Appendices

5.1 Water demand for no change in level of service
5.2 Water demand for changing level of service
5.3 Pipe layout and pipeline design for Scenario 1: all communal standpipes
5.4 Source of cost data and cost of connections
5.5 Capital and recurrent costs: Scenario 1 to 6
5.6 Summary of all costs: base year
5.7 Tariffs to break-even
5.8 Average Incremental Costs: Scenario 4,5 and 6
5.9 Cash flow: option 1, 2 and 3
5.10 Distribution of capital costs (PDG, 1996)

Appendix 5.1 Water demand for no change in level of service

Population

	Years	People	Houses
Population in 1994		1,698	283
Present population 1998	0	1,874	312
Design life Year 2008	10	2,399	400
Design life Year 2018	20	3,071	512
People per household *1	6		
Population growth rate *2	2.5%		

Demand per level of service

	Unit	Scenarios					
		1	2	3	4	5	6
		all cs	all yc	all hc	mixed	mixed	mixed
Domestic demand per level of service	(l/c/d)	25	80	130			
Communal standpipe (cs)					80%	50%	20%
Yard connection (yc)					15%	35%	50%
House (kitchen) connection (hc)					5%	15%	30%
Average domestic demand	(l/c/d)	25	80	130	39	60	84
Institutional Demand (schools, clinics, churches, tribal authority, etc.)	15%	4	12	20	6	9	13
Subtotal	(l/c/d)	29	92	150	44	69	97
Unaccounted for Water	20%	6	18	30	9	14	19
Total demand per level of service (lcd) *4	**(l/c/d)**	**35**	**110**	**179**	**53**	**83**	**116**

Average Annual Daily Demand

AADD - Present (1998)	(kl/d)	65	207	336	100	155	217
	(l/s)	0.7	2.4	3.9	1.2	1.8	2.5
AADD - Year 10 (2008)	(kl/d)	83	265	430	127	199	278
	(l/s)	1.0	3.1	5.0	1.5	2.3	3.2
AADD - Year 20 (2018)	(kl/d)	106	339	551	163	254	356
	(l/s)	1.2	3.9	6.4	1.9	2.9	4.1

Peak Factors

Daily peak *5	3	2.6	2.4	2.9	2.8	2.6
Seasonal peak *3	1.2	1.35	1.5	1.2	1.35	1.4
Distribution peak (daily peak x seasonal peak)	3.6	3.5	3.6	3.5	3.7	3.7

System components:

	Design parameters *6						
Source development	AADD (present) safe yield for 8hr pumping/day	(l/s)	2.2	7.2	11.7	3.5	5.4	7.5
Pumping main	same as source	(l/s)	2.2	7.2	11.7	3.5	5.4	7.5
Storage	AADD (present) x 48hr storage	(kl/d)	129	414	672	199	310	435
Distribution	AADD (Year 20) x Peak flow	(l/s)	4.4	13.8	23.0	6.6	11.0	15.1
Minimum standpipe yield (0.17 l/s) to 37 s/p		(l/s)	6.3					

Footnotes

*1 National average is taken as 5.6 people per household (CDE, 1995) - local survey shows around 6 people per household
*2 Estimate of local average. National average = 1% (CDE, 1995); other estimates in the area = up to 4.4%
*3 Van Schalkwyk (1996)
*4 Note: other water uses not taken into account e.g. stock watering, irrigation etc.
*5 Daily peak includes reticulation peak factor (RPF), Reticulation loss (RL), & Down time Losses (DT) (DWAF, 1997b)
*6 Adapted from DWAF design guidelines (DWAF, 1997b)

Appendix 5.2 Water demand for a changing level of service

Initial level of service as per scenario 4

Assumptions:	
Population growth =	2.5%
Annual increase in yard connections *1 =	4%
Annual increase in house connections *2 =	4%

Demand per level of service (l/c/d):	
Communal standpipes	25
Yard connections	80
House connections	130

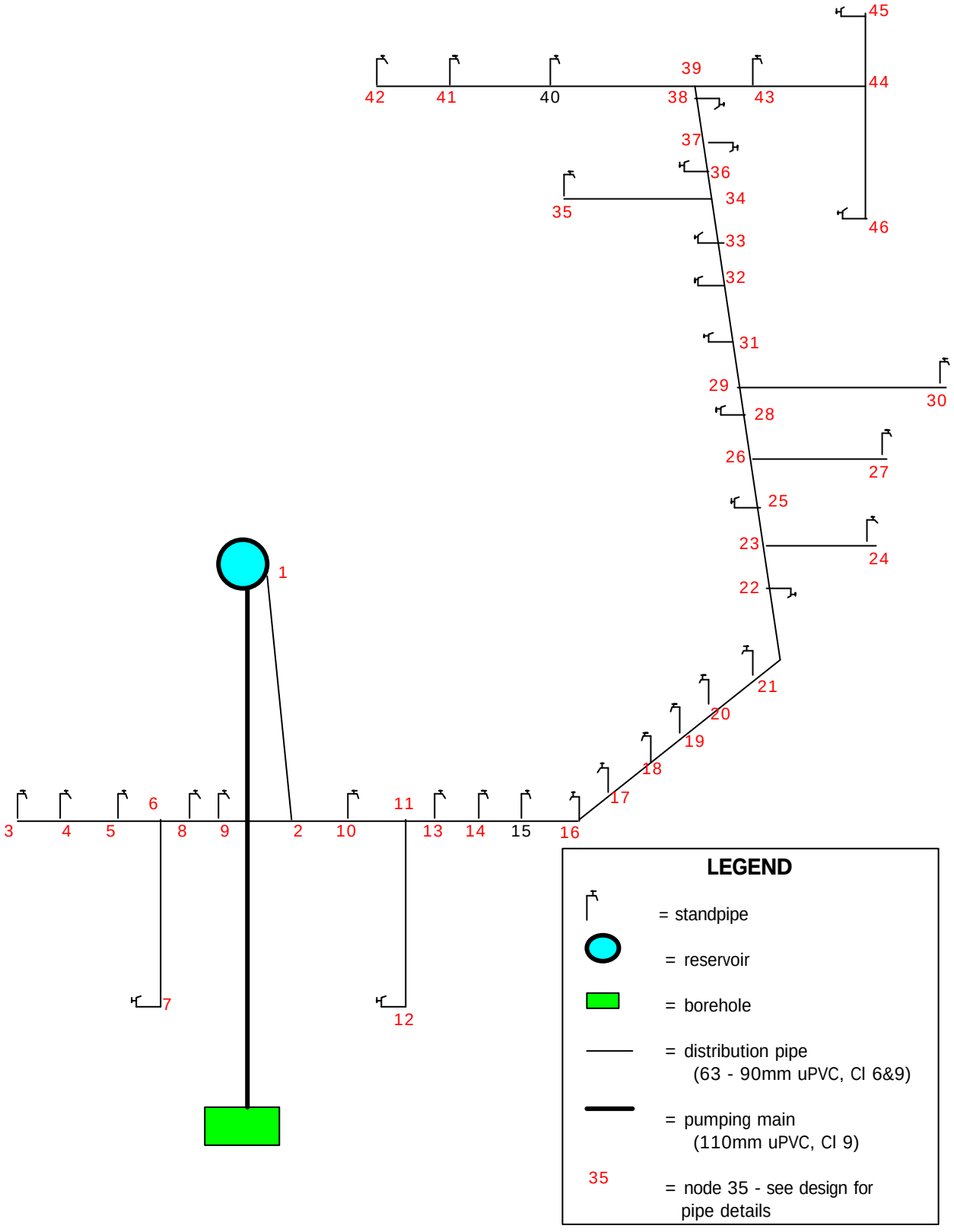
Year	Houses	Pop.	Connections						Water demand per connection (kl/d)			Domestic AADD		Institutional demand	Instit. + domestic	UFW	Total AADD	
			cs	yc	hc	cs	yc	hc	cs	yc	hc			15%		20%		
			%	%	%	no.	no.	no.	kl/d	kl/d	kl/d	kl/d	l/c/d	kl/d	kl/d	kl/d	kl/d	l/c/d
1	312	1,872	**80%**	**15%**	**5%**	250	47	16	37	22	12	72	39	11	83	17	**99**	53
2	320	1,919	79%	16%	5%	253	50	17	38	24	13	75	39	11	86	17	**103**	54
3	328	1,967	78%	16%	5%	257	53	18	39	26	14	78	40	12	90	18	**107**	55
4	336	2,016	78%	17%	6%	260	57	19	39	27	15	81	40	12	93	19	**112**	55
5	344	2,066	77%	18%	6%	264	60	20	40	29	16	84	41	13	97	19	**116**	56
6	353	2,118	76%	18%	6%	267	64	21	40	31	17	88	41	13	101	20	**121**	57
7	362	2,171	75%	19%	6%	270	69	23	41	33	18	91	42	14	105	21	**126**	58
8	371	2,225	74%	20%	7%	273	73	24	41	35	19	95	43	14	109	22	**131**	59
9	380	2,281	73%	21%	7%	276	78	26	41	37	20	99	43	15	114	23	**137**	60
10	390	2,338	72%	21%	7%	279	83	28	42	40	22	103	44	16	119	24	**143**	61
11	399	2,396	70%	22%	7%	281	89	30	42	43	23	108	45	16	124	25	**149**	62
12	409	2,456	69%	23%	8%	283	95	32	42	45	25	112	46	17	129	26	**155**	63
13	420	2,518	68%	24%	8%	285	101	34	43	48	26	117	47	18	135	27	**162**	64
14	430	2,581	67%	25%	8%	287	107	36	43	52	28	123	47	18	141	28	**169**	66
15	441	2,645	65%	26%	9%	288	115	38	43	55	30	128	48	19	147	29	**177**	67
16	452	2,711	64%	27%	9%	289	122	41	43	59	32	134	49	20	154	31	**185**	68
17	463	2,779	63%	28%	9%	290	130	43	43	62	34	140	50	21	161	32	**193**	69
18	475	2,848	61%	29%	10%	290	139	46	43	67	36	146	51	22	168	34	**202**	71
19	487	2,920	59%	30%	10%	289	148	49	43	71	38	153	52	23	176	35	**211**	72
20	499	2,993	**58%**	**32%**	**11%**	289	158	53	43	76	41	160	53	24	184	37	**221**	74

*1 Related to increase in GGP, tariff and other 'value orientation' factors (van Schalkwyk, 1996)

*2 Increase in house connections are assumed to be households upgrading from yard connections to house connections

Appendix 5.3 Layout of pipes and nodes

Scenario 1: Communal Standpipe design



Appendix 5.3 Pipeline design - Communal Standpipe

Designed using 'BRANCH' software: Modak & Dhoondia (1991) BRANCH - Version 3, The World Bank, Washington, USA

Number of Pipes : 45
Number of Nodes : 46
Number of Commercial Diameters : 13
Peak Design Factor : 1
Minimum Headloss in m/km : .001
Maximum Headloss in m/km : 100
Minimum Residual Pressure m : 10
Total cost (including VAT less discount) R 148,890

Pipe Data

Pipe; No.	From; Node	To; Node	Length m
1	1	2	210.00
2	3	4	150.00
3	4	5	150.00
4	5	6	30.00
5	6	7	50.00
6	6	8	100.00
7	8	9	125.00
8	9	2	120.00
45	2	10	60.00
9	10	11	100.00
10	11	12	100.00
11	11	13	100.00
12	13	14	190.00
13	14	15	190.00
14	15	16	190.00
15	16	17	190.00
16	17	18	190.00
17	18	19	190.00
18	19	20	190.00
19	20	21	190.00
20	21	22	190.00
21	22	23	210.00
22	23	24	60.00
23	23	25	180.00
24	25	26	181.00
25	26	27	100.00
26	26	28	200.00
27	28	29	5.00
28	29	30	150.00
29	29	31	155.00
30	31	32	220.00
31	32	33	250.00
32	33	34	87.00
33	34	35	500.00
34	34	36	150.00
35	36	37	50.00
36	37	38	150.00
37	38	39	150.00
38	39	40	220.00
39	40	41	220.00
40	41	42	220.00
41	39	43	30.00
42	43	44	170.00
43	44	45	30.00
44	44	46	300.00

