6. FINANCING PLAN

6.1 COST SCHEDULE BY MEASURE

TABLE D.6.1 (1) COST SCHEDULE BY MEASURE -- MEASURE a: LEAKAGE CONTROL MEASURES (TRANSMISSION) --

(Unit: T.Shs.million)

T.Shs. million

	GRAND TOTAL			TOTAL OF CAPITAL COST			TOTAL OF O & M COST			BUILDING 40 *			PIPE & FITTINGS 20 *			MACHINERY INSTALLED 10 *			MACHINERY MOBILE 5 *			MOTOR VEHICLE 5 *			EQUIPMENT & TOOLS 4 *			EXPERT			O & M LABOUR			O & M		
	F.C. T.SHS	LC T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL
1 1991	31	12	43	31	12	43	0	0	0	0	0	0	0	0	0	31	12	43	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
2 1992	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
3 1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
4 1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
5 1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
6 1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
7 1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
8 1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
9 1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
10 2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
11 2001	31	12	43	31	12	43	0	0	0	0	0	0	0	0	0	31	12	43	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
12 2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
13 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
14 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
15 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
16 2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
17 2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
18 2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
19 2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
20 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
21 2011	31	12	43	31	12	43	0	0	0	0	0	0	0	0	0	31	12	43	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
22 2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
23 2013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
24 2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
25 2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
Salvage cos	-16	-6	-22	-16	-6	-22	0	0	0	0	0	0	0	0	0	-16	-6	-22	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	78	30	108	78	30	108	0	0	0	0	0	0	0	0	0	78	30	108	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0

*: Depreciation Period

TABLE D.6.1 (2) COST SCHEDULE BY MEASURE – MEASURE b: LEAKAGE CONTROL MEASURES (DISTRIBUTION) –

(Unit: T.Shs.million)

PROGRAMME b

T.Shs. million

		GRAND TOTAL			TOTAL OF CAPITAL COST			TOTAL OF O & M COST			BUILDING 40 *			PIPE & FITTINGS 20 *			MACHINERY INSTALLED 10 *			MACHINERY MOBILE 5 *			MOTOR VEHICLE 5 *			EQUIPMENT & TOOLS 4 *			LABOUR			O & M LABOUR			O & M		
		F.C T.SHS	LC T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC T.SHS	TOTAL	F.C T.SHS	LC T.SHS	TOTAL	F.C T.SHS	LC T.SHS	TOTAL	F.C T.SHS	LC T.SHS	TOTAL	F.C T.SHS	LC T.SHS	TOTAL	F.C T.SHS	LC T.SHS	TOTAL	F.C T.SHS	LC T.SHS	TOTAL	F.C T.SHS	LC T.SHS	TOTAL	F.C T.SHS	LC T.SHS	TOTAL	F.C T.SHS	LC T.SHS	TOTAL
1	1991	374	28	402	374	4	378	0	24	24	0	0	0	65	3	68	0	0	0	52	0	52	118	0	118	70	1	71	69	0	69	0.0	11.7	11.7	0.0	12.4	12.4
2	1992	240	36	276	240	12	252	0	24	24	0	0	0	171	12	183	0	0	0	0	0	0	0	0	0	0	0	0	69	0	69	0.0	11.7	11.7	0.0	12.4	12.4
3	1993	217	36	253	217	12	229	0	24	24	0	0	0	148	12	160	0	0	0	0	0	0	0	0	0	0	0	0	69	0	69	0.0	11.7	11.7	0.0	12.4	12.4
4	1994	149	36	184	149	12	160	0	24	24	0	0	0	149	12	160	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	11.7	11.7	0.0	12.4	12.4
5	1995	364	465	829	364	441	805	0	24	24	0	0	0	293	441	734	0	0	0	0	0	0	0	0	0	70	1	71	0	0	0	0.0	11.7	11.7	0.0	12.4	12.4
6	1996	170	24	194	170	0	170	0	24	24	0	0	0	0	0	0	0	0	0	52	0	52	118	0	118	0	0	0	0	0	0	0.0	11.7	11.7	0.0	12.4	12.4
7	1997	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	11.7	11.7	0.0	12.4	12.4
8	1998	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	11.7	11.7	0.0	12.4	12.4
9	1999	70	25	95	70	1	71	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	70	1	71	0	0	0	0.0	11.7	11.7	0.0	12.4	12.4
10	2000	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	11.7	11.7	0.0	12.4	12.4
11	2001	170	24	194	170	0	170	0	24	24	0	0	0	0	0	0	0	0	0	52	0	52	118	0	118	0	0	0	0	0	0	0.0	11.7	11.7	0.0	12.4	12.4
12	2002	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	11.7	11.7	0.0	12.4	12.4
13	2003	70	25	95	70	1	71	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	70	1	71	0	0	0	0.0	11.7	11.7	0.0	12.4	12.4
14	2004	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	11.7	11.7	0.0	12.4	12.4
15	2005	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	11.7	11.7	0.0	12.4	12.4
16	2006	170	24	194	170	0	170	0	24	24	0	0	0	0	0	0	0	0	0	52	0	52	118	0	118	0	0	0	0	0	0	0.0	11.7	11.7	0.0	12.4	12.4
17	2007	70	25	95	70	1	71	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	70	1	71	0	0	0	0.0	11.7	11.7	0.0	12.4	12.4
18	2008	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	11.7	11.7	0.0	12.4	12.4
19	2009	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	11.7	11.7	0.0	12.4	12.4
20	2010	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	11.7	11.7	0.0	12.4	12.4
21	2011	306	28	333	306	4	309	0	24	24	0	0	0	65	3	68	0	0	0	52	0	52	118	0	118	70	1	71	0	0	0	0.0	11.7	11.7	0.0	12.4	12.4
22	2012	171	36	207	171	12	183	0	24	24	0	0	0	171	12	183	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	11.7	11.7	0.0	12.4	12.4
23	2013	148	36	184	148	12	160	0	24	24	0	0	0	148	12	160	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	11.7	11.7	0.0	12.4	12.4
24	2014	149	36	184	149	12	160	0	24	24	0	0	0	149	12	160	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	11.7	11.7	0.0	12.4	12.4
25	2015	364	465	829	364	441	805	0	24	24	0	0	0	293	441	734	0	0	0	0	0	0	0	0	0	70	1	71	0	0	0	0.0	11.7	11.7	0.0	12.4	12.4
Salvage cos		-777	-451	-1,228	-777	-451	-1,228	0	0	0	0	0	0	-725	-451	-1,175	0	0	0	0	0	0	0	0	0	-53	0	-53	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL		2,424	1,113	3,537	2,424	511	2,935	0	603	603	0	0	0	929	507	1,436	0	0	0	261	1	262	589	0	589	438	3	442	206	0	206	0.0	292.5	292.5	0.0	310.0	310.0

*: Depreciation Period

TABLE D.6.1 (3) COST SCHEDULE BY MEASURE -- MEASURE c: EXISTING PIPE CONNECTION --

(Unit: T.Shs.million)

PROGRAMME c

T.Shs. million

		GRAND TOTAL			TOTAL OF CAPITAL COST			TOTAL OF O & M COST			BUILDING 40 %			PIPE & FITTINGS 20 %			MACHINERY INSTALLED 10 %			MACHINERY MOBILE 5 %			MOTOR VEHICLE 5 %			EQUIPMENT & TOOLS 4 %			EXPERT			O & M LABOUR			O & M		
		F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL
1	1991	238	58	296	238	58	296	0	0	0	0	0	0	238	58	296	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
2	1992	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
3	1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
4	1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
5	1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
6	1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
7	1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
8	1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
9	1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
10	2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
11	2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
12	2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
13	2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
14	2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
15	2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
16	2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
17	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
18	2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
19	2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
20	2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
21	2011	238	58	296	238	58	296	0	0	0	0	0	0	238	58	296	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
22	2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
23	2013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
24	2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
25	2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
Salvage co*		-179	-44	-222	-179	-44	-222	0	0	0	0	0	0	-179	-44	-222	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL		298	73	370	298	73	370	0	0	0	0	0	0	298	73	370	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0

*: Depreciation Period

TABLE D.6.1 (4) COST SCHEDULE BY MEASURE – MEASURE d: MAIN PIPE LAYING (PRIMARY) –

(Unit: T.Shs.million)

PROGRAMME d

	GRAND TOTAL			TOTAL OF CAPITAL COST			TOTAL OF O & M COST			BUILDING 40 %			PIPE & FITTINGS 20 %			MACHINERY INSTALLED 10 %			MACHINERY MOBILE 5 %			MOTOR VEHICLE 5 %			EQUIPMENT & TOOLS 4 %			EXPERT			O & M LABOUR			O & M		
	F.C. T.SHS	LC T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL
1 1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
2 1992	534	121	655	534	121	655	0	0	0	0	0	0	534	121	655	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
3 1993	958	217	1,175	958	217	1,175	0	0	0	0	0	0	958	217	1,175	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
4 1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
5 1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
6 1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
7 1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
8 1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
9 1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
10 2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
11 2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
12 2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
13 2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
14 2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
15 2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
16 2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
17 2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
18 2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
19 2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
20 2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
21 2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
22 2012	534	121	655	534	121	655	0	0	0	0	0	0	534	121	655	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
23 2013	958	217	1,175	958	217	1,175	0	0	0	0	0	0	958	217	1,175	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
24 2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
25 2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
Salvage co	-1,242	-281	-1,523	-1,242	-281	-1,523	0	0	0	0	0	0	-1,242	-281	-1,523	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	1,743	395	2,137	1,743	395	2,137	0	0	0	0	0	0	1,743	395	2,137	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0

*: Depreciation Period

TABLE D.6.1 (5) COST SCHEDULE BY MEASURE — MEASURE e: MAIN PIPE LAYING (SECONDARY) —

(Unit: T.Shs.million)

PROGRAMME e

T.Shs. million

		GRAND TOTAL			TOTAL OF CAPITAL COST			TOTAL OF O & M COST			BUILDING 40 *			PIPE & FITTINGS 20 *			MACHINERY INSTALLED 10 *			MACHINERY MOBILE 5 *			MOTOR VEHICLE 5 *			EQUIPMENT & TOOLS 4 *			EXPERT			O & M LABOUR			O & M		
		F.C. T.SHS	LC T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC T.SHS	TOTAL	F.C. T.SHS	LCL T.SHS	TOTAL	F.C. T.SHS	LCL T.SHS	TOTAL	F.C. T.SHS	LCL T.SHS	TOTAL	F.C. T.SHS	LCL T.SHS	TOTAL	F.C. T.SHS	LCL T.SHS	TOTAL	F.C. T.SHS	LCL T.SHS	TOTAL	F.C. T.SHS	LCL T.SHS	TOTAL	F.C. T.SHS	LCL T.SHS	TOTAL
1	1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
2	1992	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
3	1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
4	1994	121	245	366	121	245	366	0	0	0	0	0	0	121	245	366	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
5	1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
6	1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
7	1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
8	1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
9	1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
10	2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
11	2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
12	2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
13	2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
14	2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
15	2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
16	2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
17	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
18	2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
19	2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
20	2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
21	2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
22	2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
23	2013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
24	2014	121	245	366	121	245	366	0	0	0	0	0	0	121	245	366	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
25	2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
Salvage co		-109	-221	-329	-109	-221	-329	0	0	0	0	0	0	-109	-221	-329	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL		133	270	403	133	270	403	0	0	0	0	0	0	133	270	403	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0

*: Depreciation Period

TABLE D.6.1 (6) COST SCHEDULE BY MEASURE – MEASURE f: PIPE CLEANING –

(Unit: T.Shs.million)

PROGRAMME f

T.Shs. million

	GRAND TOTAL			TOTAL OF CAPITAL COST			TOTAL OF O & M COST			BUILDING 40 *			PIPE & FITTINGS 20 *			MACHINERY INSTALLED 10 *			MACHINERY MOBILE 5 *			MOTOR VEHICLE 5 *			EQUIPMENT & TOOLS 4 *			EXPERT			O & M LABOUR			O & M		
	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL
1 1991	406	17	423	406	4	410	0	13	13	0	0	0	51	2	53	0	0	0	183	2	185	86	0	86	18	0	18	69	0	69	0.0	5.3	5.3	0.0	7.6	7.6
2 1992	53	16	69	53	3	56	0	13	13	0	0	0	53	3	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5.3	5.3	0.0	7.6	7.6
3 1993	53	16	69	53	3	56	0	13	13	0	0	0	53	3	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5.3	5.3	0.0	7.6	7.6
4 1994	53	16	69	53	3	56	0	13	13	0	0	0	53	3	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5.3	5.3	0.0	7.6	7.6
5 1995	71	16	87	71	3	74	0	13	13	0	0	0	53	3	56	0	0	0	0	0	0	0	0	0	18	0	18	0	0	0	0.0	5.3	5.3	0.0	7.6	7.6
6 1996	269	15	283	269	2	271	0	13	13	0	0	0	0	0	0	0	0	0	183	2	185	86	0	86	0	0	0	0	0	0	0.0	5.3	5.3	0.0	7.6	7.6
7 1997	0	13	13	0	0	0	0	13	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5.3	5.3	0.0	7.6	7.6
8 1998	0	13	13	0	0	0	0	13	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5.3	5.3	0.0	7.6	7.6
9 1999	18	13	31	18	0	18	0	13	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	18	0	0	0	0.0	5.3	5.3	0.0	7.6	7.6
10 2000	0	13	13	0	0	0	0	13	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5.3	5.3	0.0	7.6	7.6
11 2001	269	15	283	269	2	271	0	13	13	0	0	0	0	0	0	0	0	0	183	2	185	86	0	86	0	0	0	0	0	0	0.0	5.3	5.3	0.0	7.6	7.6
12 2002	0	13	13	0	0	0	0	13	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5.3	5.3	0.0	7.6	7.6
13 2003	18	13	31	18	0	18	0	13	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	18	0	0	0	0.0	5.3	5.3	0.0	7.6	7.6
14 2004	0	13	13	0	0	0	0	13	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5.3	5.3	0.0	7.6	7.6
15 2005	0	13	13	0	0	0	0	13	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5.3	5.3	0.0	7.6	7.6
16 2006	269	15	283	269	2	271	0	13	13	0	0	0	0	0	0	0	0	0	183	2	185	86	0	86	0	0	0	0	0	0	0.0	5.3	5.3	0.0	7.6	7.6
17 2007	18	13	31	18	0	18	0	13	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	18	0	0	0	0.0	5.3	5.3	0.0	7.6	7.6
18 2008	0	13	13	0	0	0	0	13	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5.3	5.3	0.0	7.6	7.6
19 2009	0	13	13	0	0	0	0	13	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5.3	5.3	0.0	7.6	7.6
20 2010	0	13	13	0	0	0	0	13	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5.3	5.3	0.0	7.6	7.6
21 2011	338	17	355	338	4	342	0	13	13	0	0	0	51	2	53	0	0	0	183	2	185	86	0	86	18	0	18	0	0	0	0.0	5.3	5.3	0.0	7.6	7.6
22 2012	53	16	69	53	3	56	0	13	13	0	0	0	53	3	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5.3	5.3	0.0	7.6	7.6
23 2013	53	16	69	53	3	56	0	13	13	0	0	0	53	3	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5.3	5.3	0.0	7.6	7.6
24 2014	53	16	69	53	3	56	0	13	13	0	0	0	53	3	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5.3	5.3	0.0	7.6	7.6
25 2015	71	16	87	71	3	74	0	13	13	0	0	0	53	3	56	0	0	0	0	0	0	0	0	0	18	0	18	0	0	0	0.0	5.3	5.3	0.0	7.6	7.6
Salvage cos	-237	-11	-248	-237	-11	-248	0	0	0	0	0	0	-223	-11	-234	0	0	0	0	0	0	0	0	0	-14	0	-14	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	1,829	346	2,175	1,829	23	1,852	0	323	323	0	0	0	302	15	316	0	0	0	916	9	924	429	0	429	114	0	114	69	0	69	0.0	132.5	132.5	0.0	190.0	190.0

