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AFRICAN DEVELOPMENT
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THE DEMOCRATIC REPUBLIC
OF THE SUDAN

**FEASIBILITY AND PRELIMINARY ENGINEERING
STUDY OF ROAD PROJECT EL OBEID-UM RUABA
THE SUDAN**

**INTERIM REPORT
ANNEXES**

OCTOBER, 1977

JAPAN INTERNATIONAL COOPERATION AGENCY

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TABLE 3-1 TOTAL POPULATION IN THE SUDAN

ANNEX III-1

Year	A) Total Population	B) Urban Population	C) The Percentage of Urban Pop. in Total Pop.	D) Rate of Yearly Increase of Total Population	E) Rate of Yearly Increase of Urban Population
	('000) (1)	('000) (1)	(%) B/A	(%) (1)	(%) (1)
1966	14,120	1,492	10.6		
1967	15,504	1,574	10.2	5.8	5.5
1968	14,936	1,661	11.1		5.5
1969	15,312	1,752	11.4	2.5	5.5
1970	15,695	1,848	11.8	2.5	5.5
1971	16,087	1,950	12.1	2.5	5.5
1972	16,489	2,058	12.5	2.5	5.5
1973	16,901	2,170	12.8	2.5	5.4
1974	17,324	2,289	13.2	2.5	5.5
Average			11.7 2)	2.6 3)	5.5 3)

Figures in A and B indicate estimates of questionable reliability.

Source: Dept. of Economics and Social Affairs, Statistical Office, Demographic Year Book 27th Issue, 1976
U.N. New York, N.Y. U.S.A.

Notes 1) Rates of Yearly Increase are calculated by the figures in Columns A and B.

2) Indicates average of percentage figures in Column C.

3) Indicates average annual growth rate from 1966 to 1974.

TABLE 3-2 POPULATION AND DENSITY BY PROVINCE IN 1955/56 AND 1973

ANNEX III-2

Province	Area km ² (A)	Population ('000)		Density (persons/km ²)		Average Growth Rate (I) Per Annum 1956-'73	Revised Population 1973	Average Growth Rate (II) Per Annum 1956-'73
		1955/56 (B)	1973 (C)	1955/56 (D)=B/A	1973 (E)=C/A			
Bahrel Ghazal	213,751	999	1,367	5	6	1.9	1,446	2.2
Blue Nile	142,138	2,069	3,914	15	28	3.8	4,065	4.1
Darfur	496,369	1,329	1,839	3	4	1.9	1,945	2.3
Equatoria	198,121	904	725	5	4	-1.3	766	-1.0
Kassala and Red Sea	340,655	941	1,472	3	5	2.6	1,557	3.0
Kordofan	380,546	1,762	2,010	5	5	0.8	2,202	1.3
Northern	477,074	873	902	2	2	0.2	954	0.5
Upper Nile	236,180	889	799	4	3	-0.7	845	0.3
Khartoum	20,971	505	1,113	24	53	4.8	1,178	5.1
Total	2,505,805	10,263	14,141	4	6	1.9	14,958	2.2

Source: Department of Statistics, Statistical Year Book, 1973

Note: 1) Average Growth Rate (I) per year is estimated by compound rate of change.

2) The total population is given by Dept. of Statistics, National Income 1972/73-1974/75. Provincial populations in column (3) are adjusted to the total.

3) The rates are estimated by using the Revised Population.

TABLE 3-3 LABOR FORCE BY OCCUPATION

ANNEX III-3

Occupation	Percentage (%)
Professional and Technical -----	1.9
Administrative and Managerial -----	0.4
Clerical and Related Scales -----	1.4
Salesmen -----	4.5
Services Workers -----	7.6
Agricultural, Animal and Forestry -----	71.6
Production, Transport, Operation -----	12.6
Total -----	100

Note: These figures are provisional and subject to revision.

Source: Population Census 1973 (Ministry of Planning,
Economic Survey, 1975/76)

TABLE 3-4 COTTON PRODUCTION BY VARIETY

ANNEX III-4

1973/74 - 1975/76

Variety	1973/74		1974/75		1975/76*		
	Acreage	Production in bales	Acreage	Production in bales	Production in bales Min. Max.		
Long Staple	824,500	1,009,000	838,000	790,500	593,523	355,695	449,111
Medium	196,500	210,400	231,000	240,000	227,839	142,260	172,642
Short	157,000	18,400	99,000	27,000	132,235	26,730	40,270
Experiments	-	-	-	-	3,932	4,398	4,894
Total	1,178,000	1,237,800	1,168,000	1,057,500	957,529	529,084	666,917

*Output of 1975/76 is an estimate.

Source: Cotton Public Corporation (Economic Survey, 1975/76)

TABLE 3-5 AREA PRODUCTION AND AVERAGE YIELD FOR SOME AGRICULTURAL CROPS

1973/74 - 1975/76

	1973/1974		1974/1975		1975/1976*			
	Production Ton	Average Yield kg/Fed.	Area Fed.	Production Ton	Average Yield Fed.	Estimated Production Ton	Average Yield kg/Fed.	
Dura	5,301,200	309	5,577,030	1,704,853	306	6,200,309	2,055,280	331
Dukhn	2,705,870	104	2,576,380	400,540	156	2,512,160	403,145	161
Groundnuts	1,725,303	315	1,785,290	929,910	521	2,065,740	930,765	451
Sesame	2,192,560	109	2,172,690	233,400	107	2,291,045	238,080	104
Wheat	420,072	562	591,437	275,265	467	713,790	397,030	556
Cotton	1,178,000	-	1,168,000	-	-	957,000	-	-
Total	13,523,000	-	13,870,000	-	-	13,783,000	-	-

* Estimated

Source: Ministry of Agriculture, Food and Natural Resources (Economic Survey, 1975/76)

TABLE 3-6 GUM ARABIC PRODUCTION 1970/71 - 1975/76

(Metric tons)

	1970/71	1971/72	1972/73	1973/74	1974/75	1975/76 (Estimates)
	44,355	25,949	21,194	22,000	52,000	30,000

Source: Forests Department, Ministry of Agriculture, Food and Natural Resources
(Economic Survey, 1975/76)

ANNEX III-7

TABLE 3-7 DOMESTIC PRODUCTION OF SUGAR AND THE RATIOS
OF PRODUCTION TO LOCAL CONSUMPTION
FOR THE SEASONS 1972/73 - 1975/76

Season	Domestic Production (in Tons)	Consumption (in Tons)	Ratio of Production To Consumption (%)
1972/73	112,641	250,000	45%
1973/74	120,571	269,754	45%
1974/75	128,651	257,917	50%
1975/76	124,000 (Estimated)	310,000	40%

Source: Sugar and Beverages Corporation (Economic Survey, 1975/76)

ANNEX III-8

TABLE 3-8 LIVESTOCK WEALTH ESTIMATES FOR THE FISCAL YEAR
1973/1974 (In Heads)

Province	Cattle	Sheep	Goats	Camels
Kordofan	1,989,850	2,961,330	1,004,850	1,231,300
Khartoum	57,980	91,480	346,140	54,060
Darfur	4,752,420	2,900,860	2,507,870	434,350
Blue Nile	1,196,470	3,623,970	2,403,320	252,140
Kassala	385,590	1,116,210	655,630	637,710
Northern	207,350	525,810	327,890	79,840
Upper Nile	1,850,820	697,810	1,242,650	-
Equatoria	628,610	478,420	861,300	-
Bahr El Ghazal	3,084,680	976,820	1,146,960	-
Total	14,153,770	13,272,710	10,496,610	2,698,400

Source: Ministry of Agriculture, Food and Natural Resources
(Economic Survey, 1975/76)

TABLE 3-9 GROSS DOMESTIC PRODUCT
ACCORDING TO THE CURRENT PRICES IN LS MILLION

G.D.P. at Current Market Prices ¹⁾	1967/66		1968/67		1969/68		1970/69		1971/70		1972/71		1973/72		1974/73		1975/74	
	mil. of pounds	share %	LS mil.	%	LS mil.	%	LS mil.	%	LS mil.	%	LS mil.	%	LS mil.	%	LS mil.	%	LS mil.	%
Agriculture	176.2	33.0	194.0	33.9	203.9	33.2	209.2	32.3	219.1	31.9	243.8	32.4	334.6	38.4	516.4	41.4	585.3	38.7
Manufacturing and Mining	49.4	9.3	54.9	9.7	57.3	9.3	66.8	10.3	69.2	10.1	76.8	10.2	82.9	9.2	111.2	8.9	142.9	9.5
Electricity and Water	16.6	3.1	16.3	2.8	16.6	2.7	16.5	2.6	16.6	2.4	16.9	2.2	17.5	2.0	18.6	1.5	20.9	1.4
Construction and Building	23.9	4.5	22.8	4.0	24.4	4.0	24.3	3.8	23.3	3.4	26.2	3.5	31.2	3.5	61.0	4.9	65.0	4.3
Wholesale Trade, Finance, Real- estate, etc.	154.0	28.9	162.7	28.4	178.9	29.1	146.4	22.6	158.6	23.1	179.8	23.9	197.0	22.0	271.5	21.8	354.4	23.4
Transport and Communication	33.4	6.3	33.6	5.9	36.1	5.9	51.1	7.9	50.7	7.4	51.3	6.8	61.5	6.9	74.8	6.0	89.4	5.9
Sub Total	453.5	85.1	484.3	84.6	517.2	84.2	514.3	79.5	537.5	78.4	595.0	79.1	734.7	82.0	1053.6	84.5	1257.9	83.2
Government Services	44.4	8.3	50.7	8.9	53.3	8.7	81.5	12.6	87.4	12.7	98.2	13.1	104.8	11.7	127.9	10.3	151.2	10.0
Customs and Others	35.5	6.6	37.3	6.5	43.4	7.1	51.2	7.9	60.9	8.9	58.9	7.8	57.3	6.3	64.7	5.2	101.7	6.8
Total	533.4	100.0	572.3	100.0	613.9	100.0	647.0	100.0	685.8	100.0	752.1	100.0	896.8	100.0	1246.2	100.0	1510.8	100.0
Price Index ²⁾							100.0		107.5		118.2		137.6		172.2		211.1	
G.D.P. at Constant Price ³⁾							647.0		638.0		636.3		651.7		723.7		715.7	

* This Figure does not contain the workers compensation in the southern region government.

