

Table 3.4.1 Government Revenue by Source

Unit: Million Birr

Source of Revenue	Year (Ending July 7)													
	1991/92		1992/93		1993/94		1994/95		1995/96		1996/97		1997/98	
	Amount	Dist. (%)	Amount	Dist. (%)	Amount	Dist. (%)	Amount	Dist. (%)	Amount	Dist. (%)	Amount	Dist. (%)	Amount	Dist. (%)
<b>Direct Taxes</b>	<b>631.5</b>	<b>19.2</b>	<b>771.5</b>	<b>16.0</b>	<b>1,032.0</b>	<b>12.6</b>	<b>1,154.3</b>	<b>11.6</b>	<b>1,516.4</b>	<b>15.0</b>	<b>1,739.2</b>	<b>16.0</b>	<b>2,062.7</b>	<b>17.4</b>
Personal Income Tax	255.0	7.8	250.0	5.2	294.0	3.6	261.0	2.6	310.1	3.1	335.6	3.1	359.5	3.0
Rental Income Tax		0.0		0.0	44.9	0.5	39.1	0.4	22.7	0.2	18.9	0.2	19.6	0.2
Business Profit Income Tax	275.0	8.4	400.0	8.3	505.1	6.2	697.1	7.0	906.9	9.0	1,174.0	10.8	1,406.0	11.9
Agricultural Tax	55.0	1.7	65.0	1.3	107.0	1.3	85.6	0.9	94.2	0.9	94.9	0.9	102.0	0.9
Tax on Dividend & Chance Winnings	1.5	0.0	1.5	0.0	2.0	0.0	2.0	0.0	4.0	0.0	4.5	0.0	5.0	0.0
Rural Land Use Fee	45.0	1.4	55.0	1.1	79.0	1.0	69.5	0.7	78.5	0.8	82.2	0.8	100.1	0.8
Capital Gains Tax		0.0		0.0		0.0		0.0		0.0	0.3	0.0	1.7	0.0
Urban Land Lease		0.0		0.0		0.0		0.0	100.0	1.0	28.8	0.3	68.8	0.6
<b>Indirect Taxes</b>	<b>645.7</b>	<b>19.7</b>	<b>964.5</b>	<b>20.0</b>	<b>1,013.3</b>	<b>12.3</b>	<b>1,023.9</b>	<b>10.3</b>	<b>1,039.3</b>	<b>10.3</b>	<b>1,267.0</b>	<b>11.7</b>	<b>1,354.3</b>	<b>11.7</b>
Excise/Sales Tax	581.7	17.7	886.5	18.4	911.2	11.1	889.6	8.9	864.9	8.6	1,044.7	9.6	1,129.8	9.5
Petroleum	38.5	1.2	60.0	1.2	60.0	0.7	78.0	0.8	70.0	0.7	71.0	0.7	42.0	0.4
Alcohol	155.0	4.7	300.0	6.2	326.6	4.0	227.2	2.3	243.0	2.4	278.0	2.6	294.0	2.5
Tobacco	81.3	2.5	185.0	3.8	99.7	1.2	99.0	1.0	107.1	1.1	119.0	1.1	107.0	0.9
Others	306.9	9.3	341.5	7.1	424.9	5.2	485.4	4.9	444.8	4.4	576.7	5.3	686.8	5.8
Services Sales Tax	32.0	1.0	36.0	0.7	42.2	0.5	56.8	0.6	80.2	0.8	92.8	0.9	122.0	1.0
Stamp Duties	32.0	1.0	42.0	0.9	59.9	0.7	71.5	0.8	94.0	0.9	129.5	1.2	132.5	1.1
<b>Foreign Trade Taxes</b>	<b>440.8</b>	<b>13.4</b>	<b>677.5</b>	<b>14.1</b>	<b>1,264.0</b>	<b>15.4</b>	<b>1,682.3</b>	<b>16.9</b>	<b>1,904.0</b>	<b>18.9</b>	<b>2,166.7</b>	<b>20.0</b>	<b>2,380.4</b>	<b>20.1</b>
Import Duties	227.7	6.9	363.0	7.5	643.3	7.8	735.3	7.4	880.0	8.7	1,093.7	10.1	1,170.0	9.9
Sales/Excise Tax on Imports	183.4	5.6	277.0	5.8	567.0	6.9	820.5	8.2	814.8	8.1	991.0	9.1	1,065.5	9.0
Petroleum	25.0	0.8	25.0	0.5	50.8	0.6	49.6	0.5	45.0	0.4	62.5	0.6	35.0	0.3
Alcohol	0.5	0.0	3.0	0.1	8.0	0.1	14.5	0.1	3.5	0.0	6.8	0.1	6.5	0.1
Tobacco	1.2	0.0	2.0	0.0	4.3	0.1	14.0	0.1	10.0	0.1	8.5	0.1	6.5	0.1
Others	155.7	4.8	247.0	5.1	503.9	6.1	742.4	7.4	756.3	7.5	913.2	8.4	1,016.5	8.6
Export Taxes	29.7	0.9	37.5	0.8	53.7	0.7	126.5	1.3	209.2	2.1	82.0	0.8	144.9	1.2
<b>Other Current Receipt</b>	<b>482.0</b>	<b>14.7</b>	<b>610.5</b>	<b>12.7</b>	<b>514.5</b>	<b>6.3</b>	<b>1,293.8</b>	<b>13.0</b>	<b>1,916.5</b>	<b>19.0</b>	<b>1,665.0</b>	<b>15.4</b>	<b>2,019.8</b>	<b>17.1</b>
Charge & Fees	37.0	1.1	45.0	0.9	83.5	1.0	71.6	0.7	114.4	1.1	116.8	1.1	146.9	1.2
Sales of Goods and Services	50.0	1.5	55.0	1.1	87.5	1.1	82.4	0.8	92.0	0.9	145.7	1.3	169.4	1.4
Govt. Investment Income	340.0	10.4	430.0	8.9	272.0	3.3	1,012.1	10.2	924.1	9.2	918.4	8.5	1,284.8	10.8
Miscellaneous Revenue	55.0	1.7	80.5	1.7	71.5	0.9	127.7	1.3	145.0	1.4	234.1	2.2	218.7	1.8
Extraordinary Revenue									640.0		250.0		200.0	
<b>Contribution to Pension Fund</b>	<b>42.0</b>	<b>1.3</b>	<b>45.0</b>	<b>0.9</b>	<b>56.5</b>	<b>0.7</b>	<b>77.4</b>	<b>0.8</b>	<b>85.1</b>	<b>0.8</b>	<b>88.9</b>	<b>0.8</b>	<b>94.8</b>	<b>0.8</b>
<b>External Assistance</b>	<b>336.1</b>	<b>10.2</b>	<b>506.9</b>	<b>10.5</b>	<b>2,012.1</b>	<b>24.5</b>	<b>1,793.7</b>	<b>18.0</b>	<b>1,348.4</b>	<b>13.4</b>	<b>2,165.8</b>	<b>20.0</b>	<b>2,063.9</b>	<b>17.4</b>
<b>Capital Receipt</b>	<b>706.4</b>	<b>21.5</b>	<b>1,241.2</b>	<b>25.8</b>	<b>2,314.7</b>	<b>28.2</b>	<b>2,940.2</b>	<b>29.5</b>	<b>2,288.0</b>	<b>22.7</b>	<b>1,747.1</b>	<b>16.1</b>	<b>1,838.6</b>	<b>15.5</b>
External Loans & Credits	656.4	20.0	1,196.2	24.8	1,003.8	12.2	1,292.6	13.0	1,241.0	12.3	1,160.9	10.7	1,171.3	9.9
Domestic Sources	50.0	1.5	45.0	0.9	55.9	0.7	163.9	1.6	158.0	1.6	465.2	4.3	487.3	3.9
Counterpart Fund Loans					1,255.0		1,483.7		889.0		121.0		200.0	
<b>TOTAL</b>	<b>3,284.5</b>	<b>100.0</b>	<b>4,817.1</b>	<b>100.0</b>	<b>8,207.1</b>	<b>100.0</b>	<b>9,965.6</b>	<b>100.0</b>	<b>10,997.5</b>	<b>100.0</b>	<b>10,832.7</b>	<b>100.0</b>	<b>11,844.5</b>	<b>100.0</b>

Source: Ministry of Finance

Table 3.4.2 Government Expenditure

Unit: Million Birr

Expenditure	Year (Ending July 7)													
	1991/92		1992/93		1993/94		1994/95		1995/96		1996/97		1997/98	
	Amount	Distr. (%)	Amount	Distr. (%)	Amount	Distr. (%)	Amount	Distr. (%)	Amount	Distr. (%)	Amount	Distr. (%)	Amount	Distr. (%)
<b>A. Federal Government</b>	4,653	100.0	5,934	100.0	8,449	100.0	9,964	100.0	9,669	100.0	6,197	57.2	6,800	57.4
<b>1. Recurrent Budget</b>	3,166	68.0	3,167	53.4	4,602	54.5	5,369	53.9	5,703	59.0	3,563	32.9	3,752	31.7
<b>1.1 Administration and General Services</b>	1,026	22.1	1,147	19.3	1,345	15.9	1,478	14.8	1,582	16.4	1,187	11.0	1,306	11.0
Organs of State	60	1.3	103	1.7	115	1.4	142	1.4	176	1.8	47	0.4	51	0.4
National Defense	681	14.6	660	11.1	653	7.8	706	7.1	742	7.7	752	7.2	873	7.4
Internal Order of Justice	147	3.2	191	3.2	278	3.3	320	3.2	329	3.4	111	1.0	121	1.0
Foreign Relation	28	0.6	30	0.5	87	1.0	117	1.2	111	1.1	125	1.2	130	1.1
Finance Planning	75	1.6	77	1.3	109	1.3	98	1.0	130	1.3	35	0.4	29	0.2
General Services	35	0.8	86	1.4	69	1.2	95	1.0	93	1.0	83	0.8	102	0.9
<b>1.2 Economic Services</b>	275	5.9	297	5.0	464	5.5	573	5.8	626	6.5	246	2.3	282	2.4
Agriculture and Natural Resources	156	3.4	173	2.9	280	3.3	351	3.5	398	4.1	72	0.7	90	0.8
Industry, Trade and Tourism	26	0.6	27	0.5	36	0.4	37	0.4	40	0.4	14	0.1	15	0.1
Mines and Energy	8	0.2	8	0.1	13	0.2	18	0.2	18	0.2	15	0.1	16	0.1
Transport and Communication	1	0.0	4	0.1	5	0.1	9	0.1	11	0.1	2	0.0	3	0.0
Construction	70	1.5	71	1.2	120	1.4	147	1.5	148	1.5	129	1.2	139	1.2
Economic Development Study	14	0.3	14	0.2	10	0.1	11	0.1	11	0.1	14	0.1	20	0.2
<b>1.3 Social Services</b>	776	16.7	886	14.9	1,220	14.4	1,396	14.0	1,464	15.1	278	2.6	300	2.5
Education and Training	532	11.4	568	9.6	790	9.4	885	8.9	943	9.8	147	1.4	180	1.5
Culture and Sports	17	0.4	18	0.3	23	0.3	29	0.3	32	0.3	10	0.1	6	0.0
Public Health	170	3.7	191	3.2	301	3.6	346	3.5	361	3.7	61	0.6	62	0.5
Labor and Social Affairs	30	0.6	37	0.6	44	0.5	47	0.5	49	0.5	36	0.3	39	0.3
Rehabilitation	27	0.6	72	1.2	62	0.7	89	0.9	79	0.8	24	0.2	14	0.1
<b>1.4 Pension Payments</b>	170	3.7	187	3.2	238	2.8	294	3.0	300	3.1	150	1.4	157	1.3
<b>1.5 Public Debt</b>	323	6.9	357	6.0	892	10.6	1,247	12.5	1,442	14.9	1,347	12.4	1,526	12.9
Internal Debt	233	5.0	261	4.4	585	6.9	805	8.1	633	7.1	696	6.4	774	6.5
Principal Repayment		0.0		0.0		0.0	139	1.4	47	0.5	128	1.2	240	2.0
Interest and Charges	233	5.0	261	4.4	585	6.9	666	6.7	636	6.6	568	5.2	534	4.5
External Debt	90	1.9	96	1.6	307	3.6	442	4.4	759	7.8	651	6.0	753	6.4
Principal Repayment	42	0.9	43	0.7	137	1.6	191	1.9	403	4.2	306	2.8	377	3.2
Interest and Charges	48	1.0	53	0.9	170	2.0	251	2.5	356	3.7	345	3.2	376	3.2
<b>1.6 Various Bank Charges</b>	5	0.1	5	0.1	5	0.1	5	0.1	5	0.1	18	0.2	20	0.2
<b>1.7 Unallocated</b>	591	12.7	288	4.9	438	5.2	376	3.8	284	2.9	337	3.1	162	1.4
<b>2. Capital Budget</b>	1,487	32.0	2,767	46.6	3,847	45.5	4,595	46.1	3,966	41.0	2,634	24.3	3,047	25.7
<b>2.1 Economic Development</b>	1,283	27.6	2,406	40.5	3,049	36.1	3,438	34.5	2,846	29.4	2,318	21.4	2,573	21.7
<b>2.2 Social Development</b>	174	3.7	297	5.0	646	7.6	840	8.4	831	8.6	196	1.8	224	1.9
<b>2.3 General Development</b>	30	0.6	64	1.1	152	1.8	317	3.2	289	3.0	120	1.1	251	2.1
<b>B. State Govt. Subsidy*</b>	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3,379	31.2	3,653	30.8
<b>C. Federal Govt. Total</b>	4,653	100.0	5,934	100.0	8,449	100.0	9,964	100.0	9,669	100.0	9,576	88.3	10,452	88.2
<b>D. Regional Revenue**</b>	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1,264	11.7	1,393	11.8
<b>Total Government Expenditure</b>	4,653	100.0	5,934	100.0	8,449	100.0	9,964	100.0	9,669	100.0	10,840	100.0	11,845	100.0

Source: Ministry of Finance

Note: \* State government subsidies until the fiscal year 1995/96 are included in each item of expenditure.

\*\* Regional revenue until the fiscal year 1995/96 are included in each item of expenditure.

Table 3.4.3 Capital Expenditure by Source of Finance and Purpose

Unit: Million Birr

Capital Expenditure	1993/94						1994/95						1995/96						1996/97						1997/98										
	Local Funds		External Assistance		Loans		Local Funds		External Assistance		Loans		Local Funds		External Assistance		Loans		Local Funds		External Assistance		Loans		Local Funds		External Assistance		Loans						
1. Social Development	312	148	186	646	839	460	49	321	830	109	11	75	195	132	22	70	224	145	62	110	317	411	188	17	189	394	96	11	40	147	122	15	28	165	
Education	86	83	29	198	234	140	24	72	236	5	-	7	12	2	-	4	6	72	236	5	-	7	12	2	-	4	6	-	-	-	-	-	-	6	
Health	72	3	47	121	187	109	8	60	177	6	-	28	34	6	-	38	44	72	236	5	-	7	12	2	-	4	6	-	-	-	-	-	-	6	
Urban Devt & Housing	6	-	-	6	3	16	-	-	16	-	-	-	-	-	-	-	0	-	16	3	-	-	-	-	-	-	-	-	-	-	-	-	-	0	
Social Welfare	4	0	-	4	4	7	-	-	7	-	-	-	-	-	-	-	-	7	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	
Sport and Culture	1,744	487	818	3,049	3,437	1,373	225	920	2,518	1,219	332	768	2,319	1,232	370	970	2,573	1,744	487	818	3,049	3,437	1,373	225	920	2,518	1,219	332	768	2,319	1,232	370	970	2,573	
2. Economic Development	233	57	80	371	361	130	49	84	263	29	19	25	73	103	32	35	170	233	57	80	371	361	130	49	84	263	29	19	25	73	103	32	35	170	
Agriculture Development	340	319	97	756	312	173	58	69	300	83	7	1	91	58	2	32	92	340	319	97	756	312	173	58	69	300	83	7	1	91	58	2	32	92	
Natural Resources & Settlement	309	52	165	526	377	225	44	80	349	555	6	98	659	558	36	102	696	309	52	165	526	377	225	44	80	349	555	6	98	659	558	36	102	696	
Mining and Energy	195	21	113	329	340	120	2	257	379	88	-	123	211	24	-	24	24	195	21	113	329	340	120	2	257	379	88	-	123	211	24	-	24	24	
Industry	550	32	300	882	1,273	615	41	243	899	307	289	244	840	418	250	329	997	550	32	300	882	1,273	615	41	243	899	307	289	244	840	418	250	329	997	
Road Construction	82	5	63	150	271	77	8	187	272	128	5	277	410	70	50	472	592	82	5	63	150	271	77	8	187	272	128	5	277	410	70	50	472	592	
Transport & Communication	5	-	-	5	0	-	-	-	0	-	-	-	0	-	-	-	0	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	
Commerces & Tourism	30	-	-	30	149	-	-	-	149	-	-	-	0	-	-	-	0	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	
Financial Agencies	-	-	-	0	2	33	6	-	39	29	6	-	35	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
Science and Technology	-	-	-	0	172	161	17	-	352	17	-	-	0	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	
Unallocated	140	13	0	152	315	139	3	0	142	120	0	0	120	251	0	0	251	140	13	0	152	315	139	3	0	142	120	0	0	120	251	0	0	251	251
3. General Development	86	-	-	86	160	124	-	-	124	39	-	-	39	77	-	-	77	86	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	77
Public Administration & Building	54	13	-	66	93	15	3	-	18	28	-	-	28	35	-	-	35	54	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	35	
Mapping, Stat., Sci. & Technol.	0	-	-	0	0	-	-	-	0	-	-	-	0	-	-	-	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	
Public Work Program	-	-	-	0	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Compensation Payment	-	-	-	0	37	-	-	-	37	-	-	-	37	-	-	-	37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	37
Social Rehabilitation & Development	-	-	-	0	25	-	-	-	25	-	-	-	25	-	-	-	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	
Financial Obligation	-	-	-	0	25	-	-	-	25	-	-	-	25	-	-	-	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	
Total of Capital Expenditure	2,196	647	1,004	3,847	4,591	1,972	277	1,241	3,490	1,448	343	843	2,634	1,615	392	1,040	3,047	2,196	647	1,004	3,847	4,591	1,972	277	1,241	3,490	1,448	343	843	2,634	1,615	392	1,040	3,047	

Source: Ethiopia Statistical Abstract 1995, CSA  
Ministry of Finance

Table 3.4.4 Region 14 Administration Recurrent and Capital Budget by Sector

Unit: Birr

Sector/Bureau	1997/98			1998/99			1999/00			2000/01			2001/02		
	Recurrent	Capital	Total	Recurrent	Capital	Total	Recurrent	Capital	Total	Recurrent	Capital	Total	Recurrent	Capital	Total
1. Administration Sector	33,953,800	5,100,000	38,953,800	71,699,151	6,377,100	77,996,251	78,630,915	12,833,200	91,464,115	82,056,200	4,723,600	86,779,800	82,056,200	4,723,600	86,779,800
1.1 Council of Region 14 Administration	9,605,657	2,600,000	12,205,657	34,108,547	3,000,000	37,108,547	25,018,700	1,000,000	26,018,700	27,842,600	-	27,842,600	27,842,600	-	27,842,600
1.2 Audit and Control Office	771,430	-	771,430	1,025,308	-	1,025,308	981,800	-	981,800	1,409,400	-	1,409,400	1,409,400	-	1,409,400
1.3 Office of Region 14 Administration	3,827,112	1,000,000	4,827,112	4,766,874	1,322,200	6,089,074	5,177,300	-	5,177,300	5,984,300	-	5,984,300	5,984,300	-	5,984,300
1.4 Office of Region 14 Adm. Attorney	1,570,528	-	1,570,528	1,608,040	-	1,608,040	1,793,500	-	1,793,500	2,172,700	-	2,172,700	2,172,700	-	2,172,700
1.5 Police Commission	16,984,467	-	16,984,467	22,882,005	647,600	23,529,605	25,579,638	215,500	25,795,138	30,404,200	300,000	30,704,200	30,404,200	300,000	30,704,200
1.6 Prison Administration	-	-	-	5,033,407	192,300	5,225,707	6,633,474	1,478,100	8,111,574	7,303,400	377,200	7,680,600	7,303,400	377,200	7,680,600
1.7 Acts & Documents Registration Office	444,721	-	444,721	767,525	-	767,525	559,600	-	559,600	848,100	200,000	1,048,100	848,100	200,000	1,048,100
1.8 Public Service Bureau	649,885	1,500,000	2,149,885	1,417,445	1,215,000	2,632,445	4,884,903	141,600	5,026,503	5,539,500	809,000	6,348,500	5,539,500	809,000	6,348,500
1.9 Culture & Information Bureau	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.10 Project Office for the CSSBO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2. Economic Sector	27,555,863	249,368,527	276,924,390	29,693,326	391,082,660	620,775,986	33,244,000	467,486,163	500,730,163	37,064,600	180,019,000	217,083,603	37,064,600	180,019,000	217,083,603
2.1 Finance Bureau	6,532,412	-	6,532,412	7,528,851	958,900	8,487,751	11,330,400	4,057,200	15,387,600	13,336,700	5,224,400	18,561,100	13,336,700	5,224,400	18,561,100
2.2 Planning & Economic Development Bureau	871,467	-	871,467	1,052,363	-	1,052,363	979,800	-	979,800	1,316,000	-	1,316,000	1,316,000	-	1,316,000
2.3 Urban Development and Works Bureau	7,381,650	147,568,830	154,950,480	6,582,422	242,271,300	248,853,722	7,660,200	114,665,237	122,325,437	9,073,000	34,154,200	43,227,200	9,073,000	34,154,200	43,227,200
2.4 Agricultural Bureau	4,263,214	862,900	5,126,114	3,415,500	4,464,700	7,880,200	3,395,200	3,614,500	7,009,700	3,999,800	1,205,800	5,205,600	3,999,800	1,205,800	5,205,600
2.5 Environmental Protection Bureau	1,493,478	3,230,800	4,724,278	2,813,457	5,561,500	8,374,957	3,029,300	1,599,500	4,628,800	839,100	400,000	1,239,100	839,100	400,000	1,239,100
2.6 Trade Industry and Tourism Bureau	3,485,886	7,108,900	10,594,786	4,039,563	24,174,600	28,154,163	4,142,100	788,600	4,930,700	4,550,500	617,000	5,167,500	4,550,500	617,000	5,167,500
2.7 Transport and Communication Bureau	3,627,856	2,819,197	6,447,053	4,261,190	540,160	4,801,350	2,807,000	4,450,000	7,257,000	3,265,400	4,072,000	7,337,400	3,265,400	4,072,000	7,337,400
2.8 Environmental Development Project Office	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.9 Addis Ababa Flood Control & Prevention Office	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.10 Project Implementation Office	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.11 Land Information System Project	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.12 Lease Board Office	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.13 Addis Ababa Water & Sewerage Authority	-	88,257,900	88,257,900	-	113,162,000	113,162,000	-	283,052,900	283,052,900	-	704,100	704,100	-	704,100	704,100
3. Social Sector	107,224,534	19,691,600	126,916,134	110,654,394	29,517,300	140,171,694	115,522,997	19,807,200	135,330,197	125,563,700	10,079,600	135,643,300	125,563,700	10,079,600	135,643,300
3.1 Education Bureau	62,587,671	12,955,700	75,543,371	62,472,726	15,254,800	77,727,526	73,602,870	9,074,700	82,677,570	81,128,500	4,763,500	85,892,000	81,128,500	4,763,500	85,892,000
3.2 Health Bureau	33,614,434	2,092,000	35,706,434	38,190,703	7,684,400	45,875,103	35,918,800	7,539,400	43,458,200	37,269,500	4,473,200	41,742,700	37,269,500	4,473,200	41,742,700
3.3 Labour and Social Affairs Bureau	4,525,701	1,137,400	5,663,101	3,920,982	2,653,300	6,574,282	4,020,400	374,700	4,395,100	4,891,200	100,000	4,991,200	4,891,200	100,000	4,991,200
3.4 Physical Culture and Sports Office	5,105,019	3,506,500	8,611,519	5,160,069	3,944,800	9,104,869	995,727	2,818,400	3,814,127	1,068,100	524,300	1,592,400	1,068,100	524,300	1,592,400
3.5 Foreign Relation & Development Cooperation Bur.	1,301,709	-	1,301,709	909,914	-	909,914	985,100	-	985,100	1,206,400	-	1,206,400	1,206,400	-	1,206,400
3.6 Rehabilitation Committee	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4. Others	6,420,000	0	6,420,000	8,080,000	0	8,080,000	1,100,000	0	1,100,000	41,750,200	0	41,750,200	41,750,200	0	41,750,200
4.1 Bank Loan Payment	-	-	-	-	-	-	-	-	-	16,200,000	-	16,200,000	16,200,000	-	16,200,000
4.2 Pension Payment	-	-	-	1,080,000	-	1,080,000	1,100,000	-	1,100,000	1,150,000	-	1,150,000	1,150,000	-	1,150,000
4.3 Payments Transfer to the Ministry of Finance	6,420,000	-	6,420,000	-	-	-	-	-	-	8,700,000	-	8,700,000	8,700,000	-	8,700,000
4.4 Debt Payments	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.5 Amhara City Bus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.6 Provisions	-	-	-	7,000,000	-	7,000,000	-	-	-	15,700,200	-	15,700,200	15,700,200	-	15,700,200
TOTAL	175,354,297	274,660,127	450,014,424	220,036,871	436,977,060	647,013,931	221,497,812	500,126,568	723,724,380	286,454,700	164,822,200	451,276,900	286,454,700	164,822,200	451,276,900

Note: CSSBO stands for Creation Small Scale Business Opportunity.  
Source: Region 14 Administration, Finance Bureau

Table 3.4.5 Region 14 Administration Recurrent and Capital Expenditure by Sector

Sector/Bureau	1993/94			1994/95			1995/96			1996/97 (for six months)		
	Recurrent	Capital	Total	Recurrent	Capital	Total	Recurrent	Capital	Total	Recurrent	Capital	Total
<b>1. Administration Sector</b>	33,852,677	2,011,891	35,864,568	55,063,125	1,949,943	57,013,068	69,125,295	2,167,250	71,292,545	34,346,036	1,731,836	36,077,872
1.1 Council of Region 14 Administration	9,604,908	-	9,604,908	19,494,442	383,306	20,077,748	23,701,919	193,419	23,900,338	11,704,369	-	11,704,369
1.2 Audit and Control Office	771,430	-	771,430	825,747	-	825,747	988,211	-	988,211	441,680	-	441,680
1.3 Office of Region 14 Administration	3,827,112	630,180	4,457,292	4,358,371	55,650	4,414,021	4,238,975	-	4,238,975	748,438	-	748,438
1.4 Office of Region 14 Admin. Attorney	1,570,525	-	1,570,525	1,482,306	-	1,482,306	1,592,578	-	1,592,578	15,674,394	-	15,674,394
1.5 Police Commission	16,984,167	-	16,984,167	22,523,885	569,101	23,092,986	27,699,612	-	27,699,612	3,481,820	-	3,481,820
1.6 Prison Administration	-	-	0	5,026,660	192,300	5,218,960	6,674,334	331,732	7,006,066	-	-	-
1.7 Acts & Documents Registration Office	-	-	0	-	-	0	-	-	0	25,711	-	25,711
1.8 Public Service Bureau	444,719	-	444,719	597,293	-	597,293	525,072	-	525,072	255,085	-	255,085
1.9 Culture & Information Bureau	649,813	1,391,711	2,041,524	1,154,221	619,485	1,773,706	3,704,575	108,534	3,813,109	2,014,538	-	2,014,538
1.10 Project Office for the CNSBO	-	-	0	-	-	0	-	-	0	1,528,572	-	1,528,572
<b>2. Economic Sector</b>	27,844,974	78,630,519	106,465,493	52,199,997	146,710,518	198,910,514	30,218,350	141,525,713	171,744,063	13,675,357	79,125,599	92,800,916
2.1 Finance Bureau	6,526,835	-	6,526,835	8,241,138	476,230	8,717,368	8,711,244	2,468,872	11,180,117	4,371,525	935,164	5,306,689
2.2 Planning & Economic Development Bureau	871,467	-	871,467	994,675	-	994,675	914,621	-	914,621	482,946	-	482,946
2.3 Urban Development and Works Bureau	7,381,650	49,791,438	57,173,088	6,529,103	106,280,544	112,809,647	7,194,110	29,036,421	36,230,532	3,534,514	8,560,310	12,094,823
2.4 Agricultural Bureau	4,263,209	781,790	5,044,999	3,653,324	1,741,155	5,394,479	3,847,979	519,938	4,367,918	1,794,982	220,883	2,015,865
2.5 Environmental Protection Bureau	1,693,478	2,306,951	4,000,429	2,344,867	1,083,703	3,428,570	2,579,642	592,775	3,172,416	256,990	-	256,990
2.6 Trade Industry and Tourism Bureau	3,484,479	2,193,271	5,677,750	3,968,271	781,631	4,749,902	3,836,292	5,852,111	9,603,403	1,507,533	48,400	1,555,933
2.7 Transport and Communication Bureau	3,623,856	825,624	4,449,480	3,274,293	2,378,284	5,652,577	3,134,461	1,526,043	4,660,504	1,644,042	162,562	1,806,604
2.8 Environmental Development Project Office	-	-	0	-	-	0	-	-	0	7,116,704	-	7,116,704
2.9 Addis Ababa Flood Control & Prevention Office	-	-	0	-	-	0	-	-	0	731,704	-	731,704
2.10 Project Implementation Office	-	11,791,506	11,791,506	1,857,948	1,857,948	3,715,896	-	2,647,222	2,647,222	-	694,671	694,671
2.11 Land Information System Project	-	-	0	-	-	0	-	-	0	7,236,858	-	7,236,858
2.12 Lease Board Office	-	444,778	444,778	-	-	0	-	-	0	394,828	-	394,828
2.13 Lafo Project (house construction)	-	10,485,161	10,485,161	22,984,346	33,307,404	56,291,750	-	83,432,236	83,432,236	-	62,536,267	62,536,267
2.14 Addis Ababa Water & Sewerage Authority	-	-	0	-	-	0	-	-	0	-	-	0
<b>3. Social Sector</b>	103,404,239	11,174,950	114,579,189	111,440,842	6,897,770	118,338,612	112,190,476	8,338,550	120,529,025	50,795,920	1,949,780	52,745,699
3.1 Education Bureau	59,237,726	7,769,065	67,006,791	65,718,242	3,750,148	69,468,390	71,560,130	3,666,378	75,226,509	34,068,561	37,518	34,106,079
3.2 Health Bureau	33,602,293	1,119,304	34,721,597	34,848,901	627,112	35,476,013	34,157,484	1,528,921	35,686,405	14,300,214	1,718,816	16,019,030
3.3 Labour and Social Affairs Bureau	4,339,829	823,732	5,163,561	5,090,344	254,149	5,344,493	3,821,654	227,872	4,049,527	1,564,629	-	1,564,629
3.4 Physical Culture and Sports Office	5,105,018	1,462,849	6,567,867	4,851,101	2,266,320	7,098,421	1,716,336	2,915,378	4,631,715	395,628	93,445	493,073
3.5 Foreign Relation & Development Cooperation Bur.	1,049,373	-	1,049,373	951,195	-	951,195	934,871	-	934,871	414,967	-	414,967
3.6 Rehabilitation Committee	-	-	0	-	-	0	-	-	0	47,921	-	47,921
<b>4. Others</b>	1,011,433	0	1,011,433	4,031,399	0	4,031,399	66,081,802	0	66,081,802	16,320,029	0	16,320,029
4.1 Bank Loan Payment	-	-	0	-	-	0	-	-	0	-	-	0
4.2 Pension Payment	1,011,433	-	1,011,433	998,225	-	998,225	1,055,435	-	1,055,435	566,150	-	566,150
4.3 Payments Transfer to the Ministry of Finance	-	-	0	-	-	0	-	-	0	-	-	0
4.4 Debt Payments	-	-	0	3,033,174	-	3,033,174	9,242,314	-	9,242,314	8,582,200	-	8,582,200
4.5 Amhara City Bus	-	-	0	-	-	0	55,783,554	-	55,783,554	6,851,649	-	6,851,649
4.6 Provisions	-	-	0	-	-	0	-	-	0	-	-	0
<b>TOTAL</b>	166,113,823	91,802,360	257,916,183	223,335,303	155,458,090	378,793,453	277,615,903	152,031,519	429,647,422	115,137,541	82,707,174	197,844,516

Note: CNSBO stands for Creation Small Scale Business Opportunity.