*: Depreciation Period

TABLE D.6.1 (7) COST SCHEDULE BY MEASURE – MEASURE g: MIDDLE ZONE CREATION –

(Unit: T.Shs.million)

PROGRAMME g

		GRAND TOTAL			TOTAL OF CAPITAL COST			TOTAL OF O & M COST			BUILDING 40 %			PIPE & FITTINGS 20 %			MACHINERY INSTALLED 10 %			MACHINERY MOBILE 5 %			MOTOR VEHICLE 5 %			EQUIPMENT & TOOLS 4 %			EXPERT			O & M LABOUR			O & M		
		F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL
1	1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
2	1992	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
3	1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
4	1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
5	1995	1,181	667	1,848	1,181	667	1,848	0	0	0	195	459	654	986	208	1,194	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
6	1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
7	1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
8	1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
9	1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
10	2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
11	2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
12	2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
13	2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
14	2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
15	2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
16	2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
17	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
18	2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
19	2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
20	2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
21	2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
22	2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
23	2013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
24	2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
25	2015	986	208	1,194	986	208	1,194	0	0	0	0	0	0	986	208	1,194	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
Salvage cos		-1,029	-416	-1,445	-1,029	-416	-1,445	0	0	0	-93	-218	-311	-937	-198	-1,134	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL		1,138	459	1,597	1,138	459	1,597	0	0	0	102	241	343	1,035	218	1,254	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0

*: Depreciation Period

TABLE D.6.1 (8) COST SCHEDULE BY MEASURE – MEASURE h: TREATMENT PLANT –

(Unit: T.Shs.million)

PROGRAMME h

	GRAND TOTAL			TOTAL OF CAPITAL COST			TOTAL OF O & M COST			BUILDING 40 %			PIPE & FITTINGS 20 %			MACHINERY INSTALLED 10 %			MACHINERY MOBILE 5 %			MOTOR VEHICLE 5 %			EQUIPMENT & TOOLS 4 %			EXPERT			O & M LABOUR			O & M		
	F.C. T.SHS	LC. T.SHS	TOTAL	F.C T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C T.SHS	LC. T.SHS	TOTAL
1 1991	53	6	59	53	6	59							32	5	35				22	1	23														
2 1992	0	0	0	0	0	0									0				0	0	0														
3 1993	0	0	0	0	0	0									0				0	0	0														
4 1994	0	0	0	0	0	0									0				0	0	0														
5 1995	0	0	0	0	0	0									0				0	0	0														
6 1996	22	1	23	22	1	23									0				22	1	23														
7 1997	0	0	0	0	0	0									0				0	0	0														
8 1998	0	0	0	0	0	0									0				0	0	0														
9 1999	0	0	0	0	0	0									0				0	0	0														
10 2000	0	0	0	0	0	0									0				0	0	0														
11 2001	22	1	23	22	1	23									0				0	0	0														
12 2002	0	0	0	0	0	0									0				22	1	23														
13 2003	0	0	0	0	0	0									0				0	0	0														
14 2004	0	0	0	0	0	0									0				0	0	0														
15 2005	0	0	0	0	0	0									0				0	0	0														
16 2006	22	1	23	22	1	23									0				0	0	0														
17 2007	0	0	0	0	0	0									0				22	1	23														
18 2008	0	0	0	0	0	0									0				0	0	0														
19 2009	0	0	0	0	0	0									0				0	0	0														
20 2010	0	0	0	0	0	0									0				0	0	0														
21 2011	53	6	59	53	6	59							32	5	36				22	1	23														
22 2012	0	0	0	0	0	0							0	0	0				0	0	0														
23 2013	0	0	0	0	0	0							0	0	0				0	0	0														
24 2014	0	0	0	0	0	0							0	0	0				0	0	0														
25 2015	0	0	0	0	0	0							0	0	0				0	0	0														
Salvage cos	-24	-3	-27	-24	-3	-27							-24	-3	-27				0	0	0														
TOTAL	149	11	160	149	11	160							39	6	45				109	5	115														

TABLE D.6.1 (9) COST SCHEDULE BY MEASURE -- MEASURE i: TREATMENT PLANT --

(Unit: T.Shs.million)

		GRAND TOTAL			TOTAL OF CAPITAL CO			TOTAL OF O & M COST			BUILDING 40			PIPE & FITTINGS 20			MACHINERY INSTALLED 10			MACHINERY MOBILE 5			MOTOR VEHICLE 5			EQUIPMENT & TOOLS 4			EXPERT			O & M LABOUR			O & M		
		F.C. T.SHS	LC. T.SHS	TOTAL	F.C T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C T.SHS	LC. T.SHS	TOTAL
1	1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0
2	1992	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0
3	1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0
4	1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0
5	1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0
6	1996	1,273	730	2,003	972	557	1,529	301	173	474	843	545	1,388	126	12	138	0	0	0	3	1	4	0	0	0	0	0	0	0	0	0	0	301.2	172.8	474.0
7	1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0
8	1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0
9	1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0
10	2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0
11	2001	4	1	5	3	1	4	1	0	1	0	0	0	0	0	0	0	0	0	3	1	4	0	0	0	0	0	0	0	0	0	0	1.0	0.2	1.1
12	2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0
13	2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0
14	2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0
15	2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0
16	2006	4	1	5	3	1	4	1	0	1	0	0	0	0	0	0	0	0	0	3	1	4	0	0	0	0	0	0	0	0	0	0	1.0	0.2	1.1
17	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0
18	2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0
19	2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0
20	2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0
21	2011	4	1	5	3	1	4	1	0	1	0	0	0	0	0	0	0	0	0	3	1	4	0	0	0	0	0	0	0	0	0	0	1.0	0.2	1.1
22	2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0
23	2013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0
24	2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0
25	2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0
Salvage cos		-422	-272	-694	-422	-272	-694	0	0	0	-422	-272	-694	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
TOTAL		864	460	1,324	560	287	846	304	173	477	422	272	694	126	12	138	0	0	0	13	2	15	0	0	0	0	0	0	0	0	0	0	304	173	477

TABLE D.6.1 (10) COST SCHEDULE BY MEASURE -- MEASURE j: METER INSTALLATION --

(Unit: T.Shs.million)

PROGRAMME I

T.Shs. million

		GRAND TOTAL			TOTAL OF CAPITAL COST			TOTAL OF O & M COST			BUILDING 40 *			PIPE & FITTINGS 20 *			MACHINERY INSTALLED 10 *			MACHINERY MOBILE 5 *			MOTOR VEHICLE 5 *			EQUIPMENT & TOOLS 4 *			EXPERT			O & M LABOUR			O & M		
		F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL	F.C. T.SHS	L.C. T.SHS	TOTAL
1	1991	274	3	277	274	0	274	0	3	3	0	0	0	0	0	0	249	0	249	0	0	0	15	0	15	9	0	9	0	0	0	0.0	0.9	0.9	0.0	2.0	2.0
2	1992	249	3	252	249	0	249	0	3	3	0	0	0	0	0	0	249	0	249	0	0	0	1	0	1	0	0	0	0	0	0	0.0	0.9	0.9	0.0	2.0	2.0
3	1993	0	3	3	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.9	0.9	0.0	2.0	2.0
4	1994	0	3	3	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.9	0.9	0.0	2.0	2.0
5	1995	9	3	12	9	0	9	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	9	0	0	0	0.0	0.9	0.9	0.0	2.0	2.0
6	1996	15	3	18	15	0	15	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	15	0	15	0	0	0	0	0	0	0.0	0.9	0.9	0.0	2.0	2.0
7	1997	1	3	3	1	0	1	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0.0	0.9	0.9	0.0	2.0	2.0
8	1998	0	3	3	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.9	0.9	0.0	2.0	2.0
9	1999	9	3	12	9	0	9	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	9	0	0	0	0.0	0.9	0.9	0.0	2.0	2.0
10	2000	0	3	3	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.9	0.9	0.0	2.0	2.0
11	2001	264	3	267	264	0	264	0	3	3	0	0	0	0	0	0	249	0	249	0	0	0	15	0	15	0	0	0	0	0	0	0.0	0.9	0.9	0.0	2.0	2.0
12	2002	249	3	252	249	0	249	0	3	3	0	0	0	0	0	0	249	0	249	0	0	0	1	0	1	0	0	0	0	0	0	0.0	0.9	0.9	0.0	2.0	2.0
13	2003	9	3	12	9	0	9	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	9	0	0	0	0.0	0.9	0.9	0.0	2.0	2.0
14	2004	0	3	3	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.9	0.9	0.0	2.0	2.0
15	2005	0	3	3	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.9	0.9	0.0	2.0	2.0
16	2006	15	3	18	15	0	15	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	15	0	15	0	0	0	0	0	0	0.0	0.9	0.9	0.0	2.0	2.0
17	2007	10	3	13	10	0	10	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	9	0	9	0	0	0	0.0	0.9	0.9	0.0	2.0	2.0
18	2008	0	3	3	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.9	0.9	0.0	2.0	2.0
19	2009	0	3	3	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.9	0.9	0.0	2.0	2.0
20	2010	0	3	3	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.9	0.9	0.0	2.0	2.0
21	2011	274	3	277	274	0	274	0	3	3	0	0	0	0	0	0	249	0	249	0	0	0	15	0	15	9	0	9	0	0	0	0.0	0.9	0.9	0.0	2.0	2.0
22	2012	249	3	252	249	0	249	0	3	3	0	0	0	0	0	0	249	0	249	0	0	0	1	0	1	0	0	0	0	0	0	0.0	0.9	0.9	0.0	2.0	2.0
23	2013	0	3	3	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.9	0.9	0.0	2.0	2.0
24	2014	0	3	3	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.9	0.9	0.0	2.0	2.0
25	2015	9	3	12	9	0	9	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	9	0	0	0	0.0	0.9	0.9	0.0	2.0	2.0
Salvage cos		-281	0	-281	-281	0	-281	0	0	0	0	0	0	0	0	0	-274	0	-274	0	0	0	0	0	0	-7	0	-7	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL		1,358	73	1,431	1,358	0	1,358	0	73	73	0	0	0	0	0	0	1,219	0	1,219	0	0	0	80	0	80	59	0	59	0	0	0	0.0	22.5	22.5	0.0	50.0	50.0

*: Depreciation Period

TABLE D.6.1 (11) COST SCHEDULE BY MEASURE – MEASURE k: ARREARS AND ILLEGAL CONNECTION –

(Unit: T.Shs.million)

PROGRAMME k

	GRAND TOTAL			TOTAL OF CAPITAL COST			TOTAL OF O & M COST			BUILDING 40			PIPE & FITTINGS 20			MACHINERY INSTALLED 10			MACHINERY MOBILE 5			MOTOR VEHICLE 5			EQUIPMENT & TOOLS 4			EXPERT			O & M LABOUR			O & M		
	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL	F.C. T.SHS	LC. T.SHS	TOTAL
1 1991	2	24	26	2	0	2	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0.0	24.0	24.0	0.0	0.2	0.2
2 1992	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	24.0	24.0	0.0	0.2	0.2
3 1993	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	24.0	24.0	0.0	0.2	0.2
4 1994	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	24.0	24.0	0.0	0.2	0.2
5 1995	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	24.0	24.0	0.0	0.2	0.2
6 1996	2	24	26	2	0	2	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0.0	24.0	24.0	0.0	0.2	0.2
7 1997	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	24.0	24.0	0.0	0.2	0.2
8 1998	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	24.0	24.0	0.0	0.2	0.2
9 1999	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	24.0	24.0	0.0	0.2	0.2
10 2000	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	24.0	24.0	0.0	0.2	0.2
11 2001	2	24	26	2	0	2	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0.0	24.0	24.0	0.0	0.2	0.2
12 2002	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	24.0	24.0	0.0	0.2	0.2
13 2003	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	24.0	24.0	0.0	0.2	0.2
14 2004	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	24.0	24.0	0.0	0.2	0.2
15 2005	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	24.0	24.0	0.0	0.2	0.2
16 2006	2	24	26	2	0	2	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0.0	24.0	24.0	0.0	0.2	0.2
17 2007	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	24.0	24.0	0.0	0.2	0.2
18 2008	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	24.0	24.0	0.0	0.2	0.2
19 2009	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	24.0	24.0	0.0	0.2	0.2
20 2010	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	24.0	24.0	0.0	0.2	0.2
21 2011	2	24	26	2	0	2	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0.0	24.0	24.0	0.0	0.2	0.2
22 2012	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	24.0	24.0	0.0	0.2	0.2
23 2013	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	24.0	24.0	0.0	0.2	0.2
24 2014	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	24.0	24.0	0.0	0.2	0.2
25 2015	0	24	24	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	24.0	24.0	0.0	0.2	0.2
Salvage cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	10	605	615	10	0	10	0	605	605	0	0	0	0	0	0	0	0	0	0	0	0	10	0	10	0	0	0	0	0	0	0.0	600.0	600.0	0.0	5.0	5.0

*: Depreciation Period

6.2 DEPRECIATION

1. DEPRECIATION PERIOD

According to NUWA regulation, depreciation period is as follows:

-Land and Buildings	40 years
-Water supply pipe and fittings	20 years
-Electrical installations	20 years
-Plant and machinery installed	10 years
-Plant and machinery mobile	5 years
-Motor vehicles	5 years
-Computor hard ware	5 years
-Laboratory, workshop equipment and tools	4 years

2. DEPRECIATION SCHEDULE OF THE PROJECT

DEPRECIATION COSTS

DEPRECIATION PERIOD		TOTAL			BUILDING 40 YEARS			PIPE & FITTINGS 20 YEARS			MACHINERY INSTALLED 10 YEARS			MACHINERY MOBILE 5 YEARS			MOTOR VEHICLE 5 YEARS			EQUIPMENT & TOOLS 4 YEARS		
		F.C. T.SHS	LC T.SHS	TOTAL	F.C T.SHS	LC T.SHS	TOTAL	F.C T.SHS	LC T.SHS	TOTAL	F.C T.SHS	LC T.SHS	TOTAL	F.C T.SHS	LC T.SHS	TOTAL	F.C T.SHS	LC T.SHS	TOTAL	F.C T.SHS	LC T.SHS	TOTAL
1	1991	192	6	199	0	0	0	22	4	26	32	1	34	59	1	60	51	0	51	28	0	28
2	1992	265	14	279	0	0	0	66	12	77	61	1	62	59	1	60	51	0	51	28	0	28
3	1993	332	27	359	0	0	0	132	25	157	61	1	62	59	1	60	51	0	51	28	0	28
4	1994	350	42	392	0	0	0	151	40	191	61	1	62	59	1	60	51	0	51	28	0	28
5	1995	432	95	527	6	13	19	228	79	307	61	1	62	59	1	60	51	0	51	28	0	28
6	1996	432	95	527	6	13	19	228	79	307	61	1	62	59	1	60	51	0	51	28	0	28
7	1997	432	95	527	6	13	19	228	79	307	61	1	62	59	1	60	51	0	51	28	0	28
8	1998	432	95	527	6	13	19	228	79	307	61	1	62	59	1	60	51	0	51	28	0	28
9	1999	432	95	527	6	13	19	228	79	307	61	1	62	59	1	60	51	0	51	28	0	28
10	2000	432	95	527	6	13	19	228	79	307	61	1	62	59	1	60	51	0	51	28	0	28
11	2001	432	95	527	6	13	19	228	79	307	61	1	62	59	1	60	51	0	51	28	0	28
12	2002	432	95	527	6	13	19	228	79	307	61	1	62	59	1	60	51	0	51	28	0	28
13	2003	432	95	527	6	13	19	228	79	307	61	1	62	59	1	60	51	0	51	28	0	28
14	2004	432	95	527	6	13	19	228	79	307	61	1	62	59	1	60	51	0	51	28	0	28
15	2005	432	95	527	6	13	19	228	79	307	61	1	62	59	1	60	51	0	51	28	0	28
16	2006	432	95	527	6	13	19	228	79	307	61	1	62	59	1	60	51	0	51	28	0	28
17	2007	432	95	527	6	13	19	228	79	307	61	1	62	59	1	60	51	0	51	28	0	28
18	2008	432	95	527	6	13	19	228	79	307	61	1	62	59	1	60	51	0	51	28	0	28
19	2009	432	95	527	6	13	19	228	79	307	61	1	62	59	1	60	51	0	51	28	0	28
20	2010	432	95	527	6	13	19	228	79	307	61	1	62	59	1	60	51	0	51	28	0	28
21	2011	432	95	527	6	13	19	228	79	307	61	1	62	59	1	60	51	0	51	28	0	28
22	2012	432	95	527	6	13	19	228	79	307	61	1	62	59	1	60	51	0	51	28	0	28
23	2013	432	95	527	6	13	19	228	79	307	61	1	62	59	1	60	51	0	51	28	0	28
24	2014	432	95	527	6	13	19	228	79	307	61	1	62	59	1	60	51	0	51	28	0	28
25	2015	432	95	527	6	13	19	228	79	307	61	1	62	59	1	60	51	0	51	28	0	28
TOTAL		10,217	2,082	12,299	118	277	395	5,151	1,750	6,900	1,491	34	1,526	1,480	17	1,497	1,274	0	1,274	703	4	707