Node Data

Node; No.	Peak; Factor	Flow; lps	Elevation; m	Residual Pressure m
1	1.00	0.000	100.00	10.00
2	1.00	0.000	67.00	10.00
3	1.00	-0.170	82.00	10.00
4	1.00	-0.170	79.00	10.00
5	1.00	-0.170	77.00	10.00
6	1.00	0.000	76.00	10.00
7	1.00	-0.170	73.00	10.00
8	1.00	-0.170	70.00	10.00
9	1.00	-0.170	69.00	10.00
10	1.00	-0.170	68.00	10.00
11	1.00	0.000	66.00	10.00
12	1.00	-0.170	63.00	10.00
13	1.00	-0.170	61.00	10.00
14	1.00	-0.170	59.00	10.00
15	1.00	-0.170	57.00	10.00
16	1.00	-0.170	55.00	10.00
17	1.00	-0.170	43.00	10.00
18	1.00	-0.170	52.00	10.00
19	1.00	-0.170	50.00	10.00
20	1.00	-0.170	49.00	10.00
21	1.00	-0.170	47.00	10.00
22	1.00	-0.170	42.00	10.00
23	1.00	0.000	41.00	10.00
24	1.00	-0.170	36.00	10.00
25	1.00	-0.170	39.00	10.00
26	1.00	0.000	42.00	10.00
27	1.00	-0.170	35.00	10.00
28	1.00	-0.170	50.00	10.00
29	1.00	0.000	52.00	10.00
30	1.00	-0.170	43.00	10.00
31	1.00	0.000	53.00	10.00
32	1.00	-0.170	50.00	10.00
33	1.00	-0.170	43.00	10.00
34	1.00	0.000	40.00	10.00
35	1.00	-0.170	55.00	10.00
36	1.00	-0.170	42.00	10.00
37	1.00	-0.500	44.00	10.00
38	1.00	-0.170	46.00	10.00
39	1.00	0.000	47.00	10.00
40	1.00	-0.170	50.00	10.00
41	1.00	-0.170	53.00	10.00
42	1.00	-0.170	57.00	10.00
43	1.00	-0.170	50.00	10.00
44	1.00	0.000	55.00	10.00
45	1.00	-0.170	58.00	10.00
46	1.00	-0.170	41.00	10.00

Commercial Diameter Data

All pipes uPVC class 9

Pipe Dia. Bore (mm)	Hazen's Const	Unit Cost R/m
50.0	150.00000	14.20

Cost Summary

Diameter (mm)	Length (m)	Cost (1000 R)	Cum. Cost (1000 R)
50.0	2961.23	42.05	42.05
65.0	1280.77	25.26	67.31

65.0	150.00000	19.72		80.0	2541.00	72.77	140.08
80.0	150.00000	28.64		100.0	210.00	8.81	148.89
100.0	150.00000	41.95					
110.0	150.00000	55.32					
125.0	150.00000	68.89					
150.0	150.00000	86.22					
175.0	150.00000	132.06					
300.0	150.00000	200.00					
400.0	150.00000	300.00					
500.0	150.00000	400.00					
600.0	150.00000	500.00					
700.0	150.00000	600.00					

Pipe Details

Pipe; From; To; Peak Flow; Diam; Hazen's; HL; HL/1000; Length

No.	Node	Node	(lps)	(mm)	Const	(m)	(m)	(m)
1	1	2	6.280	100.0	150.00000	1.32	6.29	210.00
2	4	3	0.170	50.0	150.00000	0.03	0.20	150.00
3	5	4	0.340	50.0	150.00000	0.12	0.80	150.00
4	6	5	0.510	50.0	150.00000	0.05	1.67	30.00
5	6	7	0.170	50.0	150.00000	0.01	0.20	50.00
6	8	6	0.680	50.0	150.00000	0.30	3.00	100.00
7	9	8	0.850	50.0	150.00000	0.57	4.56	125.00
8	2	9	1.020	50.0	150.00000	0.76	6.33	120.00
45	2	10	5.260	80.0	150.00000	0.80	13.33	60.00
9	10	11	5.090	80.0	150.00000	1.26	12.60	100.00
10	11	12	0.170	50.0	150.00000	0.02	0.20	100.00
11	11	13	4.920	80.0	150.00000	1.18	11.80	100.00
12	13	14	4.750	80.0	150.00000	2.11	11.11	190.00
13	14	15	4.580	80.0	150.00000	1.97	10.37	190.00
14	15	16	4.410	80.0	150.00000	1.84	9.68	190.00
15	16	17	4.240	80.0	150.00000	1.71	9.00	190.00
16	17	18	4.070	80.0	150.00000	1.58	8.32	190.00
17	18	19	3.900	80.0	150.00000	1.46	7.68	190.00
18	19	20	3.730	80.0	150.00000	1.35	7.11	190.00
19	20	21	3.560	80.0	150.00000	1.24	6.53	190.00
20	21	22	3.390	80.0	150.00000	1.13	5.95	190.00
21	22	23	3.220	80.0	150.00000	1.14	5.43	210.00
22	23	24	0.170	50.0	150.00000	0.01	0.17	60.00
23	23	25	3.050	80.0	150.00000	0.88	4.89	180.00
24	25	26	2.880	80.0	150.00000	0.80	4.42	181.00
25	26	27	0.170	50.0	150.00000	0.02	0.20	100.00
26	26	28	2.710	65.0	150.00000	2.16	10.80	200.00
27	28	29	2.540	65.0	150.00000	0.05	10.00	5.00
28	29	30	0.170	50.0	150.00000	0.03	0.20	150.00
29	29	31	2.370	65.0	150.00000	1.31	8.45	155.00
30	31	32	2.370	65.0	150.00000	1.85	8.41	220.00
31	32	33	2.200	65.0	150.00000	1.84	7.36	250.00
32	33	34	2.030	65.0	150.00000	0.55	6.32	87.00
33	34	35	0.170	50.0	150.00000	0.12	0.24	500.00
34	34	36	1.860	65.0	150.00000	0.81	5.40	150.00
35	36	37	1.690	65.0	150.00000	0.23	4.60	50.00
36	37	38	1.190	65.0	150.00000	0.35	2.33	150.00
37	38	39	1.020	50.0	150.00000	0.87	6.39	136.23
				65.0	150.00000	0.02	1.45	13.77
38	39	40	0.510	50.0	150.00000	0.39	1.77	220.00
39	40	41	0.340	50.0	150.00000	0.18	0.82	220.00
40	41	42	0.170	50.0	150.00000	0.05	0.23	220.00
41	39	43	0.510	50.0	150.00000	0.05	1.67	30.00
42	43	44	0.340	50.0	150.00000	0.14	0.82	170.00
43	44	45	0.170	50.0	150.00000	0.01	0.33	30.00
44	44	46	0.170	50.0	150.00000	0.07	0.23	300.00

Node Details

Node; Peak Flow; Elevation; H G L; Cal Pres; Spc Pres

No.	(lps)	(m)	(m)	(m)	(m)	Pres. (Y)
1 S	6.280	100.00	100.00	0.00		10.00
2	0.000	67.00	98.68	31.68		10.00
3 T	-0.170	82.00	96.84	14.84		10.00
4	-0.170	79.00	96.87	17.87		10.00
5	-0.170	77.00	97.00	20.00		10.00
6	0.000	76.00	97.05	21.05		10.00
7 T	-0.170	73.00	97.04	24.04		10.00
8	-0.170	70.00	97.35	27.35		10.00
9	-0.170	69.00	97.92	28.92		10.00
10	-0.170	68.00	97.88	29.88		10.00
11	0.000	66.00	96.62	30.62		10.00
12 T	-0.170	63.00	96.59	33.59		10.00
13	-0.170	61.00	95.43	34.43		10.00
14	-0.170	59.00	93.32	34.32		10.00
15	-0.170	57.00	91.35	34.35		10.00
16	-0.170	55.00	89.52	34.52		10.00
17	-0.170	43.00	87.81	44.81		10.00
18	-0.170	52.00	86.22	34.22		10.00
19	-0.170	50.00	84.76	34.76		10.00
20	-0.170	49.00	83.41	34.41		10.00
21	-0.170	47.00	82.17	35.17		10.00
22	-0.170	42.00	81.04	39.04		10.00
23	0.000	41.00	79.91	38.91		10.00
24 T	-0.170	36.00	79.90	43.90		10.00
25	-0.170	39.00	79.03	40.03		10.00
26	0.000	42.00	78.23	36.23		10.00
27 T	-0.170	35.00	78.21	43.21		10.00
28	-0.170	50.00	76.07	26.07		10.00
29	0.000	52.00	76.03	24.03		10.00
30 T	-0.170	43.00	75.99	32.99		10.00
31	0.000	53.00	74.72	21.72		10.00
32	-0.170	50.00	72.86	22.86		10.00
33	-0.170	43.00	71.03	28.03		10.00
34	0.000	40.00	70.48	30.48		10.00
35 T	-0.170	55.00	70.36	15.36		10.00
36	-0.170	42.00	69.67	27.67		10.00
37	-0.500	44.00	69.45	25.45		10.00
38	-0.170	46.00	69.09	23.09		10.00
39	0.000	47.00	68.20	21.20		10.00
40	-0.170	50.00	67.81	17.81		10.00
41	-0.170	53.00	67.63	14.63		10.00
42 T	-0.170	57.00	67.58	10.58		10.00
43	-0.170	50.00	68.15	18.15		10.00
44	0.000	55.00	68.01	13.01		10.00
45 T	-0.170	58.00	68.00	10.00		10.00
46 T	-0.170	41.00	67.94	26.94		10.00

Appendix 5.4 Source of cost data

The following items were costed from the sources below. All prices for May, 1998. VAT, transport and discounts inclusive.

1. Groundwater development costs: Water Systems Management, Pietersburg, SA.
2. Pipes, fittings, valves: Main Industries, Pietersburg, SA and National Trading; Company (NTC), Pietersburg, SA.
3. Reservoir: Averaged R/m3 price for concrete reservoirs constructed in Mvula projects in Mpumalanga.
4. Professional fees: DWAF/ECSA recommended rates for rural water supply projects.
5. O&M:
    - Connection costs: Prices from Main Industries, NTC, Kent Meters and local labour rates;
    - Staffing, administration and capacity building: estimated costs from author's experience and consultation with consultants;
    - Operation costs: based on expected performance of Lister engines.

Other information sourced from personal communication with: Mike Thompson (Tsogang Water and Sanitation), Eric Harvey (Mvula Trust), Adie Vienings (DWAF) and Pierre Mouton (Water Systems Management).

Appendix 5.4 Cost of connections

Cost per standpipe

Item	Description	Unit	Qty	Rate	Total
Materials	75/63/50/40/35 x 1" (25mm) saddle	ea.	1	28.24	28.24
	25mm HDPE Cl 6	m	20	3.09	61.80
	160mm PVC + end cap	m	0.5	60.36	30.18
	3/4" GI pipe (standpipe) x 1000mm	ea.	1	12.02	12.02
	3/4" (20mm) GI pipe (standpipe) x 500mm	ea.	1	6.14	6.14
	Cement (OPC)	bags	2	22.19	44.38
	3/4" globe valve (stopcock)	ea.	1	40.54	40.54
	3/4" elbow	ea.	2	6.98	13.96
	3/4" brass tap (plain bibcock)	ea.	1	39.94	39.94
	3/4" nipple	ea.	1	2.00	2.00
	25 x 1" male adapter	ea.	1	10.57	10.57
	25 x 3/4" male adapter	ea.	1	10.57	10.57
	Drainage: 300mm cast iron grid	ea.	1	50.00	50.00
	- 90mm HDPE Cl 6	m	8	26.90	215.20
	- soakaway (within labour cost)	m^3	12	0.00	0.00
	Subtotal				565.54
	Total + VAT	VAT =	14%		644.72
Labour	semi-skilled	mandays	0.5	60.00	30.00
	unskilled	mandays	12	30.00	360.00
	Subtotal				390.00
	TOTAL				1,034.72

Cost per yard connection

Item	Description	Unit	Qty	Rate	Total
Materials	75/63/50/40/35 x 1/2" saddle	ea.	1	28.24	28.24
	16mm HDPE	m	90	1.64	147.60
	160mm PVC + end cap	m	0.5	60.36	30.18
	1/2" GI pipe x 1000mm	ea.	1	10.14	10.14
	1/2" GI pipe x 500mm	ea.	1	5.11	5.11
	Cement	bags	0.5	22.19	11.10
	1/2" globe valve (stopcock)	ea.	1	24.51	24.51
	1/2" (15mm) elbow	ea.	2	4.65	9.30
	1/2" threaded brass tap (hose bibcock)	ea.	1	26.26	26.26
	1/2" nipple	ea.	1	1.54	1.54
	16 x 1/2" male adapter	ea.	2	6.88	13.76
	1/2" Kent water meter	ea.	1	183.70	183.70
	Meter box + key	ea.	1	60.00	60.00
	Drainage: 200mm cast iron grid	ea.	1	35.00	35.00
	- 90mm HDPE Cl 6	m	5	26.90	134.50
	- soakaway (within labour cost)	m^3	6	0.00	0.00
	Subtotal				720.94
	Total + VAT	VAT =	14%		821.87
Labour	semi-skilled	mandays	0.5	60.00	30.00
	unskilled (pipework + yard standpipe)	mandays	3	30.00	90.00
	unskilled (trenching from mainline)	mandays	11	0.00	0.00
	Subtotal				120.00
	TOTAL				941.87

