Table 9. Schedule for Mining the First Six Blocks (1/3)

Block	Material	Unit	Years after operation									
			1	2	3	4	5	6	7	8	9	10
B3	Overburden	BOM million	0.914	0.914	0.914	0.914	0.914	0.914	0.914	0.914	0.914	0.914
	Coal CC	t million	2.053	2.053	2.053	2.053	2.053	2.053	2.053	2.053	2.053	2.053
	Total ROM	t million	2.053	2.053	2.053	2.053	2.053	2.053	2.053	2.053	2.053	2.053
B2N	Overburden	BOM million	1.382	1.382	1.382	1.382	1.382	1.382	3.107	3.107	3.107	
	Coal CC	t million	1.980	1.980	1.980	1.980	1.980	1.980	1.980	1.980	1.980	
	Total ROM	t million	1.980	1.980	1.980	1.980	1.980	1.980	2.053	1.980	1.980	
B6C	Overburden	BOM million			0.799	0.799	0.799	0.799	0.799	0.799	0.799	0.888
	Coal waste*	BOM million			0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044
	Interburden	BOM million			0.782	0.782	0.782	0.782	0.782	0.782	0.782	0.782
	Total waste	BOM million			1.625	1.625	1.625	1.625	1.625	1.625	1.625	1.625
	Coal OG	t million			0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
	Coal CB	t million			0.395	0.395	0.395	0.395	0.395	0.395	0.395	0.395
	Coal CC	t million			1.582	1.582	1.582	1.582	1.582	1.582	1.582	1.582
	Total ROM	t million			1.980	1.980	1.980	1.980	1.980	1.980	1.980	1.980
B2C	Overburden	BOM million										1.367
	Coal CC	t million										1.980
	Total ROM	t million										1.980
B4E	Overburden	BOM million										
	Coal waste*	BOM million										
	Interburden	BOM million										
	Total waste	BOM million										
	Coal CG	t million										
	Coal CB	t million										
	Coal CC	t million										
	Total ROM	t million										
B4W	Overburden	BOM million										
	Coal waste*	BOM million										
	Interburden	BOM million										
	Total waste	BOM million										
	Coal CG	t million										
	Coal CB	t million										
	Coal CC	t million										
	Total ROM	t million										
Totals	ROM Coal	t million	4.033	4.033	6.013	6.013	6.013	6.013	6.013	6.013	6.013	6.013
	Burden	BOM million	2.296	2.296	3.921	3.921	3.921	3.921	5.646	5.646	5.646	3.906
	Strip ratio	BOM/t	0.569	0.569	0.652	0.652	0.652	0.652	0.939	0.939	0.939	0.649
	Price TOC	US$	12.00	12.00	12.00	11.00	11.00	11.00	11.00	11.00	11.00	12.00
	Transport C	US$	18.00	18.00	18.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
	Price FOB	US$	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00
	Depreciation	US$ million	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
	Income	US$ million	9.60	9.60	15.54	39.59	39.59	39.59	39.59	39.59	39.59	33.58
	Royalty	3%	0.29	0.29	0.47	1.19	1.19	1.19	1.19	1.19	1.19	1.01
	Tax (20%, 40%)	20% (10years), 40%	1.92	1.92	3.11	7.92	7.92	7.92	7.92	7.92	7.92	6.72
	Total profit after tax	US$ million	7.39	9.31	15.07	38.41	38.41	38.41	38.41	38.41	38.41	32.57
	Total of capital costs	US$ million 75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
	Cash-flow	US$ million -75	6.14	8.06	13.82	37.16	37.16	37.16	37.16	37.16	37.16	31.32
	Capital costs	US$75 million										

Notes: Project net present value (10%) / Project IRR (28%) / Coal waste from other coal does not seem to be exploited at this stage of the study. / Railroad transportation capacity max. 1.50 million tons for the first three years + truck charge.

Table 9. Schedule for Mining the First Six Blocks (2/3)

Block	Material	Unit	Years after operation									
			11	12	13	14	15	16	17	18	19	20
B3	Overburden	BOM million										
	Coal CC	t million										
	Total ROM	t million										
B2N	Overburden	BOM million										
	Coal CC	t million										
	Total ROM	t million										
B6C	Overburden	BOM million	0.888	0.888	0.983	0.983	0.983	0.983	0.983	0.983	0.983	0.983
	Coal waste*	BOM million	0.044	0.044	0.132	0.132	0.132	0.132	0.132	0.132	0.132	0.132
	Interburden	BOM million	0.782	0.782	2.295	2.295	2.295	2.295	2.295	2.295	2.295	2.295
	Total waste	BOM million	1.625	1.625	3.312	3.312	3.312	3.312	3.312	3.312	3.312	3.312
	Coal OG	t million	0.004	0.004	0.168	0.168	0.168	0.168	0.168	0.168	0.168	0.168
	Coal CB	t million	0.395	0.395	0.567	0.567	0.567	0.567	0.567	0.567	0.567	0.567
	Coal CC	t million	1.582	1.582	1.244	1.244	1.244	1.244	1.244	1.244	1.244	1.244
	Total ROM	t million	1.980	1.980	1.980	1.980	1.980	1.980	1.980	1.980	1.980	1.980
B2C	Overburden	BOM million	1.367	1.367	1.367	3.545	3.545	3.545	3.545	3.545	6.000	6.000
	Coal CC	t million	1.980	1.980	1.980	1.980	1.980	1.980	1.980	1.980	1.980	1.980
	Total ROM	t million	1.980	1.980	1.980	1.980	1.980	1.980	1.980	1.980	1.980	1.980
B4E	Overburden	BOM million	1.191	1.191	1.191	1.209	1.209	1.209	1.209	0.000	0.000	0.000
	Coal waste*	BOM million	0.002	0.002	0.002	0.248	0.248	0.248	0.248	0.000	0.000	0.000
	Interburden	BOM million	0.588	0.588	0.588	2.187	2.187	2.187	2.187	0.000	0.000	0.000
	Total waste	BOM million	1.781	1.781	1.781	3.644	3.644	3.644	3.644	0.000	0.000	0.000
	Coal CG	t million	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.000	0.000	0.000
	Coal CB	t million	0.310	0.310	0.310	0.591	0.591	0.591	0.591	0.000	0.000	0.000
	Coal CC	t million	1.744	1.744	1.744	1.460	1.460	1.460	1.460	0.000	0.000	0.000
	Total ROM	t million	2.053	2.053	2.053	2.053	2.053	2.053	2.053	0.000	0.000	0.000
B4W	Overburden	BOM million								0.721	0.721	0.721
	Coal waste*	BOM million								0.021	0.021	0.021
	Interburden	BOM million								1.382	1.382	1.382
	Total waste	BOM million								2.123	2.123	2.123
	Coal CG	t million								0.000	0.000	0.000
	Coal CB	t million								0.575	0.575	0.575
	Coal CC	t million								1.478	1.478	1.478
	Total ROM	t million								2.054	2.054	2.054
Totals	ROM Coal	t million	6.013	6.013	6.013	6.013	6.013	6.013	6.013	6.013	6.013	6.013
	Burden	BOM million	4.773	4.773	6.460	10.50 1	10.50 1	10.50 1	10.50 1	8.980	11.436	11.436
	Strip ratio	BOM/t	0.794	0.794	1.074	1.746	1.746	1.746	1.746	1.494	1.902	1.902
	Price TOC	US$	12.00	11.00	11.00	11.00	11.00	11.00	11.00	12.00	11.00	11.00
	Transport C	US$	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
	Price FOB	US$	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00
	Depreciation	US$ million	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Income	US$ million	36.08	42.09	42.09	42.09	42.09	42.09	42.09	36.08	42.09	42.09
	Royalty	3%	1.08	1.26	1.26	1.26	1.26	1.26	1.26	1.08	1.26	1.26
	Tax (20%, 40%)	20% (10years), 40%	14.43	16.84	16.84	16.84	16.84	16.84	16.84	14.43	16.84	16.84
	Total profit after tax	US$ million	20.57	23.99	23.99	23.99	23.99	23.99	23.99	20.56	23.99	23.99
	Total of capital costs	US$ million 75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
	Cash-flow	US$ million -75	16.82	20.24	20.24	20.24	20.24	20.24	20.24	16.81	20.24	20.24
	Capital costs	US$75 million										

Notes: Project net present value (10%) / Project IRR (28%) / Coal waste from other coal does not seem to be exploited at this stage of the study. / Railroad transportation capacity max. 1.50 million tons for the first three years + truck charge.

Table 9. Schedule for Mining the First Six Blocks (3/3)

Block	Material	Unit	21	22	23	24	25	Total
B3	Overburden	BOM million						9.136
	Coal CC	t million						20.532
	Total ROM	t million						20.532
B2N	Overburden	BOM million						17.615
	Coal CC	t million						17.819
	Total ROM	t million						17.893
B6C	Overburden	BOM million	0.983	0.983	0.983	0.983	0.983	21.036
	Coal waste*	BOM million	0.132	0.132	0.132	0.132	0.132	2.160
	Interburden	BOM million	2.295	2.295	2.295	2.295	2.295	37.660
	Total waste	BOM million	3.312	3.312	3.312	3.312	3.312	59.312
	Coal OG	t million	0.168	0.168	0.168	0.168	0.168	2.225
	Coal CB	t million	0.567	0.567	0.567	0.567	0.567	11.322
	Coal CC	t million	1.244	1.244	1.244	1.244	1.244	31.997
	Total ROM	t million	1.980	1.980	1.980	1.980	1.980	45.544
B2C	Overburden	BOM million	6.000	6.000	0.000	0.000	0.000	47.192
	Coal CC	t million	1.980	1.980	0.000	0.000	0.000	25.739
	Total ROM	t million	1.980	1.980	0.000	0.000	0.000	25.739
B4E	Overburden	BOM million	0.000	0.000	0.000	0.000	0.000	8.409
	Coal waste*	BOM million	0.000	0.000	0.000	0.000	0.000	0.999
	Interburden	BOM million	0.000	0.000	0.000	0.000	0.000	10.512
	Total waste	BOM million	0.000	0.000	0.000	0.000	0.000	19.920
	Coal CG	t million	0.000	0.000	0.000	0.000	0.000	0.006
	Coal CB	t million	0.000	0.000	0.000	0.000	0.000	3.294
	Coal CC	t million	0.000	0.000	0.000	0.000	0.000	11.073
	Total ROM	t million	0.000	0.000	0.000	0.000	0.000	14.373
B4W	Overburden	BOM million	0.721	0.721	1.930	1.930	1.930	9.395
	Coal waste*	BOM million	0.021	0.021	0.408	0.408	0.408	1.328
	Interburden	BOM million	1.382	1.382	5.710	5.710	5.710	24.037
	Total waste	BOM million	2.123	2.123	8.048	8.048	8.048	34.759
	Coal CG	t million	0.000	0.000	0.393	0.393	0.393	1.179
	Coal CB	t million	0.575	0.575	1.060	1.060	1.060	6.056
	Coal CC	t million	1.478	1.478	2.654	2.654	2.654	15.354
	Total ROM	t million	2.054	2.054	4.107	4.107	4.107	22.588
Totals	ROM Coal	t million	6.013	6.013	6.086	6.086	6.086	146.587
	Burden	BOM million	11.436	11.436	11.360	11.360	11.360	187.935
	Strip ratio	BOM/t	1.902	1.902	1.867	1.867	1.867	1.282
	Price TOC	US$	11.00	11.00	11.00	11.00	11.00	11.24
	Transport C	US$	15.00	15.00	15.00	15.00	15.00	15.36
	Price FOB	US$	33.00	33.00	33.00	33.00	33.00	33.00
	Depreciation	US$ million	0.00	0.00	0.00	0.00	0.00	25.00
	Income	US$ million	42.09	42.09	42.60	42.60	42.60	926.75
	Royalty	3%	1.26	1.26	1.28	1.28	1.28	9.18
	Tax (20%, 40%)	20% (10years), 40%	16.84	16.84	17.04	17.04	17.04	248.35
	Total profit after tax	US$ million	23.99	23.99	24.28	24.28	24.28	648.68
	Total of capital costs	US$ million 75	3.75	3.75	3.75	3.75	3.75	93.75
	Cash-flow	US$ million -75	20.24	20.24	20.53	20.53	20.53	579.93
	Capital costs	US$75 million						

Notes: Project net present value (10%) / Project IRR (28%) / Coal waste from other coal does not seem to be exploited at this stage of the study. / Railroad transportation capacity max. 1.50 million tons for the first three years + truck charge.

Table 10. Schedule for Mining the First Three Blocks (1/3)

Block	Material	Unit	Years after operation									
			1	2	3	4	5	6	7	8	9	10
B2N	Overburden	BOM million	1.382	1.382	1.382	1.382	1.382	1.382	3.107	3.107	3.107	
	Coal CC	t million	1.980	1.980	1.980	1.980	1.980	1.980	1.980	1.980	1.980	
	Total ROM	t million	1.980	1.980	1.980	1.980	1.980	1.980	2.053	1.980	1.980	
B6C	Overburden	BOM million			0.799	0.799	0.799	0.799	0.799	0.799	0.799	0.888
	Coal waste*	BOM million			0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044
	Interburden	BOM million			0.782	0.782	0.782	0.782	0.782	0.782	0.782	0.782
	Total waste	BOM million			1.625	1.625	1.625	1.625	1.625	1.625	1.625	1.625
	Coal OG	t million			0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
	Coal CB	t million			0.395	0.395	0.395	0.395	0.395	0.395	0.395	0.395
	Coal CC	t million			1.582	1.582	1.582	1.582	1.582	1.582	1.582	1.582
	Total ROM	t million			1.980	1.980	1.980	1.980	1.980	1.980	1.980	1.980
B2C	Overburden	BOM million										1.367
	Coal CC	t million										1.980
	Total ROM	t million										1.980
Totals	ROM Coal	t million	1.980	1.980	3.960	3.960	3.690	3.690	4.033	3.960	3.960	3.960
	Burden	BOM million	1.382	1.382	3.007	3.007	3.007	3.007	4.733	4.733	4.733	2.992
	Strip ratio	BOM/t	0.698	0.698	0.759	0.759	0.759	0.759	1.173	1.195	1.195	0.756
	Price TOC	US$	12.00	12.00	12.00	11.00	11.00	11.00	11.00	11.00	11.00	12.00
	Transport C	US$	18.00	18.00	18.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
	Price FOB	US$	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00
	Depreciation	US$ million	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
	Income	US$ million	3.44	3.44	9.38	25.22	25.22	25.22	25.73	25.22	25.22	21.26
	Royalty	3%	0.10	0.10	0.28	0.76	0.76	0.76	0.77	0.76	0.76	0.64
	Tax (20%, 40%)	20% (10years), 40%	0.92	0.69	1.88	5.04	5.04	5.04	5.15	5.04	5.04	4.25
	Total profit after tax	US$ million	2.65	3.34	9.10	24.46	24.46	24.46	24.96	24.46	24.46	20.62
	Total of capital costs	US$ million 50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
	Cash-flow	US$ million -50	2.65	3.34	9.10	24.46	24.46	24.46	24.96	24.46	24.46	20.62
	Capital costs	US$75 million										

Notes: Project net present value (10%) / Project IRR (26%) / Coal waste from other coal does not seem to be exploited at this stage of the study. / Railroad transportation capacity max. 1.50 million ton for the first three years + truck charge.

Table 10. Schedule for Mining the First Three Blocks (2/3)

Block	Material	Unit	Years after operation									
			11	12	13	14	15	16	17	18	19	20
B2N	Overburden	BOM million										
	Coal CC	t million										
	Total ROM	t million										
B6C	Overburden	BOM million	0.888	0.888	0.983	0.983	0.983	0.983	0.983	0.983	0.983	0.983
	Coal waste*	BOM million	0.044	0.044	0.132	0.132	0.132	0.132	0.132	0.132	0.132	0.132
	Interburden	BOM million	0.782	0.782	2.295	2.295	2.295	2.295	2.295	2.295	2.295	2.295
	Total waste	BOM million	1.625	1.625	3.312	3.312	3.312	3.312	3.312	3.312	3.312	3.312
	Coal OG	t million	0.004	0.004	0.168	0.168	0.168	0.168	0.168	0.168	0.168	0.168
	Coal CB	t million	0.395	0.395	0.567	0.567	0.567	0.567	0.567	0.567	0.567	0.567
	Coal CC	t million	1.582	1.582	1.244	1.244	1.244	1.244	1.244	1.244	1.244	1.244
	Total ROM	t million	1.980	1.980	1.980	1.980	1.980	1.980	1.980	1.980	1.980	1.980
B2C	Overburden	BOM million	1.367	1.367	1.367	3.545	3.545	3.545	3.545	3.545	6.000	6.000
	Coal CC	t million	1.980	1.980	1.980	1.980	1.980	1.980	1.980	1.980	1.980	1.980
	Total ROM	t million	1.980	1.980	1.980	1.980	1.980	1.980	1.980	1.980	1.980	1.980
Totals	ROM Coal	t million	3.960	3.960	3.960	3.960	3.960	3.960	3.960	3.960	3.960	3.960
	Burden	BOM million	2.922	2.922	4.678	4.679	6.857	6.857	6.857	6.857	9.313	9.313
	Strip ratio	BOM/t	0.756	0.756	1.182	1.732	1.732	1.732	1.732	1.732	2.352	2.352
	Price TOC	US$	12.00	11.00	11.00	11.00	11.00	11.00	11.00	12.00	11.00	11.00
	Transport C	US$	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
	Price FOB	US$	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00
	Depreciation	US$ million	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Income	US$ million	23.76	27.72	27.72	27.72	27.72	27.72	27.72	27.72	27.72	27.72
	Royalty	3%	0.71	0.83	0.83	0.83	0.83	0.83	0.83	0.71	0.83	0.83
	Tax (20%, 40%)	20% (10years), 40%	9.50	11.09	11.09	11.09	11.09	11.09	11.09	9.50	11.09	11.09
	Total profit after tax	US$ million	13.54	15.80	15.80	15.80	15.80	15.80	15.80	13.54	15.80	15.80
	Total of capital costs	US$ million 50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
	Cash-flow	US$ million -50	11.04	13.30	13.30	13.30	13.30	13.30	13.30	11.04	13.30	13.30
	Capital costs	US$505 million										

Notes: Project net present value (10%) / Project IRR (28%) / Coal waste from other coal does not seem to be exploited at this stage of the study. / Railroad transportation capacity max. 1.50 million ton for the first three years + truck charge.

Table 10. Schedule for Mining the First Three Blocks (3/3)

Block	Material	Unit	Years after operation					
			21	22	23	24	25	Total
B2N	Overburden	BOM million						17.615
	Coal CC	t million						17.819
	Total ROM	t million						17.893
B6C	Overburden	BOM million	0.983	0.983	0.983	0.983	0.983	21.036
	Coal waste*	BOM million	0.132	0.132	0.132	0.132	0.132	2.160
	Interburden	BOM million	2.295	2.295	2.295	2.295	2.295	37.660
	Total waste	BOM million	3.312	3.312	3.312	3.312	3.312	59.312
	Coal OG	t million	0.168	0.168	0.168	0.168	0.168	2.225
	Coal CB	t million	0.567	0.567	0.567	0.567	0.567	11.322
	Coal CC	t million	1.244	1.244	1.244	1.244	1.244	31.997
	Total ROM	t million	1.980	1.980	1.980	1.980	1.980	45.544
B2C	Overburden	BOM million	6.000	6.000	6.000	6.000	6.000	65.193
	Coal CC	t million	1.980	1.980	1.980	1.980	1.980	31.679
	Total ROM	t million	1.980	1.980	1.980	1.980	1.980	31.679
Totals	ROM Coal	t million	3.960	3.960	3.960	3.960	3.960	95.115
	Burden	BOM million	9.313	9.313	9.313	9.313	9.313	142.120
	Strip ratio	BOM/t	2.352	2.352	2.352	2.352	2.352	1.494
	Price TOC	US$	11.00	11.00	11.00	11.00	11.00	11.24
	Transport C	US$	15.00	15.00	15.00	15.00	15.00	15.36
	Price FOB	US$	33.00	33.00	33.00	33.00	33.00	33.00
	Depreciation	US$ million	0.00	0.00	0.00	0.00	0.00	25.00
	Income	US$ million	27.72	27.72	27.72	27.72	27.72	597.25
	Royalty	3%	0.83	0.83	0.83	0.83	0.83	5.68
	Tax (20%, 40%)	20% (10years), 40%	11.09	11.09	11.09	11.09	11.09	163.16
	Total profit after tax	US$ million	15.80	15.80	15.80	15.80	15.80	648.68
	Total of capital costs	US$ million 50	2.50	2.50	2.50	2.50	2.50	62.50
	Cash-flow	US$ million -50	13.30	13.30	13.30	13.30	13.30	377.99
	Capital costs	US$75 million						

Notes: Project net present value (10%) / Project IRR (28%) / Coal waste from other coal does not seem to be exploited at this stage of the study. / Railroad transportation capacity max. 1.50 million ton for the first three years + truck charge.