Source: Dept of Statistics, June 1977

Note 1) Current price is used instead of factor cost in this publication.

2) Price index of the cost of living (1970-75) is applied in this Table.

The index is quoted from the Economic Survey, 1975/76. Min. of Planning.

3) The constant price as in 1970 was derived by dividing 1) by 2). It is calculated that G.D.P. has grown at 2.0% p.a. in terms of constant price.

TABLE 3-10 THE BALANCE OF PAYMENTS
(LS. MILLION)

ANNEX III-10

	71/72 Actual	72/73 Actual	73/74 Actual	74/75 Actual	75/76 1) Prov. Actual
(A) The Current Account					
(1+2+3)	-30.9	-1.5	-30.5	-160.3	-178.9
1. Exports	102.4	127.6	142.8	157.8	183.3
Cotton	55.3	71.7	73.8	63.1	90.0
Others	47.1	55.9	69.0	94.7	93.3
2. Imports	121.4	113.1	149.6	280.0	341.8
Government Purchases	37.3	39.8	48.1	137.7	211.8
Private Sector Imports	84.1	73.3	101.5	142.3	130.0
Trade Balances (1-2)	-19.0	14.5	-6.8	-122.2	-15.8
3. Invisible Account (net)	-11.9	-16.0	-23.7	-38.1	-20.4
Receipts	16.4	16.4	17.8	28.9	39.6
Payments	28.3	32.4	41.5	67.0	60.0
(B) Capital Account (net)	8.1	2.6	16.8	108.6	110.0
Drawings	20.1	17.9	41.3	111.5	142.0
Repayments	12.0	15.3	18.2	13.3	32.0
Compensations for Nationalized Companies	-	-	6.3	-	-
External assets of S.D.C.	-	-	-	10.4	-
(C) Errors and Omissions	2.6	-1.8	-1.5	0.2	-
(D) Balance of Payments	-20.2	-0.7	-15.2	51.9	-68.9

Note: 1) Preliminary Estimates

Source: Bank of Sudan (Economic Survey, 1975/76)

TABLE 3-11 QUANTITY AND VALUE OF MAIN EXPORTS DURING 1971-75
(VALUE IN LS MILLION, QUANTITY IN METRIC TON)

ANNEX III-11

	1971		1972		1973		1974		1975	
	Q.	V.	Q.	V.	Q.	V.	Q.	V.	Q.	V.
Cotton	294,585	69,906	256,315	73,088	743,726	84,311	78,646	43,202	156,652	70,193
Gum Arabic	41,971	8,030	40,758	8,729	33,941	7,403	19,987	14,157	15,643	7,548
Sesame	84,442	7,997	85,197	8,810	101,863	10,706	83,508	16,511	56,624	11,939
Groundnuts	115,061	9,327	113,740	9,637	138,425	12,993	99,052	18,163	204,960	34,382
Cotton Seeds	49,770	1,468	21,815	611	14,987	530	4,562	253	-	-
Dura	32,428	1,085	7,032	1,646	93,953	2,922	89,217	3,401	45,084	2,233
Hides and Skins	8,829	1,938	5,991	3,011	8,159	6,072	5,276	3,777	6,040	3,187
Others	-	14,683	-	17,702	-	27,235	-	21,486	-	22,980
	-	114,374	-	123,234	-	152,172	-	122,010	-	152,468

Source: Bank of Sudan (Ministry of Planning, Economic Survey, 1975/76)

TABLE 3-12 IMPORTS-BY COMMODITY

ANNEX III-12

(Value in LS. million)

	1971	1972	1973	1974	1975
Food Stuffs	21.65	27.75	33.93	56.47	60.45
Drinks and Tobacco	3.00	3.95	2.32	3.20	4.26
Crude Materials	3.37	1.55	1.52	33.98	28.20
Chemicals	12.88	14.30	18.95	27.21	40.16
Manufactured Goods	24.57	24.12	33.61	38.73	60.16
Machinery and Equipment	14.19	15.93	20.00	20.09	59.14
Transport Equipment	11.45	13.40	25.29	33.68	64.47
Textiles	25.33	16.91	16.23	24.15	43.06
Total	116.44	117.91	151.85	247.5	359.9

Source: Bank of Sudan (Economic Survey, 1975/76)

TABLE 3-13 TRANSPORT TRAFFIC IN THE SUDAN, 1973 1) ANNEX II-13

Transport Mode	Freight		Passenger	
	Ton-km (Billion)	(%)	Passenger-km (Billion)	(%)
Railway	2.8	75.7	1.00	71
Road	0.8	21.6	0.27	19
River	0.1	2.7	0.08	6
Air	0.0	0.0	0.05	4
Total	3.7	100.0	1.40	100

Source: National Planning Commission; Transport Statistical Bulletin, 1974

Note: 1) These figures do not include intra-urban traffic

FIG.3-1 ROADS AND BRIDGES PUBLIC CORPORATION ORGANIZATIONAL CHART 1977.

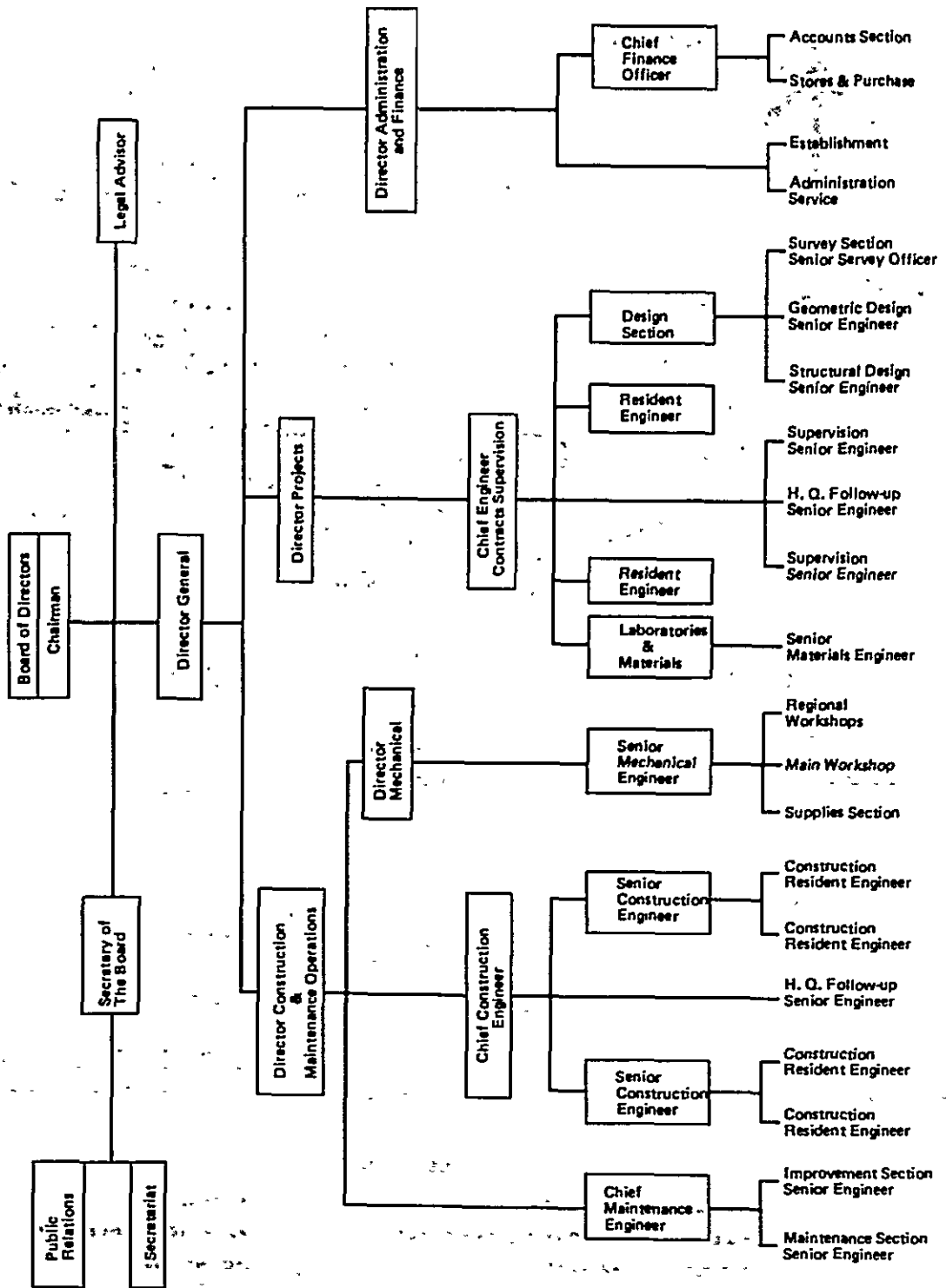
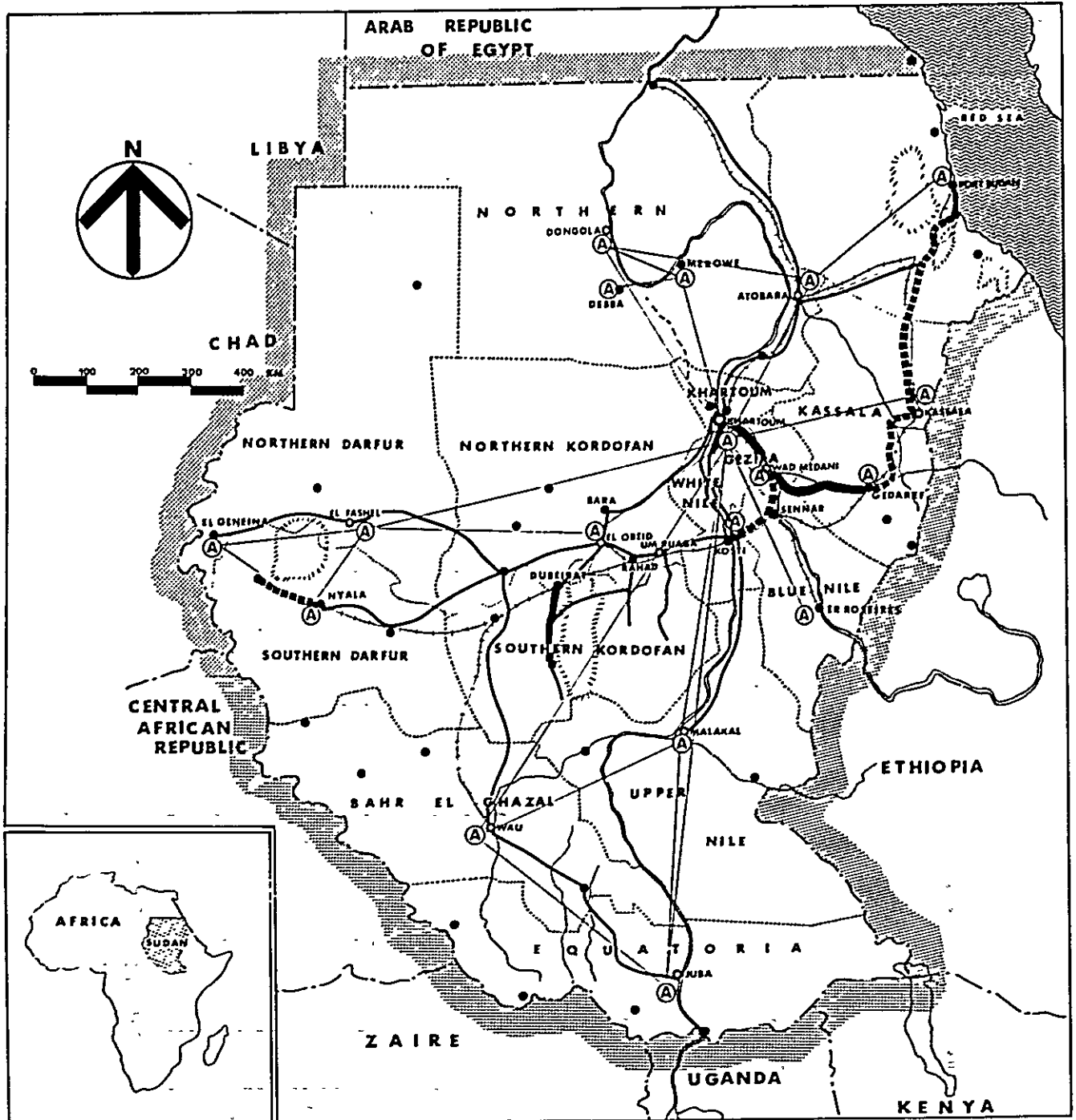