6.3 ASSESSMENT OF WITHOUT THE PROJECT AND WITH THE PROJECT

(1) DEMAND, SUPRRESSION FACTOR, CONSUMPTION, WATER CHARGES AND UNACCOUNTED FOR WATER
- WITHOUT THE PROJECT -

	199091	1991/2	1992/3	1993/4	1994/5	1995/6
DEMAND FOR CONSUMPTION(M3/DAY)						
Domestic	128,185	131,555	134,925	138,294	141,664	145,034
Industrial	4,612	4,785	4,959	5,132	5,306	5,479
Commercial	6,282	6,518	6,754	6,990	7,226	7,462
Institutional	5,355	5,557	5,758	5,960	6,161	6,363
Total	144,434	148,415	152,396	156,376	160,357	164,338
SUPPRESSION FACTOR	0.87	0.86	0.82	0.79	0.76	0.73
SUPPRESSED CONSUMPTION(M3/DAY)						
Domestic	111,584	112,665	110,774	108,894	107,024	105,163
Industrial	4,015	4,098	4,071	4,041	4,009	3,973
Commercial	5,468	5,582	5,545	5,504	5,459	5,411
Institutional	4,661	4,759	4,727	4,693	4,654	4,614
Total	125,729	127,104	125,118	123,132	121,146	119,160
WATER CHARGES/YEAR(T.Shs.million)						
Domestic	315	535	527	518	510	502
Industrial	435	739	727	716	704	693
Commercial	166	282	278	273	269	264
Institutional	107	182	179	176	173	170
Sub-total	1,023	1,737	1,710	1,683	1,656	1,629
UN-ACCOUNTED FOR WATER						
NUMBER OF ILLEGAL CONNECTIONS						
	63,000	63,000	63,000	63,000	63,000	63,000
UNCOLLECTED PER CENT OF TOTAL BILLINGS(BAD DEBTS)						
	30%	30%	30%	30%	30%	30%

(2) DEMAND, SUPRRESSION FACTOR AND CONSUMPTION
- WITH THE PROJECT -

	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
DEMAND FOR CONSUMPTION(M3/DAY)						
Domestic	128,185	129,443	130,753	132,034	133,291	134,518
Industrial	4,612	4,708	4,806	4,900	4,992	5,082
Commercial	6,282	6,413	6,545	6,674	6,799	6,921
Institutional	5,355	5,468	5,580	5,690	5,797	5,902
Total	144,434	146,032	147,684	149,298	150,879	152,423
SUPPRESSION FACTOR	0.87	0.90	0.93	0.96	0.99	1.00
SUPPRESSED CONSUMPTION(M3/DAY)						
Domestic	111,584	115,634	120,871	126,195	131,521	134,518
Industrial	4,015	4,369	4,566	4,768	4,969	5,082
Commercial	5,468	5,949	6,219	6,493	6,767	6,921
Institutional	4,661	5,073	5,303	5,537	5,771	5,902
Total	125,729	131,025	136,959	142,992	149,027	152,423

6.4 FINANCING PLANS

(1) GRANTS

Tentative financing plan subsidized by grants is formulated adopting the following assumptions:

- illegal connections and arrears is assumed to reduce half as the present level, in 1995.
- 70 % of foreign currency portion of capital cost during the period 1991 through 1995 hasbeen assumed to be subsidized by grant.

The required grant during the period 1991 through 1995 amounts to T.Shs.5,250 million, including inflation. The disbursement schedule is given in Table 1.

TABLE 1 GRANT DISBURSEMENT SCHEDULE

T.Shs.million

year	Capital cost in foreign currency	Grant
1991	1,665	1,165
1992	1,365	955
1993	1,635	1,144
1994	451	316
1995	2,385	1,670
Total	7,500	5,250

The FIRR of the Project is estimated at 25% as shown in Table 2 after subsidized by a form of grants, according to the conditions assumed above.

TABLE 2 CASH-FLOW OF THE PROPOSED PROJECT FINANCED BY GRANT

T.Shs. million

		BASIC CASE										
		CASH-INFLOW			CASH-OUTFLOW							NET CASH-FLOW
		INCREASED REVENUE	GRANTS (70%)	TOTAL INFLOW	CAPITAL COST			O & M COST			TOTAL OUTFLOW	
					F.C.	L.C.	SUB-TOTAL	F.C.	L.C.	SUB-TOTAL		
1	1991	115	1,110	1,225	1,585	96	1,681	0	74	74	1,755	-530
2	1992	354	866	1,220	1,238	156	1,393	0	74	74	1,467	-247
3	1993	578	988	1,566	1,412	266	1,678	0	74	74	1,752	-185
4	1994	788	260	1,048	371	298	669	0	74	74	743	305
5	1995	977	1,308	2,285	1,869	1,277	3,146	0	74	74	3,220	-935
6	1996	977		977	550	3	553	0	74	74	627	350
7	1997	977		977	1	0	1	0	74	74	74	903
8	1998	977		977	0	0	0	0	74	74	74	903
9	1999	977		977	113	1	113	0	74	74	187	790
10	2000	977		977	0	0	0	0	74	74	74	903
11	2001	977		977	872	17	889	0	74	74	963	14
12	2002	977		977	287	0	287	0	74	74	361	616
13	2003	977		977	113	1	113	0	74	74	187	790
14	2004	977		977	0	0	0	0	74	74	74	903
15	2005	977		977	0	0	0	0	74	74	74	903
16	2006	977		977	550	3	553	0	74	74	627	350
17	2007	977		977	113	1	114	0	74	74	187	790
18	2008	977		977	0	0	0	0	74	74	74	903
19	2009	977		977	0	0	0	0	74	74	74	903
20	2010	977		977	0	0	0	0	74	74	74	903
21	2011	977		977	1,428	96	1,524	0	74	74	1,597	-620
22	2012	977		977	1,159	156	1,314	0	74	74	1,388	-411
23	2013	977		977	1,333	266	1,599	0	74	74	1,673	-696
24	2014	977		977	371	298	669	0	74	74	743	234
25	2015	977		977	-2,832	-898	-3,729	0	147	147	-3,582	4,559
TOTAL		22,352	4,533	26,885	10,532	2,037	12,569	0	1,917	1,917	14,486	12,399
NPV(3%)				19,790							12,213	7,577
NPV(10%)				11,658							9,060	3,511
B/C(3%)												1.62
B/C(10%)												1.29
FIRR												25%

Note: Inflation is not included

(2) SOFT LOAN

It is required that illegal connections and arrears will be reduced to at least 70 % of the present level to evaluatethe Project financed by soft loan.

Tentative financing plan subsidized by soft loans is formulated adopting the following assumptions:

- Foreign currency portion of the capital costs during the period 1991 through 1995 has been assumed to be financed from soft loans and the conditions assumed to be that for multilateral loans as follows:

Interest rate	8 % per annum.
Grace period	5 years
Payment period for principal payment including grace period	20 years

Table 3 provides the long-term loan schedule, including the loan disbursement schedule, principal payment, loan balance of loan amount and interest payment. Inflation is taken into account to calculate the amount.

TABLE 3 LOAN SCHEDULE OF THE PROJECT

T.Shs. million

		LOAN DISBURSEMENT	PRINCIPAL REPAYMENT	BALANCE OF LOAN AMOUNT	INTEREST PAYMENT	TOTAL PAYMENT
1	1991	1,665		1,665		0
2	1992	1,365		3,029	133	133
3	1993	1,635		4,664	242	242
4	1994	451		5,115	373	373
5	1995	2,385		7,500	409	409
6	1996		111	7,389	600	711
7	1997		202	7,187	591	793
8	1998		311	6,876	575	886
9	1999		341	6,535	550	891
10	2000		500	6,035	523	1,023
11	2001		500	5,535	483	983
12	2002		500	5,035	443	943
13	2003		500	4,535	403	903
14	2004		500	4,035	363	863
15	2005		500	3,535	323	823
16	2006		500	3,035	283	783
17	2007		500	2,535	243	743
18	2008		500	2,035	203	703
19	2009		500	1,535	163	663
20	2010		500	1,035	123	623
21	2011		389	646	83	472
22	2012		298	348	52	350
23	2013		189	159	28	217
24	2014		159	0	13	172
25	2015		0	0	0	0
TOTAL		7,500	7,500		7,200	14,700
	FINANCING CONDITION					
			INTEREST RATE		8%	
			GRACE PERIOD		5 YEARS	
			REPAYMENT YEAR		20 YEARS INCLUDING GRACE PERIOD	

The cash-flow is shown in Table 4 by adopting a 70 % reduction of illegal connections and arrears.

TABLE 4 CASH-FLOW OF THE PROPOSED PROJECT FINANCED BY SOFT LOAN

T.Shs. million

		IMPROVEMENT 70%												
		CASH-INFLOW			CASH-OUTFLOW									NET CASH-FLOW
		INCREASED REVENUE	GRANTS 0%	TOTAL INFLOW	CAPITAL COST F.C.	L.C.	SUB-TOTAL	O & M COST F.C.	L.C.	SUB-TOTAL	LOAN(LONG-TERM) REPAY-MENT	INTEREST	TOTAL OUTFLOW	
1	1991	135	0	135	0	96	96	0	74	74	0	0	170	-35
2	1992	419	0	419	0	156	156	0	74	74	0	127	356	63
3	1993	696	0	696	0	266	266	0	74	74	0	226	566	130
4	1994	967	0	967	0	298	400	0	74	74	0	339	812	155
5	1995	1,220	0	1,220	0	1,277	1,277	0	74	74	0	368	1,719	-499
6	1996	1,220		1,220	550	3	553	0	74	74	106	518	1,251	-31
7	1997	1,220		1,220	1	0	1	0	74	74	188	510	772	448
8	1998	1,220		1,220	0	0	0	0	74	74	282	495	851	369
9	1999	1,220		1,220	113	1	113	0	74	74	307	472	966	254
10	2000	1,220		1,220	0	0	0	0	74	74	432	447	953	267
11	2001	1,220		1,220	872	17	889	0	74	74	432	413	1,807	-587
12	2002	1,220		1,220	287	0	287	0	74	74	432	378	1,171	49
13	2003	1,220		1,220	113	1	113	0	74	74	432	344	962	258
14	2004	1,220		1,220	0	0	0	0	74	74	432	309	815	405
15	2005	1,220		1,220	0	0	0	0	74	74	432	275	780	440
16	2006	1,220		1,220	550	3	553	0	74	74	432	240	1,299	-79
17	2007	1,220		1,220	113	1	114	0	74	74	432	206	825	395
18	2008	1,220		1,220	0	0	0	0	74	74	432	171	676	544
19	2009	1,220		1,220	0	0	0	0	74	74	432	137	642	578
20	2010	1,220		1,220	0	0	0	0	74	74	432	102	607	613
21	2011	1,220		1,220	1,428	96	1,524	0	74	74	326	67	1,991	-771
22	2012	1,220		1,220	1,159	156	1,314	0	74	74	243	41	1,673	-453
23	2013	1,220		1,220	1,333	266	1,599	0	74	74	149	22	1,844	-624
24	2014	1,220		1,220	371	298	669	0	74	74	125	10	877	343
25	2015	1,220		1,220	-2,832	-898	-3,729	0	74	74	0	0	-3,656	4,876
TOTAL		27,837	0	27,837	4,158	2,037	6,195	0	1,843	1,843	6,475	6,216	20,730	7,107
NPV(3%)				19,293									15,256	4,037
NPV(10%)				9,745									8,419	1,770
B/C(3%)														1.26
B/C(10%)														1.16

Note: Inflation is not included.

6.5 ESTIMATION OF BENEFITS

1. CONSUMERS' WILLINGNESS TO PAY

(1) SHARE OF WATER CONSUMPTION BY CONSUMER GROUP

	SUPPRESSED WATER CONSUMPTION M3/DAY(1)	%	%
LEGAL CONNECTION			
DOMESTIC	44,422	75%	36%
INDUSTRIAL	4,120	7%	3%
COMMERCIAL	5,697	10%	4%
INSTITUTIONAL	4,854	8%	4%
SUB-TOTAL	59,093	100%	(47%)
ILEGAL CONNECTION			
DOMESTIC	66,634		53%
SUB-TOTAL	66,634		
TOTAL	125,727		100%

NOTE: (1)REFER TO DEMAND ANALYSIS

(2) ESTIMATION OF CONSUMERS' WILLINGNESS TO PAY

	WATER CHARGE PER YEAR(1) T.SHS.MILLION	%	ESTIMATED WILLINESS TO PAY(2)	%	
LEGAL CONNECTION					
DOMESTIC	315	31%	529		
INDUSTRIAL	435	43%	731		
COMMERCIAL	166	16%	279		
INSTITUTIONAL	107	10%	180		
SUB-TOTAL	1,023	100%	1,719	68%	
ILEGAL CONNECTION					
DOMESTIC			794	32%	(3)
SUB-TOTAL					
TOTAL			2,512		

NOTE: (1)REFER TO NUWA BEDGET IN 1990/91 FISCAL YEAR
(2)68 % OF TARIFF INCREASE IS INCLUDED
(3)CALCULATED BASED ON LEGAL DOMESTIC CHARGE
T.SHS.529,000,000 X (66,634/44,422) = 793,511,909

ESTIMATED CONSUMERS' WILLINGNESS TO PAY/M3 : **T.SHS.54.8**
T.SHS.2,512,000,000/(125,727 M3 X 365 DAYS)= T.SHS.54.75

(3) INCREASE IN ANNUAL WATER CONSUMPTION(SUPRESSED) FROM FACILITY IMPROVEMENT PROGRAMMES

THOUSAND M3/YEAR

	1991	1992	1993	1994	1995
CASE 1	642	1,186	1,927	2,570	3,212
CASE 2	1,431	2,862	4,292	5,723	7,154
CASE 3	1,431	4,322	7,249	10,176	11,607
CASE 4	1,431	4,322	7,249	10,176	12,155
CASE 5	1,431	4,322	7,249	10,176	12,155
CASE 6	1,431	4,322	7,249	10,176	12,155

(4)ESTIMATED INCREASE OF CONSUMERS' WILLINGNESS TO PAY FROM FACILITY REHABILITATION PROJECT

T.SHS. MILLION/YEAR

	1991	1992	1993	1994	1995
CASE 1	35.2	65.0	105.6	140.8	176.0
CASE 2	78.4	156.8	235.2	313.6	392.0
CASE 3	78.4	236.8	397.2	557.6	636.1
CASE 4	78.4	236.8	397.2	557.6	666.1
CASE 5	78.4	236.8	397.2	557.6	666.1
CASE 6	78.4	236.8	397.2	557.6	666.1

