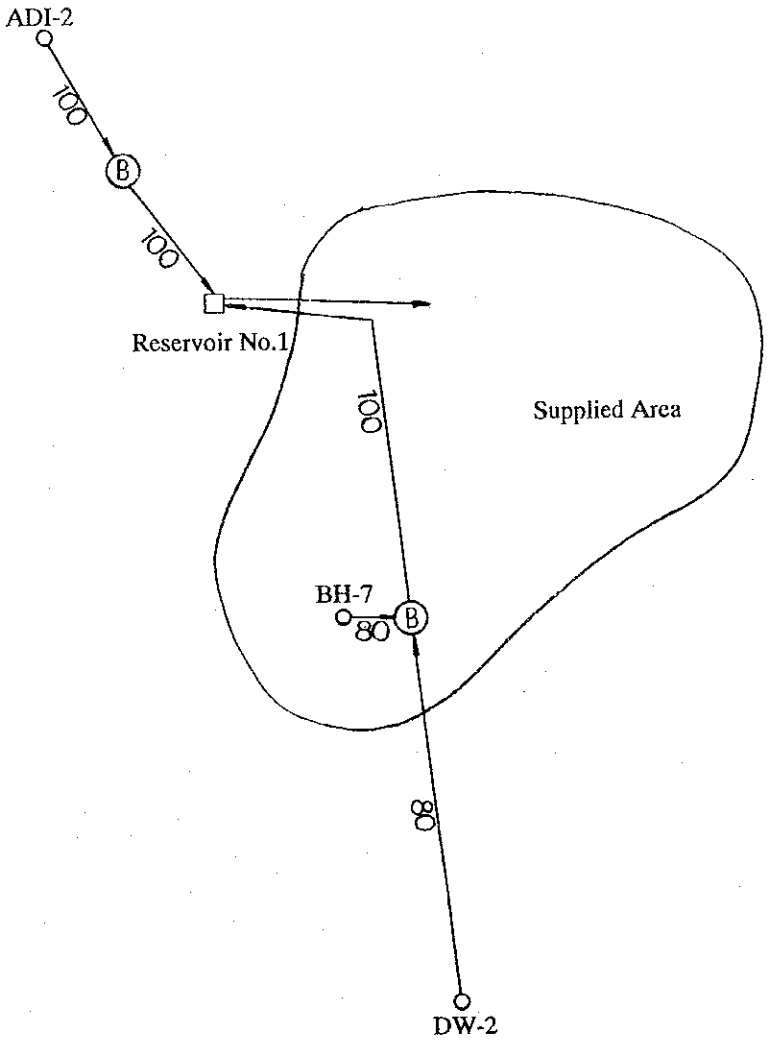

N
D-27
Legend
Distribution pipeline
12.0 Supplied area (ha)
S = 1:5000
0 100 200 300 400 500M
Supplied Points and Its Area
STATE OF ERITREA
MINISTRY OF LAND, WATER & ENVIRONMENT
JAPAN INTERNATIONAL COOPERATION AGENCY
STUDY ON GROUNDWATER DEVELOPMENT & WATER SUPPLY FOR SEVEN TOWNS IN SOUTHERN REGION
ADI KEYIH
Scale 1 : 5,000
WATER RESOURCES DEPARTMENT (ASMARA, ERITREA)
SANYU CONSULTANTS INC. (JAPAN)
Drawing No.