Cost per house (kitchen) connection

Item	Description	Unit	Qty	Rate	Total
Materials	75/63/50/40/35 x 1/2" saddle	ea.	1	28.24	28.24
	15mm HDPE	m	100	1.64	164.00
	1/2" GI pipe x 1500mm	ea.	1	15.09	15.09
	1/2" GI pipe x 500mm	ea.	2	5.11	10.22
	Cement	bags	1	22.19	22.19
	1/2" globe valve	ea.	1	24.51	24.51
	1/2" elbow	ea.	4	4.65	18.60
	1/2" threaded brass tap (hose bibcock)	ea.	1	26.26	26.26
	1/2" nipple	ea.	1	1.54	1.54
	15 x 1/2" male adapter	ea.	3	6.88	20.64
	1/2" Kent water meter	ea.	1	183.70	183.70
	Meter box	ea.	1	60.00	60.00
	Basin (stainless steel, 900x535mm)	ea.	1	288.88	288.88
	U-tube and drainage pipe (6m x 50mm dia.)	ea.	1	67.50	67.50
	- soakaway (within labour cost)	m^3	12	0.00	0.00
	Subtotal				931.37
	Total + VAT	VAT =	14%		1,061.76
Labour	semi-skilled	mandays	1	60.00	60.00
	unskilled (pipework + kitchen tap)	mandays	4	30.00	120.00
	unskilled (trenching from mainline)	mandays	12	0.00	0.00
	Subtotal				180.00
	TOTAL				1,241.76

Appendix 5.5 Costs for Scenario 1: All communal standpipes

Present population (1998) 1874
No of households 312
ALL PRICES INCLUDE VAT AT 14%

Capital Costs

						Capital cost				
		No. of holes	Quantity	Unit	Rate	Plant / contractor	Materials	Labour	TOTAL (R)	
1	**Source development** need (l/s) **2.2**									
	(Assume water quality is adequate i.e. no treatment needed)									
	Ground water development costs									
	Drilling (estimated depths from experience in area)									
	Drilling (165mm dia)	2	65	m	48	6,240			6,240	
	Reaming (215mm dia)	1	35	m	75	2,625			2,625	
	Casing (177mm)	1	35	m	95	3,325			3,325	
	Development, sanitary seal & concrete, borehole cap	1	1	hole	800	800			800	
	Traveling and set up costs	1	1	hole	1,000	1,000			1,000	
	Testing (4 steps + 24hr CD + recovery)	1	1	hole	4,500	4,500			4,500	
	Professional fees: siting, geophysics & water quality	1	1	hole	2,500	2,500			2,500	
	Supervision	2	1	hole	3,600	7,200			7,200	
	Reporting	1	1	hole	3,500	3,500			3,500	
	Borehole equipment									
	Mono pump - 80m static head, 2.5l/s	1	1	hole	7,500		7,500		7,500	
	Pipework at borehole (steel rising main)	1	1	hole	4,500		4,500		4,500	
	Diesel engine - Lister TS1	1	1	hole	12,000		12,000		12,000	
	Pump house	1	1	hole	3,800		3,800		3,800	
	Installation	1	1	hole	5,000	5,000			5,000	
	Subtotal borehole								64,490	
	Subtotal borehole - including VAT at 14%								73,519	
	Pumping main: materials (uPVC 110 Cl 9)		730	m	41.95		30,624		30,624	
	Labour		730	m	7.20			5,256	5,256	
	Subtotal pumping main								35,880	
	SUBTOTAL								100,370	100,370
2	**Storage** need (kl/d) **129**									
	Reinforced concrete reservoir		150	m3	746	111,900			111,900	111,900
3	**Distribution** need (l/s) **6.3**									
	Pipeline (designed on BRANCH)									
	Materials u PVC pipe (63-110mm Cl 9)						148,890		148,890	
	Fittings and valves @ 15%						22,334		22,334	
	Labour		6993	m	7			50,350	50,350	
	Subtotal								221,573	
	Connections (standpipes)									
	Materials		37	ea.	645		23,854		23,854	
	Labour		37	ea.	390			14,430	14,430	
	Subtotal								38,284	
	SUBTOTAL								259,858	259,858
	SUBTOTAL CAPITAL COSTS (exl. Prof. fees)					148,590	253,501	70,036		472,127
4	**Professional costs**									
	Technical 12.50% of capital cost (<500,000)					59,016			59,016	
	Social & training lump sum					50,000			50,000	
	Committee / local government costs - admin., overheads etc.					10,000			10,000	
	SUBTOTAL								119,016	
	Subtotal + VAT 14%								135,678	135,678
	TOTAL					284,268	253,501	70,036		**607,805**

Recurrent costs

	Item	Quantity /month	Unit	Rate	Economic life (yrs)	Capital cost	CRF	Estimated cost Annual	R/month
1	**Staffing, administration & capacity building**								
	Salaries:								
	Water committee(chairperson, secretary & bookkeeper)	1.5	people/	750					1,125
	Pump operators	1	month	750					750
	Maintenance team	1		400					400
	Water Bailiffs	0.2		400					80
	Billing, collection etc. - standpipes (flat rate)	312	houses	1					312
	- individual connections (metered rate)	0	houses	5					-
	Transport	300	km	1.5					450
	Capacity building	1	ea.	200					200
	Administration & overheads	5%	%	3,317					166
2	**Operation costs**								-
	Diesel for engines (estimation related to flow) (diesel priced at R2.05	1,968	m3/mon	0.5					984
	Other (oil, etc.) (estimated % of power costs)	15%	%	984					148
3	**Routine maintenance (spare parts etc.)**								-
	Tools	1		50					50
	Source (borehole, pump, engine, pump house)	1		200					200
	Reservoir	1		50					50
	Distribution pipeline + pumping main	1		100					100
	Standpipes	312		0.1					31
	SUBTOTAL O & M COSTS								**5,046**
4	**Depreciation (replacement costs)** DF = 8%								
	Source (borehole, pump, engine, pump house)				10	64,490	0.149	9,611	801
	Reservoir				30	111,900	0.089	9,940	828
	Distribution pipeline + pumping main				30	257,453	0.089	22,869	1,906
	Standpipes				20	38,284	0.102	3,899	325
	SUBTOTAL DEPRECIATION COSTS					472,127			**3,860**
	TOTAL O & M + DEPRECIATION COSTS								**8,906**

Costs for Scenario 2: All yard connections

Present population (1998) 1874
No of households 312
ALL PRICES INCLUDE VAT AT 14%

Capital Costs

						Capital cost				
		No of holes	Quantity	Unit	Rate	Plant / contractor	Materials	Labour	TOTAL (R)	
1	**Source development** need (l/s) **7.2**									
	(Assume water quality is adequate i.e. no treatment needed)									
	Ground water development costs									
	Drilling (estimated depths from experience in area)									
	Drilling (165mm dia)	2	65	m	48	6,240			6,240	
	Reaming (215mm dia)	1	35	m	75	2,625			2,625	
	Casing (177mm)	1	35	m	95	3,325			3,325	
	Development, sanitary seal & concrete, borehole cap	1	1	hole	800	800			800	
	Traveling and set up costs	1	1	hole	1,000	1,000			1,000	
	Testing (4 steps + 24hr CD + recovery)	1	1	hole	4,500	4,500			4,500	
	Professional fees: siting, geophysics & water quality	1	1	hole	2,500	2,500			2,500	
	Supervision	2	1	hole	3,600	7,200			7,200	
	Reporting	1	1	hole	3,500	3,500			3,500	
	Borehole equipment									
	Mono pump - 80m static head, 9 l/s	1	1	hole	16,000		16,000		16,000	
	Pipework at borehole (steel rising main)	1	1	hole	4,500		4,500		4,500	
	Diesel engine - Lister TS2	1	1	hole	22,000		22,000		22,000	
	Pump house	1	1	hole	3,800		3,800		3,800	
	Installation	1	1	hole	5,000	5,000			5,000	
	Subtotal borehole								82,990	
	Subtotal borehole - including VAT at 14%								94,609	
	Pumping main materials (uPVC 140mm Cl 9)		730	m	68.89		50,290		50,290	
	Labour		730	m	7.20			5,256	5,256	
	Subtotal pumping main								55,546	
	SUBTOTAL								150,154	150,154
2	**Storage** need (kl/d) **414**									
	Reinforced concrete reservoir		450	m3	746	335,700			335,700	335,700
3	**Distribution** need (l/s) **13.8**									
	Pipeline (designed on BRANCH - World Bank, 1991)									
	Materials u PVC pipe (O.D.63-140mm Cl 9)						224,890		224,890	
	Fittings and valves @ 15%						33,734		33,734	
	Labour		5584	m	7.2			40,205	40,205	
	Subtotal								298,828	
	Connections (yard)									
	Materials		312	ea.	821.87		256,696		256,696	
	Labour		312	ea.	120			37,480	37,480	
	Subtotal								294,176	
	SUBTOTAL (Distribution)								593,004	
	SUBTOTAL without connection costs (financed by households)								298,828	298,828
	SUBTOTAL CAPITAL COSTS (exl. Prof. fees)					335,700	565,609	82,941		784,683
4	**Professional costs**									
	Technical 10% of capital cost (>500,000; <1.5M)					78,468			78,468	
	Social & training lump sum					50,000			50,000	
	Committee / local government costs - admin., overheads etc.					10,000			10,000	
	SUBTOTAL								138,468	
	Subtotal + VAT 14%								157,854	157,854
	TOTAL					493,554	565,609	82,941		**942,536**

Recurrent Costs

	Item	Quantity	Unit	Rate	Economic life (yrs)	Capital Cost	CRF	Estimated costs Annual	R/month
1	**Connection cost**								
	50% of connection cost up front	471							
	50% household loan over 5 yrs Interest	15%			5	471	0.298	140	12
2	**Staffing, administration & capacity building**								
	Salaries:								
	Water committee(chairperson, secretary & bookkeeper)	2	people/	750					1,500
	Pump operators	1	month	750					750
	Maintenance team	1		400					400
	Water Bailiffs	0.2		400					80
	Billing, collection etc. - standpipes (flat rate)	0	houses	1					-
	- individual connections (metered rate)	312	houses	5					1,562
	Transport	500	km	1.5					750
	Capacity building	2	ea.	200					400
	Administration & overheads	5%	%	5,442					272
2	**Operation costs**								
	Diesel for engines (estimation related to flow)	6,298	m3/mon	0.5					3,149
	Other (oil, etc.) (estimated % of power costs)	15%	%	3,149					472
3	**Routine maintenance (spare parts etc.)**								-
	Tools	1.5		50					75
	Source (borehole, pump, engine, pump house)	1		200					200
	Reservoir	1.5		50					75
	Distribution pipeline + pumping main	2		100					200
	Standpipes	0		1					-
	SUBTOTAL O & M COSTS								**9,885**
5	**Depreciation (replacement costs)** DF = 8%								
	Source (borehole, pump, engine, pump house)				10	94,609	0.149	14,099	1,175
	Reservoir				30	335,700	0.089	29,819	2,485
	Distribution pipeline + pumping main				30	354,374	0.089	31,478	2,623
	SUBTOTAL DEPRECIATION COSTS					784,683			**6,283**
	TOTAL O & M + DEPRECIATION COSTS								**16,168**

Costs for Scenario 3: All house (kitchen) connections

Present population (1998) 1874
No of households 312
ALL PRICES INCLUDE VAT AT 14%

Capital Costs

						Capital cost				
		No. of holes	Quantity	Unit	Rate	Plant / contractor	Materials	Labour	TOTAL (R)	
1	**Source development** need (l/s) 11.7									
	(Assume water quality is adequate i.e. no treatment needed)									
	Ground water development costs									
	Drilling (estimated depths from experience in area)									
	Drilling (165mm dia)	4	65	m	48	12,480			12,480	
	Reaming (215mm dia)	2	35	m	75	5,250			5,250	
	Casing (177mm)	2	35	m	95	6,650			6,650	
	Development, sanitary seal & concrete, borehole cap	2	1	hole	800	1,600			1,600	
	Traveling and set up costs	1	1	hole	1,000	1,000			1,000	
	Testing (4 steps + 24hr CD + recovery)	2	1	hole	4,500	9,000			9,000	
	Professional fees: siting, geophysics & water quality	2	1	hole	2,500	5,000			5,000	
	Supervision	4	1	hole	3,600	14,400			14,400	
	Reporting	1.5	1	hole	3,500	5,250			5,250	
	Borehole equipment									
	Mono pump - 80m static head, 6 l/s	2	1	hole	12,000		24,000		24,000	
	Pipework at borehole (steel rising main)	2	1	hole	4,500		9,000		9,000	
	Diesel engine - Lister TR1	2	1	hole	15,000		30,000		30,000	
	Pump house	2	1	hole	3,800		7,600		7,600	
	Installation	2	1	hole	5,000	10,000			10,000	
	Subtotal borehole								141,230	
	Subtotal borehole - including VAT at 14%								161,002	
	Pumping main materials (uPVC 140mm Cl 9)		2,500	m	68.89		172,225		172,225	
	Labour		2,500	m	7.20			18,000	18,000	
	Subtotal pumping main								190,225	
	SUBTOTAL								351,227	351,227
2	**Storage** need (kl/d) 672									
	Reinforced concrete reservoir		700	m3	746	522,200			522,200	522,200
3	**Distribution** need (l/s) 23.0									
	Pipeline (designed on BRANCH - World Bank, 1991)									
	Materials u PVC pipe (O.D.75-160mm Cl 9)						325,150		325,150	
	Fittings and valves @ 15%						48,773		48,773	
	Labour		5584	m	7			40,205	40,205	
	Subtotal								414,127	
	Connections (kitchen)									
	Materials		312	ea.	1,062		331,624		331,624	
	Labour		312	ea.	180			56,220	56,220	
	Subtotal								387,844	
	SUBTOTAL								801,971	
	SUBTOTAL without connection costs (financed by households)								414,127	414,127
	SUBTOTAL CAPITAL COSTS (exl. Prof. fees)					522,200	877,771	114,425		1,287,555
4	**Professional costs**									
	Technical 10% of capital cost (>500,000; <1.5M)					128,755			128,755	
	Social & training lump sum					50,000			50,000	
	Committee / local government costs - admin., overheads etc.					10,000			10,000	
	SUBTOTAL								188,755	
	Subtotal + VAT 14%								215,181	215,181
	TOTAL					737,381	877,771	114,425		**1,502,736**