2. INCREASED REVENUE FROM THE PROJECT

(1) REVENUE WITHOUT THE PROJECT

	1991	1992	1993	1994	1995
SUPPRESSED CONSUMPTION (THOUSAND M3/YEAR)					
Domestic	40,728	41,123	40,433	39,746	39,064	38,384
Industrial	1,465	1,496	1,486	1,475	1,463	1,450
Commercial	1,996	2,037	2,024	2,009	1,993	1,975
Institutional	1,701	1,737	1,725	1,713	1,699	1,684
Total	45,890	46,393	45,668	44,943	44,219	43,493
WATER CHARGES (T.Shs.million)					
Domestic	315	535	527	518	510	502
Industrial	435	739	727	716	704	693
Commercial	166	282	278	273	269	264
Institutional	107	182	179	176	173	170
TOTAL	1,023	1,737	1,710	1,683	1,656	1,629
REVENUE COLLECTED (T.Shs.million)					
		1,216	1,197	1,178	1,159	1,140

(2) REVENUE WITH THE FACILITY IMPROVEMENT

	1991	1992	1993	1994	1995
SUPPRESSED CONSUMPTION (THOUSAND M3/YEAR)					
Domestic	40,728	42,391	44,260	46,157	48,054	49,111
Industrial	1,465	1,542	1,627	1,713	1,800	1,855
Commercial	1,996	2,100	2,216	2,333	2,452	2,527
Institutional	1,701	1,791	1,888	1,989	2,090	2,155
Total	45,891	47,824	49,990	52,192	54,395	55,648
Increase of suppressed consumptio					
	0	1,431	4,322	7,249	10,176	12,155
WATER BILLINGS (T.Shs.million)/YEAR					
Domestic	315	551	576	602	627	642
Industrial	435	762	796	831	866	886
Commercial	166	291	304	317	331	338
Institutional	107	187	196	204	213	218
Sub-total	1,023	1,791	1,872	1,955	2,037	2,084
Increase of water billings from facility improvement					
	0	54	162	271	381	455
Increase of revenue collection from facility improvement (70%)					
		38	113	190	267	319

(3) REVENUE WITH THE PROJECT INCLUDING ADMINISTRATIVE IMPROVEMENT

T.Shs. million

IMPROVEMENT	50%					
	1990	1991	1992	1993	1994	1995
1.LEAKAGE CONTROL						
INCREASE OF BILLINGS		54	162	271	381	455
INCREASE IN COLLECTED REVENUE(70%)		**38**	**113**	**190**	**267**	**319**
2.ILLEGAL REDUCTION	63,000					
NUMBER OF REDUCTION IN ILLEGAL CONNECTION						
NUMBER OF REDUCTION/YEAR		3,500	7,000	7,000	7,000	7,000
ACCUMMILATED		3,500	10,500	17,500	24,500	31,500
INCREASE OF BILLINGS		28	86	148	214	278
INCREASE IN COLLECTED REVENUE(70%)		**19**	**60**	**104**	**150**	**195**
3.INCREASE OF COLLECTED REVENUE						
RESULT FROM IMPROVEMENT BILLING & COLLECTING SYSTEM						
% OF BAD DEBTS	30%	28%	25%	22%	18%	15%
1) EXISTING BILLINGS	1,023	1,737	1,710	1,683	1,656	1,629
INCREASED COLLECTION		29	86	140	193	244
2) INCREASED BILLINGS		82	248	419	595	733
INCREASED COLLECTION		1	12	35	69	110
INCREASE IN COLLECTED REVENUE		**30**	**98**	**175**	**263**	**354**
4.METERING		**27**	**82**	**109**	**109**	**109**
TOTAL INCREASE OF COLLECTED REVENUE		**115**	**354**	**578**	**788**	**977**

IMPROVEMENT	100%					
	1990	1991	1992	1993	1994	1995
1.LEAKAGE CONTROL						
INCREASE OF BILLINGS		54	162	271	381	455
INCREASE IN COLLECTED REVENUE(70%)		**38**	**113**	**190**	**267**	**319**
2.ILLEGAL REDUCTION	63,000					
NUMBER OF REDUCTION IN ILLEGAL CONNECTION						
NUMBER OF REDUCTION/YEAR		7,000	14,000	14,000	14,000	14,000
ACCUMMILATED		7,000	21,000	35,000	49,000	63,000
INCREASE OF BILLINGS		56	172	296	428	557
INCREASE IN COLLECTED REVENUE(70%)		**39**	**120**	**207**	**299**	**390**
3.INCREASE OF COLLECTED REVENUE						
RESULT FROM IMPROVEMENT BILLING & COLLECTING SYSTEM						
% OF BAD DEBTS	30%	27%	20%	13%	7%	0%
1) EXISTING BILLINGS	1,023	1,737	1,710	1,683	1,656	1,629
INCREASED COLLECTION		58	171	281	386	489
2) INCREASED BILLINGS		110	334	567	809	1,012
INCREASED COLLECTION		4	33	95	189	304
INCREASE IN COLLECTED REVENUE		**62**	**204**	**375**	**575**	**792**
4.METERING		**27**	**82**	**109**	**109**	**109**
TOTAL INCREASE OF COLLECTED REVENUE		**165**	**520**	**881**	**1,250**	**1,610**

IMPROVEMENT	90%					
	1990	1991	1992	1993	1994	1995
1.LEAKAGE CONTROL						
INCREASE OF BILLINGS		54	162	271	381	455
INCREASE IN COLLECTED REVENUE(70%)		38	113	190	267	319
2.ILLEGAL REDUCTION	63,000					
NUMBER OF REDUCTION IN ILLEGAL CONNECTION						
NUMBER OF REDUCTION/YEAR		6,300	12,600	12,600	12,600	12,600
ACCUMMILATED		6,300	18,900	31,500	44,100	56,700
INCREASE OF BILLINGS		50	155	267	385	501
INCREASE IN COLLECTED REVENUE(70%)		35	108	187	269	351
3.INCREASE OF COLLECTED REVENUE						
RESULT FROM IMPROVEMENT BILLING & COLLECTING SYSTEM						
% OF BAD DEBTS	30%	27%	21%	15%	9%	3%
1) EXISTING BILLINGS	1,023	1,737	1,710	1,683	1,656	1,629
INCREASED COLLECTION		52	154	252	348	440
2) INCREASED BILLINGS		104	317	538	766	956
INCREASED COLLECTION		3	29	81	161	258
INCREASE IN COLLECTED REVENUE		55	182	333	509	698
4.METERING		27	82	109	109	109
TOTAL INCREASE OF COLLECTED REVENUE		155	486	818	1,154	1,476

IMPROVEMENT	80%					
	1990	1991	1992	1993	1994	1995
1.LEAKAGE CONTROL						
INCREASE OF BILLINGS		54	162	271	381	455
INCREASE IN COLLECTED REVENUE(70%)		38	113	190	267	319
2.ILLEGAL REDUCTION	63,000					
NUMBER OF REDUCTION IN ILLEGAL CONNECTION						
NUMBER OF REDUCTION/YEAR		5,600	11,200	11,200	11,200	11,200
ACCUMMILATED		5,600	16,800	28,000	39,200	50,400
INCREASE OF BILLINGS		44	138	237	342	446
INCREASE IN COLLECTED REVENUE(70%)		31	96	166	240	312
3.INCREASE OF COLLECTED REVENUE						
RESULT FROM IMPROVEMENT BILLING & COLLECTING SYSTEM						
% OF BAD DEBTS	30%	27%	22%	17%	11%	6%
1) EXISTING BILLINGS	1,023	1,737	1,710	1,683	1,656	1,629
INCREASED COLLECTION		46	137	224	309	391
2) INCREASED BILLINGS		98	300	508	723	901
INCREASED COLLECTION		3	24	68	135	216
INCREASE IN COLLECTED REVENUE		49	161	292	444	607
4.METERING		27	82	109	109	109
TOTAL INCREASE OF COLLECTED REVENUE		145	453	757	1,059	1,346

IMPROVEMENT	70%					
	1990	1991	1992	1993	1994	1995
1.LEAKAGE CONTROL						
INCREASE OF BILLINGS		54	162	271	381	455
INCREASE IN COLLECTED REVENUE(70%)		**38**	**113**	**190**	**267**	**319**
2.ILLEGAL REDUCTION	63,000					
NUMBER OF REDUCTION IN ILLEGAL CONNECTION						
NUMBER OF REDUCTION/YEAR		4,900	9,800	9,800	9,800	9,800
ACCUMMILATED		4,900	14,700	24,500	34,300	44,100
INCREASE OF BILLINGS		39	120	207	299	390
INCREASE IN COLLECTED REVENUE(70%)		**27**	**84**	**145**	**210**	**273**
3.INCREASE OF COLLECTED REVENUE						
RESULT FROM IMPROVEMENT BILLING & COLLECTING SYSTEM						
% OF BAD DEBTS	30%	28%	23%	18%	14%	9%
1) EXISTING BILLINGS	1,023	1,737	1,710	1,683	1,656	1,629
INCREASED COLLECTION		41	120	196	270	342
2) INCREASED BILLINGS		93	282	478	680	845
INCREASED COLLECTION		2	20	56	111	177
INCREASE IN COLLECTED REVENUE		**43**	**139**	**252**	**382**	**520**
4.METERING		**27**	**82**	**109**	**109**	**109**
TOTAL INCREASE OF COLLECTED REVENUE		**135**	**419**	**696**	**967**	**1,220**

IMPROVEMENT	60%					
	1990	1991	1992	1993	1994	1995
1.LEAKAGE CONTROL						
INCREASE OF BILLINGS		54	162	271	381	455
INCREASE IN COLLECTED REVENUE(70%)		**38**	**113**	**190**	**267**	**319**
2.ILLEGAL REDUCTION	63,000					
NUMBER OF REDUCTION IN ILLEGAL CONNECTION						
NUMBER OF REDUCTION/YEAR		4,200	8,400	8,400	8,400	8,400
ACCUMMILATED		4,200	12,600	21,000	29,400	37,800
INCREASE OF BILLINGS		33	103	178	257	334
INCREASE IN COLLECTED REVENUE(70%)		**23**	**72**	**124**	**180**	**234**
3.INCREASE OF COLLECTED REVENUE						
RESULT FROM IMPROVEMENT BILLING & COLLECTING SYSTEM						
% OF BAD DEBTS	30%	28%	24%	20%	16%	12%
1) EXISTING BILLINGS	1,023	1,737	1,710	1,683	1,656	1,629
INCREASED COLLECTION		35	103	168	232	293
2) INCREASED BILLINGS		87	265	449	638	789
INCREASED COLLECTION		2	16	45	89	142
INCREASE IN COLLECTED REVENUE		**36**	**119**	**213**	**321**	**435**
4.METERING		**27**	**82**	**109**	**109**	**109**
TOTAL INCREASE OF COLLECTED REVENUE		**125**	**386**	**636**	**876**	**1,097**

IMPROVEMENT	40%					
	1990	1991	1992	1993	1994	1995
1.LEAKAGE CONTROL						
INCREASE OF BILLINGS		54	162	271	381	455
INCREASE IN COLLECTED REVENUE(70%)		**38**	**113**	**190**	**267**	**319**
2.ILLEGAL REDUCTION	63,000					
NUMBER OF REDUCTION IN ILLEGAL CONNECTION						
NUMBER OF REDUCTION/YEAR		2,800	5,600	5,600	5,600	5,600
ACCUMMILATED		2,800	8,400	14,000	19,600	25,200
INCREASE OF BILLINGS		22	69	118	171	223
INCREASE IN COLLECTED REVENUE(70%)		**16**	**48**	**83**	**120**	**156**
3.INCREASE OF COLLECTED REVENUE						
RESULT FROM IMPROVEMENT BILLING & COLLECTING SYSTEM						
% OF BAD DEBTS	30%	29%	26%	23%	21%	18%
1) EXISTING BILLINGS	1,023	1,737	1,710	1,683	1,656	1,629
INCREASED COLLECTION		23	68	112	155	195
2) INCREASED BILLINGS		76	231	389	552	678
INCREASED COLLECTION		1	9	26	52	81
INCREASE IN COLLECTED REVENUE		**24**	**78**	**138**	**206**	**277**
4.METERING		27	82	109	109	109
TOTAL INCREASE OF COLLECTED REVENUE		105	321	520	702	860

IMPROVEMENT	30%					
	1990	1991	1992	1993	1994	1995
1.LEAKAGE CONTROL						
INCREASE OF BILLINGS		54	162	271	381	455
INCREASE IN COLLECTED REVENUE(70%)		**38**	**113**	**190**	**267**	**319**
2.ILLEGAL REDUCTION	63,000					
NUMBER OF REDUCTION IN ILLEGAL CONNECTION						
NUMBER OF REDUCTION/YEAR		2,100	4,200	4,200	4,200	4,200
ACCUMMILATED		2,100	6,300	10,500	14,700	18,900
INCREASE OF BILLINGS		17	52	89	128	167
INCREASE IN COLLECTED REVENUE(70%)		**12**	**36**	**62**	**90**	**117**
3.INCREASE OF COLLECTED REVENUE						
RESULT FROM IMPROVEMENT BILLING & COLLECTING SYSTEM						
% OF BAD DEBTS	30%	29%	27%	25%	23%	21%
1) EXISTING BILLINGS	1,023	1,737	1,710	1,683	1,656	1,629
INCREASED COLLECTION		17	51	84	116	147
2) INCREASED BILLINGS		71	214	360	509	622
INCREASED COLLECTION		1	6	18	36	56
INCREASE IN COLLECTED REVENUE		**18**	**58**	**102**	**152**	**203**
4.METERING		27	82	109	109	109
TOTAL INCREASE OF COLLECTED REVENUE		95	289	463	617	747

IMPROVEMENT	20%					
	1990	1991	1992	1993	1994	1995
1.LEAKAGE CONTROL						
INCREASE OF BILLINGS		54	162	271	381	455
INCREASE IN COLLECTED REVENUE(70%)		**38**	**113**	**190**	**267**	**319**
2.ILLEGAL REDUCTION	63,000					
NUMBER OF REDUCTION IN ILLEGAL CONNECTION						
NUMBER OF REDUCTION/YEAR		1,400	2,800	2,800	2,800	2,800
ACCUMMILATED		1,400	4,200	7,000	9,800	12,600
INCREASE OF BILLINGS		11	34	59	86	111
INCREASE IN COLLECTED REVENUE(70%)		8	24	41	60	78
3.INCREASE OF COLLECTED REVENUE						
RESULT FROM IMPROVEMENT BILLING & COLLECTING SYSTEM						
% OF BAD DEBTS	30%	29%	28%	27%	25%	24%
1) EXISTING BILLINGS	1,023	1,737	1,710	1,683	1,656	1,629
INCREASED COLLECTION		12	34	56	77	98
2) INCREASED BILLINGS		65	196	330	467	566
INCREASED COLLECTION		0	4	11	22	34
INCREASE IN COLLECTED REVENUE		12	38	67	99	132
4.METERING		27	82	109	109	109
TOTAL INCREASE OF COLLECTED REVENUE		85	258	407	535	637

IMPROVEMENT	10%					
	1990	1991	1992	1993	1994	1995
1.LEAKAGE CONTROL						
INCREASE OF BILLINGS		54	162	271	381	455
INCREASE IN COLLECTED REVENUE(70%)		**38**	**113**	**190**	**267**	**319**
2.ILLEGAL REDUCTION	63,000					
NUMBER OF REDUCTION IN ILLEGAL CONNECTION						
NUMBER OF REDUCTION/YEAR		700	1,400	1,400	1,400	1,400
ACCUMMILATED		700	2,100	3,500	4,900	6,300
INCREASE OF BILLINGS		6	17	30	43	56
INCREASE IN COLLECTED REVENUE(70%)		**4**	**12**	**21**	**30**	**39**
3.INCREASE OF COLLECTED REVENUE						
RESULT FROM IMPROVEMENT BILLING & COLLECTING SYSTEM						
% OF BAD DEBTS	30%	30%	29%	28%	28%	27%
1) EXISTING BILLINGS	1,023	1,737	1,710	1,683	1,656	1,629
INCREASED COLLECTION		6	17	28	39	49
2) INCREASED BILLINGS		60	179	301	424	511
INCREASED COLLECTION		0	2	5	10	15
INCREASE IN COLLECTED REVENUE		**6**	**19**	**33**	**49**	**64**
4.METERING		27	82	109	109	109
TOTAL INCREASE OF COLLECTED REVENUE		75	226	352	454	531

IMPROVEMENT	0%					
	1990	1991	1992	1993	1994	1995
1.LEAKAGE CONTROL						
INCREASE OF BILLINGS		54	162	271	381	455
INCREASE IN COLLECTED REVENUE(70%)		**38**	**113**	**190**	**267**	**319**
2.ILLEGAL REDUCTION	63,000					
NUMBER OF REDUCTION IN ILLEGAL CONNECTION						
NUMBER OF REDUCTION/YEAR		0	0	0	0	0
ACCUMMILATED		0	0	0	0	0
INCREASE OF BILLINGS		0	0	0	0	0
INCREASE IN COLLECTED REVENUE(70%)		0	0	0	0	0
3.INCREASE OF COLLECTED REVENUE						
RESULT FROM IMPROVEMENT BILLING & COLLECTING SYSTEM						
% OF BAD DEBTS	30%	30%	30%	30%	30%	30%
1) EXISTING BILLINGS	1,023	1,737	1,710	1,683	1,656	1,629
INCREASED COLLECTION		0	0	0	0	0
2) INCREASED BILLINGS		54	162	271	381	455
INCREASED COLLECTION		0	0	0	0	0
INCREASE IN COLLECTED REVENUE		0	0	0	0	0
4.METERING		**27**	**82**	**109**	**109**	**109**
TOTAL INCREASE OF COLLECTED REVENUE		**65**	**195**	**299**	**376**	**428**

E.