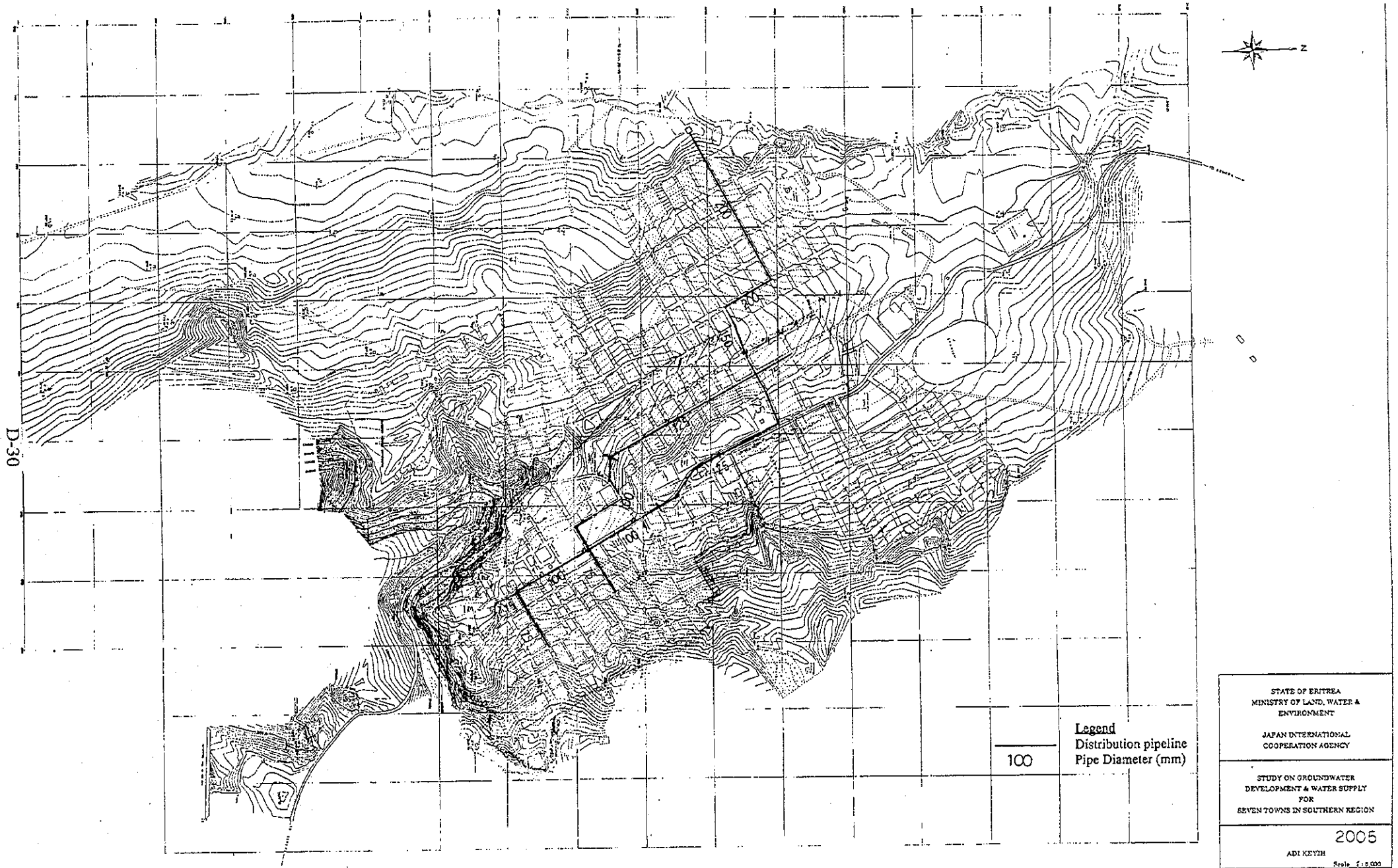
2.8 Location of Proposed Communal Water Point



2.9 Plan of Water Source and Transmission Pipeline (2005)

Adi Keyih





Plan of Distribution Pipeline (2005)