Recurrent costs

	Item	Quantity	Unit	Rate	Economic life (yrs)	Capital Cost	CRF	Estimated costs Annual	R/month
1	**Connection cost**								
	50% of connection cost up front	621							
	50% household loan over 5 yrs Interest	15%			5	621	0.298	185	15
2	**Staffing, administration & capacity building**								
	Salaries:								
	Water committee(chairperson, secretary & bookkeeper)	2	people/	750					1,500
	Pump operators	2	month	750					1,500
	Maintenance team	1		400					400
	Water Bailiffs	0.2		400					80
	Billing, collection etc. - standpipes (flat rate)	0	houses	1					-
	- individual connections (metered rate)	312	houses	5					1,562
	Transport	500	km	1.5					750
	Capacity building	2	ea.	200					400
	Administration & overheads	5%	%	6,192					310
2	**Operation costs**								
	Diesel for engines (estimated kWhr related to flow)	10,234	m3/mor	0.5					5,117
	Other (oil, etc.) (estimated % of power costs)	15%	%	5,117					768
3	**Routine maintenance (spare parts etc.)**								-
	Tools	1.5		50					75
	Source (borehole, pump, engine, pump house)	2		200					400
	Reservoir	2		50					100
	Distribution pipeline + pumping main	2		100					200
	Standpipes	0		1					-
	SUBTOTAL O & M COSTS								**13,161**
5	**Depreciation (replacement costs)** DF = 8%								
	Source (borehole, pump, engine, pump house)				10	161,002	0.149	23,994	2,000
	Reservoir				30	522,200	0.089	46,386	3,865
	Distribution pipeline + pumping main				30	604,352	0.089	53,683	4,474
	SUBTOTAL DEPRECIATION COSTS					1,287,555			**10,339**
	TOTAL O & M + DEPRECIATION COSTS								**23,500**

Costs for Scenario 4: Mixed level of service

Present population (1998) 1874
No of households 312
ALL PRICES INCLUDE VAT AT 14%

Capital Costs

		No. of holes	Quantity	Unit	Rate	Capital cost: Plant / contractor	Materials	Labour	TOTAL (R)	
1	**Source development** need (l/s) 3.5									
	(Assume water quality is adequate i.e. no treatment needed)									
	Ground water development costs									
	Drilling (estimated depths from experience in area)									
	Drilling (165mm dia)	2	65	m	48	6,240			6,240	
	Reaming (215mm dia)	1	35	m	75	2,625			2,625	
	Casing (177mm)	1	35	m	95	3,325			3,325	
	Development, sanitary seal & concrete, borehole ca	1	1	hole	800	800			800	
	Travelling and set up costs	1	1	hole	1,000	1,000			1,000	
	Testing (4 steps + 24hr CD + recovery)	1	1	hole	4,500	4,500			4,500	
	Professional fees: siting, geophysics & water quality	1	1	hole	2,500	2,500			2,500	
	Supervision	2	1	hole	3,600	7,200			7,200	
	Reporting	1	1	hole	3,500	3,500			3,500	
	Borehole equipment									
	Mono pump - 80m static head,6 l/s	1	1	hole	12,000		12,000		12,000	
	Pipework at borehole (steel rising main)	1	1	hole	4,500		4,500		4,500	
	Diesel engine - Lister TR1	1	1	hole	15,000		15,000		15,000	
	Pump house	1	1	hole	3,800		3,800		3,800	
	Installation	1	1	hole	5,000	5,000			5,000	
	Subtotal borehole								71,990	
	Subtotal borehole - including VAT at 14%								82,069	
	Pumping main materials (uPVC 110mm Cl 9)		730	m	41.95		30,624		30,624	
	Labour		730	m	7.20			5,256	5,256	
	Subtotal pumping main								35,880	
	SUBTOTAL								117,948	117,948
2	**Storage** need (kl/d) 199									
	Reinforced concrete reservoir		200	m3	746	149,200			149,200	149,200
3	**Distribution** need (l/s) 6.6									
	Pipeline (designed on BRANCH - World Bank, 1991)									
	Materials u PVC pipe (O.D.63-110mm Cl 9)						149,480		149,480	
	Fittings and valves 15%						22,422		22,422	
	Labour		6993	m	7.2			50,350	50,350	
	Subtotal								222,252	
	Connections									
	Standpipe Materials		37	ea.	644.72		23,854		23,854	
	Labour		37	ea.	390.00			14,430	14,430	
	Yard Materials		47	ea.	821.87		38,504		38,504	
	Labour		47	ea.	120.00			5,622	5,622	
	House Materials		16	ea.	######		16,581		16,581	
	Labour		16	ea.	180.00			2,811	2,811	
	Subtotal								101,803	
	SUBTOTAL (Distribution)								324,055	
	SUBTOTAL without individual connections (incl. standpipes)								260,536	260,536
	SUBTOTAL CAPITAL COSTS (exl. Prof. fees)					149,200	281,466	78,469		527,684
4	**Professional costs**									
	Technical 10% of capital cost (>500,000; <1.5M)					52,768			52,768	
	Social & training lump sum					50,000			50,000	
	Committee / local government costs - admin., overheads etc.					10,000			10,000	
	SUBTOTAL								112,768	
	Subtotal + VAT 14%								128,556	128,556
	TOTAL					277,756	281,466	78,469		**656,240**

Recurrent costs

	Item	Quantity	Unit	Rate	Economic life (yrs)	Capital Cost	CRF	Estimated costs: Annual	R/month
1	**Connection costs**								
	Yard: 50% of connection cost up front	471							
	50% household loan over 5 yrs Interest	15%			5	471	0.298	140	12
	House: 50% of connection cost up front	621							
	50% household loan over 5 yrs Interest	15%			5	621	0.298	185	15
2	**Staffing, administration & capacity building**								
	Salaries:								
	Water committee(chairperson, secretary & bookkeeper)	2	people/	750					1,500
	Pump operators	2	month	750					1,500
	Maintenance team	1		400					400
	Water Bailiffs	0.2		400					80
	Billing, collection etc. - standpipes (flat rate)	250	houses	1					250
	- individual connections (metered rate)	62	houses	5					312
	Transport	500	km	1.5					750
	Capacity building	2	ea.	200					400
	Administration & overheads	5%	%	5,192					260
2	**Operation costs**								
	Diesel for engines (estimated kWhr related to flow)	3,031	m3/mo	0.5					1,515
	Other (oil, etc.) (estimated % of power costs)	15%	%	1,515					227
3	**Routine maintenance (spare parts etc.)**								-
	Tools	1.5		50					75
	Source (borehole, pump, engine, pump house)	1		200					200
	Reservoir	1		50					50
	Distribution pipeline + pumping main	1		100					100
	Standpipes	250		0.1					25
	SUBTOTAL O & M COSTS								**7,645**
5	**Depreciation (replacement c** DF = 8%								
	Source (borehole, pump, engine, pump house)				10	82,069	0.149	12,231	1,019
	Reservoir				30	149,200	0.089	13,253	1,104
	Distribution pipeline + pumping main				30	258,131	0.089	22,929	1,911
	Standpipes				20	38,284	0.102	3,899	325
	SUBTOTAL DEPRECIATION COSTS					527,684			**4,359**
	TOTAL O & M + DEPRECIATION COSTS								**12,004**

Costs for Scenario 5: Mixed level of service

Present population (1998) 1874
No of households 312
ALL PRICES INCLUDE VAT AT 14%

Capital Costs

		No. of holes	Quantity	Unit	Rate	Capital cost: Plant / contractor	Materials	Labour	TOTAL (R)	
1	**Source development** need (l/s) 5.4									
	(Assume water quality is adequate i.e. no treatment needed)									
	Ground water development costs									
	Drilling (estimated depths from experience in area)									
	Drilling (165mm dia)	2	65	m	48	6,240			6,240	
	Reaming (215mm dia)	1	35	m	75	2,625			2,625	
	Casing (177mm)	1	35	m	95	3,325			3,325	
	Development, sanitary seal & concrete, borehole ca	1	1	hole	800	800			800	
	Traveling and set up costs	1	1	hole	1,000	1,000			1,000	
	Testing (4 steps + 24hr CD + recovery)	1	1	hole	4,500	4,500			4,500	
	Professional fees: siting, geophysics & water quality	1	1	hole	2,500	2,500			2,500	
	Supervision	2	1	hole	3,600	7,200			7,200	
	Reporting	1	1	hole	3,500	3,500			3,500	
	Borehole equipment									
	Mono pump - 80m static head, 6 l/s	1	1	hole	12,000		12,000		12,000	
	Pipework at borehole (steel rising main)	1	1	hole	4,500		4,500		4,500	
	Diesel engine - Lister TR1	1	1	hole	15,000		15,000		15,000	
	Pump house	1	1	hole	3,800		3,800		3,800	
	Installation	1	1	hole	5,000	5,000			5,000	
	Subtotal borehole								71,990	
	Subtotal borehole - including VAT at 14%								82,069	
	Pumping main materials (uPVC 140mm Cl 9)		730	m	68.89		50,290		50,290	
	Labour		730	m	7.20			5,256	5,256	
	Subtotal pumping main								55,546	
	SUBTOTAL								137,614	137,614
2	**Storage** need (kl/d) 310									
	Reinforced concrete reservoir		350	m3	746	261,100			261,100	261,100
3	**Distribution** need (l/s) 11.0									
	Pipeline (designed on BRANCH - World Bank, 1991)									
	Materials u PVC pipe (O.D.63-140mm Cl 9)						198,880		198,880	
	Fittings and valves 15%						29,832		29,832	
	Labour		6993	m	7.2			50,350	50,350	
	Subtotal								279,062	
	Connections									
	Standpipe Materials		37	ea.	644.72		23,854		23,854	
	Labour		37	ea.	390.00			14,430	14,430	
	Yard Materials		109	ea.	821.87		89,844		89,844	
	Labour		109	ea.	120.00			13,118	13,118	
	House Materials		47	ea.	1,061.76		49,744		49,744	
	Labour		47	ea.	180.00			8,433	8,433	
	Subtotal								199,423	
	SUBTOTAL (Distribution)								478,484	
	SUBTOTAL without individual connections (incl. standpipes)								317,346	317,346
	SUBTOTAL CAPITAL COSTS (exl. Prof. fees)					261,100	442,443	91,587		716,060
4	**Professional costs**									
	Technical 10% of capital cost (>500,000; <1.5M)					71,606			71,606	
	Social & training lump sum					50,000			50,000	
	Committee / local government costs - admin., overheads etc.					10,000			10,000	
	SUBTOTAL								131,606	
	Subtotal + VAT 14%								150,031	150,031
	TOTAL					411,131	442,443	91,587		**866,091**

Recurrent costs

	Item	Quantity	Unit	Rate	Economic life (yrs)	Capital Cost	CRF	Estimated costs: Annual	R/month
1	**Connection cost**								
	Yard: 50% of connection cost up front	471							
	50% household loan over 5 yrs Interest	15%			5	471	0.298	140	12
	House: 50% of connection cost up front	621							
	50% household loan over 5 yrs Interest	15%			5	621	0.298	185	15
2	**Staffing, administration & capacity building**								
	Salaries:								
	Water committee(chairperson, secretary & bookkeeper)	2	people/	750					1,500
	Pump operators	2	month	750					1,500
	Maintenance team	1		400					400
	Water Bailiffs	0.2		400					80
	Billing, collection etc. - standpipes (flat rate)	156	houses	1					156
	- individual connections (metered rate)	156	houses	5					781
	Transport	500	km	1.5					750
	Capacity building	2	ea.	200					400
	Administration & overheads	5%	%	5,567					278
2	**Operation costs**								
	Diesel for engines (estimated kWhr related to flow)	4,724	m3/mor	0.5					2,362
	Other (oil, etc.) (estimated % of power costs)	15%	%	2,362					354
3	**Routine maintenance (spare parts etc.)**								-
	Tools	1.5		50					75
	Source (borehole, pump, engine, pump house)	1		200					200
	Reservoir	1.5		50					75
	Distribution pipeline + pumping main	2		100					200
	Standpipes	156		0.1					16
	SUBTOTAL O & M COSTS								**9,127**
5	**Depreciation (replacement c** DF = 8%								
	Source (borehole, pump, engine, pump house)				10	82,069	0.149	12,231	1,019
	Reservoir				30	261,100	0.089	23,193	1,933
	Distribution pipeline + pumping main				30	334,607	0.089	29,722	2,477
	Standpipes				20	38,284	0.102	3,899	325
	SUBTOTAL DEPRECIATION COSTS					716,060			**5,754**
	TOTAL O & M + DEPRECIATION COSTS								**14,881**

