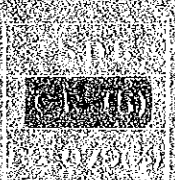


THE PRESIDENT'S COMMISSION ON
THE NATURE OF WATER RESOURCES AND UTILIZATION
RECOMMENDATIONS FOR THE DEVELOPMENT
OF
GOVERNMENT FUNDS IN SPAIN
OF
MEXICO AND MIDDLE EAST COUNTRIES

APPENDIX
VOL. II

CONTENTS

THE PRESIDENT'S COMMISSION ON THE NATURE OF WATER RESOURCES AND UTILIZATION



No. ---

THE REPUBLIC OF ZIMBAWE
THE MINISTRY OF WATER RESOURCES AND DEVELOPMENT

RURAL WATER SUPPLY PROGRAMME
IN
COMMUNAL LANDS IN PARTS
OF
MASVINGO AND MIDLANDS PROVINCES

APPENDIX

VOL. II

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APPENDIX I INTRODUCTION

APPENDIX I INTRODUCTION

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1-1-1 List of Data and Literatures Collected by the Study Team in Zimbabwe

<u>Data No.</u>	<u>Description</u>	<u>Issued</u>
Z 1	Monthly digest of statics March, 1982	Central Statistical Office
Z 2	Monthly digest of statics May, 1982	"
Z 3	Monthly digest of statics June, 1982	"
Z 4	Monthly digest of statics July, 1982	"
Z 5	Monthly digest of statics Oct. 1982	"
Z 6	Monthly digest of statics Nov. 1982	"
Z 7	Agricultural Marketing Authority information brief	Agricultural Marketing Authority
Z 8	Economic review of the Agricultural industry of Zimbabwe, 1980	Agricultural Marketing Authority
Z 9	- " - 1981	"
Z 10	Crop production of large scale commercial Agricultural units, 1980	Central Statistical Office
Z 11	Livestock in large-scale commercial Agricultural units, 1981	"
Z 12	Oilseeds situation and outlook report 1982/83	Agricultural Marketing Authority
Z 13	Cotton situation and outlook report 1982/83	"
Z 14	Grain situation and outlook report 1982/83	"
Z 15	Annual economic review of Zimbabwe August, 1981	Ministry of Economic Planning & Development
Z 16	Thirty-third Annual Report 1982 National Railway's of Zimbabwe	National Railways of Zimbabwe
Z 17	Social conditions in District Council areas, 1982 (preliminary tables) Statistical nonographs Noss 1/81	Central Statistical Office

Z 18	General conditions of contract and forms of tender, Agreement and deed of suretiship for use in connection with works of Civil Engineering Construction - third edition (1976)	
Z 19	Rural Village Water Supplies Preliminary Design Report	Nicholas O'Dwyer & Partners
Z 20	Rural Village Water Supplies Victoria Province - phase 1 preliminary design report	Sir Alexander Gibb & Partiners (Zimbabwe)
Z 21	First crop forecast, 1980 - 82 season	Midland Cominal Area
Z 22	Second crop forecast, 1974 - 85 season	"
Z 23	Second crop forecast, 1977 - 78 season	"
Z 24	Second crop forecast, 1978 - 79 season	"
Z 25	Second crop forecast, 1979 - 80 season	"
Z 26	Second crop forecast, 1980 - 81 season	"
Z 27	Harare Building materials Average price March, 1979 - December, 1982	Central Statistical Office
Z 28	Contract, borehole drilling in the Communal lands. Condition of contract, specification and schedule of unit rate	Ministry of Water Resources and Development
Z 29	An outline of the Geology of Rhodesia Bulletin No.80, 1978	Rhodesia geological survey
Z 30	The geology of the Belingwe-Shabani schist belt bulletin No.83, 1978	"
Z 31	Explanation of the Geological map of the country south of Chibi short report No.41, 1974	
Z 32	The determination of Rhodesian Economic Minerals No.42, 1956	
Z 33	The geology of the country around Umvuma & Felixburg, Bulletin No.56, 1962	Southern Rhodesia Geological survey
Z 34	The geology of the Shabani Mineral belt, Belingwe district, bulletin No.12, 1929	" "

Z 35	The geology of the Buhwa iron ore deposits and adjoining country; Belingwe district, No.53, 1962	Southern Rhodesia Geological survey
Z 36	The geology of the country around Mashaba, bulletin No.62, 1968	Rhodesia geological survey
Z 37	The geology of the country around Mount Towla, Gwanda district, bulletin No.68, 1973	"
Z 38	Provincial geological map of Rhodesia, scale 1/1,000,000	"
Z 39	Air-photographs of the survey area, scale 1:25,000	Surveyor General, Zimbabwe
Z 40	The water sources and population survey in Mberengwa district	The Lutheran world federation
Z 41	Health information system: Midlands province consolidated provincial data, November, 1982	Ministry of Health
Z 42	Number of cattle in Midlands communal area, February, 1983	Midland Province
Z 43	Data geophysical prospectings, drillings, yield test, and water quality analysis 1974 - 82	Division of Water Development/Midlands
Z 44	Data of geophysical prospectings, drillings, yield tests, and water quality analysis, 1980 - 82	Division of Water Development/Masvingo
Z 45	Hydrological year book 1964 - 1971	Ministry of Water Development
Z 46	1982. Population census	Central Statistical Office

1-1-2. List of Available Data and Literatures

<u>Data No.</u>	<u>Description</u>	<u>Issued</u>
J 1	Ministry of Water Resources and Development	Ministry of Water Resources and Development
J 2	Domestic Water Supplies in Zimbabwe	"
J 3	Ministry of Water Resources and Development Functions, Objectives and Policy	"
J 4	Project Document for International Assistance for Water Supply Project September, 1981	"
J 5	Water Quantity Standard	"
J 6	RHODESIA ACT (Water Amendment)	"
J 7	RHODESIA ACT (Water)	"
J 8	Ministry of Water Resources and Development Water Supply Rules August 31, 1982	"
J 9	Proposals for a Five-Year Programme of Development in the Public Sector January, 1979	Ministry of Finance
J 10	Annual Economic Review of Zimbabwe August, 1981	Ministry of Economic Planning & Development
J 11	Climate Handbook of Zimbabwe April, 1981	Department of Meteorological Services
J 12	Metallurgy of Gold	Ministry of Mines
J 13	Geology Ministry of Mines, Publication No.1	"
J 14	Large Scale, High Production Mining Methods	"
J 15	Rainfall Report Season 1980/81	Department of Meteorological Services
J 16	Integrated Plan for Rural Development July, 1978	Ministry of Finance

J 17	Primary Water Supplies in Communal Areas of Mashonaland, September, 1981	Division of Water Development
J 18	Project Document (A) International Assistance for Groundwater Development in Zimbabwe, March, 1980	"
J 19	Zimbabwe Agricultural and Economic Review, March, 1981	Modern Farming Publications Zimbabwe
J 20	Mugabe	Sphere Books Ltd.
J 21	The Rhodesian Place in the World	M.O Collins Ltd.
J 22	The New Junior Secondary Atlas for Zimbabwe	Longman Zimbabwe Ltd.
J 23	Guide to the Street & Buildings in the Built-Up Areas of Greater Bulawayo	Bulawayo & District Publicity Association
J 24	Historic Rhodesia	Longman Rhodesia
J 25	Greater Zimbabwe	Peter Garlake
J 26	A Handbook to the Victoria Falls Region	Longman Rhodesia
J 27	The Original Guide to Streets and Buildings of Greater Salisbury	Munn Publishing Ltd.
J 28	The Shona and Zimbabwe 900-1850 Manbo Press.	Manbo Press.
J 29	Atlas for Zimbabwe	Collings Longman
J 30	Street Map of the City of Harare	Scale 1/33,333
J 31	Geological Map	Scale 1/2,500,000
J 32	GOBO, Umvuma, Selukwe, Debwe Donga, Mushwe, Chilimanzi, Mashamba, Kashambi, Belingwe, Wanezi Mission, Belingwe Peak, Masase, Zeus Mine Bera, Mashaba Shabani, Taru, Mashandike Dam, Chibi, Mneni, Buhwa, Mataka Borda, Berejena Mission, Mukorsi, Starahuru, Luneli, West Nicholson Matabo, Gaha, Namande	"
J 69	Bangwe, Gnabe, Matangane, Rutenga	"
J 70	Gwelo, Selukwe, Bulawayo, West Nicholson	Scale 1/250,000
J 71	Fort Victoria, Nuanetsi	"

<u>Data No.</u>	<u>Description</u>	<u>Issued</u>
S 1	Project Document for International Assistance for Groundwater Development in Zimbabwe	Division of Water Development
S 2	Sabi-Limpopo Authority Rhodesia Fourteenth Annual Report and Accounts 1977/78	Sabi-Limpopo Authority
S 3	Village Water Supply. A World Bank Paper	World Bank
S 4	Village Water Supply Economics and Policy in the Developing World	World Bank
S 5	Accelerated Development in Sub-Saharan Africa	World Bank
S 6	Let's Build Zimbabwe Together Conference Documentation Zimbabwe Conference on Reconstruction and Development 23-27, March, 1981	Ministry of Economic Planning & Development Causeway, Zimbabwe
S 7	Tribal Trust Land Development Corporation Limited Annual Reports and Accounts 30th June, 1979	Tribal Trust Land Development Corp., Ltd.
S 8	Zimbabwe Country Economic Memorandum	World Bank
S 9	Social Infrastructure and Services in Zimbabwe	World Bank
S 10	Rhodesia its Natural Resources and Economic Development	M.O Collins Ltd. Salisbury, Rhodesia
S 11	Zimbabwe, Relief	Surveyor-General, Salisbury
S 12	Rhodesia African Population Distribution as at April-May, 1969 scale 1/1,250,000	Surveyor-General Salisbury Rhodesia
S 13	Rhodesia African Population Density as at April-May, 1969 scale 1/1,250,000	Surveyor-General, Causeway Rhodesia
S 14	Rhodesia Mean Annual Rainfall scale 1/2,500,000	Department of Meteorological Services