Source: Region 14 Administration Finance Bureau

Table 3.4.6 On-going and Future Project of Water Resources Development in Addis Ababa

Name of Project	Period	Stage	Total project cost (Million Birr)	Financing organization	Aid type	Executing Agency
1 Addis Ababa Water Supply Stage III A	1995 - 1998	design, map of Addis Ababa, geotechnical investigation, drilling construction	3,000	ADF & Region 14	Grant & Loan	AAWSA
2 Emergency Dire Dam Project	1997 - 1998		228	Region 14	-	AAWSA
3 Emergency Ground Water Development Project	1994 - 1998	drilling of 25 wells, pump water to Addis Ababa 72,000m <sup>3</sup> /day construction	166	Region 14	-	AAWSA
4 Akaki Town Water Supply and Construction Project	1990 - 1998		57	IDA & Region 14	Loan	AAWSA
5 Urban II - Water Distribution	1990 - 1998	construction	7.7	IDA & Region 14	Loan	AAWSA
6 Institution and Capacity Building of Water Sector in Addis Ababa	1995 - 1999	study, training, system building	56	IDA & Region 14	Loan	AAWSA
7 Strengthening Addis Ababa Water and Sewerage Authority	1995 - 1999	construction	18.8	EEC	Grant	AAWSA
8 Water Leakage Control Study Project	1995 - 1998	construction	4.9	Region 14	-	AAWSA
9 Maintenance of Legedadi Dam Project	1994 - 1998	study and construction	5.9	Region 14	-	AAWSA
10 Legedadi, Gefersa, Dire Dam Water Quality Control Project	1998	study	8.4	Region 14	-	AAWSA
11 Water and Sewerage Laboratory Building	1997 - 1999	design and construction	8	Region 14	-	AAWSA
12 Sewer Line Expansion Project	1998	design and construction	2	Region 14	-	AAWSA
13 Slag Treatment Pond Project	1998	construction	3.3	Region 14	-	AAWSA
14 Addis Ababa Sewerage Master Plan Phase I Project	2 years	study	123	bilateral & Region 14	Grant	AAWSA
15 Addis Ababa Flood Control Project	1997 - 1998	study, formulation of master plan for flood control of Addis Ababa		JICA & Region 14	Grant	AFCPO
16 Training Center for Ethiopia Ground Water Development and Water Supply Program	New	basic design and construction		JICA	Grant	Ministry of Water Resources

Source: Planning and Economic Development Bureau, Addis Ababa Administration

**Table 3.5.1 Form of Compensation Estimate for Resettlement**

1. Owner's Name -----  
Zone ---- Wereda ---- Kebele ---- House No. ----
  
2. Estimation for Priority Property in Ethiopian Birr
  - 2.1 For fence -----
  - 2.2 For plant ----
  - 2.3 For house ----
  - 2.4 For others ----
  - Sum ----- without depreciation.
  
3. Details for the Estimation of Item 2.3
  - 3.1 Number of houses in the compound ----
  - 3.2 Number of room ----
  - 3.3 Type of wall ----
  - 3.4 Number of houses occupied by people ---- and number of houses not occupied by people ----
  
4. Table for Compensation Improvement
  - 4.1 Estimation for fence based on item 2.1 ----
  - 4.2 Estimation for plant based on item 2.2 ----
  - 4.3 Estimation for walls which are constructed by chika/wood ----
  - 4.4 Houses which have more than two rooms and partition wall in the shortest direction ----
  - 4.5 Ditto as item 2.4 ----
  - Sum -----
  - For transportation 5 % ----
  - For forgotten item 15 % ----
  
5. Ground Total in Letter -----

prepared by            checked by            approved by

Name -----

Signature-----

- \*) If the total compensation is less than 5,000 Ethiopian Birr, then the compensation must be 5,000 Ethiopian Birr.