Costs for Scenario 6: Mixed level of service

Present population (1998) 1874
No of households 312
ALL PRICES INCLUDE VAT AT 14%

Capital Costs

		No. of holes	Quantity	Unit	Rate	Capital cost: Plant / contractor	Materials	Labour	TOTAL	(R)
1	**Source development** need (l/s) 7.5									
	(Assume water quality is adequate i.e. no treatment needed)									
	Ground water development costs									
	Drilling (estimated depths from experience in area)									
	Drilling (165mm dia)	2	65	m	48	6,240			6,240	
	Reaming (215mm dia)	1	35	m	75	2,625			2,625	
	Casing (177mm)	1	35	m	95	3,325			3,325	
	Development, sanitary seal & concrete, borehole ca	1	1	hole	800	800			800	
	Traveling and set up costs	1	1	hole	1,000	1,000			1,000	
	Testing (4 steps + 24hr CD + recovery)	1	1	hole	4,500	4,500			4,500	
	Professional fees: siting, geophysics & water quality	1	1	hole	2,500	2,500			2,500	
	Supervision	2	1	hole	3,600	7,200			7,200	
	Reporting	1	1	hole	3,500	3,500			3,500	
	Borehole equipment									
	Mono pump - 80m static head, 9 l/s	1	1	hole	16,000		16,000		16,000	
	Pipework at borehole (steel rising main)	1	1	hole	4,500		4,500		4,500	
	Diesel engine - Lister TS2	1	1	hole	22,000		22,000		22,000	
	Pump house	1	1	hole	3,800		3,800		3,800	
	Installation	1	1	hole	5,000	5,000			5,000	
	Subtotal borehole								82,990	
	Subtotal borehole - including VAT at 14%								94,609	
	Pumping main materials (uPVC 160mm Cl 9)		730	m	86.22		62,941		62,941	
	Labour		730	m	7.20			5,256	5,256	
	Subtotal pumping main								68,197	
	SUBTOTAL								162,805	162,805
2	**Storage** need (kl/d) 435									
	Reinforced concrete reservoir		450	m3	746	335,700			335,700	335,700
3	**Distribution** need (l/s) 15.1									
	Pipeline (designed on BRANCH - World Bank, 1991)									
	Materials u PVC pipe (O.D.63-160mm Cl 9)						244,270		244,270	
	Fittings and valves 15%						36,641		36,641	
	Labour		6993	m	7.2			50,350	50,350	
	Subtotal								331,260	
	Connections									
	Standpipe Materials		37	ea.	644.72		23,854		23,854	
	Labour		37	ea.	390.00			14,430	14,430	
	Yard Materials		156	ea.	821.87		128,348		128,348	
	Labour		156	ea.	120.00			18,740	18,740	
	House Materials		94	ea.	1,061.76		99,487		99,487	
	Labour		94	ea.	180.00			16,866	16,866	
	Subtotal								301,726	
	SUBTOTAL (Distribution)								632,986	
	SUBTOTAL without individual connections (incl. standpipes)								369,545	369,545
	SUBTOTAL CAPITAL COSTS (exl. Prof. fees)					335,700	595,541	105,642		868,050
4	**Professional costs**									
	Technical 10% of capital cost (>500,000; <1.5M)					86,805			86,805	
	Social & training lump sum					50,000			50,000	
	Committee / local government costs - admin., overheads etc.					10,000			10,000	
	SUBTOTAL								146,805	
	Subtotal + VAT 14%								167,358	167,358
	TOTAL					503,058	595,541	105,642		**1,035,407**

Recurrent costs

	Item	Quantity	Unit	Rate	Economic life (yrs)	Capital Cost	CRF	Estimated costs: Annual	R/month
1	**Connection cost**								
	Yard: 50% of connection cost up front	471							
	50% household loan over 5 yrs Interest	15%			5	471	0.298	140	12
	House: 50% of connection cost up front	621							
	50% household loan over 5 yrs Interest	15%			5	621	0.298	185	15
2	**Staffing, administration & capacity building**								
	Salaries:								
	Water committee(chairperson, secretary & bookkeeper)	2	people/	750					1,500
	Pump operators	2	month	750					1,500
	Maintenance team	1		400					400
	Water Bailiffs	0.2		400					80
	Billing, collection etc. - standpipes (flat rate)	62	houses	1					62
	- individual connections (metered rate)	250	houses	5					1,249
	Transport	500	km	1.5					750
	Capacity building	2	ea.	200					400
	Administration & overheads	5%	%	5,942					297
2	**Operation costs**								
	Diesel for engines (estimated kWhr related to flow)	6,613	m3/mo	0.5					3,307
	Other (oil, etc.) (estimated % of power costs)	15%	%	3,307					496
3	**Routine maintenance (spare parts etc.)**								-
	Tools	1.5		50					75
	Source (borehole, pump, engine, pump house)	1		200					200
	Reservoir	1.5		50					75
	Distribution pipeline + pumping main	2		100					200
	Standpipes	62		0.1					6
	SUBTOTAL O & M COSTS								**10,598**
5	**Depreciation (replacement c** DF = 8%								
	Source (borehole, pump, engine, pump house)				10	94,609	0.149	14,099	1,175
	Reservoir				30	335,700	0.089	29,819	2,485
	Distribution pipeline + pumping main				30	399,457	0.089	35,483	2,957
	Standpipes				20	38,284	0.102	3,899	325
	SUBTOTAL DEPRECIATION COSTS					868,050			**6,942**
	TOTAL O & M + DEPRECIATION COSTS								**17,539**

Appendix 5.6 Summary of costs - base year

Present population (1998) 1874
No of households 312

All prices in SA Rands for May 1998
May, 1998:
£(UK) 1 = R 8.30
$(US) 1 = R 5.00

Connection costs:

	Up front payment	Monthly payment (over 5 years)
Yard connection:	471	12
House connection:	621	15

		Capital cost			O & M costs				Unit operating costs					
					O & M		O & M		Water		Water consumed		Unit costs	
							+ depreciation		produced		(less UFW)		O & M	O & M +
					R/mon	R/mon/	R/mon	R/mon/		average		average		deprec.
		(R)		R/capita		house		house	m3/d	l/c/d		l/c/d	R/m3	R/m3
Scenario 1: All communal standpipes														
1	Source development	100,370	17%											
2	Storage	111,900	18%											
3	Distribution	259,858	43%											
4	Professional	135,678	22%											
	TOTAL	607,805	100%	324	5,046	16	8,906	29	65	35	54	29	2.56	4.52
Scenario 2: All yard connections														
1	Source development	150,154	16%											
2	Storage	335,700	36%											
3	Distribution	298,828	32%											
4	Professional costs	157,854	17%											
	TOTAL	942,536	100%	503	9,885	32	#####	52	207	110	172	92	1.57	2.57
	Difference between scenarios 2 and 1	334,731	36%	179										
Scenario 3: All house connections														
1	Source development	351,227	23%											
2	Storage	522,200	35%											
3	Distribution	414,127	28%											
4	Professional costs	215,181	14%											
	TOTAL	1,502,736	100%	802	#####	42	#####	75	336	179	280	150	1.29	2.30
	Difference between scenarios 3 and 1	894,931	60%	478										
Scenario 4: Mixed level of service														
1	Source development	117,948	18%											
2	Storage	149,200	23%											
3	Distribution	260,536	40%											
4	Professional costs	128,556	20%											
	TOTAL	656,240	100%	350	7,645	24	#####	38	100	53	83	44	2.52	3.96
	Difference between scenarios 4 and 1	48,435	7%	26										
Scenario 5: Mixed level of service														
1	Source development	137,614	16%											
2	Storage	261,100	30%											
3	Distribution	317,346	37%											
4	Professional costs	150,031	17%											
	TOTAL	866,091	100%	462	9,127	29	#####	48	155	83	129	69	1.93	3.15
	Difference between scenarios 5 and 1	258,286	30%	138										
Scenario 6: Mixed level of service														
1	Source development	162,805	16%											
2	Storage	335,700	32%											
3	Distribution	369,545	36%											
4	Professional costs	167,358	16%											
	TOTAL	1,035,407	100%	553	#####	34	#####	56	217	116	181	97	1.60	2.65
	Difference between scenarios 6 and 1	427,602	41%	228										
Average														
1	Source development	-	18%											
2	Storage	-	29%											
3	Distribution	1,035,407	36%											
4	Professional costs	-	18%											
	TOTAL	1,035,407	100%	553	-	-	-	-	3			1	0.00	0.00

Appendix 5.7 Tariffs to break-even

Assumptions:

1	All consumers pay same metered rate
2	UFW is charged to consumer

Cash Flow

	Revenue									Cost							Net revenue	
Year										Capital	Loan repay	Capital	O & M	Replace	O & M +	Total	(Revenue - cost)	
	Standpipes		Individual		Institut.	UFW	Total	Tariff	Total	cost of	over 20 yrs	difference		ment	replace.			
			connections							scenario 1	at 13%							
												*1	*2	*3				
	no.	m3/d	no.	m3/d	m3/d	m3/d	m3/d	R/m3									Annual	Cumulative
1	250	37	62	35	11	17	83	9.77	295,854	607,805	86,523	70,650	82,580	56,100	138,680	295,854	-	-
2	253	38	67	37	11	17	86	7.55	237,434		86,523	9,238	84,583	57,090	141,673	237,434	-	-
3	257	39	71	39	12	18	90	7.37	241,036		86,523	9,849	86,609	58,056	144,664	241,036	-	-
4	260	39	76	42	12	19	93	7.19	244,678		86,523	10,509	88,654	58,991	147,646	244,678	-	-
5	264	40	81	45	13	19	97	7.01	248,357		86,523	11,224	90,718	59,892	150,609	248,357	- 0	- 0
6	267	40	86	48	13	20	101	6.84	252,070		86,523	11,999	92,796	60,752	153,547	252,070	-	- 0
7	270	41	92	51	14	21	105	6.67	255,814		86,523	12,839	94,886	61,566	156,452	255,814	-	- 0
8	273	41	98	54	14	22	109	6.49	259,588		86,523	13,751	96,986	62,329	159,314	259,588	0	-
9	276	41	104	58	15	23	114	6.32	263,392		86,523	14,741	99,093	63,035	162,128	263,392	-	-
10	279	42	111	62	16	24	119	6.15	267,227		86,523	15,817	101,207	63,679	164,886	267,227	-	-
11	281	42	118	66	16	25	124	5.99	271,097		86,523	16,989	103,326	64,258	167,584	271,097	-	-
12	283	42	126	70	17	26	129	5.82	275,008		86,523	18,265	105,452	64,768	170,220	275,008	-	-
13	285	43	134	75	18	27	135	5.66	278,973		86,523	19,656	107,586	65,208	172,794	278,973	-	-
14	287	43	143	79	18	28	141	5.50	283,007		86,523	21,174	109,733	65,578	175,310	283,007	-	-
15	288	43	153	85	19	29	147	5.34	287,136		86,523	22,831	111,900	65,881	177,782	287,136	-	-
16	289	43	163	90	20	31	154	5.19	291,392		86,523	24,643	114,100	66,125	180,226	291,392	-	-
17	290	43	174	96	21	32	161	5.04	295,820		86,523	26,625	116,349	66,322	182,671	295,820	- 0	- 0
18	290	43	185	103	22	34	168	4.90	300,479		86,523	28,796	118,669	66,490	185,160	300,479	-	- 0
19	289	43	197	109	23	35	176	4.76	305,448		86,523	31,176	121,093	66,656	187,749	305,448	-	- 0
20	289	43	210	117	24	37	184	4.63	310,826		86,523	33,786	123,661	66,856	190,517	310,826	-	- 0
												353,908		1,259,633				

1 Capital cost derived from best fit curve of capital cost vs consumption: Capital cost (R) =4.773(water produced(m3/d))^2 + 1,390.6*(production) + 492,932
Note: this capital investment is an averaged figure corresponding to the scale of infrastructure needed to meet the demand consumption, in reality, this investment would be more 'lumpy' as various capital items needed upgrading

*2 Based on marginal O & M costs derived from best fit curve of cost vs consumption data: O & M cost (R/m3) = 0.00002(production (m3/d))^2 - 0.0125(production) + 3.3486