S 15	Rhodesia Hydrological Zones scale 1/1,000,000	Surveyor-General Salisbury Zimbabwe
S 16	Zimbabwe Natural Regions and Farming Areas scale 1/1,000,000	Surveyor-General Salisbury Zimbabwe
S 17	Agro-Ecological Survey Southern Rhodesia Natural Regions and Areas and Related Farming Systems scale 1/1,000,000	Federal Ministry of Agriculture
S 18	Zimbabwe Land Classification as at 2nd February, 1979 scale 1/1,000,000	Surveyor-General, Salisbury, Zimbabwe
S 19	Zimbabwe Banket Soil Map Scale 1/50,000	Surveyor-General, Salisbury, Zimbabwe
S 20	Provisional Soil Map of Zimbabwe Rhodesia Scale 1/1,000,000	Surveyor-General, Salisbury, Zimbabwe Rhodesia
S 21	Bulk Grain Handling Development Project	Grain Marketing Board
S 22	Agricultural Investigation Report Supplementary Notes	Peter Thomas and Associates, Consultants
S 23	Agricultural and Rural Development, Authority Annual Report and Accounts for the Year Ended 30th June, 1979	Agricultural and Rural
S 24	African Guide 1981	World of Information
S 25	New African Yearbook 1981-82	IC Magazines Ltd.

APPENDIX II BACKGROUND

APPENDIX II BACKGROUND

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Table A.2-1-1 Population Estimates

(Unit: thousand)

A. National Total		
<u>Year</u>	<u>As at 30th June</u>	<u>As at 31th December</u>
1901	710	-
1910	880	-
1920	1,130	-
1930	1,430	-
1940	1,940	-
1950	2,730	-
1960	3,840	-
1970	5,310	5,400
1971	5,500	5,590
1972	5,690	5,780
1973	5,890	5,980
1974	6,080	6,180
1975	6,280	6,390
1976	6,490	6,600
1977	6,700	6,810
1978	6,920	7,020
1979	7,130	7,240
1980	7,360	7,480
1981	7,600	7,730

Sources: Monthly Digest of Statistics, November, 1982

Table A.2-1-2 Gross Domestic Product at Factor Cost by Industry of Origin

(Unit: \$ million)

Description	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Agriculture and forestry	234	215	315	323	350	334	305	316	462	738
Mining and quarrying	76	104	136	131	152	149	158	191	267	217
Manufacturing	297	343	421	447	480	460	514	679	844	1,098
Electricity and water	38	41	42	50	57	56	64	67	75	88
Construction	74	81	82	94	88	84	68	78	84	126
Financial and insurance	53	59	73	86	92	102	109	126	161	189
Real estate	39	43	46	44	47	47	45	44	43	47
Distribution, hotels and restaurants	192	198	258	258	262	242	296	367	479	620
Transport and communications	114	122	138	159	172	184	191	209	230	262
Public administration	79	93	109	130	163	204	241	266	287	352
Education	43	48	55	65	73	76	86	98	169	253
Health	27	28	33	38	43	49	54	63	73	63
Domestic services	35	37	40	45	49	52	54	53	65	74
Other services, n.e.s.	65	71	85	98	105	113	120	132	185	159
Less imputed banking service charges	-30	-33	-42	-52	-56	-65	-69	-81	-108	-139
Gross domestic product	1,136	1,450	1,791	1,916	2,077	2,087	2,236	2,608	3,316	4,147
Gross domestic product at 1969 prices	1,202	1,212	1,301	1,303	1,285	1,189	1,170	1,188	1,322	1,483

Notes: (1): The use of 1969 here as the price base does not imply that 1969 in the intended general for all series.

(2): The 1980 and 1981 figures are provisional estimates.

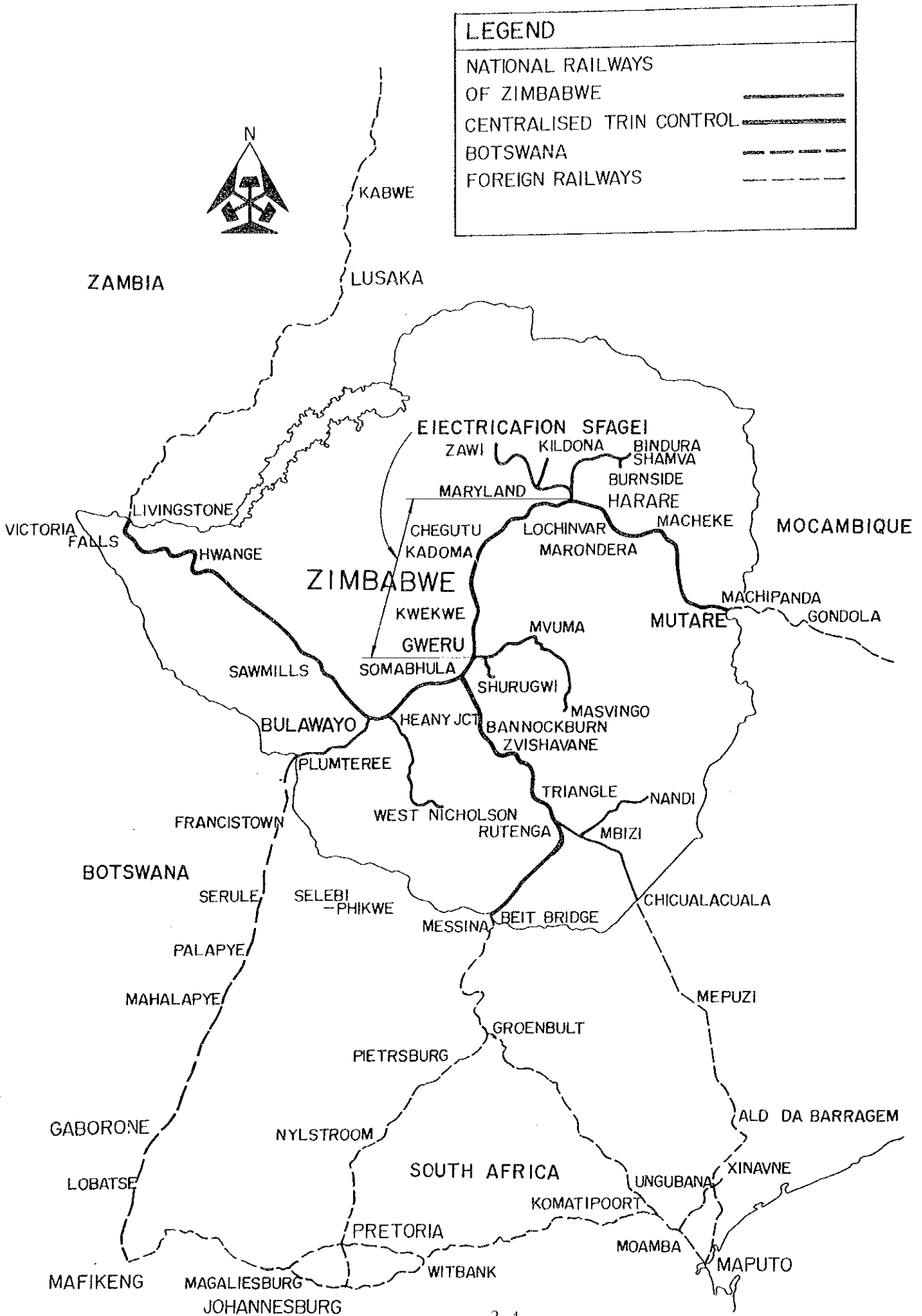
(3): The 1979 and 1980 figures have been revised.

(4): Source : Monthly Digest of Statistics, November, 1982.

Table A.2-1-3 SUMMARY OF NOTIFIABLE DISEASES OF MIDLANDS PROVINCE: NOVEMBER 1982

Disease Cases Reporting Health Districts	Amoebiasis	Anthrax	Cerebrospinal Meningitis	Diarrhoeal Disease	Diphtheria	Gonorrhoea	Leprosy	Malaria Clinica	Malaria + verified	Measles	Poliomylitis	Rabies	S. Haematotium	Syphilis	Tetanus Neonatal	Trachoma	Trypanosomiasis Pulmonary TB +	Pulmonary TB -	Non-Pulmonary	Typhoid Fever	Viral Hepatitis	Whooping Cough	Tick Typhus	Others (Specify)	Rubella	Chicken Pox	Mumps	Chamroid	
Mberengwa	29			656		82	102	4	87			481	46				8	3	3	3	1	10							
Chikomba				64		37	77		5	1		33	4	4	31	1						7					3		
Takawira		1		37		10			10			57	13				2						1						
Manyame									14								3			2									
Cheziya-Gokwe		9						16	17						2							5							
Mashambazhou				716	254		86	9	21				39				2				3	16		1	2	6	7		
Shurugwi				19	23		7		18			33	3			2						1							
Zvishavane				12					2								6	3		2									
TOTALS	33	10		1504	406		272	29	174	1		604	105		6	33	23	4	3	5	6	39	1	1	2	6	10		

Fig. A. 2 - 1 - 1 NATIONAL RAILWAY



APPENDIX III THE PROJECT AREA

APPENDIX III. THE PROJECT AREA

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3-1 General Feature

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Sources: 1982 Population Census,
Population by division of administration area.