Export coal prices have fallen steadily in real and nominal terms for the past four years. The price reductions have not been driven by steadily decreasing demand but by oversupply from key producers in Australia, China, Indonesia, and South Africa. These price reductions have had an ongoing impact on the structure and efficiency of key Asian coal suppliers. However, it has not affected overall coal supply capacity that has been rising steadily despite the fall in prices. Due to a number of structural changes within the sea-borne coal industry, such countries as Australia and Indonesia have increased their market shares in Asia while other countries including Canada, South Africa and the USA have lost theirs. Changes in market shares between the supplying countries may be caused by:

- Development of new greenfields coalfields and expectation of increasing domestic demand as in the case of Indonesia;
- Currency devaluations in Australia, Canada, Indonesia, and South Africa;
- Differential productivity improvements between competing economies; and
- Improved capital utilization through workplace and corporate restructuring.

Industry mergers and acquisitions effect synergies between assets, infrastructure and markets. The results of these changes have been significant FOB cost reductions. These cost reductions have kept pace with falling prices, and although they have not increased margins, mines in Australia, Canada and South Africa have at least maintained their operating conditions. Some Indonesian mines, due to US dollar financing and highly geared projects, have experienced very difficult operating conditions. These companies have subsequently gone into administration or handed over mining leases and assets to project bankers. However, all the mines in these cases have continued to operate at or near their capacity and will continue to do so until new companies are found to inject new capital for further capacity expansion.

One negative impact of falling prices for such a long period is that there is little confidence in investment in new greenfields projects. This has resulted from the restructuring and productivity improvements of existing mines with latent capacity available if the market improves. Some of the constraints to new project development have been offset by low capital cost entrants who are able to utilize the mature rail and port infrastructure and experiences of established mining contractors.

Overall it is apparent that falling coal prices have not negatively affected coal supply capacity into the ASEAN region. There may be some longer term negative impacts on production capacity if prices continue to fall as is now expected. However, this may be offset by a more positive movement in the spot price end of the market as benchmark or ceiling prices continue to fall.

The major impact of falling prices has been on production efficiency of the supply side of

the export coal sector, which has been to the benefits of coal buyers in Asia. Some countries have been able to respond favorably with efficiency to changes, at the same time reducing costs, while others including the USA have been adversely affected and have lost significant market share. The total latent capacity of existing mines is available for increasing demand in the short term. In the long term, however, increases in export prices will be necessary to justify the launch of major greenfields developments needed to match the growth beyond the next five-year supply period.

4. Non-metallic Minerals

4.1. Fluorite

(1) Resources

Several fluorite deposits are known to exist in different areas of Mozambique. Only one of these areas (Macossa Canxixe) has been exploited in the past. Other important deposits exist at Djanguire, Monte Domba and Mt. Muambe (in carbonatite). In the Study Area, Mt. Muambe is the only fluorite ore deposit of carbonatite ring structure about 780m high and 6km in the external diameter, which can be reached via the Moatize-Necungas road. The Moatize-Beira railway (Sena line) runs some 10km from the northeast of the deposit. The ore reserves are calculated at 1.4 million tons. Martite (without TiO_2) is estimated at 1.5 million tons. Blue fluorite contains significant amounts of Nb, Y, La, Be, and Sr as accessory rare earth minerals.

In addition to these elements, MnO and P_2O_5 are also found in the fluorite vein in carbonatite. Yellow fluorite, which is usually poorer in Mn, Y and Be is found, and so are Nb, Sr and other rare earth minerals as well.

(2) Markets

Fluorite is the principal commercial mineral of fluorine and traded in terms of two qualities, referred to as metallurgical spar and acid grade or chemical spar. The metallurgical spar, which serves in many smelting processes as a flux and is used for welding as a similar agent, accounts for about 25% of world consumption. Chemical or acid grade spar is the source of hydrofluoric acid and a range of fluorine bearing chemicals or chemical products. The world consumption of fluorite in this role occupies about 65 % of total production. The remaining production is for glass manufacturing, enamels and ceramic applications such as glazes.

The largest growth in the use of fluorine in the chemical industry for the last 20 years has been for the production of certain complex hydrocarbon compounds, which are widely used as aerosol propellants. Once released into the atmosphere, these compounds are not destroyed and the increasing pressure from environmentalists is forcing a rapid decrease in

fluorine use of this type of application.

Many metallurgical and certain specialized chemical and other products, which are imported into Mozambique, have fluorine components. However, in the foreseeable future, those indigenous fluospar resources will probably become unnecessary for local use or in their import substitution role. Their possible contribution to the economy can only come from export value as raw material.

Several major companies, principally those in North America, have expressed interest in Mozambiquan fluospar since the Ministry initiated a program to promote the mineral in 1986. A European company has also been interested in purchasing a market product delivered to a Mozambiquan port. In that year, Japan imported 150 tons of acid grade material valued at Escudos 231,759 (about US$10,000). Presumably part of this tonnage was from stockpiles.

Data on major producing countries of fluorite, taken from the USBM's *Commodities Summaries for 1996*, are given in Table 11.

Table 11. Fluorite Mine Production and Reserve Base in the World

Fluorite mine production and reserve base	Production (10^3 t)			Reserve (10^3t)
	1985	1994	1995	
France	250	125	120	10,000
Italy	210	-	-	8,000
Kenya	60	64	70	3,000
Mexico	750	327	490	24,000
South Africa	380	174	230	41,000
Spain	270	95	90	10,000
Thailand	300	-	-	2,000
United Kingdom	200	59	60	3,000
Other market countries	350	682	680	10,000
China	700	2100	2100	25,000
Mongolia	770	-	-	65,000
United States	70	49	48	37,000
USSR	600	-	-	104,000
Brazil	-	90	90	46,000
Morocco	-	85	90	-
Other centrally planned	300	-	-	20,000
World total	7,195	3,850	4,070	362,000

(3) Production plan

After the construction of an access road of several kilometers and the rehabilitation of Sena line, a joint venture company of Mozambique and other countries should develop Mt. Muambe fluorite ore deposit as a truck-less mining or an underground mining. The maximum annual production rate is estimated about 8,000-30,000 tons/year. About 800

tons/year of rare earth elements are also estimated as byproducts. This mine will produce carbonatite ($CaCO_3$) as a construction cement materials for domestic use in Tete and Moatize area.

4.2. Graphite

(1) Graphite production in Mozambique

Graphite production has increased since 1997 and graphite has become one of the most important export materials in Mozambique. Table 12 shows the annual production of graphite in Mozambique.

Table 12. Annual Production of Graphite in Mozambique

	1995	1996	1997
Production of graphite (ton/year)	3,018.4	3,289.0	5,125.1
Export price (Mt.)	10,500	8,098	20,574
Percentage in total exportation	2.10	1.04	3.94
Percentage in total ore minerals	4.11	1.95	4.70

The graphite has been produced at the Ancuabe mine in Cabo Delgado province. The graphite mine is operated jointly with Kenmare Resources Co., Ltd. in Ireland, Mozambique government (25%) and CDC (10%). The capacity of separation unit at this mining site is 10,000 tons/year, and the quality of graphite is the highest in the world (10%graphite grade).

(2) Graphite deposit in the Study Area

The largest graphite deposit in the Study Area is Satemua in Ulongue of Angonia district. The average grade of graphite from this deposit is 6% but the grade can be enhanced by hand-separation process. In addition, floatation systems should be able to enhance the grade up to 94 % concentration of graphite.

The Satemua graphite deposit is disseminated and graphite ore bodies in its veins lie in the northwest-southeast direction with 40°-60° northeastern dip. The ore body is 40m wide, 1,200m long and 90m deep. The proved ore reserves of graphite are 1.12 million tons (6% graphite grade) and probable ore reserves are 6.64 million tons (6 % graphite grade).

(3) Prospect

Exploration of the Satemua graphite deposit is highly possible once the transportation problem is solved. The price of graphite is calculated at about US$1,000/ton and FOB (at Beira) is US$1,580/ton comparable to the price of graphite from the Ancuabe mine in Mozambique. These prices show that the Satemua graphite mine should be viable. Table 13 shows the feasible cost of Satemua graphite at each step of production and transport.

Table 13. Price of Graphite of Satemua Deposit

(1998: US$/t)

Mining operational cost	1,553	(Operation+separation) x 1.25
Operation cost	850	
Separation cost	400	
Land transportation cost	100	(Using Sena rail road and truck)
Port usage	50	
FOB price (concentration)	1,580	

4.3. Limestone

There are three cement factories in Mozambique, built before the independence in Matola near Maputo city, at Dondo 30km from Beira and at the port of Nacala. All the factories are situated near seaports with railway links, except for Nacala. The Matola cement factory originally operated three furnaces of wet process, which were replaced in 1973 by one furnace of dry process with daily production of 2,000-ton clinker, i.e., 600,000-ton clinker a year. The Dondo cement factory, situated adjacent to the railway from Beira to Harare, is equipped with one furnace of wet process with daily production of 1,000-ton clinker, i.e., 300,000-ton clinker a year. The Nacala cement factory, situated at a port, is the smallest of the three using semidry process with daily production of 300-ton clinker, i.e., 90,000-ton clinker annually.

The total clinker capacity of the three factories is 990,000 tons, i.e., roughly one million tons of cement production capacity. The raw materials for the Matola factory are obtained mainly from the Salamanga limestone deposit, for the Dondo factory from the Muanza deposit and for the Nacala factory from the Nacala peninsula.

The lime produced in Mozambique is used mainly for saturation purposes in sugarcane factories and marginally in the building industry and agriculture.

Beside these lime furnaces operated officially, small local furnaces are used and operated in many areas with an occurrence of limestone. For instance, there is a small cement factory at Boroma in Tete province, whose capacity is 3,000 tons per year.

In Malawi, about 80 % of exporting coal from Moatize coalmine is used for cement kiln to produce Portland cement. Considering the disadvantage of truck transportation of coal from Moatize to Malawi, it is desirable to produce cement in the Moatize and Tete area rather than in Malawi in the near feature so that the local industries will be able to use limestone and inexpensive coal.

In-Depth Study on Rural Roads Improvement
(Project No. 3.1)

1. Background

Rural roads are under the jurisdiction of district administrations, which do not have capacity even for routine maintenance. Most rural roads are in very bad conditions, passable only during the dry season. This situation constrains villagers for their opportunities to send children to schools, receive adequate health services, market their agricultural products, and obtain daily necessities.

The rural roads improvement program covers two different levels of rural roads: feeder roads and village service roads. Feeder roads connect villages and/or production centers to main roads (national or regional roads), or village centers where basic social services are available. Village service roads connect a few villages and production areas to feeder roads.

For village service roads improvement, it is recommended that self-help efforts of villagers be mobilized, supported by technical guidance, training, and provision of simple machinery and tools for road works. In the present study, feeder roads improvement is mainly examined in more detail.

2. Objectives

The objectives of the projects are:

1) to rehabilitate rural roads to make them accessible and passable by vehicles all the year round, and
2) to ensure the permanent access and safety during both the rainy and dry seasons.

3. Project Scope

The project is to improve and upgrade feeder roads linking villages and/or production centers with the main roads or village centers. It includes improvement of bridges and culvert structures as well. The feeder road construction usually requires excavation, digging, earthwork, and gravelling works. To carry out the feeder road improvement, it is recommended to employ labor force-based construction method, rather than machinery-based one. This also contributes to generating employment opportunities in rural areas. It is noted that construction of bridges, culverts, and drainage structures on the roads is very important to ensure accessibility throughout a year. A typical rural road to be covered by the project is illustrated in Figure 1.

4. Expected Effects

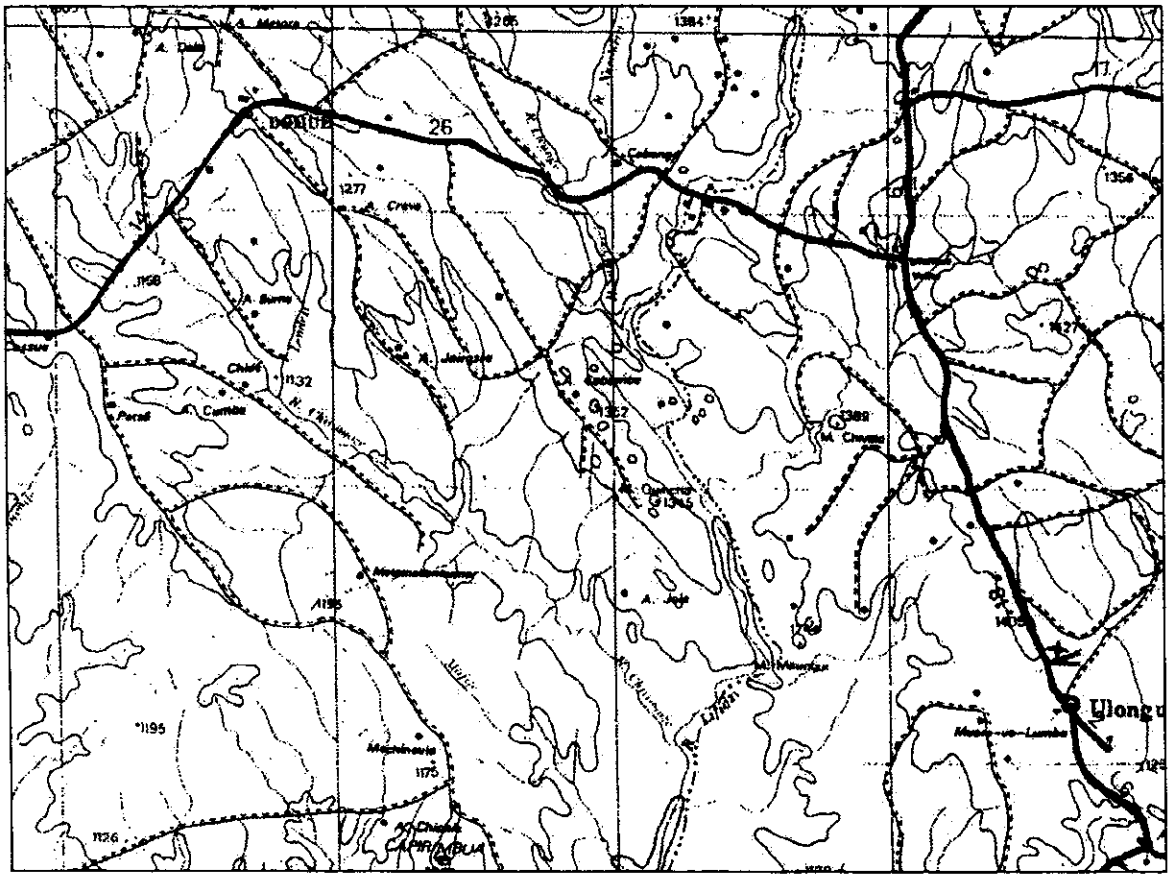
When the rural roads are constructed and/or rehabilitated, the following effects are

expected:

1) to contribute to the improvement of health services, education, and rural development,
2) to support the marketing of products to the markets far away from the production centers,
3) to support the increasing number of small enterprises, and
4) to reduce the transport costs in rural areas.

All these factors can contribute to the improvement of human life and improvement of the economy in the districts.

Figure 1. An Example of the Feeder Road



5. Comparison of Construction Methods

There are two possibilities for rehabilitation and construction of rural roads:

1) o construct by using heavy machinery such as bulldozers or road construction equipment, and
2) o construct using the labor with tools and light machinery.

Both methods have advantages and disadvantages as shown n Table 1.

Table 1. Comparison of Machinery-based and Labor Force-based Construction Methods

	Machinery-based Method	Labor Force-based Method
Advantages	• Flexibility in construction • Appropriate for large-scale road construction • Easy to manage due to reduced number of workers	• Large investment to purchase equipment • Need for careful maintenance of equipment • Qualified personnel required • Vulnerable to lack of spare parts • High costs due to fuel • A break down of one machinery can stop entire project
Disadvantages	• More opportunity to employment • Increase of economy in rural area • Simple equipment • Accessible technology • Training of workers required	• Slow work • Need very good supervision system • Manual work requires intensive physical labor • Need good administrative system

Source: ANE.

Taking into account the advantages and disadvantages the labor force-based construction method is recommended for the rehabilitation and construction of the rural roads.

6. Road Plan

6.1. Design Standards for the Feeder Roads

The design standards for the project are principally adopted as geometric design standards recently drafted out by ANE. The design standards adopted are summarized in Table 2.

Table 2. Geometric Design Standards

Description	Unit	Tertiary/Feeder Road		
Design Speed	km/h	Flat Rolling Mountainous	60 50 40	
Minimum radius	m	Flat	Rolling	Mountainous
		100	75	50
Maximum gradient	%	8.0		
Formation width	m	Type A	Type B	Type C
		7.0	6.0	4.5
Lane width	m	Type A	Type B	Type C
		6.0	5.0	3.5
Gravel thickness	cm	Type A	Type B	Type C
		15.0	15.0	12.0

Source: ANE's design standards.

6.2. Typical Cross Sections

Taking into considerations the characteristics of rural roads and geometric design standards, three different types of typical cross sections are proposed (Figure 2):

- Type A: for an ADT up to 400 vehicle per day (vpd)
- Type B: for an ADT up to 200 vpd, and
- Type C: for an ADT up to 40 vpd.

6.3. Preliminary Road Plan

Based on the rural road listing prepared by the ANE Tete office, information from district administration offices, and field surveys conducted by the JICA Study Team, the feeder roads are proposed in this study. They are listed in Appendix. Among these proposed rural roads, the typical rural road No.A-15, Chipindu-Chipala road is designed as shown in Figure 3.

Figure 2. Typical Cross Section for Rural Road

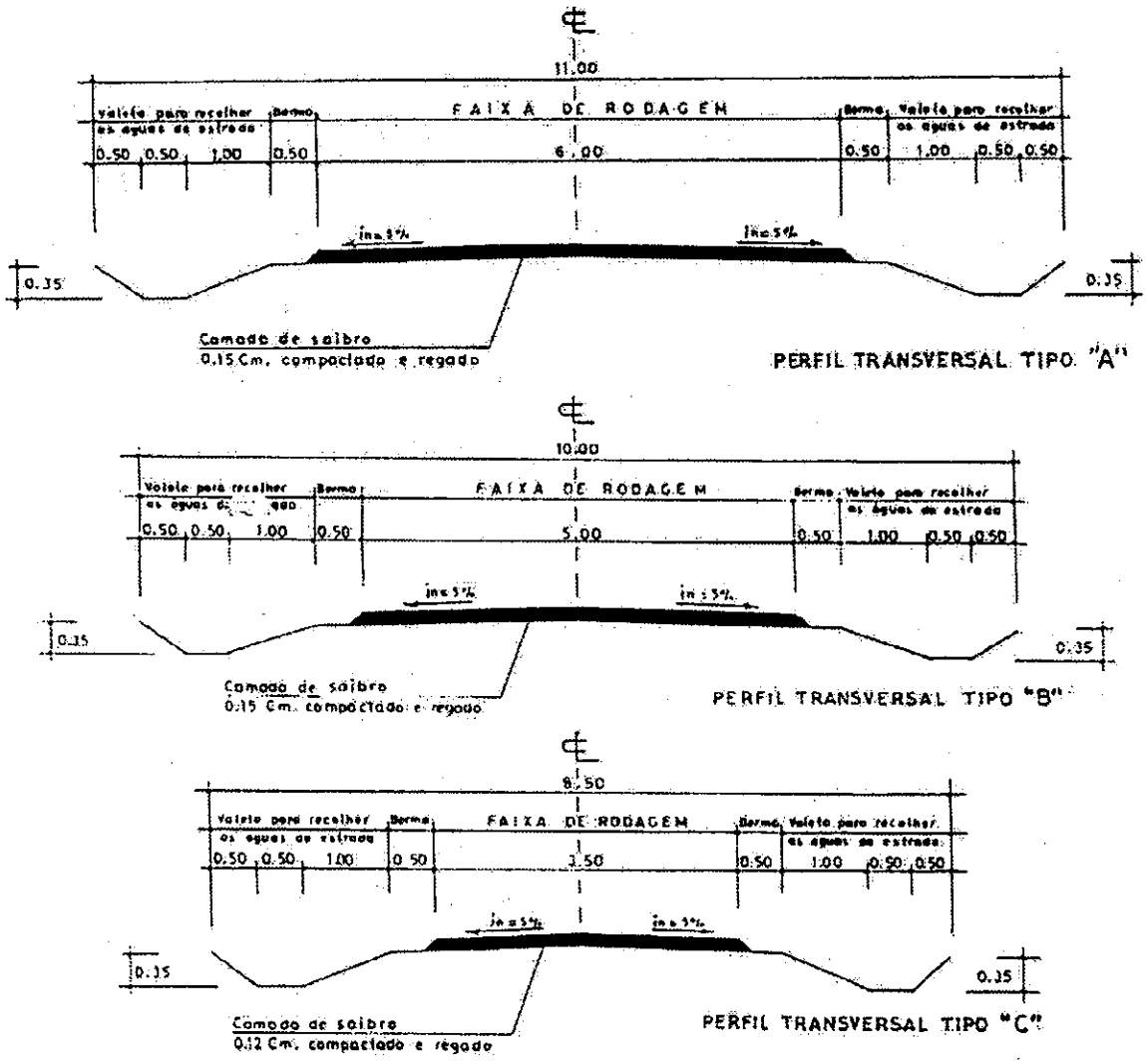
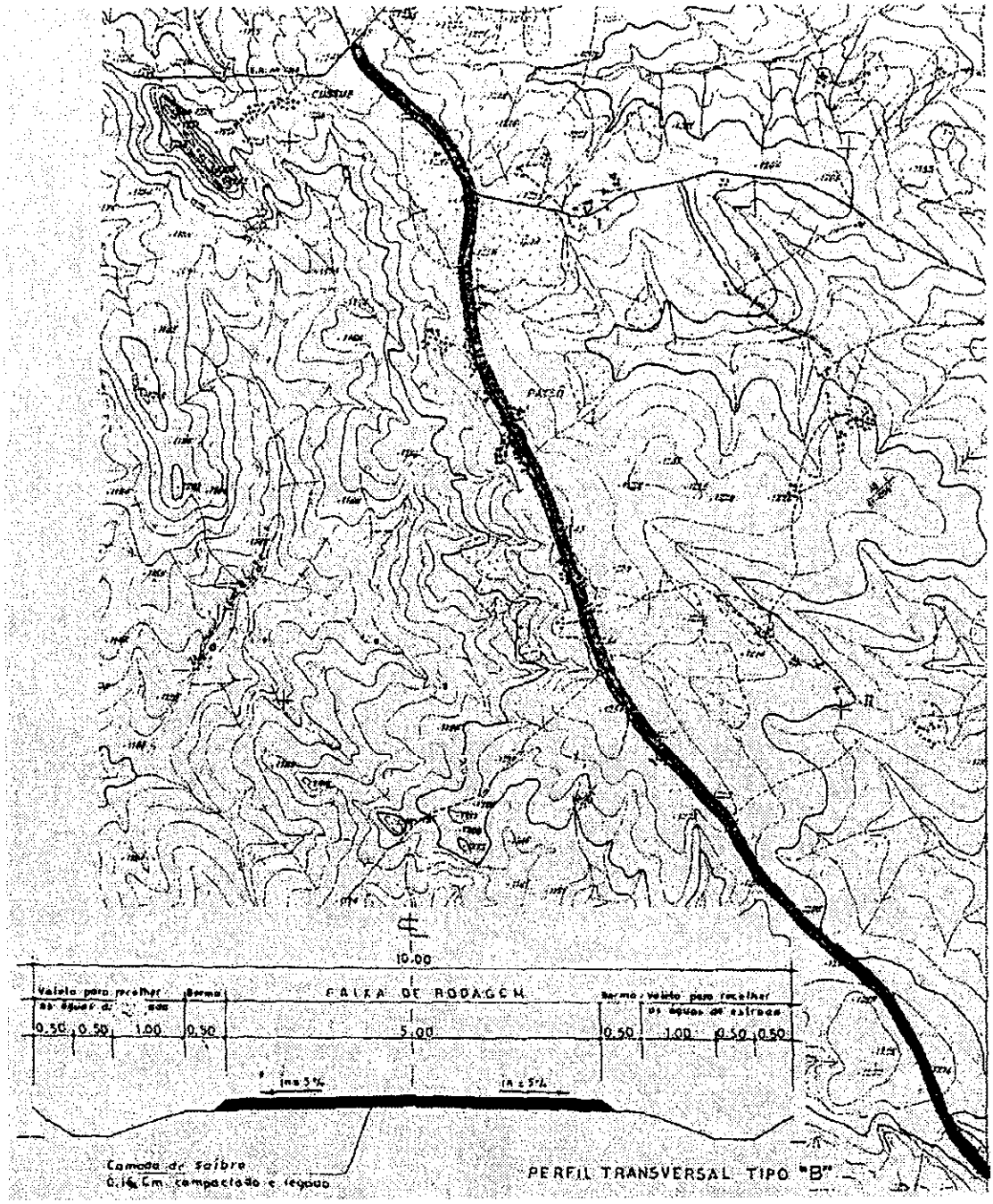