3 Based on marginal depreciation costs: Depreciation (R/m3) = .00002(production(m3/d))^2 - 0.0123*(production) + 2.5698

Appendix 5.8 Average Incremental Costs - scenario 4

Year	Discount	Capital cost			Capital cost			Capital cost difference			Replacement costs			O & M costs			Water		Water		
	factor	of communal			of scenario 4			between scenario 4 &			(based on depreciation)						produced		Consumed		
		standpipe supply						scenario 1									Total		Total		PV
		(scenario 1) *4				Incre-			Incre-								(+ UFW)		domestic		
	8%	Full repayment of loan		Interest	*1	mental	PV		mental	PV	*2		PV	*3		PV			&		8%
		20	years at	13%		Increase			Increase										Institutional		
		R	R		R	R	R	R	R	R	R/m3	R/yr.	R/yr.	R/m3	(R/yr.)	(R/yr.)	m3/day	(m3/yr)	m3/day	(m3/yr)	(m3/yr)
1	0.926	607,805	86,523	80,114	678,455	678,455	628,200	70,650	70,650	65,417	1.54	56,100	51,945	2.27	82,580	76,463	99	36,328	83	30,273	28,031
2	0.857		86,523	74,180	687,693	9,238	7,920	79,888	9,238	7,920	1.51	57,090	48,946	2.24	84,583	72,516	103	37,758	86	31,465	26,976
3	0.794		86,523	68,685	697,542	9,849	7,818	89,737	9,849	7,818	1.48	58,056	46,087	2.21	86,609	68,753	107	39,259	90	32,716	25,971
4	0.735		86,523	63,597	708,051	10,509	7,725	100,246	10,509	7,725	1.44	58,991	43,360	2.17	88,654	65,164	112	40,834	93	34,028	25,012
5	0.681		86,523	58,886	719,275	11,224	7,639	111,470	11,224	7,639	1.41	59,892	40,761	2.14	90,718	61,741	116	42,487	97	35,406	24,097
6	0.630		86,523	54,524	731,274	11,999	7,561	123,469	11,999	7,561	1.37	60,752	38,284	2.10	92,796	58,477	121	44,224	101	36,853	23,224
7	0.583		86,523	50,486	744,113	12,839	7,491	136,308	12,839	7,491	1.34	61,566	35,923	2.06	94,886	55,365	126	46,048	105	38,374	22,391
8	0.540		86,523	46,746	757,864	13,751	7,429	150,059	13,751	7,429	1.30	62,329	33,674	2.02	96,986	52,398	131	47,966	109	39,971	21,595
9	0.500		86,523	43,283	772,605	14,741	7,374	164,800	14,741	7,374	1.26	63,035	31,533	1.98	99,093	49,571	137	49,982	114	41,652	20,836
10	0.463		86,523	40,077	788,422	15,817	7,327	180,617	15,817	7,327	1.22	63,679	29,496	1.94	101,207	46,878	143	52,102	119	43,419	20,111
11	0.429		86,523	37,108	805,411	16,989	7,286	197,606	16,989	7,286	1.18	64,258	27,559	1.90	103,326	44,315	149	54,333	124	45,278	19,419
12	0.397		86,523	34,360	823,676	18,265	7,253	215,871	18,265	7,253	1.14	64,768	25,720	1.86	105,452	41,876	155	56,681	129	47,234	18,757
13	0.368		86,523	31,814	843,332	19,656	7,227	235,526	19,656	7,227	1.10	65,208	23,977	1.82	107,586	39,559	162	59,153	135	49,294	18,125
14	0.340		86,523	29,458	864,505	21,174	7,209	256,700	21,174	7,209	1.06	65,578	22,327	1.78	109,733	37,360	169	61,756	141	51,464	17,521
15	0.315		86,523	27,276	887,336	22,831	7,197	279,531	22,831	7,197	1.02	65,881	20,769	1.73	111,900	35,276	177	64,499	147	53,749	16,944
16	0.292		86,523	25,255	911,979	24,643	7,193	304,174	24,643	7,193	0.98	66,125	19,301	1.69	114,100	33,305	185	67,390	154	56,158	16,392
17	0.270		86,523	23,385	938,605	26,625	7,196	330,800	26,625	7,196	0.94	66,322	17,925	1.65	116,349	31,445	193	70,436	161	58,697	15,864
18	0.250		86,523	21,652	967,401	28,796	7,206	359,596	28,796	7,206	0.90	66,490	16,639	1.61	118,669	29,697	202	73,650	168	61,375	15,359
19	0.232		86,523	20,049	998,577	31,176	7,224	390,772	31,176	7,224	0.87	66,656	15,445	1.57	121,093	28,059	211	77,039	176	64,199	14,876
20	0.215		86,523	18,563	1,032,363	33,786	7,249	424,558	33,786	7,249	0.83	66,856	14,344	1.53	123,661	26,531	221	80,615	184	67,179	14,413
Total			1,730,467	849,499			768,725			205,942			604,015			954,749					405,913

Average Incremental Cost (AIC) = Present Value of Costs / PV of Water Consumed

AIC (O & M)	**R 954,749 /**	**405,913 m3 =**	**R 2.35 /m3**
AIC (replacement)	**R 604,015 /**	**405,913 m3 =**	**R 1.49 /m3**
AIC (O & M + replacement)			**R 3.84 /m3**
AIC (capital difference)	**R 205,942 /**	**405,913 m3 =**	**R 0.51 /m3**
AIC (O & M + replace + capital difference)			**R 4.35 /m3**
AIC (capital cost of communal standpipe supply + interest)	**R 849,499 /**	**405,913 m3 =**	**R 2.09 /m3**
AIC (O & M + replace + full capital redemption)		**m3 =**	**R 6.44 /m3**

1 Capital cost derived from best fit curve of capital cost vs consumption: Capital cost (R) =4.773(water produced(m3/d))^2 + 1,390.6*(production) + 492,932
Note: this capital investment is an averaged figure corresponding to the scale of infrastructure needed to meet the demand consumption, in reality, this investment would be more 'lumpy' as various capital items needed upgrading

*2 Based on unit costs of replacement cost vs consumption:
Unit cost (R/m3) = .00002*(production(m3/d))^2 - 0.0123*(production) + 2.5698

*3 Unit costs derived from best fit curve of cost vs consumption data
O & M cost (R/m3) = 0.00002(production (m3/d))^2 - 0.0125(production) + 3.3486

*4 Repayment of principle loan + interest set on Capital Recovery Factor at 13% (consistent with PDG, 1996) over 20 years.

Average Incremental Costs - Scenario 5

Year	Discount	Capital cost			Capital cost			Capital cost difference			Replacement costs			O & M costs			Water		Water		
	factor	of communal			of scenario 5			between scenario 5 &			(based on depreciation)						produced		Consumed		
		standpipe supply						scenario 1									Total		Total		PV
		(scenario 1) *4				Incre-			Incre-								(+ UFW)		domestic		
	8%	Full repayment of loan		Interest	*1	mental	PV		mental	PV	*2		PV	*3		PV			&		8%
		20	years at	13%		Increase			Increase										Institutional		
		R	R		R	R	R	R	R	R	R/m3	R/yr.	R/yr.	R/m3	(R/yr)	(R/yr)	m3/day	(m3/yr)	m3/day	(m3/yr)	(m3/yr)
1	0.926	607,805	86,523	80,114	823,151	823,151	762,177	215,346	215,346	199,394	1.14	64,755	59,958	1.86	105,393	97,586	155	56,614	129	47,179	43,684
2	0.857		86,523	74,180	845,188	22,037	18,893	237,383	22,037	18,893	1.10	65,244	55,936	1.81	107,780	92,404	163	59,384	135	49,486	42,427
3	0.794		86,523	68,685	869,084	23,896	18,969	261,279	23,896	18,969	1.05	65,646	52,112	1.77	110,179	87,463	171	62,312	142	51,926	41,221
4	0.735		86,523	63,597	895,022	25,938	19,065	287,217	25,938	19,065	1.01	65,965	48,487	1.72	112,600	82,765	179	65,408	149	54,507	40,064
5	0.681		86,523	58,886	923,206	28,184	19,182	315,401	28,184	19,182	0.96	66,215	45,065	1.68	115,062	78,310	188	68,684	157	57,236	38,954
6	0.630		86,523	54,524	953,862	30,656	19,318	346,057	30,656	19,318	0.92	66,415	41,853	1.63	117,590	74,102	198	72,149	165	60,124	37,888
7	0.583		86,523	50,486	987,241	33,379	19,476	379,436	33,379	19,476	0.88	66,596	38,858	1.59	120,220	70,147	208	75,817	173	63,181	36,865
8	0.540		86,523	46,746	1,023,623	36,382	19,656	415,818	36,382	19,656	0.84	66,800	36,090	1.54	123,000	66,453	218	79,699	182	66,416	35,882
9	0.500		86,523	43,283	1,063,319	39,696	19,858	455,514	39,696	19,858	0.80	67,088	33,561	1.50	125,999	63,031	229	83,809	191	69,841	34,938
10	0.463		86,523	40,077	1,106,675	43,356	20,082	498,870	43,356	20,082	0.77	67,543	31,286	1.47	129,303	59,892	241	88,163	201	73,469	34,030
11	0.429		86,523	37,108	1,154,078	47,403	20,330	546,273	47,403	20,330	0.74	68,274	29,281	1.43	133,030	57,054	254	92,773	212	77,311	33,157
12	0.397		86,523	34,360	1,205,959	51,881	20,603	598,154	51,881	20,603	0.71	69,423	27,569	1.41	137,327	54,535	267	97,658	223	81,382	32,318
13	0.368		86,523	31,814	1,262,798	56,840	20,900	654,993	56,840	20,900	0.69	71,177	26,172	1.38	142,389	52,356	282	102,835	235	85,696	31,510
14	0.340		86,523	29,458	1,325,134	62,336	21,223	717,329	62,336	21,223	0.68	73,774	25,117	1.37	148,460	50,545	297	108,321	247	90,268	30,733
15	0.315		86,523	27,276	1,393,566	68,432	21,573	785,761	68,432	21,573	0.68	77,519	24,437	1.37	155,851	49,131	312	114,137	260	95,114	29,984
16	0.292		86,523	25,255	1,468,766	75,200	21,950	860,961	75,200	21,950	0.69	82,798	24,168	1.37	164,957	48,149	329	120,304	274	100,253	29,263
17	0.270		86,523	23,385	1,551,486	82,719	22,356	943,680	82,719	22,356	0.71	90,099	24,351	1.39	176,269	47,640	347	126,843	289	105,702	28,568
18	0.250		86,523	21,652	1,642,565	91,080	22,793	1,034,760	91,080	22,793	0.75	100,032	25,033	1.42	190,406	47,649	366	133,779	305	111,482	27,898
19	0.232		86,523	20,049	1,742,948	100,382	23,260	1,135,142	100,382	23,260	0.80	113,363	26,268	1.47	208,139	48,228	386	141,137	322	117,614	27,253
20	0.215		86,523	18,563	1,853,688	110,741	23,759	1,245,883	110,741	23,759	0.88	131,042	28,115	1.55	230,423	49,437	408	148,943	340	124,119	26,630
Total			1,730,467	849,499			1,155,424			592,641			703,716			1,276,876					683,268

Average Incremental Cost (AIC) = Present Value of Costs / PV of Water Consumed

AIC (O & M)	**R 1,276,876 /**	**683,268 m3**	**=**	**R 1.87 /m3**
AIC (replacement)	**R 703,716 /**	**683,268 m3**	**=**	**R 1.03 /m3**
AIC (O & M + replacement)				**R 2.90 /m3**
AIC (capital difference)	**R 592,641 /**	**683,268 m3**	**=**	**R 0.87 /m3**
AIC (O & M + replace + capital difference)				**R 3.77 /m3**
AIC (capital cost of communal standpipe supply + interest)	**R 849,499 /**	**683,268 m3**	**=**	**R 1.24 /m3**
AIC (O & M + replace + full capital redemption)		**m3**	**=**	**R 5.01 /m3**

1 Capital cost derived from best fit curve of capital cost vs consumption: Capital cost (R) =4.773(water produced(m3/d))^2 + 1,390.6*(production) + 492,932
Note: this capital investment is an averaged figure corresponding to the scale of infrastructure needed to meet the demand consumption, in reality, this investment would be more 'lumpy' as various capital items needed upgrading

*2 Based on unit costs of replacement cost vs consumption:
Unit cost (R/m3) = .00002*(production(m3/d))^2 - 0.0123*(production) + 2.5698

*3 Unit costs derived from best fit curve of cost vs consumption data
O & M cost (R/m3) = 0.00002(production (m3/d))^2 - 0.0125(production) + 3.3486

*4 Repayment of principle loan + interest set on Capital Recovery Factor at 13% (consistent with PDG, 1996) over 20 years.