APPENDIX TO CHAPTER 6

E. APPENDIX TO CHAPTER 6

1. OPERATION IMPROVEMENT OF MTONI SYSTEM *

The capacity of the Mtoni plant represents only 3% of the total current water supply to Dar-es-Salaam. Shortage of raw water during the dry-season, coupled with the poor condition of the facilities will go to making the contribution from the plant even less significant in the future.

The proposed policy would be to prolong this plant with as minimum rehabilitation work as possible until it is decided one and for all whether Mtoni will be continued further or abandoned. To this end, the following improvement in the plant operation is proposed.

a) Initiate water quality monitoring

Equipment brought by the Study team can be used.

- water sampling points: raw water at receiving well, settled water at outlet of clarifier, filtered water at outlet of filter, and chlorinated water at inlet of reservoir
- frequency : 3 times a day at least
- parameters to be measured: turbidity and pH at all points, residual chlorine at inlet of reservoir

b) Measure flowrates and dosing rates

- flow rate : can be estimated, for instance, at the conduit between the flocculation tank and the clarifier by measuring the flow velocity and water height, using a float, watch and staff.
- dosing rate : can be calculated from the concentration of the chemical solution and the flow rate of the solution. Concentration of the solution is calculated from the weight of chemical dissolved (number of bags x weight per bag) and volume of water (bottom area of chemical solution tank x water depth), when it is dissolved and made up. Flow rate can be measured by making the solution flow into a bottle whose volume is known (for example, soda bottle) at the dosing point and measuring the time necessary for filling the bottle up.

c) Carry out jar test

This is recommended to determine the optimum dosing rates against raw water turbidity by using the jar tester from the Lower Ruvu plant for periods of 1 to 2 weeks.

If the jar tester is not available, it can be tested in actual operation. In this case, dosing rate is changed by 10 mg/l every 4 hours (this interval is required due to retention within the plant) and turbidity and

---

* The contents of this section are summarized in sub-section (4), section 6.1.2 , Main Report.

pH of raw water and treated water are measured every one hour. The dosing rate which gives the lowest turbidity would be the optimum dosing rate for a specific raw water turbidity.

d) Monitor and control chemical dosing

Chemical flowrates should be measured and checked, at least once every 2 hours, by the method proposed in item b) above to confirm whether the determined rate is actually being fed. It is to be remembered that the dosing rate of chemicals are determined by the influent water flowrate, concentration of chemicals and flowrate of the chemical solution. Therefore, whenever there are changes in any of these three items, the flowrate of chemicals should accordingly be adjusted.

e) Log records

All measurements and unusual occurrences must be recorded in a log book and kept for ten years at the very minimum. This data will give valuable information for planning, design and for other purposes.

f) Purchasing chemicals for analysis

Unfortunately, the proposed water quality analysis measures will consume chemicals, small though it might be in quantity. The analytical kits prepared by the Study team only contain amounts necessary for the study and will soon be finished. Therefore, it is advisable to prepare procedures for purchasing as soon as possible to continue the proposed analysis.

2. CLEANING AND SCRAPING METHOD

2.1 CLEANING METHOD - REMOVAL OF 'LOOSE DEPOSITS'

- Flushing
- Swabbing
- Air scouring

2.1.1 FLUSHING

- use of hydrant or washout to generate scouring velocity in pipeline.

  Typical required velocities:

Diameter	Velocity	Flow
75mm	1.6 m/s	7 l/s
100	1.8	15
150	2.2	41
200	2.6	83

- difficult to achieve velocities in low pressure areas.

2.1.2 SWABBING

- cylindrical polyurethane foam swabs inserted into mains driven by water pressure.
- different grades of hardness available
- soft swabs for exploratory 'first pass' work to prove the pipeline (accepts 50% area reduction)
- hard swabs for encrustation (accepts 30% area reduction)
- small diameter mains ($\leq$150mm) can be swabbed with entry and exit through fire hydrants. Swab inserted either by hydrant removal or applied external pressure via a standpipe.
- swab velocities 0.3 - 1.2 m/s
- max swab run 400m

2.1.3 AIR SCOURING

- Technique to generate flushing velocities in mains in excess of those obtained by conventional flushing. Involves the continuous injection of filtered compressed air into the main with a small continuous water flow.
- Equipment:

	Size	Main diameter
Air compressor	38 l/s	75-100mm
	59 l/s	100-150mm
	118 l/s	150-200mm

Matched air cooling, filtration and control equipment, air hoses and standpipes.

- air to be breathing standard.
- max. practical scouring length 1,000m.
- well suited to urban applications.
- injection of air through fire hydrant, discharge also.

2.2 SCRAPING METHOD

- Usually used as preparation for relining with cement mortar
- will remove all tuberculation from inside of iron mains but will also remove any existing pipe lining
- three methods
  (i) Power Boring
  (ii) Drag Scraping
  (iii) Pressure Scraping

2.2.1 POWER BORING

- flexible steel rods driving cutting device - mechanically driven
- max length 150m (100m more usual)
- counter flow induced into service lines to prevent blockage and wash out debris
- can be used on pipes which are almost completely blocked
- leaves cleaner pipe and less blockages than drag scraping.

2.2.2 DRAG SCRAPING

- consists of a series of sprung steel serrated blades mounted in rows on a cylindrical chassis
- cylinder drawn repeatedly through pipe until all tuberculation removed using winches
- max length 150m (100m more usual)

2.2.3 PRESSURE SCRAPING

- Similar to drag scraper but driven through the main by water pressure
- requires insertion pieces and catcher box.

3. PLANNING CONSIDERATION OF AIR SCOURING *

3.1 AIR SCORING EQUIPMENT

(1) SPECIFICATION OF EQUIPMENT

A fast towing packaged unit including compressor, cooler and filtration, manufactured in accordance with the outline specification laid down by the Water Research Centre. Delivered air is to a standard in excess of BS 4275. Ease of operation and access for service are carefully considered.

(2) CAPACITY

The unit is capable of delivering 48 l/sec (2.88m^3/min) at 6 bar.

(3) Air Purity

Air delivered at the outlet must be to the following standard which is broadly in line with BS 4275 for breathing-air:-
Particle removal down to 0.01 micron.
Maximum remaining oil content 0.003 ppm.
The air must be free from all odour.
There should be no free water.

(4) Components

1) Diesel driven	- with 12v electrics and automatic shutdown protection against excessive.
2) Air-compressor	- compressor or engine temperature and low oil pressure; also fault identifi cation LED's, pressure gauge, digital hourmeter and power switch.
3) After cooler	- air-driven to reduce the temperature to within 5 Degrees Centigrade of ambient before filtration. Fitted with a variable speed regulator and conden sate drain.
4) Filtration/ Control unit	- this will consist of the following elements in the stated order:- (1) Pressure gauge showing pressure at filter inlet. (2) A filtration package of pre, coalescing and carbon filters. (3) Ball valve.

---

* The contents of this section are summarized in section 6.5.1 "air scouring", Main Report.

(4) Pressure regulator and gauge.
(5) Ball valve.
(6) Non return valve.
(7) Pressure gauge.
(8) Bleed valve.

5) Hoses - five metres of I 1/2" ID non-toxic, food quality hose to be supplied with a Hydrant quick release coupling with two retaining clips and housed in separate stowage compartments.

6) Chassis - single axle with braking and lights to full EEC road-going regulations.

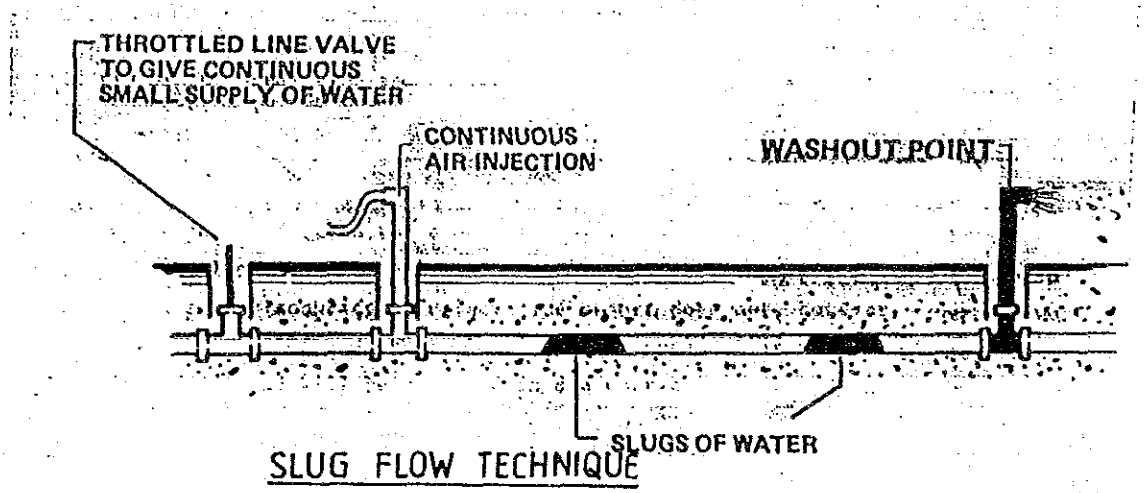
3.2 COMBINATION OF EQUIPMENT

(1) ARRANGEMENT OF EQUIPMENT FOR AIR SCOURING

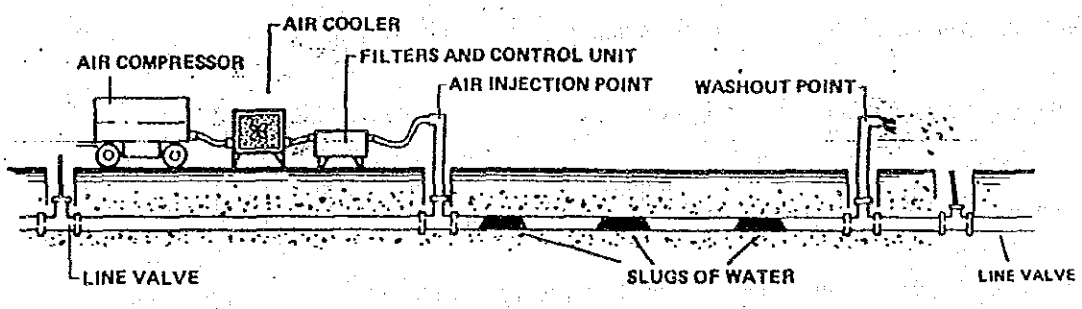
Combination of PIPE SCOURING UNIT are following:-

- Air Compressor or (125 or 250 cfm)
- Cooler and Filtration Unit
- Adaptor
- Spare Parts:
  * Pre-filter repair kit
  * Coalescing and carbon element kit
  * Auto-drain kit for filter
  * regulator repair kit
  * Inlet hose c/w coupling 5m
  * Air motor repair kit
- Spares common to both Units:
  Gauge 0-160 back entry I/N" BSP (2")
  Gauge 0-160 bottom entry 3/4" BSP (4")
  Factair coutlet hose c/w couplings 5m
  Element in after-cooler separator
  Lubricator repair kit
  Lubricator gasket kit
  Filter/regulator gasket kit
  Filter/regulator repair kit

Figure E.3.1 shows slug flow technique and arrangement of equipment.



SLUG FLOW TECHNIQUE



ARRANGEMENT OF EQUIPMENT

FIG. E.3.1	SLUG FLOW TECHNIQUE AND ARRANGEMENT OF EQUIPMENT

THE STUDY ON REHABILITATION OF DAR ES SALAAM WATER SUPPLY

(2) MINIMUM REQUIRED VELOCITY AND FLOW

The technique of air scouring involves the injection of filtered, compressed air into a water main to generate an increased water velocity which is greater than the minimum velocity required to suspend particulate matter of specific gravity 2.7 (a typical value for deposits). These minimum velocities and flow are shown in Table E.3.1.

TABLE E.3.1 VELOCITY AND FLOW REQUIRED

PIPE DIAMETER (mm)	VELOCITY REQUIRED (m/s)	FLOW REQUIRED (m^3/min)
75	1.60	0.43
100	1.80	0.90
150	2.20	2.46

SOURCE: Technical Report, TRI 79, WATER RESEARCH CENTRE.

3.3 PLANNING AN AIR SCOURING

(1) PREPARATION

Air scouring needs careful planning to prevent problems such as:-

(a) air or dirty water entering other parts of the distribution system;

(b) valves, hydrants, or wash-outs not operating correctly or not being positioned according to the distribution maps;

(c) consumers complaining of the operation.

Whenever possible air scouring should be done in a systematic way to ensure that a pipe being cleaned draws water from previously cleaned pipes.

Firstly the distribution network should be checked to determine the accuracy of the plans.

The lengths to be cleaned at any one time should be determined and injection and discharge points decided upon. Any valves or hydrants needed during the air scouring exercise should be inspected to ensure their correct operation and any found to be faulty repaired or replaced.

If a hydrant is used as an injection point it must be of the fixed jumped type. If direct injection is used, a 25 mm tapping on the main would suffice for the injection point for 38 l/s compressor, 37 mm for 59 l/s compressor and 50 mm for a 118 l/s compressor.

The injection point could be a:-

(a) direct tapping;
(b) modified swab insertion point;
(c) tapping on a blank flange on a 'T' or wash-out.

Consumers should be informed in advance of the cleaning exercise, preferably by letter or card. Generally a two-stage warning is used. The first would be a letter or card giving general background details of the work. This warning would go out one to two weeks before the cleaning is to take place. A second warning should be sent to the consumers shortly before cleaning takes place, indicating when not to draw water.

The alternative to warning the consumers not to draw water is to close all the stop cocks. However, as very few problems have occurred when adopting the warning procedure the additional effort and expense of closing stop cocks does not seem necessary.

Care should be taken to ensure that dirty water cleaned out of the main is not carried further into the distribution network. Closing a line valve downstream of the injection point should ensure that the dirty water is discharged from the hydrant.

Air scouring is normally done during the day as manning is generally cheaper and the problem of disturbance caused by the compressors can be minimised. The advantage of air scouring at night, however, is that consumers are less likely to accidentally draw water. Some water undertakings prefer to take advantage of this fact and minimise disturbance by using well-silenced compressors.

A schedule of valve operations for a complex area is often useful to ensure the smooth running of the operation.