FIG. 3-2 TRANSPORTATION NETWORK, SUDAN



LEGEND

- | | | | |
|--|--------------------------|--|---------------------|
| | PAVED ROADS | | BOUNDARY |
| | UNDER CONSTRUCTING ROADS | | PROVINCIAL BOUNDARY |
| | OTHER ROADS | | MOUNTAINS |
| | RAILWAYS | | |
| | AIRPORTS | | |

TABLE 3-14 ROAD CONSTRUCTION SCHEDULE

ANNEX III-16

Construction Segment	Length in km	Date of Completion
Wad Medani - Gedaref	235	February 1977
Gedaref - Kassala	220	October 1978
Kassala - Haiya	350	October 1978
Haiya - Suakin - Port Sudan	207	March 1978
Wad Medani - Sennar - Kosti	217	March 1979
Kosti - Bridge	800 (m)	March 1979
Nyala - Zalingei	210	

Source: R.B.P.C., Sudan, June 1977.

TABLE 3-15 LICENCED MOTOR VEHICLES

ANNEX III-17

Type of Vehicle	Passenger Cars	Buses	Lorries	Delivery Box Cars	Vans	Tractors Motorcycles	Others	Total
Year								
1970	25,387	2,003	10,817	7,770		2,030	802	49,484
1971	28,026	2,015	12,677	7,139		1,717	554	52,797
1972	29,407	2,782	15,813	7,819		2,259	660	59,450
1973	33,061	2,664	21,549	21,549		3,107	2,217	62,464
1974	38,143	3,137	22,908	11,227		2,543	1,121	79,079
Average Annual Growth rate (%)	10.2	11.7	20.6	9.6		5.8	8.7	12.4

Source: Transport Statistical Bulletin, 1975

TABLE 3-16-A GASOIL AND BENZINE CONSUMPTION
IN THE SUDAN 1)

ANNEX III-18

(1,000 Metric Tons)			
Year	Gasoil	Benzine	Total
1970	271	95	366
1971	298	97	395
1972	301	101	402
1973	323	105	428
1974	329	106	435
1975	349	116	465
1976 ²⁾	391	131	522
<hr/>			
Average Annual Growth Rate(%)	6.3	5.5	6.1

Source: 1) Transport Statistical Bulletin, 1975

2) Shell Company of the Sudan, June 1977

TABLE 3-16-B GASOIL AND BENZINE CONSUMPTION ON ROADS

(1,000 Metric Tons)			
Year	Gasoil	Benzine	Total
1970	110	95	205
1971	121	97	218
1972	128	101	229
1973	129	105	234
1974	132	106	238
1975	140	116	256
<hr/>			
Average Annual Growth Rate(%)	4.9	4.1	4.5

Source: Transport Statistical Bulletin, 1975

TABLE 3-17 RAIL PASSENGERS BY CLASS OF TRAVEL¹⁾

ANNEX III-19

Year	('000 persons)				
	Sleeper (Suppl.)	1st Class	2nd Class	3rd & 4th Class	All Classes
1970/71	20.3	65.5	192.2	3,139.2	3,417.2
1971/72	18.7	54.6	172.5	2,996.1	3,241.9
1972/73	28.4	87.6	236.4	3,029.8	3,382.8
1973/74	24.9	69.9	199.0	2,513.4	2,807.2
1974/75	24.9	79.4	233.9	2,608.6	2,946.5
1975/76 ²⁾	30.0	111.1	232.1	2,696.0	3,069.2

Source 1) Transport Statistical Bulletin, 1975.2) Sudan Railways Corporation, Annual Report, 1975/76.TABLE 3-18 SUDAN RAILWAYS TRAFFIC BY TYPE¹⁾

ANNEX III-20

Year	('000 tons)				
	Exported Traffic	Imported Traffic	Local Traffic	Livestock Equivalent	Total
Actual					
1969/70	843	1,384	725	53	3,005
1970/71	872	1,532	618	40	3,062
1971/72	923	1,460	505	20	2,908
1972/73	854	1,421	495	30	2,800
1973/74	697	1,379	477	28	2,581
1974/75	644	1,312	433	11	2,400
1975/76 ²⁾	815	1,494	346	16	2,673

Source: 1) Transport Statistical Bulletin, 1975.2) Sudan Railways Corporation, Annual Report, 1975/76.

ANNEX IV

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TABLE 4-1 POPULATION AND GROWTH RATE,
KORDOFAN PROVINCE AND SUDAN

ANNEX IV-1

	Population		Growth Rate	Sources
	1955/56	1973	per year	
Sudan Total	10,262,500	14,958,000	2.24 [§]	Department of Statistics, Ministry of National Planning, 1977.
	10,262,500	14,901,894	2.22	National Planning Commission, Sudan, <u>Economic Survey</u> , 1974.
Kordofan Province	1,762,000	2,202,346	1.32	
	1,762,000	2,099,121	1.04	Statistics Department, Northern Kordofan Province.

TABLE 4-2 URBAN POPULATION IN NORTHERN AND SOUTHERN KORDOFAN PROVINCES

ANNEX IV-2

Town	1964/65 Census 1)			1973 Urban Persons ²⁾ Present (B)	Urban Population Growth Rate Per Year, (A) to (B)
	Permanent Member of Private Households	Persons Present (A)	Of which In Private Households		
Northern Kordofan Prov.					
El Obeid	62,560	63,831	62,984	90,073	
En Nahud	19,770	20,038	19,220	26,005	
Um Ruaba	14,210	14,392	13,910	19,713	
Er Rahas	8,600	8,924	8,590	14,444	
Bara	6,140	6,431	6,060	8,927	
Sodiri	2,820	3,046	2,880	2,674	
Abu Zabad ³⁾	5,660	5,939	5,470	7,177	
Sub Total	119,760	122,601	119,114	169,013	4.10%
Southern Kordofan Prov.					
Dilling	11,910	12,696	11,890	19,216	
Kadugli	11,180	11,532	10,960	18,468	
Abu Korshola	5,120	4,970	4,860	5,274	
El Abassiya	4,470	4,667	4,420	4,801	
Muglad	4,270	4,709	4,180	6,936	
Talodi	4,030	4,250	4,100	7,738	
Rashad	3,260	3,555	3,260	3,588	
Babanousa ³⁾	7,460	7,092	6,760	12,051	
Abu Gebaha ³⁾	5,180	5,419	5,110	10,418	
Rigl El Foula ³⁾	3,750	4,131	3,610	5,294	
Sub Total	60,630	63,021	59,150	93,784	5.10%
All Towns Total	180,390	185,622	178,264	262,797	4.44%

Note: 1) Dept. of Statistics, Sudan. Population and Housing Survey, Urban Areas, Kordofan Province, 1964/66. (Khartoum, 1968)

2) Statistics Dept. of Northern Kordofan Province.

3) These towns were included in rural area at the 1964/66 census.