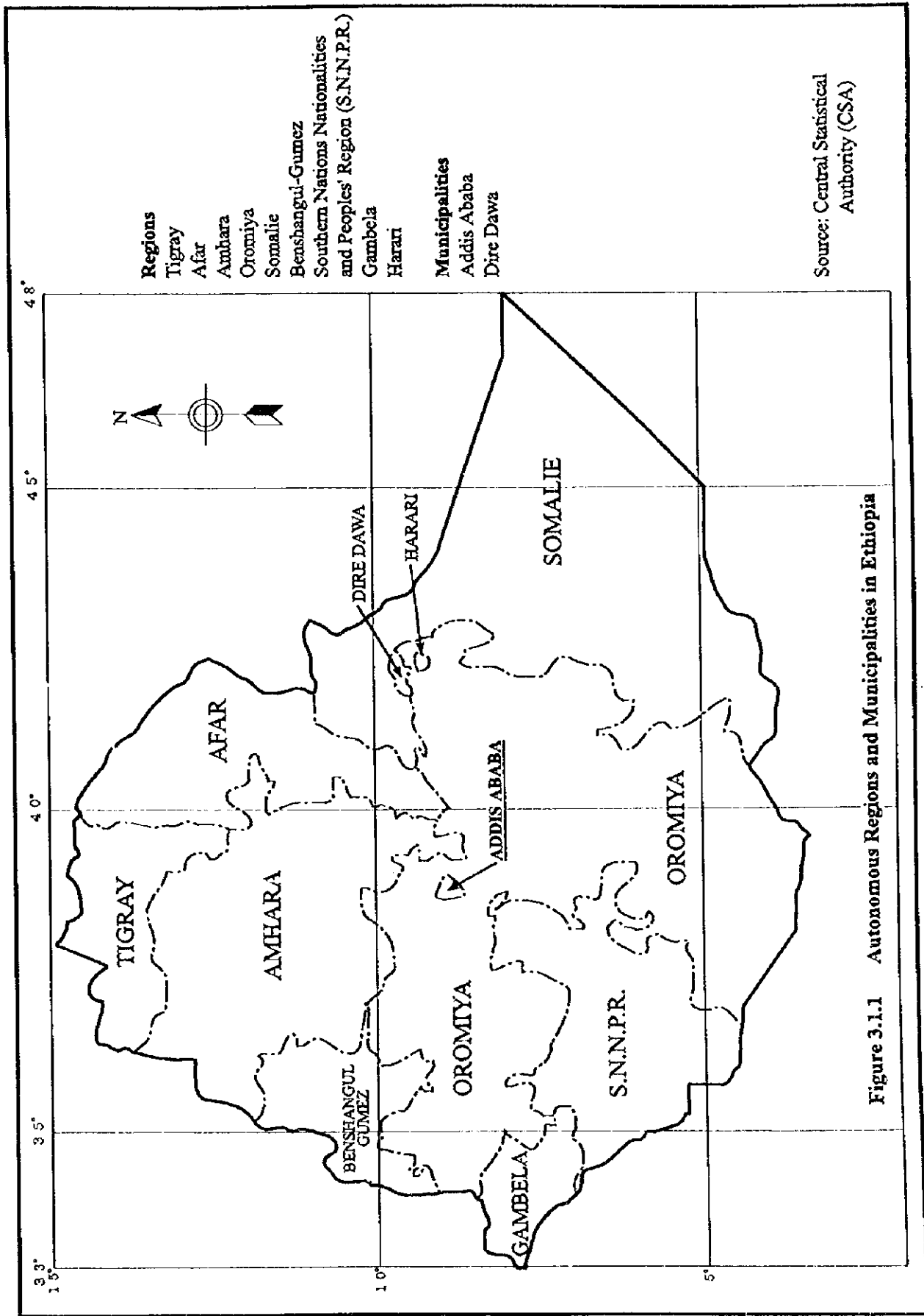


Figure 3.1.1 Autonomous Regions and Municipalities in Ethiopia

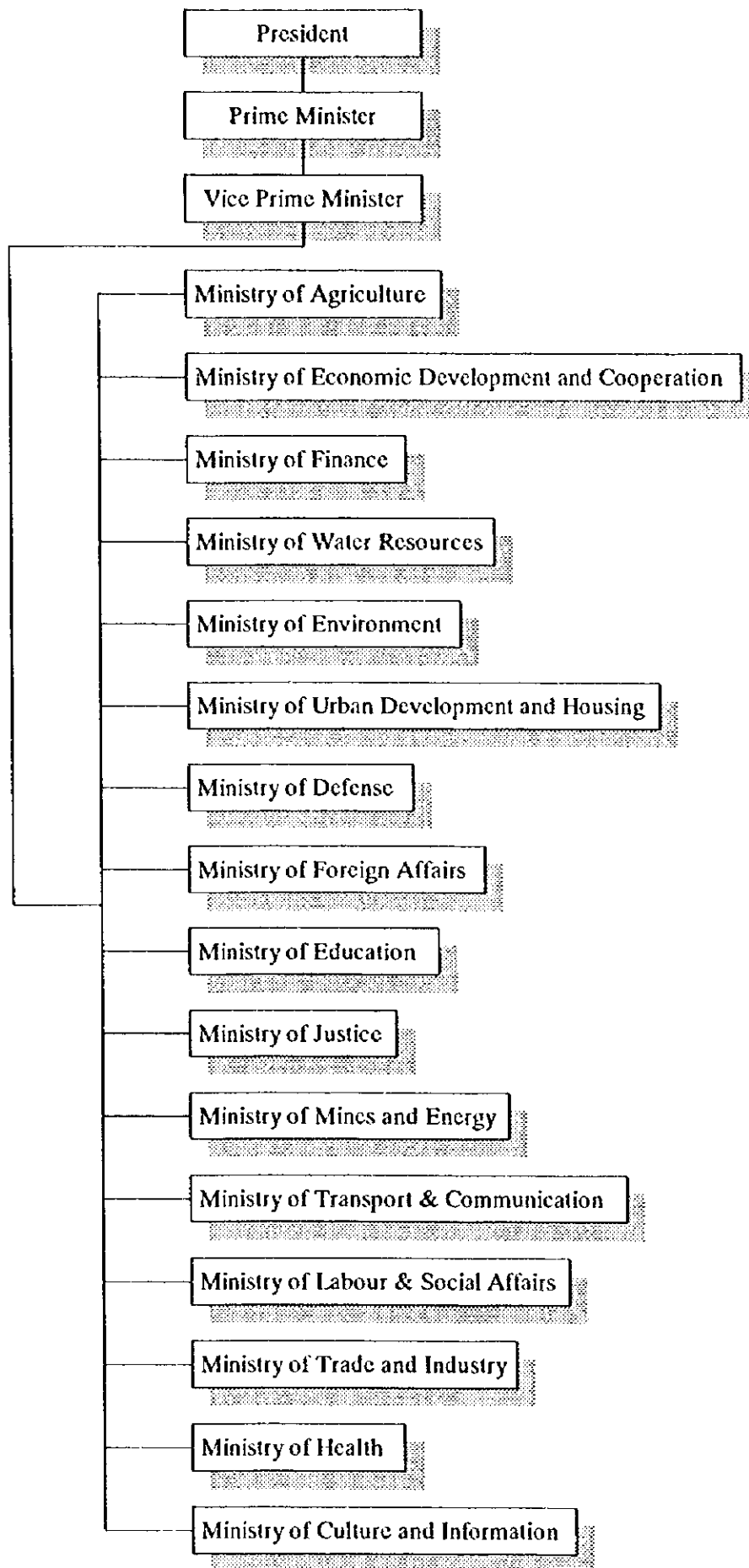


Figure 3.1.2 Administrative Structure of the Federal Government

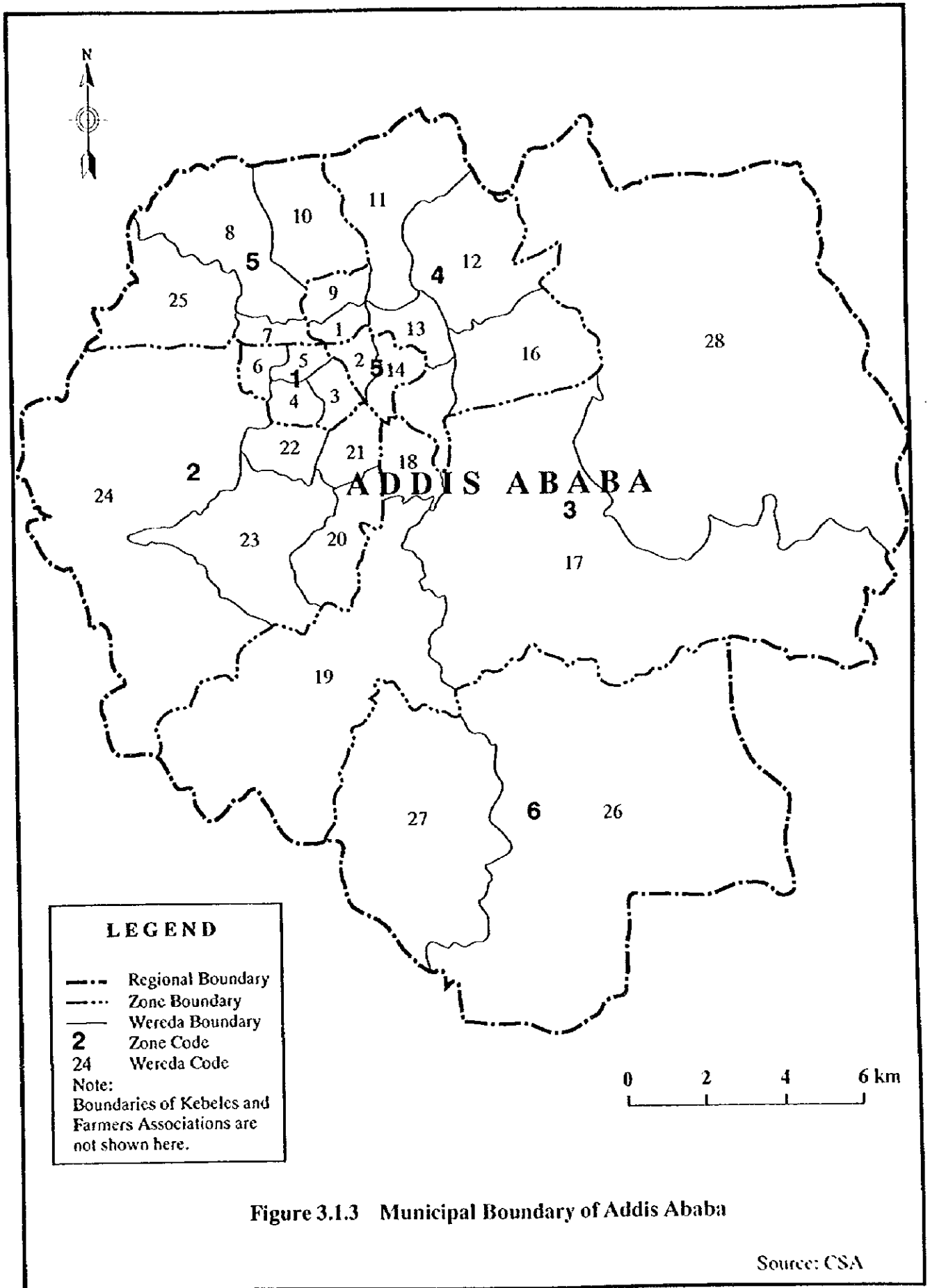


Figure 3.1.3 Municipal Boundary of Addis Ababa

Source: CSA

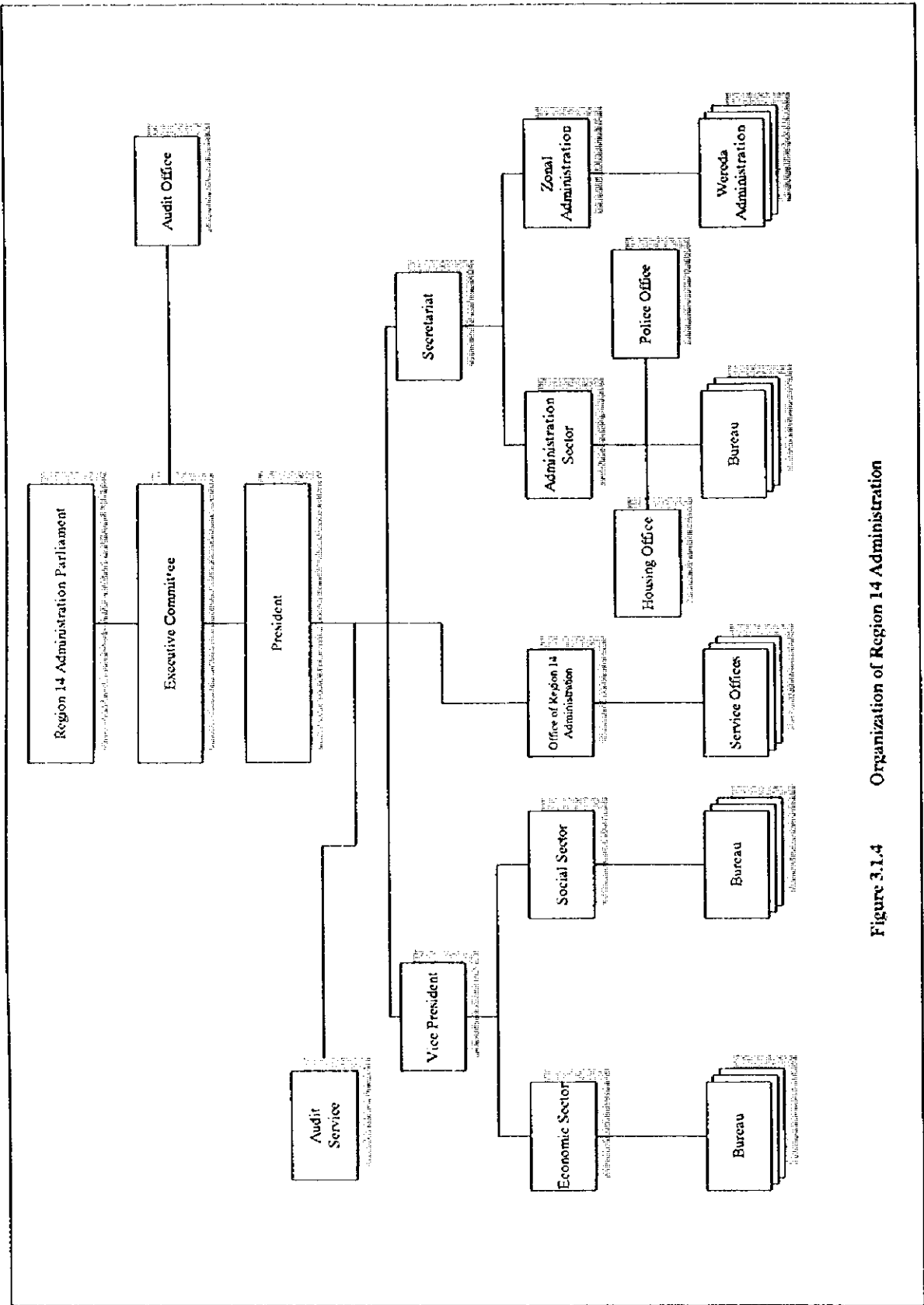


Figure 3.1.4 Organization of Region 14 Administration

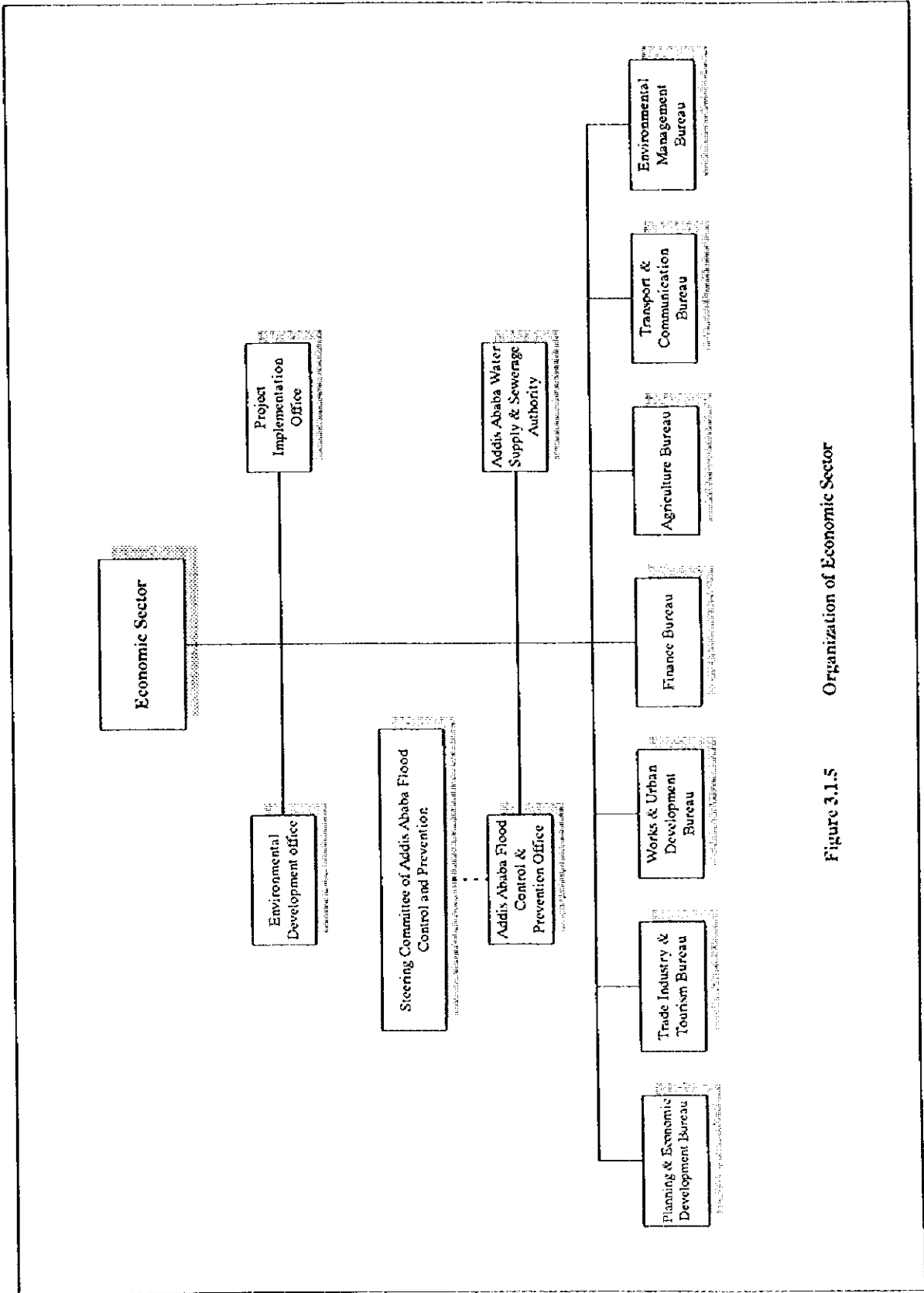


Figure 3.1.5 Organization of Economic Sector

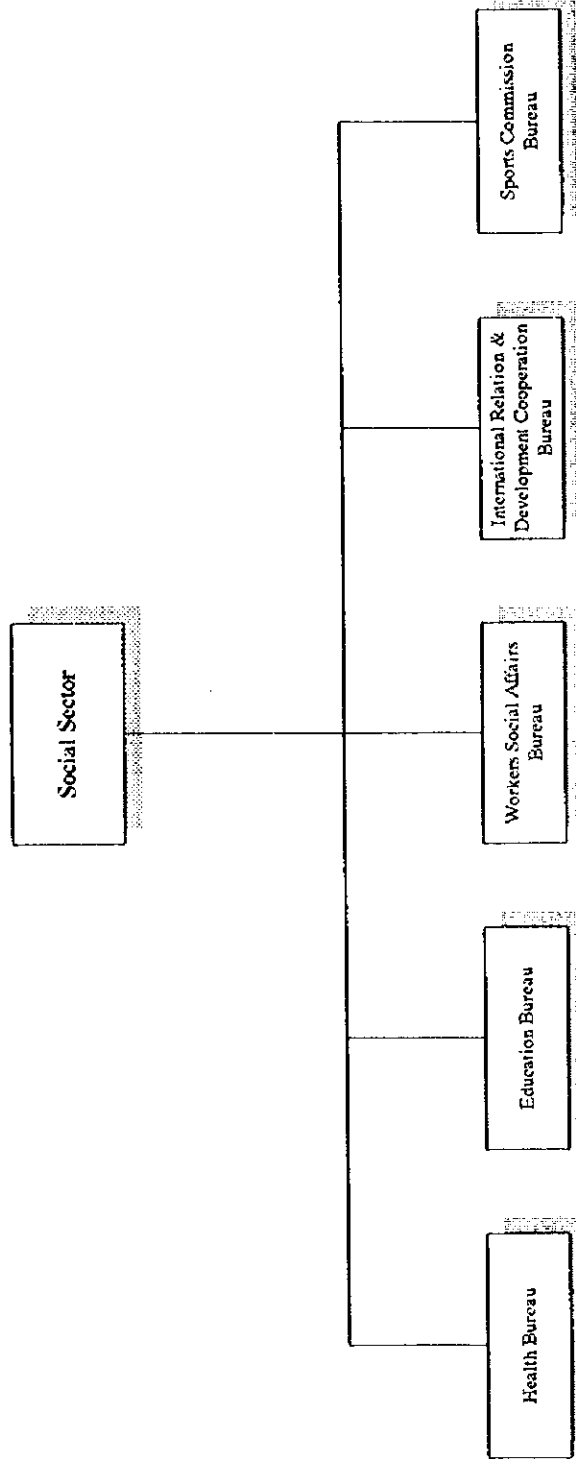


Figure 3.1.6 Organization of Social Sector

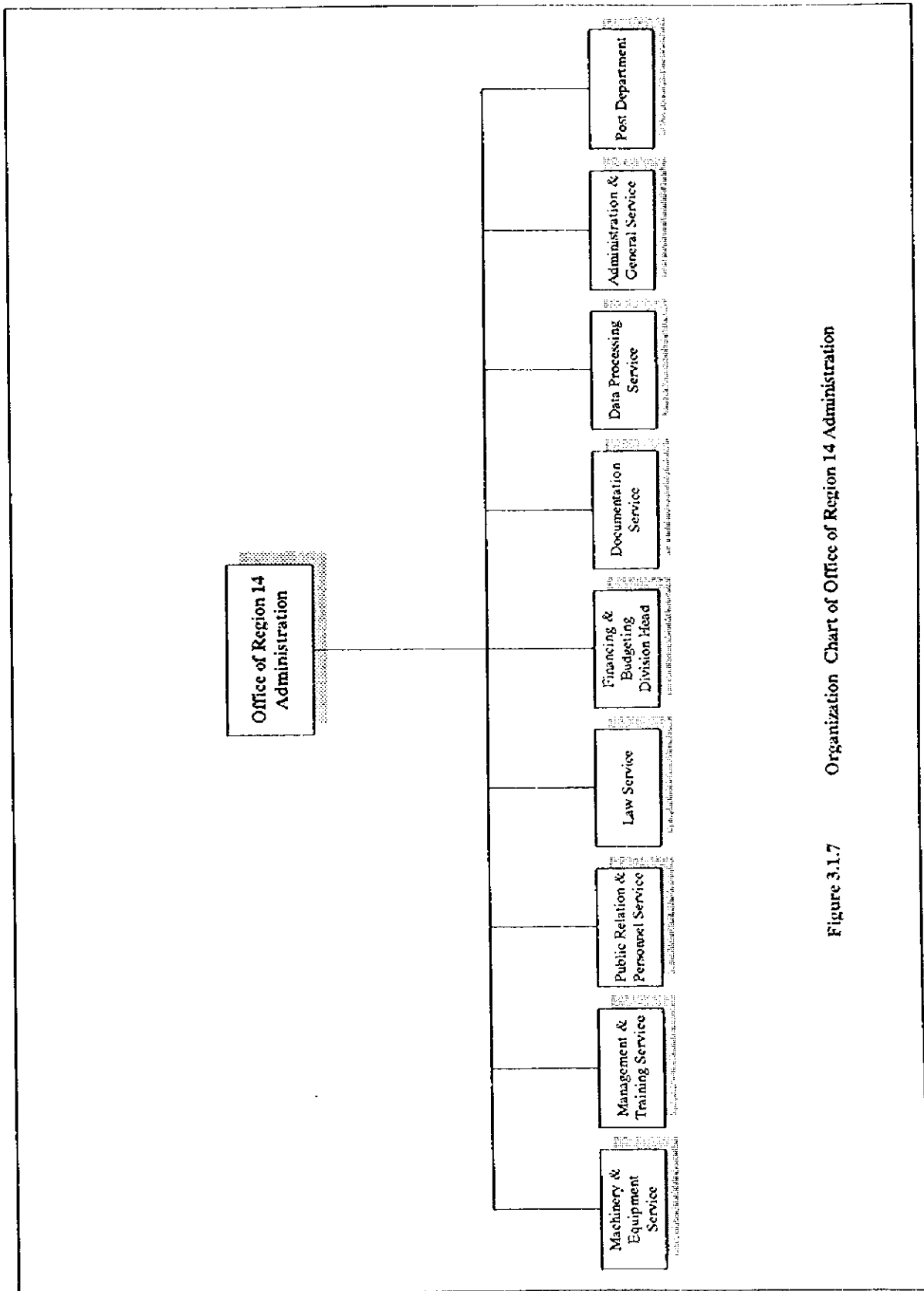
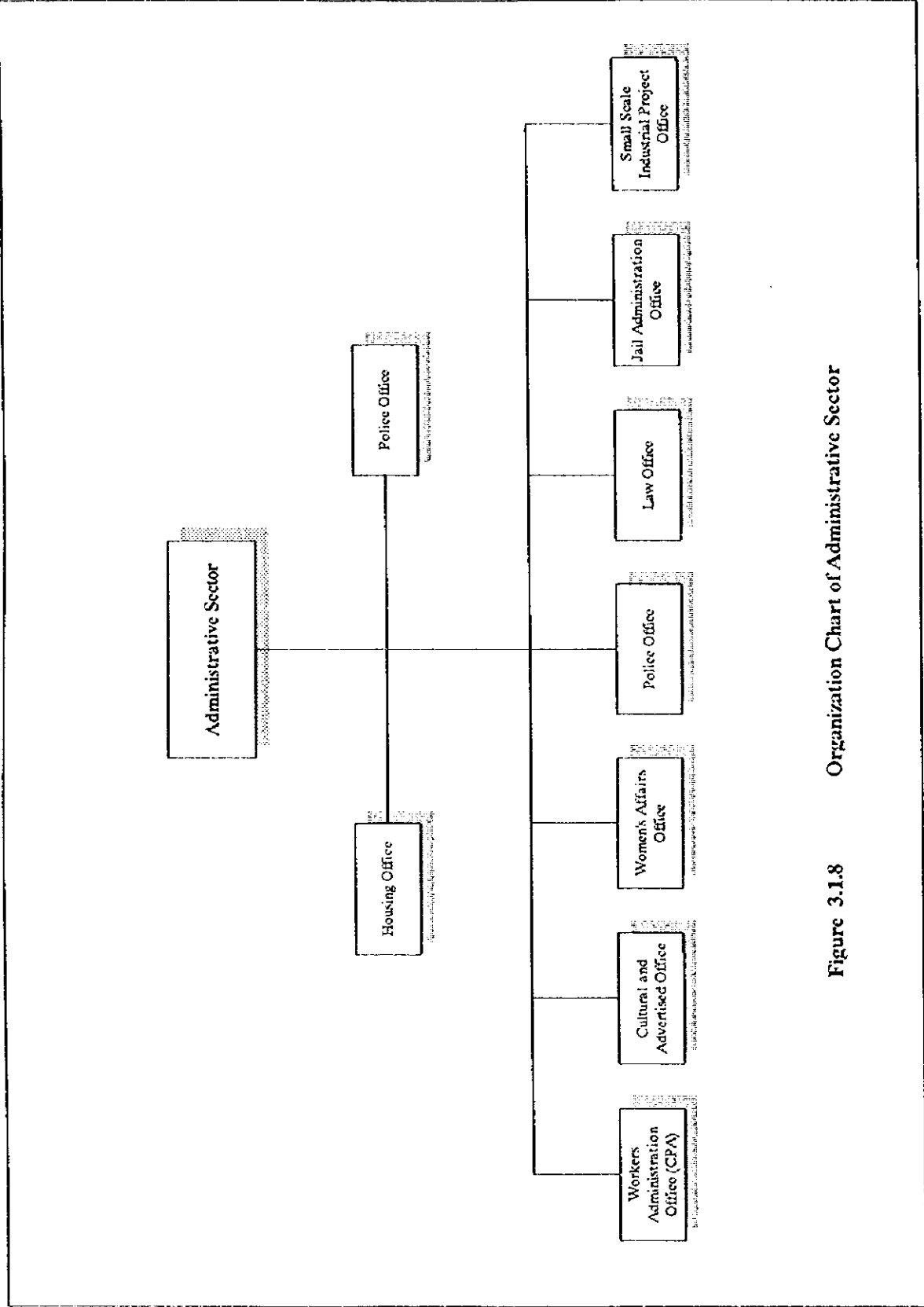


Figure 3.1.7 Organization Chart of Office of Region 14 Administration



**Figure 3.1.8 Organization Chart of Administrative Sector**



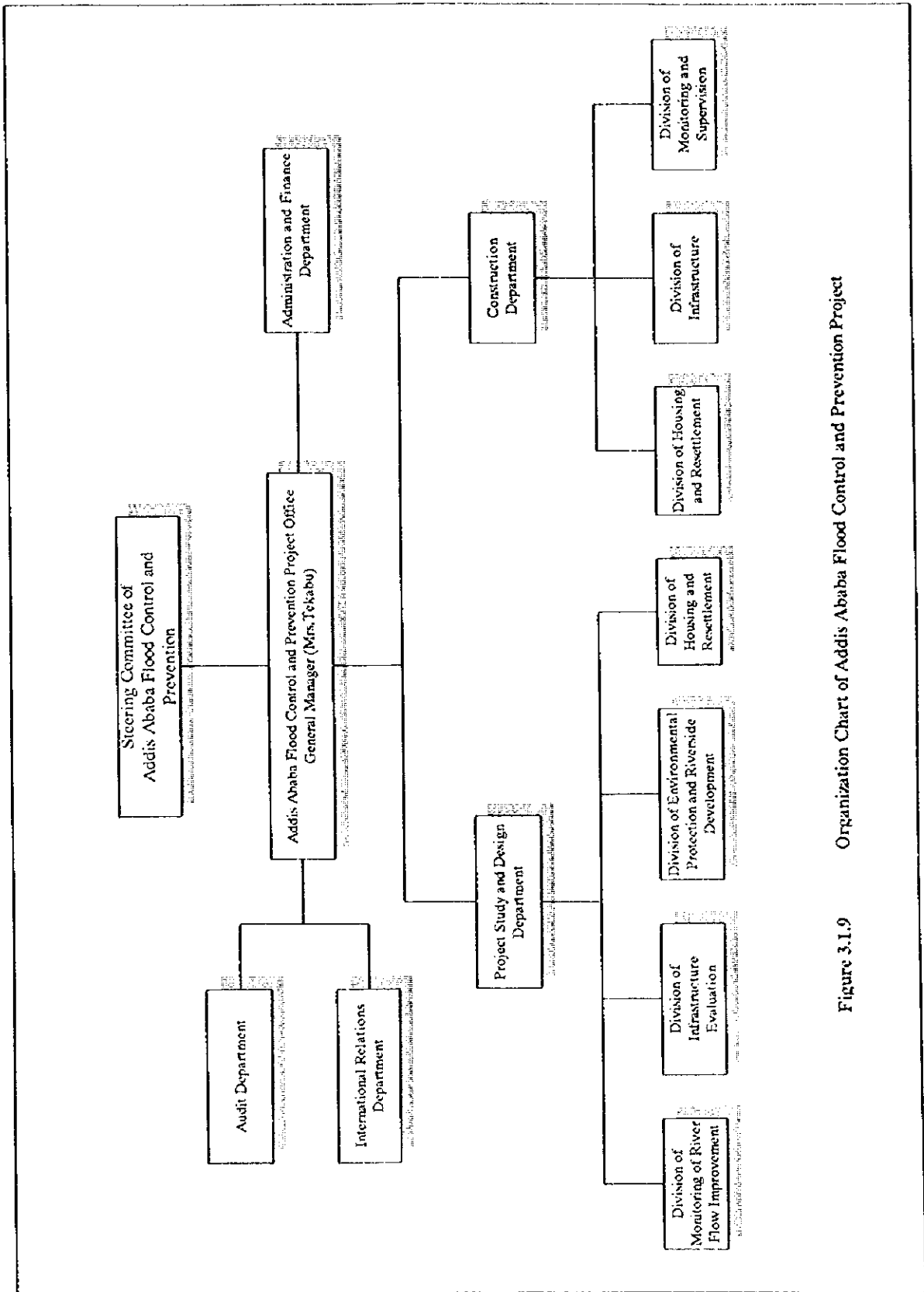


Figure 3.1.9 Organization Chart of Addis Ababa Flood Control and Prevention Project

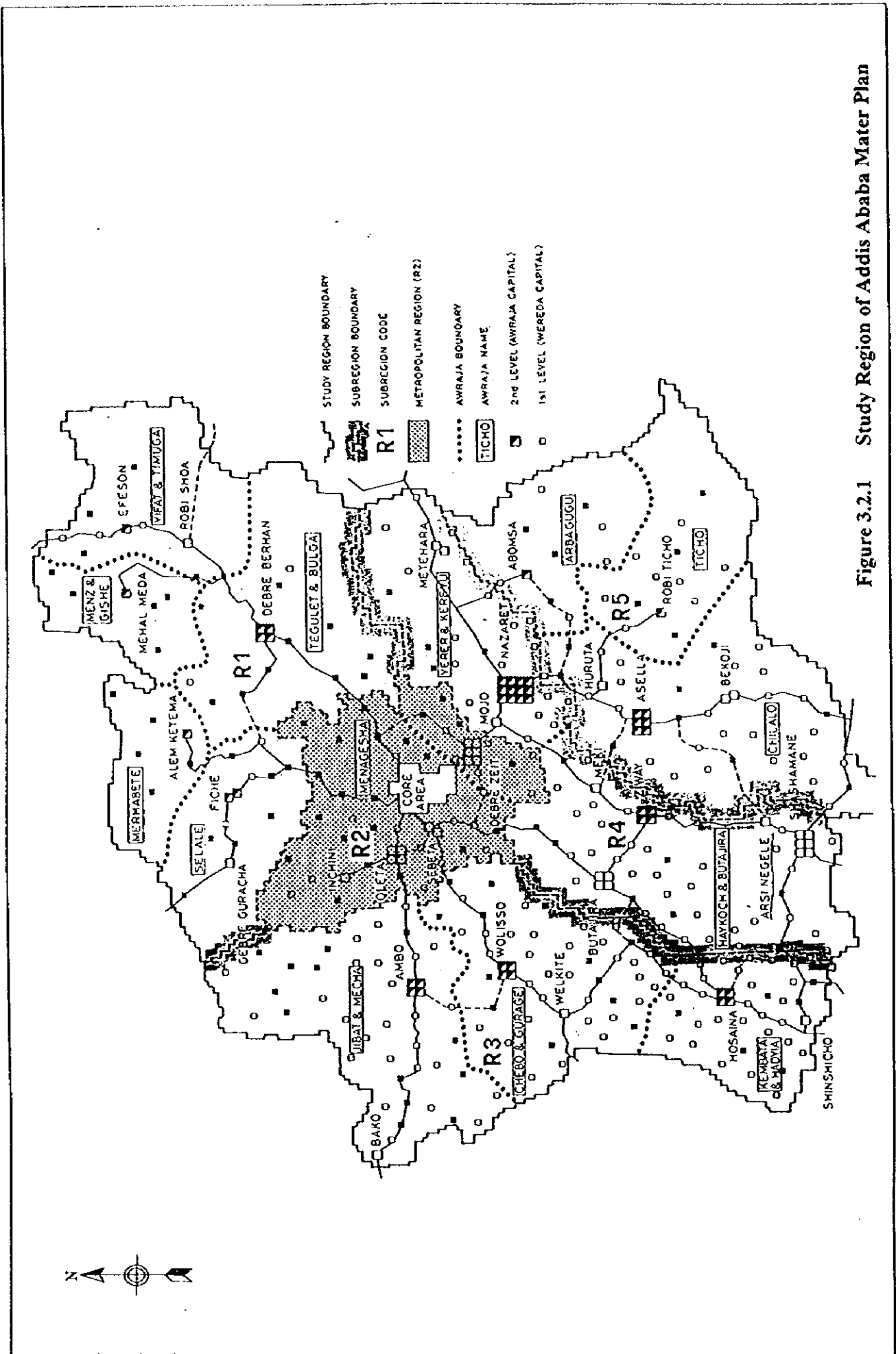


Figure 3.2.1 Study Region of Addis Ababa Mater Plan

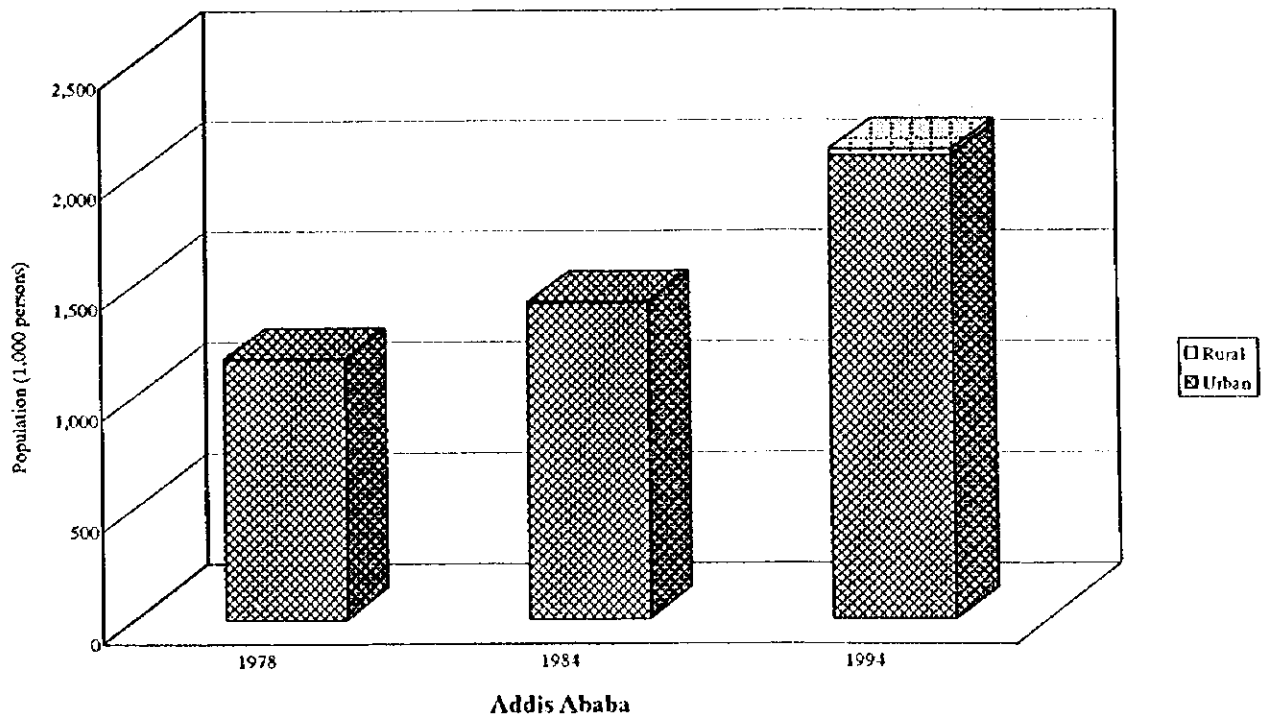
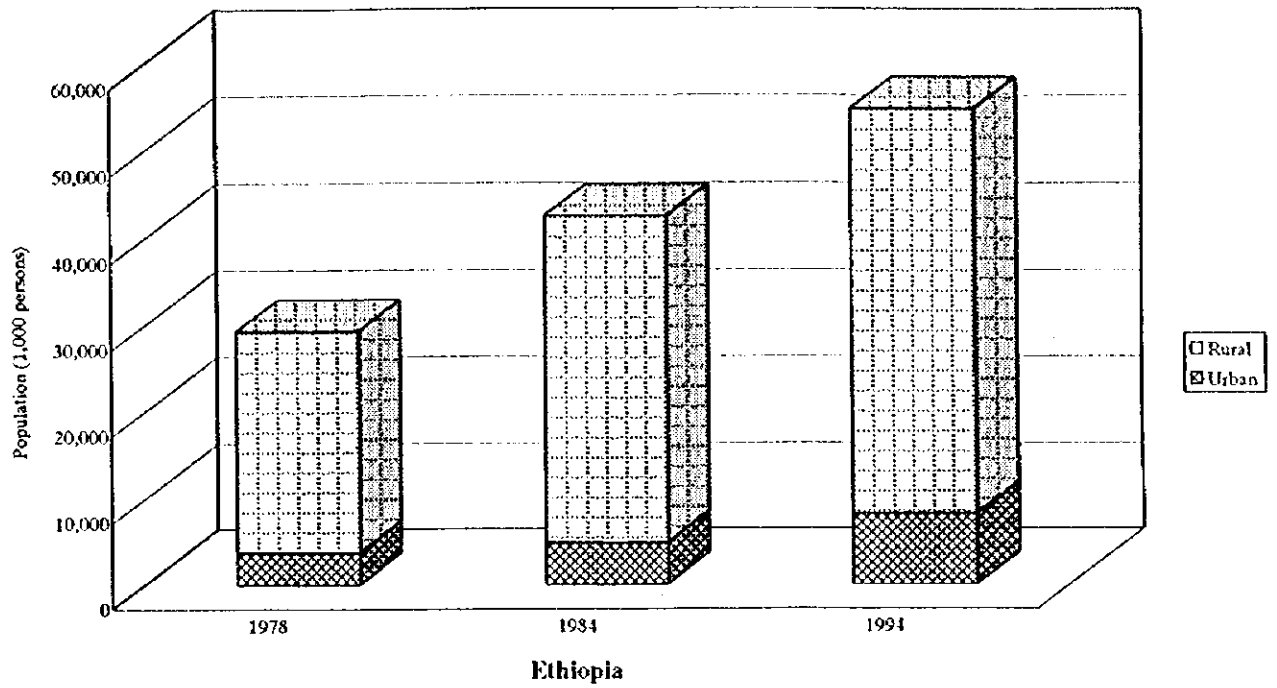


Figure 3.3.1 Population in Urban and Rural Areas of Ethiopia and Addis Ababa

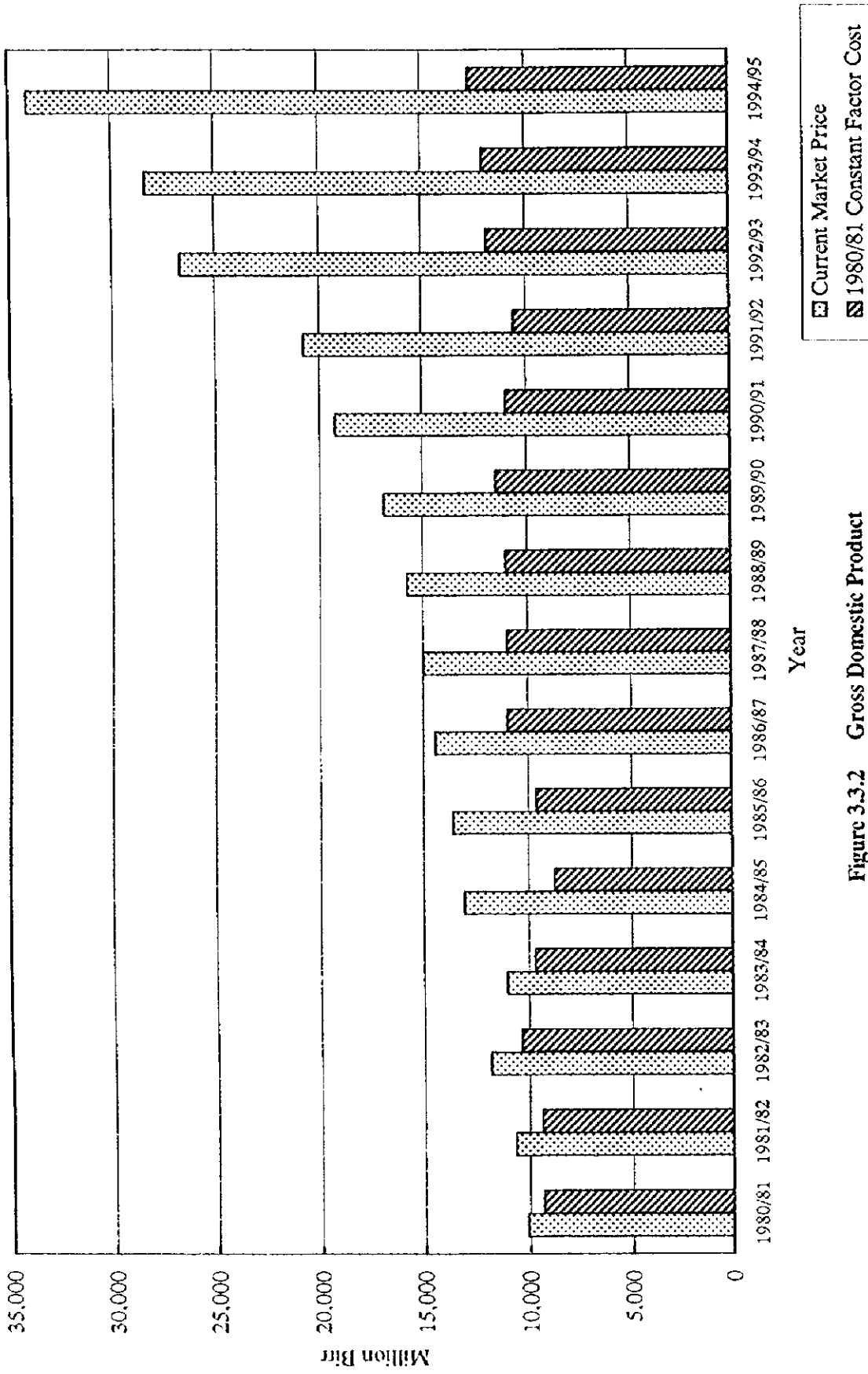
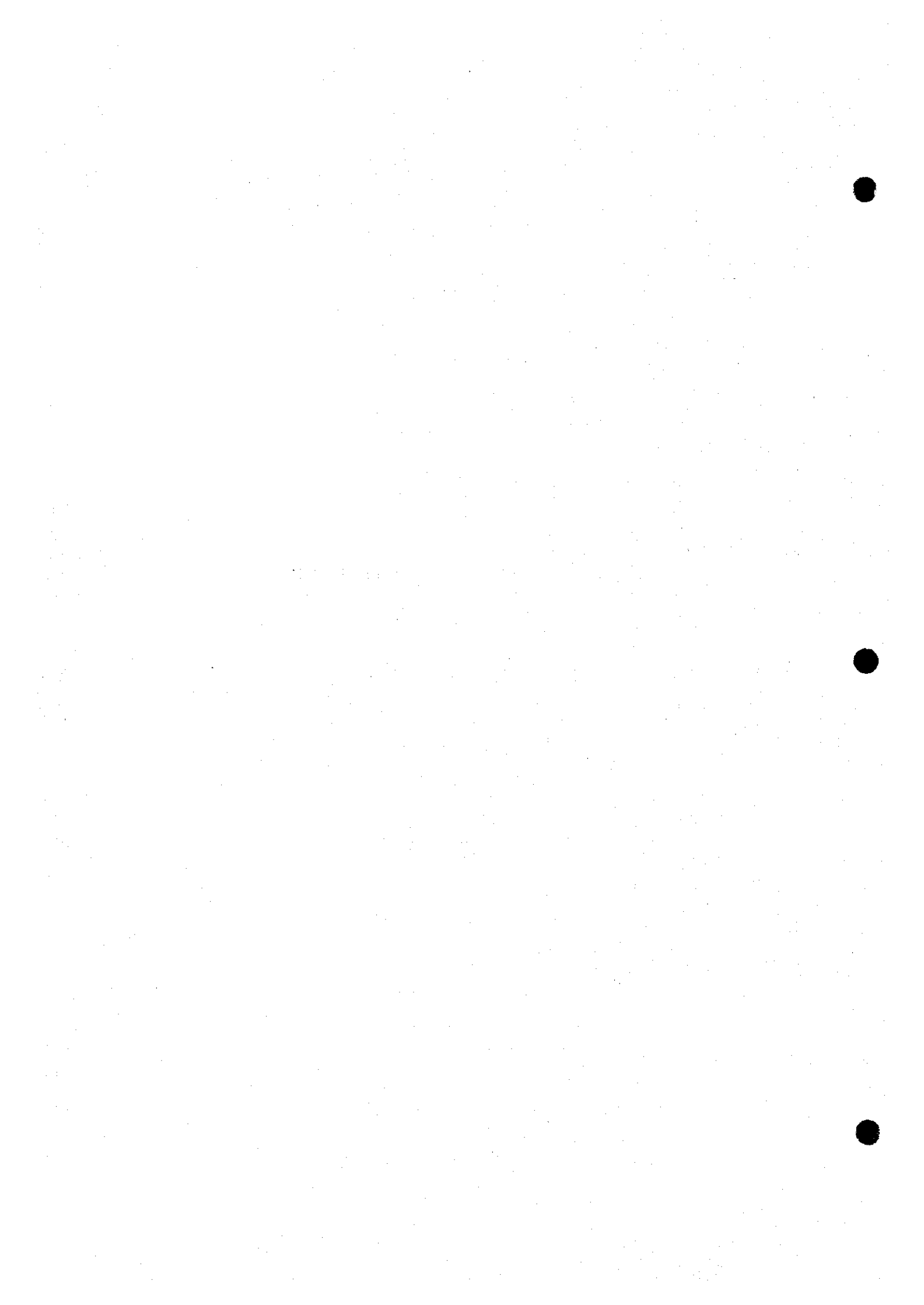


Figure 3.3.2 Gross Domestic Product

**THE STUDY ON ADDIS ABABA  
FLOOD CONTROL PROJECT**

**CHAPTER 4**

**PRESENT CONDITION  
OF STUDY AREA**



THE STUDY  
ON  
ADDIS ABABA FLOOD CONTROL PROJECT  
IN  
THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

**CHAPTER 4    PRESENT CONDITION OF STUDY AREA**

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## 4. PRESENT CONDITION OF STUDY AREA

### 4.1 Rivers

#### 4.1.1 River System

##### (1) River System

The basin of the Study Area is estimated at approximately 310 km<sup>2</sup>, as shown in Figure 4.1.1. The rain water in the western-half of the basin is drained by the West Akaki river which runs in the western mountain areas and southern outskirts of the urban area. The rest is drained mainly by the Little Akaki river, Kebena river and Bantiyketu river, passing through the urban area of Addis Ababa. Figure 4.1.2 shows the river system. Figures 4.1.3 and 4.1.4 show general profiles of major and minor rivers in the Study Area, respectively.