Figure 3. Design of No. A-15, Chipindu-Chipala Road (Example)



7. Construction Cost Estimation

The construction costs are estimated based on the standard guideline of construction cost estimation made by ANE. They include earth works, bridges and structures, gravelling, and other miscellaneous costs, but not any land acquisition costs.

The total construction cost for the project is estimated at US$12.5 million for 25 years from 2001 to 2025 (Table 3).

Table 3. Construction Cost Estimation (US$ at 2001 prices)

District	Road Length (km)	Project Cost (US$10³)
Angonia	403	2,700
Tsangano	262	1,755
Macanga	326	2,184
Chifunde	182	1,219
Chiuta	343	2,298
Moatize	358	2,399
Study Area Total	1,874	12,555

Source: JICA Study Team.

8. Implementation Program

(1) Priority for implementation

The priority of the proposed rural roads is assessed based on the following factors.

a) Administrative hierarchy:
- District capital,
- District sub-capital,
- Village center, and
- Village.

The rural road passing through higher hierarchical villages may be given higher priority for improvement.

b) Number of villages covered by the rural road

c) Agricultural promotion area identified in the Study

d) Other development promotion areas:
- Urban development (UD),
- Mining development (MD),
- Water resource development (WR), and
- Distribution center (DC).

Taking into account these factors, each rural road is given the priority for implementation. Distribution of rural road length determined by the priority assessment is summarized in Table 4.

(2) Implementation method

The labor force-based construction method is adopted for the project. The procedure is shown in Figure 4.

Table 4. Priority of Rural Roads by District

(Unit: km)

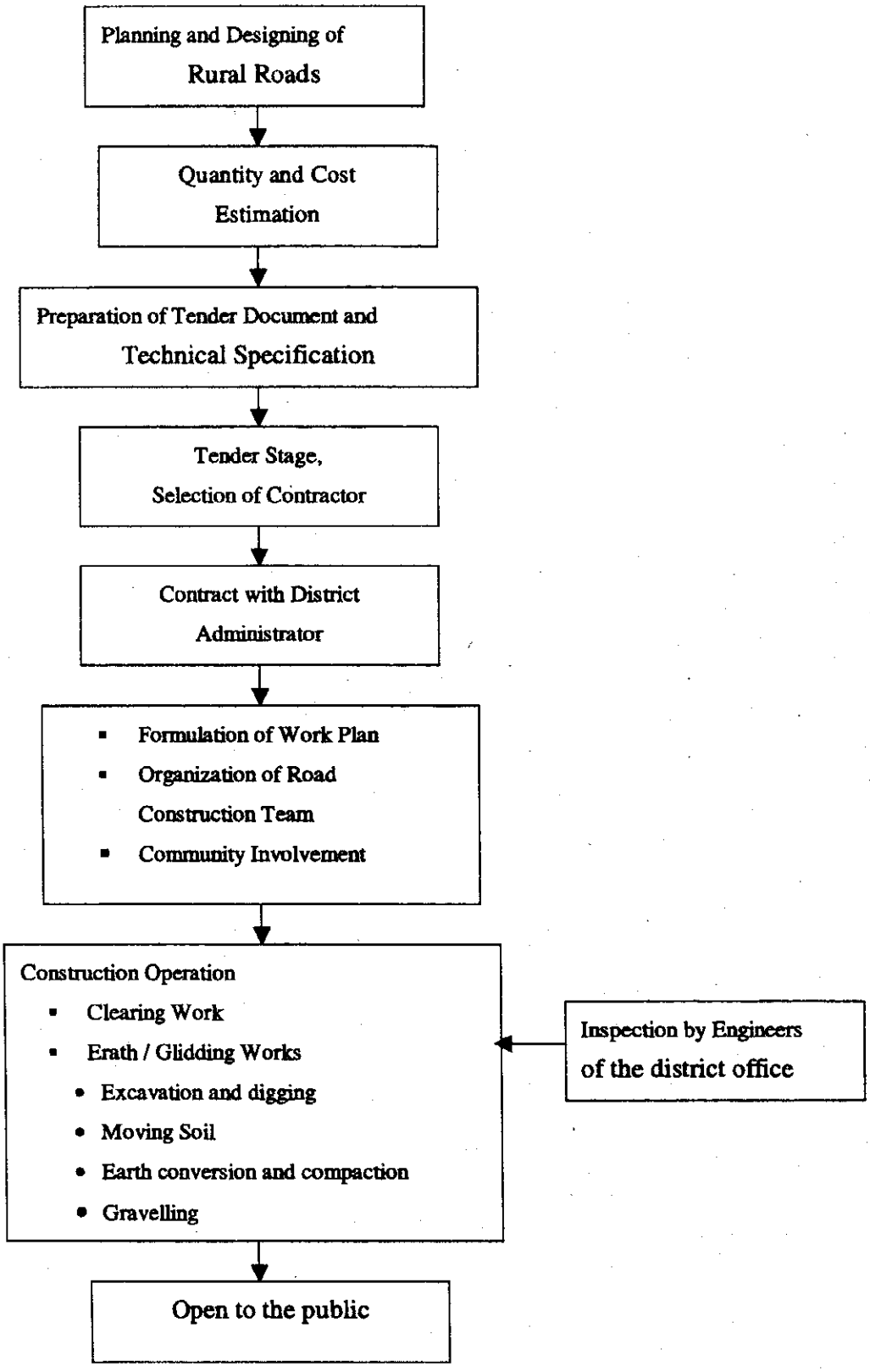
District	Rural Road		
	Phase 1 (2001- 05)	Phase 2 (2006 - 15)	Phase 3 (2016 – 20)
Angonia	83	154	166
Tsangano	43	105	114
Macanga	75	98	152
Chifunde	40	70	71
Chiuta	78	129	136
Moatize	55	159	144
Study Area Total	390	721	748

Source: JICA Study Team.

(3) Community involvement

In the rural road improvement project, the community involvement is essential for the construction and maintenance works. Villagers in the communities may obtain job opportunities although it would be temporally, and more importantly, the motivation of communities for road construction and maintenance would be increased.

Figure 4. Labor Force-based Construction Method



Appendix

Table A.1. Proposed Feeder Roads in the Study Area

(1) Angonia District

No.	Road Section			Length (km)	Administrative Status	No. of Villages	Agriculture Development	Other Development	Priority
	From	Via	To						
A-01	Ndundu	Canga	Namin'gona	27.5	Village center	7	Yes	No	1
A-02	Chissithis	Namin'gona	Massoco	19.5	Village center	2	Yes	No	3
A-03	Nsau	Monekela	Mualandan-danda	17.0	Village centr	7	Yes	No	2
A-04	Massassa	-	Monekela	11.0	Village center	2	Yes	No	3
A-05	Paalindzi	-	Khombe	11.3	Village	5	Yes	No	2
A-06	Ulongue	Chimuwala	Chiya	23.5	Village center	8	Yes	No	1
A-07	Chimwala	-	Cachere	13.8	Village	6	Yes	No	2
A-08	Chimwala	-	Muyay	4.5	Village	2	Yes	No	3
A-09	Cabambe	-	Chacanan	9.0	Village	5	Yes	No	3
A-10	Dzidzimera	Seze	Chiponde	20.8	Village center	8	Yes	No	2
A-11	Calomue	Chiponde	Mualatanga	32.0	Village	6	Yes	No	3
A-12	Dzaimebe	Lilanga	Khombe	20.5	Village center	12	Yes	No	2
A-13	Domue	-	Nchinja	13.8	Village	7	Yes	DC	2
A-14	Dzaimebe		Dziende	10.5	Village	4	Yes	No	3
A-15	Chipindu	Ndaula	Chiya	32.0	Village center	5	Yes	No	1
A-16	Catondo		Chipala	22.5	Village center	6	No	No	2
A-17	Catondo	Chifumbe	Miveuna	34.3	Village center	8	No	No	2
A-18	Domue	Nchonene	Boundary of Macanga	44.8	Village center	4	Yes	DC	3
A-19	Chipindu		Capiriuta	14.5	Village	5	Yes	No	3
A-20	Nkhame		Capiriuta	14.3	Village	2	Yes	No	3
A-21	Mpandula		Cachenje	6.3	Village	1	Yes	No	3
Total				403.0					

(2) Tsangano District

No.	Road Section			Length (km)	Administrative Status	No. of Villages	Agriculture Development	Other Development	Priority
	From	Via	To						
T-1	Tsangano	Maconi	CruzEN 223 / Ndande /Mphunhi	43	Village center	3	Yes	No	1
T-2	Tsangano		Metangobalame	45	Village	8	Yes	No	1
T-3	Maconi		Zobue	14.0	Village center	1	Yes	No	2
T-4	Duvico		Caia	35	Village	2	Yes	No	3
T-5	Tsangano		Ndzenza	17.0	Village	2	Yes	No	2
T-6	Ndzenza		Metangobalame	19.0	Village	6	Yes	No	2
T-7	Ndzenza		Nthete-Bene	29.5	Village center	6	Yes	No	2
T-8	Nsacadzi	Banga	Magumbo	20.8	Village center	5	Yes	No	3
T-9	Nsang		Mpatamanga	15.8	Village	5	Yes	No	3
T-10	Cruz EN 221		Mulamba	8.5	Village	3	No	No	3
T-11	Mulamba		Afutsa	15.0	Village	2	No	No	3
Total				202.5					

(3) Chifunde District

No.	Road Section		Length (km)	Administrative Status	No. of Villages	Agriculture Development	Other development	Priority
	From	To						
Cf-01	Chifunde	Cruz EN 222	70.0	Village	4	No	No	1
Cf-02	Chifunde	Cruz ER 548	40.0	Village center	3	No	No	2
Cf-03	Chifunde	Cruz EN 221	55.0	Village center	1	No	No	3
Cf-04	Cruz EN 222	Vuboe	17.0	Village	2	No	No	3
Cf-05	Cruz EN 222	Bolimo		Village center	3	Yes	No	1
Total			182.0					

(4) Chiuta District

No.	Road Section			Length (km)	Administrative Status	No. of Villages	Agriculture Development	Other Development	Priority
	From	Via	To						
Cu-1	Cruz EN 221		Chiuta Serra	45.0	Village	4	No	No	2
Cu-2	Cruz Saiamica		Chidzolomondo	32.0	Village center	3	Yes	No	1
Cu-3	Cruz EN 221		Casula	46.0	Village center	1	Yes	No	1
Cu-4	Massamba		Muchena	14.0	Village	2	No	No	3
Cu-5	Casula	Metenge	Nhonzue	45.0	Village	2	Yes	No	1
Cu-6	Manje	M'figo	Gombe	31.0	Village center	6	No	No	1
Cu-7	Caunda		Maiombe	0.0	Village center	5	No	No	2
Cu-8	Manje		Mudzimbe	11.0	Village	5	Yes	No	2
Cu-9	Tamuiri		Muanhahamb	26.0	Village	3	No	No	3
Cu-10	Cruz EN 221		Marcumbe	18.0	Village	2	No	No	3
Cu-11	Canhama		Carravira	37.0	Village	1	Yes	No	2
Cu-12	Saiamica		Mpondo	18.0	Village	2	Yes	No	3
Cu-13	Paiva		Cacame	22.0	Village	2	No	No	
Total				343.0					

(5) Macanga District

No.	Road Section			Length (km)	Administrative Status	No. of Villages	Agriculture Development	Other Development	Priority
	From	Via	To						
Ma-1	Cruz ER 456	Campala	Charamba	75.0	Village center	4	Yes	No	1
Ma-2	Furangungo	Muchocho	Cassupe	59.0	Village center	3	Yes	No	2
Ma-3	Cruz ER 463(Gatete)	Gandali	Mpalauzua	20.0	Village center	1	No	No	3
Ma-4	Bawe		Mbimhe	5.3	Village	2	No	No	3
Ma-5	Bawe		Chipa	8.3	Village	2	No	No	3
Ma-6	Chidzolomondo		A.Saymica (Chiuta)	16.5	District sub center	3	Yes	No	1
Ma-7	Cawere		Zhitutu	21.3	Village center	6	Yes	No	3
Ma-8	Nhamadende		Chimunda	15.0	Village center	5	Yes	No	3
Ma-9	Lhangue		Calele/Camane	17.5	Village	5	No	No	3
Ma-10	Calele		Canhadire	27.0	Village	3	No	No	3
Ma-11	Mpoto		Ganlelenovo	18.8	Village	2	No	No	3
Ma-12	Catete		Namitondgo	23.5	Village	1	No	No	2
Ma-13	Chimunda		Marco W	18.8	Village	2	No	No	3
Total				325.8					

(6) Mortize District

No.	Road Section			Length (km)	Admini-strative Status	No. of Villages	Agriculture Develop-ment	Other Develop-ment	Priority
	From	Via	To						
Mo-01	Moatize	Benga, Chiodzi	Ntsungo	66.3	Village center	10	No	UD	2
Mo-02	Moatize		Benga	8.8	Village center	2	Yes	UD	2
Mo-03	Moatize		Benga	17.5	Village center	1	No	UD	2
Mo-04	Moatize	Calabo, Mbuzemane	Necungas	62.5	Village	7	No	No	1
Mo-05	Zhangomo	Cateme	Mbuzinuane	30.0	Village	4	Yes	MD (Coal)	1
Mo-06	Mbuzinuane		Muanbe	10.0	Village	4	No	MD (Coal)	3
Mo-07	Necungas		Tsifu	22.5	Village	2	No	No	3
Mo-08	Zhangomo		Catablia	21.3	Village	2	Yes	MD (Granite)	2
Mo-09	Chitsito		Monga Rio	13.0	Village	3	Yes	MD (Granite)	3
Mo-10	Caphridzange		Duemde	16.3	Village center	4	No	No	2
Mo-11	Zobue		Tsangano	25.0	District sub-capital	5	Yes	No	1
Mo-12	Natala		Chilhethe	7.0	Village	2	Yes	UD	3
Mo-13	Chingose		Nsanja	18.0	Village	3	Yes	No	3
Mo-14	Catipo		Nhantipisa	25.0	Village	4	Yes	No	3
Mo-15	Matema		Mpanzu	15.5	Village	3	Yes	No	3
	Total			358.5					

Source: Based on ANE's road list, hearings from district administrators and field surveys.

In-Depth Study on Secondary Roads Improvement
(Project No. 3.2)

The road network in the Angonia region, consisting of primary and secondary roads, appears to be generally adequate in terms of network configuration and surface conditions, given low levels of income and transactions in cash economies, and low vehicle ownership. On some secondary roads, however, there exist bottlenecks for local traffics to transport agricultural products and consumer goods to/from nearby markets. In particular, some bridges, damaged by the civil war or natural disasters, have been restored only temporarily using simple wooden super-structure, allowing the passage only by small vehicles or carts. Also many sections of secondary roads become impassable during the rainy season due to poor surface conditions and inadequate embankment and drainage. These sections need to be improved in steps with priority to those secondary roads expected to play increasing roles as the Angonia region develops.

Two subprojects are studies in more detail here, corresponding to the needs identified above. One is to rehabilitate four bridges on secondary roads: ER462, EN222 and ER463 (two bridges). The other is to improve another secondary road, ER223, connecting Mussacana on the national road EN103 and Clomue on the border with Malawi (Figure 1). Each subproject is studied separately.

Part 1: Rehabilitation of four bridges

1. Objectives

Objectives of this subproject are:

1) to reconstruct four damaged bridges on the national and regional roads to make them passable by any type of vehicles under any conditions, and
2) to resolve road network bottlenecks to encourage transactions and stimulate regional economies.

2. Project Scope

The proposed project is to replace four of the existing temporally wooden bridges with permanent ones as follows:

- Calidezibiri river bridge on EN222,
- Luanguo river bridge on ER462,
- Nkhame river bridge on ER463, and
- Chitsuse river bridge on ER463.

3. Traffic Demands Forecast on the Project

3.1. Present Traffic Volume and Road Conditions

Those four bridges are located on the national road and regional roads, constructed basically as a two-lane single carriageway with gravel surface. Existing road conditions are summarized in Table 1.

Table 1. Existing Road Conditions

Road	Origin	Destination	Length (km)	Surface Type
EN222	Matundo	Zambia border	312.7	Gravel
ER462	Bene	Chifunde	34.3	Gravel
ER462	Furancungo	Cruz EN223	110.3	Gravel

Source: ANE.

The existing bridges are as summarized in Table 2.

Table 2. Existing Conditions of Bridges

Bridge	Length (m)	Road	Type of Bridge
Calidezibiri river bridge	84	EN222	Arch bridge
Luanguo river bridge	120	ER462	Super-structure: temporary wood bridge
Nkhame river bridge	26	ER463	Super-structure: temporary wood bridge
Chitsuse river bridge	20	ER463	Super-structure: temporary wood bridge

Source: JICA Study Team.

Presently, the traffic volume on these roads is not as many as the other sections, as the the damaged bridges are not passable by larger vehicles. Their traffic volume is ranging from 17 vehicles per day to 41 vehicles per day and is shown in Table 3.