Table A.3-1-1 Provisional Results of 1982 Census

<u>Midlands</u>				
<u>District Councils</u>	<u>Population</u>	<u>Household</u>	<u>Population Total</u>	<u>Household Total</u>
Cheziya Gokwe				
Chemagora sscfa	1,625	253	-	-
Gendavaroyi	7,348	1,375	-	-
Gokwe	168,513	28,221	-	-
Kana	23,254	3,984	-	-
Mafungabusi	7,873	1,334	-	-
Sebungwe	19,854	3,287	228,467	38,454
Chikomba				
Manyeni	7,708	1,571	-	-
Narira	26,613	5,370	-	-
Sabi North	62,902	12,640	97,223	19,581
Manyame				
Chiwundura	13,608	2,322	-	-
Lower Gweru	33,197	5,275	46,805	7,597
Mashambazou				
Silobela	34,977	5,441	-	-
Silobela sscfa	1,388	167	-	-
Zhombe	73,410	11,966	109,775	17,574
Mberengwa				
Mberengwa	150,777	24,471	150,777	24,471
Shurugwe				
Mashaba	3,526	602	-	-
Shurugwe	37,191	6,529	41,717	7,131
Takawira				
Chilimanzi	42,144	7,855	42,144	7,855
Zvishavane				
Bungowa sscfa	247	64	-	-
Mazvihwa	5,677	1,005	-	-
Runde	37,399	6,214	-	-
Ungova	12,140	2,059	55,463	9,342

Table A.3-1-2 Provisional Results of 1982 Census

<u>Rural Councils</u>	<u>Population</u>	<u>Household</u>	<u>Population Total</u>	<u>Household Total</u>
Belingwe				
Rural	12,519	3,129	-	-
Bannockburn	293	76	-	-
Belingwe	1,323	355	-	-
Dadaya	95	28	-	-
Zvishavane Township	26,758	8,538	-	-
Vanguard Mine	611	184	41,599	12,310
Charter				
Rural	8,775	2,039	-	-
Chivhu Township	3,439	915	-	-
Ialapanzi	4,714	1,518	-	-
MVuma	5,035	1,316	-	-
The Range	1,210	310	23,173	6,098
Chitenderano				
Chenjiri	3,275	520	-	-
Chitenderano	2,508	406	-	-
Copper Queen	2,081	306	-	-
Sachuru	3,681	676	-	-
Gokwe Resettlement	8,018	1,337	19,563	3,245
Chivhu				
Hampshire Majoi	643	133	-	-
Lancashire	4,212	540	-	-
Maronda Mashanu	1,017	252	-	-
Mtoro	810	142	-	-
Wiltshire	7,373	1,101	14,055	2,173
Featherstone				
Rural	3,529	941	3,529	941
Gwelo Selukwe				
Rural	17,346	4,073	-	-
Guinea Fowl	1,028	305	-	-
Tokwe Resettlement	4,582	808	-	-
Shurugwe S Reset.	1,757	299	24,715	5,490
Que Que				
Rural	20,685	5,432	20,685	5,432
Kubatana Turgwi				
Gamwa	989	141	-	-
Jobolinko	672	121	-	-
Tokwe	701	112	2,362	374

Table A.3-1-3 Provisional Results of 1982 Census

<u>Rural Councils</u>	<u>Population</u>	<u>Household</u>	<u>Population Total</u>	<u>Household Total</u>
Vungu Upper Nogozi				
Rural	7,670	1,247	-	-
Somabhula	231	100	7,901	1,347
<u>Urban Authorities</u>				
Gweru Municipality				
Ascot	5,335	1,629	-	-
Mambo	3,979	714	-	-
Monomotapa	4,823	1,483	-	-
Mkoba	43,311	10,974	-	-
Senka	2,583	518	-	-
Other	18,887	5,416	78,918	20,737
Kwekwe Municipality				
Amaveni	11,187	2,806	-	-
Moizo	24,384	5,894	-	-
Other	12,036	3,115	47,607	11,815
Redcliff Municipality				
Redcliff	4,462	1,349	-	-
Rutendo	5,130	1,399	-	-
Torwood	124,423	5,028	22,015	5,776
Shurugwe TC				
Makusha	2,312	619	-	-
Sebanga	5,550	1,376	-	-
Shurugwe Peak	2,506	580	-	-
Shurugwe Township	2,983	825	13,351	3,400
<u>Total Midlands</u>			<u>1,091,844</u>	<u>211,143</u>

Table A.3-1-4 Provisional Results of 1982 Census

<u>District Councils</u>	<u>Population</u>	<u>Household</u>	<u>Population Total</u>	<u>Household Total</u>
<u>Masvingo</u>				
Batanai				
Maranda	33,490	6,242	-	-
Matibi No.1	39,837	7,670	73,327	13,912
Bikita People's				
Bikita	99,339	18,958	-	-
Matazi	34,489	5,988	133,828	24,946
Gaza Komanani				
Gonakudzingwa sscfa	509	76	-	-
Matibi No.2	31,012	5,521	-	-
Sangwa	17,400	3,615	-	-
Sengwe	14,248	2,744	63,169	11,956
Gutu				
Chikwanda	42,907	7,974	-	-
Denhere	3,818	738	-	-
Dewure sscfa	7,365	1,272	-	-
Gutu	108,957	21,022	-	-
Mazari sscfa	175	24	-	-
Nyazvidzi sscfa	4,890	979	-	-
Serima	9,019	1,738	177,131	33,747
Masvingo				
Chikungurube sscfa	567	143	-	-
Mshagashe sscfa	3,328	583	-	-
Mshawasha sscfa	7,665	1,015	-	-
Mtilikwe	16,094	2,941	-	-
Nyajena	40,165	6,799	-	-
Nyanda	34,892	6,283	-	-
Zimutu	12,192	2,272	-	-
Zinyaningwe sscfa	2,010	317	116,913	20,353
Nyaningwe				
Chibi	103,656	18,072	-	-
Mashaba	34,052	5,723	137,708	23,795
Zaka				
Ndanga	137,891	26,103	137,891	26,103

Table 3-1-5 Provisional Results of 1982 Census

<u>Rural Councils</u>	<u>Population</u>	<u>Household</u>	<u>Population Total</u>	<u>Household Total</u>
Chiredzi				
Rural	8,477	2,280	-	-
Buffalo Range	1,174	274	-	-
Chiredzi Township	10,257	2,828	-	-
Hippo Valley	35,249	10,072	-	-
Mkwasiné	15,602	4,980	-	-
Triangle	32,347	8,996	-	-
Resettlement	7,191	1,210	110,297	30,640
Gutu Chatsworth				
Rural	2,834	851	-	-
Chatsworth	526	180	-	-
Soti Source Resett.	3,787	634	7,147	1,665
Nyahunda				
Mungesi	812	259	-	-
Nyahunda	3,821	532	-	-
Nyika Growth Point	1,035	218	5,668	1,009
Victoria				
Rural	17,382	4,052	-	-
Mashava Area	16,290	5,514	-	-
Mukorsi Resettlement	5,729	874	39,401	10,440
<u>Urban Authority</u>				
Masvingo Municipality				
Mucheke	20,837	5,541	-	-
Other	9,805	2,449	30,642	7,990
Other				
Gonarezhou NP	779	322	779	322
<u>Total Masvingo</u>			<u>1,033,901</u>	<u>206,878</u>

3-2 Physical Conditions

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3-2-1 Geology

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Fig. A.3-2-53	Geological Survey	3-80

3-2-1. Topography

1. Progress of the Field Survey

The progress of the field survey which was carried out by the Study Team of JICA during the period from December 1982 to March 1983 is briefly summarized in this paragraph.

Geological survey was performed in the purposes (i) to clarify geology and geological structure of the study area (ii) to investigate detailed geology around the survey point (iii) to determine to geophysical site.

These survey was carried out by field survey, analyzing 1/50,000 topo-maps, reviewing existing reports and analyzing aerial photographs.

Areal geological survey was largely assisted by analyzing topo-maps, aerial photographs and reviewing existing reports. Most of survey works was focussed on the purposes (ii) and (iii).

The names which has used in the report are due to the following existing reports.

"An Outline of the Geology of Rhodesia" by J.G. STAGMAN, D.Sc., C. Eng., F.I.M.M. PHODESIA GEOLOGICAL SURVEY.

2. Geology of the Study Area

(1) Drainage

The drainage of the Area is effected by three major rivers Tokwe, Runde, and Mwenezi and their tributaries. They pass through the study area with their headwaters lying to the north and west, on the central watershed of Zimbabwe. They are roughly parallel to one another, and drain in a general southern direction for approximately 20°E.Lat. and then swing gradually south-east-ward.

The Tokwe river rises in Iron Mine Hill between Mvuma and Gweru and leaves southern boundary of the Area in Chibi C.L. at an altitude of 600 m. This river joins the Ngezi and Shase river at near Mashava. These two tributaries flow for about 100 km through Chilimanzi C.L. in a general southerly direction, but other tributaries flow for a short time, and drain the area soon after a downpour during the rainy season. The gradient of the river bed is about 49/1,000 in the Area, and the length is about 183 km. Down the confluence of the Ngezi and the Shase river has carved steep banks.

The Runde river which is the biggest river in the Area rises in Gweru and centers at an altitude of 1,040 m, to leave the eastern boundary in Matibi No.1 C.L. at 540 m. It has many major tributaries, -Musavezi, Shabi, Ngezi, and Chingewezi river-, and drains across the Area from north-west to south-east direction. The main stream and the major tributaries meander and have carved steep banks. The gradient of the river bed is about 2.9/1,000 in the Area, and the length is about 175 km.