Such rivers in the Study Area locate in the uppermost of the Awash river basin. Figure 4.1.5 presents schematically overall river system of the Awash river basin. The Awash river is ranked at the fourth biggest one in Ethiopia in the size of basin area. The total basin area and length are reported to be 113,700 km<sup>2</sup> and 1,200 km, respectively.

The West Akaki river discharges into the lake of Aba Samuel after flowing down southwards for about 15 km. In similarly, the Kebena river which is joined by the Akaki river also discharges into the said lake. The water in the lake is further drained through the Akaki river which is joined by the upper Awash river that takes its route in the Rift Valley. Then, the water is poured into the lake of Koka. The water in the lake of Koka is discharged through the Awash river in the north-easterly direction. Finally, it is poured into the lake of Gamari which locates near the boundary with Djibouti.

The rivers in the Study Area are grouped into the five (5) river systems; specifically the West Akaki, Little Akaki, Kebena, Bantiyketu with 2 tributaries of Kechene and Kurtume, and Hanku in order from west to east. These rivers in the Study Area are being administrated by the Addis Ababa Flood Control and Prevention Project Office (AFCPO).

Table 4.1.1 shows basin area and length of the said principal rivers. Detail features of the channels such as width, depth and profile are shown in Figure 4.1.6, based on the surveyed river cross-sections. The following are the major dimensions of rivers within the Study Area.

River	Basin Area(km <sup>2</sup> )	River Length(km)	River Slope
West Akaki	203.0	35.6	1/50-1/100
Little Akaki	30.8	20.5	1/25-1/100
Kebena	89.1	23.9	1/20-1/100
Bantyketu	5.4	4.5	1/100
Kechene	13.6	11.2	1/20-1/50
Kurtume	10.3	9.3	1/20-1/50
Hanku	11.1	8.6	1/50-1/70

Note: Basin area: West Akaki includes the Little Akaki and Kebena includes the Bantyketu, Kechene and Kurtume.

Outline and characteristics of each river are summarized below.

#### 1) West Akaki River

The West Akaki river originates in the west mountain ridge of the catchment. After flowing down in the south-east direction for a distance of 10 km, the water in the river is stored in the reservoir of the Gefersa dam. The reservoir area is an approximately 1.3 km<sup>2</sup>. The dam is being administrated by the Addis Ababa Water Supply and Sewerage Authority (AAWSA) of the Region 14 Administration. Two functions not only for water supply but also for flood control as a natural one without specific flood control space, are involved in this dam.

Just downstream of the dam, the West Akaki (locally called as Menjaro river in the uppermost) collects a right tributary of Welenso. The West Akaki river further flows down for 20 km in the mountainous, valley and suburban areas of the city of Addis Ababa, collecting some tributaries.

Then, it joins a tributary of the Little Akaki and a small drainage way of the Perennial on the left. The West Akaki river in the suburban areas is of large one, having an average width of more than 60 m. Its river bank areas have been kept as open area covered with grasses, small trees and vegetable fields. Upstream point of the confluence with the Bantyketu, the river channel is being widely and deeply excavated as quarry site for

construction materials. The West Akaki river finally discharges into the lake of Aba Samuel.

The basin area and river length at the confluence with the Little Akaki river are 203 km<sup>2</sup> and 36 km, respectively. Figure 4.1.6 (1/7) shows the channel features of the West Akaki river within the Study Area. The channel has slopes of 1/100 to 1/50.

## **2) Little Akaki River**

The Little Akaki river starts at the Intoto mountain ridge. Passing through the mountainous areas for 3 km long, it further flows down through the urban area for 4 km in the south direction. Then it runs for a distance of 5 km in the dense populated areas in the south-eastwards, collecting two drainage ways of the Fereja and Buhe on the left bank.

The stretches upstream of the confluence with the Fereja is running in the incised valley and some points of the river course are meandering, although those fluctuations are of within the valley area. Further, turning its direction to south, the Little Akaki river which collects rain water from both the banks, is joined by the West Akaki.

The Little Akaki river from the confluence of the Fereja up to the Ethiopian Abattoir Factory is quite narrow one owing to occupation by building and houses. The minimum width due to constriction is less than 10 m. The riverine areas are, therefore, subject to flooding. Actually, these reaches have been suffered from recurrent flooding up to now.

The basin area and river length at the confluence with the West Akaki are 31 km<sup>2</sup> and 20.5 km, respectively. The channel features of the Little Akaki are shown in Figure 4.1.6 (2/7). The channel slopes vary widely from 1/100 to 1/25.

## **3) Kebena River**

The Kebena river has its origin in the Intoto mountain ridge. Collecting rain water in the mountainous areas, it takes route in the south direction. At about 700 m upstream of the Tesfa Aseged bridge, the Kebena river joins a left tributary of the Abo river. The river in this stretch consists of wide and incised valley .

After flowing down southwards for a distance of 5 km in the populated areas , it joins a small right drainage way, the Ginfile at just upstream of the Urael bridge. In this stretch, the original river width has been relatively kept, because of destructive flood flow directly coming from the mountain areas.

Then, the Kebena river flows down for 1.5 km and joins the largest right tributary of the Bantiyketu, 700 m upstream of the Bole bridge. A natural retarding basin stretches over the confluence with the Bantiyketu river. No serious flood damage in this river has been reported so far due to relatively wide channel with 25 m on average.

The Kebena river downstream of the Bole bridge runs in the valley areas. After joined by the Akaki river which is the main river of the Kebena, it is poured into the lake of Aba Samuel.

The basin area is 89 km<sup>2</sup> at the Bole bridge and 53 km<sup>2</sup>, at the upstream of the confluence of the Bantiyketu river. On the other hand, the river length is 23.9 km and 23.2 km, respectively. Figure 4.1.6 (3/7) shows the channel features of the Kebena river. The Kebena channel has slopes of 1/100 to 1/20.

#### 4) Bantiyketu River

The Bantiyketu river has two tributaries of the Kechene and Kurtume. The Kechene is the main tributary of the Bantiyketu.

##### a) Kechene River

The Kechene river starts in the Intoto mountain ridge and flows down in the south direction. The river channel upstream of the Kechene bridge is of an incised with wide and deep valley. After flowing down in the valley for further 1 km long, the Kechene river joins a right tributary of the Kostre.

Then, the Kechene river flows down for 3.5 km long towards confluence with the Bantiyketu. Some points (around bridges) of this reach are being constricted by private houses and buildings. The river bank areas (terrace of the valley) have been densely covered with houses prone to flooding. Therefore, this reach has habitually suffered from flooding. Especially, the lower reaches have been vulnerable in flooding.

The basin area and river length at the confluence are 13.6 km<sup>2</sup> and 11.2 km, respectively. The channel features are shown in Figure 4.1.6 (4/7). Average channel slopes range from 1/50 to 1/20.

b) Kurtume River

The Kurtume river originates in the southern slopes of the Intoto ridge. Five major drainage ways are joined as the Kurtume river at the upstream of the Habte Giyorgis bridge. Then, the Kurtume river flows south-eastwards in the densely urbanized area for about 2 km up to the Churchill Avenue which is one of the main street in Addis Ababa. The channel between the Habte Giyorgis bridge and Churchill Avenue is relatively wide having an average width of 10 m.

At the crossing point of the Churchill Avenue, the Kurtume river flows through a culvert which across under the Avenue and building area of the General Post Office. The culvert is of a width of 4.5 m and height of 4 m, and about 350 m in long. Due to sudden decreasing of flow area at the culvert inlet compared with those of upstream, river water overflows the Avenue. After passing the culvert, the Kurtume river as an open channel is joined by the Bantiyketu river.

The basin area and river length of the Kurtume at the confluence are 10.3 km<sup>2</sup> and 9.3 km, respectively. Average river slopes are from 1/50 to 1/20. Figure 4.1.6 (5/7) shows the channel features of the Kurtume river.

c) Bantiyketu River

The Kechene and Kurtume join at the Filwiha bridge and the river is called as the Bantiyketu river. The Bantiyketu river takes its route in the south-easterly direction for a distance of 3.5 km towards the confluence with the Kebena river.

The Bantiyketu river runs in the central area of Addis Ababa and then, gets to a natural retarding basin, locating in and around the confluence with the Kebena. The channel width in the upper and middle reaches is narrow, having a minimum width of around 10 m. The riverine areas has habitually suffered from recurrent flooding.

The basin area and river length including the tributaries are 29.3 km<sup>2</sup> and 15.7 km at the confluence with the Kebena, respectively. The average slope of the Bantiyketu river itself is around 1/100. Figure 4.1.6 (6/7) shows the channel features of the Bantiyketu river.

## 5) Hanku River

The Hanku river originates in the Intoto mountain ridge in the east of the Study Area. Flowing through the mountain slopes, it flows down towards south direction for about 2 km. Then, the river including a left drainage way crosses under the Fikre Maryam Aba Techan Street through small culvert. Therefore, in heavy rain time, the river water especially in the left drainage way frequently flows over the street towards downstream.

After across under the Street, it joins the said left drainage way, just upstream of the Asmera Street. In the far lower reaches, there exists an extensive natural retarding basin which is kept as an open area. Further, the Hanku river flows down for about 7 km in the south-eastwards in the valley area and finally joined by the Akaki river at the south-eastern point of the Bole International Airport.

The basin area and river length are 11.1 km<sup>2</sup> and 8.6 km at the main road across the natural retarding basin. Figure 4.1.6 (7/7) shows the channel features of the Hanku river.

### (2) Carrying Capacity of River Channels

Based on the river cross-sections surveyed, harmless channel capacities of the respective rivers were estimated. The channel width and capacity in each river are summarized below, as presented in Figure 4.1.6 (1/7 to 7/7).

River	Average Slope	Channel Width(m)		Carrying Capacity (m <sup>3</sup> /sec)
		Minimum	Average	
West Akaki	1/100	15	40	400 - 800
Little Akaki	1/50	5	20	50 - 300
Kebena	1/50	5	25	150 - 800
Kechene	1/30	8	15	50 - 250
Kurtume	1/35	8	10	30 - 150
Bantyketu	1/120	10	20	30 - 150
Hanku	1/60	5	10	20 - 150

Source: Study Team



## **4.1.2 River and Related Structures**

### **(1) River Structures**

#### **1) Flood Wall**

There are several completed flood protection works in the Little Akaki river. Flood protection works are of flood walls. Figure 4.1.7 (1/2) shows their locations and Table 4.1.2 shows those dimensions.

The walls consist of wet masonry gravity ones with direct heights varying from 5 to 6 m. These walls were constructed by AFCPO in the last 2 years. The purposes of the constructed walls are to protect houses from attacking by flood flow.

Besides, there are many walls and revetment works in the major channels. These were constructed privately as bank protection and building foundation. According to the site reconnaissance, some points of river channels have been constricted by such structures, especially at just downstream of Habte Giyorgis bridge and just upstream of Filwiha bridge in the Kurtume river.

#### **2) River Bed Protection Works**

In order to protect sub-structures of bridge, river bed protection works have been provided. Major ones are observed at the Filwiha bridge and the downstream bridge of the Bantyketu bridge in the Bantyketu river. Figure 4.1.7 (1/2) presents those locations.

### **(2) Irrigation Intake**

Surface water in the Study Area has been utilized for irrigation purpose. The irrigation is for growing vegetable. The water users are the following 5 vegetable grower associations:

- 1) Kebena and Bulbula Vegetable Grower Association,
- 2) Makenisa Furi and Saries Vegetable Grower Association,
- 3) Karanyo and Akaki River Surrounding Area Vegetable Grower Association,

- 4) Shankla River and Kacha Fabrica River Vegetable Grower Association, and
- 5) Kolfe and Lideta Area Vegetable Grower Association.

These vegetable grower associations have irrigation intakes in the Study Area as follows:

Name of Association	Objective River	Number of Intake Weir
1. Kabena & Bulbula	Kabena, Bantiyketu	2
2. Makewisa Furi & Saries	West Akaki	7
3. Karanyo & Akaki River Surroundign Area	West Akaki	3
4. Shankla & Kacha Fabrica	Little Akaki	2
5. Kolfe & Lideta Area	West Akaki	3

Source : Agricultural Development Department, Agricultural Bureau of Region 14 Administration

The locations of these weirs are shown in Figure 4.1.7 (2/2).

These intakes are of wet masonry wall type and no gate is provided. The withdrawal method is of gravity flow type. The direct heights of the weirs vary depending on the locations from about 2.5 to 0.5 m. Some of these are damaged or flushed away. The crop fields are all located in the strip area along the river banks.

### (3) Water Supply Pipes Across Over River Channel

There are many pipe lines of water supply (aqueduct) which across over the major river channels. Such pipelines are being administrated by the AAWSA. Table 4.1.3 shows the details of water supply pipe.

### (4) Bridges

There exist tremendous numbers of bridges over the major river channels in the urban area. Major bridges including bridge type and dimensions are listed in Table 4.1.4 and their locations are shown on Figure 4.1.8.

Most of the enlisted bridges are for car traffic, being furnished with sidewalks. One of the bridges is a railroad bridge and two of them are only for pedestrians.

Bridge type is mainly limited to either stone masonry arch bridge or reinforcing concrete (RC) bridge. The latter uses either T- shaped beam or simple slab. Hollow slab is not applied as long as our on-site survey is concerned. Among bridges for car traffic, a bridge which was reportedly constructed in a park along the Bantiyketu river in 1980's and another bridge now under construction at the entrance of the Gihon Hotel, are made of reinforcing concrete box culvert. The type of the railroad bridge is of steel truss.

The number of span is mostly one span. The length of a span for stone masonry bridges is 1 to 10 meters. While the length of a span for RC bridges with T- shaped beams is 10 to 17 meters, that for RC bridges with simple slabs is 3 to 10 meters. The length of a span for reinforcing concrete box culverts is 5 to 8 meters.

Abutments and piers are unexceptionally made of stone masonry. Sometimes, abutments for RC bridge are furnished with weep holes. At most bridges, geological conditions of riverbed are hard rock.

Among those bridges, some bridges are disturbing flow area due to small span, although they act as a retention of flood flow and velocity control towards downstream reaches.

#### (5) Gefersa Dam

The Gefersa dam locates in the upper West Akaki river. Figures 4.1.2 and 4.1.5 show its location. The dam is of gravity arch, which is being used as water supply to Addis Ababa. The dam is being administrated by Addis Ababa Water Supply and Sewerage Authority (AAWSA).

The dam was originally constructed as a gravity one in 1938. In 1954, the dam was renovated and an arch portion was additionally constructed on the then crest of gravity dam. The following are major dimensions of the dam and reservoir.

- a) Dam
- Dam Crest length: 150 m
  - Dam height: 20 m
  - Outlet: Pipe in diameter of 20 cm with a valve
  - Spillway: Overflow type

- b) Reservoir
  - Total catchment area: 57 km<sup>2</sup>.
  - Reservoir area: 1.3 km<sup>2</sup>
  - Storage volume: 6,500,000 m<sup>3</sup>
  
- c) Water Treatment
  - Treatment facility: 2 units with 2 booster pumps
  - Treatment capacity: 25,000 m<sup>3</sup> to 30,000 m<sup>3</sup> per day
  - Service area: city of Addis Ababa

The Gefersa dam has a sub dam for storage control in the left tributary which joins in the dam reservoir. The sub dam was constructed in 1966. The dam is of earth one, covered with rip rap stones and facilitated by a spillway with about 25 m long. The dam height and length are 25 m and 150 m, respectively. The reservoir area is around 75,000 m<sup>2</sup> with its storage volume of 1,500,000 m<sup>3</sup>. In the dry season, the stored water has been supplied through a pipe into the reservoir of the Gefersa dam.

#### 4.1.3 Sediment

Major rivers in the Study Area are steeper ones and their river beds are generally composed of volcanic rocks. Colluvial or alluvial fans can not be observed according to site investigation and geological maps, although small volume of alluvial materials can be observed at the gorges of the valleys and in the lower reaches of the Little Akaki, Kebena and Bantiyketu rivers at where the topography changes to relatively flat one. The alluvial materials consist of silty clay and clayey silt.

With the limited data presently available, suspended load estimated at the proposed Gerbi dam, which is planned to be constructed in the northern part of Addis Ababa, is presented below, based on HYDROLOGY OF GERBI DAM, FINAL REPORT in Addis Ababa Water Supply Project-Stage IIIA (AAWSA), by AE-HBT AGRA JOINT VENTURE, Jan.1997.

Location	Drainage Area (km <sup>2</sup> )	Annual Average (ton/year)	Suspended Load (ton/km <sup>2</sup> /year)
Gerbi	58.9	3,585	60.9

From the above table, an average annual suspended load is estimated at 60.9 ton/km<sup>2</sup>/year or 36.9 m<sup>3</sup>/km<sup>2</sup>/year (divided by unit weight of 1.65). This means that land erosion is 0.004 cm in thick per year and is quite small. In this aspect, it seems that sediment originating from the mountain areas of the Study Area is negligible small one.

On the other hand, the river banks have been composed of and covered mainly by clayey silt with sand. Some river banks slightly eroded by flow attacking have been observed. In this regard, it is due partly fact that the river bank materials will be dominant sources for sediment mainly as suspended load to downstream reaches.

Sediment materials sampled at river terrace, downstream of the Bole bridge in the Kebena river are of very fine ones, as shown in Figure 4.1.9. Therefore, such materials are easily transported to downstream by floods. Accordingly, it seems that river bed fluctuations in these rivers are of negligible ones and an attention must be paid to bank erosion.

#### **4.1.4 Water Use and Water Quality**

##### **(1) Water Use**

The surface water of the rivers in the objective areas of the Study has been used for irrigation and municipal purposes.

##### **1) Irrigation Water**

There exist five vegetable grower associations that take water of the objective rivers in the project area for irrigation purpose.

They are: 1) Kebena and Bulbula Vegetable Grower Association, 2) Makenisa Furi and Saries Vegetable Grower Association, 3) Karanyo and Akaki River Surrounding Area Vegetable Grower Association, 4) Shankla River and Kacha Fabrica River Vegetable Grower Association, and 5) Kolfe and Lideta Area Vegetable Grower Association.

The general features of those associations are as follows:

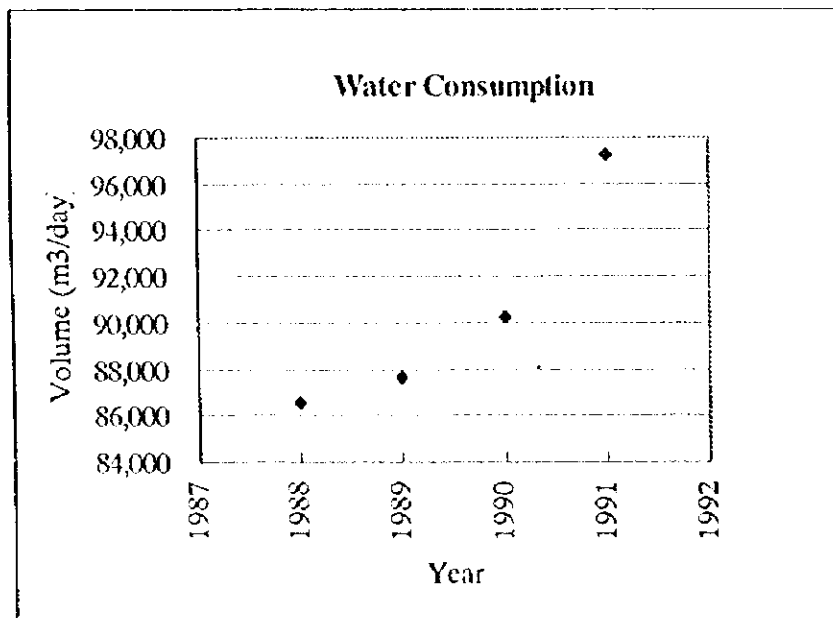
Name of Association	Objective River	Irrigation Area (ha)
1. Kabena & Bulbula	Kabena, Bantyketu	10
2. Makewisa Furi & Saries	Little Akaki and West Akaki	150
3. Karanyo & Akaki River Surroundign Area	West Akaki	8
4. Shankla & Kacha Fabrica	Little Akaki	10
5. Kolfe & Lideta Area	West Akaki	45

Source : Agricultural Development Department, Agricultural Bureau of Region 14 Administration

The harvest is twice a year. The river water is taken only during the dry season. The record of water intake from those rivers are not available. The locations of those crop fields are shown in Figure 4.1.7 (2/2).

## 2) Municipal Water

The municipal water for Addis Ababa is supplied by the Addis Ababa Water and Sewerage Authority of Region 14 administration. The water consumption in the municipality of Addis Ababa was 86,500 m<sup>3</sup>/day, 87,600 m<sup>3</sup>/day, 90,250 m<sup>3</sup>/day, and 97,250 m<sup>3</sup>/day in 1988, 1989, 1990, 1991 respectively, as graphically shown below:



Source: Master Plan Study for the Development of Wastewater Facilities for the City of Addis Ababa, August 1993.

The user category and the source of water supply are also reported as: 1) domestic and small commercial 55 %, 2) government, industries and large users 35 %, 3) public fountains 1 %, 4) additional consumption from wells for public and industrial use 9 %.

The intakes for the municipal water are located along the Legedadi river near the Legedadi reservoir which is located outside of the Study Area to the east and along the West Akaki river near Gefersa reservoir which is located in the Study Area but far upstream of the objective area of the flood control master plan of Addis Ababa.

### 3) Industrial Water

Industrial water use data are under the management of the Data Processing and Documentation Services, Trade, Industry and Tourism Bureau of Region 14 administration. According to the Services, there is no water right of surface water in the Study Area.

#### (2) Water Quality

Addis Ababa Water and Sewerage Authority has been supplying municipal water to the municipality of Addis Ababa. The raw water has been taken near the Legedadi and Gefersa reservoirs. The water qualities of raw water and treated water have been investigated by the Authority. Table 4.1.5 shows the results of the water quality investigation by the Authority for the maximum, minimum and average values of various test items for the period of 1986 to 1996.

On the other hand, water qualities of the rivers flowing in the Addis Ababa city were investigated by previous studies as follows:

Report Name	Year	Sampling Location
Zawide Prel. Rep.	1976	Great Akaki, Little Akaki
Geological Report – Ministry of Planning	1990	Little Akaki, Kechene
Master Plan Study AAWSA	1993	Little Akaki, Kebena, Great Akaki, Aba Samuel Lake

The test results of each above are shown in Table 4.1.6 respectively. According to these results, the water quality of surface water in Addis Ababa city was deteriorated since long time ago, though the discharge at the time of sampling was not mentioned in the report.

#### **4.1.5 Flood Forecasting and Warning System**

##### **(1) Disaster Prevention and Management**

Ethiopia has been frequently threatened by disasters induced by drought and other factors of flooding, earthquake, etc. A national disaster prevention and management policy has been established by the Federal Government, to warn in advance to the questioned areas and provide relief assistance to the affected people. In emergency case of serious flooding, such warning and relief assistance will be, in this regard, applicable to the questioned riverine areas.

The national disaster prevention and management are being administrated by the National Disaster Prevention and Preparedness Committee (NDPPC) and its secretariat committee of the National Committee for Early Warning (NCEW) in the national level. Figures 4.1.10 and 4.1.11 show those organizations.

The said committees are further supported by each level of regional and wereda. The regional level is being administrated and controlled by the Regional Disaster Prevention and Preparedness Committee (RDPPC). RDPPC is supported by the International Relation and Development Cooperation Bureau of the Social Sector of the Region 14 Administration.

The wereda level is being controlled by the Wereda Disaster Prevention and Preparedness Committee (WDPPC) supported by the Wereda Disaster Relief Cell (WRDC). WRDC acts as an actual implementing body for the relief action. Various non-government organizations(NGO) will be also expected to involve, depending on condition of the disasters.

##### **(2) Flood Forecasting and Warning System**

As can be seen in Figure 4.1.1 of the river system in the Study Area, the run-off basins of the Kebena including the tributaries of the Kechene, Kurtume, Kostre, and the Little



Akaki rivers, are located so close to the urban area of the Addis Ababa city. The Intoto ridge as the basin boundary of those basins to the north is located at only about a few kilometers from the urban area boundary on the north especially for the basins of the Kostre, Kurtume and the Little Akaki. Besides the average slope of these basins toward the urban area is only about 1/10 – 1/20.

Due to this topographical situation, the run-off of rain storm in these basins to the city area is very rapid only within a few hours. In addition to this situation, there have been no automatic rainfall recorder installed in the basin connected to certain government agency through telemetering system.

Under these circumstances, there have been no flood forecasting and warning system established in the basin.

In view of the above-mentioned hydrological situations, flood forecasting system may not be applicable in the basin. But establishing a flood warning system seems to be needed very much since the velocity of the flood flow is so high due to the very steep slope even in the city area and accordingly the flood flow is very destructive and the fact that there still exist so many houses vulnerable to high speed flood flow in the flood plain of the rivers.

#### **4.1.6 Previous Studies and Plans**

The following three studies on flood prevention in Addis Ababa have been conducted so far. One is FEASIBILITY STUDY ON FLOOD PROTECTION AND STORM SEWER SYSTEM OF ADDIS ABABA. Others are REVIEW OF FLOODING AND PROPOSALS FOR REMEDIAL WORKS and CONDITIONAL SURVEY AND FUNDAMENTAL INFORMATION ON FLOOD AFFECTED AREAS IN ADDIS ABABA. The above three studies are briefed below.

##### **(1) Feasibility Study on Flood Protection and Storm Sewer System of Addis Ababa**

The study was conducted by the Municipality of Addis Ababa in 1982, assisted by the Government of Republic French. The study was actually carried out by the Bureau Central D'etudes Pour Les Equipments D'outer-Mer (BCEOM) entrusted by the said

Government. The proposed plan consists of a priority program and a first phase works, respectively for flood protection and storm sewer improvement. However, the first phase works (urgent works) have not realized yet so far.

### 1) Objectives of the Study

The objectives of the study are 1) to conduct a feasibility study on a priority program for flood protection and storm sewer system of Addis Ababa and 2) to select and provide the first phase works from the formulated priority program for urgent implementation.

### 2) Objective Rivers

The objective rivers are the Bantiyketu with 2 tributaries of Kechene and Kurtume, the Little Akaki with the tributary of Buhe and the Kebena with the tributary of Ginfile.

### 3) Proposed Priority Program

#### a) Flood Protection

The flood protection measures have been proposed for structural and non-structural ones. The following were proposed.

- |                         |  |
|-------------------------|--|
| The Kechene river:      | <ol style="list-style-type: none"><li>1. Construction of retaining wall<br/>(365 m in length at 22 sections)</li><li>2. Construction of flood control dam<br/>(3.5 m high with 14 m wide spillway)</li></ol>   |
| The Kurtume river:      | <ol style="list-style-type: none"><li>1. Construction of retaining wall<br/>(685 m in length at 8 sections)</li><li>2. Construction of small flood control dam<br/>(3.5 m high with 6.5 m wide spillway)</li></ol>   |
| The Bantiyketu river:   | <ol style="list-style-type: none"><li>1. Channel improvement (1,250 m in length)</li><li>2. Construction of dike (440 m )</li></ol>  |
| The Little Akaki river: | <ol style="list-style-type: none"><li>1. Construction of flood control dams with following 2 alternatives.<br/>(The decision was left to Region 14 Administration)<br/>Alternative-1: 6 m high with 22 m wide spillway<br/>Alternative-2: 5 m high with 22 m wide spillway</li></ol> |

The Kebena river

1. No structural measures except very localized retaining wall near the confluence with the Bantiyketu river

Aside from the structural measures, non-structural measures have been recommended for three items of 1) regulation of land use in the river bank areas, 2) displacement of houses in the vulnerable areas to flood and 3) self-protection of houses and properties.

The total investment cost is estimated at 14.26 million Birr at 1982 price level.

#### b) Storm Sewer System

The priority program consists of preparation of design criteria to be used in the proposed structures, rehabilitation of old sewer systems, construction of a new diversion canal and recommendation on a new organization. The design criteria were provided for designs of inspection manholes, sewer inlets and outlets.

The rehabilitation of old sewer system consists of rehabilitation works for main systems with a total length of 12,450 m. The protection level for storm water has been recommended as follows:

- 10 year return period in flat urban area,
- 5 year return period along main road, and
- 2 year return period along secondary road.