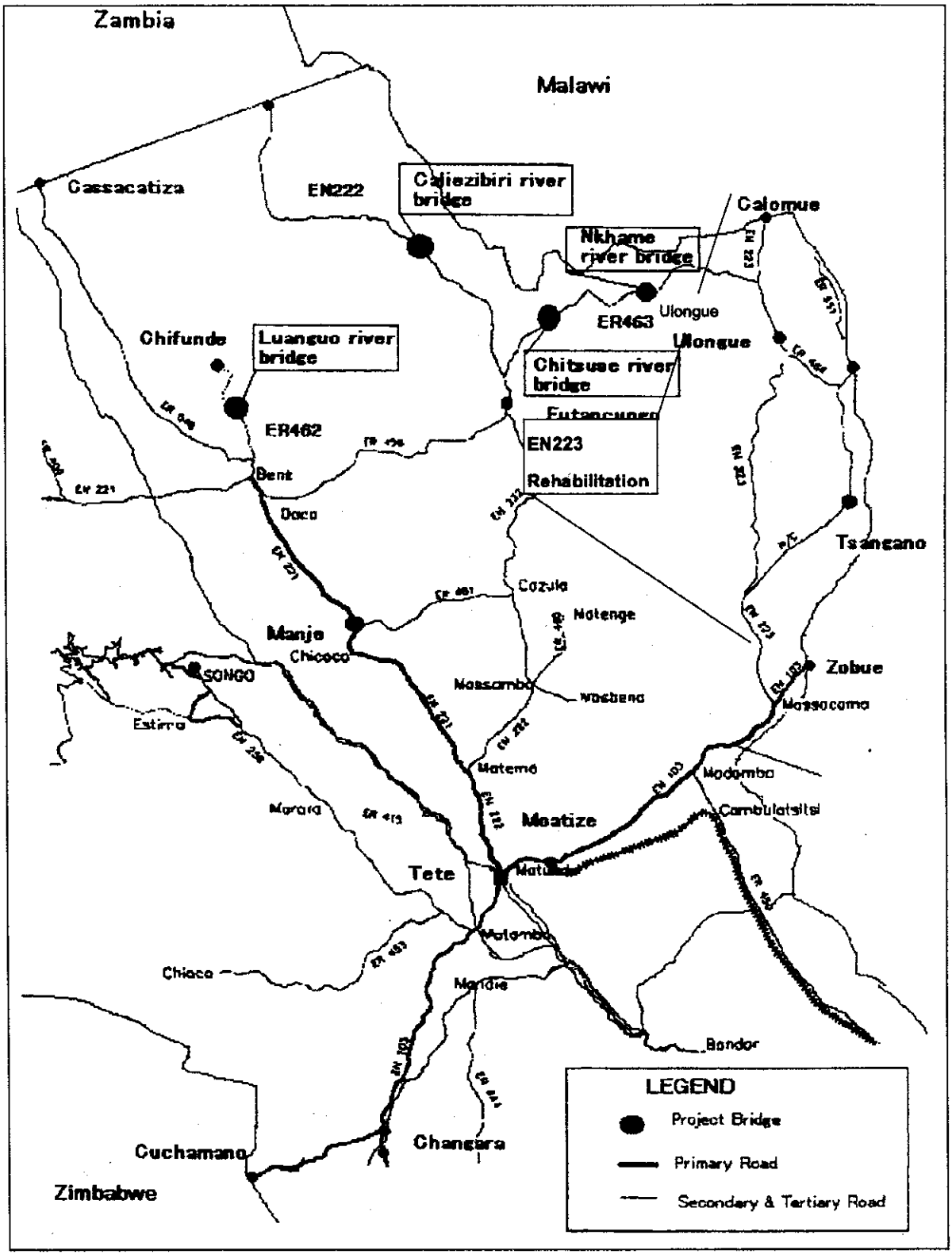
Table 3 Daily Traffic Volume on the Roads in 1998

Unit: Traffic volume/day

Road	Origin	Destination	Small Vehicle	Tractor	Truck	Bus	Total
EN222	Furancungo	Zambia border	6	2	6	3	17
ER462	Bene	Chifunde	16	9	10	6	41
ER463	Furancungo	Angonia	7	2	6	3	18

Source: ANE.

Figure 1. Location Map of the Proposed Secondary Road Improvement Projects



3.2. Future Traffic Volume

In order to forecast the road traffic volume on the project bridges, first the relationship between the growth rate of past road traffic volume and that of economic indicator in terms of GDP is analyzed for 1996-98. The analysis shows that the elasticity of road traffic volume to GDP is almost 1.0. Therefore it is assumed that the elasticity of the road traffic demand to GDP is assumed to be 1.0. The future traffic demand on the road is forecasted on the basis of the annual traffic count survey carried out by ANE and economic growth rate of the region as shown in Table 4.

Table 4. Forecasted Daily Traffic Volume on the Roads

Unit: Traffic volume/day

Road	Origin	Distination	2000 (Base)	2005	2015	2025
EN222	Furancungo	Zambia border	21	27	70	159
ER462	Bene	Chifunde	50	65	170	384
ER463	Furancungo	Angonia	22	29	75	169

Source: JICA Study Team.

4. Preliminary Engineering Study

4.1. Design Standards of the Roads and Bridges

As for roads, the design standards adopted for road projects in Mozambique are in accordance with the geometric design standards recently drafted by ANE. The design standards are summarized in Table 5.

Table 5. Geometric Design Standards

Description	Unit	Secondary Road
Design speed	km/h	80
Minimum radius	m	210
Maximum gradient	%	6.0
Lane width	m	3.0
Minimum surfaced shoulder width	m	1.5

Source: ANE design standards.

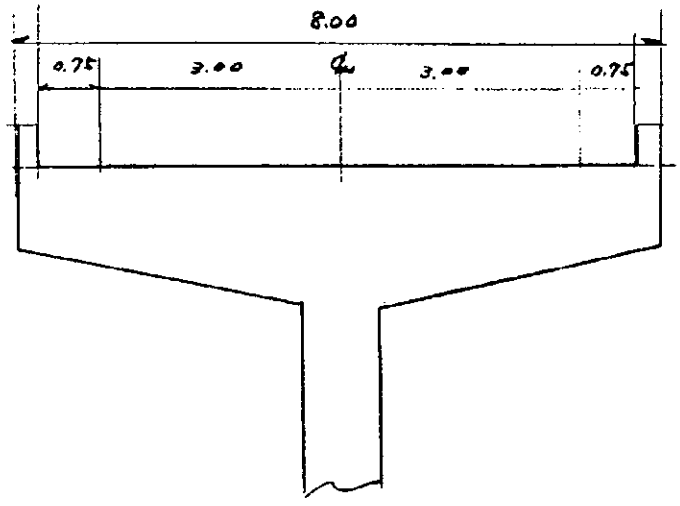
The bridge design standard in Mozambique is principally of the "code of practice for the design of road bridges and culverts" (*SATCC: Code of Practice for the Design of Road Bridges and Culverts, September*, 1998). In the present study, the same design standard is applied for the proposed road bridges.

4.2. Typical Cross-Section

Taking into account characteristics of the roads and the geometric design standards of

roads, the typical cross section of the project bridges is proposed as shown in Figure 2.

Figure 2. Typical Cross-Section of Bridge



4.3. Bridge Plan

Taking into account characteristics of the roads, the road bridge design standards, and economic aspect of the construction and maintenance, it is proposed to employ the pre-stressed concrete (PC) bridge as shown in Figure 3 and Table 6.

Table 6. Proposed Bridge Plan

Bridge	Length (m)	Road	Type
Calidezibiri river bridge	84	EN222	PC concrete bridge, 30m + 27m x 2
Luanguo river bridge	120	ER462	PC concrete bridge, 30m x 4
Nkhame river bridge	26	ER463	PC concrete bridge, 26m
Chitsuse river bridge	20	ER463	PC concrete bridge, 20m

Source: JICA Study Team.

Figure 3 (1). Side-View of Calidezibiri River Bridge

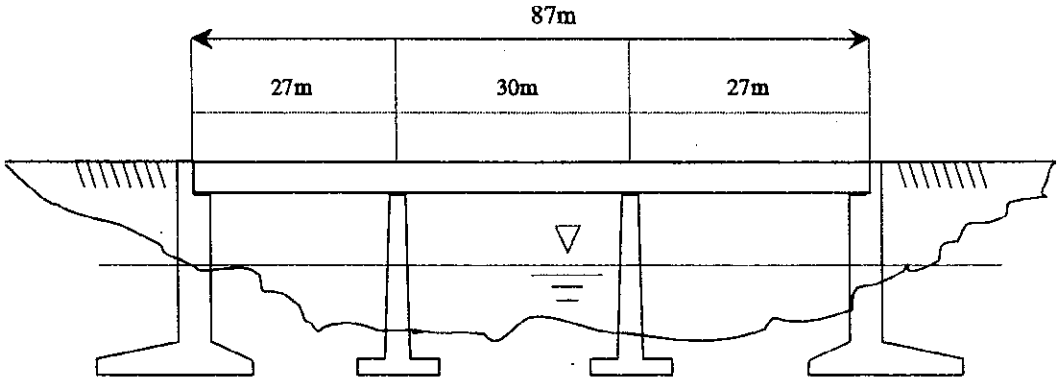


Figure 3 (2). Side-View of Luanguo River Bridge

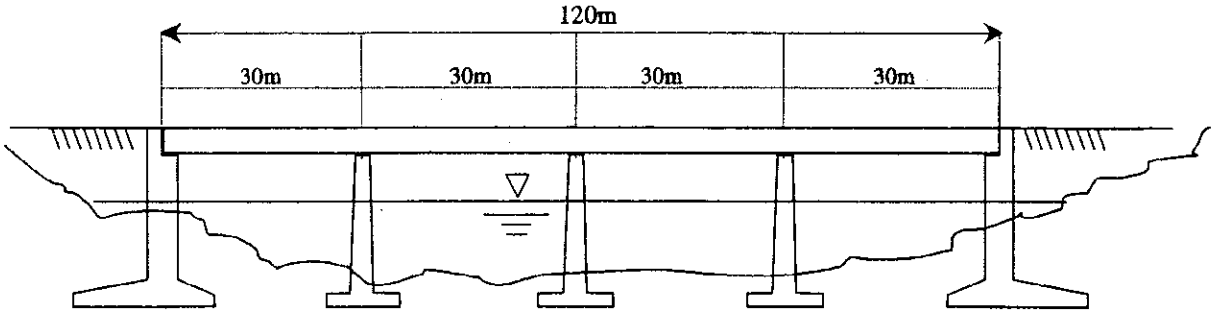


Figure 3 (3). Side-View of Nkhame River Bridge

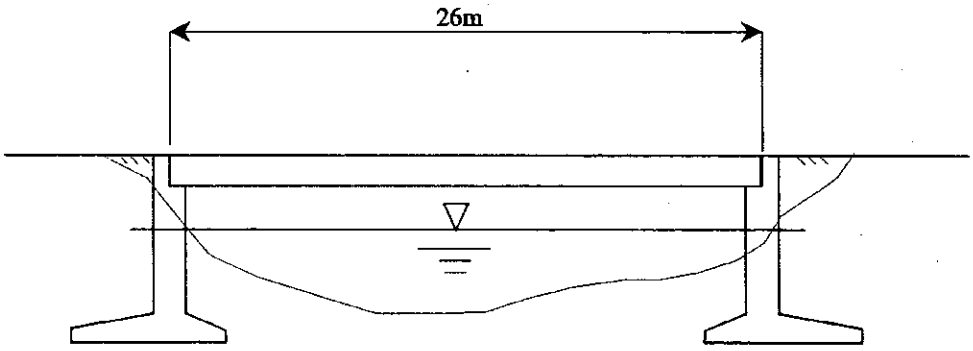
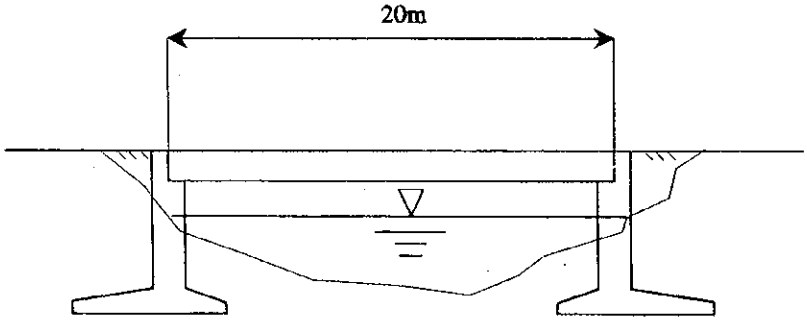


Figure 3 (4). Side-View of Chitsuse River Bridge



5. Cost Estimation

5.1. Construction Costs

Rehabilitation costs are estimated based on the standard guideline of rehabilitation cost estimation made by ANE. They include earthwork, bridges and structures, pavement, and other miscellaneous costs and engineering services, but not any land acquisition cost.

The construction period will be for three years from the year 2002. The total construction cost may be distributed over the three years by 30%, 40%, and 30%, respectively. Table 7 summarizes the construction costs of the project.

Table 7. Rehabilitation Cost Estimation

Bridge	Length (m)	Type	Cost (US$10³)
Calidezibiri river bridge (EN222)	84	PC concrete bridge 30m + 27m x 2	2,560
Luanguo river bridge (ER462)	120	PC concrete bridge 30m x 4	2,070
Nkhame river bridge (ER463)	26	PC concrete bridge 26m	610
Chitsuse river bridge (ER463)	20	PC concrete bridge 20m	480
Total			5,720

Source: JICA Study Team.

5.2. Maintenance Cost

Once the PC concrete bridges would be constructed at the project sites, it is not necessary to maintain the bridges for about 50 years based on the experiences of the past bridge projects constructed so that no maintenance cost is accounted for.

6. Expected effects

The project in general will contribute to internal integration of the Angonia region, especially in the districts of Angonia, Macanga and Chifunde. Transactions between area in these three districts will increase, which in turn will stimulate the overall regional economy. More specific effects of each bridge are outlined below.

Luanguo river bridge on ER462

This will improve the access to the district capital of Chifunde. The daily traffic volume on the road is projected to be 384 in 2025, but this represents a conservative estimate. It may be comparable to the present traffic volume on the national artery roads extending from Tete city. This means that agricultural products, especially livestock products from vast agricultural hinterland of Chifunde can be more easily marketed in urban markets of Tete city and its vicinities.

Caliezibiri river bridge on EN222

This will improve the link between Macanga and Zambia, and may turn out to be the first step for the national road EN222 to become an alternate artery linking Zambia and Tete city. This road passes through potentially most productive agricultural areas from the lowland around Cazula to the highland around Furancungo.

Nkhame river bridge and Chitsuse river bridge on ER463

These bridges will improve the link between Angonia and Macanga initially, and the link with Malawi through Calomue in the long run. The regional road ER463 serves most productive agricultural land in the highland for diversified agriculture including high-value crops, tree crops and integrated farming. Commercial agriculture in Angonia district will expend to Macanga through this road, and agricultural products in Francungo area may increasingly find markets in urban markets of Ulongue and further export market to Malawi.

Part 2: Improvement of national road EN223

1. Objective of the Project

The objectives of the projects are:

1) to improve the road conditions of EN223 to make it passable under any conditions,
2) to provide the international transport route to Malawi so as to support the outward-oriented production and to access to international market, and
3) to ensure access to all district capitals, agricultural production centers and agricultural distribution centers.

2. Project Scope

The proposed road starts at the intersection of Mussacama on EN103 with EN223, follows the existing alignment of the road passing through Ulongue, the district capital of Angonia, and finally reaches Calomue on the border with Malawi. The improvement of the road shall include rehabilitation of tarred sectoins, bituminaization of gravel sections and reconstruction of two brigdes: namely Agua Boa river bridge and Luia river bridge (Figure 1).

3. Traffic Demand Forecast on the Project

3.1. Present Traffic Volume and Road Condition

The existing EN223 road is basically a two-lane single carriage-way with tarred surface, except some sections with gravel surface. Existing road conditions are shown in Tables 8 and 9. Although EN223 has been paved mostly, but poor pavement conditions prevail for 70% of the total length.

Table 8. Road Length by Surface Type

Surface Type	Length (km)	%
Paved	147	88.0
Gravel	20	12.0
Dirt	0	0.0
Total	167	100.0

Source: JICA Study Team.

Table 9. Road Length by Surface Conditions

Surface Condition	Length (km)	%
Good	0	0.0
Fair	50	30.0
Poor	117	70.0
Very poor	0	0.0
Total	167	100.0

Source: ibid.

The traffic volume on EN223 is given in Table 10. Although traffic volume on EN223 is comparatively low, the following characteristics are noted:

(1) Heavy trucks to/from Malawi and/or the district center of Angonia share over 50 % and

(2) Traffic volume on EN223 is steadly increasing.

Table 10. Daily Traffic Volume on EN223 in 1998

Unit: Traffic volume/day

Origin	Destination	Small Vehicle	Tractor	Truck	Bus	Total
Mussacama	Tsangano access	118	6	92	12	228
Tsangano access	Maud	49	0	49	4	102
Maud	Ulongue	12	5	6	3	26
Ulongue	Colomue	7	5	3	3	18

Source: GPZ, *Rehabilitacao Urgente de infra-Estrutur as Produtizvas no Vale do Zamveze:Relatorio Final*, 1999.

3.2. Future Traffic Volume

In order to forecast the road traffic volume on the project road, first the relationship between the growth rate of past road traffic volume and that of economic indicator in terms of GDP is analyzed for 1996-98. The analysis shows that the elasticity of road traffic volume to GRDP is almost around 1.0. Therefore, it assumed that the elasticity of the road traffic demand to GDP is assumed to be 1.0. The future traffic demand on the road is forecasted on the basis of the annual traffic count survey carried out by ANE and economic growth rate of the region as shown in Table 11.

Table 11. Forecasted Daily Traffic Volume on ER 223

Unit: Traffic volume/day

Origin	Distination	2000 (Base)	2005	2015	2025
Mussacama	Tsangano access	279	364	944	2,135
Tsangano access	Maud	125	163	423	955
Maud	Ulongue	32	42	108	243
Ulongue	Colomue	22	29	75	169

Source: JICA Study Team.

4. Preliminary Engineering Study

4.1. Design Standards of the Road

The design standards adopted for the road rehabilitation projects principally conform to the geometric design standards as recently drafted out by ANE (Table 5).

4.2. Road Plan

(1) Road characteristics

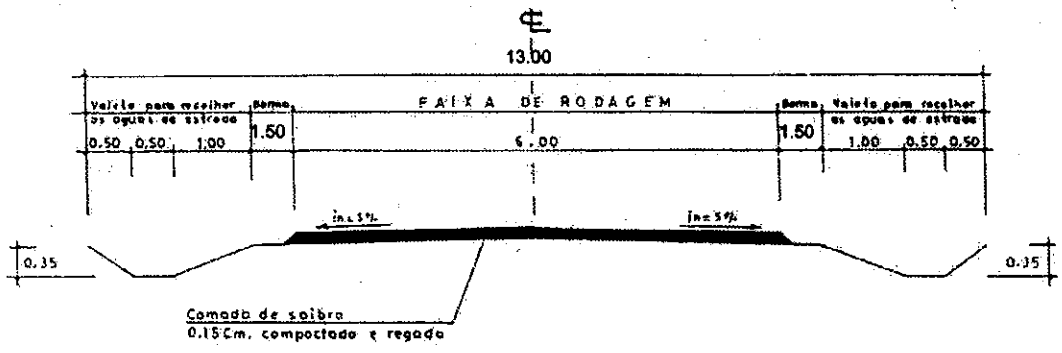
The project road can be characterized as:

1) backbone road in the Angonia region, which links the districts of Angonia, Tsangano, and Moatize.
2) supplementary international road to link between Malawi, Mozambique, Zimbabwe, and South Africa, and
3) access road to district capitals, village centers, agricultural farms, and distribution centers.

(2) Typical cross section

Taking into considerations the characteristics of road and geometric design standards, the typical cross section of the project road is adopted as shown in Figure 4.

Figure 4. Typical Cross-Section of ER223



5. Cost Estimation

5.1. Construction Costs

The construction costs are estimated based on the standard guideline of rehabilitation cost estimation made by ANE. They include earthwork, bridges and structures, pavement, and other miscellaneous costs and engineering services, but not any land acquisition cost. The construction period will be for three years from the year 2002. The total construction cost may be distributed are three years by 30%, 40%, and 30%, respectively. Table 12 summarizes the construction costs of the project.

Table 12. Construction Cost Estimation

Section		Length (km)	Unit Cost (US$/km)	Project Cost (US$10³)
Mussacama	Tsangano access	35.0	120,300	4,210.5
Tsangano access	Maud	82.2	120,300	9,888.7
Maud	Ulongue	17.3	120,300	2,081.2
Ulongue	Calomue	26.3	120,300	3,163.9
Total				19,344.5

Source: JICA Study Team.

5.2. Maintenance Costs

The maintenance costs consist of routine and periodic maintenance costs. The routine maintenance covers patching work, clearing of roadside, road lighting and others. The latter include overlay of pavement, repainting of the bridges, repairs of road structure, etc. The maintenance costs are estimated based on ANE's standard guideline of the maintenance works. The estimated costs for maintenance are divided into two different categories, routine maintenance and periodic maintenance. The cost of the routine maintenance per km is estimated at Mt.350 million per year and the latter is estimated at Mt.500 million per year.