TABLE 4-3 DISTRICT POPULATION OF NORTHERN
AND SOUTHERN KORDOFAN PROVINCES, 1973

ANNEX IV-3

Province & District	Population Settled			Nomad	Total
	Urban	Rural	Subtotal		
<u>Northern Kordofan Province</u>					
Central Dist.	90,073	94,446	184,519	4,973	189,492
Eastern Dist.	34,157	281,481	315,638	20,634	336,272
Western Dist.	33,182	296,530	329,712	9,486	339,198
Northern Dist.	8,927	135,880	144,807	14,762	159,569
North-Western Dist.	2,674	63,851	66,525	137,523	204,048
Free Lance	-	-	-	67,509	67,509
Total	169,013	872,188	1,041,201	254,887	1,296,088
%	13.0	67.3	80.3	19.7	100.0
<u>Southern Kordofan Province</u>					
Miosaria Dist.	24,281	148,074	172,355		
Northern Hills Dist.	19,216	151,597	170,813		
Southern Hills Dist.	26,206	206,674	232,880	99,266	
Tagali Dist.	24,081	171,147	195,228		
Free Lance	-	-	-	35,716	
Total	93,784	677,492	771,276	134,982	906,258
%	10.3	74.8	85.1	14.9	100.0

SOURCES: Statistics Dept., Northern Kordofan Province,
Eastern Kordofan District Office and the Dept. of
Statistics, Sudan Government.

TABLE 4-4 POPULATION AND ITS GROWTH RATE IN URBAN AND RURAL AREAS
OF NORTHERN AND SOUTHERN KORDFAN PROVINCES, 1955/56-1977

ANNEX IV-4

	1955/56 Census (1956)	1964/66 Urban Census (1966)	1973 Census	1977 Estimate
(1) Population in both provinces	1,762,000 ¹⁾		2,202,346 ¹⁾	2,321,044
Yearly Growth Rate		1.321%	1.321%	
(2) Urban Population	123,340	185,622 ²⁾	262,797 ²⁾	312,792
Yearly growth Rate		4.65%	4.44%	4.44%
Northern Kordfan Urban Area		122,601 ²⁾	169,013 ³⁾	198,406
Yearly Growth Rate		4.09%	4.09%	4.09%
Southern Kordfan Urban Area		63,021 ²⁾	93,784 ²⁾	114,386
Yearly Growth Rate		5.09%	5.09%	5.09%
(3) Rural Population including Nomads	1,638,660		1,939,549	2,008,252
Yearly Growth Rate		1.00%	0.874%	0.874%
Northern Kordfan Rural Area			1,127,075	1,166,999
Southern Kordfan Rural Area			812,474	841,253
Yearly Growth Rate			0.874%	0.874%

Sources: 1) National Planning Commission, Economic Survey, 1974 (Sudan, 1975).
2) Population and Housing Survey, Urban Area, Kordfan Province, 1964/66.
3) Northern Kordfan Province Government

ANNEX VI-5 THE ESTIMATE OF POPULATION IN THE ZONES

The number of villages in each zone was counted on the photo mosaic at 1 : 48,000 produced in 1962, the map at 1 : 250,000 revised - 1975, and the photo mosaic at 1 : 25,000 produced by the JICA consultants in 1977. To classify the villages three classes were established, 330 houses for the largest villages, 150 houses for the second class, and 80 houses for the smallest. The results of these studies are shown in the following Table.

TABLE 1. NUMBER OF VILLAGES

ANNEX IV-5-1

Zone	Urban Area	Number of Villages			Total
		Largest	medium	Smallest	
1	El Obeid	-	1	33	34
2	-	2	-	28	30
3	-	1	2	21	24
4	-	-	7	13	20
5	Um Ruaba	-	2	41	43
6	-	1	2	16	19
7	-	2	2	19	23
8	Rahad	1	-	28	29
9	-	-	1	15	16
10	-	-	4	7	11
Total	3	7	21	221	249

Assuming a house is occupied by a family of five persons, the number of inhabitants in each zone is estimated in Table 2 on the next page.

TABLE 2. POPULATION BY ZONE

ANNEX IV-5-2

<u>Zone No.</u>	<u>Urban</u>	<u>Rural</u>	<u>Total</u>
1	105,738	13,950	119,688
2	-	13,340	13,340
3	-	10,970	10,970
4	-	13,950	13,950
5	23,141	17,900	41,041
6	-	9,614	9,614
7	-	12,922	12,922
8	16,956	12,270	29,226
9	-	6,750	6,750
10	-	12,800	12,800
Total	145,835	124,466	270,301

The ratio of urban population to total population by 1955/56 census was 7.0 percent and labourers in the agriculture sector comprised 85.8 percent of the total labour force (economically active population). Also, it was found that a family in the urban area averaged 5.5 persons, that families settled in a rural area had 4.9 persons, and that nomad families averaged 5.7 persons at that time. The average of the country as a whole was 5.1 persons per family. It was estimated that the population in the agriculture sector was 8,806,000, or 85.8 percent of the total population.

Since the rural population including nomads numbered 9,545,000, the people in the agriculture sector was 92.3 percent. By studying other figures in 1970 and 1973, it is considered that agricultural population embraces 85 percent of the rural population of the Sudan in 1977. When this percentage figure is applied to the Northern Kordofan Province the following Table 3 results.

TABLE 3. RURAL AND AGRICULTURAL POPULATION
IN NORTHERN KORDOFAN PROVINCE

ANNEX IV-5-3

	Rural population including nomad (1)	Agricul- tural population (1)x0.85 (2)	Nomad (3)	Agricul- tural population settled (2)-(3)	Rural population settled (4)=(1)-(3)	(2)-(3)/(4) (%)
Central Dist	102,941	87,500	5,149	82,351	97,792	84.2
Eastern Dist	312,816	265,894	21,365	244,529	291,451	83.9
Sub Total	415,757	353,394	26,514	326,880	389,243	84.0
Northern Province	1,166,999	991,949	23,916	928,033	903,083	86.1

The average ratio of agricultural population in both districts is 84.0 percent in the above Table. By applying this ratio, the population in each zone is established and is presented in Table IV-2.

TABLE 4. POPULATION BY ZONE, 1977

ANNEX IV-5-4

Zone	Rural population settled (1)	Agricultural population settled (1) x 0.84	Farm households (family)
1	13,950	11,718	2,344
2	13,340	11,206	2,241
3	10,970	9,215	1,843
4	13,950	11,718	2,344
5	17,900	15,036	3,007
6	9,614	8,076	1,615
7	12,922	10,854	2,171
8	12,270	10,307	2,061
9	6,750	5,670	1,134
10	12,800	10,752	2,150
Total	124,466	104,552	20,910

TABLE 4-5 AGRICULTURAL AND FORESTRY PRODUCTS
IN NORTHERN KORDOFAN PROVINCE

ANNEX IV-6

	Dukhn			Dura			Sesame		
	Area feddan	Yield kg/f.	Production ton	Area feddan	Yield kg/f.	Production ton	Area feddan	Yield kg/f.	Production ton
1970	718,046	196	140,955	476,046	162	77,309	1,061,370	143	152,098
1971	1,157,342	150	185,726	559,877	145	81,256	1,008,058	81	82,151
1972	1,564,925	68	106,699	731,831	137	100,029	1,778,940	91	161,722
1973									
1974	1,250,000	90	112,500	685,224	140	95,931	923,800	70	64,670
1975	1,257,000	100	125,700	672,954	140	94,214	950,000	75	71,290
1976	1,353,000	145	196,000	631,000	200	126,000	900,000	70	63,000
Average	1,216,719	119	114,597	626,155	153	95,790	1,103,695	90	99,155
	Groundnuts			Watermelon Seeds			Karkadeh		
	Area feddan	Yield kg/f.	Production ton	Area feddan	Yield kg/f.	Production ton	Area feddan	Yield kg/f.	Production ton
1970	244,569	172	41,949						
1971	840,597	91	76,420						
1972	810,597	91	73,690						
1973									
1974	578,830	320	185,230	410,430	97	39,812	47,481	13	617
1975	593,930	375	222,720	382,718	97	37,124	44,095	13	573
1976	418,000	375	157,000	389,885	90	35,090	20,276	10	203
Average	581,087	217	126,168	394,344	95	37,342	37,284	12	464
	Sanamakar			Gum Arabic			Cotton		
	Area feddan	Yield kg/f.	Production ton	Area feddan	Yield kg/f.	production ton	Area feddan	Yield kg/f.	Production ton
1970				312,240	50	14,667	945	15,612	
1971				350,900	50	16,950	595	17,545	2,063
1972				287,400	50	11,496		14,370	3,000
1973				134,600	50	6,730		6,730	
1974	6,842	540	3,695						
1975	2,460	540	1,328						
1976	6,482	540	3,500	133,000	50			6,650	
Average	5,261	540	2,841	243,628	50			12,181	2,532
								133	337

TABLE 4-5 AGRICULTURAL AND FORESTRY PRODUCTS
IN NORTHERN KORDOFAN PROVINCE

ANNEX IV-6

-continued-

	Charcoal ¹⁾ ton	Fire wood ¹⁾	
		Private Products m ³	Government Products m ³
1970			
1971	12,000	3,300	2,500
1972			
1973			
1974			
1975			
1976			
Average	12,000	3,300	2,500

Note: 1) Approximately estimated by taking half of the production of Northern and Southern Kordofan Provinces. The statistical data registering the production in both Kordofan Provinces in 1971 are as follows:

Charcoal	23,750 tons
Firewood---Private	6,601 m ³
---Government	5,000 m ³

Sources: Sudan Yearbook of Agricultural Statistics, 1974;
Current Agricultural Statistics CAS-Vol.1, No.2,
1976; H.M. AWOUDA, Forest Department, Production
& Supply of Gum Arabic 1970-1971; Statistics Dept.
of Northern Kordofan Prov.; and Dept. of
Agricultural Economics and Statistics, Ministry
of Agriculture, Khartoum.

TABLE 4-6 LIVESTOCK IN TWO DISTRICTS, 1976

ANNEX IV-7

		Rainy Season	Dry Season
Central Kordofan District ₁₎	Cattle	156,000	81,000
	Sheep	125,000	64,000
	Goats	109,000	56,000
	Camels	8,000	4,000
	Donkeys	3,000	2,000
	Horses	4,000	2,000
	Total	405,000	209,000
Eastern Kordofan District ₂₎	Cattle	250,000	75,000
	Sheep	125,000	17,500
	Goats	200,000	150,000
	Camels	130,000	100,000
	Total	705,000	342,500

Source: 1) Acting Commissioner for Animal Resources
Northern Kordofan Province, El-Obeid.

2) District Veterinary Office, Eastern District
Northern Kordofan Province, Rahad.