Average Incremental Costs - Scenario 6

Year	Discount	Capital cost			Capital cost			Capital cost difference			Replacement costs			O & M costs			Water		Water		
	factor	of communal			of scenario 6			between scenario 6 &			(based on depreciation)						produced		Consumed		
		standpipe supply						scenario 1									Total		Total		PV
		(scenario 1) *4				Incre-			Incre-								(+ UFW)		domestic		
	8%	Full repayment of loan		Interest	*1	mental	PV		mental	PV	*2		PV	*3		PV			&		8%
		20	years at	13%		Increase			Increase										Institutional		
		R	R		R	R	R	R	R	R	R/m3	R/yr.	R/yr.	R/m3	(R/yr)	(R/yr)	m3/day	(m3/yr)	m3/day	(m3/yr)	(m3/yr)
1	0.926	######	86,523	80,114	1,019,456	1,019,456	943,941	411,651	411,651	381,158	0.84	66,774	61,828	1.55	122,684	113,597	217	79,260	181	66,050	61,157
2	0.857		86,523	74,180	1,060,524	41,068	35,209	452,718	41,068	35,209	0.80	67,065	57,497	1.51	125,787	107,842	229	83,524	191	69,603	59,674
3	0.794		86,523	68,685	1,105,490	44,966	35,696	497,685	44,966	35,696	0.77	67,528	53,606	1.47	129,212	102,573	241	88,045	201	73,371	58,244
4	0.735		86,523	63,597	1,154,776	49,286	36,227	546,971	49,286	36,227	0.74	68,287	50,193	1.43	133,086	97,822	254	92,840	212	77,367	56,867
5	0.681		86,523	58,886	1,208,852	54,076	36,803	601,046	54,076	36,803	0.71	69,499	47,300	1.40	137,575	93,631	268	97,926	223	81,605	55,539
6	0.630		86,523	54,524	1,268,243	59,391	37,426	660,438	59,391	37,426	0.69	71,374	44,978	1.38	142,896	90,049	283	103,322	236	86,101	54,258
7	0.583		86,523	50,486	1,333,538	65,295	38,099	725,733	65,295	38,099	0.68	74,182	43,284	1.37	149,325	87,130	299	109,047	249	90,872	53,023
8	0.540		86,523	46,746	1,405,395	71,857	38,822	797,590	71,857	38,822	0.68	78,267	42,285	1.37	157,213	84,937	315	115,122	263	95,935	51,831
9	0.500		86,523	43,283	1,484,553	79,158	39,599	876,748	79,158	39,599	0.69	84,068	42,055	1.37	167,008	83,545	333	121,571	277	101,309	50,680
10	0.463		86,523	40,077	1,571,838	87,285	40,430	964,033	87,285	40,430	0.72	92,144	42,680	1.40	179,272	83,037	352	128,416	293	107,013	49,568
11	0.429		86,523	37,108	1,668,178	96,340	41,318	1,060,373	96,340	41,318	0.76	103,193	44,258	1.44	194,712	83,509	371	135,683	310	113,069	48,494
12	0.397		86,523	34,360	1,774,613	106,435	42,267	1,166,808	106,435	42,267	0.82	118,097	46,898	1.49	214,215	85,068	393	143,400	327	119,500	47,455
13	0.368		86,523	31,814	1,892,312	117,699	43,278	1,284,506	117,699	43,278	0.91	137,952	50,725	1.58	238,884	87,837	415	151,596	346	126,330	46,451
14	0.340		86,523	29,458	2,022,586	130,274	44,353	1,414,781	130,274	44,353	1.02	164,129	55,879	1.68	270,091	91,956	439	160,300	366	133,584	45,480
15	0.315		86,523	27,276	2,166,910	144,324	45,497	1,559,105	144,324	45,497	1.17	198,326	62,521	1.83	309,542	97,581	464	169,547	387	141,289	44,540
16	0.292		86,523	25,255	2,326,942	160,032	46,712	1,719,137	160,032	46,712	1.35	242,649	70,827	2.00	359,344	104,889	491	179,371	409	149,475	43,630
17	0.270		86,523	23,385	2,504,546	177,604	48,001	1,896,741	177,604	48,001	1.58	299,702	81,000	2.22	422,103	114,081	520	189,808	433	158,174	42,749
18	0.250		86,523	21,652	2,701,820	197,273	49,367	2,094,014	197,273	49,367	1.86	372,695	93,267	2.49	501,029	125,382	550	200,900	458	167,417	41,896
19	0.232		86,523	20,049	2,921,124	219,304	50,815	2,313,319	219,304	50,815	2.19	465,584	107,882	2.82	600,075	139,045	582	212,688	485	177,240	41,069
20	0.215		86,523	18,563	3,165,117	243,994	52,348	2,557,312	243,994	52,348	2.59	583,231	125,131	3.22	724,099	155,354	617	225,217	514	187,680	40,267
Total			1,730,467	849,499			1,746,209			1,183,426			1,224,094			2,028,865				992,872

Average Incremental Cost (AIC) = Present Value of Costs / PV of Water Consumed

AIC (O & M)	**R 2,028,865 /**	**992,872 m3 =**	**R 2.04 /m3**
AIC (replacement)	**R 1,224,094 /**	**992,872 m3 =**	**R 1.23 /m3**
AIC (O & M + replacement)			**R 3.28 /m3**
AIC (capital difference)	**R 1,183,426 /**	**992,872 m3 =**	**R 1.19 /m3**
AIC (O & M + replace + capital difference)			**R 4.47 /m3**
AIC (capital cost of communal standpipe supply + interest)	**R 849,499 /**	**992,872 m3 =**	**R 0.86 /m3**
AIC (O & M + replace + full capital redemption)		**m3 =**	**R 5.32 /m3**

1 Capital cost derived from best fit curve of capital cost vs consumption: Capital cost (R) =4.773(water produced(m3/d))^2 + 1,390.6*(production) + 492,932
Note: this capital investment is an averaged figure corresponding to the scale of infrastructure needed to meet the demand consumption, in reality, this investment would be more 'lumpy' as various capital items needed upgrading

*2 Based on unit costs of replacement cost vs consumption:
Unit cost (R/m3) = .00002*(production(m3/d))^2 - 0.0123*(production) + 2.5698

*3 Unit costs derived from best fit curve of cost vs consumption data
O & M cost (R/m3) = 0.00002(production (m3/d))^2 - 0.0125(production) + 3.3486

*4 Repayment of principle loan + interest set on Capital Recovery Factor at 13% (consistent with PDG, 1996) over 20 years.

Appendix 5.9 Cash flows - option 1

Assumptions:

		Tariff
1	DWAF subsidises capital cost of RDP level of service (scenario 1) = R607,805	(R 324 / capita)
2	Communal standpipe users pay flat rate based on O & M costs for RDP LOS	R 16 /house/month
3	Individual connections (yard & house) pay AIC based on O & M, depreciation + capital differenc	R 4.35 /m3
	+ connection costs (half up front + half over 5 yr.)	/m3
4	Institutions pay AIC based on O & M + deprec. + full capital cost	R 6.44 /m3

Cash Flow

	Revenue									Cost					Net revenue		Net Present Value		Internal Rate of Return
Year										Capital	O & M	Replace	O & M +	Total	(Revenue - cost)				
	Standpipes			Individual connections			Institutional water		Total	difference		ment	replace.				DF	PV	7.6%
	no.	R/mon	R/yr.	no.	m3/d	R/yr.	m3/d	R/yr.							Annual	Cumulative	8%		
1	250	4,032	48,387	62	35	54,993	11	25,430	128,811	70,650	82,580	56,100	138,680	209,330	- 80,520	- 80,520	0.926	- 74,555	0.930 - 74,860
2	253	4,092	49,101	67	37	58,622	11	26,432	134,155	9,238	84,583	57,090	141,673	150,911	- 16,756	- 97,275	0.857	- 14,365	0.864 - 14,483
3	257	4,150	49,800	71	39	62,492	12	27,482	139,774	9,849	86,609	58,056	144,664	154,513	- 14,739	- 112,014	0.794	- 11,700	0.804 - 11,844
4	260	4,207	50,481	76	42	66,616	12	28,585	145,682	10,509	88,654	58,991	147,646	158,155	- 12,473	- 124,487	0.735	- 9,168	0.747 - 9,319
5	264	4,262	51,143	81	45	71,013	13	29,742	151,898	11,224	90,718	59,892	150,609	161,834	- 9,936	- 134,423	0.681	- 6,762	0.695 - 6,902
6	267	4,315	51,781	86	48	75,699	13	30,958	158,438	11,999	92,796	60,752	153,547	165,546	- 7,108	- 141,531	0.630	- 4,479	0.646 - 4,590
7	270	4,366	52,393	92	51	80,696	14	32,235	165,323	12,839	94,886	61,566	156,452	169,291	- 3,967	- 145,499	0.583	- 2,315	0.600 - 2,382
8	273	4,415	52,975	98	54	86,022	14	33,578	172,574	13,751	96,986	62,329	159,314	173,065	- 491	- 145,990	0.540	- 265	0.558 - 274
9	276	4,460	53,523	104	58	91,699	15	34,989	180,211	14,741	99,093	63,035	162,128	176,869	3,342	- 142,648	0.500	1,672	0.519 1,734
10	279	4,503	54,034	111	62	97,751	16	36,473	188,259	15,817	101,207	63,679	164,886	180,704	7,555	- 135,093	0.463	3,499	0.482 3,645
11	281	4,542	54,503	118	66	104,203	16	38,035	196,741	16,989	103,326	64,258	167,584	184,573	12,168	- 122,925	0.429	5,219	0.449 5,458
12	283	4,577	54,926	126	70	111,080	17	39,679	205,685	18,265	105,452	64,768	170,220	188,485	17,200	- 105,725	0.397	6,830	0.417 7,173
13	285	4,608	55,298	134	75	118,411	18	41,409	215,118	19,656	107,586	65,208	172,794	192,449	22,669	- 83,056	0.368	8,335	0.388 8,789
14	287	4,634	55,612	143	79	126,226	18	43,232	225,070	21,174	109,733	65,578	175,310	196,484	28,586	- 54,470	0.340	9,732	0.360 10,304
15	288	4,655	55,864	153	85	134,557	19	45,152	235,573	22,831	111,900	65,881	177,782	200,613	34,960	- 19,510	0.315	11,021	0.335 11,716
16	289	4,671	56,047	163	90	143,438	20	47,175	246,660	24,643	114,100	66,125	180,226	204,869	41,792	22,282	0.292	12,199	0.312 13,021
17	290	4,680	56,155	174	96	152,905	21	49,308	258,368	26,625	116,349	66,322	182,671	209,297	49,071	71,353	0.270	13,262	0.290 14,215
18	290	4,682	56,179	185	103	162,997	22	51,557	270,733	28,796	118,669	66,490	185,160	213,956	56,777	128,130	0.250	14,208	0.269 15,291
19	289	4,676	56,114	197	109	173,755	23	53,930	283,798	31,176	121,093	66,656	187,749	218,925	64,874	193,004	0.232	15,032	0.250 16,243
20	289	4,662	55,950	210	117	185,222	24	56,433	297,605	33,786	123,661	66,856	190,517	224,303	73,302	266,306	0.215	15,727	0.233 17,064
										353,908		1,259,633						**- 6,873**	**- 0**

Typical tariff

	Consumption		Connection		Tariff		Total	Average
		m3/house	up front	/mon			R/house	actual
	l/c/d	/month			R/m3	R	/month	unit cost
Standpipe	25	4,566					**16**	(3.54)
Yard connection	80	14,610	471	12	4.35	64	**75**	(5.15)
House connection	130	23,741	621	15	4.35	103	**119**	(5.00)
Institutions					R 6.44			

Comments:

1 Institutions and individual connections subsidise communal standpipes and UFW
2 Communal standpipes don't pay actual cost of O & M - pay O & M cost for 'RDP level of service'
3 WSP needs incentives to reduce UFW
4 Main influences on net present value:
Annual increase in individual connections (this example is set at 4% per anum)

Cash flows - option 2

Assumptions:

		Tariff
1	DWAF subsidises capital cost of RDP level of service (scenario 1) = R607,805	(R 324 / capita)
2	Communal standpipe users pay flat rate based on O & M costs for RDP LOS	R 5 /house/month
3	Individual connections (yard & house) pay AIC based on O & M, depreciation + capital differenc	R 6.16 /m3
	+ connection costs (half up front + half over 5 yr.)	/m3
4	Institutions pay AIC based on O & M + deprec. + full capital cost	R 6.16 /m3