6. Preliminary Economic Evaluation

6.1. Benefits

(1) Types of benefits

The improvement of the national road EN223 would generate various benefits, both direct and indirect ones. Reductions both in vehicle operating costs and in travel time resulting from improvement of road conditions are significant as direct benefits. An increase in sales value of agriculture products due to increased access to processing factory/distribution centers/markets is also considered as a direct benefit. In addition to

the above, the elimination of problems due to impassable conditions caused by rainfall during the rainy season is an essential benefit. Moreover, the following additional benefits are recognized: 1) improvement of accessibility to/from existing communities, 2) traffic safety and comfort for road users, and 3) promotion of regional development. Among these, the quantifiable benefits, derived from the project, consist of:

a) saving in vehicle operating cost, and
b) saving in travel time of freight and passenger.

The project is evaluated by comparing two cases, one including project implementation (with the project) and the other without project implementation (without the project).

(2) Estimation of benefits

The benefit calculation is based on the HDM-VOC model derived from the Highway Design and Maintenance Standard Model by ANE (Update of HDMIII/HNMS VOC, inputs, prepared for ANE, November1999). Estimated benefits are summarized in Table 13.

Table 13. Estimated Benefits by Year

	2000	2005	2010	2025
Saving in VOC	833,116	1,077,277	2,819,671	6,358,902
Saving in travel time cost	44,622	54,641	71,020	184,872
Total	877,738	1,131,918	2,890,692	6,643,774

Source: JICA Study Team estimation.

6.2. Economic Evaluation

The economic evaluation is made by comparing benefit and cost streams. The results are presented in Table 14.

Table 14. Economic Performance of the Project

Indicators	Unit	Value
Net present value	US$10^6	20.3
Benefit cost ratio	-	1.297
Economic rate of return	%	11.0

Notes: 1) Discount rate is assumed to be 8 %/year; .2) A project life is assumed to be 25 years.
Source: JICA Study team.

The calculated economic rate of return is higher than the opportunity cost of capital, considered to be 10% in Mozambique, indicating the improvement of EN223 is economically feasible.

6.3. Sensitivity Analysis

A sensitivity analysis is made on the basis of varying investment costs and benefits. The results of the sensitivity analysis are shown in Tables 15. The economic feasibility is ensured in most cases.

Table 15. Sensitivity Analysis

		Investment Cost		
		-10%	Base	+10%
Benefit	-10%	11.4	10.5	9.7
	Base	12.3	11.4	10.6
	+10%	13.2	12.2	11.4

Source: JICA Study Team.

7. Conclusion and Recommendations

Based on the study as reported above, the following conclusions are drawn.

(1) The project will contribute to the internal integration of the Angonia region, as it will strengthen links between the districts of Angonia, Tsangano and Moatize and improve the access to district capital of Tsangano.

(2) The projected daily traffic in 2025 is over 2,000 in the lower section, close to 1,000 in the middle, and much lower in the northern most section; this represents a rather conservative estimate especially in the northern sections where large traffics are expected to be generated as agricultural productivity is increased and the urbanization proceeds in and around Ulongue, and international traffics with Malawi will increase significantly.

(3) The calculated value of economic internal rate of return (EIRR) indicates that the project is feasible but only marginally; considering the conservative estimate of the traffic volume mentioned above, the project should be more feasible than the calculated EIRR indicates.

It is recommended, therefore, that the project proceed for early implementation. The present study should be used and upgraded to a complete feasibility study in the nearest future, followed by detailed design and implementation. Since the traffic volume on the project road in 2025 is expected to be much larger than the existing traffic volume on the national artery road EN103, the design standards of EN223 should be reflected in the future artery road of the Angonia region.

In-Depth Study on the Sena Railway
(Project No. 3.4)

1. Introduction

Rehabilitation of the Sena railway (Figure 1), particularly between Moatize and the port of Beira, is considered a must for the Angonia regional development as envisioned by its master plan. The project will support the following:

(1) It will facilitate the export of high quality coking coal from the Moatize mine,

(2) It will provide an alternative and less expensive transport means for other local products such as mineral products, construction materials, timber and agricultural products,

(3) It will stimulate cross-border trade with Malawi and possibly Zambia as well, and

(4) It will constitute an important part of the multi-modal transport system serving the Angonia region linked with neighboring countries and regions, and the port of Beira, the outer port for the region.

The present study assessed the rehabilitation of the Sena railway based on existing study reports and related data, and limited field surveys conducted by the JICA Study Team as part of the Integrated Development Master Plan Study for the Angonia Region. Since the Master Plan Study has covered only the Angonia region with six districts and Tete city, for other areas to be served by the Sena Line, the study is based generally on the Sena Line Program (SLP) prepared by GPZ.

2. Sena Line Program

The Sena Line Program proposed the following three development scenarios:

- Scenario I – High-level development including Moatize line
- Scenario II – Low-level development including Moatize line
- Scenario III – Minimum-level development not including Moatize line

Table 1 compares the three scenarios. The SLP study has evaluated the scenarios and concluded that low-level rehabilitation starting within two or three years is preferable over a high level rehabilitation that starts in ten years.

Figure 1. Map of Sena Line

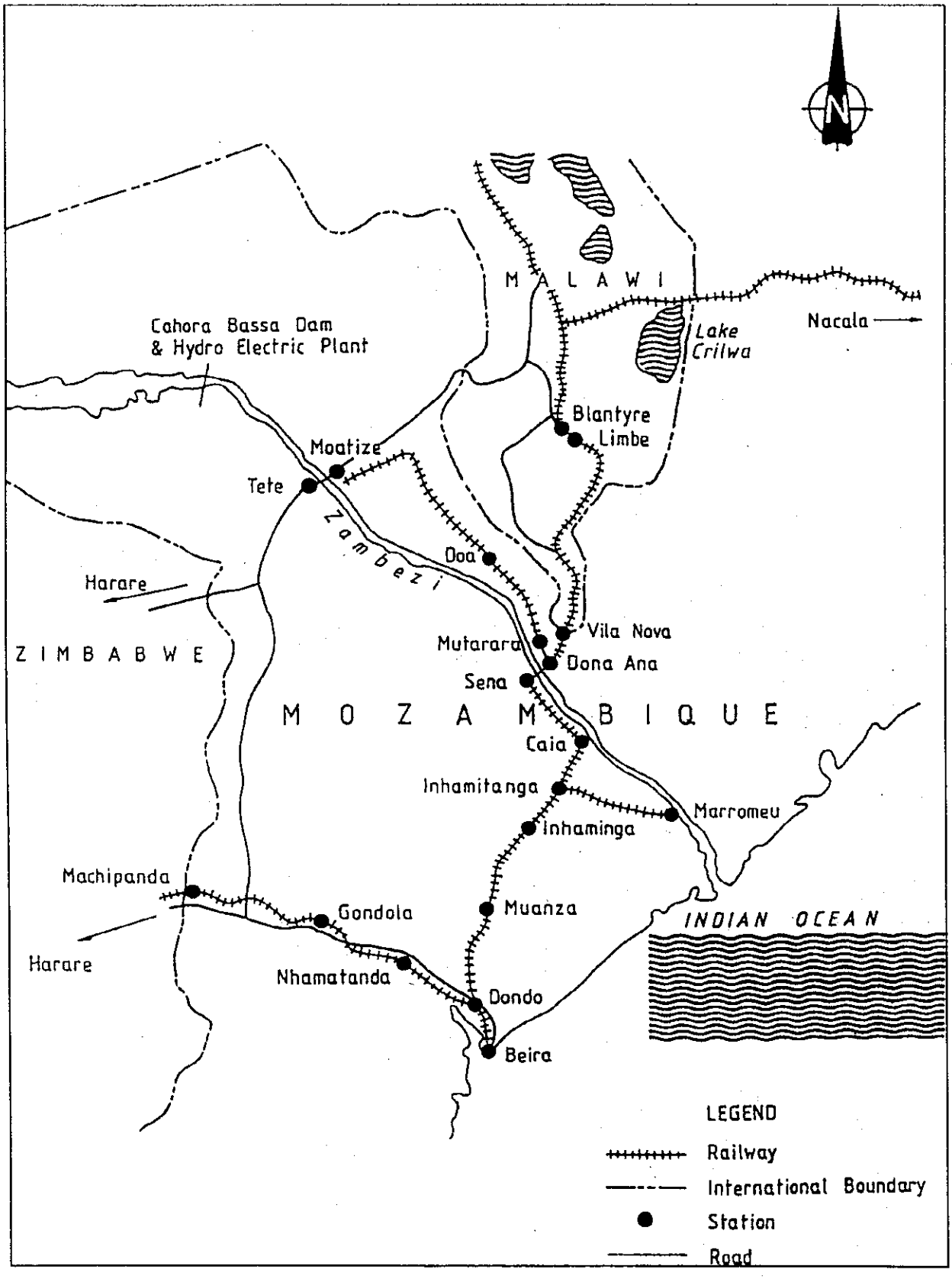


Table 1. Sena Railway Development Scenarios by GPZ

Item	Unit	Scenario I	Scenario II	Scenario III
Minerals	10^6t/yr.	5-7	1.0	-
Petrochemicals	10^6t/yr.	0.5	-	-
Traffic from Malawi	10^6t/yr.	0.6	0.6	0.6
Domestic traffic	10^6t/yr.	0.5	0.5	0.5
Total cargo	10^6t/yr.	6.6-8.6	2.1	1.1
Thermal plant	MW	1,000	-	-
Public investment	US10^6	600	200	180
Private investment	US10^6	3,700	750	500

Source: GPZ, *Sena Line Program, Summary of the Development Strategy*, July 2000.

3. Study Approach

The principal study approach to the Sena line Rehabilitation Project (SLRP) is based on the viewpoint that the enormous and diversified potentials of the Zambezi Valley are the basis and driving force for the SLRP. Moatize coal and freight traffic to/from Malawi are the most reliable freight traffic at the initial stage of the SLRP. The regional development effects to be induced by the Sena line may come at a later stage.

The following three scenarios are considered in this study:

- Scenario 1 – Low investment scenario of the Sena line; traffic capacity of the Sena line would be 1.6 million ton/year
- Scenario 2 – Medium investment scenario of the Sena line; the traffic capacity of the Sena line would be 3.5 million ton/year
- Scenario 3 – High investment scenario of the Sena line; the traffic capacity of the Sena line would be 9 million ton/year

4. Traffic Demands Forecast on the Project

The JICA Study Team has carried out a freight traffic survey of the entry/exit points or the cross boarder points. This traffic survey provided with useful information on the cross-border freight flow to/from Malawi, Zimbabwe and the Angonia region.

The freight traffic demand forecast on the Sena railway in this study is principally based on data obtained from this freight traffic survey. However, these data are limited because the Study did not cover all the influence areas of the Sena line. The information on the freight traffic demand in other areas related to the Sena line is supplemented by the Sena line Program prepared for GPZ in May 2000.

4.1. Moatize Coal and Other Mineral Products

The mineral products are the most promising products in the region. Among these

products, the Moatize coal is most important. Based on the examination and investigation made on various mineral products as part of the Master Plan Study, the following three cases are assumed for the mineral products to be transported from the Study Area to Beira by the SRL (Table 2):

- Low production case: minimum production of Moatize coal, and total amount of about 1,000,000 ton/year including some granites would be produced and transported by the SRL;
- Medium production case: medium production of Moatize coal, and total amount of 3,000,000 ton/year including some other mineral products such as granite, copper, etc. would be produced and transported by the SRL; and
- High production case: international marketable scale of Moatize coal totaling amounts of 6.0 million ton/year with the some mineral products would be produced and transported by the SRL.

Table 2 shows the comparison of the three cases.

Table 2. Potential Mineral Products in the Study Area in 2010

Unit: ton/year

Sector	Low production	Medium production	High production
1. Coal	1,000,000	3,000,000	6,000,000
2. Iron	0	0	200,000
3. Copper	0	0	200,000
4. Fluorite	0	0	50,000
5. Appetite	0	0	100,000
6. Black/Brown and Red Granites	0	0	3,000
7. Graphite	0	0	10,000
Total	1,000,000	3,000,000	6,563,000

Source: Study Team's estimation.

4.2. Rail Traffic to/from Malawi

According to the cross-boarder traffic survey, it is estimated that the freight traffic between the Study Area and Malawi in 2000 was 453,000 tons for export and 700,000 tons for import, totally 1,153,000 ton/year. Some of the freight traffic may be diverted from road-based transport system to railway, but all cargoes may not be diverted to railway. This is largely depending upon the type, origins and destinations of cargoes.

In order to forecast the rail traffic to /from Malawi, the following assumptions are made in this study:

a) Some of cargoes are diverted from road-based transport system to rail-based transport, because of the lower transport cost of railways;

b) If the origin and destination of freight traffic belong to areas affected by the Sena line, bulky cargoes, which include mineral products, wood products, construction materials, petroleum products, may be diverted almost 100% to the railway, while the non-bulky cargoes such as coffee, tea, general cargoes, consumer goods, etc. are diverted by about 50% (Malawi-Beira) or 33% (Malawi- South Africa); and

c) Generated traffic due to existence of railway is expected to be about 20% of the diverted traffic of railway in case of high estimation, while in case of low estimation, no generated traffic is considered.

Based on these assumptions, the diverted traffic to the Sena Railway is forecasted. The result of this forecast is shown in Table 3. According to the result, about 546,000 tons in case of low estimation and 655,000 tons in case of high estimation in 2010 would be used for the Sena Railway.

4.3. Rail Traffic between the Study Area and Other Regions

It is estimated that the potential railway freight traffic to/from the Study Area in 2000 would be 120,000 tons for outgoing and 142,000 tons for incoming, totally 262,000 tons. Using the same assumptions as made for Malawi, the traffic in Tete province to be diverted to the Sena Railway is forecasted. The result of this forecast is shown in Table 3. About 139,000 tons in case of low and medium estimation and 167,000 tons in case of high estimation in 2010 would use the Sena Railway. The forecasted rail traffic in other regions is basically the same as that made in the GPZ and CFM studies as shown in Table 4.

As seen from Table 3, the total freight traffic would be 2.1 million ton/year in the low case, 4.1 million ton/year in the medium case and 7.5 million ton/year in the high case.

Table 3. Potential Freight Traffic Demand of Sena Railway in 2010

Unit: ton/year

	Item	High investment scenario	Medium investment scenario	Low investment scenario
1	Moatize coal and minerals	6,500	3,000	1,000
2	Traffic from Malawi	655	546	546
3	Traffic from Tete prov.	167	139	139
4	Traffic from Sofala prov.	654	380	380
	Total cargo	7,476	4,065	2,065

Source: JICA Study Team.

Table 4. Freight Traffic Demand of Sena Railway in 2010

Unit; 1000 ton/year

Direction		High investment scenario	Medium investment scenario	Low investment scenario
Moatize coal with some mineral products, up		6,500	3,000	1,000
Traffic to/from Tete province, down		136	114	114
Traffic to/from Tete province, up		30	25	25
Traffic to/from Malawi, down		417	347	347
Traffic to/from Malawi, up		239	199	199
Traffic to/from other Sena regions, down		193	134	134
Traffic to/from other Sena regions, up		461	246	246
Total	down	746	595	595
	up	7,230	3,470	1,470

Source: JICA Study Team.

5. Rehabilitation of Rail Infrastructure

5.1. Existing Railway Infrastructure

The line from Beira (Dondo) to Moatize, and the man line to Malawi were originally built with 30kg/m rail on wooden sleepers to carry a maximum axle load of 16 tons. The length and specifications of the Sena line at the time of closure are summarized in Tables 5 and 6.

Table 5. Physical Characteristics of Original Sena Railway

Item		Description
Truck		Single truck
Gauge		1,067mm
Axle load		16 ton/axle
Length	Dondo–Dona Ana	298km
	Dona Ana–Moatize	254km
	Dona Ana–Vila Nova	44km
	Inhamitanga–Marromeu	88km
Gradients	Moatize–Cateme	2.2%
	Cambulatsitse–Chueza	1.8%
	Mwanza–Inhaminga	1.8%
	Mwanza–Dondo	1.3%

Source: CFM Development Study of Moatize Coal Fields and Transport Infrastructure, 1998

Field observations from roads parallel with the Sena line have revealed damages caused by the civil war in many sections. Some of railway formations and minor bridge structures are damaged due to sabotages and construction of roads. It is reported that the line is generally heavily mined with explosive devices. However, the CFM has already started

to demine between about 40km away from Mwanza and Mwanza, and has already completed sections between Dondo and Mwanza and between Moatize and Necangas. Following the ongoing program, the Government intends to complete the demining works for other sections within two years period.

Table 6. Specifications of Original Sena Line

Section	Length (km)	Specification
Dondo-Sena	287	37, 40, 45kg/m rail on timber sleepers
Sena-Dona Ana	4	Bridge over Zambezi river, now utilizing as road bridge. Designed as A 20-ton axle load rail bridge
Dona Ana-Moatize	254	30kg/m rail on timber sleepers
Dona Ana-Vila Nova	44	30kg/m rail on timber sleepers
Inhamitanga-Marromeu	88	30kg/m rail on timber sleepers

Source: CFM, Development Study of Moatize Coal Fields and Transport Infrastructure, 1998.

5.2. Infrastructure Rehabilitation

There are many scenarios proposed to rehabilitate the Dondo-Sena-Moatize section. The following three scenarios of rehabilitation are considered in this study as mentioned in the previous section.

(1) Low investment scenario

This scenario is to secure the traffic capacity of 1.6 million tons/year. To achieve this traffic capacity, it would be necessary to repair and rehabilitate the Sena line as follows.

Repair and Rehabilitation

- Utilize steel sleepers as much as possible and replace timber sleepers,
- Utilize the existing rail as much as possible and replace damaged rail,
- Provide new signal system,
- Provide cleaned and supplementary ballast,
- Track repairs, and
- Structural repairs to bridges, buildings, workshop, staff quarters, etc.

(2) Medium investment scenario

This scenario is to provide the traffic capacity of the Sena line with 3.5 million tons/year. In order to achieve this traffic capacity, it would be necessary to repair and upgrading of the Sena line as follows.

Repair and Upgrading

- Supply and lay 495,000 concrete sleepers,
- Replace all the sections of line laid with 45kg/m rail,
- Provide 20 ton axle load

- Provide new signal system,
- Supply and lay 220,000m^3 track ballast, and
- Track repairs, and
- Structural repairs to bridges, buildings, workshop, staff quarters, etc.

(3) High investment scenario

This scenario is based on providing the traffic capacity of the Sena line of 9 million tons/year. In order to achieve this traffic capacity, it would be necessary to rehabilitate the Sena line as follows.

Repair and Upgrading

- Supply and lay 495,000 concrete sleepers,
- Replace all the sections of line laid with 45kg/m rail,
- Supply and lay 495,000 concrete sleepers,
- Provide new signal system,
- Provide plant and equipment to new ballast quarry,
- Supply and lay 220,000 m3 track ballast,
- Track repairs, and
- Structural repairs to bridges, buildings, workshop, staff quarters, etc.

Section	Low investment	Medium investment	High investment
Dondo–Sena	Rail retaining, re-sleepering & additional ballast 30/40/45kg/m rail & timber sleepers	Rail retaining, re-sleepering & additional ballast 45kg/m rail & concrete sleepers	Rail retaining, re-sleepering & additional ballast 45kg/m rail & concrete sleepers
Sena–Dona Ana	40kg/m rail & timber sleepers	45kg/m rail & concrete sleepers	45kg/m rail & concrete sleepers
Dona Ana–Moatize	30kg/m rail & timber sleepers	45kg/m rail & concrete sleepers	45kg/m rail & concrete sleepers
Dona Ana–Vila Nova	30kg/m rail & timber sleepers	45kg/m rail & concrete sleepers	45kg/m rail & concrete sleepers
Inhamitanga–Marromeu	30kg/m rail & timber sleepers	45kg/m rail & timber sleepers	45kg/m rail & timber sleepers

Source: Based on Giersing Rose study (for the low investment scenario) & CFM, Development Study of Moatize Coal Fields and Transport Infrastructure, 1998.

6. Cost Estimation

6.1. Cost for Railway Rehabilitation

The cost for railway rehabilitation for three scenarios is estimated based on the previous studies and proposals. Results are summarized in Table 7. The rehabilitation cost of the low cost scenario would be required at US$ 114 million, while that of the medium and high

cost cases is required at US$ 212 million and US$ 328 million, respectively. These rehabilitation costs include the costs of branches of Malawi and Marromeu lines.

Table 7. Rehabilitation Cost of Sena Railway

Section/Item	Length (km)	Low investment		Medium investment		High investment	
		Unit Cost (US$10³)	Amount (US$10³)	Unit Cost (US$10³)	Amount (US$10³)	Unit Cost (US$10³)	Amount (US$10³)
Dondo–Derunde	29	102	2,958	235	6,815	364	10,556
Derunde–Dona Ana	262	126	33,012	291	76,242	451	118,162
Dona Ana–Moatize	254	126	32,004	291	73,914	451	114,554
Dona Ana–Vila Nova	44	143	6,292	143	6,292	143	6,292
Dona Ana Bridge	4	LS	0	LS	0	LS	2,000
Bridges & Culverts	--	LS	2,500	LS	2,500	LS	5,000
Alignment modification	78	LS	12,000	LS	12,000	LS	24,000
Workshops	--	LS	2,000	LS	1,000	LS	4,000
Sub-total			90,766		178,763		284,564
Engineering & supervision		-10%	9,077	-10%	17,876	-10%	28,456
Inhamitanga–Marromeu	88	174	15,312	174	15,312	174	15,312
Total Cost			115,155		212,051		328,332

Source: Giersing Rose A/S, Development Study of Moatize Coal Fields and Transport Infrastructure, 1997.