TABLE 4-7 LIVESTOCK TRADED

ANNEX IV-8

CENTRAL KORDOFAN DISTRICT ANIMAL MARKETS, JAN.-MAR. 1977^{a)}

	Jan. 1977		Feb. 1977		Mar. 1977		Total Jan-Mar.	
	(A) Brought	(B) Sold	(A) Brought	(B) Sold	(A) Brought	(B) Sold	(A) Brought	(B) Sold
Cattle	3,590	1,331	3,899	213	2,749	1,074	10,238	2,618
Sheep	10,051	6,387	8,233	5,467	7,185	5,509	25,469	17,363
Goats	482	294	-	-	699	132	1,181	426
Camels	1,023	162	1,591	134	960	89	3,574	385
Donkeys	1,193	336	1,175	269	897	191	3,265	796
Horses	121	46	119	24	121	73	361	143
Total	16,460	8,556	15,017	6,107	12,611	7,068	44,088	21,731

UM RUABA ANIMAL MARKET 1973/74 - 75/76 ^{b)}

	1973/74		1974/75		1975/76	
	(A) Brought	(B) Sold	(A) Brought	(B) Sold	(A) Brought	(B) Sold
Cattle	700	500	5,750	3,594	13,980	11,070
Sheep	1,900	1,400	4,250	3,466	29,300	19,750
Goats	1,000	750	910	546	9,120	2,230
Total	3,600	2,650	10,910	7,606	52,400	33,050

CENTRAL KORDOFAN DISTRICT SLAUGHTER HOUSES ^{a)}

Slaughtered Heads	74/75	75/76	Prices registered	
Cattle	24,647	24,058	}	46.50
Cows	5,218	7,223		
Sheep	51,598	81,602		7.50
Goats	6,919	9,409		4.00
Camels	1,340	991		80.00
Total	89,722	123,283		

Source: a) Acting Commissioner for Animal Resources, Northern Kordofan Province, El Obeid.

b) District Veterinary Office, Eastern District Northern Kordofan Province, Rahad.

The volumes traded at Rahad animal market is said to be of one-third of those at Um Ruaba animal market.

Note: 1) Prices are an average £.s. per head March, 1977.

TABLE 4-8 CROP PRODUCTION ESTIMATES IN THE ZONES OF THE PROJECT AREA, 1977

unit : Area - faddan
Product- ton

Zone	Crop Area	Dukhn		Dura		Sesame		Groundnuts		Watermelon seeds		Karkadeh		Sanamakar		Gum arabic	
		Product Area	Product Area	Product Area	Product Area	Product Area	Product Area	Product Area	Product Area	Product Area	Product Area	Product Area	Product Area	Product Area	Product Area	Product Area	Product Area
1	19,488	2,341	9,905	1,486	13,807	1,036	7,954	2,784	5,928	563	555	7	75	40	2,026	101	
2	18,618	2,237	9,463	1,420	13,191	989	7,599	2,660	5,663	538	530	6	72	39	1,936	97	
3	15,312	1,840	7,783	1,167	10,849	814	6,250	2,187	4,658	442	436	5	59	32	1,592	80	
4	19,488	2,341	9,905	1,486	13,807	1,036	7,954	2,784	5,928	563	555	7	75	40	2,026	101	
5	25,056	3,010	12,735	1,910	17,752	1,331	10,227	3,580	7,622	724	714	8	96	52	2,605	130	
6	13,398	1,610	6,810	1,022	9,493	712	5,469	1,914	4,076	387	382	5	52	28	1,393	70	
7	18,096	2,174	9,198	1,380	12,821	962	7,386	2,585	5,505	523	516	6	70	38	1,881	94	
8	17,226	2,069	8,756	1,313	12,205	915	7,031	2,461	5,240	498	491	6	66	36	1,791	90	
9	9,396	1,129	4,776	716	6,657	499	3,835	1,342	2,858	272	268	3	36	20	977	49	
10	17,922	2,153	9,109	1,366	12,698	952	7,315	2,560	5,452	518	511	6	69	37	1,863	93	
Total	174,000	20,904	88,440	13,266	123,280	9,246	71,020	24,857	52,930	5,028	4,958	59	670	362	18,090	905	

Note : The distribution of cultivated area by zone is calculated by the percentage

distribution of farm households among the zones.

TABLE 4-9 PRODUCER'S PRICES IN CROP MARKETS IN
EL OBEID AND EASTERN KORDOFAN DISTRICT

ANNEX IV -10

Products and Markets	1974/75	1975/76	1976/77	Producer's Price, 1977
	£S/Kg (£S/Kantar)	£S/Kg (£S/Kantar)	£S/Kg (£S/Kantar)	£S/Kg (£S/Kantar)
<u>Dukhn</u>				
El Obeid	-----	-----	0.093 (4.200)	0.093 (4.200)
<u>Dura</u>				
El Obeid	-----	-----	0.055 (2.500)	0.055 (2.500)
<u>Sesame</u>				
El Obeid	0.125 (5.632)	0.125 (5.624)	0.102 (4.600)	
Eastern Kordofan District. (14 markets)	0.119 (5.370)	0.118 (5.300)	-----	0.111 (5.000)
<u>Groundnuts</u>				
El Obeid	0.078 (3.507)	0.077 (3.467)	0.071 (3.200)	
East Kordofan (14 markets)	0.071 (3.187)	0.071 (3.190)	-----	0.071 (3.200)
<u>Water melon seeds</u>				
El Obeid	0.054 (2.414)	0.066 (2.936)	0.093 (4.200)	
East Kordofan (14 markets)	0.044 (1.995)	0.021 (0.934)	-----	0.089 (4.000)
<u>Karkadeh</u>				
El Obeid	0.144 (6.484)	0.116 (5.228)	0.333 (15.000)	
East Kordofan (14 markets)	0.158 (7.127)	0.123 (5.535)	-----	0.222 (10.000)
<u>Gum arabic</u>				
El Obeid	0.406 (18.250)	0.272 (12.250)	0.208 (9.353)	
East Kordofan (14 markets)	0.345 (15.547)	0.191 (8.605)	-----	0.200 (9.000)

Source: El Obeid and Um Ruaba crop markets, 1977

TABLE 4-10 CROP PRODUCTION AND INCOME PER FARM HOUSEHOLD IN THE DIRECT INFLUENCE ZONES

ANNEX IV-11

Area	Total Production kg	Home Consumption 1)				Seed kg	Total Quant. kg	Value ₹S*2)	Quantity kg	Value ₹S*3)
		Net Food kg cap*1)	Feed kg	Waste kg	1)					
Dukhn	1,000.0	245.0	—	50.0	58.0	353.0	29.546	647.0	54.154	
Dura	634.0	472.5	11.4	29.4	15.0	528.3	26.151	105.7	5.232	
Sesame	442.0	116.0	—	15.0	30.0	161.0	16.084	281.7	28.072	
Ground Nuts (in shell)	1,189.0	158.0	—	120.0	272.0	550.0	35.145	639.0	40.832	
Water Melon Seeds	240.0	—	—	—	—	—	—	240.0	19.224	
Karkadeh	3.0	—	—	—	—	—	—	3.0	0.599	
Sanamakar	17.0	—	—	—	—	—	—	17.0	—	
Gum Arabic	43.0	—	—	—	—	—	—	43.0	7.740	
(Fallow Land)	—	—	—	—	—	—	—	—	—	
Total	3,568.0	991.5	11.4	214.4	375.0	1,592.3	106.926	1,975.7	155.853	

Source 1). Estimation based on the data provided by Current Agricultural Statistics, June 1976

(Ministry of Agriculture)

Note *1). Assuming each family has five persons.

*2). Unit values are determined ten percent less than the price in Annex IV-10 because of transport cost and losses.

*3). Settled farmers have few animals with which they can earn cash income. Majority of livestock is held by nomads. Therefore, earnings by selling livestock by settled farmers is not included in this table.

TABLE 4-11 UNIT YIELD OF MAIN CROPS (KG/FEDDAN)

	Dura		Dukhn		Sesame		Groundnuts	
	Whole Sudan	North2) Kordfan	Whole Sudan	North2) Kordfan	Whole Sudan	North2) Kordfan	Whole Sudan	North2) Kordfan
1970 71 1)	314	162	253	196	160	143	371	172
1971 72 1)	349	145	210	150	154	81	256	91
1972 73 1)	317	137	139	68	119	91	346	91
1974 75 3)	306	150	156	90	107	70	521	320
1975 76 3)	327	164	161	100	104	75	451	375
1970/71-1974/75 Average	323	152	184	121	129	92	389	210

Source : 1). National Planning Commission, Economic Survey, 1974.

2). Ministry of Agricultural, Food and Natural Resources (MIN. AFNR),
Yearbook of Agricultural Statistics, 1974.

3). MIN. AFNR, Current Agricultural Yearbook, June 1976.

ANNEX IV-13 · EL OBEID AIRPORT CONSTRUCTION

The existing airport at El Obeid has a gravel surfaced runway of 1,800 m. Normally, Sudan Airways' flies F27s with seats for 36 passengers and B737s with a seat capacity of 100 passengers in and out of this airport. The apron, terminal building, landing instruction system, etc. are all obsolete.

The airport situates 4 km. away from the center of El Obeid along a paved road toward the south-west. There is one regular flight daily to Khartoum. The seats are fully occupied throughout the year. The schedule is uncertain and cancellations and delays are frequent causing trouble and inconvenience to users.

The urgent necessity to improve the airport facility is recognized by the government. Accuracy of flight schedules, maintenance of flight safety and the use of larger aircraft are required and are of high priority.

Under the circumstances, the new runway construction has been carried out as one improvement project (see below).

New Runway: 2,500 m. in length and 45 m. in width.

1st Stage: The formation of runway structures, up to base course and drainage system, by June, 1977.

2nd Stage: Asphalt surfacing of runway by December, 1978.

Total Cost: £S 1.5 million at 1976 price levels.

The existing water reservoirs at El'Ain are not sufficient to supply the water requirements of the people in El Obeid. At present, the maximum capacity is about 3.5 million M³. Thus, the people in El Obeid have been suffering a constant water shortage, except for a few months during the rainy season.