(2) CHOICE OF LENGTH OF MAIN TO BE AIR SCOURED

The length of main which can be effectively air scoured depends on four factors:-

a) Static water mains pressure - at the start of the air scouring exercise the injected air pressure is set 0.5 bars below the measured mains static pressure. This should prevent the pressure in the main

rising above the static pressure and prevent air travelling backwards along the main. The length of main which can be air scoured increases with increasing static pressure.

b) Friction - the air injection pressure required to produce slug flow of sufficient velocity will increase according to the headloss developed along the pipe. Therefore with a maximum available pressure the length of main which can be effectively cleaned decreases with increasing friction in the pipe.

c) Compressor size - increasing the compressor size will generate higher slug velocities in a particular main. The higher velocities would, however, generate a greater headloss.

d) Pipe gradient - to set up slug flow downhill requires more water entering the length being cleaned than when setting up slug flow along a horizontal pipe or a pipe running uphill. The extra water causes an increase in headloss and therefore with a limited available water pressure the length of main which can be successfully air scoured downhill is less than uphill.

The aim in planning any air scouring exercise is to arrange for each single length to be as long as practicable. It is possible to determine this length knowing the available static pressure (daytime static pressure if the exercise is carried out during they day), estimating the friction factor (Hazen-Williams C values are used in the charts) and using the charts described below. The maximum length is normally about 1000 m. Any change at the inlet, such as an alteration in the line valve to increase or decrease the amount of water entering the main, may take up to 5 minutes to reach the discharge hydrant 1000 m away and achieve steady conditions. Longer lengths can be air scoured but will require longer than 5 minutes before achieving steady conditions.

As the length which can be air scoured successfully are much shorter if the main runs downhill every effort should be made to air scour uphill. On many systems, particularly in urban areas, this is possible by careful valve control. In rural areas it may not be possible to alter the direction of flow and subsequently the length air scoured may have to be reduced when the main runs downhill.

3.4 PERFORMING AN AIR SCOURING

(1) PROCEDURE

Having set up the equipment, an air scouring exercise can then be divided into four main steps:

(a) Measuring the static pressure and setting the pressure regulator to below the static pressure.
(b) Driving all of the water out of the main.
(c) Setting up slug flow.

(d) Dismantling the equipment after the main has been cleaned.

(2) SITE PREPARATION

(a) Sterilize the injection hydrant.
(b) Set up the compressor, cooler and filter at the injection hydrant but leave the hydrant shut.
(c) Close the line valve beyond the discharge point.
(d) Set up and wedge the discharge hydrant but leave the hydrant shut.
(e) Close the valve and open valve on the control unit, and open the injection hydrant.
(f) Start the compressor and allow it to reach normal operating conditions.
(g) Alter the valves in the distribution system to ensure one-way flow along the main being cleaned. Ensure that there is no flow beyond the hydrant being cleaned.
(h) Measure the pressure on gauge and set the pressure by adjusting valve to 0.5 bars below the pressure on gauge.

(3) CONTROLLING AIR INJECTION

(a) Close the upstream line valve.
(b) Open the discharge hydrant.
(c) Open valve on control unit to start air injection.
(d) On mild/warm days the air cooler regulator can be set to about 3 bars to ensure efficient cooling of the air. On hot days a higher setting of about 4 bars may be required. On cold days the cooler regulator should be shut at first to allow the cooler to warm up slightly to prevent any icing up. As soon as the discharge pipe feels slightly warm the cooler fan should be started and the regulator set at about 2 bars.
(e) As air is being injected the compressor will speed up. The compressor should run at full speed during air scouring. As the water is being pushed out of the downstream hydrant the pressure on gauges will fall.
(f) As the pressure falls on adjust valve to maintain the pressure to about 6 bars and ensure the compressor is running at full speed.
(g) Once all of the water has been ejected from the main, which can take up to 20 minutes depending on the length of main and the size of compressor, the pressure will have fallen to about 2 bars or less.
(h) 'Crack open' (and leave open) the line valve to allow a small amount of water into the main. Pressure will rise slightly on gauge.
(i) As water enters the main, valve may have to be opened to prevent the compressor slowing down or cutting out. (NB the compressor should be running at full speed during air scouring.) However, under no circumstances should the pressure on G3 exceed 0.5 bars below the mains static pressure,

i.e. the pressure measured during the setting up of the equipment.

(j) Slug flow should then be seen at the discharge hydrant. When this is the case the hydrant will run full for a few seconds and then 'splutter'.

(k) If the hydrant is 'spluttering' all the time and not occasionally running full then the line valve should be opened a small amount more (about 1/4 turn).

(l) Allow sufficient time between valve adjustments for the system to stabilise. Up to 5 minutes may be required for 1000 mm of main.

(m) This process (h to l) should continue until slug flow has been set up.

(n) When slug flow is set up at the hydrant it can be checked that it is also occurring further back along the main by listening on intermediate valves or hydrants. This is particularly important when air scouring downhill, as the discharge from the hydrant may resemble slug flow, whereas slug flow has not been set up along the main. The sound to listen for is exactly like waves beating on a sea shore.

(o) When the water at the discharge hydrants runs clear the air can be shut off by closing valve on the control unit. The main should then be recharged slowly to prevent major disturbances upstream of the air scour site.

(4) DISMANTLING THE EQUIPMENT

(a) Close the injection hydrant.

(b) Close the air cocks on the compressor.

(c) Open the relief valve on the injection stand pipe (or on the filter control unit if fitted).

(d) When the pressure has been released disconnect the hoses.

(5) PRECAUTIONS

It is impossible to foresee all the dangers and therefore the necessary precautions which should be taken when air scouring. However, the following includes some precautions worthy of note.

(a) Air scouring equipment operates at 7 bars and all safety precautions associated with operating compressed air equipment should be observed. In particular, care should be taken to release all the pressure in the pipelines before disconnecting the equipment.

(b) When air scouring is being used the hydrant discharge and its debris can be thrown some considerable distance. One water undertaking has constructed a large hydrant bag approximately 1 m diameter by 2 m long. The bag was held in shape by plastic netting with further plastic netting in the centre to break the flow. This was successful at keeping the discharge under control.

(c) Unless the injection hydrant bowl is sterilized there is a danger of pushing contaminated water into the main.

(d) Unless the discharge hydrant stand-pipe is tightly wedged there is a danger of the stand-pipe working loose and plumes of dirty water going into the air. An unwedged stand-pipe may cause damage to the hydrant.

(e) If hydrant bags are used to collect deposits from the main during air scouring, care should be taken to ensure that they do not block with sediment, as the bags may subsequently burst.

The following describe the preparatory work to be done in planning air scouring.

Since air scouring method needs careful planning to carry out the cleaning, firstly, the existing distribution network should be checked and confirmed to determine the accuracy of the plans. The length to be cleaned at any one time should be determined and injection and discharge points decided upon. Any valves or hydrants needed during the air scouring exercise should be inspected to ensure their correct operation and any found to be faulty repaired or replaced.

In order to plan small waste districts which can be isolated by sluice valves, proposed sluice valve shall be installed to network system. Sluice valve and fire hydrants installation are two basic conditions to make the required span which can be isolated with appropriate length. Since new sluice valve have been proposed to install to the network system in order to make waste district, most suitable number of sluice valves can be expected for the entire city. It is also recommended the fire hydrants have been installed at every 500 meter just close to the sluice valve.

4. EFFECT OF METER INSTALLATION ON WATER CONSERVATION

4.1 PURPOSE

The purpose of this study was to assess how much water would be conserved if a metered water tariff system was to be introduced.

4.2 SECTIONS INVESTIGATED

The following five pipe sections (refer to Figure E.4.1) were selected for study :
- Kariakoo (location: refer to Figure E.4.2)
- Magomeni (location: refer to Figure E.4.3)
- Kinondoni (location: refer to Figure E.4.4)
- Ilala (location: refer to Figure E.4.5)
- Sinza (location: refer to Figure E.4.6)

4.3 PROCEDURE

1) Select a section of distribution pipe which contains approximately 20 branched service pipes.
2) Confirm water availability in all the service pipes.
3) Install two flow meters, one at the inlet and another at the at the outlet of the distribution pipe section.
4) Measure inlet and outlet flows over 2 or 3, 24 hour periods.
5) Install 20 meters and, inform inhabitants that water will be charged according to the metered consumption.
6) Measure inlet, outlet flow and flow through the 20 meters.

During the measurements, use of "Portaflow" (flowmeter) was abandoned for inflow and outflow. Instead, consumer meters were used; "Portaflow" meters were initially used to measure inflow to and outflow from the designated pipe section. However, the measured flows did not appear to be reliable. For example, outflow was almost equal to inflow and, in some case, outflow was larger than inflow. To adjust measured flows to actual flows, effective sectional areas were measured by the use of the scale checker. Then, actual flows were estimated by multiplying the effective sectional areas with the measured velocities ("portaflow" measures velocity and, and this is done by assuming that there is no encrustation inside the pipe).

But even with this adjustment, reliable flow measurements were not forthcoming. This was due to the low velocity in Dar-es- Salaam water pipes (refer to Table C.4.17, Appendix C). Low velocity gives

"Portaflow" a large inherent inaccuracy, considering the small difference between inflow and outflow flow. The difference with some 20 service connections is, at most, approximately 40 m^3 per day or 0.46 liters per second (20 connections X 10 persons/connection X 100 liters per person per day / 50% leakage = 40 m^3 per day). Therefore, use of "Portaflow" was abandoned after measurement in two pipe sections. Instead, consumer meters were also used for measuring inflow and outflow. In order to not suppress water demand arising from high frictional loss in the small by-pass inflow pipe due to large flow through it, the outflow valve was closed, if necessary.

4.4 EQUIPMENT USED

- "Portaflow" flow meter
- scale checker
- consumer meter

4.5 RESULT

The results in Kariakoo, Magomeni and Kinondoni model areas are shown in Tables E.4.1 to 4.1.3.

TABLE E.4.1 EFFECT ON METER INSTALLATION IN KARIAKOO MODEL AREA

(Unit:m^3/day)

	First day	Second day	Third day	Average	Remarks
(1)Inflow without meter	-	-	-	-	
(2)Inflow with meter	20.6	18.4	22.4	20.5	
(3)Total metered consumption	20.2	18.1	21.7	20.0	refer to Table A.2.8
(4)Leakage (%)	---	---	---	2.4%	((2)-(3))/(2)
(5)Consumption without meter				-	(1)*((100-(4))%
(6)Conserved ratio				-	((5)-(3))/(5)

TABLE E.4.2 EFFECT ON METER INSTALLATION IN MAGOMENI MODEL AREA

(Unit:m^3/day)

	First day	Second day	Average	Remarks
(1)Inflow without meter	25.8	27.9	26.9	
(2)Inflow with meter	26.5	27.7	27.1	
(3)Total metered consumption	24.9	26.0	25.5	refer to Table A.2.10
(4)Leakage (%)	---	---	6.0%	((2)-(3))/(2)
(5)Consumption without meter			25.3	(1)*((100-(4))%
(6)Conserved ratio			-0.8%	((5)-(3))/(5)

TABLE E.4.3 EFFECT ON METER INSTALLATION IN KINONDONI MODEL AREA

(Unit:m^3/day)

	First day	Second day	Average	Remarks
(1)Inflow without meter	56.7	57.2	57.0	
(2)Inflow with meter	54.5	54.5	54.5	
(3)Total metered consumption	45.3	45.2	45.2	refer to Table A.2.11
(4)Leakage (%)	----	----	17.0%	((2)-(3))/(2)
(5)Consumption without meter			47.3	(1)*((100-(4))%
(6)Conserved ratio			-4.4%	((5)-(3))/(5)

4.6 ANALYSIS

It appears that meter installation has little effect on the water consumption and there is very little decrease in the consumed volume, despite installation of water meters. At Magomeni, the decrease in consumption was 0.8 %, while at Kinondoni, it was 4.4%. Those in Ilala and Sinza showed similar effect to those in the former three areas; no effect on water conservation.

The reason why Kinondoni shows greater reduction than Magomeni has to do with the relative affluence, and consequently, the relative water use patterns, of the surveyed population in Kinondoni as compared with Magomeni. The absolute per capita water consumption in Kinondoni is much greater than in Magomeni. Therefore, there is greater latitude available to residents of Kinondoni to reduce wasteful expenditure of water, while at Magomeni, due to the already restrained use of water, there appears to be very little scope for further reduction.

From this, it appears that installation of meters will be effective in conserving water in the more affluent areas, where water consumption is already high. On the other hand, in areas where the living standards are low, and where water usage is already low, further reduction from water meter installation will not be achieved.

4.7 REMEASUREMENT

The above results were a surprise. Water consumption is usually sensitive to the water charge to some extent. Consumption of water goes down somewhat when water charge goes up. The degree of decrease depends upon price elasticity in each household. The unexpected result may have resulted from improper measurements, caused by insufficient time periods allocated to each measurement.

The above measurement took longest periods among all measurements we did between the scheduled July first and early September in 1990. The procedure used is firstly to measure the inflow to and out-flow from the model area using e bulk meters installed. Following this, consumer meters were installed within the designated pipe sections, which took one or two days. Simultaneously, each consumer was informed that, from then on, water would be charged based on the actual metered volume instead of the previously used assessed volume. After meter installation and notice to consumers, measurement of the bulk flow meter and consumer meters were done again.

Since at least two days were assigned for meter readings before and after consumer meters installations, it took a total of one week for the entire measurement for one model area. The two day period assigned were the maximum that could be allocated. Before measurement utilizing the consumer meters with new pipes as bulk inflow meter could be started, the following had to be done

1) using "portaflow" flow meter (which was later found to be ineffective in measuring small flows) as bulk inflow meter,
2) locating flanges, welding machines etc. and assembling "bulk flow meters" and
3) trial measurement to ascertain whether the assembled devices would produce effective data or not.

Therefore, since only a few days notice, at the most, was given to consumers, it is possible that most consumers had still not got accustomed to the idea that there were water meters that would determine their water bills and hence inadvertently continued their old water use patterns.

Re-measurement started from October 11, 1990. The per capita consumption before (without) meter installation are considered well as effective. Based on the data in each connection, the measured amount have firstly been invoiced with NUWA's official invoice form. On that day, consumers were informed of change of charge system from assessed value to measured value. At the same time meters were read as an initial value after (with) meter installation. Meters were read thrice each in November and December, 1990 and January, 1991 (refer to Table E.4.4 and Figure E.4.7). About 10% reduction is seen in "high" house connection while no change is observed in other connections.