6.2. Operation Cost

The operating cost of the Sena line would consist of the following items.

(1) Variable cost
   a) Crew and fuel cost
   b) Maintenance cost
   c) Terminal Cost
   d) Lease charges for Locomotives and wagons
   e) Insurance cost
   f) Personnel cost
   g) Miscellaneous cost

(2) Fixed cost
   a) Maintenance cost
   b) Other fixed cost

On the basis of the CFM's operating cost data, the operation cost for the Sena line is determined as the following:

- Variable cost US$5.710/ton, and
- Fixed cost US$0.368/ton.

7. Preliminary Financial Analysis

7.1. Introduction

The financial analysis on the project will be based on the following conditions:

a) Period of the financial analysis would be 25 years after commissioning of the line;
b) The fare level of the Sena line is fixed at 30 cent/ton-km, irrespective of types of freight;
c) Project cost and revenue are calculated on the basis of US dollars;
d) Depreciation of the Sena line facilities is 25 years;
e) Rolling stock such as locomotives and wagons would principally be leased from CFM;
f) An opportunity cost of capital in terms of US dollars is assumed to be 8%; and
g) All the revenue and expenditure are expressed in US dollars.

The preliminary financial analysis will be made only on the low and the medium cost scenarios. The high cost scenario will not be analyzed, because it would require a large-scale additional investment for coal handling facilities at the Beira port.

7.2. Financial Analysis

(1) Revenue

Using the unit fare level of 30 cent/ton-km and distances between areas, the fares could be calculated as follows.

• Moatize Coal–Beira	575km	US$17.25
• Tete–Beira traffic	575km	US$17.25
• Malawi–Beira traffic	365km	US$10.95
• Sena regions–Beira traffic	317km	US$9.51

The annual revenues are calculated on the basis of the traffic demands forecasted and the fare level.

(2) Preliminary financial analysis

The financial analysis is made using the calculated revenue and the estimated transport infrastructure and operation costs. An indicator of the preliminary financial analysis is an internal rate of return (IRR). The results of the analysis are shown in Table 8.

From Table 8, the following observations may be made:

a) The low cost scenario may not be justified; and
b) The medium investment scenario is financially viable, but the level of viability is not high enough to be implemented as a BOT project.

Table 8. Financial Analysis of the SLRP

	Internal rate of return (IRR)
Low investment scenario	3.2%
Medium investment scenario	9.2%

Note: The project life is 25 years after commissioning of the line.
Source: JICA Study Team.

(3) Sensitivity analysis

The sensitivity analysis is performed on the basis of varying investment costs and revenues. The results of the sensitivity analysis are shown in Table 9.

Table 9. Investment Cost Sensitivity Analysis

(Unit: %)

		Low investment scenario			Medium investment scenario		
		-10 %	Base	+10%	-10%	Base	+10%
Fare (US$/ton-km)	0.027	2.5	0.6	-0.8	8.1	6.6	5.3
	0.030	4.7	3.2	1.8	10.7	9.1	7.0
	0.033	6.9	5.4	4.0	13.0	11.4	9.9

Source: JICA Study Team.

The sensitivity analysis shows the following:

a) Large increase in freight fare is required to make the low investment scenario justifiable, but still the viability will be marginal; and
b) The medium investment scenario could not be justified in some cases, especially when the investment costs increase significantly.

(4) Incentive measures

The financial analysis shows that the project would not be attractive for private investors because there are many risks such as project cost increase, political risk, etc. while the financial return is very small. In order to attract private investors, it would be necessary to provide incentive measures. One of them is to give a concession of Moatize coal field. The project becomes financially viable if the concession of about 20 ha is given to the Sena rail operator to effectively reduce the construction cost (Table 10).

Table 10. Incentive Measure for Sena Line (Medium investment scenario)

		IRR (%)
Level of subsidy to construction costs	25%	13.6
	30%	14.7
	50%	20.9

Source: JICA Study Team.

8. Conclusions and Recommendations

The following conclusions are drawn from the study on the SLRP as reported above.

(1) The medium investment scenario with the freight capacity of 3.5 million ton/year is financially viable, but the level of viability is not high enough for the project to be implemented on a BOT base.

(2) The low investment scenario with the freight capacity of 1.6 million ton/year is not justified, and this should be dropped from further consideration.

(3) The project viability may be higher for larger-scale investment, but the high investment scenario could not be examined at this time, because it would require a large-scale investment for coal handling facilities at the Beira port.

(4) Additional benefits/revenues will accrue from the main line to Malawi, while it shares the same line section to Beira, so that the viability of the Sena railway as a whole should be higher than it appears from the IRR value for the medium investment scenario. In fact, the project is a national project serving the central Mozambique.

Recommendations for immediate actions are as follows.

(1) A complete feasibility study should be undertaken in the immediate future, taking the Moatize coal mining, transport infrastructure for the Sena Railway, and the Beira port as an integrated project.

(2) Considering the nature as a national project, incentive measures should be examined to encourage private investors to participate in the implementation, such as concession of the Moatize coalfield.

(3) Demining should be completed promptly along the entire stretch of the Sena Railway.

Appendix 1. Coal Handling Facilities at Beira Port

The coal handling facilities are located at Wharf 8 of the Beira Port. Dimensions of the existing facilities are as follows.

- Length 875m
- Depth 7.2m
- Capacity 1.2 million m^3
- Handling equipment 4,800 ton/day

After appropriate maintenance dredging to be made, it should be possible to accommodate 25,000DWT carriers with full loads. If the existing handling facilities are used, the maximum capacity of the Wharf 8 would be around 1.5 million ton/year. If some modifications can be made to allow more than one coal vessel to be handled at the same time, the maximum capacity would be approximately 3 million ton/year. Export volumes higher than this will require new coal handling facilities, which should be designed to accommodate at least Panamix size vessels (70,000DWT) or Cape size vessels. This should be investigated further.

Appendix 2. Related Road Improvement

The major roads along the Sena line are as follows:

- Regional road ER450, from Madamba to Mutarara, and
- National Road EN213, from Bondo to Sena via Caia.

As the results of the reconnaissance survey made in this study, the section of ER450 between Madanba and Dzimira is generally passable during dry season and rainy season except river crossing. However, the section between Dzimira and Mutarara is impassable during rainy season. It is suggested, therefore, to construct alternative roads of ER450 between Dzimira and Mutarara which would run parallel to the Sena line.

As for the national road EN213, the road conditions between Sena and Inhaminga are generally acceptable, but the road between Inhaminga and Dondo is in very bad conditions. In order to rehabilitate the Sena line, it is necessary at the same time to improve parallel roads to the Sena line.

Appendix 3. Financial Analysis of the Sena Line: Low Investment Case

	IRR	4.5 %																												
	-5	-4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Total
	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Year 2011	Year 2012	Year 2013	Year 2014	Year 2015	Year 2016	Year 2017	Year 2018	Year 2019	Year 2020	Year 2021	Year 2022	Year 2023	Year 2024	Year 2025	Year 2026	Year 2027	Year 2028	Year 2029	Year 2030	
Traffic																															
Coal					1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	
Traffic from Tete					86,360	88,569	90,778	92,987	95,196	97,405	99,941	102,477	105,013	107,548	110,084	113,256	116,428	119,601	122,773	125,945	129,117	132,289	135,461	138,634	141,806	141,806	141,806	141,806	141,806	141,806	
Traffic from Malawi					127,313	135,928	144,543	153,158	161,773	170,387	182,743	195,099	207,455	219,810	232,166	253,512	274,858	296,203	317,549	338,895	360,241	381,586	402,932	424,278	445,624	445,624	445,624	445,624	445,624	445,624	
Traffic from Sena Region					19,538	20,076	20,614	21,153	21,691	22,229	22,864	23,500	24,135	24,770	25,405	26,243	27,082	27,920	28,758	29,597	30,435	31,274	32,112	32,950	33,789	33,789	33,789	33,789	33,789	33,789	
Total					1,233,211	1,244,573	1,255,935	1,267,297	1,278,660	1,290,022	1,305,549	1,321,075	1,336,602	1,352,128	1,367,655	1,393,011	1,418,368	1,443,724	1,469,080	1,494,437	1,519,793	1,545,149	1,570,506	1,595,862	1,621,218	1,621,218	1,621,218	1,621,218	1,621,218	1,621,218	
Revenue																															
Coal						16,350	16,350	16,350	16,350	16,350	16,350	16,350	16,350	16,350	16,350	16,350	16,350	16,350	16,350	16,350	16,350	16,350	16,350	16,350	16,350	16,350	16,350	16,350	16,350	16,350	408,750
Traffic from Tete						1,448	1,484	1,520	1,556	1,593	1,634	1,675	1,717	1,758	1,800	1,852	1,904	1,955	2,007	2,059	2,111	2,163	2,215	2,267	2,319	2,319	2,319	2,319	2,319	2,319	48,630
Traffic from Malawi						1,366	1,453	1,539	1,626	1,712	1,837	1,961	2,085	2,209	2,333	2,548	2,762	2,977	3,191	3,406	3,620	3,835	4,049	4,264	4,479	4,479	4,479	4,479	4,479	4,479	75,645
Traffic from Sena Region						173	177	182	187	191	197	202	208	213	219	226	233	240	248	255	262	269	276	284	291	291	291	291	291	291	5,989
Total						19,337	19,464	19,592	19,719	19,846	20,017	20,189	20,360	20,531	20,702	20,975	21,249	21,523	21,796	22,070	22,344	22,617	22,891	23,164	23,438	23,438	23,438	23,438	23,438	23,438	539,014
Engineering and Supervision	2,269	2,269	1,513	1,513	1,513																										9,076
Rail Infrastructure																															0
Dondo - Moatize			22,658	22,658	22,658																										67,974
Dona Ana – Vila Nova			2,097	2,097	2,097																										6,292
Dona Ana Bridge			0	0	0																										0
Bridges and Culverts			833	833	833																										2,500
Alignments			6,000	6,000																											12,000
Workshops				500	500																										1,000
Inhamitanga – Maromeu			5,104	5,104	5,104																										15,312
Telecommunication				1,000	1,000																										2,000
Depreciation						4,243	4,243	4,243	4,243	4,243	4,243	4,243	4,243	4,243	4,243	4,243	4,243	4,243	4,243	4,243	4,243	4,243	4,243	4,243	4,243	4,243	4,243	4,243	4,243	4,243	106,075
Operating cost-Variable						7,107	7,171	7,236	7,301	7,366	7,455	7,543	7,632	7,721	7,809	7,954	8,099	8,244	8,388	8,533	8,678	8,823	8,968	9,112	9,257	9,257	9,257	9,257	9,257	9,257	206,685
Operating cost-Fix						458	462	466	471	475	480	486	492	498	503	513	522	531	541	550	559	569	578	587	597	597	597	597	597	597	13,320
Total	2,269	2,269	38,205	39,705	33,705	11,808	11,877	11,946	12,015	12,084	12,178	12,272	12,367	12,461	12,556	12,710	12,864	13,018	13,172	13,326	13,480	13,634	13,789	13,943	14,097	14,097	14,097	14,097	14,097	14,097	442,233
Net revenue	-2,269	-2,269	-38,205	-39,705	-33,705	7,530	7,588	7,646	7,704	7,763	7,839	7,916	7,993	8,070	8,146	8,266	8,385	8,505	8,624	8,744	8,863	8,983	9,102	9,222	9,341	9,341	9,341	9,341	9,341	9,341	96,781
Cumulative net revenue	-2,269	-4,538	-42,743	-82,449	-116,154	-108,624	-101,037	-93,391	-85,686	-77,924	-70,084	-62,168	-54,175	-46,106	-37,960	-29,694	-21,309	-12,804	-4,180	4,564	13,427	22,410	31,512	40,734	50,075	59,416	68,758	78,099	87,440	96,781	

Appendix 4. Financial Analysis of the Sena Line: Medium Investment Case

	IRR	9.1 %																												
	-5	-4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Total
	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Year 2011	Year 2012	Year 2013	Year 2014	Year 2015	Year 2016	Year 2017	Year 2018	Year 2019	Year 2020	Year 2021	Year 2022	Year 2023	Year 2024	Year 2025	Year 2026	Year 2027	Year 2028	Year 2029	Year 2030	
Traffic																														
Coal					3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	
Traffic from Tete					86,360	88,569	90,778	92,987	95,196	97,405	99,941	102,477	105,013	107,548	110,084	113,256	116,428	119,601	122,773	125,945	129,117	132,289	135,461	138,634	141,806	141,806	141,806	141,806	141,806	141,806	
Traffic from Malawi					127,313	135,928	144,543	153,158	161,773	170,387	182,743	195,099	207,455	219,810	232,166	253,512	274,858	296,203	317,549	338,895	360,241	381,586	402,932	424,278	445,624	445,624	445,624	445,624	445,624	445,624	
Traffic from Sena Region					19,538	20,076	20,614	21,153	21,691	22,229	22,864	23,500	24,135	24,770	25,405	26,243	27,082	27,920	28,758	29,597	30,435	31,274	32,112	32,950	33,789	33,789	33,789	33,789	33,789	33,789	
Total					3,233,211	3,244,573	3,255,935	3,267,297	3,278,660	3,290,022	3,305,548	3,321,075	3,336,602	3,352,128	3,367,655	3,393,011	3,418,368	3,443,724	3,469,080	3,494,437	3,519,793	3,545,149	3,570,506	3,595,862	3,621,218	3,621,218	3,621,218	3,621,218	3,621,218	3,621,218	3,621,218	
Revenue																														
Coal						49,050	49,050	49,050	49,050	49,050	49,050	49,050	49,050	49,050	49,050	49,050	49,050	49,050	49,050	49,050	49,050	49,050	49,050	49,050	49,050	49,050	49,050	49,050	49,050	49,050	1,226,250
Traffic from Tete						1,448	1,484	1,520	1,556	1,593	1,634	1,675	1,717	1,758	1,800	1,852	1,904	1,955	2,007	2,059	2,111	2,163	2,215	2,267	2,319	2,319	2,319	2,319	2,319	2,319	48,630
Traffic from Malawi						1,366	1,453	1,539	1,626	1,712	1,837	1,961	2,085	2,209	2,333	2,548	2,762	2,977	3,191	3,406	3,620	3,835	4,049	4,264	4,479	4,479	4,479	4,479	4,479	4,479	75,645
Traffic from Sena Region						173	177	182	187	191	197	202	208	213	219	226	233	240	248	255	262	269	276	284	291	291	291	291	291	291	5,989
Total						52,037	52,164	52,292	52,419	52,546	52,717	52,889	53,060	53,231	53,402	53,675	53,949	54,223	54,496	54,770	55,044	55,317	55,591	55,864	56,138	56,138	56,138	56,138	56,138	56,138	1,356,514
Engineering and Supervision	4,469	4,469	2,979	2,979	2,979																										17,876
Rail Infrastructure																															
Dondo - Moatize			52,324	52,324	52,324																										156,971
Dona Ana – Vila Nova			2,097	2,097	2,097																										6,292
Dona Ana Bridge			0	0	0																										0
Bridges and Culverts			833	833	833																										2,500
Alignments			6,000	6,000																											12,000
Workshops				500	500																										1,000
Inhamitanga – Marromeu			5,104	5,104	5,104																										15,312
Telecommunication				1,000	1,000																										2,000
Depreciation						8,520	8,520	8,520	8,520	8,520	8,520	8,520	8,520	8,520	8,520	8,520	8,520	8,520	8,520	8,520	8,520	8,520	8,520	8,520	8,520	8,520	8,520	8,520	8,520	8,520	213,000
Operating cost-Variable						18,527	18,591	18,656	18,721	18,786	18,875	18,963	19,052	19,141	19,229	19,374	19,519	19,664	19,808	19,953	20,098	20,243	20,388	20,532	20,677	20,677	20,677	20,677	20,677	20,677	492,183
Operating cost-Fix						1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	30,982
Total	4,469	4,469	69,338	70,838	64,838	28,286	28,351	28,416	28,480	28,545	28,634	28,723	28,811	28,900	28,989	29,133	29,278	29,423	29,568	29,713	29,857	30,002	30,147	30,292	30,436	30,436	30,436	30,436	30,436	30,436	950,117
Net revenue	-4,469	-4,469	-69,338	-70,838	-64,838	23,751	23,814	23,876	23,939	24,001	24,083	24,166	24,248	24,331	24,413	24,542	24,671	24,800	24,929	25,057	25,186	25,315	25,444	25,573	25,702	25,702	25,702	25,702	25,702	25,702	406,397
Cumulative net revenue	-4,469	-8,938	-78,276	-149,113	-213,951	-190,200	-166,386	-142,510	-118,571	-94,570	-70,487	-46,321	-22,073	2,258	26,672	51,214	75,885	100,684	125,613	150,670	175,856	201,172	226,615	252,188	277,890	303,591	329,293	354,994	380,696	406,397	

In-Depth Study on GPZ Strengthening
(Project No. 4.1)

1. Introduction

Priority policy and commitment by the Government for the development of the Zambezi Valley are embodied into the establishment of GPZ as a statutory body. GPZ can plan for any projects in any sectors within its territorial jurisdiction for approval by the Government through the Council of Ministers. GPZ coordinates development activities of sector agencies and promote their implementation. GPZ guides the private sector and facilitates private investments.

The functions of GPZ at present are largely planning and coordination, and its activities are constrained by limited financial and manpower resources. As of the end of 2000, GPZ had a total of 51 staff members, of which 33 were senior specialists, nine junior specialists and nine clerks. GPZ is currently undergoing restructuring of its organization, and expected to expand its staff capacity significantly by 2003.

2. Objectives

The project will support and extend the on-going organizational reform of GPZ. Objectives of the project are:

(1) To strengthen GPZ functions for planning and coordination, private sector supports, and promotion of participatory community development, and

(2) To expand GPZ capacities to implement projects in selected areas and to establish GPZ ownership.

3. Recommended Organizational Reform of GPZ

3.1. Framework for the Reform

Any proposal to strengthen organizational structure and functions of GPZ should be in line with the on-going organizational restructuring. In fact, the on-going changes are in a welcome direction in the sense that staff capacity will be expanded and sub-regional units are introduced to enhance the GPZ presence in the fields. Along these lines, further strengthening of GPZ is recommended.

Additionally, GPZ strengthening should satisfy the following conditions:

(1) The planning and coordinating functions should be strengthened to foster an integrated view and long-term vision of the Angonia regional development and to ensure these to be reflected in sub-regional development and development of different districts and cities;

(2) Functions to support the private sector should be strengthened to foster local industries, particularly small and medium enterprises (SMEs), to encourage linkages such as sub-contracting, and to attract investors from the outside;

(3) Broad local participation should be effected both for effective social and community development and for expanding resources base for other development and management activities; and

(4) GPZ ownership should be established in selected fields such as water resources development and management, environmental management, integrated rural development and social/livelihood development.

3.2. Recommended Reform

(1) Organization along sector lines

The original setup of GPZ should be expanded in steps along sector lines as the staff capacity is increased. The Department of Project Promotion may be expanded with separate sections in charge of different economic sectors. To utilize limited manpower in a more effective and flexible manner in the short to medium term, experts in agriculture, industry, trade and services as well as regional economy may be posted to the department rather than creating separate sections. The Department of Infrastructure may be expanded similarly with expertise in different kinds of infrastructure. This sector-wise organization will allow to maintain a regional view of the respective sector and complement the sub-regional division currently undertaken.

(2) Strengthening of planning and coordination

The Department of Planning and Studies should be much strengthened to foster and maintain an integrated regional view and a long-term vision under the sector-wise and sub-regional subdivisions. Under the ongoing restructuring, the department is expected to expand from two branches with six staff members to five branches with 25 staff members by 2003. Technical supports to district administrations and municipalities for socio-economic and land use planning in line with the integrated regional view are among the functions to be much strengthened in this department.

(3) SMEs promotion

A section in charge of SMEs promotion should be created to support SMEs growth through improving their management and training their staff. The section will facilitate introduction of new technologies and modernization of equipment by SMEs, develop markets and products ("Tete brand", for instance), and promote inter-industry linkages through subcontracting and alliances.

(4) Participatory development

The Department of Community Development should be strengthened to encourage broad

local participation in a wide range of development activities. Participatory development will cover not only various socio-economic activities but also cooperative community works to improve and manage various rural infrastructure.

Another main area where more active local participation is expected is environmental impact assessment or more broadly environmental monitoring and management. For these activities, GPZ should establish and maintain good working relationship with district administrations, farmers' associations and other private alliances, and NGOs. GPZ should maintain a registry of NGOs with good track records for development activities. Under the ongoing restructuring, the department is expected to expand from three staff members at present to four branches with 18 to 20 staff members by 2003. GPZ would recruit community development specialists locally to utilize their communication capability in local languages and their human networks.

(5) Support functions

In addition to the Department of Administration and Finance, another support department should be created for information and technology. The department will have dual functions. One is to provide information services related to technology, markets and business opportunities to the private sector, and the other is to provide information necessary for operation of other departments. The proposed Zambezi River Database will be attached to it initially.