Cash Flow

	Revenue									Cost					Net revenue		Net Present		Internal Rate	
Year										Capital	O & M	Replace	O & M +	Total	(Revenue - cost)		Value		of Return	
	Standpipes			Individual connections			Institutional water		Total	difference		ment	replace.				DF	PV	8.0%	
	no.	R/mon	R/yr.	no.	m3/d	R/yr.	m3/d	R/yr.							Annual	Cumulative	8%			
1	250	1,248	14,976	62	35	77,965	11	24,338	117,279	70,650	82,580	56,100	138,680	209,330	- 92,052	- 92,052	0.926	- 85,233	0.926	- 85,233
2	253	1,266	15,197	67	37	83,111	11	25,296	123,604	9,238	84,583	57,090	141,673	150,911	- 27,307	- 119,359	0.857	- 23,412	0.857	- 23,412
3	257	1,284	15,413	71	39	88,596	12	26,301	130,311	9,849	86,609	58,056	144,664	154,513	- 24,202	- 143,561	0.794	- 19,213	0.794	- 19,213
4	260	1,302	15,624	76	42	94,443	12	27,357	137,424	10,509	88,654	58,991	147,646	158,155	- 20,731	- 164,292	0.735	- 15,238	0.735	- 15,238
5	264	1,319	15,829	81	45	100,677	13	28,464	144,970	11,224	90,718	59,892	150,609	161,834	- 16,864	- 181,156	0.681	- 11,477	0.681	- 11,477
6	267	1,336	16,026	86	48	107,321	13	29,628	152,975	11,999	92,796	60,752	153,547	165,546	- 12,571	- 193,728	0.630	- 7,922	0.630	- 7,922
7	270	1,351	16,216	92	51	114,404	14	30,850	161,470	12,839	94,886	61,566	156,452	169,291	- 7,821	- 201,548	0.583	- 4,563	0.583	- 4,563
8	273	1,366	16,396	98	54	121,955	14	32,135	170,486	13,751	96,986	62,329	159,314	173,065	- 2,579	- 204,127	0.540	- 1,393	0.540	- 1,393
9	276	1,380	16,566	104	58	130,004	15	33,485	180,055	14,741	99,093	63,035	162,128	176,869	3,186	- 200,941	0.500	1,594	0.500	1,594
10	279	1,394	16,724	111	62	138,584	16	34,906	190,214	15,817	101,207	63,679	164,886	180,704	9,511	- 191,430	0.463	4,405	0.463	4,405
11	281	1,406	16,869	118	66	147,731	16	36,401	201,001	16,989	103,326	64,258	167,584	184,573	16,427	- 175,003	0.429	7,045	0.429	7,045
12	283	1,417	17,000	126	70	157,481	17	37,974	212,455	18,265	105,452	64,768	170,220	188,485	23,970	- 151,033	0.397	9,519	0.397	9,519
13	285	1,426	17,115	134	75	167,875	18	39,630	224,620	19,656	107,586	65,208	172,794	192,449	32,170	- 118,862	0.368	11,829	0.368	11,829
14	287	1,434	17,212	143	79	178,955	18	41,374	237,541	21,174	109,733	65,578	175,310	196,484	41,057	- 77,806	0.340	13,978	0.340	13,978
15	288	1,441	17,290	153	85	190,766	19	43,211	251,267	22,831	111,900	65,881	177,782	200,613	50,655	- 27,151	0.315	15,968	0.315	15,968
16	289	1,446	17,347	163	90	203,356	20	45,148	265,851	24,643	114,100	66,125	180,226	204,869	60,982	33,831	0.292	17,800	0.292	17,800
17	290	1,448	17,380	174	96	216,778	21	47,189	281,347	26,625	116,349	66,322	182,671	209,297	72,050	105,882	0.270	19,473	0.270	19,473
18	290	1,449	17,388	185	103	231,085	22	49,342	297,815	28,796	118,669	66,490	185,160	213,956	83,859	189,740	0.250	20,986	0.250	20,986
19	289	1,447	17,367	197	109	246,337	23	51,612	315,317	31,176	121,093	66,656	187,749	218,925	96,392	286,133	0.232	22,335	0.232	22,335
20	289	1,443	17,317	210	117	262,595	24	54,008	333,920	33,786	123,661	66,856	190,517	224,303	109,617	395,749	0.215	23,518	0.215	23,518
										353,908		1,259,633						**- 0**		**0**

Typical tariff

	Consumption		Connection		Tariff		Total	Average
		m3/house	up front	/mon			R/house	actual
	l/c/d	/month			R/m3	R	/month	unit cost
Standpipe	25	4,566					**5**	(1.10)
Yard connection	80	14,610	471	12	6.16	90	**102**	(6.96)
House connection	130	23,741	621	15	6.16	146	**162**	(6.81)
Institutions					R 6.16			

Comments:

1 Institutions and individual connections subsidise communal standpipes and UFW
2 Communal standpipes don't pay actual cost of O & M - pay O & M cost for 'RDP level of service'
3 WSP needs incentives to reduce UFW
4 Main influences on net present value:
Annual increase in individual connections (this example is set at 4% per anum)

Cash flows - option 3

Assumptions:

		Tariff
1	DWAF subsidises capital cost of RDP level of service (scenario 1) = R607,805	(R 324 / capita)
2	Communal standpipe users pay flat rate based on O & M costs for RDP LOS	R 0 /house/month
3	Individual connections (yard & house) pay AIC based on O & M, depreciation + capital differenc	R 5.63 /m3
	+ connection costs (half up front + half over 5 yr.)	/m3
4	Institutions pay AIC based on O & M + deprec. + full capital cost	R 11.26 /m3

Cash Flow

	Revenue									Cost					Net revenue		Net Present Value		Internal Rate of Return	
Year										Capital	O & M	Replace	O & M +	Total	(Revenue - cost)					
	Standpipes			Individual connections			Institutional water		Total	difference		ment	replace.				DF	PV	8.0%	
	no.	R/mon	R/yr.	no.	m3/d	R/yr.	m3/d	R/yr.							Annual	Cumulative	8%			
1	250	-	-	62	35	71,223	11	44,466	115,689	70,650	82,580	56,100	138,680	209,330	- 93,641	- 93,641	0.926	- 86,705	0.926	- 86,705
2	253	-	-	67	37	75,924	11	46,217	122,141	9,238	84,583	57,090	141,673	150,911	- 28,770	- 122,412	0.857	- 24,666	0.857	- 24,666
3	257	-	-	71	39	80,935	12	48,054	128,989	9,849	86,609	58,056	144,664	154,513	- 25,524	- 147,936	0.794	- 20,262	0.794	- 20,262
4	260	-	-	76	42	86,276	12	49,982	136,258	10,509	88,654	58,991	147,646	158,155	- 21,897	- 169,833	0.735	- 16,095	0.735	- 16,095
5	264	-	-	81	45	91,971	13	52,006	143,976	11,224	90,718	59,892	150,609	161,834	- 17,857	- 187,690	0.681	- 12,154	0.681	- 12,154
6	267	-	-	86	48	98,041	13	54,131	152,172	11,999	92,796	60,752	153,547	165,546	- 13,375	- 201,065	0.630	- 8,428	0.630	- 8,428
7	270	-	-	92	51	104,511	14	56,365	160,876	12,839	94,886	61,566	156,452	169,291	- 8,415	- 209,480	0.583	- 4,910	0.583	- 4,910
8	273	-	-	98	54	111,409	14	58,712	170,121	13,751	96,986	62,329	159,314	173,065	- 2,944	- 212,424	0.540	- 1,591	0.540	- 1,591
9	276	-	-	104	58	118,762	15	61,180	179,942	14,741	99,093	63,035	162,128	176,869	3,073	- 209,351	0.500	1,537	0.500	1,537
10	279	-	-	111	62	126,600	16	63,775	190,375	15,817	101,207	63,679	164,886	180,704	9,672	- 199,679	0.463	4,480	0.463	4,480
11	281	-	-	118	66	134,956	16	66,506	201,462	16,989	103,326	64,258	167,584	184,573	16,888	- 182,791	0.429	7,243	0.429	7,243
12	283	-	-	126	70	143,863	17	69,380	213,243	18,265	105,452	64,768	170,220	188,485	24,758	- 158,033	0.397	9,832	0.397	9,832
13	285	-	-	134	75	153,358	18	72,405	225,763	19,656	107,586	65,208	172,794	192,449	33,314	- 124,719	0.368	12,250	0.368	12,250
14	287	-	-	143	79	163,480	18	75,592	239,072	21,174	109,733	65,578	175,310	196,484	42,588	- 82,131	0.340	14,499	0.340	14,499
15	288	-	-	153	85	174,269	19	78,949	253,218	22,831	111,900	65,881	177,782	200,613	52,606	- 29,525	0.315	16,584	0.315	16,584
16	289	-	-	163	90	185,771	20	82,487	268,258	24,643	114,100	66,125	180,226	204,869	63,390	33,864	0.292	18,503	0.292	18,503
17	290	-	-	174	96	198,032	21	86,217	284,249	26,625	116,349	66,322	182,671	209,297	74,952	108,816	0.270	20,257	0.270	20,257
18	290	-	-	185	103	211,102	22	90,150	301,252	28,796	118,669	66,490	185,160	213,956	87,296	196,112	0.250	21,846	0.250	21,846
19	289	-	-	197	109	225,035	23	94,298	319,333	31,176	121,093	66,656	187,749	218,925	100,408	296,520	0.232	23,266	0.232	23,266
20	289	-	-	210	117	239,887	24	98,675	338,562	33,786	123,661	66,856	190,517	224,303	114,259	410,780	0.215	24,514	0.215	24,514
										353,908		1,259,633						**0**		**0**

Typical tariff

	Consumption		Connection		Tariff		Total	Average
		m3/house	up front	/mon			R/house	actual
	l/c/d	/month			R/m3	R	/month	unit cost
Standpipe	25	4,566					**0**	(0.00)
Yard connection	80	14,610	471	12	5.63	82	**94**	(6.43)
House connection	130	23,741	621	15	5.63	134	**149**	(6.28)
Institutions					R 11.26			

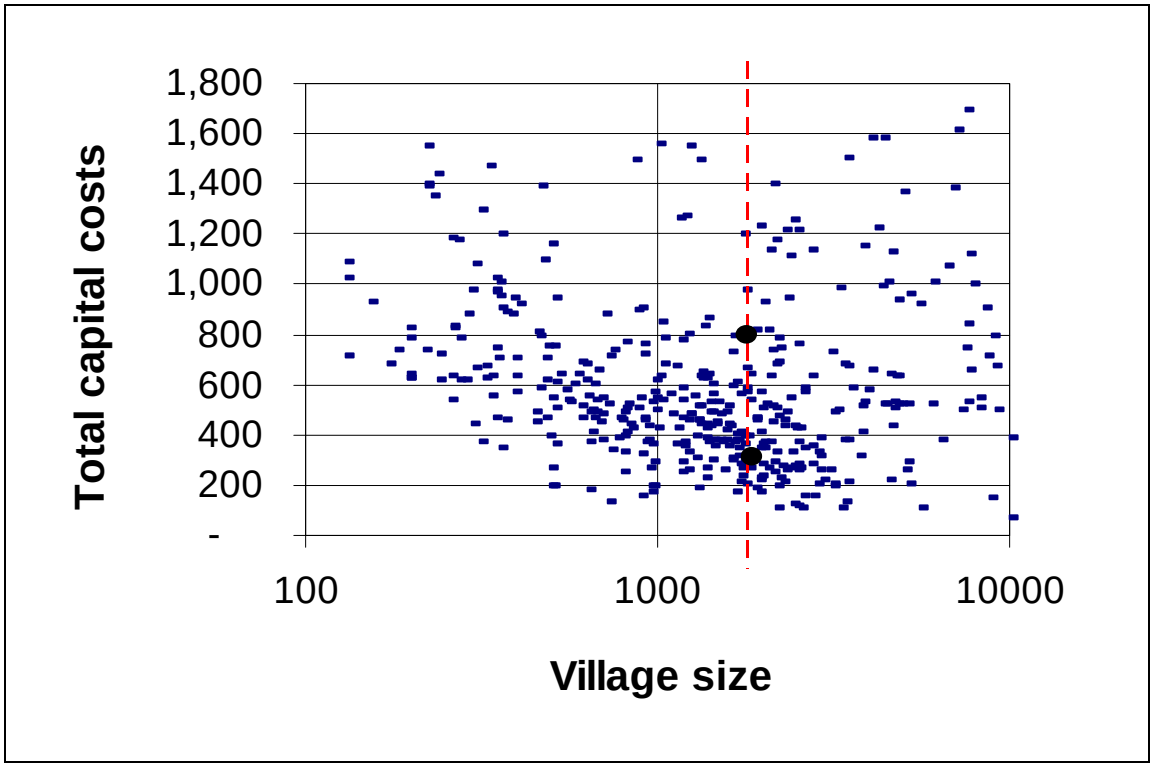
Comments:

1 Institutions and individual connections subsidise communal standpipes and UFW
2 Communal standpipes don't pay actual cost of O & M - pay O & M cost for 'RDP level of service'
3 WSP needs incentives to reduce UFW
4 Main influences on net present value:
Annual increase in individual connections (this example is set at 4% per anum)

Appendix 5.10

Distribution of capital costs for RWS in SA (1995)

Comparison between this study and financial modelling exercise synthesised by Palmer Development Group (1996). PDG study calculated the capital cost of 'scenario 2' (closest equivalent scenario to this study) for 467 villages in 5 regional studies. Per capita capital costs ranged from R200 - R4,000. Graph shows 95% of villages < R1,800 / capita in 1995 SA Rands.



Seokodibeng (1,874)

Costs of six scenarios in Seokodibeng case study (between R324 and R802 per capita)