Further, a new diversion canal has been proposed from the upstream basin in the Ginfile river to those of the Kebena. A length of the canal is 1,750 m. Finally, the new organization has been proposed for planning and maintenance sections with a total personnel of 134.

The total construction cost is estimated at 15.25 million Birr at the price level in 1982.

#### 4) First Phase works

In line with the proposed priority program, the following first phase works for urgent implementation have been proposed, under a condition of further review of the designs. The construction works are scheduled to be executed for three years. The proposed

flood protection and storm sewer system are outlined below. Figure 4.1.12 shows the proposed dam locations.

a) Flood Protection

- The Bantiyketu river:
1. Channel improvement (1,250 m in length)
  2. Construction of dike (440 m in length)

The total construction cost is estimated at 7,800 thousand Birr, broken down into 1,560 thousand Birr of foreign and 6,240 thousand Birr of local currencies at 1982 price level.

b) Storm Sewer System

- The Bantiyketu and Ginifile areas:
1. Rehabilitation of existing system (4,350 m in length)
  2. Construction of a new diversion canal (1,750 m) from Ginifile river to the Kebena river

The total construction cost is estimated at 8,185 thousand Birr, consisting of 1,637 thousand of foreign and 6,548 thousand of local currencies in 1982 price level.

**(2) Review of Flooding and Proposal for Remedial Works**

A review was conducted by the Addis Ababa Flood Control and Prevention Project, assisted by the British Council for two weeks from the end of November to the beginning of December in 1994. The following are main features of the review.

1) Objectives of the Review

The objectives are to scrutinize the existing available data on flooding and make recommendations concerning rehabilitation of displaced population, method of investigation and implementation of long term strategies for flood alleviation and necessary immediate remedial flood protection works in Addis Ababa.

## **2) Recommendations**

The recommendation has been made for the following rehabilitation of displaced population and flood remediation.

### **a) Rehabilitation of Displaced Population**

- To design necessary development work on both the single and multi-story housing for vulnerable homeless family, and
- To identify the most vulnerable homeless families and re-housed immediately in traditional housing, if necessary.

### **b) Flood Remedial Works**

- An optimum solution will depend upon the condition, however, re-housing is the most economic approaches.
- A survey of existing river structures should be commenced immediately to identify and prioritize urgent repair works to prevent further deterioration.
- High flood risk areas should be investigated and in consultation with local residents, flood remedial works consisting of flood limitation by structural works and reducing vulnerability by land use control will be studied.
- To implement the project, it is recommended that technical advice by specialist is necessary.

## **(3) Conditional Survey and Fundamental Information on Flood Affected Areas in Addis Ababa**

### **1) Objectives of the Survey**

A historical flood occurred in August 1994. Immediately after the flood, a detailed survey was conducted to investigate flood damages, clarify causes of flooding and recommend countermeasures for flood protection. The detailed survey was proceeded by Mr. Takuji Kono, a member of Japan Overseas Cooperation Volunteers of JICA, in cooperation with AFCPO in Region14 Administration.

## **2) Survey Result**

The survey was conducted for about 1 year from September 1994 to October 1995, for damage by the floods of August 26, 1994 and August 6, 1995. The survey covered the Little Akaki river including Buhe and Fereja, Lower Kebena and Bantiyketu river including Kechene and Kurtume rivers.

Throughout the survey, damaged facilities such as house, retaining wall and bridge, and numbers of affected people due to flooding were investigated in detail. Finally, causes of the flooding have been clarified site by site.

The causes of flooding have examined to be bottle necks of river channels and structural necks of bridges including water supply pipes (aqueduct), as shown in Figure 4.1.13.

## **3) Recommendation**

A recommendation has been made for mitigation of flooding damage. The recommend matters are as follows:

- Construction of a regulating pond, downstream of the Filwiha bridge in the Bantiyketu river,
- Construction of a regulating pond in the downstream reach of the Mekanisa bridge in the Little Akaki river,
- Improvement and reconstruction of bridges, and
- Rehabilitation and maintenance of retaining walls.

### **4.1.7 Completed and Ongoing Works**

Several flood prevention works have been completed so far. The works are locally limited to protect houses in the river banks from flooding. Such works were designed by AFCPO and constructed by the selected contractors throughout competitive bidding. Table 4.1.7 presents a list of the completed works. Those locations are shown in Figure 4.1.14. Yet, no work is being undertaken.

## **4.2 Urban Drainage and Sewerage**

### **4.2.1 Urban Drainage**

#### **(1) General**

The Addis Ababa city is located on the high plateau of the mountain slope of Intoto ridge. The rivers and the canals in the city flow generally in the north-south direction with rather steep slope. The rivers and the canals are generally deeply dissected and the rainstorm in the city can easily flow into the rivers and canals just by gravity drainage.

With such circumstances, the city of Addis Ababa formerly did not suffer from serious drainage congestion. Consequently the city has no Master Plan of Urban Drainage at present. The responsible agency of the Region 14 Administration for urban drainage is the Urban Development Works Bureau. The activity of the Bureau concerning the urban drainage is presently the maintenance works of the existing drainage canals.

Recent migration of people to the city from various parts of the country resulted in settlement in a greater part along the rivers and canals where the open space was available as flood water flowing area. In addition, the open space, rivers and canals in the city area are being used as the solid waste disposal area at various locations causing the flowing congestion in the city.

#### **(2) Drainage Canal**

Among several rivers and canals flowing through the city area of Addis Ababa, the Ginfile as the tributary of the Kebena, the Perennial, Kirkos, Buhe and Fereja as the tributaries of the Little Akaki have the main drainage basin in the urban area of the city.

##### **1) The Ginfile**

The Ginfile originates in the area near the Addis Ababa University in the northern part of the city and flows down to the south-southeast and joins the Kebena river near the Urael bridge on the Asmara road in the central part of the city. The river in the upstream reaches has the biggest cross sections in the whole reaches. The cross-sections are the smallest in the area about 800 m downstream of the Ginfile bridge in its middle reaches

due to the resettlement very close to the low water channel. The river in the downstream reaches has wider and deeper cross-sections than those in the middle reaches and surrounded by flood walls at many locations. The area at the confluence with the Kebena river forms a rather wide open area but new resettlement is starting in the area.

## **2) The Perennial**

The Perennial originates in the area near the railway station in the central part of the city and flows down to the south and joins the Little Akaki river near the Bihere Tsige park in the southern part of the city.

## **3) The Kirkos**

The Kirkos originates in the area close to the railway station in the central part of the city and flows down to the south-southwest and joins the Little Akaki river near the embassy of Hungary. The Kirkos even in the reaches near the confluence with the Little Akaki has the cross-sections of 2 to 3 m width and 1 to 1.5 m depth. The area at the confluence with the Little Akaki forms a rather small open area with some dwellers.

## **4) The Buhe**

The Buhe originates in the area rather close the Merkato area in the central part of the city, flows down to the southeast, turns to the southwest in its middle reaches, and joins the Little Akaki near the Mekanisa bridge on the Roosevelt street in the southern part of the city. The area at the location of the confluence with the Little Akaki is a wide flat open area.

## **5) The Fereja**

The Fereja originates near the Fitawrari Habte Giyorgis street in the western part of the city, flows down to the south, and joins the Little Akaki river about 600 m upstream of the Akaki bridge on the Smuts street in the south-western part of the city. The area at the confluence with the Little Akaki river has no wide open area with the dwellers very close to the channel.



#### 4.2.2 Sewerage

The sewerage system in Addis Ababa city was commissioned in 1981. The capacity of the system is sufficient for some 200,000 people. But the system has been connected to some 800 to 1,000 dwellings, a few institutions and city center offices. Large water consumers such as hotels are not connected. Of the sewerage that is collected, only a portion reaches the treatment works. The balance leaks into the watercourse due to maintenance problems.

The following are the population and connection to sewerage or toilet facility in 1991.

Population	Connection
6,000	Sewer
175,000	Septic tank and soak-away system
1,459,000	Dry pit latrine
700,000	Without any form of toilet

Source: Master Plan Study for the Development of Wastewater Facilities for the City of Addis Ababa, January 1993)

The sludge from the pit latrine and septic tanks is discharged directly into the Akaki river without any treatment. The consequential pollution of the river is causing severe environmental damage.

Due to the above situation, the risk of major epidemic in Addis Ababa city was increasing. With such circumstance, the Master Plan for the Development of Wastewater Facilities for the City of Addis Ababa was formulated in 1993.

The Master Plan consists of structural measures and non-structural measures. The structural measures consists of the improvement of the collection system of domestic sludge, expansion of service area connected to sewerage system, and the improvement/new construction of the treatment plants.

Expansion of service area is to be achieved by the increase of connection to the existing sewerage network and extension of the present sewerage system. These are planned to be achieved by laying pipes of around 1,200 km.

The sewerage system in Addis Ababa does not take into account of rain storm drainage in urban area at all. The system is composed of only pipe network.

### **4.3 Flood and Flood Damages**

#### **4.3.1 Flooding Mechanism**

The Study Area is characterized by an intensive rainfall in short time and steep riverbed slopes. Figure 4.1.3 shows the general profiles of principal rivers in the urban area.

In addition, river bank areas, especially in the middle Little Akaki and Bantiyketu including two (2) tributaries of the Kechene and Kurtume, are being physically constricted owing to occupation of buildings and traditional houses.

If rain falls in the upper basins, water levels in the middle and lower reaches rise rapidly with a short concentration time of 2 to 3 hours. The floods are considerably flashy ones and that with destructive flow velocities. Average duration of stage hydro graph is also short in time with 3 to 6 hours.

The characteristics of the flooding in the major rivers are summarized below, based on the site investigation and study results.

##### **(1) West Akaki River**

This river is wide and deep one. The land use in the river bank has been regulated and controlled in an ideal condition as open area covered with grass, therefore, the flooding problem is quite small.

##### **(2) Little Akaki River**

The river in the upstream of the confluence with the Pereja river is of deep valley. Contrary, the river channel in the middle reaches has been artificially constricted due to occupation of buildings, houses and disposal of garbage, especially in the reaches from Mekanisa bridge up to the Ethiopian Abattoir Factory. Accordingly, the middle reaches of the Little Akaki river are subject to habitual flooding caused by destructive flow

velocity, as shown in Figure 4.1.13. It can be said that the flood water in the middle Little Akaki is of a diffusion type.

### **(3) Buhe, Fereja and Perennial Rivers**

These channels are of quite narrow like ditches flowing through the dense building and house areas. In addition, their secondary channels are of very poor. Accordingly, such river bank areas are easily subject to local flooding. However, it is not destructive flooding and limited to local area.

### **(4) Kebena River**

The Kebena river is, as a whole, of wide and deep channel. Not serious flood damage has been reported up to now. However, the lower reaches downstream of the Urael bridge is vulnerable to flooding.

### **(5) Kechene River**

The Kechene river in the valley area is also wide and deep one. The river channel in the urban areas was originally deep and wide one with terrace. However, many houses have constructed on the said terrace, and that the channel has been further constricted by such houses, walls and garbage disposed.

Accordingly, the river bank areas in the lower reaches are subject to flooding with destructive flow velocity directly coming from the mountain areas. Especially, the confluence area with the Bantyketu river are habitual flooding zone. The flood water flows over roads into the urban areas with the diffusion type.

### **(6) Kurtume River**

The upper basin of the Kurtume is drained by the five (5) small ditches. Their secondary channels are of very poor. Therefore, the upper basin is subject to local flooding due to shortage of secondary and tertiary channels. The lower reaches of the Habte Giyorgis bridge are generally deep and wide channel, except just downstream of the said bridge which has been constricted to less than 5 m due to building.

In addition, flow area of the culvert across under the Churchill Avenue is small one compared with that of the upstream, as explained in 4.1.1 (1). Accordingly, the riverine areas near the confluence including that of the Kechene river, are subject to flooding.

#### **(7) Bantiyketu River**

The Bantiyketu river is shallow and narrow one compared with its size of basin area including those of the Kechene and Kurtume. Therefore, all reaches of the Bantiyketu river are subject to habitual flooding, as ascertained in Figure 4.1.13.

#### **(8) Hanku River**

Passing through the mountain area, the Hanku river crosses under the Fikre Maryam Aba Techan Street through quite small culvert in size. Due to this reason, flood flows over the street towards downstream. However, it is limited to as local flooding.

The causes of the flooding in the urban areas of Addis Ababa are summarized below. It is noted that flooding is caused by following single factor and/or their combinations:

- Deforestation in the mountain areas especially a part in the eastern basins,
- Shortage of flood retention areas in the mountain areas,
- Shortage of channel capacity of main rivers,
- Constriction by private facilities such as foundation and wall of buildings, and by illegal disposal of solid waste and earth soil,
- Shortage of flow area due to bridges, although these bridges act as flood regulation and velocity control to downstream,
- Shortage of channel capacities in the secondary and tertiary, and,
- Moreover, lack of public awareness for flooding (construction of houses near river bank and disposal of solid waste and soil) is also one of the causes of flooding.

### **4.3.2 Flood Damages and Areas in the Past Flood**

Due to natural and social characteristics mentioned above, damages by recurrent floods are inevitable in the urban areas, especially flood prone areas in the middle reaches of the

Little Akaki and the Bantiyketu rivers including the lower reaches of the Kechene and Kurtume rivers.

The urban areas suffered serious damages by floods occurred in August of 1978, 1994 and 1995. The damages and areas due to the three past floods are summarized below.

**(1) August 1978 Flood**

According to Feasibility Study Report on Flood Protection and Storm Sewer System of Addis Ababa, the flood occurred throughout Addis Ababa; 23 keftegnas out of 25 keftegnas, 108 kebeles out of 289 kebeles. 1,255 houses and 6,000 people were affected by the flood, and most of them were made homeless. Kebele offices, vehicles and community facilities were also damaged. Total damage by the flood was estimated at 2 million Birr as shown Table 4.3.1. This damage amount is only direct damage to dwellings, and it does not include damages to infrastructure or damages to economic activities (indirect damage). Furthermore, 12 people were killed by the flood. Affected areas by the flood are shown in Figure 4.3.1.

**(2) August 1994 Flood**

According to Conditional Survey and Fundamental Information on Flood Affected Areas in Addis Ababa (September 1994 - October 1995) by Mr. Takuji Kono, a member of Japan Overseas Cooperation Volunteers, 7,655 people were affected and 2,880 people were made homeless by the flood in August 1994. 461 families require rehousing in 5 zones and 18 kefitenya as shown in Table 4.3.2. Three people were killed by the flood. Total direct flood damage has been estimated at 16.4 million Birr as shown in Table 4.3.3. This does not include indirect damage. Affected area by the flood is shown in Figure 4.3.1.

**(3) August 1995 Flood**

Detailed flood damage survey has not been made for August 1995 flood. However it is assumed that the flood in August 1995 affected a wide area in Addis Ababa according to result of the interview survey, which was conducted in this study. Judging from the result of the interview survey, it seems that considerable number of houses suffered flood damages.

#### **(4) Other Flood**

Other than floods discussed above, floods occurred in many places of Ethiopia from June to August 1996. Regions suffer flood damages were Oromia, Afar, Somali Gambela, Amhara and S.N.N.P.R. One of the most serious floods occurred along the Awash river basin.

Major cause of the flood was unusually heavy rainfall from March to August. Koka lake dam, which is located middle reaches of the Awash river, recorded the highest water level since its operation.

In order to mitigate flood damages of the Awash river basin, where various kinds of plantation are exist, the logistics committee was organized by the Prime Minister. Flood forecasting and warning had been made by the committee. About 3,000 people and soldiers worked to strengthen the dikes along the Awash river. Various kinds of construction equipment such as excavators, bulldozers or dump trucks were also mobilized.

Although the committee made all efforts, down stream reaches of the Awash river suffered serious flood damage due to unavoidable discharge of Koka lake dam. Sugarcane plantation, sugar factories, and houses were inundated for almost three weeks. The cost spent for measures to mitigate flood damages and food and medical assistance for the people amounted to 4.7 million Birr. One of the state sugar estates in Wonji estimated their flood damage; damage to the state houses: 26 million Birr, damage to sugarcane: 47 million Birr and damage to household effects: 3 million Birr. Though the flood damage amount to all the Awash river basin has not been estimated yet, it must be enormous.

#### **4.4 Water Supply**

Addis Ababa Water supply and Sewerage Authority (AAWSA) is responsible for water supply and waste water disposal in Addis Ababa. Any master plan for water supply is not presently available. The present condition of water supply in Addis Ababa is outlined below.

#### **4.4.1 Present Water Supply in Addis Ababa**

The municipal and industrial water in Addis Ababa has been mainly supplied through the 2 dam reservoirs. One is Gefersa dam reservoir (a design capacity of 25,000 m<sup>3</sup> per day, actually 23,000 m<sup>3</sup> per day) located in the uppermost of the West Akaki river. Another is Legedadi dam reservoir (a design capacity of 150,000 m<sup>3</sup> per day, actually 114,000 m<sup>3</sup> per day) located in the upper Akaki river in the 30 km north-east of Addis Ababa.

Other sources are of wells consisting of 11 wells having a total capacity of 10,000 m<sup>3</sup> per day by AAWSA and privately owned wells. According to the AAWSA, the existing system covers only about 130,000 connections in the urban area.

#### **4.4.2 Ongoing Project**

There are three under construction projects as major ones. Figure 4.4.1 shows their locations.

##### **(1) Akaki emergency ground water project**

The Akaki emergency ground water project consists of 25 well developments with a total service capacity of 72,000 m<sup>3</sup> per day. The project is located in the town of Akaki, in the southern part of Addis Ababa. Out of the above, the 15 wells are presently developing by using the national budget.

##### **(2) Akaki town water supply project**

This project is underway in Akaki town, having a total capacity of 10,000 m<sup>3</sup> per day and financed by World Bank.

##### **(3) Emergency construction project of Dire dam**

The dam is under construction in the upper tributary of the Akaki river in the north eastern part of Addis Ababa. It has a total capacity of 60,000 m<sup>3</sup> per day. The water to be created is to supply to the existing reservoir of the Legedadi dam so as to satisfy the original design capacity of 150,000 m<sup>3</sup> per day. The dam construction cost has been financed by the national budget.

#### 4.4.3 Proposed Project

There are 15 projects which are under design. Out of those, features of the two (2) major dam projects are briefed below.

One is the Gerbi dam, having a daily service capacity of 77,000 m<sup>3</sup>. Another is the Sibilu, having a daily service capacity of 611,000 m<sup>3</sup>. Both the dams are located in the northern part of Intoto ridge. Newly created water in both the reservoirs is to be supplied to Addis Ababa by distribution pipe of 250 km in total length and 13 pumping stations to be newly installed.

The design is presently conducted by the Canadian Consultants of Associated Engineering Ltd. and HBT Agra, and the local consultant (AE-HBT AGRA JOINT VENTURE). The required cost of the design has financed by the World Bank and EU. The required cost of the Gerbi dam system construction is estimated at 450 million US\$ according to AAWSA. The design is to be finished in August 1997.

According to the AAWSA, the construction and operation are to be started in 1998 and 2001 for the Gerbi system, and in 1999 and 2004 for the Sibilu system.

#### 4.5 Road

Addis Ababa, as not only an international center and national capital but also industrial, commercial and social center, is the hub of transport activities of the nation. The urban transport system is one of the most important elements of the structural plan of the city of Addis Ababa. The proposed road network consists of ring road system and radial road system as arterial road network in the metropolitan area.

The ring road system is further classified into the three rings of first (outer), second (middle) and third (inner). On the other hand, the radial road system is of the existing 5 main arterial roads. According to the urban transport system in the Master Plan of Addis Ababa, main points of the road system are summarized below.

- The first ring road is to be newly constructed along the boundary of future urban area to be extended. The first ring road construction has not yet started.



- The second ring road is to be constructed along the boundary of the existing urban area and some parts are jointly formed by the existing arterial roads, as shown in Figure 4.4.2. All existing radial roads in the present urban area are to be connected by this second ring road. The second ring road to be newly constructed is in the west portion including bridge across over the upper Little Akaki river and in the east portion including bridge over the lower Kebena river, and
- The existing radial roads are used as radial road system, which are to be improved.

## **4.6 Reforestation**

### **4.6.1 General**

Reforestation activities in the run-off basin of objective rivers on the mountain slope of Intoto are presently conducted independently by three agencies.

They are:

- 1) Addis Ababa Fuel Wood Development and Marketing Organization,
- 2) Region 14 Bureau of Agriculture, and
- 3) Ethiopian Heritage Trust and other agencies.

The following are the general features of their activities:

### **4.6.2 Addis Ababa Fuel Wood Development and Marketing Organization**

The reforestation activity was formerly conducted with the financial aid of IBRD. The activity was later decided to be conducted without the loan from IBRD. The activity was transferred to the Enterprise of Addis Ababa Fuel Wood Development and Marketing Organization. The staff cost is borne by the Ministry of Agriculture but the running cost is borne by the organization itself. The revenue source is obtained from the wood market. The objective area is some 5,000 ha and the location is mainly along the Intoto ridge. The main objective of the activity is to supply fuel wood and construction material for Addis Ababa. Accordingly the planting species is limited to eucalyptus.

#### **4.6.3 Region 14 Administration, Bureau of Agriculture**

The present forestation activity was started three years ago. The agency has 5-year program of forestation. The objective area is also located on the Intoto mountain slope but lower place than the area of the Addis Ababa Fuel Wood Development and Marketing Organization. Objective areas are catchment areas of the Kebena, the Akaki, and the Bulbula rivers. The objectives of the activity are; 1) soil conservation, 2) to supply fuel wood and construction material for Addis Ababa, and 3) to supply seeds of eucalyptus for local people to plant them around their settlements.

The activity also includes terracing and construction of check dam of small scales (2 to 3 m width, 0.5 to 1.0 m depth) for the purpose of soil conservation. Terracing activity includes construction of soil ban that implies the construction of ditches with the scale of about 30 to 50 cm width and depth, and 10 to 30 m length with right angle to the flow direction of rain storm.

Although the planting species is limited to eucalyptus, indigenous plants (Juniper Procera, Acacia Abyssinica, and others) are growing in the objective areas. This may be attributed to the activity that the planting density is rather low, and the planted areas are guarded from grazing and people's activity of raking up leaves and others.

#### **4.6.4 Ethiopian Heritage Trust and Other Agencies**

The objective area of the activity by this agency is some 1,300 ha and the area was obtained from the area of Addis Ababa Fuel Wood Development and Marketing Organization. The details of their program are not fixed yet since the program is now under the process of formulation by experts. The activity by this agency is presently as follows:

As previously mentioned, the present vegetation coverage of the Intoto mountain slope is not in a desirable situation from the viewpoints of flood control, soil erosion protection and recharging of ground water. In view of that present situation, some activities from environmental protection standpoint have been started in 1996. The activities include construction of check dams, replacing the eucalyptus tree species with indigenous species of vegetation. The aims of the activities include; 1) to bring back to the area the native

trees, shrubs, flowers, birds, and animals that used to be found on Intoto, 2) to help preventing soil erosion and flooding.

This is being implemented by,

- 1) Ethiopian Wildlife and Natural History Society,
- 2) The Ethiopia Heritage Trust,
- 3) Canadian Physicians Aid and Relief (CPAR),
- 4) LEM ( Amharic word meaning "Fertile Ethiopia"),

under the auspices of Oromia Educational Bureau, Ministry of Education, Region 14 Educational Bureau, Region 14 Environmental Protection Bureau, and Economic Commission for Africa.

The constructed check dams are located on the Intoto mountain slope near the headwaters of the Kebena river. But the check dams constructed so far as of June 1997 are still very simple and small ones with the scale some 3 m wide and 1 m high of a type of dry masonry. Some of them seem to have functioned against light rainfall for the purpose of soil trapping but seem to be very vulnerable to heavy rainfall.

The vegetation species to be planted on the Intoto mountain slope instead of Eucalyptus tree as of June 1997 are 1) *Milletia Ferriginea*, 2) *Acacia Abyssinica*, 3) *Hagenia Abyssinica* as good for nitrogen fixation or for high altitude

#### **4.7 Design Standard**

There are a series of design standards in Ethiopia: "Ethiopian Standard Code of Practice" issued by Ministry of Construction in 1983. The revised and additional versions of the said design standards were published in 1995. The design standards covers various subjects, though not limited to, as follows:

- Design of concrete structures exclusively for architectural buildings; specifications of concrete materials; specifications for constructing concrete structures (Concrete structures such as dam, weir, retaining wall and bridge substructures are not covered.)

- Design of foundations including shallow foundations, pile foundations; classification of soils and rocks; methods of soils investigation
- Design of masonry structures such as retaining wall, bridge abutment and pier
- Loading conditions pertaining to the design of architectural buildings (loading conditions for design of road, bridge, dam, weir and retaining wall are not covered.)
- Electrical and utility works for architectural buildings

From Transport Construction Design Enterprise (TCDE) which is an independent consulting firm established by Ethiopian Road Authority (ERA), the following information is obtained about design of road and bridge .

- AASHTO standard of the United States of America is generally used in Ethiopia for design of road and bridge including determination of loading conditions.
- The magnitude of seismic force used in design of bridge and road embankment is based on Ethiopian Standard Code of Practice for Loading, according to which Ethiopia is divided into four seismic zones and the Addis Ababa area belongs to the second highest seismic zone.

According to inquiries through various agencies including municipal government offices and Addis Ababa Water Supply and Sewerage Authority (AAWSA), there is no Ethiopian design standard of weirs . The existing dams/weirs near Addis Ababa, namely, the Gefersa dam and the Koka lake dam, were designed on the basis of design standards of overseas financing country

## **4.8 Construction and Procurement**

### **4.8.1 Procurement of Construction Works**

Public construction works are executed by both methods of direct operation and contract basis under the control of Region 14 administration. The method is selected case by case depending on the kind, scale and specialty of work.

The maintenance and repair works of the regional roads in Addis Ababa are carried out in direct operation by the Addis Ababa Road Authority, which was derived from the Construction department of the Works and Urban Development Bureau, Economic Sector. Such road repair works, though each work is not large scale, occur frequently and successively through a year and require the urgency. The road authority has many staffs of engineers/experts and much number of construction equipment, also keeps around 2,500 number of common laborers making annual contracts. The authority forms such organization that could handle maintenance works, including construction works, of the regional roads in the capital territory.

The large scale project works which are undertaken by the authorities and offices other than the Road Authority are usually executed on contract basis.

Once a governmental office or authority forms such organization that could execute the construction works in the direct operation, it must sustain much number of staff and equipment. The project construction works will be executed on contract basis in the future implementation stage, because the project facilities does not require the frequent maintenance and repair works mobilizing much number of staffs and equipment after the construction.

Owners estimate for public works is calculated based on the norm, which was authorized by the Ethiopian Building Construction Authority in 1980s. The norm describes production rate of labor, materials and construction equipment for major units of building and civil works.

#### 4.8.2 Labor

Because the Addis Ababa City is the capital and is much populated in the country, enough number and types of skilled and common workers are expected to be employed for the project construction works. The study team has surveyed on labor wage giving some interview in the market. The net wage of a daily common worker is Birr 8 for temporary employment in Addis Ababa.

#### 4.8.3 Construction Materials

Sand, gravel and stone materials can be procured from the domestic resources within a range of 160 km at Addis Ababa. Cement, brick, galvanized iron pipe and PVC pipe are purchased from domestic manufacturers. Ready mixed concrete is also produced and sold by a domestic manufacturer. The cement is mainly produced by the Mughher Cement Factory which is located around 70 km north from Addis Ababa, and by Addis Ababa Cement Factory located in the Addis Ababa city. Both of the factories are managed by governmental agencies under the Ministry of Industry. Most of other domestic manufacturers are located in the Akaki Industrial Estate, which is around 15 km far from the capital. Other materials, such as reinforcing bar, steel materials, iron wire, asphalt and fuel are usually imported from other countries of Italy, Egypt and Turkey, etc.

Prices of some major construction materials are obtained through a simple market survey and from the report on average retail prices of goods and services published by the Central Statistical Authority. The following are the prevailing purchasing prices of such construction materials at Addis Ababa.

No.	Kind of materials	Unit	Price (Birr)	Remarks
1.	Cement	quintal	50	
2.	Fine aggregate	m <sup>3</sup>	92	
3.	Coarse aggregate	m <sup>3</sup>	80	
4.	Ready mixed concrete	m <sup>3</sup>	500	price at Akaki
5.	Reinforcing bar, deformed	kg	4	
6.	Iron wire	kg	10	
7.	Gasoline	litter	2.64	
8.	Gas oil	litter	1.95	
9.	Galvanized iron pipe, dia.= 1 inch	m	18	
10.	PVC pipe, dia.= 4 inch	m	25	

#### 4.8.4 Construction Equipment

Almost all the construction equipment is imported. Some larger private construction companies and some governmental offices and authorities have such equipment. In the Region 14 administration, the Addis Ababa Road Authority has the construction equipment as mentioned above in this section. Most of the equipment was supplied by other countries on official development assistance basis. Out of about 150 number of equipment belonging to the authority, 100 number of equipment was supplied by the Government of Japan on grant basis in June 1996. Some of the equipment is shared to and used by the Environmental Development Project Office, Economic Sector.