3.3. Manpower Requirements

The staff capacity of GPZ will have to be expanded continuously beyond what has already been planned. The number of staff in each department existing at present should increase as follows, aiming at the year 2005: 12 in the Department of Administration and Finance, 20 in the Project Promotion, 25 in the Planning and Studies, and 20 in the Community Development, and eight in the secretariat for a total of 105 staff members. The newly proposed Department of Information and Technology may be staffed with 10 experts and assistants. The Project Management units may have five staff members in each sub-region. The total number of GPZ staff may be close to 140 by 2005.

4. Project Costs

Investment costs of the project consist of costs of staff housing and associated facilities and benefits, additional equipment for the Department of Information and Technology, and some training for newly recruited staff members. Costs of the on-going GPZ headquarters and their facilities and equipment are not included. The total cost is estimated to be US$1.59 million, consisting of US$1,500,000 for staff housing, US$80,000 for equipment, and US$10,000 for training.

In-Depth Study on Tete Provincial Hospital Upgrading
(Project No. 4.5)

1. Background

1.1. General

The Tete provincial hospital is a top referral hospital with 300 beds to serve the whole provincial population. Nearly 3,000 patients in serious conditions are referred from other health facilities in each district to this hospital every year. Although the hospital seems well managed, lack of basic equipment and old buildings without air-conditioning constrain the provision of better health services. Since DANIDA, which implemented a comprehensive health program in Tete province, concentrated its support for rural hospitals in Angonia and Mutarara, the provincial hospital has been left poorly equipped for a long time.

At the same time, the number of AIDS patients including opportunistic infection with TB (tuberculosis) has been increasing at the hospital because the prevalence rate of HIV is higher in Tete than other provinces. AIDS ranked as the second highest cause of death at the hospital in 1998 and 2000 and the fourth in 1999 and 2001. However, there is neither isolation ward nor special treatment for them. Due to lack of adequate laboratory machines and training, accurate diagnosis of HIV infection cannot be made. The proposed HIV/AIDS care center is expected to offer home-based care and research activities as well.

1.2. Outline of Tete Provincial Hospital

(1) Manpower

The number of beds, doctors and nurses in each department is shown in the Table 1.

Table 1. Number of Beds, Doctors and Nurses at Tete Provincial Hospital in 2001

	Internal	Surgery	Pediatrics	Eye	Dental	Emergency	Other	Total
Bed	98	87	67	28	-	6	13	299
Dr. (general)	6						3	9
Dr. (specialist)	1	1	1		1		13	17
Nurse	12	13	9	5		7	8	54

Source: Tete Provincial Hospital.

In addition, this hospital has 11 midwives, seven pharmacists, five laboratory technicians, five X-ray technicians and 10 workshop technicians. The number of medical staff is not in a serious shortage except for specialist doctors. Specialist doctors for major departments (internal medicine, surgery and pediatrics) are all foreigners from Cuba,

Russia, and India, respectively because Mozambican specialist doctors are only a few in the entire nation and they do not prefer to work in places far from the capital.

(2) Equipment

The existing medical equipment in the hospital consists of a general X-ray machine, electric microscopes, electric aspirators, autoclaves, and a spectrophotometer. Although DANIDA has provided several equipments in laboratories, other departments especially operation and labor rooms are very poorly equipped without air-conditioning. Several departments including nursing department and lady's infirmary need construction and rehabilitation. The hospital does not have equipment essential for a top referral hospital such as incubators, electrocardiography and ambulances.

Since the hospital has 10 workshop technicians, maintenance of equipments seems properly carried out even though they sometimes face spare parts shortage.

(3) Utilization

Table 2 presents the number of patients in Tete provincial hospital.

Table 2. Trend in the Number of Patients and Referred Patients

	No of patients		No of referred patients	
	Outpatients	Inpatients	Referred from other facilities	Referred to other hospitals
1996	30,583	9,512	3,478	-
1997	34,770	10,728	3,070	61
1998	49,235	9,659	3,111	52
1999	44,234	11,726	2,780	71
2000	41,670	11,527	2,637	67
Daily ave. (2000)	114.1	-	7.2	-

The number of outpatients has been decreasing since 1999 because health centers and health posts have been newly constructed in each district. Therefore the number of referred patients from other facilities also has been gradually decreasing since 1999. On the other hand, the number of inpatients has been increasing with a very high bed occupancy rate (BOR) as Table 3 indicates.

The BOR is the fundamental index of hospital utilization. In general, a BOR higher than 70% indicates that the hospital is highly utilized with proper quality of services and management. The Tete provincial hospital keeps a high BOR because this is the sole health facility with specialist doctors serving the whole province, while health centers and health posts in each district cannot treat neither serious patients nor emergency cases because there is no medical doctors. Another reason is that this is the only health facility operating 24 hours a day.

Table 3. BOR, Number of Deliveries and Operations

	BOR	No of deliveries	No of operations	
			Minor operations	Major operations
1996	80.5%	2,573	6,565	556
1997	94.8%	2,704	7,054	749
1998	83.8%	2,696	3,457	425
1999	73.4%	3,002	5,195	717
2000	69.9%	3,103	3,070	728
Daily ave. (2000)	-	8.5	8.4	1.9

(4) HIV/AIDS

The number of AIDS patients in this hospital including opportunistic infection with tuberculosis is increasing as indicated in Table 4. An estimated HIV prevalence rate of central provinces including Tete is higher than other provinces partly due to the population movements of refugees returned from surrounding countries with high HIV infection, namely, Zimbabwe, Malawi and Zambia. As the Angonia region develops, the HIV prevalence may be higher with more population movements.

At present there is no isolation ward for AIDS patients and only two nurses, who have not received any special training, take care of these patients.

Table 4. Top 10 Causes of Death in Tete Provincial Hospital

	1996	1997	1998	1999	2000	2001
1	Malaria	Malaria	Malaria	Malaria	Malaria	Malaria
2	Pulmonary tuberculosis	Broncho pneumonia	AIDS	Broncho pneumonia	AIDS	Broncho pneumonia
3	Broncho pneumonia	Malnutrition	Broncho pneumonia	Malnutrition	Broncho pneumonia	Malnutrition
4	Anemia	Anemia	Malnutrition	AIDS	Malnutrition	AIDS
5	Pneumonia	Pulmonary tuberculosis	Pulmonary Tuberculosis	Pulmonary tuberculosis	Pulmonary Tuberculosis	Pulmonary tuberculosis
6	Malnutrition	Diarrhea	Anemia	Cardiac insufficiency	Anemia	Cardiac insufficiency
7	Pneumonia	AIDS	Diarrhea	Diarrhea	Diarrhea	Diarrhea
8	AIDS	Meningitis	Meningitis	Anemia	Meningitis	Anemia
9	Cardiac insufficiency	Pneumonia	Cardiac insufficiency	Meningitis	Cardiac insufficiency	Meningitis
10	Meningitis	Cardiac insufficiency	Pneumonia	Pneumonia	Pneumonia	Pneumonia

Source: Tete Provincial Hospital.

2. Objectives

The project has the following objectives:

(1) to improve health services of the top referral hospital in Tete province with

sophisticated medical equipments; and

(2) to establish a provincial center for AIDS related activities in the Tete provincial hospital for strengthening both treatment and research activities in the region.

The overall goal of the project is to provide better quality of services and to ensure accessible and effective health care for all population in the Study Area.

3. Project Components

The project consist of the two components as described below.

(1) Provision of medical equipments and rehabilitation of buildings

The following facilities and equipments are required:

1) Facilities:
   - construction of new operation theater,
   - rehabilitation of nursing department, and
   - rehabilitation of lady's infirmary;

2) Equipments:
   - electrocardiography,
   - incubator,
   - ambulance,
   - spectrophotometer,
   - electric aspirator,
   - sphygmomanometer,
   - auto clave sterilization,
   - refrigerator for kitchen,
   - electric generator, and
   - air conditioning.

(2) Establishment of HIV/AIDS Care Center in Tete provincial hospital

The center has the following functions:

- to provide special treatment including counseling and prescribing AIDS medicine for AIDS patients by trained personnel,
- to strengthen prevention activities such as reproductive health education and IEC in cooperation with NGOs and communities,
- to train health personnel who can provide both special treatment in the center and home-based care in communities,
- to collect and analyze AIDS related data and information including those of surrounding countries whose HIV infection are much serious, and
- to coordinate all AIDS related activities, including those implemented by foreign

donors and international NGOs, for more efficient program implementation in the whole province.

4. Implementing Arrangements

Implementing agencies are MOH, Provincial Health Directorate, Tete Provincial Hospital, National AIDS Council at province level, NGOs implementing activities on HIV/AIDS, and communities. The entire project will be coordinated mainly by the Provincial Health Directorate and through a steering committee to be established.

5. Project Cost

The total cost of the project will be approximately US$3.1 million, consisting of US$2.5 million for equipments, US$0.5 million for facilities and US$0.1 million for training and research.

In-Depth Study on Extension Services Enhancement
(Project No. S.1)

1. Implementing Agencies

Implementation agencies for the project are the Ministry of Agriculture and the Provincial Service of Extension, Tete Province.

2. Overview

Enhancement of extension services is identified as an important strategy in the community development sector. The Study Team stresses the role of extension as one of top priorities for attaining empowered communities in the Study Area. Communities need to develop a strong foundation of human development in order to achieve objectives set by the Study. Empowered communities equipped with strong sense of self-governance and self-determination can only support the various projects and programs proposed in different sectors in the Study.

Skillfully designed training programs ensure the provision of extension services in the Study Area. The delivery of extension services is achieved only through strengthening existing extension related institutions. Such empowered extension services are the only means for the Government to initiate and motivate technological changes proposed by the Study. If implemented successfully, communities could cope with changes initiated by implementation of the project.

3. Roles of Extension and Training in Human Resources Development

3.1. Extension and Training

'Training' and 'extension' are crudely differentiated as *training* is aimed at enabling people to acquire specific knowledge, skills and attitude while *extension* is aimed at encouraging changes in behavior. In the agricultural context, this usually means encouraging people to change the way in which they practice farming (e.g., to adopt line planning instead of random planting) or to change the farming activities in which they engage (e.g., to adopt irrigated rice instead of – or in addition to – upland rice).

Assumptions are that (a) the problems of poor productivity and low incomes are technical ones, (b) the solutions are to be found in agricultural research, and (c) the results of which could be transmitted to farmers via an agricultural extension system.

Training and extension are thus mutually reinforcing and, in practice, they are likely to overlap one and another. For training of farmers and farm-level extension to be effective, it is important that the extension workers and trainers in direct contact with farmers should themselves be trained for their tasks.

3.2. Justification of the Program

Of the twelve villages surveyed in the socio-economic survey, none of communities receive any technical assistance from the Government. According to the Provincial Extension Services of Tete, the number of the extension workers in operation is only 21 in the Study Area. For each extension worker, the average number of family designated to serve is around 500, but that number is reaching 170 thousand households in the Study Area. In addition to the number of the extension workers, their work conditions are extremely poor as the resources available for their activities are very limited. While they are assigned to the vast area to serve, most extension workers lack transportation. Only bicycles are the most efficient means of transportation as budget of gasoline for motorcycle is still not affordable by the department. Given the number of extension workers in the Study Area, it is quite understandable that none of the communities surveyed receive agriculture-related technical assistance from the Government.

While the achievement of government extension services is not sufficient, those of Mozambique Leaf Tobacco Company (MLTC) and private traders of paprika demonstrated successful record of extension services in the Study Area. Equipped with motorcycles and other advanced technology such as two-way radio, they demonstrated very powerful role of change agents. In an economic sense, this is a sound approach to use extension workers to promote new crops and new technology.

4. Description of the Program

4.1. Goals

The technology-driven conventional extension approach seen in the example of MLTC (which inherits 'top-down' nature), however, has experienced the following problems in many African countries:

a) Generally poor response to extension messages;
b) Uptake mainly by better-off farmers who are able to finance investment and the take the risks inherent in adoption of new technology;
c) Subsequent concentration of such farmers ('progressive' farmers) by agricultural extension services, and neglect of poorer farmers; and
d) Use of credit programs to reinforce extension and encourage farmers to adopt new technologies – in which credit programs themselves become dysfunctional.

These problems occur because extension services are implemented with the assumptions that top-down approaches of conventional extension services are not necessarily effective.

There are four goals of the project. They are summarized as follows.

(1) Technology transfer

Extension programs pass along information with the intent that a learner will adopt a particular practice that leads to improved productivity or quality of life. With technology transfer, adoption of particular behavior or practice is the desired outcomes.

(2) Education

Extension services help participants come to understand how to make decisions regarding various courses of action. The desired outcome is the ability to make decisions given appropriate information.

(3) Problem solving

Extension services focus on the application of knowledge to solve problems. Participants' ability to use information and make decisions as they relate to the resolution of specific, short-term problems is the desired outcome.

(4) Development of technology

Extension services strive to build on the long-term capacity of communities and individuals to act on issues they identify. Communities and individuals gain knowledge and skills necessary to orchestrate the process of planned change.

4.2. Objectives

The project attempts above all to avoid the vicious cycle in which the farmers with the least urgently need to improve their income and productivity are those who respond to extension most readily and therefore receive most attention from extension workers. In order to minimize such negative impacts, the proposed extension services should have the following objectives:

a) to identify poorer members of the community and the particular constraints they face in adopting new technologies (e.g., labor or capital shortage, inability to take risks);
b) to encourage farmers both to identify their own problems and to develop their own solutions to them;
c) to use the indigenous technical knowledge amasses in any rural community as a bank from which much of the basic information needed to devise new technologies can be drawn;
d) to ensure that new technologies are tested and validated on farms, before expecting them to be widely adopted; and
e) to allow farmers to change at their own pace; if they perceive change to be beneficial and if there are no serious constraints, their pace will not be slow.

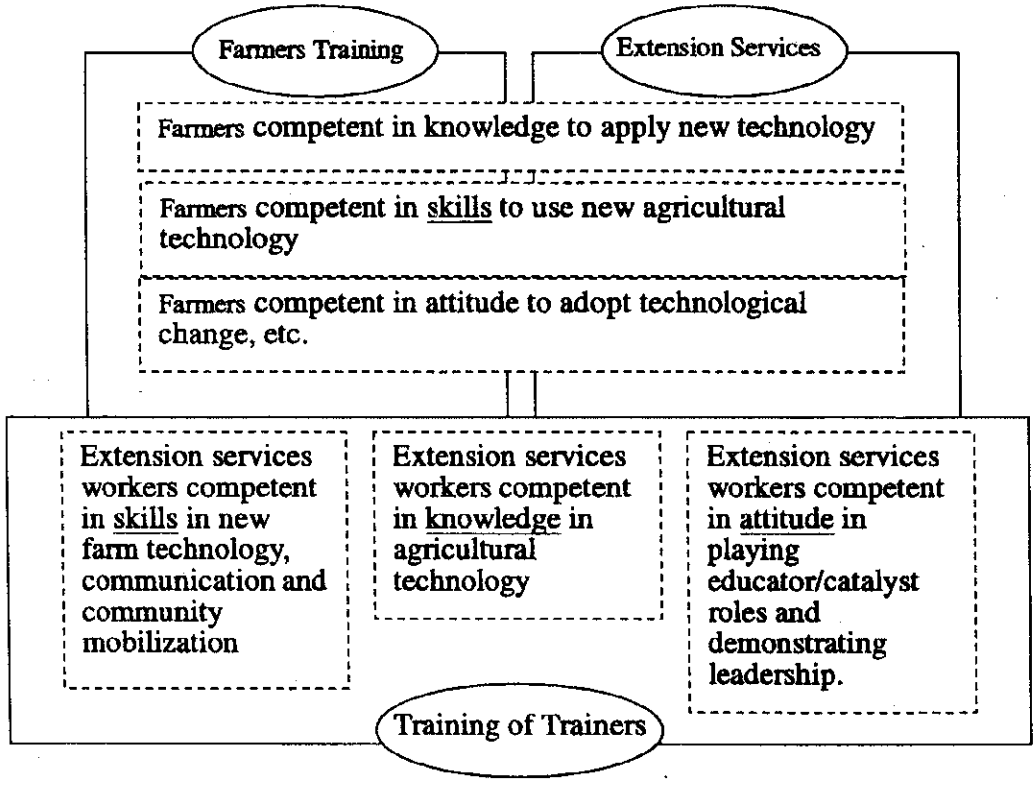
4.3. Training of Trainers, Farmers Training and Extension Services

Enhancement of extension services consists of a two-tier training arrangement. Training of trainers (TOT) is a foundation of the whole training design. Professional trainers train extension service workers who will have direct contact with communities. The multiplier effect of training of trainers should be high, assuming that the trainers are used in programs for the benefit of large numbers rather than small exclusive group.

After completing the TOT, extension workers are assigned to communities. They provide farmers training aiming at specific technology transfer to community members. Extension services are provided to support and reinforce the learning process initiated by the farmers training. Extension services aim at motivating farmers to change their behaviors.

Both farmers training and extension services should be experimental and reflective in order to facilitate farmers' learning process. Figure 1 shows the relationship between farmer training, farmer extension and training of trainers.

Figure 1 Training of Trainers (TOT) and Farmers Training



4.4. Activities

Specific activities of extension enhancement are summarized as follows.

(1) Training of trainers

An important factor in the success of village extension is that the extension services workers should be well prepared for their tasks. Apart from personal qualities and motivation, trainers should be:

a) technically competent;
b) competent in communication methods and strategies; and
c) competent in social development and social education.

One round of training of trainers aims to train up to 45 extension services workers for three months of duration by two professional trainers. The first professional trainer teaches mainly technical aspects of agriculture. The other trainer covers communication and community development methodologies. The setting of the training should be in classrooms.

Topics covered include not only various subjects of agricultural technical training, but also principle of adult education, introduction of experiential training, conflict transformation, basic accounting skills, monitoring and evaluation of training, and community development principles.

(2) Farmers training

Farmers training is designed to teach community members by an short and informal training session in the field within the community or up-to three-day-long short but formal training course in a specific topic at a class room setting close to the community. Extension service workers provide the services. Example of training topics include as well as training schedule is shown in the Appendix 1.

(3) Extension services

Occasional field visits and informal meetings/dialogues with individuals or farmers groups are a main activity of extension service. During the field visits, the extension services workers provide advise and technical supports to farmers.

The difficulties of implementing extension services should not be minimized. Even where a particularly poor village or region has been selected, extension services workers seeking to promote mainly technical change will almost certainly find that they receive the readiest response from the relatively wealthy, articulate, innovative and 'progressive' members of the community who will always be at the forefront in the village meetings. Extension services workers may find it difficult even to make contact with the poorest groups (landless families, widows, the elderly, etc.). Two approaches to this difficulty can be suggested:

a) To form (or facilitate the formation of) groups of individuals/households with similar problems and needs, identified as specifically as possible; and
b) To be prepared to recognize that problems of poverty may not be amenable to

technical solutions, but may need social and political change, and to help groups to identify and work toward such solutions.

Table 2 summarizes the description of training of trainers, farmers training and extension services discussed in this section.

Table 2. Summary of Enhancement of Extension Services

Items		Training of Trainers (TOT)	Farmers Training	Extension Services
Trainers		Professional trainers	Extension services workers who received TOT	Extension services workers who received TOT
Participants		Extension services workers	Farmers in communities	Farmers in communities
Duration		3 month for training up to 15 extension workers	A day up to three days. Depending on the topics etc.	Mostly a few hours to up to two days
Competence (Objectives)	Skill	Technical skills, communication, social/community development skill	Technical skills in new agricultural production	Technical skills in new agricultural production
	Know-ledge	Technical knowledge in new agricultural technology	Knowledge to adopt new crops etc.	Technical knowledge to adopt new crops, etc.
	Attitude	Leadership, openness, willingness for services	Willingness to change different/new farm technologies, motivated	Motivated to change different/new farm technologies, motivated
Number of trainees		15 trainees per class, up to three classes every three month (45/every three month=135/year)	Approx 15 trainees (farmers) per session	Up to 15 trainees (farmers) per visit
Setting/Facility		Three class rooms with TV, VCR, camcorder, etc., and experiment field	Class room (facility of primary school in the community is used) and/or experiment field in the community	Mostly fields in the communities assigned
Teaching methodology		Experiential, reflective dialogue and some lecture	Experiential, reflective dialogue and minimal lecture	Experiential, some reflective dialogue

Source: JICA Study Team.

4.5. Proposed Location

The proposed agricultural research center in the Tete-Moatize Core Urban Development will have an extension training function in addition to practical farming training. The adjunct experiment station can be used for field training. The proximity to Moatize and Tete will make it an attractive site for trainees from not only the Study Area but also central region of Mozambique.

4.6. Budget

The total cost of five years of operation of this program is estimated at US$16 million. The benefit of the program is estimated at US$16 million annually by the fifth year since the implementation of the program.

During the implementation period, about 600 extension workers are trained. It is estimated that a half the graduates will be hired by the empowered Provincial Extension Services of Tete, and 300 extension service workers train and give advise to approximately 130 thousand rural farmers in the next five years. It is estimated that at least, all the households who have had direct contact with the extension workers could achieve 20% production increase as the extension workers provide technical assistant to a vast majority of farmers. Details of the financial information are provided in the Appendix 2.