TABLE E.4.4 FLUCTUATION OF CONSUMPTION BY METER INSTALLATION

Description	BEFORE Sept.	AFTER METER INSTALLATION Oct.	Nov.	Dec.	Jan.	Remarks
Total Consumption (m^3/day)						(No. of) (House)
House(High)	21.6	19.8	18.3	18.0	19.0	9
House(Middle)	23.5	24.4	24.5	23.0	21.2	21
House(Low)	33.4	33.5	34.5	35.1	34.5	23
Yard	71.9	72.9	75.4	77.1	74.2	62
Total	150.4	150.5	152.7	153.3	149.0	115
Consumption(m^3/month/connection)						
House(High)	73.1	66.8	61.9	60.7	64.2	
House(Middle)	34.0	35.3	35.4	33.4	30.7	
House(Low)	44.1	44.2	45.6	46.5	45.6	
Yard	35.3	35.7	37.0	37.8	36.4	
Total	39.8	39.8	40.4	40.5	39.4	
Ratio of Consumption based on without Meter installation						
House(High)	1.000	0.914	0.846	0.830	0.879	
House(Middle)	1.000	1.037	1.041	0.981	0.903	
House(Low)	1.000	1.002	1.033	1.052	1.033	
Yard	1.000	1.013	1.048	1.072	1.032	
Total	1.000	1.000	1.015	1.019	0.990	
Tariff(T.Shs./month/connection) (Tariff)						(Current) (Average)
House(High)	921	841	780	765	809	450
House(Middle)	428	445	446	421	387	298
House(Low)	555	557	574	586	574	408
Yard	445	450	466	476	458	407
Total	501	501	509	510	496	391