All the equipment is not fully operated at present. Some of them are lying idle. It may bring less project construction cost, for the Region 14 administration, to mobilize such idling equipment effectively lending contractors for this project construction works in the future implementation stage, if possible.

The usable construction equipment belonging to the Addis Ababa Road Authority is listed below.

No.	Type of equipment	Japan's grant (no.)	Others (no.)	Total (no.)
1.	Bulldozer	3	1	4
2.	Back hoe	3	1	4
3.	Loader	9	2	11
4.	Motor grader	2	1	3
5.	Dump truck	32	18	50
6.	Lorry	-	8	8
7.	Trailer	2	-	2
8.	Roller and compactor	12	2	14
9.	Water tanker	1	1	2
10.	Asphalt related equipment	12	11	23
11.	Others (Pick-up, portable pump, air compressor and generator, etc.)	26	10	36
	Total	102	55	157

Table 4.1.1 Catchment Area and Length of Major Rivers

River Name	Point	Length (km)	Catchment Area (sq km)	Total Catchment Area (sq km)
1. West Akaki River	Downstream of confluence with Little Akaki R.	35.6	203	203
	Upstream of confluence with Little Akaki R.	35.6	172.2	
Little Akaki River	Upstream of confluence with West Akaki R.	20.5	30.8	
	Downstream of confluence with Buhe R.	15	22.4	
	Downstream of confluence with Fereja R.	11.7	15.9	
	Upstream of confluence with Fereja R.	11.7	14.2	
	Arbeynoch street	5	3.7	
	Buhe River	Upstream of confluence with Little Akaki R.	6.3	
Fereja River	Upstream of confluence with Little Akaki R.	3.2	1.7	
2. Perennial River	Upstream of confluence with West Akaki R.	9	6.5	6.5
3. Kebena River	Bole bridge	23.9	89.1	89.1
	Upstream of confluence with Bantiyketu R.	23.2	53.1	
	Tesfa Aseged bridge	16.1	44	
	Downstream of confluence with Abo R.	13.3	42.2	
	Upstream of confluence with Abo R.	13.3	17.2	
Ginfile River	Upstream of confluence Kebena R.	6.2	4.4	
Bantiyketu River	Upstream of confluence with Kebena	15.7	29.3	
	Downstream of confluence with Kechene and Kurtume	11.2	23.9	
Kechene River	Upstream of confluence with Bantiyketu R.	11.2	13.6	
	Downstream of confluence with Kostre R.	7.2	9.9	
	Kechene bridge	5.8	6.8	
Kostre River	Upstream of confluence with Kechene R.	3	2.4	
Kurtume River	Upstream of confluence with Bantiyketu R.	9.3	10.3	
	Habte Giyorgis bridge	6.4	8.2	
4. Hanku River	Main road downstream of natural retarding basin	8.6	11.1	11.1
5. Grand Total				309.7

Note: Measured on the Topographic Map by 1/10,000



Table 4.1.2 Completed Flood Control and Prevention Works by AFCPO

Serial No	Work Item	Location	Completion Date	Dimension	Construction Cost (Birr)	Budget Source	Contractor
1	Retaining Wall	Little Akaki River	Jul-95	H=5.75 L=327	387,000	AFCPO	Asrat Gashaw General Contractor
2	Retaining Wall	Little Akaki River	Jul-96	H=5.00 L=297	359,000	AFCPO	Ali Misikir Building Contractor
3	Retaining Wall & River Widening	Little Akaki River	Jul-96	H=5.00 L=168 V=2,400	209,000	AFCPO	Getu Difabachew Building Contractor
4	Retaining Wall	Little Akaki River	Dec-95	H=5.50 L=510	602,000	AFCPO(20%) Ethiopian Social and Rehabilitation Fund(80%)	Tesfaye Liramo General Contractor and Avern Building Contractor
5	Retaining Wall & River Diversion	Little Akaki River	Nov-96	H=5.25 L=83 V=4,600	359,000	AFCPO	Tedla Moges Building Contractor
6	Steel Bridge	Little Akaki River	Aug-95	W=5.60 L=9.40	58,600	AFCPO	Liramo Gudisso Metal Work

Data Source: Addis Ababa Flood Control and Prevention Office(AFCPO)

Note: H : Height of Wall(m)

L : Length(m)

V : Excavation volume(cu.m)

W : Width of bridge(m)

Above works are shown in Fig.—— with each serial No.

Table 4.1.3 List of Major Water Supply Pipes Across Over Rivers

River	Location	Pipe Diameter(m)	River	Location	Pipe Diameter(m)	
West Akaki River	Simaroud bridge(1), D/S	0.150	Bantiyiketu River	Bantiyiketu(1), U/S	0.450	
	Simaroud bridge(2), D/S	0.300		Bantiyiketu(2), U/S	0.900	
Little Akaki River	Beyene Merid bridge, U/S	0.300	Keechene River	Finfine bridge, D/S	0.100	
	Mekamisa bridge, U/S	0.250		Kera bridge, U/S	?	
	, D/S	0.200		, D/S	?	
	Akaki bridge, U/S	0.300		Keechene(1), U/S	0.350	
	, D/S	0.500		Ifri Bekentu bridge, U/S	0.200	
	Little Akaki(1)	0.150		, D/S	0.500	
	Little Akaki(2), U/S	0.400		Ras Mekonnen bridge, U/S	0.500	
	, D/S	0.400		, D/S	0.200	
Buhe River	Arbeyonoch bridge, U/S	0.200	Kostre River	Alinchober bridge, U/S	0.250	
	Smute, U/S	0.300		, D/S	0.200	
	, D/S	0.600		Keechene bridge, U/S	0.150	
	Buhe(1), U/S	0.250		, U/S	0.200	
	Fereja(1), U/S	0.200		Kostre(1), U/S	0.250	
	, D/S	0.200		, D/S	0.200	
	Fereja(2), D/S	0.150		Kostre(2), U/S	0.150	
	Fereja(3), U/S	0.150		Kurtume River	Kurtume (1), U/S	0.350
	Habte Giorgis, U/S	0.300			Churehill road, D/S	0.200
	Beyene Merid bridge, D/S	0.200			Kurtume(2), D/S	0.200
Kebena River	Perennial(1), D/S	0.150	Hanku River	Kurtume(3), U/S	0.250	
	Bole bridge, U/S	0.400		, D/S	0.200	
	, U/S	0.250		Habte Giorgis bridge, D/S	0.250	
	, U/S	0.200		Kurtume(4), D/S	0.400	
	, U/S	0.200		Kurtume(5), U/S	0.150	
	, D/S	0.125		, D/S	0.400	
	Kebena(1), U/S	0.250		Kurtume(6), U/S	0.150	
	Asmera Road bridge, U/S	0.900		, U/S	0.400	
	Kebena(2), U/S	0.150		, D/S	0.400	
	Testa Aseged bridge, U/S	0.350		Kurtume(7), D/S	0.150	
, D/S	0.900	Kurtume(8), U/S	0.200			
Ginfile river	Kebena(3), D/S	0.125	Hanku River	Hank(1), U/S	0.400	
	Ginfile bridge(1), U/S	0.150		Hank(2), U/S	0.200	
	, D/S	0.300		Asmera Road bridge, U/S	0.900	
	Ginfile bridge(2), U/S	0.150		Hank(3), U/S	0.400	
	, D/S	0.300		, D/S	0.900	

Data Source: Addis Ababa Water Supply and Sewerage Authority(AAWSA)

Note: D/S means downstream and U/S, upstream

Table 4.1.4 Inventory of Existing Bridges (1/4)

River	Bridge No.	Bridge Name	Street Name	Bridge Type	Width(m)	Total Length(m)	No. of Span	No. of Roadway Lanes	No. of Sidewalks	Geological Conditions of Riverbed	Remarks
West Akaki	WA1		Jime Road	Stone Masonry Arch	10	5	1	2	0	Hard rock	A new bridge is now under construction immediately downstream from the existing one. Its type is of RC slab with 5m in width and 5 m in span.
	WA2		Jime Road	Stone Masonry Arch	6	10	1	2	0	Hard rock	
	WA3		Jime Road	Stone Masonry Arch	10	2	1	2	0	Hard rock	
	LAK1			RC slab	20	6	1	4	2	Hard rock	
Little Akaki	LAK2	Mekanisa Bridge	Roosevelt Street	RC T-beam	12	15	1	4	2	Hard rock	
	LAK3	Akaki Bridge	Smuts Street	RC slab		15	1	4	2	Hard rock	
	LAK4			Downstream : Stone Masonry Arch, Upstream : RC slab	20	5	1	3	2	Hard rock	There are two bridges, that is, upstream and downstream bridges, which are structurally separate each other.
	KK1		Fitawrat Damigew	RC slab	40	3	1	2	2	(Observation impossible)	
Kirkos	KK2		Dejasmach Beyene Merid Street	-	-	-	-	-	-	(Observation impossible)	No observation was possible because fences were put up along the perimeter of the both sides of the bridge.
	KK3			RC slab	10	7	1	2	0	Hard rock	
Buhe	BH1		Smuts Street	RC slab	15	3	1	4	2	Hard rock	
	KBN1	(Railroad)		Steel Truss	5	15	1			Hard rock	One lane railroad bridge.
Kebena	KBN2	Bole Bridge	Africa Avenue	RC T-beam	30	10	1	4	2	Hard rock	
	KBN3		Zewditu	RC T-beam	8	24	2	2	0	Hard rock	
	KBN4	Urrel Bridge	Asmera Road	Stone Masonry Arch	30	10	1	2	2	Hard rock	
	KBN5	Tesfa Aseged Bridge	Fikre Maryam Aba Techan Street	Stone Masonry Arch	10	10	1	2	2	Hard rock	
	KBN6		Fikre Maryam Aba Techan Street		10	10	1	2	2	Hard rock	
Griffite	GF1			RC T-beam	10	12	1	2	2	Soil deposit (depth unknown)	
	GF2			Stone Masonry Arch	4	2	1	2	0	(Observation impossible)	
	GF3		Queen	Stone Masonry Arch	10	2	1	2	2	(Observation impossible)	

Table 4.1.4 Inventory of Existing Bridges (2/4)

River	Bridge No.	Bridge Name	Street Name	Bridge Type	Width(m)	Total Length(m)	No. of Span	No. of Roadway Lanes	No. of Sidewalks	Geological Conditions of Riverbed	Remarks
Bankyiketu	BK1			Box Culvert	8	15	2	2	2	Soil deposit (depth unknown)	A bridge in a park
	BK2			RC T-beam	2	15	1	-	-	Soil deposit (depth unknown)	A bridge for pedestrians in a park. A drop structure of stone masonry, about 2m in height, exists about 50m upstream from the bridge.
	BK3			RC T-beam	10	15	1	2	2	Soil deposit (depth unknown)	There is a drop structure made of stone masonry upstream from the bridge.
	BK4	Bankyiketu Bridge	Jomo Kenyatta Avenue	Stone Masonry Arch	30	15	1	4	2	Soil deposit (depth unknown)	
	BK5	Finfine Bridge	Menelik II Bridge	RC T-beam	20	50	3	4	2	Soil deposit (depth unknown)	
	BK6			RC T-beam	5	10	1	2	2	Soil deposit (depth unknown)	A new bridge of box culvert type (2 lanes) is under construction immediately upstream from the existing bridge. It is 5m in width and 10m in length parallel to bridge axis.
	BK7	Filwba Bridge	Yohanis Street	RC slab	30	10	1	4	2	Soil deposit (depth unknown)	There are two drop structures made of stone masonry, one below the bridge and another immediately upstream from the bridge.
Keocene	KC1		Tamu Street	RC slab	10	9	1	4	2	Soil deposit (depth unknown)	
	KC2		Firawan Street	RC slab	6	10	1	2	2	Soil deposit (depth unknown)	The downstream right abutment of stone masonry remains collapsed.
	KC3	Kera Bridge	Colson Street	Stone Masonry Arch	10	9	1	2	0	Hard rock	
	KC4	In Bekenku Bridge	General Wingate	Stone Masonry Arch	10	6	1	2	1	Hard rock	
	KC5	Ras Mekonen Bridge	Adwa Avenue	RC slab	20	6	1	2	2	Hard rock	
	KC6	Afincho Ber Bridge	Weatheral Street	RC slab	12	6	1	2	2	Hard rock	
	KC7	Keocene Bridge	Abera Gizaw Street	RC slab	10	7	1	4	2	Hard rock	

Table 4.1.4 Inventory of Existing Bridges (3/4)

River	Bridge No.	Bridge Name	Street Name	Bridge Type	Width(m)	Total Length(m)	No. of Span	No. of Roadway Lanes	No. of Sidewalks	Geological Conditions of Riverbed	Remarks
Kurume	KRT1		Taru Street	RC slab	8	2	1	4	2	Soil deposit (depth (Observation impossible))	
	KRT2		Churchill Avenue	Box Culvert (1 Lane)	4		1	-	-		The box culvert underpass the general post office too.
	KRT3			Steel Truss	2	10	1	-	-	Soil deposit (depth unknown)	Only for pedestrians
	KRT4		Gaston Guez Street	-	-		-	-	-	Soil deposit (depth unknown)	Under Construction
	KRT5		Gobena Aba Tigu Street	RC slab	20	-	1	2	2	(Observation impossible)	No observation was possible because fences were put up along the perimeter of the both sides of the bridge.
	KRT6	Habile Giyorgis Bridge	Fitawran Gebeyehu Street	Stone Masonry Arch	60	4	1	6	4	(Observation impossible)	The bridge exists at the crossing of infurcated roads.
	KRT7			RC T-beam	4	18 (=3-15)	2	-	-	Hard rock	
	KRT8		Dejazmach Nesibu Street	RC slab	6	7	1	2	2	(Observation impossible)	
	KRT9	Dejazmach Yiseza Bridge	Arbeynoch Street	Stone Masonry Arch	6	2	1	2	0	Hard rock	
	KRT10		Dejazmach Nesibu Street	Stone Masonry Arch	8	6	1	2	2	Hard rock	
	KRT11			RC slab	12	3	1	2	2	(Observation impossible)	
	KRT12		Arbeynoch Street	Stone Masonry Arch	8	2	1	2	0	Hard rock	The bottom of upstream right abutment (stone masonry) remains collapsed.
	KRT13		Arbeynoch Street	Stone Masonry Arch	6	3	1	2	2	Hard rock	
	KRT14			RC T-beam	20	9	1	2	2	Hard rock	
	KRT15			Stone Masonry Arch	6	3	1	2	2	(Observation impossible)	
	KRT16		Arbeynoch Street	Stone Masonry Slab	10	3	3	2	0	Hard rock	The riverbed protection works made of stone masonry remains collapsed.

Table 4.1.4 Inventory of Existing Bridges (4/4)

River	Bridge No.	Bridge Name	Street Name	Bridge Type	Width(m)	Total Length(m)	No. of Span	No. of Roadway Lanes	No. of Sidewalks	Geological Conditions of Riverbed	Remarks
Hanku	HNK1		Asmera Road	RC slab	16	3	1	4	2	Hard rock	
	HNK2		Fikre Maryam Aba Techan Street	Stone Masonry Arch	10	2	1	2	1	Hard rock	
	HNK3		Fikre Maryam Aba Techan Street	Stone Masonry Arch	10	2	1	2	1	Hard rock	
	HNK4		Asmera Road	RC T-beam	16	12	1	4	2	Hard rock	

Table 4.1.5 Water Quality of Surface Water at Leggedadi and Gefersa (1986 - 1996)

Item No.	Parameter	Unit	Leggedadi			Gefersa		
			Minimum	Maximum	Mean	Minimum	Maximum	Mean
1	Temperature	C	14.0	19.0	17.5	17.0	19.0	16.7
2	Turbidity	F.T.U.	65	1350	304	12	500	70
3	Colour	Pt-Co Unit	357	8100	1573	72	3250	421
4	Odour		N.O.	O.	O.	N.O.	O.	O.
5	Taste		O.	O.	O.	O.	O.	O.
6	Ph		6.7	7.8	7.2	6.7	7.4	7.2
7	Total dissolved solids	mg/l	57	75	62	47	71	54
8	Conductivity	mS/cm	0.08	0.10	0.087	0.07	0.104	0.080
9	Total Alkalinity as CaCO <sub>3</sub>	mg/l	46	68	46	22.5	42.5	33.0
10	Total Hardness as CaCO <sub>3</sub>	mg/l	44	80	53	24.0	41.5	34.0
11	Calcium Hardness as CaCO <sub>3</sub>	mg/l	30	70	38	16	36	25
12	Magnesium Hardness as CaCO <sub>3</sub>	mg/l	10	18	15	4.0	17.5	9.0
13	Carbon Dioxide as CO <sub>2</sub>	mg/l	3.0	71.5	19.0	4.0	57.7	13.5
14	Dissolved Oxygen	mg/l	5.4	8.2	6.9	5.4	7.76	6.5
15	Nitrate as N	mg/l	0.3	2.5	1.0	0.35	7.0	1.8
16	Nitrite as N	mg/l	-0.0	0.13	0.08	0	0.09	0.02
17	Ammonia as NH <sub>3</sub>	mg/l	0.0	0.85	0.6	0	0.95	0.37
18	Iron as Fe	mg/l	0.1	2.71	0.31	0.06	2.4	0.9
19	Manganese as Mn	mg/l	0.0	0.09	0.001	0	0.4	0.15
20	Chloride as Cl	mg/l	1.6	5.0	3.1	2.0	6.1	3.5
21	Fluoride as F	mg/l	0.1	0.71	0.26	0.07	0.4	0.31
22	Hexavalent Chromium as Cr	mg/l	0.0	0.0	0.0	0	0	0
23	Copper as Cu	mg/l	0.005	0.06	0.008	0	0.3	0.07
24	Phosphate as PO <sub>4</sub>	mg/l	0.03	0.64	0.3	0.1	4.2	0.72
25	Silica as SiO <sub>2</sub>	mg/l	1.2	16.3	8.0	1.2	17.2	7.3
26	Sulfate as SO <sub>4</sub>	mg/l	3.1	22.0	6.2	1.8	12.0	6.2
27	Potassium as K	mg/l	-	-	2.5	-	-	-
28	Sodium as Na	mg/l	-	-	3.8	-	-	-
29	Chemical Oxygen Demand (COD)	mg/l	6.0	40.0	20.5	-	-	-
30	Saturation Index	-	-2.15	-0.42	-1.47	-2.65	-1.29	-1.77

(Source: Potential Impacts of the Upgrading Water Supply Projects of the Addis Ababa City. Addis Ababa Water and Sewerage Authority, Adinew Adam, January 1997)

**Table 4.1.6(1/3) Surface Water Quality as of 1976**

Item	Unit	Quality	
		Great Akaki	Little Akaki
Ph		6.5 - 7.5	6.9 - 8.0
Turbidity	mg/l	90 - 780	210 - 730
Suspended Solid	mg/l	40 - 480	40 - 240
BOD	mg/l	44 - 76	60 - 470
DO	mg/l	5 - 13	0 - 3
Coliform	counts per ml	320 - 510	43*10 <sup>4</sup> - 13*10 <sup>6</sup>

(Source: EVDSA Study, Dec. 1989 - Zawide Prel. Rep. 1976)

(Source: Potential Impacts of the Upgrading Water Supply Projects of the Addis Ababa City, Addis Ababa Water and Sewerage Authority, Adinew Adam, January 1997)

**Table 4.1.6(2/3) Surface Water Quality as of 1990**

Test Item	Unit	Location		
		Little Akaki near Prison	Kechene near Ambassador Theatre	Kechene near Mekonen Bridge
Suspended Solids	mg/l	400	400	400
BOD5	mg/l	160	140	40
Nitrates	mg/l	0.33	8	8
Chlorides	mg/l	100	105	65
Coliforms	counts per ml	5.7 bil.	1.4 bil.	0.2 bil.

(Source : Tequam Tesfa Mariam ( Geological Report-Ministry of Planning - July 1990) )

(Source : the Master Plan Study for the Development of Wastewater Facilities for the City of Addis Ababa, August 1993)

**Table 4.1.6(3/3) Surface Water Quality as of 1993**

Item	Unit	Location			
		Little Akaki	Kebena	Great Akaki	Aba Samuel Lake
Ph	mg/l	8.2	8.0	7.6	7.0
DO	mg/l	0.8	0.6	1.0	1.4
COD	mg/l	542	112	37	7.0
BOD5	mg/l	339	60	32	2.2
Coliforms	counts per ml	56 mil.	38,000	5	350

(Source : the Master Plan Study for the Development of Wastewater Facilities for the City of Addis Ababa, August 1993)



Table 4.3.1 Damage Caused by the Flood of August 19th, 1978

Keftegna	No. of Kebeles Affected	No. of Houses Affected	No. of Affected Persons	No. of Houses by Degree of Damage			Cost of Damage (Birr)
				Heavy	Medium	Light	
1	1	3	10	-	-	3	2,000
2	6	84	357	49	21	14	127,000
3	4	28	148	18	8	2	50,000
4	6	100	578	43	27	30	136,000
5	4	27	145	7	12	8	36,000
6	8	76	377	45	26	5	119,000
7	8	52	305	23	18	11	83,000
8	2	2	9	-	1	1	2,000
9	4	23	109	6	10	7	31,000
10	3	7	28	1	3	-	6,000
11	4	30	115	8	11	11	35,000
12	3	5	6	3	1	1	8,000
13	10	52	166	29	15	-	82,000
14	6	95	381	51	34	10	203,000
15	11	291	1,382	146	102	39	448,000
16	-	-	-	-	-	-	-
17	1	3	21	3	-	-	22,000
18	3	197	1,001	70	89	37	263,000
19	1	6	32	-	-	6	4,000
20	4	36	225	16	16	4	80,000
21	5	65	365	12	46	7	88,000
22	5	27	170	7	12	8	32,000
23	6	26	138	7	16	3	35,000
24	3	20	128	2	13	5	26,000
25	-	-	-	-	-	-	-
<b>Total</b>	<b>108</b>	<b>1,255</b>	<b>6,196</b>	<b>546</b>	<b>481</b>	<b>212</b>	<b>1,918,000</b>
							<b>2,000,000</b>

Note: The number of houses affected is higher than the number of houses damaged since a certain number of these suffered negligible damage.

Source: Flood Protection and Storm Sewer System of Addis Ababa, Feasibility Study, Volume I - General Report, BCEOM

Table 4.3.2 Affected Population by Flood in August 1994

Serial No.	River	Location			Affected Population			Population became homeless				Remarks
		Zone	Keft	Kebele	Family head	Family member	Total pop.	Family head	Family member	Total pop.	Ratio	
1	Little Akaki	1	4	35	87	460	547	31	243	274	50%	
2	"	1	6	1	9	38	47	9	38	47	100%	
3	"	1	6	13	14	112	126	-	-	0	0%	
4	"	1	6	24	62	286	348	10	81	91	26%	
5	"	1	6	25	6	22	28	-	-	0	0%	
6	"	2	20	18	31	163	194	31	163	194	100%	
7	"	2	21	19	168	684	852	65	305	370	43%	
8	"	2	21	20	32	167	199	13	85	98	49%	
9	"	2	22	1	37	277	314	17	104	121	39%	
10	"	2	22	2	32	155	187	27	118	145	78%	
11	"	2	22	3	17	82	99	3	8	11	11%	
12	"	2	22	7	14	73	87	-	-	0	0%	
13	"	2	23	8	29	273	302	10	90	100	33%	
14	"	2	23	9	98	253	351	45	253	298	85%	1 baby lost
15	"	2	24	10	3	7	10	2	7	9	90%	
16	"	2	24	11	4	36	40	4	36	40	100%	
17	"	2	24	12	58	70	128	12	70	82	64%	
18	"	5	7	17	30	214	244	-	-	0	0%	
19	"	5	8	3	4	22	26	-	-	0	0%	
20	"	5	8	6	33	231	264	-	-	0	0%	
21	"	5	8	13	3	16	19	3	16	19	100%	
22	Kurtume	1	5	7			160			0	0%	
23	"	5	2	11	29	268	297	11	75	86	29%	
24	"	5	8	10	13	46	59	12	45	57	97%	1 baby died
25	"	5	8	11	6	30	36	6	30	36	100%	
26	"	5	8	15	20	80	100	-	-	0	0%	
27	Kechene	4	9	20	10	57	67	1	5	6	9%	1 woman died
28	"	4	11	16	20	99	119	6	30	36	30%	
29	"	4	13	1	10	45	55	1	9	10	18%	
30	"	5	2	17	112	536	648	9	41	50	8%	
31	"	5	14	12	37	212	249	15	54	69	28%	
32	"	5	14	21	60	298	358	3	14	17	5%	
33	Kostre	5	10	13	4	13	17	-	-	0	0%	
34	Bantyketo	3	18	7	28	158	186	28	158	186	100%	
35	"	3	18	18	25	110	135	25	110	135	100%	
36	"	4	15	34	65	308	373	55	195	250	67%	
37	"	4	15	36	46	340	386	7	34	41	11%	
Total		5	18	37	1,256	6,241	7,657	461	2,417	2,878	38%	
River Total												
Little Akaki River							4,412			1,899	43%	
Bantyketo River							1,080			612	57%	
Kechene River							1,496			188	13%	
Kostre River							17			0	0%	
Kurtume River							652			179	27%	
Affected Population Total							7,657			2,878	38%	

Source: Conditional Survey and Fundamental Information on Flood of Affected Areas in Addis Ababa, September 1994 - October 1995, Kono Takuji

Table 4.3.3 Damage Caused by Flood in August 1994

Unit of amount: Birr

Serial No.	River	Location			Physical Damage and Its Estimated Value										
		Zone	Keb.	Keb.	Houses			Household	Livestock		Vegetables		Bridges		Total
					Partially Damaged (a)	Totally Damaged (b)	Cost Estimate (c)	Furniture & Equipment (d)	No. (e)	Estimated Amount (f)	ha (g)	Estimated Amount (h)	No. (i)	Cost Estimate (j)	Physical Damage (k = d + f + h + j)
1	Little Akaki	1	4	35	10	17	290,000	175,000	-	-	2.5	8,000	-	-	473,000
2	"	1	6	1	4	6	40,000	30,000	-	-	6	30,000	-	-	100,000
3	"	1	6	13	3	1	41,000	9,600	-	-	3	11,900	3	104,000	166,500
4	"	1	6	24	14	7	200,000	80,000	12	8000	-	-	2	15,000	303,000
5	"	1	6	25	14	6	200,000	85,000	-	-	-	-	-	-	285,000
6	"	2	20	18	23	8	226,973	700,000	3	400	-	2,000	-	-	929,373
7	"	2	21	19	142	26	300,000	150,000	-	-	-	-	-	-	450,000
8	"	2	21	20	38	5	-	70,000	2	20	-	-	-	-	70,020
9	"	2	22	1	20	17	-	471,000	-	-	-	-	-	-	471,000
10	"	2	22	2	5	27	-	606,000	-	-	-	-	-	-	606,000
11	"	2	22	3	14	3	-	52,000	-	-	-	-	-	-	52,000
12	"	2	22	7	14	-	204,000	-	-	-	-	-	1	75,000	279,000
13	"	2	23	8	19	10	250,000	201,000	3	300	-	-	-	-	451,300
14	"	2	23	9	30	45	735,000	1,000,000	-	-	2	5,000	2	40,000	1,780,000
15	"	2	24	10	3	2	18,000	1,000	-	-	0.12	2,000	1	5,000	26,000
16	"	2	24	11	-	4	20,000	3,000	-	-	-	-	2	6,000	29,000
17	"	2	24	12	-	12	70,000	30,000	-	-	-	40,000	3	20,000	160,000
18	"	5	7	17	8	-	200,000	70,000	-	-	-	-	-	-	270,000
19	"	5	8	3	5	-	2,000	4,000	-	-	-	-	-	-	6,000
20	"	5	8	6	18	-	45,000	34,000	-	-	2.5	7,000	-	-	86,000
21	"	5	8	13	3	3	260,602	26,073	-	-	-	-	-	-	286,675
22	Kurtume	1	5	7	-	-	-	-	-	-	-	-	-	-	0
23	"	5	2	11	18	11	290,000	280,000	-	-	-	-	-	-	570,000
24	"	5	8	10	8	5	5,750	3,000	-	-	-	-	-	-	8,750
25	"	5	8	11	4	2	42,000	5,000	-	-	-	-	1	4,000	51,000
26	"	5	8	15	5	-	40,000	40,000	-	-	-	-	-	-	50,000
27	Kechene	4	9	20	-	10	50,300	60,000	3	2500	-	-	-	-	112,500
28	"	4	11	16	1	4	100,100	25,000	-	-	-	-	-	-	125,100
29	"	4	13	1	-	-	-	-	-	-	-	-	-	-	0
30	"	5	2	17	94	4	-	-	-	-	-	-	-	-	0
31	"	5	14	12	25	12	360,000	50,000	-	-	-	-	-	-	410,000
32	"	5	14	21	60	3	1,800,000	500,000	-	-	-	-	-	-	2,300,000
33	Kostre	5	10	13	4	-	5,000	5,000	-	-	-	-	1	4,000	14,000
34	Bantiyketu	3	18	7	26	2	300,000	-	-	-	-	-	-	-	300,000
35	"	3	18	18	24	-	-	-	2	200	-	-	-	-	200
36	"	4	15	34	5	34	3,500,000	1,300,000	3	4000	-	-	-	-	4,804,000
37	"	4	15	36	7	-	200,000	100,000	-	-	40	45,000	-	-	345,000
Total		5	18	37	668	286	9,795,725	6,165,673	28	15,420	56	150,900	16	273,000	16,400,718
<b>River Total</b>															
Little Akaki River							3,102,575	3,797,673	-	8,720	-	105,900	-	265,000	7,279,868
Bantiyketu River							4,000,000	1,400,000	-	4,200	-	45,000	-	0	5,449,200
Kechene River							2,310,400	635,000	-	2,500	-	0	-	0	2,947,900
Kostre River							5,000	5,000	-	0	-	0	-	4,000	14,000
Kurtume River							377,750	328,000	-	0	-	0	-	4,000	709,750
Affected Population Total							9,795,725	6,165,673	-	15,420	-	150,900	-	273,000	16,400,718