The Mwenezl river rises in the east of Mberengwa and enters at an altitude 960 m, to leave the southern boundary in Mberengwa C.L. at 520 m. It has three major tributaries -Njoro, Mondi and Mushawe river- and drains at the south-eastern end of the Area. The drainage system is parallel pattern and rectilinear. The gradient of the river bed is about 3.2/1,000 in the Area, and the length is about 138 km.

The drainage system is characterized by geology. It is classified into 3 areas, upstream area, mid-stream area, downstream area. (shown in Fig. A.3-2-1) The upstream area shows three like pattern and has many tributaries. It consists of the Older Gneiss Complex and the Younger Granite, of which the rocks are hard and homogeneous. The relief is mostly flat plane. The mid-stream area shows trellis pattern, and has few tributaries. It consists of the Older Gneiss Complex and the Younger Granite, and is characterized by many dolerite dykes. The relief is hilly ground which consists of dwala, bronhardt, and castle koppie. The drainage is mostly controlled by faults. Most of the tributaries of the major rivers flow for a short distance and are fast flowing owing to steep gradient.

The downstream area shows parallel pattern. The relief is rolling plane and low hilly ground. It consists of the Basement Schist Complex, the Limpopo Mobile Belt, the Old Gneiss Complex and the Younger Granite. The major streams meander and most of the tributaries of the major rivers flow rectilinear eastwards and southwards.

(2) Relief

Most of the Area lies between 1,400 m and 500 m above sea level. The highest point on the Area is Mt. Buhwa (1,627 m) of Bulawayan rocks about 40 km south-east of Zvishavane, and rises 800 m above the surrounding country. This rocks form long, high, well

wooded ridge trending north-eastward. Generally the land slopes gently north to south. (shown Fig. A.3-2-2)

The differences in topographical expression of the major rock types are very marked. The Basement Schist Complex forms high, long, well wooded ridges, i.e., there are two major hills which lie in Mberengwa C.L. and Chibi C.L. trending north eastward, and near Zvishavane trending northward.

The Younger Granite forms hilly ground which has conspicuous features. These hills are named dwala, bornhardt and castle koppie owing to the shape. Where intersecting joints are well developed in this rock, the castle koppie predominates, and forms large blocks and scree of rubble occurs at their bases. Where the break-down of the rock is not so well controlled by vertical jointing, a dwala and bornhardt result, which have smooth steep flanks. These hills seldom reach up to 100 m above the nearby rivers. The Younger Granite are found in four parts in the Area. Except for some places the vast area of the "Older Gneiss" forms flat, featureless sandveld where the rocks are exposed in small areas and soil cover is less than about 2 m thickness. The granulitic gneiss forms hilly ground, but is featureless than the Younger Granite, and consist of small dwalas or castle coppies.

The wider mafic dykes usually weather to form low, rocky, tree-covered ridges. The particularly broad Great Dyke, however, forms a prominent line of hills, many of which are similar to the castle koppies of the granite.

(3) Vegetation

The natural vegetation of the Area is very scarce owing to cultivation and firewood taking. The distribution of vegetation was investigated in the 49 survey points and on the topo-maps and is classified as follows.

Cultivation area	41.3%
Dense bush area	0 "
Medium bush area	7.5"
Sparse bush area	51.2"
Plantation area	0 "

$$(49 \text{ points} \times 9 \text{ km}^2 = 441 \text{ km}^2)$$

(4) Geology

Geology of the study area consists of Basement Schist Complex, igneous rocks, metamorphic rocks, and alluvial deposits. Except alluvial deposits and intruded rocks all rocks are pre-Cambrian.

(5) Basement Schist Complex

Basement Schist Complex consists of Sebakwian Group, Bulawayan Group and Beitbridge Group.

(i) Sebakwian Group lies east of Vukwe Mountain (1,336 m) in a limited area and consists of schist, serpentite, quartzite, limestone, phyllite, and greenstone. In general it has a north trend.

(ii) Bulawayan Group consists of the Mberengwa Greenstone Belt and the Mweza Schist Belt.

The Mberengwa Greenstone Belt lies west of Vukwe Mountain. It is the least metamorphosed and disturbed, has a generally northerly trend and consists of metamorphosed, ultramafic rocks, sediments, andesitic pillow lavas and pyroclastic rocks. It has been folded

into a tight syncline on a north trending axis and east-west trending fault.

The Mweza Schist Belt lies in the center of the Area, strikes north-east and forms long narrow ridge-like hills. It is more deformed and metamorphosed than the Mberengwa Greenstone Belt, both by the adjacent Chibi Batholith to the north and the Limpopo Mobile Belt to the south.

It consists of an assemblage of mafic to ultramafic igneous rocks, but contains well intercalated non clastic sediments that are now recrystallized to tremolite schists, banded ironstone, fuchsite quartzite, calc-silicate rocks and limestone.

(iii) Beitbridge Group lies in the south-east corner of Maranda C.L., strikes north-east and consists of mostly sillimanite para-gneiss, and a few more fine grained tonalitic gneisses, banded ironstone, quartzite and dolomite.

(6) Limpopo Mobile Belt

A few kilometers south of the Mweza Schist Belt lies the boundary, where tonalitic gneiss of the Craton Marzin grades into granulite facies rock of the Limpopo Mobile Belt, and in the south it is bordered by the Beitbridge Group. This large zone, south of the boundary, is 30 km in width and consists of mainly south-dipping, tightly folded, plastically deformed strips, boudins and dismembered remnants of schist belt materials. It has a general north-north-east striking trend, but spectacular fold closures in lineated zones suggested domal structures.

It has been severely fractured in north-north-west and north-north-east directions, and forms intruded gabbroic and dorelite dykes. All the rocks are very fresh, have very few joints, have darker colours than their mineral composition could suggest and

weathering produces a red soil. In general they are very poorly exposed and the outcrops are restricted to the vicinity of water courses.

(7) Older Gneiss Complex

Older gneiss complex covers a large area from north to south in the Area and consists of tonalitic gneiss zone and granitic gneiss zone.

(i) Tonalitic Gneiss lies around the Mweza Schist Belt and the north part of the Chibi Granite. In general the exposure is very poor, and outcrops are restricted to the vicinity of water courses. These commonly take the form of low rounded outcrops and bare very small dwalas or bornhardt of fresh rocks. Rolling sandveld occurs between outcrops and the soil pale in colour tending to white. It generally is medium to coarse grained and well jointed, but well banded and massive rocks also occur.

Towards north part of the Area this rocks are cut by the ultramafic bodies and by numerous dolerite and metadolerite dykes. The contact zone between these rocks are very important as a source of ground water.

(ii) Granitic Gneiss lies in the north west of the Area. In general it is very poorly exposed. Flat or rolling sandveld covers much of the terrain and bare very small dwalas or bornhardt. It has a diverse lithology from migmatite to foliated leucocratic gneiss.

Typically it is finer grained than tonalitic gneiss and granitic rocks, has well developed jointing, and range from migmatite through banded to homogeneous foliated rocks. Some hills, i.e. the Mavinga Hills and the hill in the vicinity of the Jenya Fault, are better exposed and forming castle koppie, dwala, and bornhardt, and are well vegetated by variety of trees and between

outcrops there is rolling sandveld largely under cultivation.

(8) Mashaba Serpentite

Mashaba serpentite lies in the south-east corner of Shurugwi C.L. It has a variable topographic expression forming both hills and flat areas without exposure. These hills are named Shamba (1,344 m), Bungwe (1,251 m), rise over 200 to 250 m above surrounding country and forms a prominent land mark in Shurugwi C.L. In general the rock type is silicified weathered serpentite with jointed and coloured pale yellow brown, but fresh rocks are very dark green. The body dips steeply north-eastward.

(9) Younger Granite

Younger Granite consists of Umvuma Granite, Shabani Granite, Chibi Granite and Porphyritic Granite.

These rocks cut the Older Gneiss Complex and Basement Schist Complex, and are cut by numerous dykes and sheets.

(i) Umvuma Granite lies southern part of the Area. the outcrops consist mostly of bornhardts, dwalas and castle koppies. In general the most prominent rock type is a fine grained, whit granodiorite, but there are rare occurrences of medium to coarse grained rocks, and are poorly developed joints.

(ii) Shabani Grainte lies east of Great Dyke and is in contact with it. The rock body stretches northward and is cut by the Jenya Fault which has west-east trending and largest fault in the Area.

The rock is generally medium grained but there are rare occurrences of coarse grained rocks. In places within the main mass of the granite there is poorly developed foliation but generally the rock is massive. It has variable but generally good exposure. The

outcrops consist mostly of bornhards, dwalas and castle koppie. White to light grey coloured soils rich in quartz lie in the areas between outcrops. In outcrop, the granite commonly forms large, flat to rounded boulders.

The weathered surface is very rough and often covered by grey lichen.

(iii) Chibi Granite lies in the centre of the Area crossing diagonally, and north of Schist Belt. This granite consists of one large main body, has a total areal extent of 2,217 km² and width of between 3.5 and 15 km.

It is coarse to medium grained, leucocratic, and is in part a slightly porphyritic rock with a rough weathered surface. It has two major fracture strikes. One fracture strike is north-west trending. It breaks the Chibi Granite into a number of elongate hills and considerable relief.

Another one, striking north-north-east is not so closely spaced and in places contains quartz filled fissures and lenses. This granite cuts the gneisses and the schists, in turn it is cut by Great Dike and by dolerite.

(iv) Porphyritic Granite has the smallest body in the Younger Granite, lies along the northern end of the Limpopo Mobile Belt, has a continuous east-north-east trending body.