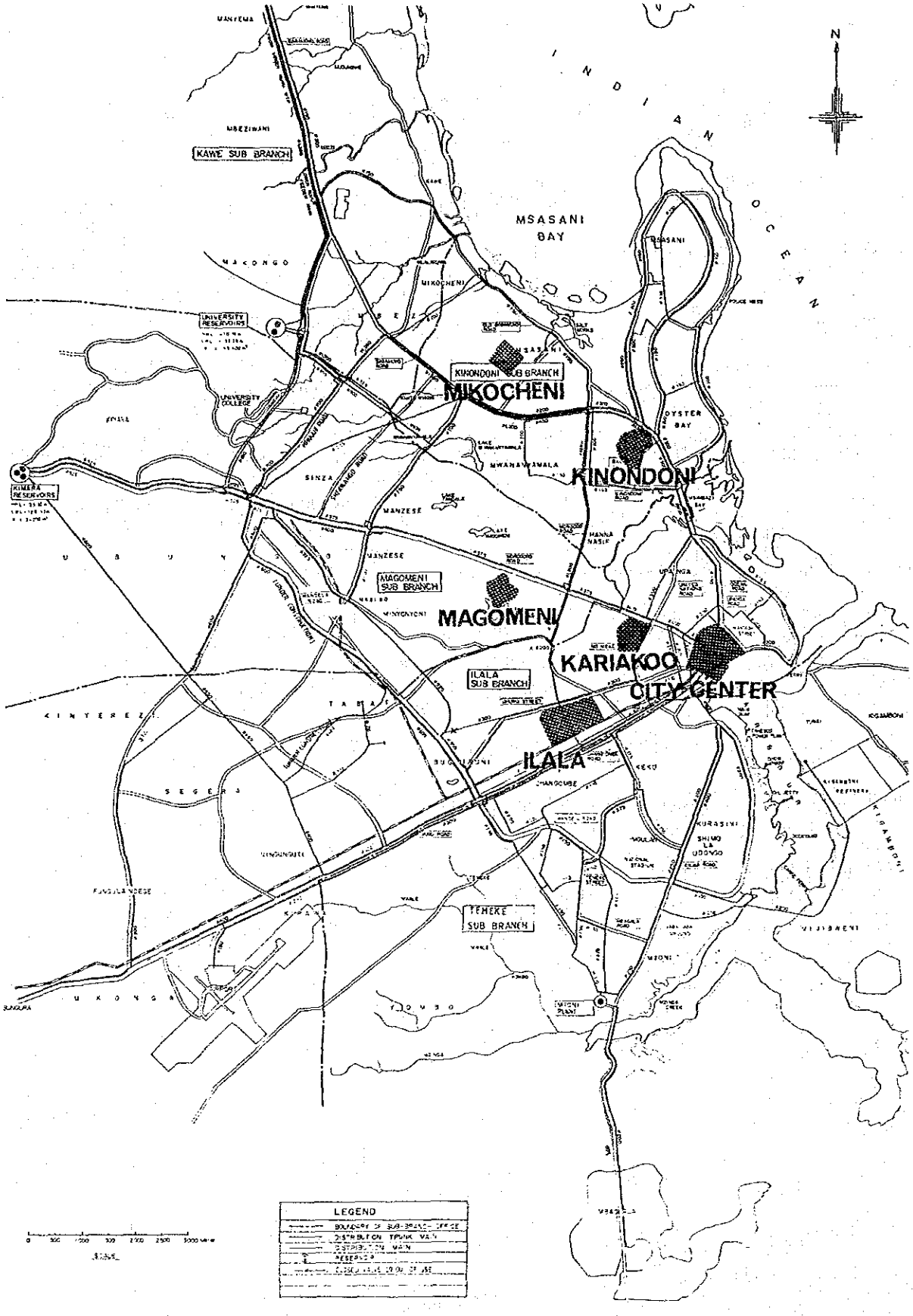


FIG. E.4.1 LOCATION OF EFFECT OF METER INSTALLATION ON WATER CONSERVATION

THE STUDY ON REHABILITATION OF DAR ES SALAAM WATER SUPPLY

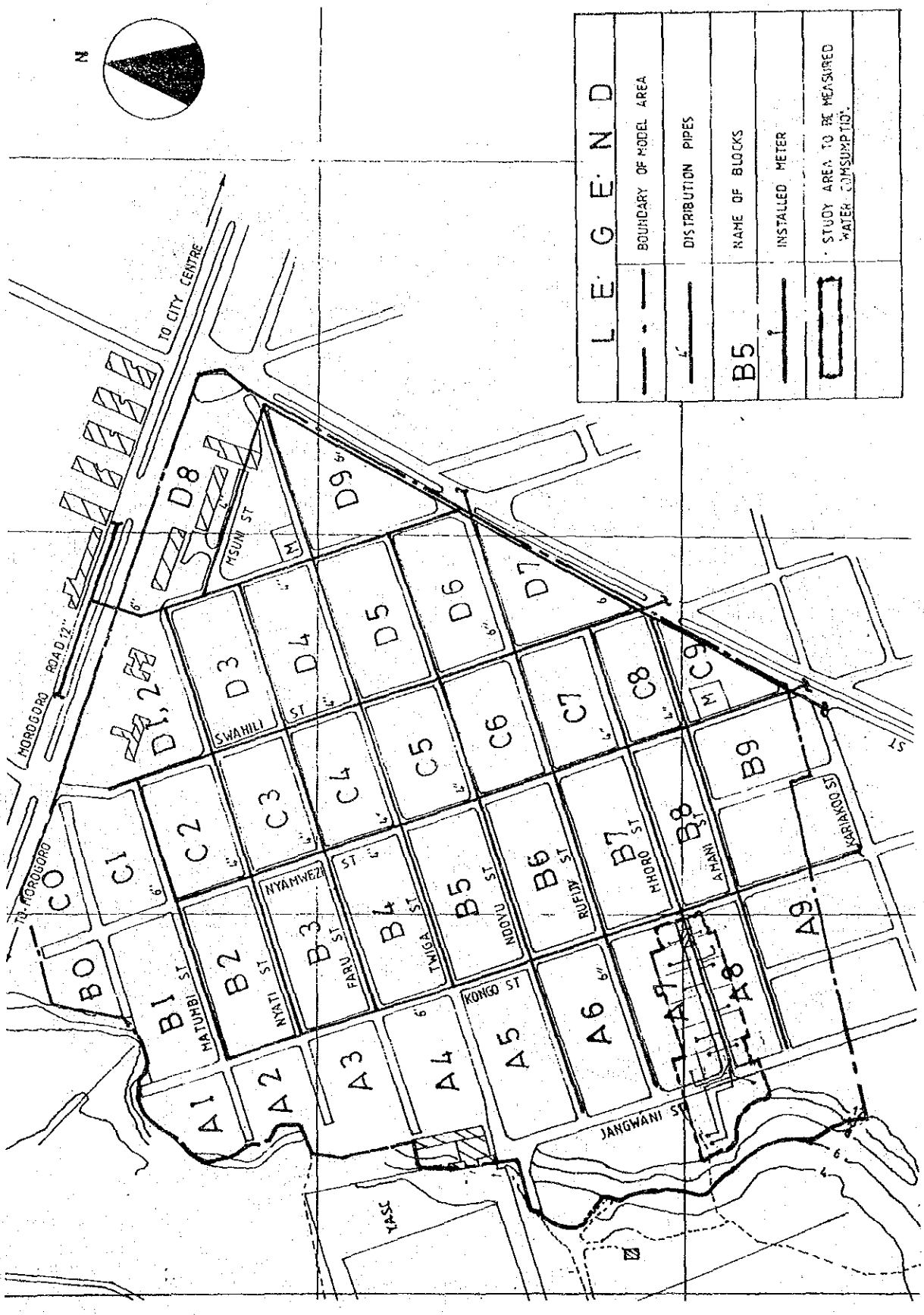


FIG. E.4.2 LOCATION OF MEASUREMENT OF LEAKAGE, KARIAKOO MODEL AREA

THE STUDY ON REHABILITATION OF DAR ES SALAAM WATER SUPPLY

FIG. E.4.3 LOCATION OF MEASUREMENT OF LEAKAGE, MAGOMENI MODEL AREA

THE STUDY ON REHABILITATION OF DAR ES SALAAM WATER SUPPLY

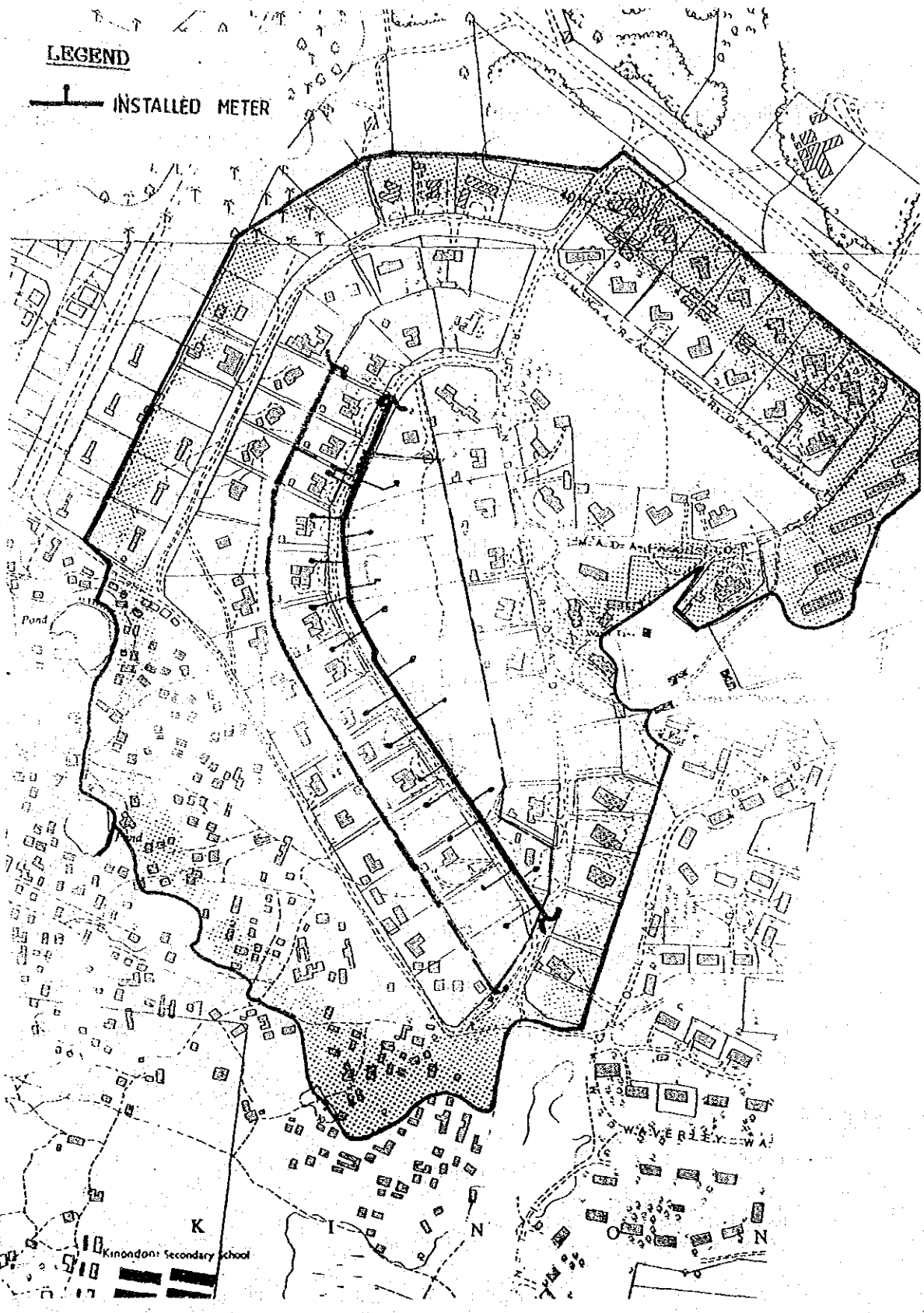


FIG. E.4.4 LOCATION OF MEASUREMENT OF LEAKAGE, KINONDONI MODEL AREA

THE STUDY ON REHABILITATION OF DAR ES SALAAM WATER SUPPLY

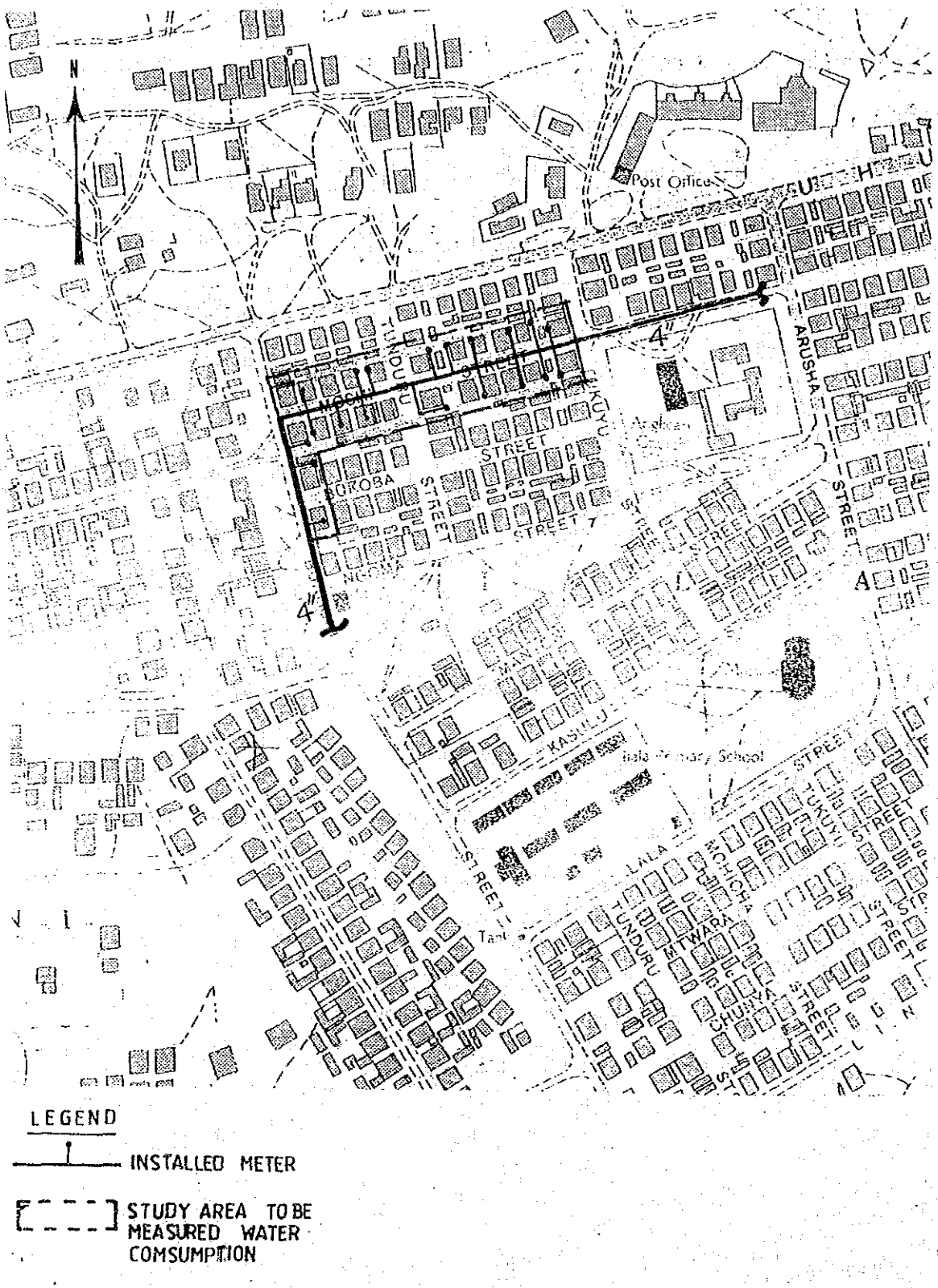


FIG. E.4.5	LOCATION OF MEASUREMENT OF LEAKAGE, ILALA AREA

THE STUDY ON REHABILITATION OF DAR ES SALAAM WATER SUPPLY

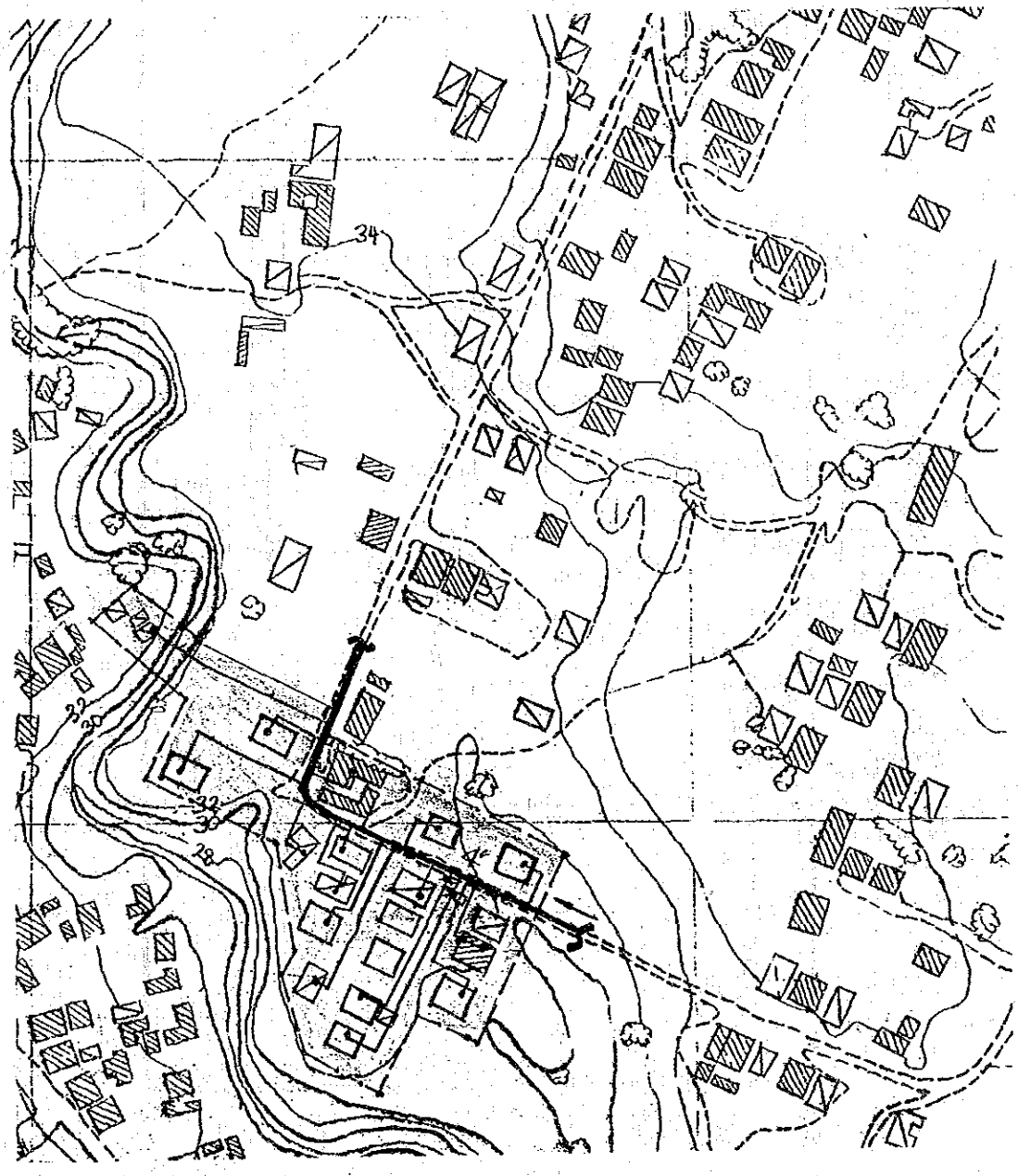
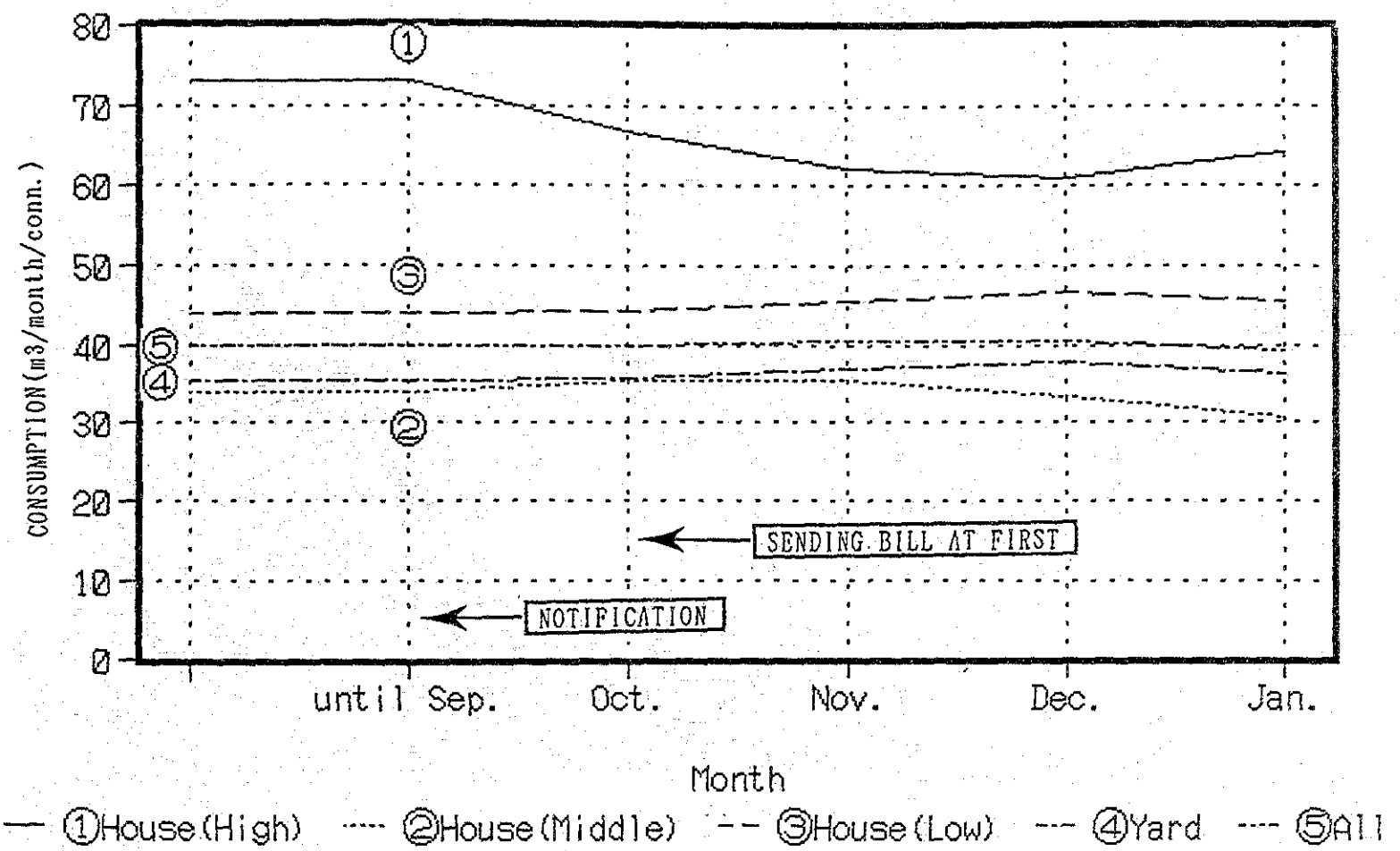


FIG. E.4.6 LOCATION OF MEASUREMENT OF LEAKAGE, SINZA AREA.

THE STUDY ON REHABILITATION OF DAR ES SALAAM WATER SUPPLY

FIG E.4.7 FLUCTUATION OF CONSUMPTION BY METER INSTALLATION



5. STUDY OF USED WATER METERS

5.1 PURPOSE

The purpose of this study is to investigate the causes for clogged and broken meters, and also to investigate how such meters should be maintained for longer useful life.

5.2 OBJECTIVE

The following meters were analyzed.

1) Water meter installed in February, 1990.
2) Water meter installed before 1980.
3) Water meters that have already broken or in the process of being broken for some reason.

5.3 PROCEDURE

1) Selection of four meters for the study.
2) Getting information about history of each meter such as:-
   * installed year
   * origin of manufacture
   * Water pressure
   * confirmation of initial and last readings

   Table E.5.1 shows the results from site survey.
3) Removing the meters from each household, and replacing them with new meters.
4) Investigate possible causes at a meter factory in Japan.
5) Analyzing the outcome of the study.

5.4 ITEMS TO BE TESTED

The following items are tested in a laboratory;
* Accuracy test on the condition at present.
* Accuracy test after washing and cleaning like overhaul.
* Observation test after taking apart from the meter case.

TABLE E.5.1 WATER METER INVESTIGATION

ITEM	NO.1	NO.2	NO.3	NO.4
Meter Number (old)	0091	0083	16975	17044
Meter Size	3/4"	3/4"	3/8"	3/8"
Location of Meter	Zanaki	Jamhuri (Radha T.Room)	Kisutu /Zanaki	Kisutu /Zanaki
Manufacturer's Name	Aichi, Japan	Aichi, Japan	? Israel	? Israel
Installed Year	March,90	March,90	April,69	April,69
Date of Removal	4-12-90	4-12-90	4-12-90	5-12-90
Meter Reading at Removal	0162.8m3	0721.1m3	42810.0 gallon	64224.0 gallon
Water Pressure (Average)	1.5 Bar	1.5 Bar	1.5 Bar	1.5 Bar
Meter Number (new)	00176	00175	00178	00177

5.5 RESULT AND ANALYSIS

1) Performance Test

At first this tests have been carried out by accuracy test, and after that each parts of meter have been cleaned with water to measure accuracy with various flow. Following Table shows the outcome of accuracy test which indicates percentage of meter error.

TABLE E.5.2. PERCENTAGE OF METER ACCURACY

(Unit: Percent)

Goods of Origin	Japanese origin				Israeli origin	
Meter number	00083		00091		17044	
flow condition	at present	after washing	at present	after washing	at present	after washing
5,000 (l/h)	-1.9	+1.5	-0.8	+0.8	----	----
3,000	-1.8	+1.5	-0.7	+1.6	-1.1	+4.1
2,000	-1.3	+1.3	-0.6	+1.3	-1.6	+4.1
1,000	-1.4	+0.9	+0.4	+1.3	-3.3	+3.5
600	-0.7	+0.4	+1.2	+1.1	-3.7	+1.8
200	-1.3	-0.2	-0.5	-0.3	-5.9	+0.9
100	-0.3	-0.3	-0.7	+0.6	-5.9	+5.0
50	-7.8	-1.0	-3.0	+4.2	-14.3	+2.7
30	-99.7	-17.3	-24.6	-2.0	NR	-1.7
20	NR	-99.5	NR	-20.5	NR	-25.0

Notes: i) NR ---------- No Rotating

ii) Meter Number 16975 ----- Untestable on the condition at present.

2) Breaking Down and Observation Test

Four sample meters have been broken down and observed after accuracy test. The followings are results of the laboratory observation as to sample meters.

"Japanese Origin"

* Meter Case ---------- It has observed some accumulation of silt on the bottom of case.
* Strainer ---------- It has seen a lots of silt wound.
* Register Box ---------- It has observed some accumulation of silt in the bottom of box.
* Vane-wheel ---------- It has seen a lots of silt wound.
* Inner case and pivot ------- It has observed the accumulation of silt inside of inner case and also can be seen foreign matters with pivot.

"Israel Origin"

* Meter Case ---------- It has observed a lots of accumulation of silt inside of case.
* Indicating Device --- It can be seen much incrustation and silt.
* Upper Plate ---------- Adhesive incrustation can be seen with the plate.
* Gear ---------- It has been observed deterioration and incrustation.
* Vane-wheel ---------- It can be seen accumulation of silt.
* Inner Case ---------- It has observed much incrustation and silt.

3) Summarization Of Sample Meter

According to results of a accuracy test, the following are summarization of sample meter.

"Japanese Origin"

As indicated the meter accuracy in Table E.5.2 based on an accuracy test, the meter accuracy has been measured for each flow rate. These data show that each meter accuracy were within standard of "ISO Class B", but it has observed that meter accuracy was out of above standard in case of under small flow which is less than 70 liter/hour.

In spite of short use since April, 1990, it is obviously clear that adhesive accumulation has caused deterioration of accuracy to pivot of vane-wheel for two reasons. At first, silt has really been accumulated to the each parts of meter, and for another, meter accuracy has been become good after washing the each parts.

"Israeli Origin"

Israeli origin meter did not indicated enough accuracy to measure the exact test flow at any flow range,

and meter accuracy was almost out of ISO standard regardless washing each parts.

With the long period using at the site, there are much accumulation of silt, incrustation and foreign matters. Old meters, therefore, seem to be almost condition of deterioration with plastic material such as inner case, strainer and vane-wheel. Another Israeli meter actually was untestable due to existing condition and it was almost out of order.

5.6 RECOMMENDATION

The following factor are proposed to recommended for changing the consumer meter:-

1) Reinstallation Work

Water meter shall always be reinstalled to keep level with its cover glass and it shall not give hard shock so as not to make no rotation. The suitable packing can be adopted to the joint so as not to let the water leak from them. It shall be confirmed the configuration of the water meter.

During the site survey of ground water leakage, NUWA staff has to check and confirm whether the water meter still work without any problem.

2) Expectation Of Effect To Early Changing The Water Meter.

It seems to be occur unusual situation and conditions that it may be non-sensitiveness water due to corrosion of case and rotating out of flow range. Therefore, NUWA has to see to it that it can be expected the high ratio of effective paid water with changing the water meter even if it is will be judged to last for the time being to rotate.

Another reason why it shall be proposed to change the water meter even within valid for another few years, is that variable period depend upon the water pressure, diameter of service pipe, water consumption and quantity of non-sensitive water which is increase as years go by.

3) Operate The Workshop

Where a section of each sub-branch could not, on its own, support a work shop fully equipped for all the engineering work associated with maintenance of the meter works, meter work shop might well be able to do this task. To this meter workshop may be sent all the engineering work from each sub-branch of the undertaking which have no facilities of their own, and all the work beyond the capability of the light specialist workshop.

4) Maintenance as routine work

Daily maintenance is very significant to keep good conditions. If the metering system is not operating and the equipment is not maintained, the range of meter accuracy will really be increased considerably. Therefore, only thing is to carry out routine work for a day-to-day basis to maintain the water meters such as washing every three to four years, and changing the assembly itself of indicating device. Thus, it is proposed to get the consumer meter overhauled every three to four years so as not to being abandoned the installed meter because of becoming decreasing.

The following process for the servicing consumer meters are recommended:

- clean outside and strip,
- clean housing, measuring and index mechanism,
- paint the case, if desired,
- replace or recondition defective measuring parts or index mechanism,
- reassemble,
- pressure test and
- calibrate and seal.

5) Proposed Materials Of Consumer Meters

Due to much accumulation of silt, darts and foreign matters,dry type of indicating device have been proposed for the new installation. Indicating device of meter can be separate to the surface attached with water.

The following recommendations can be made regarding good maintenance of meters and can be adopted by the planning section and workshop.

1) Adjustment after cleaning and/or repairs to be made with respect to a standard meter, should be as follows.

* Flow to be tested
* Exact measure to be adjusted
* Cross checking after repair

2) As far as daily operation and maintenance, the following items shall be done routinely.

* Measuring turbidity every day
* Checking condition of meter which seems to be wrong by comparing monthly consumption.
* Requesting the leakage detection section to carry out a leakage survey of these households.