The Rural Water Corporation of the Sudan is in direct charge of the expansion programme of the water system. The project consists of the construction of new dams of 2 million M³ capacity close to the existing dams at Khor Baggara and the installation of a new pipeline of 30 km. to the town of El Obeid.

The construction work has been underway since November, 1972 and is scheduled to be completed July, 1977. When the work is completed, the total maximum capacity of all reservoirs will be 5.5 million M³. The last stage of the project, the construction of a dam of 0.5 million M³ capacity, started in January, 1977, will cost £S 0.20 million. That computes to £S 0.40 per the capacity of M³.

It is expected after completion, the dam will supply sufficient water for the people in El Obeid with some remaining for other uses, especially for agriculture.

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TABLE 5-1 GRADIENT CONDITION OF EXISTING ROADS

(Km)

Route	Surface	Distance by Gradient			Total	Remarks
		i = 0-3%	i = 3-5%	i = 5%-		
I	Pavement	2.2	0	0	75.2	
	Earth	1.4	0	0		
	Track	67.8	3.8	0		
	Total	71.4	3.8	0		
II	Pavement	2.2	0	0	75.8	
	Earth	24.1	0	0		
	Track	48.2	1.1	0.2		
	Total	74.5	1.1	0.2		
III	Pavement	0	0	0	79.0	
	Earth	2.5	0	0		
	Track	76.5	0	0		
	Total	79.0	0	0		
IV	Pavement	0	0	0	72.5	
	Earth	3.9	0	0		
	Track	41.8	17.1	9.7		
	Total	45.7	17.1	9.7		
V	Pavement	0	0	0	118.7	
	Earth	3.7	0	0		
	Track	81.5	22.1	11.4		
	Total	85.2	22.1	11.4		
Access Road	Pavement	0	0	0	40.9	
	Earth	1.6	0	0		
	Track	38.3	1.0	0		
	Total	39.9	1.0	0		

TABLE 5-2 SURFACE CONDITION OF EXISTING ROADS

(Km)

Route	Length by Surface Condition							Total
	Pavement	Earth			Track			
	Poor	Fair	Poor	Bad	Fair	Poor	Bad	
I	2.2	0	1.0	0.4	29.5	20.1	22.0	75.2
II	2.2	14.6	6.6	2.9	9.2	21.0	19.3	75.8
III	0	0	1.1	1.4	16.3	23.3	36.9	79.0
IV	0	0	1.1	2.8	0	6.6	62.0	72.5
V	0	1.0	2.7	0	2.3	27.8	84.9	118.7
Access Road	0	0	1.6	0	0	10.3	29.0	40.9

TABLE 5-3-1. INVENTORY OF THE EXISTING ROAD									
Route I El Obeid ~Rahad (75.2km) (KM)									
Gradient	Surface Condition		Soil Condition				Sub Total	Total	
			Qoz	Sandy Silt	Silty Clay	Cotton Clay			Clay
0% < i < 3%	Pavement	Poor	Bituminous 2.2					2.2	71.4
		Earth	Poor	1.0					
	Bad		0.4						
	Track	Fair		20.1	5.9 2.6				
		Poor	3.8	8.3	6.7			67.8	
		Bad	9.1	4.0	7.3				
3% ≤ i < 5%	Track	Fair	0.5		0.4			3.8	
		Poor	1.3						
		Bad	1.4		0.2				

* Hard Condition

ANNEX V-4

TABLE 5-3-2 INVENTORY OF THE EXISTING ROAD									
Route II El Obeid ~Rahad (75.8km) (KM)									
Gradient	Surface Condition		Soil Condition				Sub Total	Total	
			Qoz	Sandy Silt	Silty Clay	Cotton Clay			Clay
0% < i < 3%	Pavement	Poor	Bituminous 2.2					2.2	74.5
		Earth	Fair		6.4	8.2			
	Poor		0.2	1.4	5.0				
	Bad			0.6	2.3				
	Track	Fair		3.1	6.1			48.2	
		Poor	1.6	10.3	8.4				
Bad		6.7	5.7	6.3					
3% ≤ i < 5%	Track	Poor	0.3	0.4				1.1	
		Bad	0.2	0.2					
5% ≤ i	Track	Bad		0.2			0.2	0.2	

Gradient	Surface Condition		Soil Condition					Sub Total	Total
			Qoz	Sandy Silt	Silty Clay	Cotton Clay	Clay		
0% < i < 3%	Earth	Poor	1.1					2.5	
		Bad	1.4						
	Track	Fair				16.3		76.5	
		Poor	4.1			19.2			
		Bad	8.1			28.8			

Gradient	Surface Condition		Soil Condition					Sub Total	Total
			Qoz	Sandy Silt	Silty Clay	Cotton Clay	Clay		
0% < i < 3%	Earth	Poor	1.1					3.9	
		Bad	2.8						
	Track	Poor	6.4					41.8	
		Bad	34.2				1.2		
3% ≤ i < 5%	Track	Poor	0.2					17.1	17.1
		Bad	15.9				1.0		
i ≥ 5%	Track	Bad	9.7					9.7	9.7

Table 5-3-5 INVENTORY OF THE EXISTING ROAD								
Route V El Obeid ~ Um Ruaba (118.7km) (KM)								
Gradient	Surface Condition		Soil Condition				Sub Total	Total
			Qoz	sandy silt	silty clay	cotton clay		
0% < i < 3%	Earth	Fair		1.0				3.7
		Poor	0.7	2.0				
	Track	Fair		2.3				81.5
		Poor	7.5	15.9	2.3			
		Bad	42.0	4.9	4.6		2.0	
3% ≤ i < 5%	Track	Poor		2.1				22.1
		Bad	15.1	2.9	2.0			
5% ≤ i	Track	Bad	11.4					11.4

Table 5-3-6 INVENTORY OF THE EXISTING ROAD								
Access Road Route Rahad ~ Route F (40.9km) (KM)								
Gradient	Surface Condition		Soil Condition				Sub Total	Total
			Qoz	Sandy Silt	Silty Clay	Cotton Clay		
0% < i < 3%	Earth	Poor	1.6					1.6
		Track	Poor	8.0	2.3			
	Bad		23.7	4.3				39.9
3% ≤ i < 5%	Track	Bad	1.0					1.0