South of Mount Buhwa (1,627 m) it divides into several bodies and strikes east and northeast. The granite generally forms large characteristically smooth flanked hills which are steep on the north side and slope gently southwards. The granite is very coarse grained and contains numerous large potash feldspar, and large leucocratic xenoliths of the surrounding gneiss, in places measuring 25 mm in length, are found included in the porphyritic Granite. In general

it is well exposed, massive and unjointed. But toward the contact zone, the granite is strongly jointed and lineation is even more also show a similar joint and lineation.

(10) Great Dyke

Great dyke consists of great dyke and east dyke.

(i) Great dyke lies in a limited area of Runde C.L. and Mberengwa C.L. It consists of quartz gabbro, serpentite and pyroxenite.

(ii) East dyke occur discontinuously from north to south. The outcrops, where found, are low and bouldery and do not form the ridge-feature. It is a medium grained, grey-brown quartz gabbro. The contact zone is very important as a source of ground water.

(11) Dolerite Dyke

Mainly in the tonalitic gneiss zone of the Area occur a number of dolerite and metadolerite dykes in an easterly direction.

These dykes, vary from fine grained, partly grassy, basaltic to porphyritic and even to vesicular types. Some form low, rocky, tree-covered ridges and others were mapped as photo trace.

(12) Alluvial Deposit

A patch of alluvium is shown on the map. It occurs 10 km northwest of Zvishavane. This flat terrain is covered by thick, deepred, clay soils.

3. Geology of the Geophysical Survey Area.

Geological maps and short comments of the survey areas are shown in the figure A. 3-2-1, A.3-2-2. The list of the survey points is shown in Table A.3-2-1.

Table A.3-2-1 List of the Geological Survey Points

<u>Name of C.L.</u>	<u>Figure No.</u>	<u>Site No.</u>	<u>Site Name</u>	<u>Grid Ref.</u>
Chilimanzi	1	JA-01	GOVERE Sch.	TP560-192
	2	JA-02	CHIZHOU B.C.	TP382-364
	3	JA-03	MUWANI B.C.	TP540-385
	4	JA-04	SHASHE Sch.	TP561-055
	5	JA-05	VUDZI B.C.	TP435-216
Runde	6	JB-01	MARIRA B.C.	SN976-778
	7	JB-02	near RUSVINGE Sch.	RH033-671
	8	JB-03	near CHINAMI Sch.	RH090-770
	9	JB-05	MABASA B.C.	SN960-695
Mazviwa	10	JC-01	near COUNCIL OFFICE	TN160-345
	11	JC-02	MUROWA Sch.	TN273-287
Shurugwi	12	JD-01	MAKOTORE Sch.	TP045-065
	13	JD-02	MAZIVISA B.C.	TP105-086
	14	JD-03	HANKE B.C.	TP036-234
	15	JD-04	BANGA Sch.	TN053-945
	16	JD-05	MATUMBA Sch.	TP092-193
Mberengwa	17	JE-01	MWEMBE B.C.	TN009-158
	18	JE-02	RENGWE B.C.	TN010-068
	19	JE-03	CHINGEZI Sch.	QH933-083
	20	JE-04	MVUMBURA Sch.	QG856-818
	21	JE-05	MBIRASHAVA Sch.	TN083-175
	22	JE-06	MUDZIDZI Sch.	TN105-025
	23	JE-07	RUSINGE Sch.	SN937-032
	24	JE-08	BUKUTA B.C.	TN211-023
<u>Sub-total</u>	<u>24 Sites</u>			

<u>Name of C.L.</u>	<u>Figure No.</u>	<u>Site No.</u>	<u>Site Name</u>	<u>Grid Ref.</u>
Chibi	25	JF-01	MUTOTI Sch.	TM643-962
	26	JF-02	CHIGWIKWE B.C.	TN045-725
	27	JF-03	GORORO B.C.	TN818-025
	28	JF-04	MAKAMURE Sch.	TN497-262
	29	JF-05	CHISHAWA B.C.	TN440-390
	30	JF-06	MAKOVERE Sch.	TN306-660
	31	JF-07	TARU B.C.	TN320-540
	32	JF-08	BELLA Sch.	TN249-578
	33	JF-09	SHINDI B.C.	TN766-919
	34	JF-10	DAVIRA Sch.	TN356-319
	35	JF-11	DAVIRA B.C.	TN319-359
	36	JF-12	MASUNIRE STORE	TN256-425
	37	JF-13	BEFURE Sch.	TN222-840
	38	JF-14	CHISENGA Sch.	TN264-508
	39	JF-15	MADZIVADONDO B.C.	TN136-656
	40	JF-16	MUKOTOSI Sch.	TN166-841
Matibi No. i	41	JG-01	MATANDE Sch.	TM596-883
	42	JG-02	MASOGWE Sch.	TM590-831
	43	JG-03	PEMBA Sch.	TM400-894
	44	JG-04	MAKWIRE Sch.	TM436-837
	45	JG-05	MUSHAVA B.C.	TM448-675
Maranda	46	JH-01	MAZATESE B.C.	TM201-698
	47	JH-02	MUNYAMANI Sch.	TM252-709
	48	JH-03	LAAGER	TM213-638
	49	JH-04	CHEHOMA B.C.	TM318-625
<u>Sub-Total</u>	<u>25 Sites</u>			
<u>Total</u>	<u>49 Sites</u>			

4 Method of Geoelectric Resistivity Survey

For geoelectric resistivity survey a vertical survey using Wenner configuration was adopted. The Wenner configuration is widely used as it measures the a -value (apparent resistivity) of the ground depth which is equal to a (voltage electrode spacing). Geoelectric resistivity surveying is based on evaluating the a (apparent resistivity) of subsurface material by passing a known electric current through the ground and measuring the potential difference between two points. The current is applied to metal rods driven into the ground. (refer Figure A.3-2-3) The distance a is varied 37 times from 1.0 to 120 m. The voltage or potential difference is measured with two separate voltage electrodes located symmetrically on one line between the current electrodes. Major equipment used and their specifications are given in Table A.3-2-3.

(1) Drawing up the Vertical Resistivity Logs

The distribution of electrodes by Wenner's 4-pole configuration is shown in Figure A.3-2-3. The values measured at site of Geophysical Prospecting Survey are V (Voltage difference between P₁ and P₂) and I (electric current between C₁ and C₂). From these values the apparent resistivity (ρ_a) of the depth (a) which is equivalent to the distance between any two electrodes can be calculated by the following formula:

$$\rho_a = 2\pi a \frac{V}{I}$$

The ρ_a - a curve is given on full logarithmic sheet by plotting the apparent resistivity (ρ_a) against distance of electrodes (a).

A sample of ρ_a - a curve is shown in Figure A.3-2-A.

The Sundberg Standard Curve (Figure A.3-2-B) and Auxiliary Curve (Figure A.3-2-C) drawn based on theoretical calculations are used to analyse the boundary depth of each layer and the true specific resistivity value of formation from ρ_a - a curve drawn up.

The procedure using Figure A.3-2-D is explained below:

The first, the ρ_a - a curve plotted on a transparent full logarithmic sheet is moved parallelly on the Standard Curve, with ρ_a - axis of ρ_a - a curve and the ordinate of the Standard Curve, and with a - axis and the abscissa in the parallel position. Then the most similar curve to (A) - (B) part of ρ_a - a curve is selected from the Standard Curve. The zero point of the Standard Curve is then marked on the full logarithmic sheet as 0₁ point.

The readings of 0₁ point are :

$$\rho_1 = 430 \Omega - m, \quad d_1 = 0.8 m \quad \text{on the } \rho_a - a \text{ curve.}$$

These values signify that the apparent specific resistivity value from the ground surface to 0.8 m depth is 430 Ω -m. Further as the (A)-(B) part of ρ_a -a curve coincides with 1/2.5 line of the Standard Curve, ρ_2 , i.e., the true specific resistivity between 0₁ and 0₂ is calculated as follows:

$$\rho_2 = 430 \Omega - m \times 1/2.5 = 170 \Omega - m$$

As the next procedure, ρ_a -a curve is put on the Auxiliary Curve, 0₁ point marked on the full logarithmic sheet is fitted to zero point of Auxiliary Curve, and 1/2.5 line is traced from the Auxiliary Curve on the full logarithmic sheet as shown by dotted line of 0₁-0₂.

ρ_a -a Curve is then put on the Standard Curve again, and ρ_a -a curve is moved parallelly on the Standard Curve, sliding the zero point of Standard Curve on the dotted line of 0₁-0₂. And then the most similar curve with (B)-(C) part of ρ_a -a curve is selected from the Standard Curve. The zero point of the Standard Curve is marked on the full logarithmic sheet as 0₂ point. This 0₂ point shows the boundary depth between 2nd and 3rd layers as $d_2 = 2.4$ m.

As the line 2.5 of the Standard Curve fits the (B)-(C) part of ρ_a -a curve, the true specific resistivity value (ρ_3) of the 3rd layer is calculated as follows:

$$\rho_3 = 210 \Omega - m \times 2.5 = 520 \Omega - m$$

The boundary depth (d_3) between 3rd and 4th layers is determined as 7 m according to the aforementioned procedure.

The Vertical Resistivity Log which appears at right side of Figure A.3-2-D is obtained repeating the above procedure.

(2) Drawing up Geological Cross-Section

The geological cross-section is drawn up using the vertical resistivity logs obtained from the analysis of ρ_a -a curve. The procedure and method are similar to drawing up the geological cross section from drilling logs. The zones which show the same resistivity value on the cross-section are assumed to be the same layer. When the geological cross-section is drawn, the results of field reconnaissance and existing geological maps have to be referred in addition to the analysed resistivity values.