Source: Conditional Survey and Fundamental Information on Flood of Affected Areas in Addis Ababa, September 1994 - October 1995, Kono Takuji

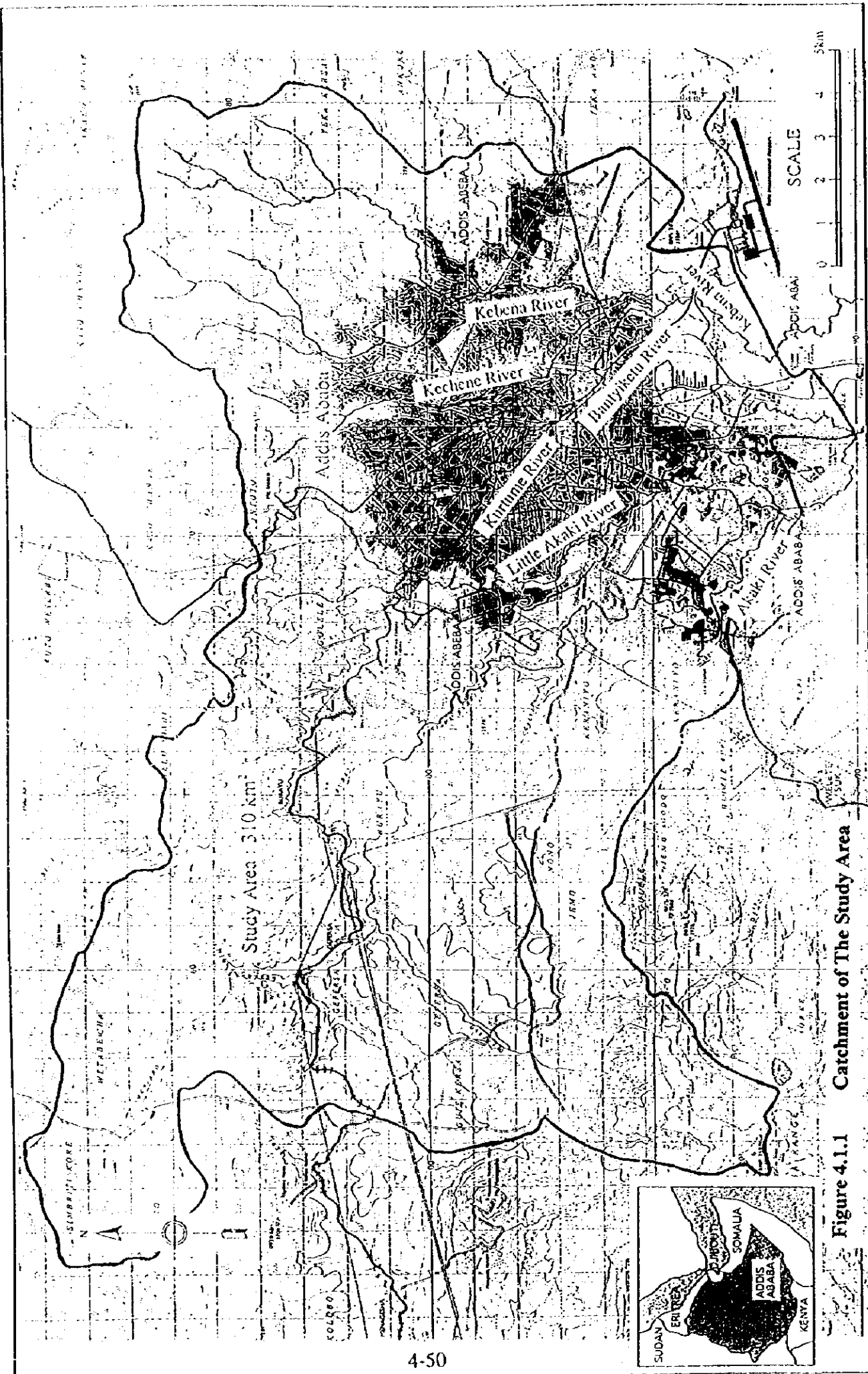


Figure 4.1.1 Catchment of The Study Area

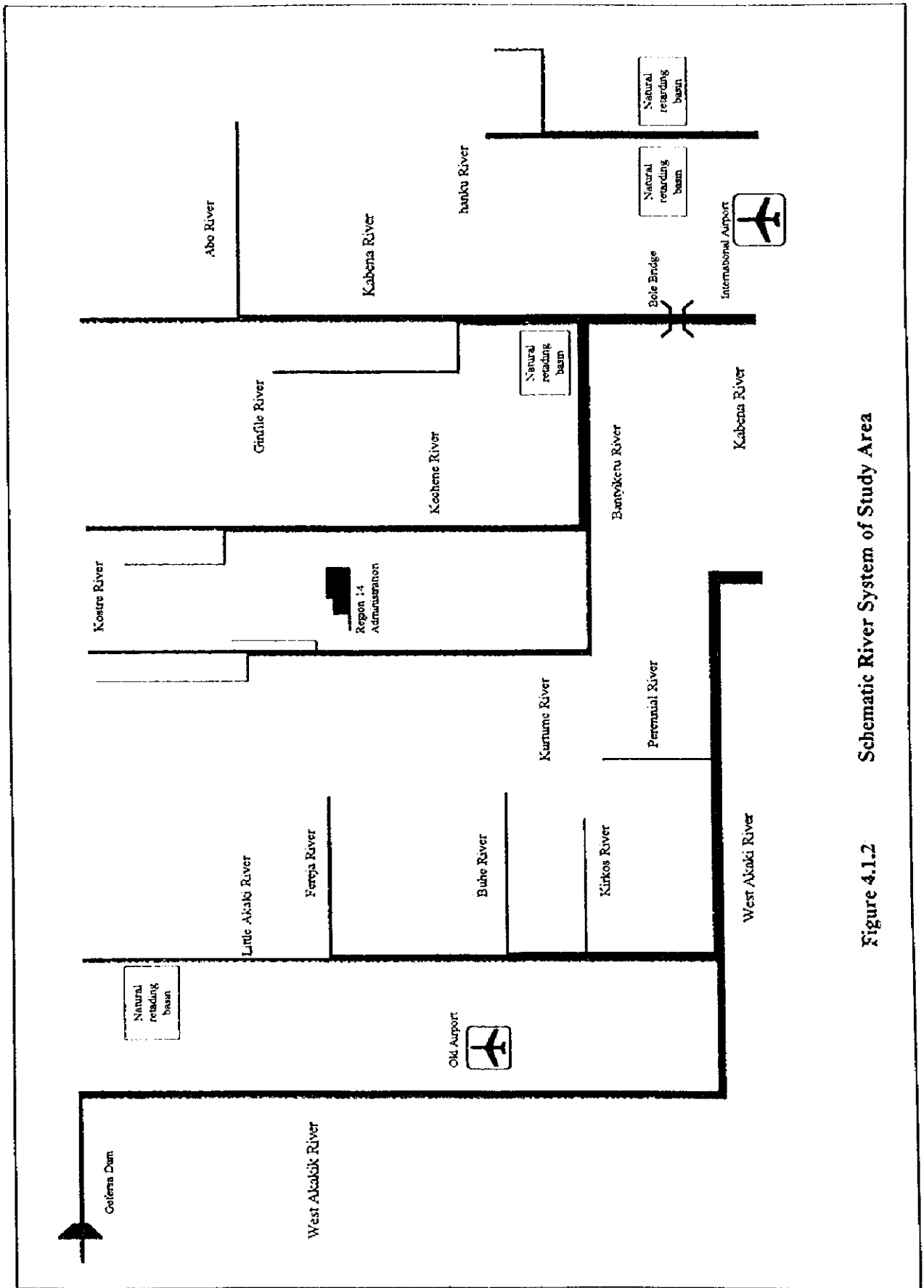


Figure 4.1.2 Schematic River System of Study Area

Figure 4.1.2

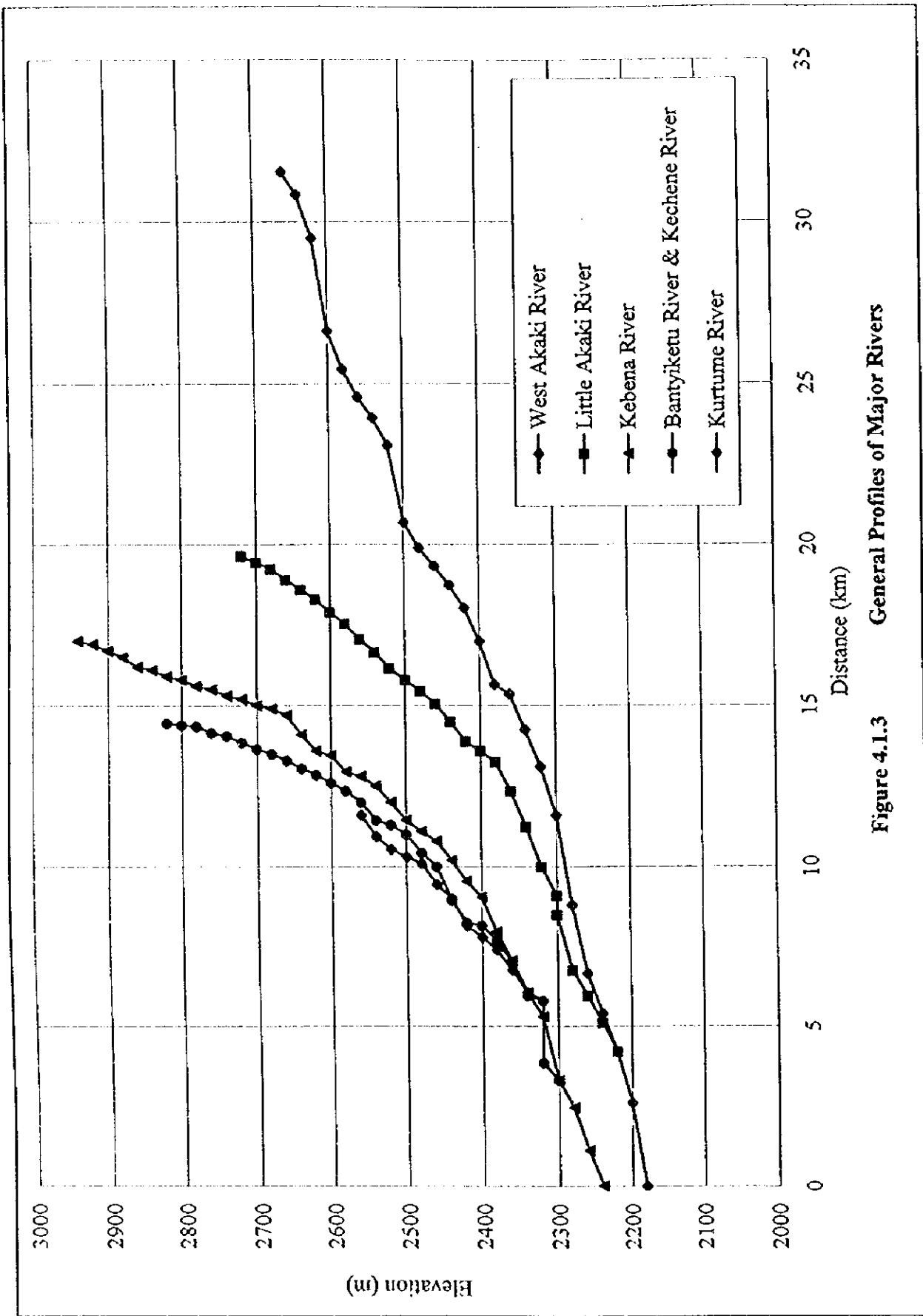


Figure 4.1.3 General Profiles of Major Rivers

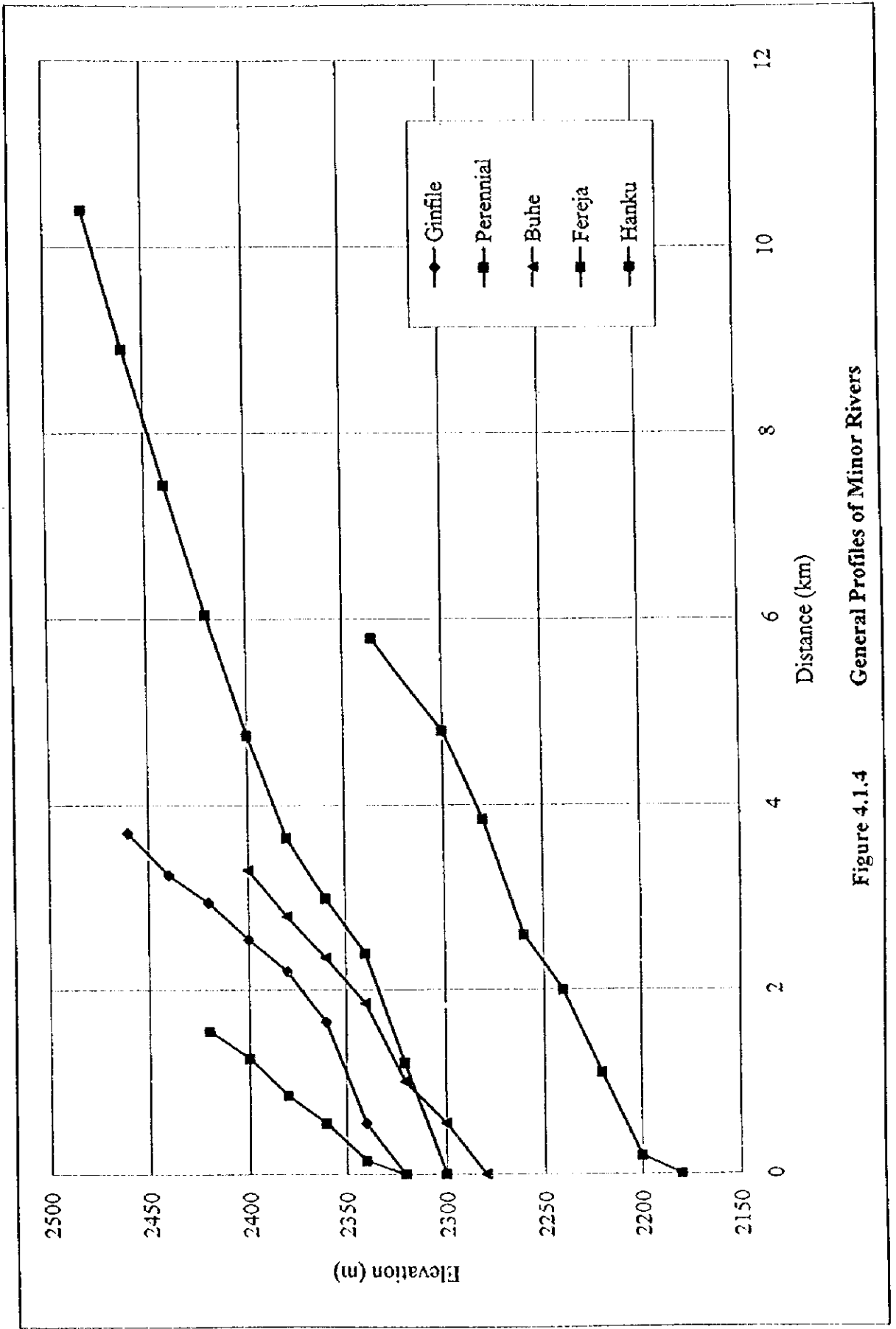


Figure 4.1.4 General Profiles of Minor Rivers

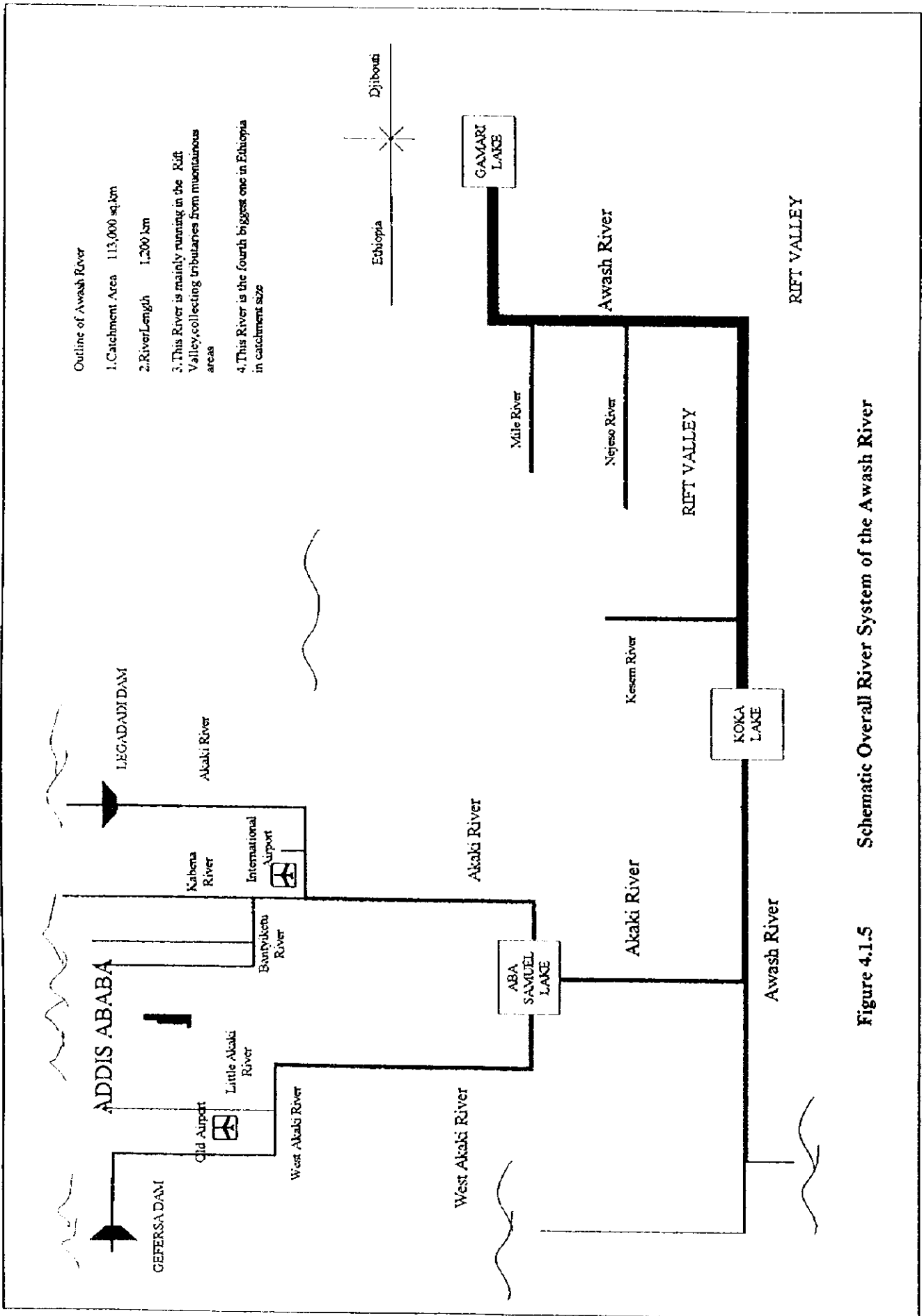
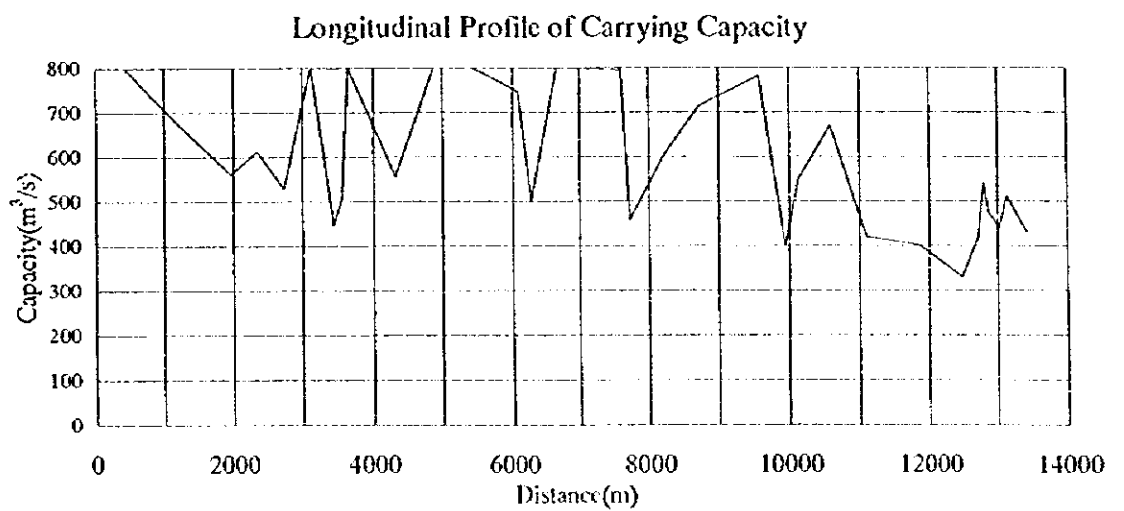
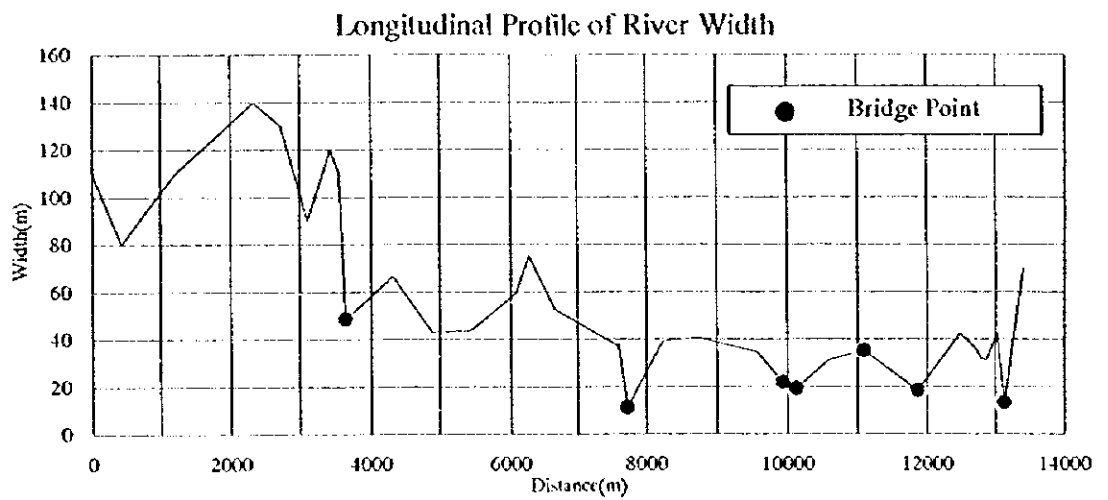
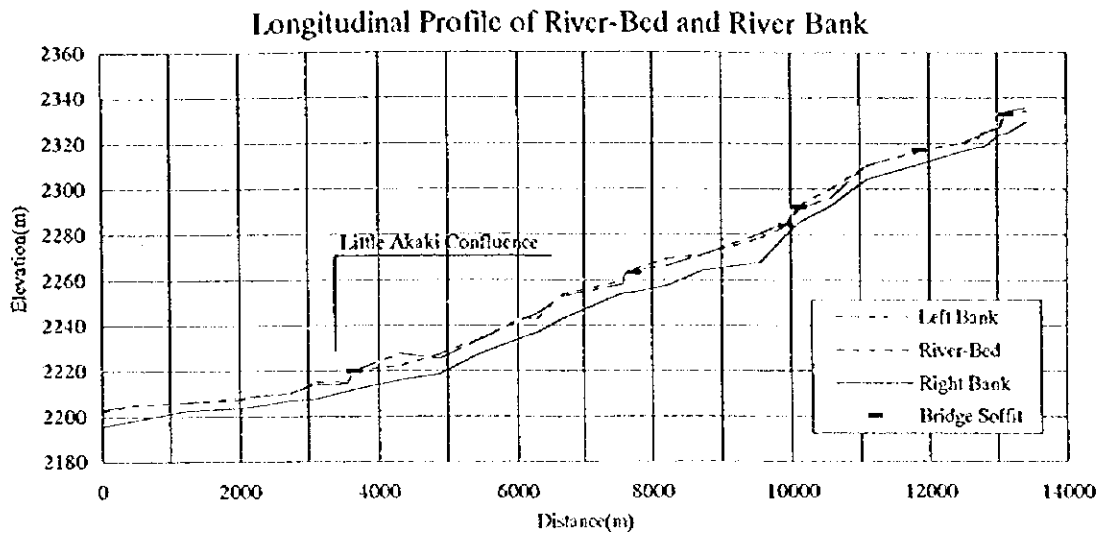


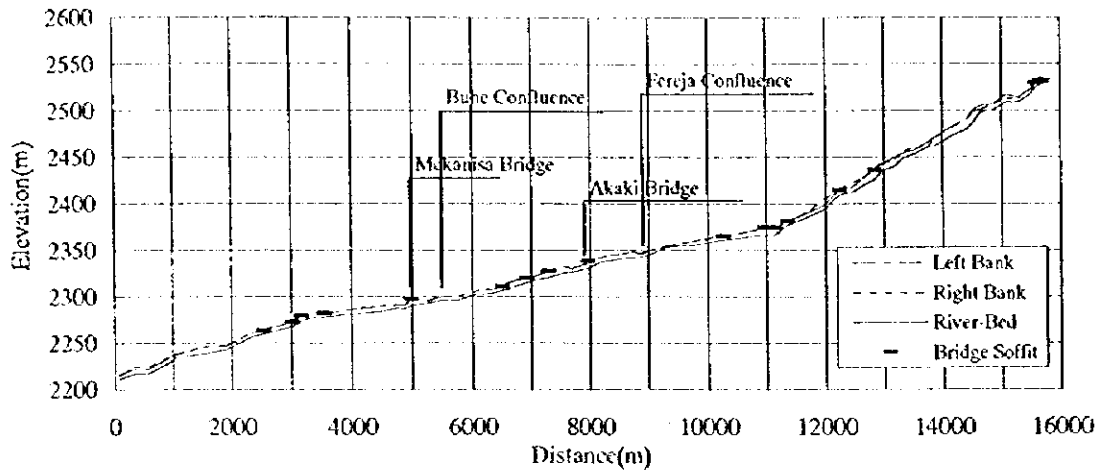
Figure 4.1.5 Schematic Overall River System of the Awash River