Appendix 1-1: Sample Topics and Training Schedule

Farmers Training on Leadership and Community Mobilization

Number of Participants		Day	Time	Topics	Training Method	Facilitators
Male	Female					
8	6	1	8:00 ~ 9:00	Introduction of Participants	Activity and Reflective Dialogue	A
			9:00 ~ 10:00	Introduction of Training	Lecture	B
			10:00 ~ 10:45	Tea Break	-	
			10:45 ~ 11:45	Roles of Leader and Definition of Terms	Reflective Dialogue and Lecture	C
			11:45 ~ 14:00	Lunch	-	
			14:00 ~ 15:00	Roles of Communities and NGO's in Development	Demonstration	B
			15:00 ~ 16:00	Cultural Believes, Customs and Development	Small Group Reflective Dialogue	C
			16:00 ~ 16:15	Closing	Activity	
		2	8:00 ~ 9:00	Review of the Previous Topics	Facilitated Discussion	A
			9:00 ~ 10:00	Types of Leadership and Characteristics	Experiential Activity	B
			10:00 ~ 10:45	Tea Break	-	
			10:45 ~ 11:45	Needs Identification and Priority	Dialogue	C
			11:45 ~ 14:00	Lunch	-	
			14:00 ~ 15:00	Leaders or Means of Communication	Experiential Activity	A
			15:00 ~ 16:00	Duties of Community Committees and Type of Leadership	Reflective Dialogue and Lecture	B
			16:00 ~ 16:15	Closing	Activity	C
		3	8:00 ~ 9:00	Review of the Previous Topics	Facilitated Discussion	A
			9:00 ~ 10:00	Duties of Community Leader	Reflective Dialogue and Lecture	B
			10:00 ~ 10:45	Tea Break	-	
			10:45 ~ 11:45	Duties of Treasurer	Reflective Dialogue and Lecture	C
			11:45 ~ 14:00	Lunch	-	
			14:00 ~ 15:00	Duties of Secretary	Reflective Dialogue and Lecture	A
			15:00 ~ 16:00	Conflicts and Its Management	Facilitated Discussion	B
			16:00 ~ 16:15	Closing and Last Day of the Training	Activity	ABC

Appendix 1-2: Sample Topics and Training Schedule

Adult Education on Land Owenership and Sustainable Agriculture

Participants		Day	Time	Topics	Training Method	Facilitators
Male	Female					
6	5	1	8:00 ~ 9:00	Introduction of Participants	Activity and Reflective Dialogue	A
			9:00 ~ 10:00	Introduction of Training	Lecture	B
			10:00 ~ 10:45	Tea Break	-	
			10:45 ~ 11:45	Land Law Issues	Reflective Dialogue and Lecture	C
			11:45 ~ 14:00	Lunch	-	
			14:00 ~ 15:00	Proper Land Preparation	Demonstration	B
			15:00 ~ 16:00	Seed Selection	Demonstration	C
			16:00 ~ 16:15	Closing	Activity	
		2	8:00 ~ 9:00	Review of the Previous Topics	Facilitated Discussion	A
			9:00 ~ 10:00	Timely Planting	Lecture	B
			10:00 ~ 10:45	Tea Break	-	
			10:45 ~ 11:45	Use of Organic Compost	Demonstration	C
			11:45 ~ 14:00	Lunch	-	
			14:00 ~ 15:00	Judicial Use of Fertilizer	Demonstration	A
			15:00 ~ 16:00	Intercropping Issues	Lecture	B
			16:00 ~ 16:15	Closing	Activity	ABC
		3	8:00 ~ 9:00	Review of the Previous Topics	Facilitated Discussion	A
			9:00 ~ 10:00	Crop Diversification	Experiential Activity	B
			10:00 ~ 10:45	Tea Break	-	
			10:45 ~ 11:45	Crop Rotation	Dialogue	C
			11:45 ~ 14:00	Lunch	-	
			14:00 ~ 15:00	Grain Storage Improvement	Experiential Activity	A
			15:00 ~ 16:00	Food Stock Reserve	Reflective Dialogue and Lecture	B
			16:00 ~ 16:15	Closing	Activity	C
		4	8:00 ~ 9:00	Review of the Previous Topics	Facilitated Discussion	A
			9:00 ~ 10:00	Danger of Early Selling of Green Maize	Reflective Dialogue and Lecture	B
			10:00 ~ 10:45	Tea Break	-	
			10:45 ~ 11:45	Agri-production Trade on Fair-basis	Reflective Dialogue and Lecture	C
			11:45 ~ 14:00	Lunch	-	
			14:00 ~ 15:00	Reviewing the Training Plan	Group Discussion and Lecture	A
			15:00 ~ 16:15	Closing and Last Day of the Training	Activity	ABC

Appendix 1-3: Sample Topics and Training Schedule

Farmers Training on Small Animal Husbandry (Poultry Management)

Participants		Day	Time	Topics	Training Method	Facilitators
Male	Female					
3	4	1	8:00 ~ 9:00	Introduction of Participants	Activity and Reflective Dialogue	A
			9:00 ~ 10:00	Introduction of Training	Lecture	B
			10:00 ~ 10:45	Tea Break	-	
			10:45 ~ 11:45	Type of Breeds and Housing	Demonstration and Lecture	C
			11:45 ~ 14:00	Lunch	-	
			14:00 ~ 15:00	Type of Feeds and Feeding	Demonstration and Lecture	B
			15:00 ~ 16:00	Desease Control Issue	Lecture	C
			16:00 ~ 16:30	Dressing	Lecture	
			16:30 ~ 17:00	Marketing	Reflective Dialogue	
			17:00 ~ 17:15	Closing	Activity	

Appendix 1-4: Sample Topics and Training Schedule

Farmers Training on Horticulture / Tree Planting

Participants		Day	Time	Topics	Training Method	Facilitators
Male	Female					
8	8	1	8:00 ~ 9:00	Introduction of Participants	Activity and Reflective Dialogue	A
			9:00 ~ 10:00	Introduction of Training	Lecture	B
			10:00 ~ 10:45	Tea Break	-	
			10:45 ~ 11:45	Soil Preparation and Fence Making	Demonstration	C
			11:45 ~ 14:00	Lunch	-	
			14:00 ~ 15:00	Establishing Seed Bed	Demonstration	B
			15:00 ~ 16:00	Seed Bed Management	Lecture	C
			16:00 ~ 16:15	Closing	Activity	
		2	8:00 ~ 9:00	Review of the Previous Topics	Facilitated Discussion	A
			9:00 ~ 10:00	Planting	Demonstration	B
			10:00 ~ 10:45	Tea Break	-	
			10:45 ~ 11:45	Scoutings and Diseases	Lecture	C
			11:45 ~ 14:00	Lunch	-	
			14:00 ~ 15:00	Countrey and Diseases	Lecture	A
			15:00 ~ 16:00	Harvesting	Demonstration	B
			16:00 ~ 16:15	Marketing	Group Discussion	
			16:15 ~ 16:30	Closing	Activity	C

Appendix 1-5: Sample Topics and Training Schedule

Farmers Training on Small-Scale Business

Participants		Day	Time	Topics	Training Method	Facilitators
Male	Female					
6	5	1	8:00 ~ 9:00	Introduction of Participants	Activity and Reflective Dialogue	A
			9:00 ~ 10:00	Introduction of Training	Lecture	B
			10:00 ~ 10:45	Tea Break	-	
			10:45 ~ 11:45	Record Keeping	Reflective Dialogue and Lecture	C
			11:45 ~ 14:00	Lunch	-	
			14:00 ~ 15:00	Financial Record	Demonstration	B
			15:00 ~ 16:00	Production Record and Inventory	Demonstration	C
			16:00 ~ 16:15	Closing	Activity	
		2	8:00 ~ 9:00	Review of the Previous Topics	Facilitated Discussion	A
			9:00 ~ 10:00	Business Plan Development	Lecture	B
			10:00 ~ 10:45	Tea Break	-	
			10:45 ~ 11:45	Use of Organic Compost	Demonstration	C
			11:45 ~ 14:00	Lunch	-	
			14:00 ~ 15:00	Judicial Use of Fertilizer	Demonstration	A
			15:00 ~ 16:00	Intercropping Issues	Lecture	B
			16:00 ~ 16:15	Closing	Activity	ABC
		3	8:00 ~ 9:00	Review of the Previous Topics	Facilitated Discussion	A
			9:00 ~ 10:00	Crop Diversification	Experiential Activity	B
			10:00 ~ 10:45	Tea Break	-	
			10:45 ~ 11:45	Crop Rotation	Dialogue	C
			11:45 ~ 14:00	Lunch	-	
			14:00 ~ 15:00	Grain Storage Improvement	Experiential Activity	A
			15:00 ~ 16:00	Food Stock Reserve	Reflective Dialogue and Lecture	B
			16:00 ~ 16:15	Closing	Activity	C
		4	8:00 ~ 9:00	Review of the Previous Topics	Facilitated Discussion	A
			9:00 ~ 10:00	Danger of Early Selling of Green Maize	Reflective Dialogue and Lecture	B
			10:00 ~ 10:45	Tea Break	-	
			10:45 ~ 11:45	Agri-production Trade on Fair-basis	Reflective Dialogue and Lecture	C
			11:45 ~ 14:00	Lunch	-	
			14:00 ~ 15:00	Reviewing the Training Plan	Group Discussion and Lecture	A
			15:00 ~ 16:15	Closing and Last Day of the Training	Activity	ABC

Appendix 2-1. Project/Program: Extension Enhancement Program

Component 1: Training of Trainers

Item	Descriptions	Qty.	Unit	Unit Price (US$)	Amount (US$)
1. Training of Trainers					
A. Capital Investment					
Classroom Facility and Adm. Office		200	m^2	850	170,000
Fax		1		300	300
Computer (w/ software)		1		1,000	1,000
Laser Printer		1		2,000	2,000
Camcorder (video)		1		1,200	1,200
TV+VCR		1		500	500
Textbooks		1		2,000	2,000
Photocopier		1		3,000	3,000
Motor Vehicle		1		25,000	25,000
Trainer A (Agriculture, Plant Science)		6	m/m	2,500	15,000
Trainer B (Extension Education, Training)		6	m/m	2,500	15,000
Administrator		6	m/m	1,500	9,000
Administrative Assistant		6	m/m	1,000	6,000
Telephone		6	month	300	1,800
Paper and Supplies		6	month	200	1,200
Gas and Mileage		6	month	200	1,200
Msc. Expenses	15% of total labor cost	1			1,125
Subtotal					255,325
B. Operational Cost					
Trainer A (Agriculture, Plant Science)		12	m/m	2,500	30,000
Trainer B (Extension Education, Training)		12	m/m	2,500	30,000
Administrator		12	m/m	1,500	18,000
Administrative Assistant		12	m/m	1,000	12,000
Telephone		12	month	300	3,600
Paper and Supplies		12	month	200	2,400
Gas and Mileage		12	month	200	2,400
Textbook etc	$2000+200*12	ramp sum		2,400	2,400
Misc.	15% of total labor cost	ramp sum		1,125	1,125
Bording Expenses	15*30*9*2 night*person/year	8,100		5	40,500
Subtotal					142,425
Operating Cost per semester					47,475
Total Cost for 5-year program					
A. Initial Investment		1		255,325	255,325
B. Operational Cost		5	years	142,425	640,913
Total					896,238
	Cost of Training One Trainee=				2,213

Appendix 2-2. Project/Program: Extension Enhancement Program

Component 2: Extension Services / Component 3: Farmers Training

2. Extension Services						
A. Initial Investment						
Motorcycle	15*2*3*4.5*50%		200	Units	2,000	400,000
Bags & Cosumables			200	Units	200	40,000
Uniform			200	Units	50	10,000
Houses for the services workers			200	Units	8,000	1,600,000
Allowance for Moving, etc.			200	Families	500	100,000
Subtotal						2,150,000
B. Operating Cost						
Wage plus other benefits	200*(12+2)*800		2,800	month	800	2,240,000
Gas and Milage	200*12		2,400	month	150	360,000
Misc. Expenses	200*12	15% of labor cost	2,400	month	120	288,000
Subtotal						2,888,000
Annual operating cost per extension worker						14,440
C. Motor Vehicle						
Isuzu 4WD	5 province*3		15	units	25,000	375,000
3. Farmers Training						
A. Initial Expenses						
Easel			1	unit	70	70
Agricultural Implements	Hoe, water can, rake etc.		20	sets	200	4,000
Subtotal					270	4,070
B. Operating Cost						
Meals, etc.	5 sessions per year		5	session	200	1,000
Boad	15 trainees *13 nights *5		975	night	5	4,875
Seeds and seedlings, etc.			1		200	200
Fertilizers			1		1,500	1,500
Chemicals			1		300	300
Other agricultural consumables	15% of total inputs		1		300	300
Paper and supplies			5	session	50	250
Subtotal					2,555	8,425
					34	

1. Trainees Estimation

Year	1			2			3			4			5			Total
Semester	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
Number of Trainees	0	15	45	45	45	45	45	45	45	45	45	45	45	45	45	585
Total	0	15	60	105	150	195	240	285	330	375	420	465	510	555	600	600
50% of Total	0	8	30	53	75	98	120	143	165	188	210	233	255	278	300	300
Extension in operation	0	0	8	30	53	75	98	120	143	165	188	210	233	255	278	
No. Farmers Trained	0	0	600	2,250	3,938	5,625	7,313	9,000	10,688	12,375	14,063	15,750	17,438	19,125	20,813	138,975
Number of Households Served	0	0	4,000	15,000	26,250	37,500	48,750	60,000	71,250	82,500	93,750	105,000	116,250	127,500	138,750	

2. Cost Estimate

2.1 Training of Trainers																
Initial Cost	255,325	0	0	0	0	0	0	0	0	0	0	0	0	0	0	255,325
Operating Cost	47,475	47,475	47,475	47,475	47,475	47,475	47,475	47,475	47,475	47,475	47,475	47,475	47,475	47,475	47,475	712,125
																967,450
2.2 Extension Service																
Initial Cost	0	0	28,667	78,833	80,625	80,625	80,625	80,625	80,625	80,625	80,625	80,625	80,625	80,625	80,625	994,375
Operating Cost	0	0	38,507	144,400	252,700	361,000	469,300	577,600	685,900	794,200	902,500	1,010,800	1,119,100	1,227,400	1,335,700	8,919,107
Motor Vehicle	0	0	125,000	0	0	125,000	0	0	125,000	0	0	0	0	0	0	375,000
																10,288,482
2.3 Farmer Training																
Initial Cost			2,160	5,940	6,075	6,075	6,075	6,075	6,075	6,075	6,075	6,075	6,075	6,075	6,075	74,925
Operating Cost			20,440	76,650	134,138	191,625	249,113	306,600	364,088	421,575	479,063	536,550	594,038	651,525	709,013	4,734,415
																4,809,340
Total for 5 year operation																16,065,272

3. Benefit

Number of Households Trained	138,750	
Estimated Population	693,750	
Ave consumption per capita	123	USD
20% increase of above	25	USD
Gross increase in the households	17,066,250	USD

Total Project Cost 16,065,272

In-Depth Study on Small-scale Business Program
(Project No. S.7)

1. Introduction

The Small-scale Business Program is proposed with the following three components: (1) provision of soft loans to community members through the peer-to-peer informal lending scheme; (2) skills training for start-ups; and (3) business assistant to support small business owners.

Within the scope of this program, small-scale cooking oil processing is identified as a promising business in the community of Nsadzo in Chifunde district by the socio-economic survey and the farmers' association survey. In the following section the detail of cooking oil processing business is discussed.

2. Implementing agency

The Women's Committee in Nsadzo will owns the proposed business. The community is responsible for managing the small-scale cooking oil production. The committee recruits female community members to operate the business, and to manage the participating members.

3. Current Situations and Problems

3.1. Community Profile

Nsadzo is situated in Chifunde district at Casacatiza Administrative Post. It is located at the border area with Zambia. The population of Nsadzo is 10,370. The entire population has experienced refugees during the civil war. The community is still in the process of major transition as most farmers are struggling to produce from the land they are resettled after the repatriation program administered by UNHCR was completed.

The total farming area is estimated at 17,400ha. Main crops are maize, tobacco, cotton and sunflower. Public service infrastructure is fair, while there is a primary school, health post and some boreholes. The road access is good as the community center is located along the side of the major road connecting Tete city and Zambia. Because of the location, 75% of farm products go to Zambia.

3.2. Problems

While the people of Nsadzo community lack appropriate means to utilize oil seeds (sunflower seeds and ground nuts) and they are sold almost entirely to Zambia to be processed as cooking oil, they continue to spend money to buy cooking oil with significantly at higher prices in spite of their economic difficulty.

4. Description of the Project

4.1. Activities

One set of 'Yenga' oilseed press is provided to the Women's Committee of Nsadzu to implement the project. The oil press is to extract oil from soft oil seeds (e.g., sunflower or groundnuts). The Committee assigns a member to operate the press.

Whenever they need cooking oil, community members of Nsadzo bring groundnuts or sunflower seeds from their farms to process oil. The machine is operated by one of the assigned member of the committee. The committee charges community members a user fee for the labor and processing oil. The customers have choices of payment, to pay in cash, extra oilseeds or processed oil according to the fee schedule set forth by the committee. The committee accumulates the proceeds for repayment or other activities.

4.2. Resources/inputs

The following items are required to implement the project:

Item	Qty	Unit price (US$)	Price (US$)	Note
'Yenga' Oilseed Press	1	250.00	250.00	Including S&H
Plank (2.0m long)	1	20.00	20.00	
Bolts & nuts	4	1.25	5.00	
Containers (20-liter water jug)	2	7.50	15.00	
Technical training for operation	1	50	50.00	Production & marketing
Total			340.00	

4.3. Expected Outcomes

(1) Job creation specifically for women

The provision of the oil press machine provides the women's group ability to offer a service of oil production at cost basis to whole community of Nsadzo. The fee is collected based on an agreed fee schedule mutually agreed by the community members. Income is saved into a common saving account to accumulate for a certain period of time for further use as mutually agreed by the members.

(2) Provision of cooking oil to entire community

The service provides cooking oil at cost basis. Compared with the price of the cooking oil obtained in the community, the fee is set significantly lower the market price of cooking oil in Nsadzo. This service will make expensive cooking oil more affordable for entire community.

4.4. Justification of the Project

There are some advantages of the project:

(1) Cooking oil is an expensive commodity in Nsadzo

In Nsadzo, most households produce their own cooking oil for home consumption because the retail price of the oil is more expensive than that of Tete city. The price of typical cooking oil in Nsadzo costs about Mt.45,000 per liter while it is 25,000 per liter in Tete city.

(2) Current production method can be much improved by a simple investment scheme

Cooking oil is produced from oil seeds such as groundnuts and sunflower seeds by pounding with a stick and a mortar. Oil is extracted when the paste is put in a containers and crude oil is separated by gravity. Every 2.5kg of shelled groundnuts produces approximately 0.75 liter of cooking oil. The process takes about eight hours, a painstaking process. The consumption of the oil varies household-by-household depending on the size of family and type of cooking they do. Income level of a family is another factor of cooking oil consumption.

(3) Nsadzo produces sunflower seeds which is still under-utilized resources in the region

Sunflower seed is one of major cash crops in Nsadzo, but it is almost entirely sold to Zambia for oil processing, while farmers buy cooking oil. This project utilizes unused resources to add value.

4.5. Best Scenarios to Implement the Project

Two alternative scenarios were evaluated based on the current socio-economic situations of the community to increase the probability of successful implementation. They are as follows:

(1) User-fee collection scenario

The first alternative is that the committee members only collect the user-fee and cost of labor based on the fee schedule set forth by the committee. Community members make the payment in the form of cash, unprocessed oil seeds, or produced oil. The proceeds are accumulated for repayment of the machine or other use mutually agreed by the committee members.

(2) Purchase-production-sales scenario

The second alternative is that the committee members accumulate fund to purchase seeds from the community. The processed oil is disinfected, packaged, stocked and marketed for sales. The product is for sale to community members at regular market prices, expected to be lower than the current cooking oil price in the community.

(3) Evaluation

Two scenarios are evaluated based on available data and socio-economic conditions of the community. The summary of the evaluation is shown in Table 1.

Table 1. Evaluation of Two Alternative Scenarios of Oil Production

	Advantages	Disadvantages
(1) User-fee collection scenario	- Small capital investment can start the project. - Marketing portion is minimal. Use-fee is a major source of proceeds. - Simple project scheme. High transparent for other community members - Increment approach allows to grow with relatively slow pace within the manageable expansion possible. - Benefit whole community. - Relatively low risks while profit is almost guaranteed as long as allocation of labor is secured/machine is functioning	- Because labor is the major source of income, the expected profit may be small
(2) Purchase-production-sales scenario	- Large profit can be expected, only if successfully managed - Can produce more seeds - All profits can be retained in the committee.	- Relatively large capital investment required. (containers, pot, etc. for sales.) - Marketing and sales is a key to the success. - Complex management required (production plan-purchase-process-inventory-market-sales)

Source: JICA Study Team.

Based on the evaluation, (1) user-fee collection scenario has greater advantages over the second scenario. Because of the simple project scheme, it does not require complex management such as production control, inventory management and marketing. By simply assigning operators, and as long as the machine is properly maintained, they can collect proceed. Compared with the other approach, it seems to be more sustainable.