STATE OF ERITREA
MINISTRY OF LAND, WATER & ENVIRONMENT

JAPAN INTERNATIONAL COOPERATION AGENCY

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

2005

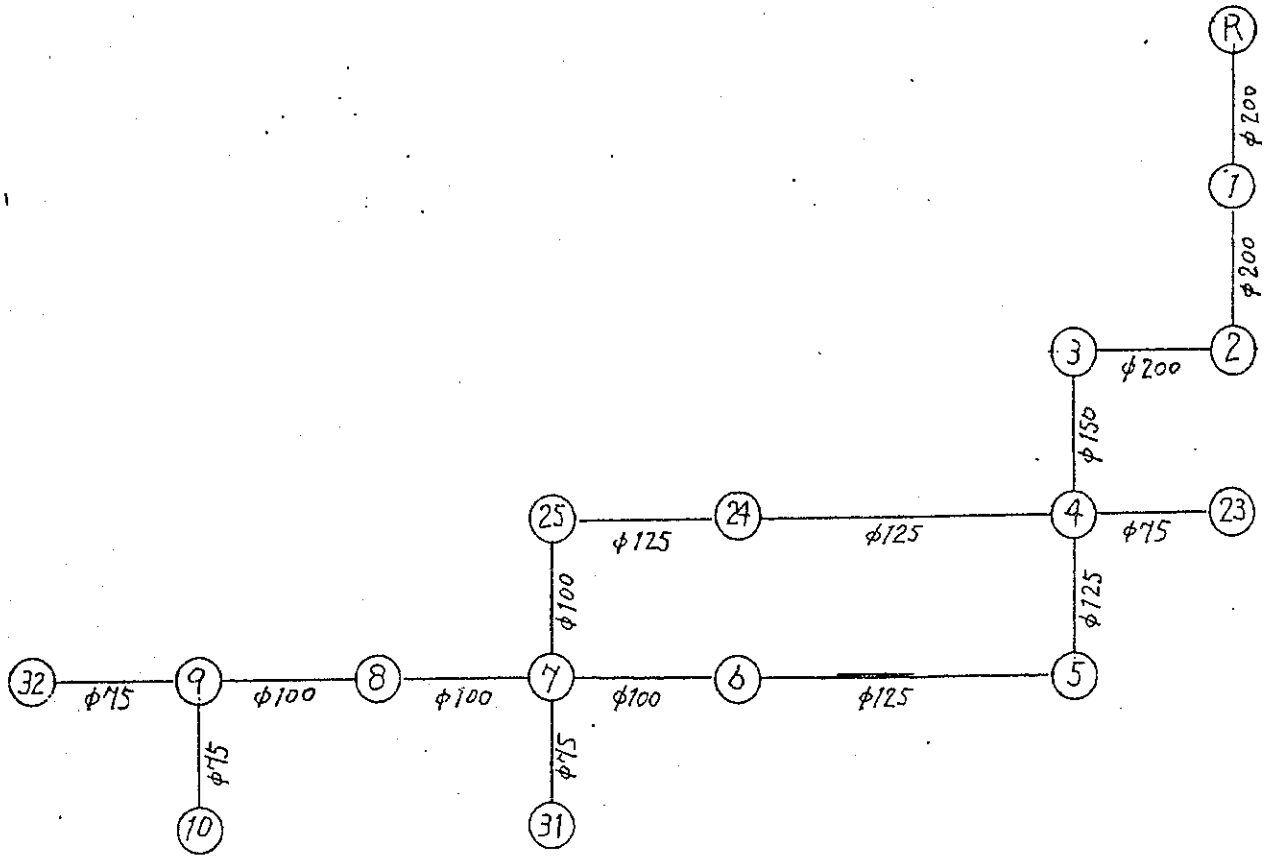
ADI KEYIH

Scale 1:5,000

WATER RESOURCES DEPARTMENT (ASMARA, ERITREA)
SANYU CONSULTANTS INC. (JAPAN)

Drawing No.

ADI KEYIN 2010 (2005area)



Node No.	Dynamic (WL.m)	Ground Elevation (EL.m)	Effective Head (m)	Area (ha)	Outflow Quantitiy (L/sec)
0	2398.000	2392.500	5.500	-72.50	-14.85
1	2397.548	2378.600	18.948	0.00	0.00
2	2397.106	2370.900	26.206	0.00	0.00
3	2396.831	2366.300	30.531	0.00	0.00
4	2395.207	2368.600	26.607	0.00	0.00
5	2394.579	2376.500	18.079	0.00	0.00
6	2392.918	2372.300	20.618	12.40	2.54
7	2391.796	2363.500	28.296	0.00	0.00
8	2391.173	2362.100	29.073	6.40	1.31
9	2390.658	2360.100	30.558	0.00	0.00
10	2389.164	2367.400	21.764	10.00	2.05
23	2393.841	2372.600	21.241	10.30	2.11
24	2394.133	2365.200	28.933	0.00	0.00
25	2393.368	2359.600	33.768	11.90	2.44
31	2389.127	2348.000	41.127	15.00	3.07
32	2390.522	2359.500	31.022	6.50	1.33

Pipe line No.	Node 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 Hummer Head	Design Pressure (kg/sq.cm)	Pipe Material
1	0	1	200	250.00	110	14.7	0.467	0.452	1.807	0.03244	2.02	2.02	4.04	
2	1	2	200	244.00	110	14.7	0.468	0.442	1.812	0.03243	2.79	2.79	5.58	
3	2	3	200	149.00	110	14.8	0.473	0.275	1.845	0.03239	3.25	3.25	6.50	
4	3	4	150	216.00	110	14.9	0.842	1.625	7.521	0.03119	3.25	3.25	6.49	
5	4	5	125	160.00	110	6.5	0.528	0.628	3.923	0.03445	3.02	3.02	6.03	
6	5	6	125	424.00	110	6.5	0.528	1.661	3.918	0.03446	2.65	2.65	5.29	
7	6	7	100	242.00	110	3.9	0.502	1.122	4.635	0.03603	3.52	1.75	5.27	
8	7	8	100	97.00	110	4.7	0.599	0.624	6.431	0.03509	3.66	1.75	5.41	
9	8	9	100	147.00	110	3.4	0.431	0.514	3.499	0.03684	3.86	1.75	5.61	
10	9	10	75	267.00	110	2.0	0.464	1.494	5.595	0.03824	3.86	1.75	5.61	
11	4	23	75	230.00	110	2.1	0.479	1.366	5.939	0.03806	3.01	3.01	6.03	
12	4	24	125	290.00	110	6.3	0.512	1.074	3.703	0.03461	3.36	3.36	6.71	
13	24	25	125	207.00	110	6.3	0.511	0.765	3.694	0.03462	3.92	1.75	5.67	
14	25	7	100	358.00	110	3.8	0.488	1.572	4.390	0.03618	3.91	1.75	5.66	
15	7	31	75	225.00	110	3.1	0.696	2.669	11.862	0.03601	5.07	1.75	6.82	
16	9	32	75	54.00	110	1.3	0.302	0.136	2.523	0.04076	3.92	1.75	5.67	
合計				3560.00										