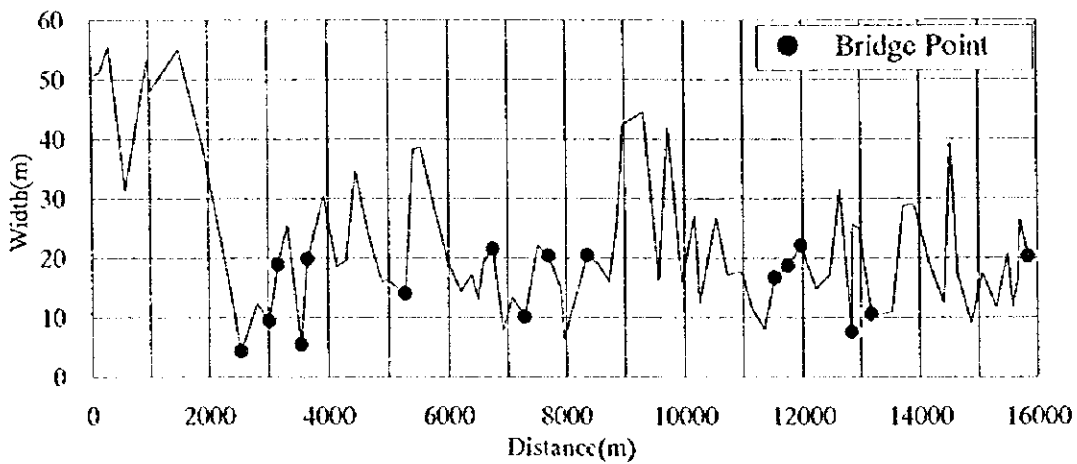


**Figure 4.1.6 (1/7) Longitudinal Profile of West Akaki River**

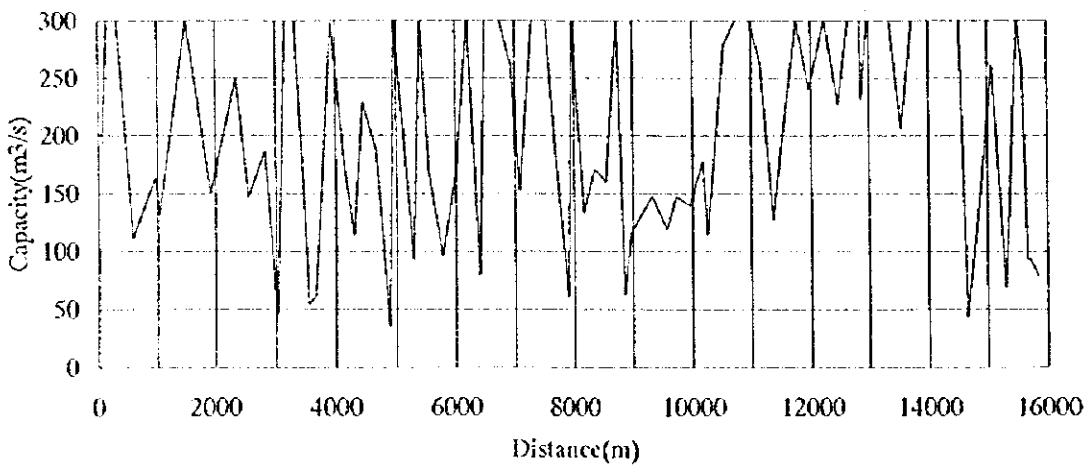
### Longitudinal Profile of River-bed and River Bank



### Longitudinal Profile of River Width

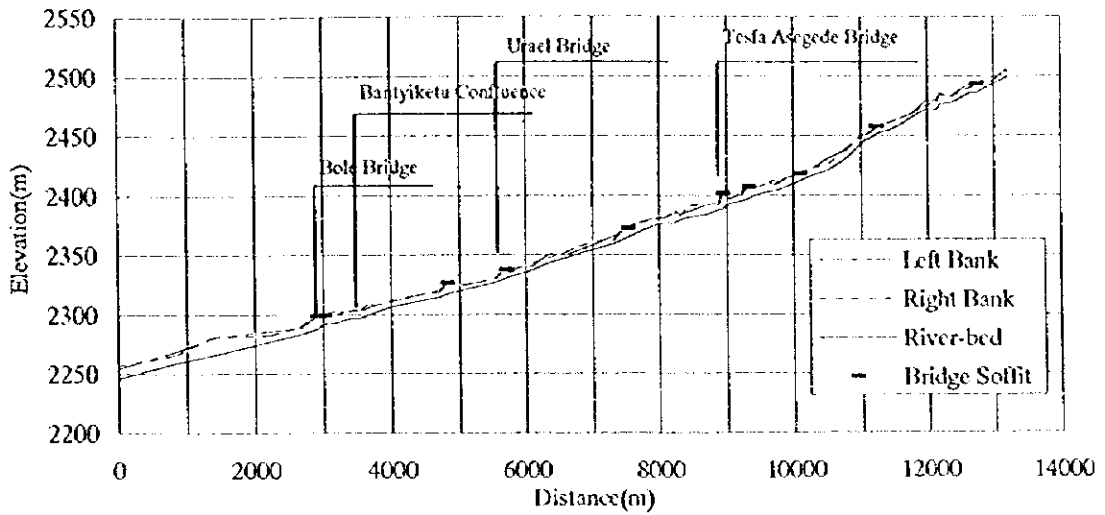


### Longitudinal Profile of Carrying Capacity

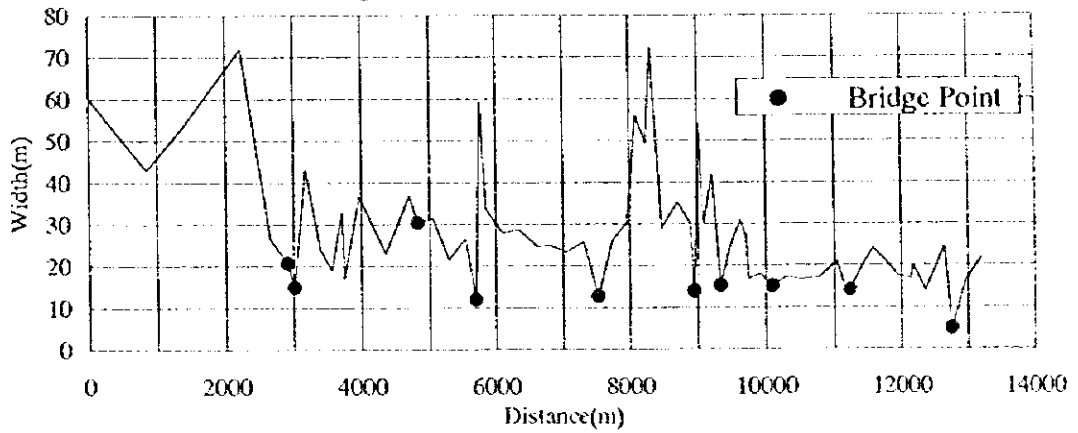


**Figure 4.1.6 (2/7) Longitudinal Profile of Little Akaki River**

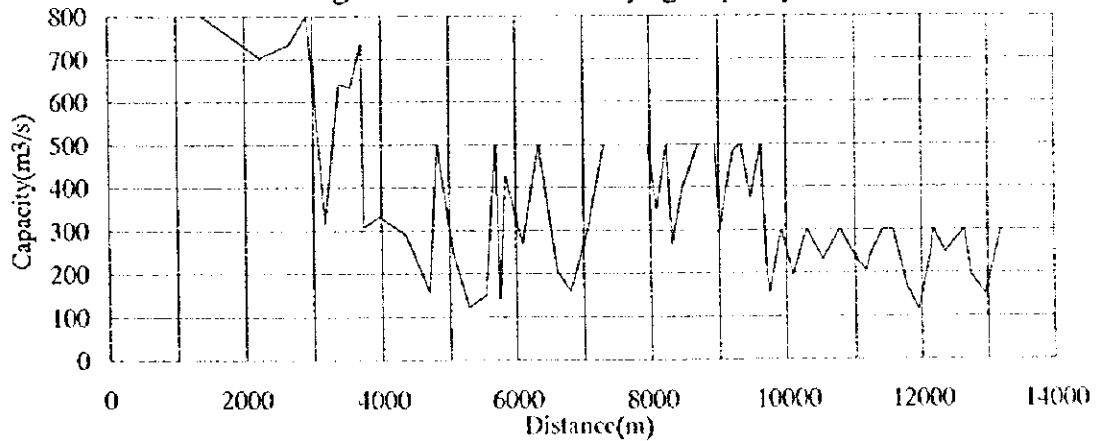
### Longitudinal Profile of River-bed and River Bank



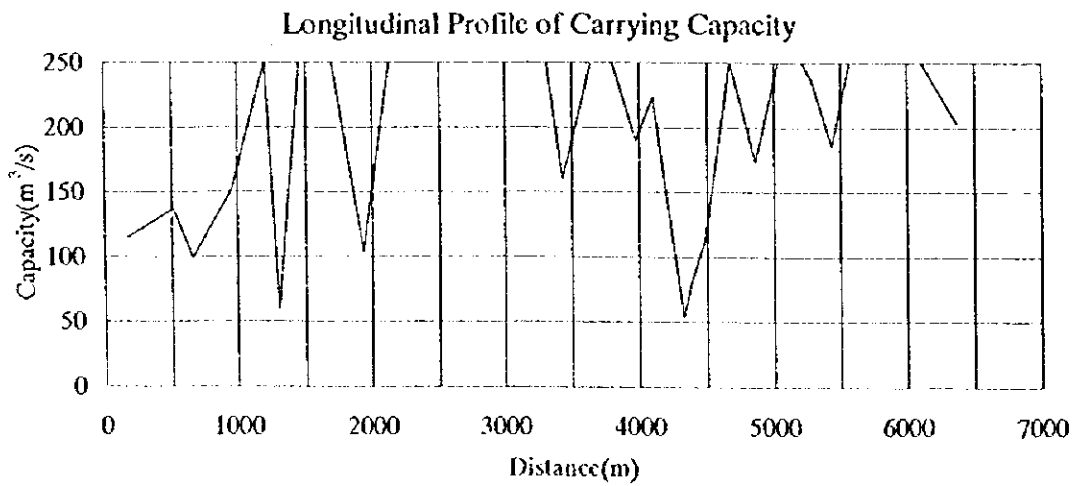
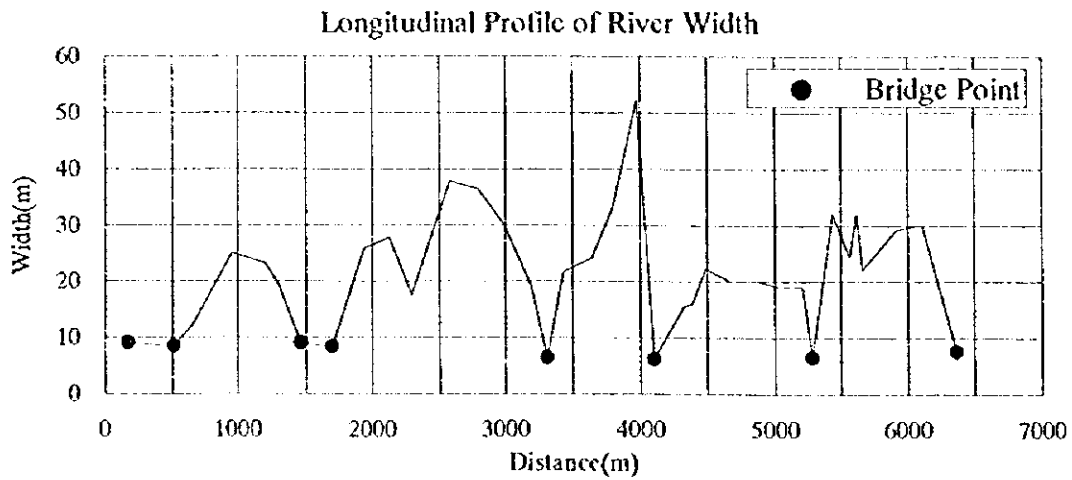
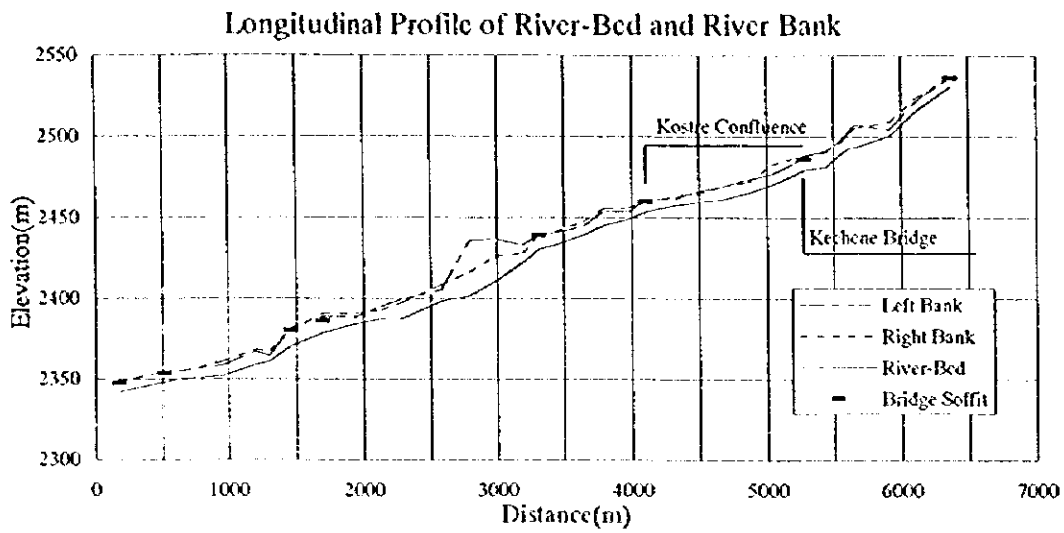
### Longitudinal Profile of River Width



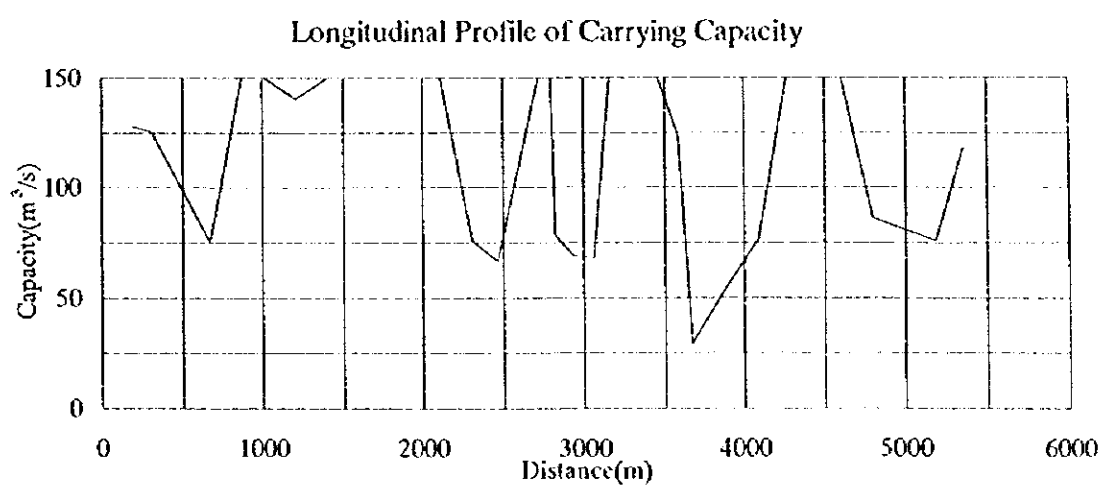
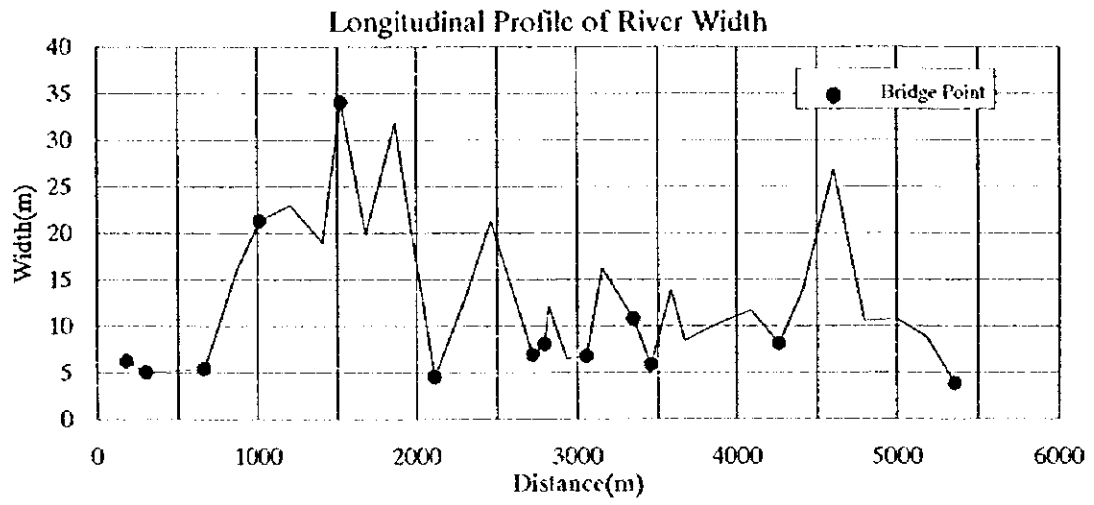
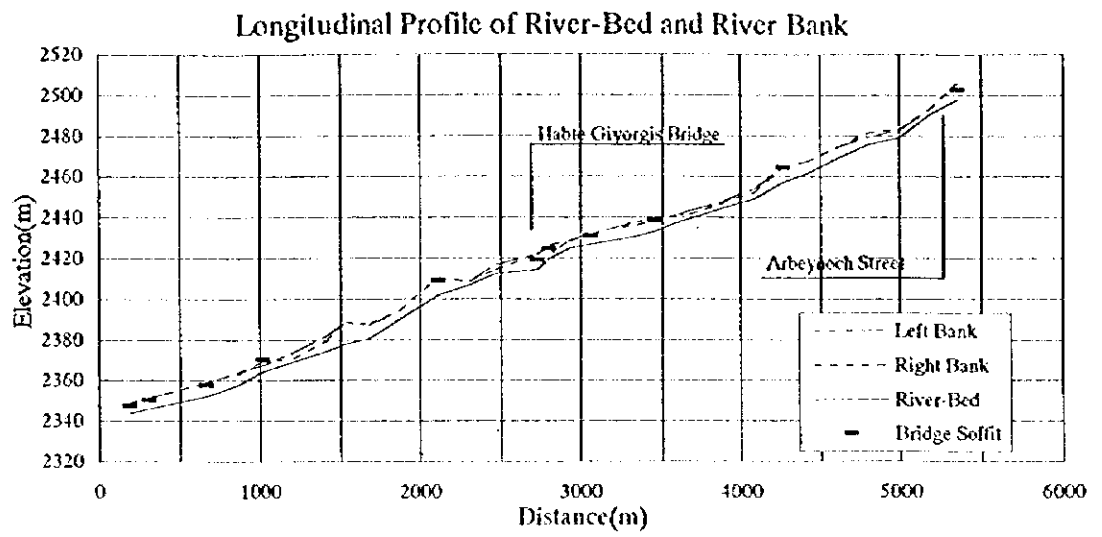
### Longitudinal Profile of Carrying Capacity



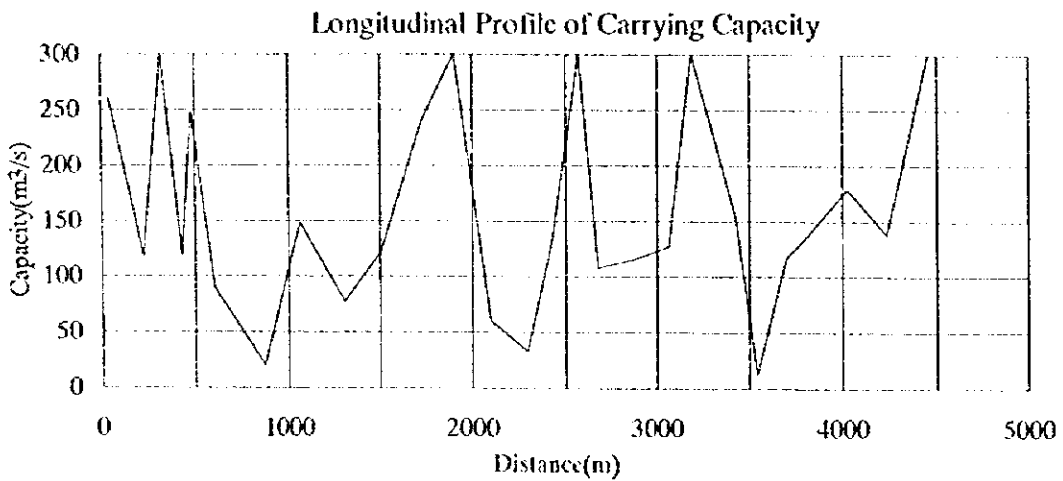
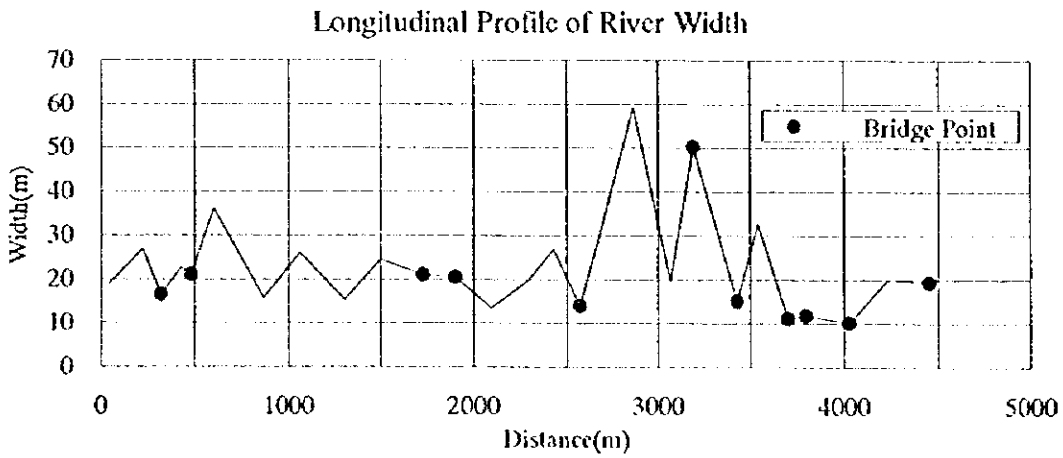
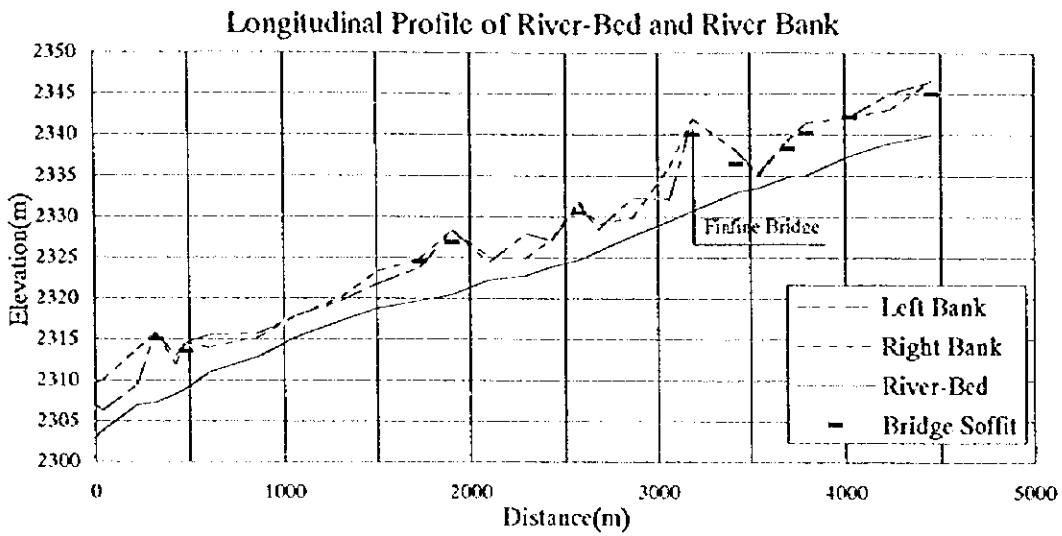
**Figure 4.1.6 (3/7) Longitudinal Profile of Kebena River**



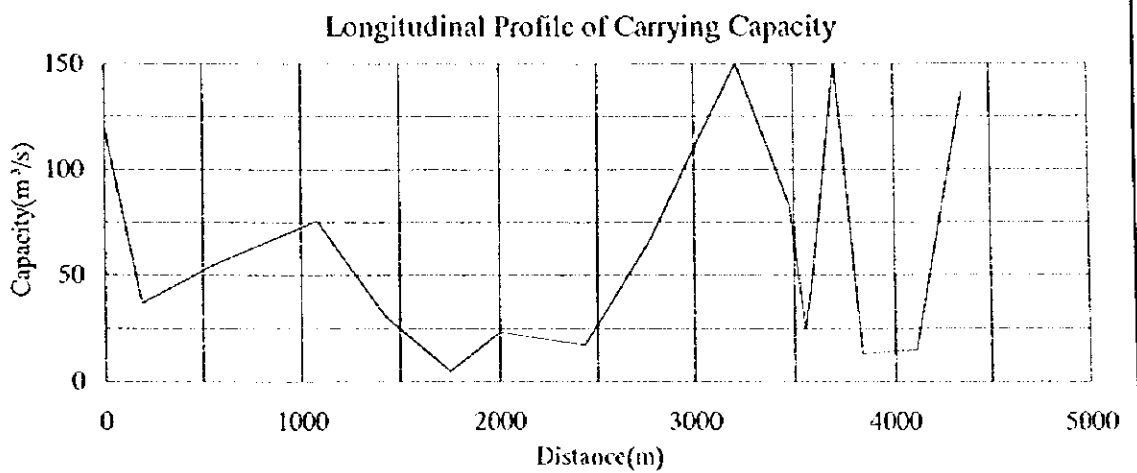
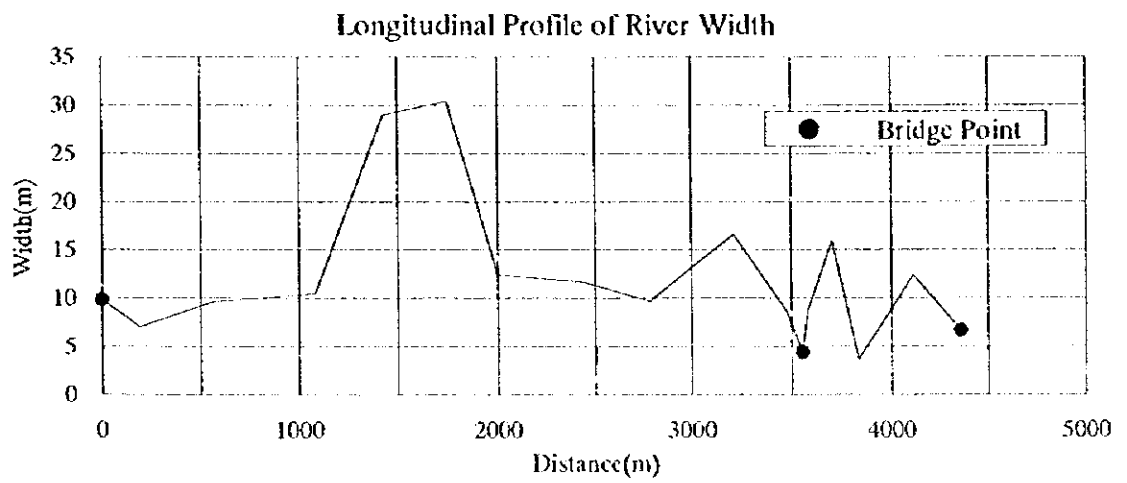
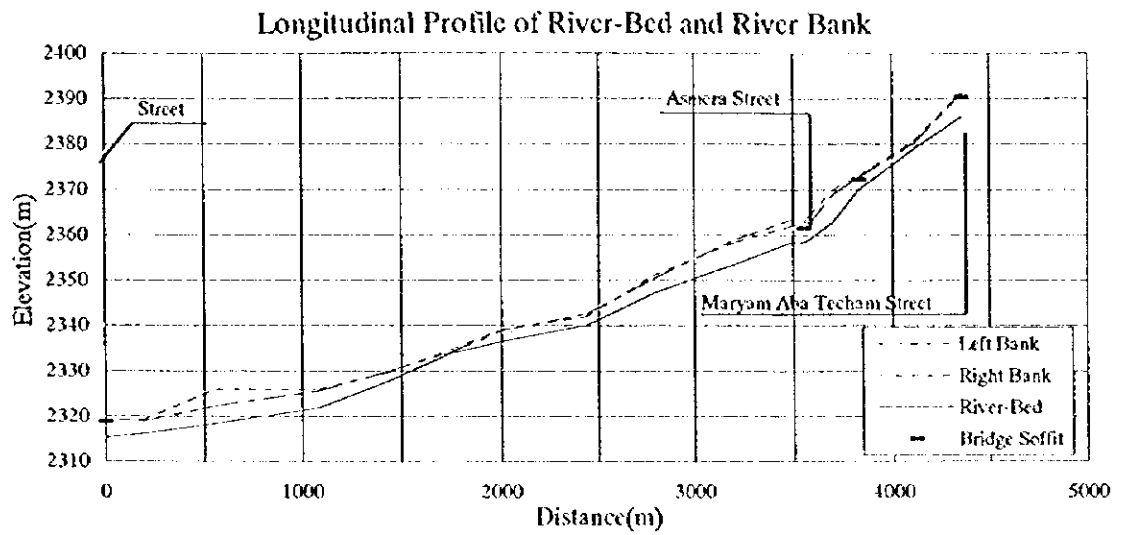
**Figure 4.1.6 (4/7) Longitudinal Profile of Kechene River**



**Figure 4.1.6 (5/7) Longitudinal Profile of Kurtume River**



**Figure 4.1.6 (6/7) Longitudinal Profile of Bantiyketu River**



**Figure 4.1.6 (7/7) Longitudinal Profile of Hanku River**