FIG. 5-2 SOIL MAP OF PROJECT AREA

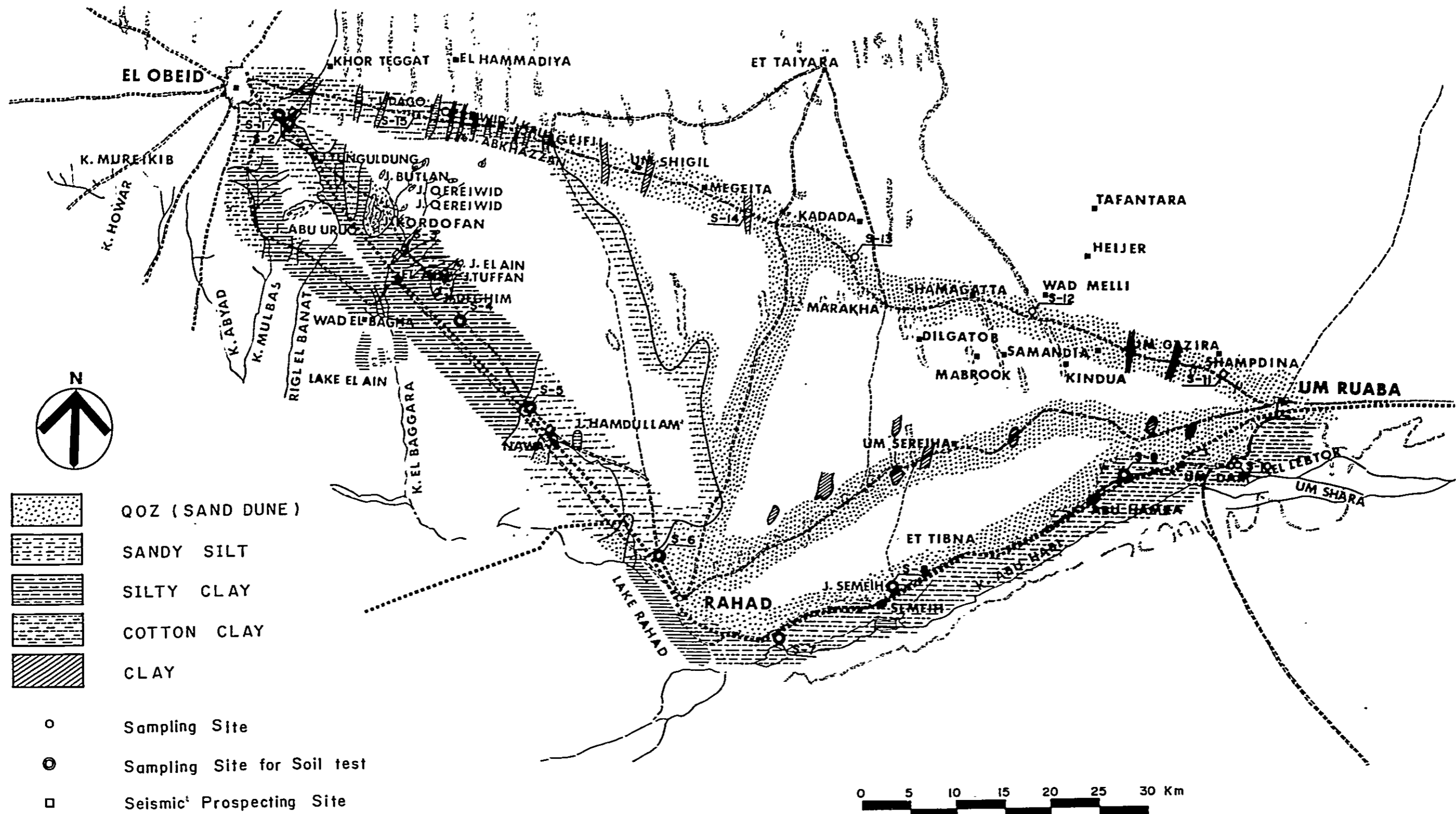


TABLE 5-4 SUMMARY OF SOIL TEST

Sample No.	S-6	S-8	S-1	S-5	S-2	S-4	S-7	S-10
Soil Type	QOZ (sand dune)	QOZ (sand dune)	Sandy Silt	Sandy Slit	Brown Silty Clay	Yellow Grey Silty Clay	Cotton Clay	Cotton Clay
Specific Gravity	2.59	2.60	2.58	2.45	2.68	2.68	2.64	2.70
Particle Size Analysis								
Sand %	87.9	96.5	78.4	71.4	59.5	51.8	61.1	1.4
Silt and Clay %	12.1	3.5	21.6	28.6	40.5	48.2	38.9	98.6
Atterberg Limit								
Liquid Limit %	-	-	-	17.0	38.3	24.9	28.5	63.4
Plastic Limite %	N.P.	N.P.	N.P.	N.P.	18.7	13.7	12.2	32.8
Plasticity Index	N.P.	N.P.	N.P.	N.P.	19.6	11.2	16.3	30.6
Shrinkage Limit %	-	-	-	-	-	-	23.25	23.56
Classification	A-3 (0)	A-3 (0)	A-2-4 (0)	A-2-4 (0)	A-6 (4)	A-6 (3)	A-6 (2)	A-7-6 (13)
Casagrande	SU	SU	SC	SC	CI	CL	CL	OH
O.M.C. %	9.4	11.2	7.4	6.4	11.2	9.4	11.2	19.0
Compaction								
M.D.D. t/m ³	1.93	1.76	2.06	2.07	2.02	2.06	1.97	1.71
C.B.R. Modified %	18.6	13.2	18.0	12.4	9.2	5.6	2.2	3.2
Adopted C.B.R. for Pavement Design %	12	12	12	12	9	5	3	3
Classification of Adopted Design C.B.R.	IV				III	II		I

7.1 Elastic Wave Velocity of Foundation Ground

The results of an analysis by seismic prospecting test indicate that P-wave velocity (V_p) is 800 to 900 m./sec. as shown in FIG.1 - FIG. 3, which means the foundation ground is rather firmly compacted. The relation between P-wave velocity (V_p) and S-wave velocity is shown in FIG. 4 by using Poison's Ratio (ν)¹⁾ as a parameter. According to the data noted in FIG. 4, the Poison's Ratio (ν) is in between 0.45 and 0.49 of which the average is 0.47 which makes the S-wave velocity of the foundation ground $V_s=230 + 250$ m./sec.

7.2 N Value of Foundation Ground

N value is estimated as $N=22 - 23$ based on the S-wave velocity obtained in paragraph 1 above. The relation between N value and S wave velocity is shown by FIG.5.¹⁾

7.3 Bearing Capacity of Foundation Ground

The estimation of allowable bearing capacity based on N value is made in accordance with the following formula, which Dunham proposed.

Note: 1) T. Imai and M. Yoshimura, "The Relation of Mechanical Properties of Soils to P and S Wave Velocities", Geophysical Exploration, VOL. XXV, No. 6 (Tokyo, The Society of Exploration Geophysicists of Japan, 1972)

$$Q_{as} = 1.17 N \text{ (t/m}^2\text{)}$$

(Note: In case the soil is diluvium silty clay)

When $N=22 - 23$ is substituted in this formula,

$$Q_{as} = 25.7 - 26.9 \text{ t/m}^2$$

Therefore, when the foundation ground supports a spread foundation for structures, an allowable bearing capacity of more than 25 t/m^2 is estimated.

Fig. 1 Analysis of Seismic Method
(7.4 km from ELOBID)

Time - Distance C'urve

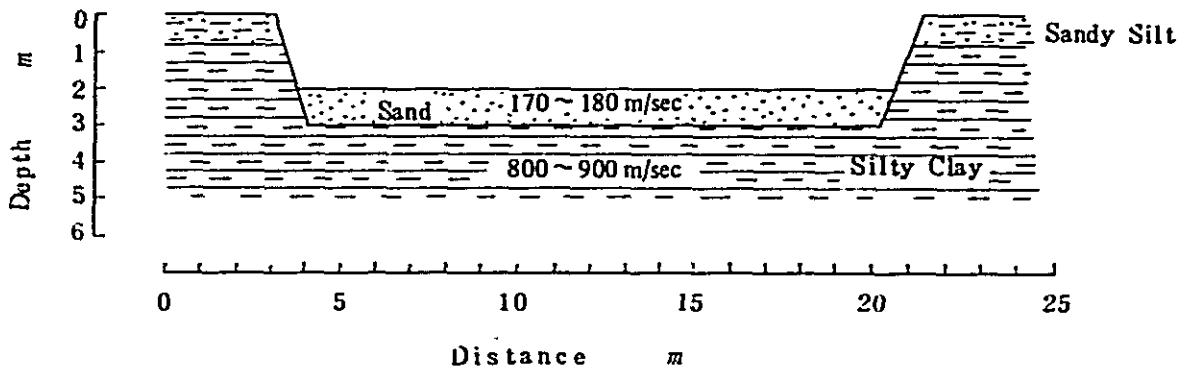
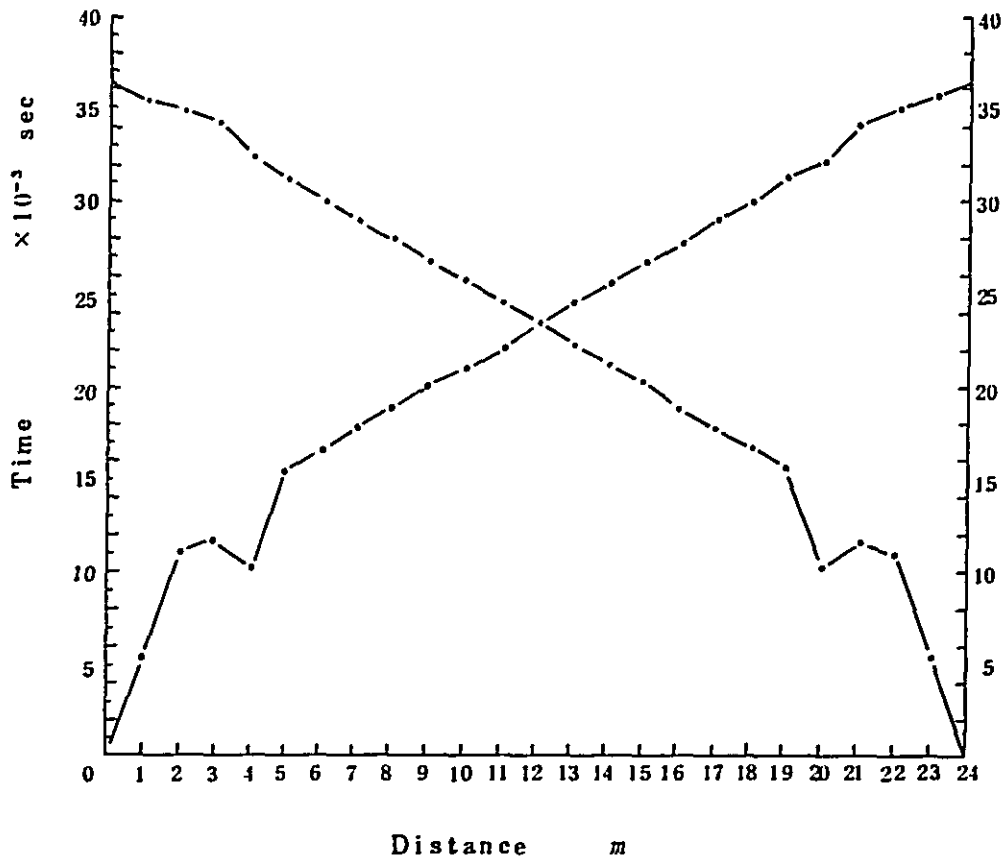


Fig. 2 Analysis Data of Seismic Prospecting
(K. EL BAGGARA)

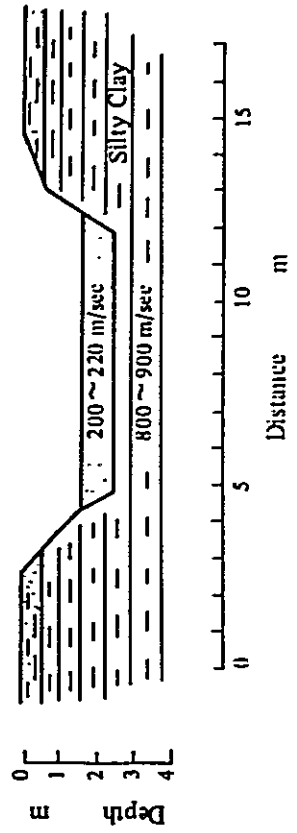
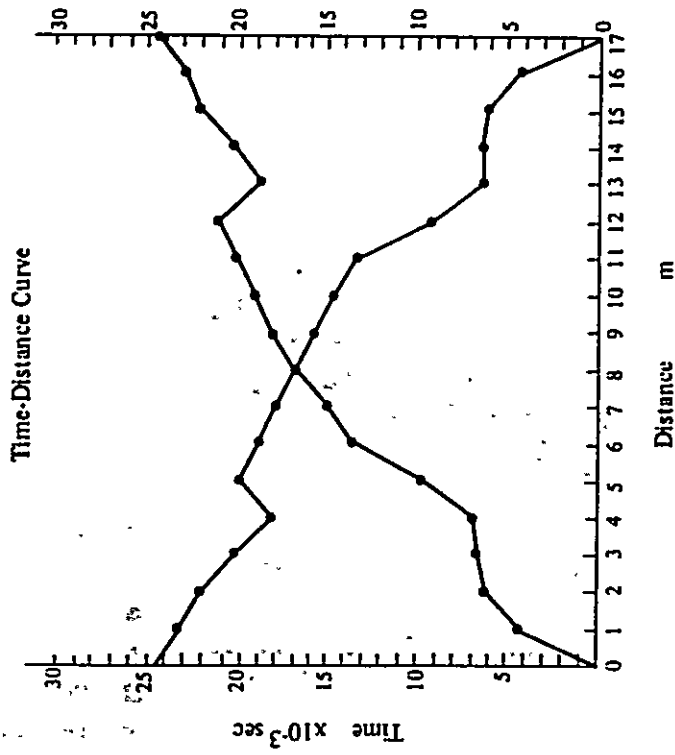