A geological log is drawn by identifying each layer with the classification notation according to the specific resistivity value as given under Section 3-2-4 "Hydrogeology" of the Main Report. Such log is illustrated on the right side of Figure A.3-2- D. In the case of location JA03 such logs are put together and the prospecting profile is drawn up as shown on Figure A.3-2-7. Some manipulation is required to fit the results into the drawing up of the profile. For example the notation of MW should be revised to HW for the layer (2.4 m - 7 m) and MW layer with the resistivity value of 6900 Ω -m should start at 55 m depth to achieve compatibility with other readings (GP-01, GP-02 and GP-04).

Figure A.3-2-15 shows an example of a simplified three layer structure. Figure A.3-2-16 illustrates dyke intrusions. In this case a layer with a lower specific resistivity exists inside the higher resistivity layer. Such cross-section as shown was assumed by observing the geological feature of the site.

Fig. A.3-2-A

Location : JA03/GP-3

Example of ρ_a - a Curve

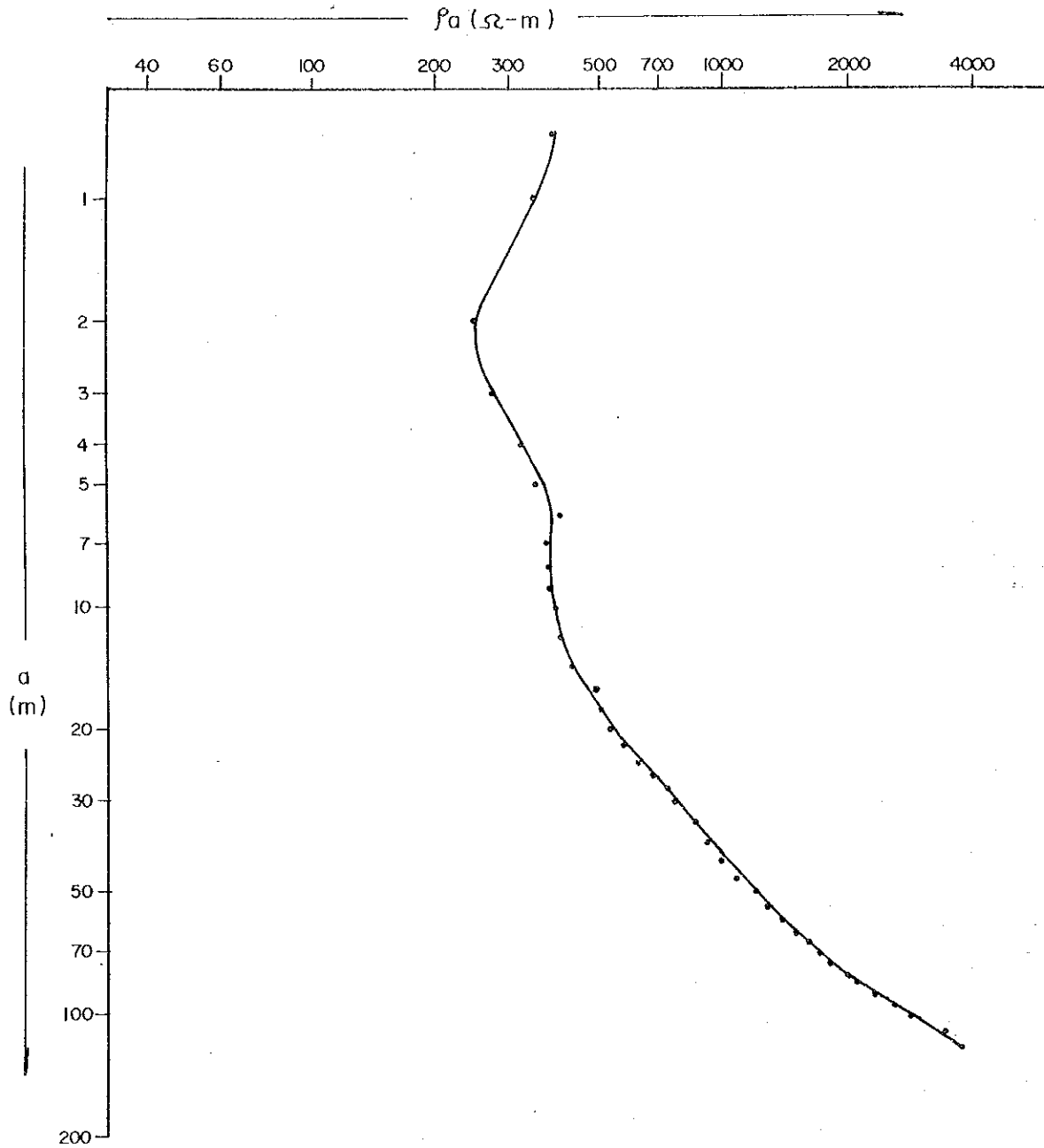


Fig. A.3-2-B
Standard curve

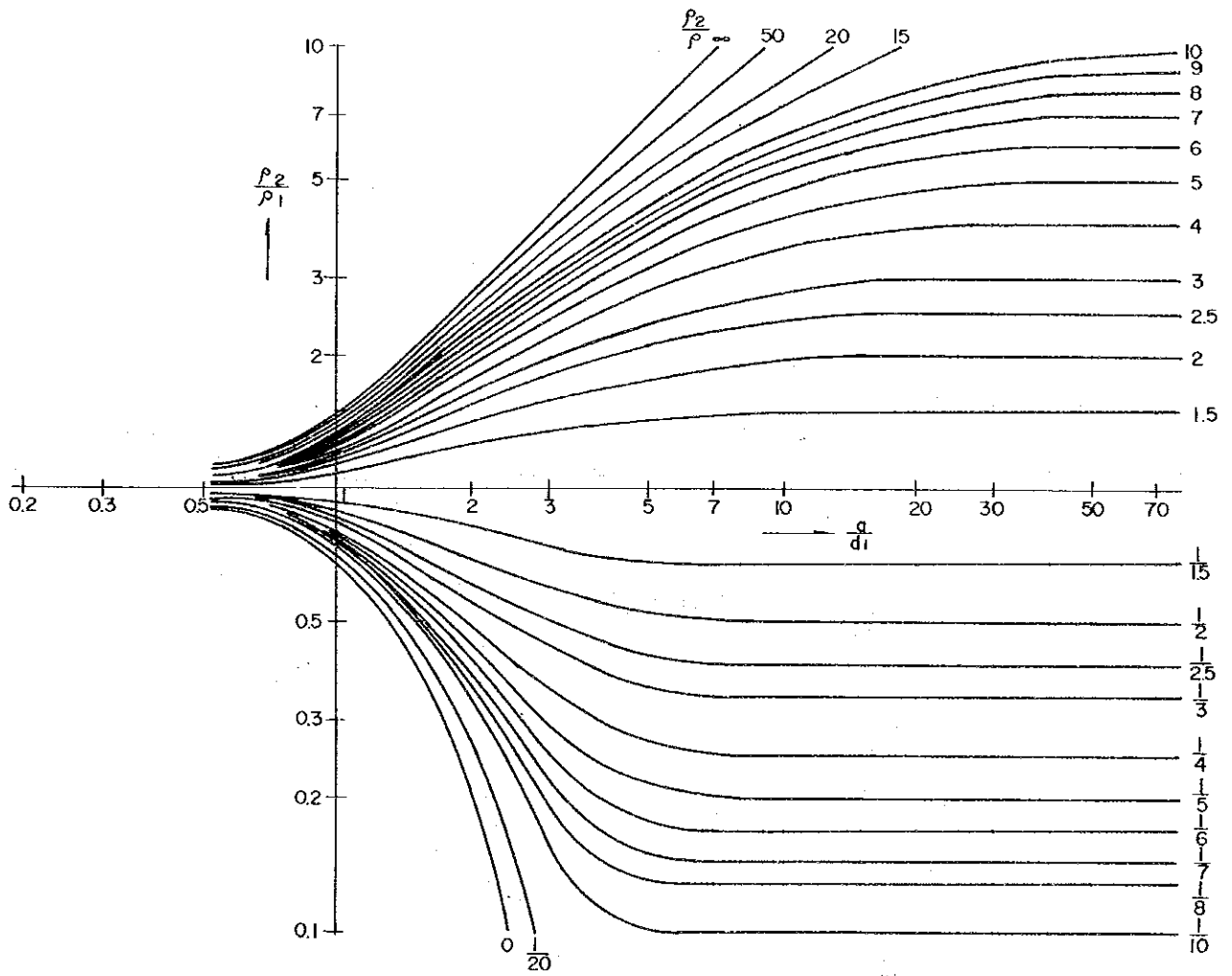


Fig. A.3-2-C

Auxiliary Curve

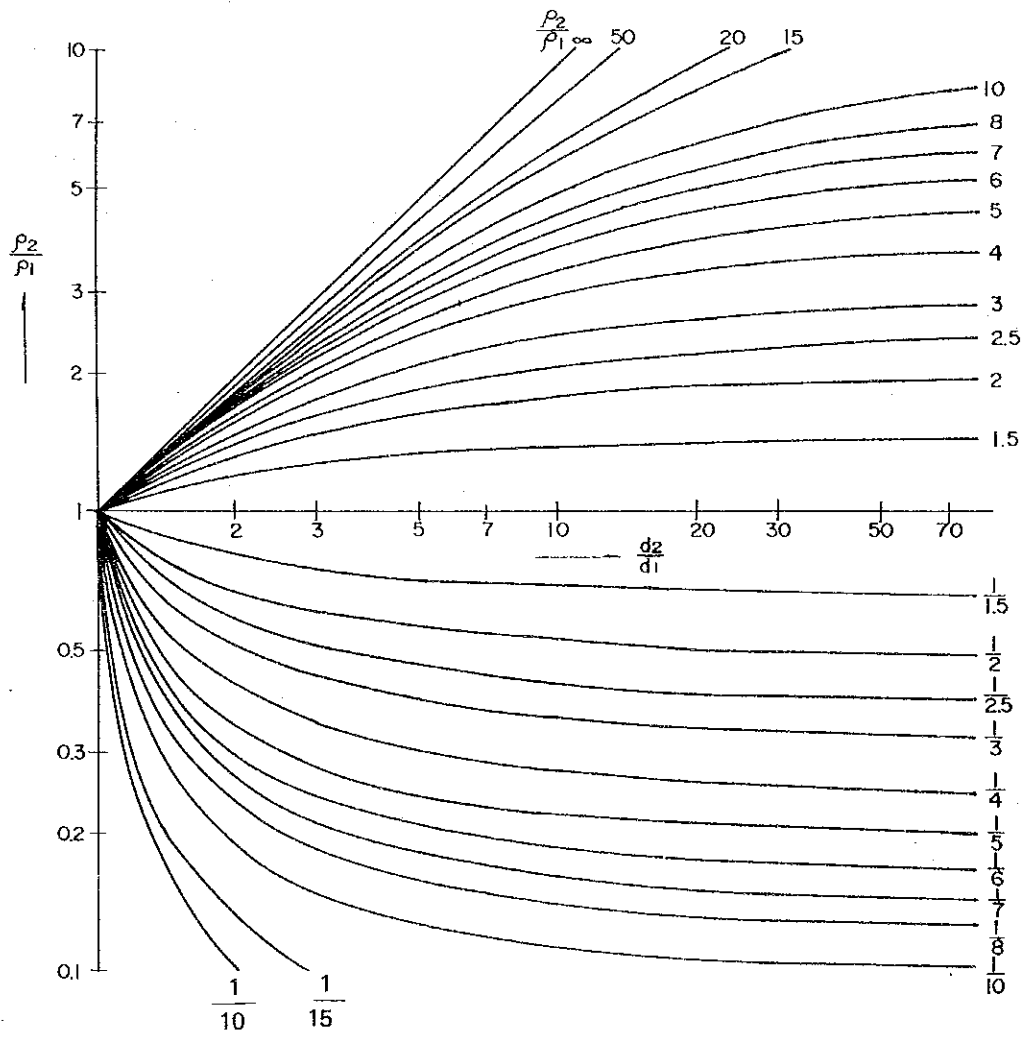


Fig. A.3-2-D

Location : JAO3/GP-3

Example of Analysis of $\rho_a - a$ Curve and Vertical Resistivity Log

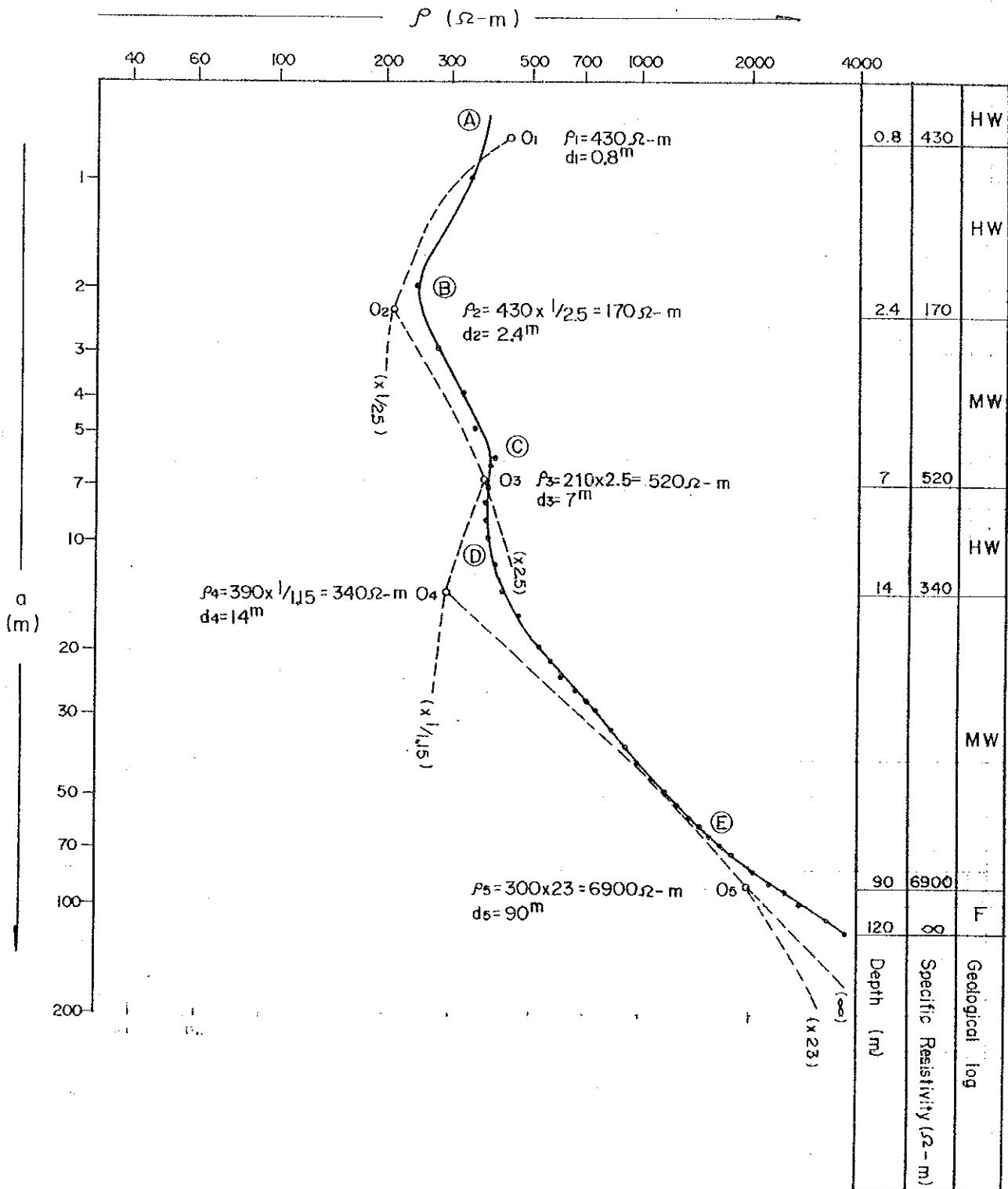


Fig. A. 3-2-1 Drainage System of The Survey Area

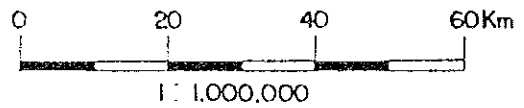
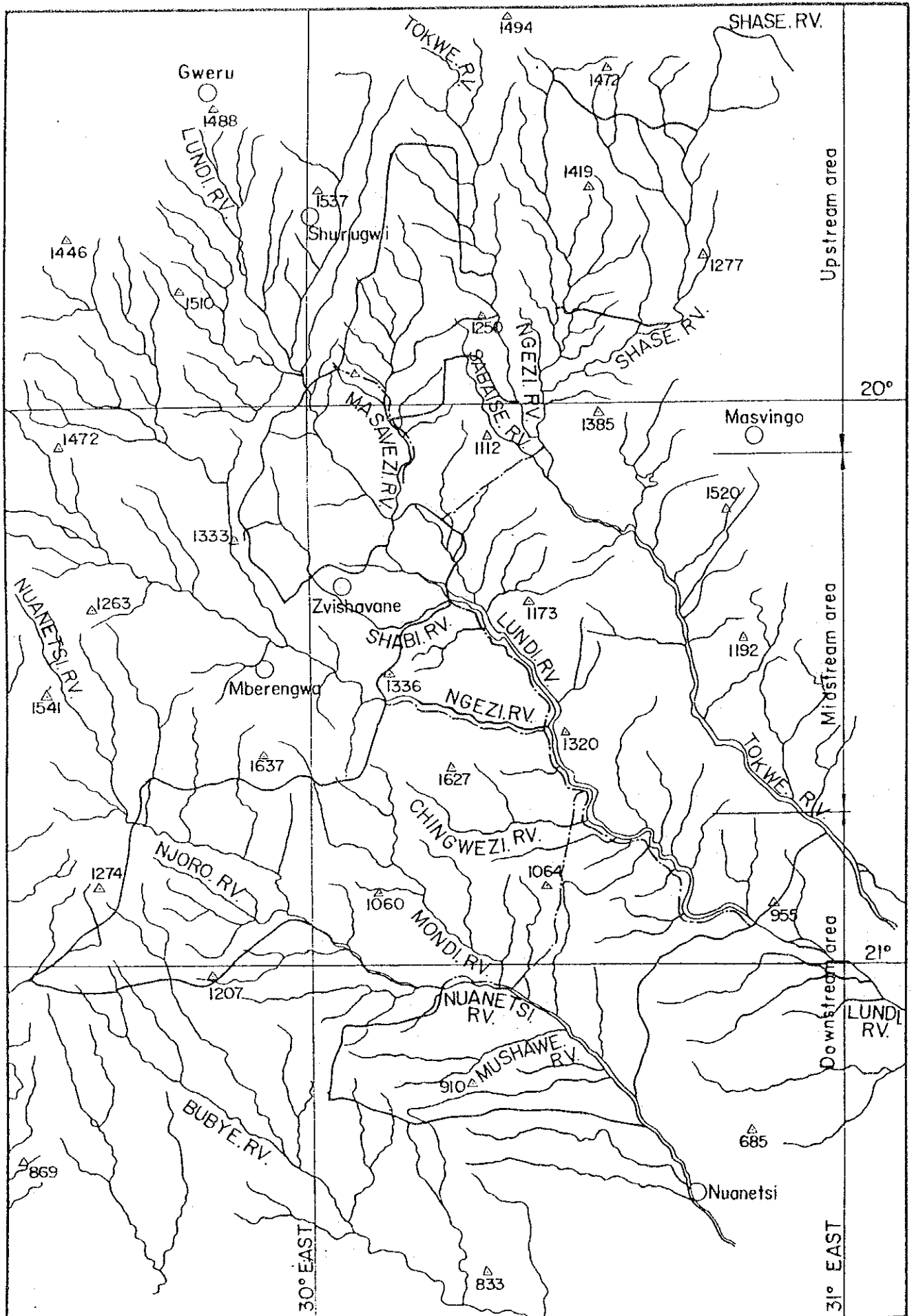