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	60	80	100	125	150	200	Total Length	Cost	Cost/Year	Pumps: Well Pump Cost	Well Pump (Kw)	Booster Pump Cost	Booster Pump (Kw)	Cost/Year	O&M cost	Total Cost	
		Unit Price	442.41	521.87	583.63	645.92	661.27	806.43	(m)	(Nkf)	(Nkf)	(Nkf)		(Nkf)		(Nkf)	(Nkf)	(Nkf)	(%)
Debarwa																			
2005	DEB-1	24 ope.	0	690	0	0			690	360,090	7,202	148,693	7.5			9,913	39,420	56,535	100.0
	DEB-1	24 ope.	0	0	690	0			690	402,705	8,054	148,693	7.5			9,913	39,420	57,387	101.5
	DEB-1	18 ope.	0	0	690	0			690	402,705	8,054	149,864	7.5			9,991	39,420	57,465	101.6
2010	DEB-1	Single	0	0	690	0			690	402,705	8,054	151,193	11.0			10,080	57,816	75,950	134.3
	DEB-1	Addition	0	1,380	0	0			1,380	720,181	14,404	285,364	15.0			19,024	78,840	112,268	198.6
	DEB-1	Double	0	1,380	0	0			1,380	720,181	14,404	289,257	15.0			19,284	78,840	112,527	199.0
2015	DEB-1	Single	0	0	0	690			690	445,685	8,914	176,838	15.0			11,789	78,840	99,543	176.1
	DEB-1	Addition	0	0	1,380	0			1,380	805,409	16,108	299,728	15.0			19,982	78,840	114,930	203.3
	DEB-1	Double	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.	24 ope.		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
	All Ex.	24 ope.			2,851				2,851	1,663,929	33,279	172,851	11.0			11,523	57,816	102,618	72.0
	All Ex.	18 ope.			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.	24 ope.			2,851				2,851	1,663,929	33,279	172,851	11.0			11,523	57,816	102,618	72.0
2015	All Ex.	24 ope.			2,851				2,851	1,663,929	33,279	172,851	11.0			11,523	57,816	102,618	72.0
2010	nADQ-1	24 ope.		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
	nADQ-1	24 ope.		100	5,000	0			5,100	2,970,337	59,407	100,913	1.5	358,053	30.0	30,598	165,564	255,568	79.0
	nADQ-1	18 ope.		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
2015	nADQ-1	24 ope.		100		5,000			5,100	3,281,787	65,636	100,913	1.5	460,302	74.0	37,414	396,828	499,878	154.6
Dekemhare																			
2005	BH-14,DEK-1,DEK-2	Case-1		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
	BH-14,DEK-1,DEK-2	Case-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	0	6,191	7,767	5,873,624	117,472	390,135	15.2	217,629	30.0	40,518	237,571	395,561	121.8
2015	BH-14,DEK-1,DEK-2			628	948	0	0	6,191	7,767	5,873,624	117,472	390,135	15.2	217,629	30.0	40,518	237,571	395,561	121.8
Segeneiti																			
2005	SEG-2	24 ope.		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
	SEG-2	24 ope.		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
	SEG-2	18 ope.		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	24 ope.	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	Single	0	1,085	4,168				5,253	2,998,799	59,976	176,838	11.0	196,341	22.5	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	15.0	18,028	136,656	187,986	100.0
2010	ADI-2	24 ope.			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	24 ope.			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
2005	DW-2,BH-7	Case-1	2,105	928					3,033	1,415,568	28,311	211,795	5.2	82,104	5.5	19,593	56,239	104,144	100.0
		Case-2	343	1,772	918				3,033	1,612,273	32,245	211,748	5.2	82,104	5.5	19,590	56,239	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	11.0	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

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