Fig. A. 3-2-2 Geographical Map of The Area

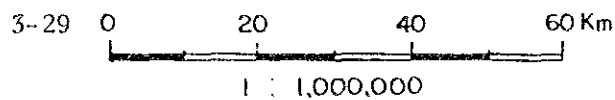
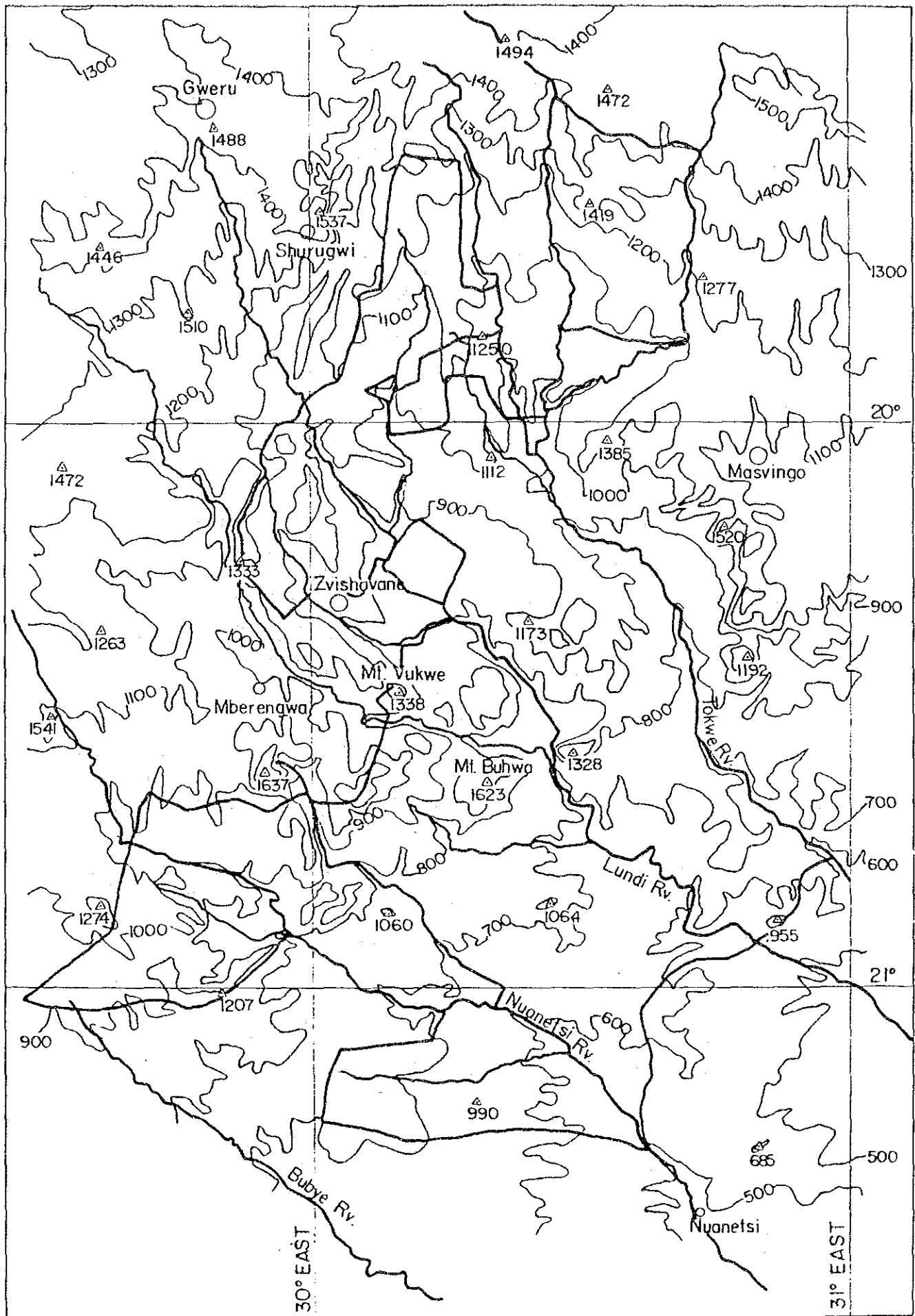


Fig. A.3-2-3

Current and Voltage Electrodes
for Wenner Configuration

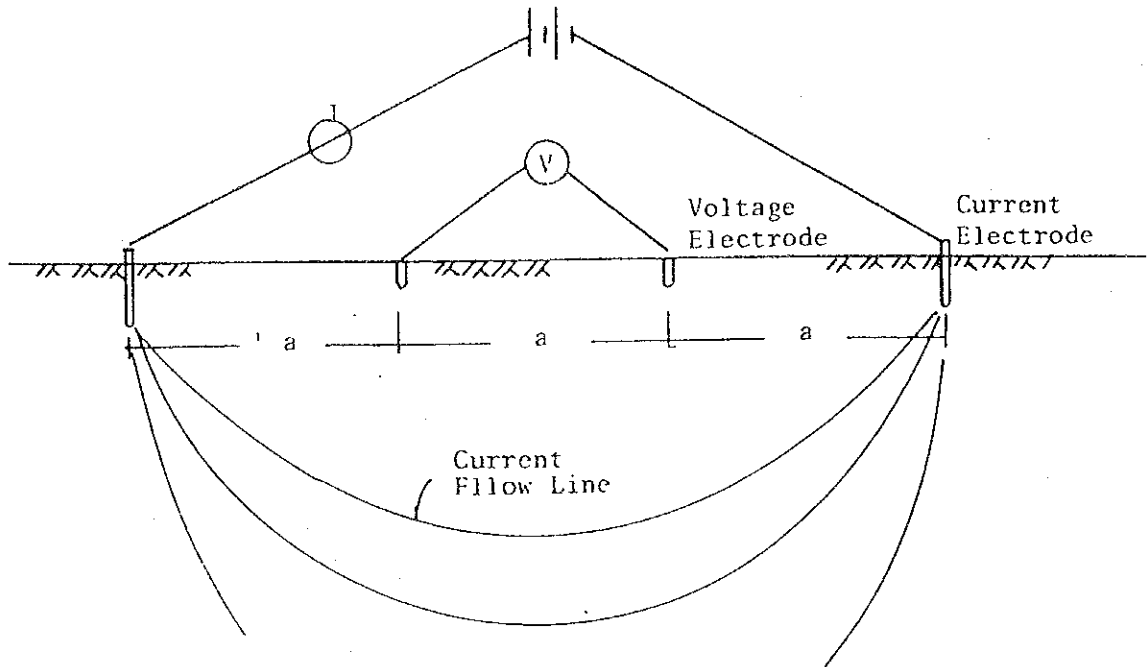
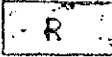

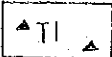
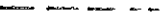
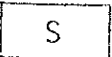

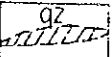
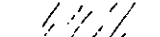
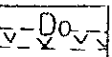

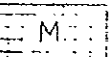
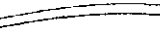
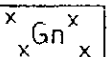
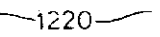
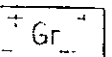

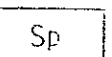

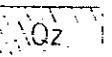

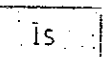

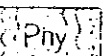

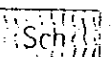


Table A.3-2-3 Major Equipment of Geoelectric Resistivity Survey

<u>Description</u>	<u>Type & Specification</u>	<u>Quantity</u>
Detector	Oyo ES-G2	2 sets
Level	Nikon E-6	2 sets
Pocket compass	Mikasa S-25	2 sets
Measuring tape	100 m long	8 pcs
Electric wire	200 m long	6
Electrode	ϕ 19 mm, 600 mm long	12
Dry cell battery	45V BM-1	30
Battery	12V	2
Hammer	2 lbs	10
Spare parts, others		2 sets

Fig. A.3-2-4

LEGEND FOR GEOLOGICAL SURVEY

	River Deposit		Geological Boundary
	Talus		Fault and Thurust
	Soil, Gravel		Air Photo Trend Line
	Quartz Vein		Joint
	Dolerite Dyke		Cross Section Line
	Ultramafic Rock		Road
	Gneiss		Contour at 20m interval
	Granite		River
	Serpentinite		Dam, Weir
	Quartzite		Service Center, Business Center or School
	Ironstone		Geophysical Survey Point
	Phyllite		Point of Water Quality Test
	Schist	HW	Highly Weathered
		MW	Moderately Weathered
		SW	Slightly Weathered
		F	Fresh