Fig. 3 Analysis Data of Seismic Prospecting
(K. NAWA)

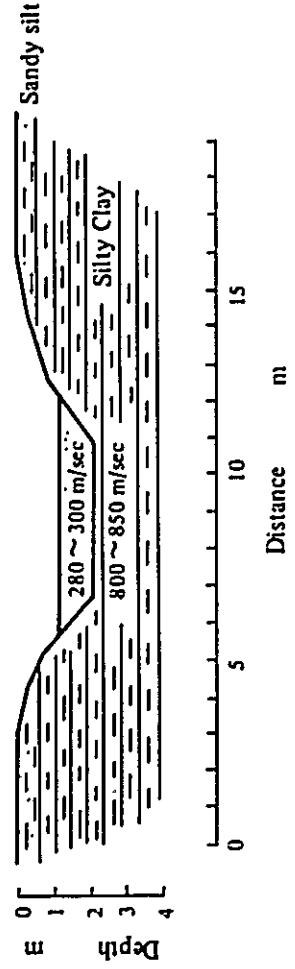
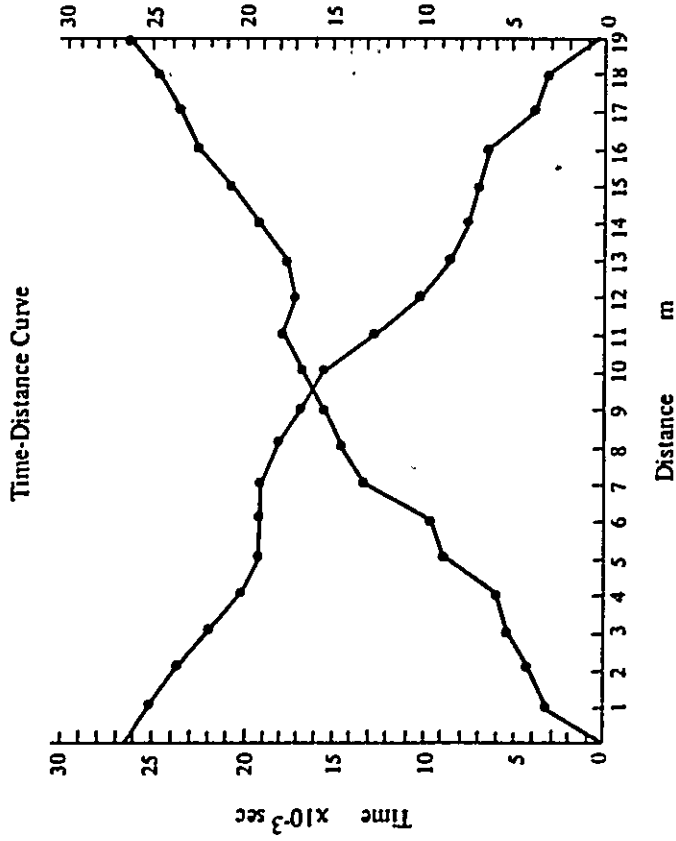


FIG. 4 S Wave Velocity — P Wave Velocity

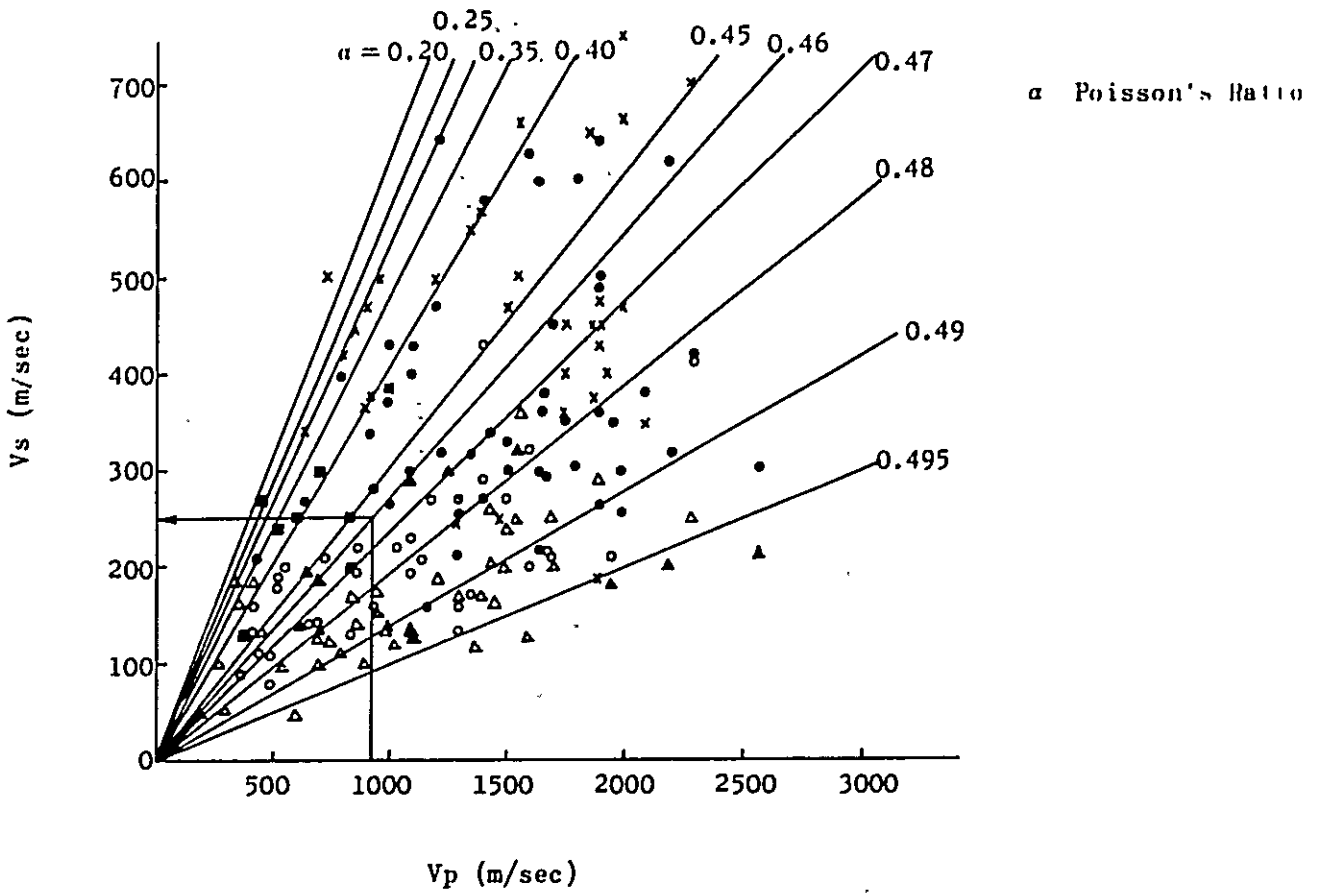


FIG. 5 N Value — S Wave Velocity

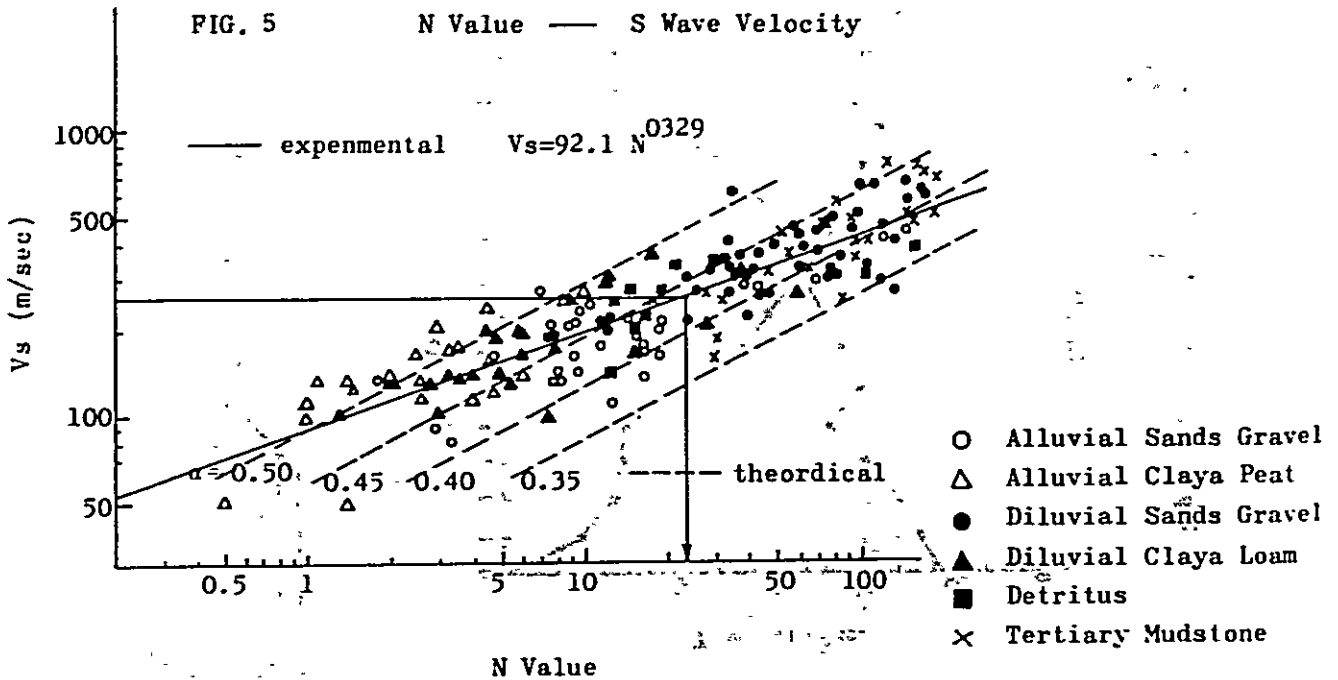
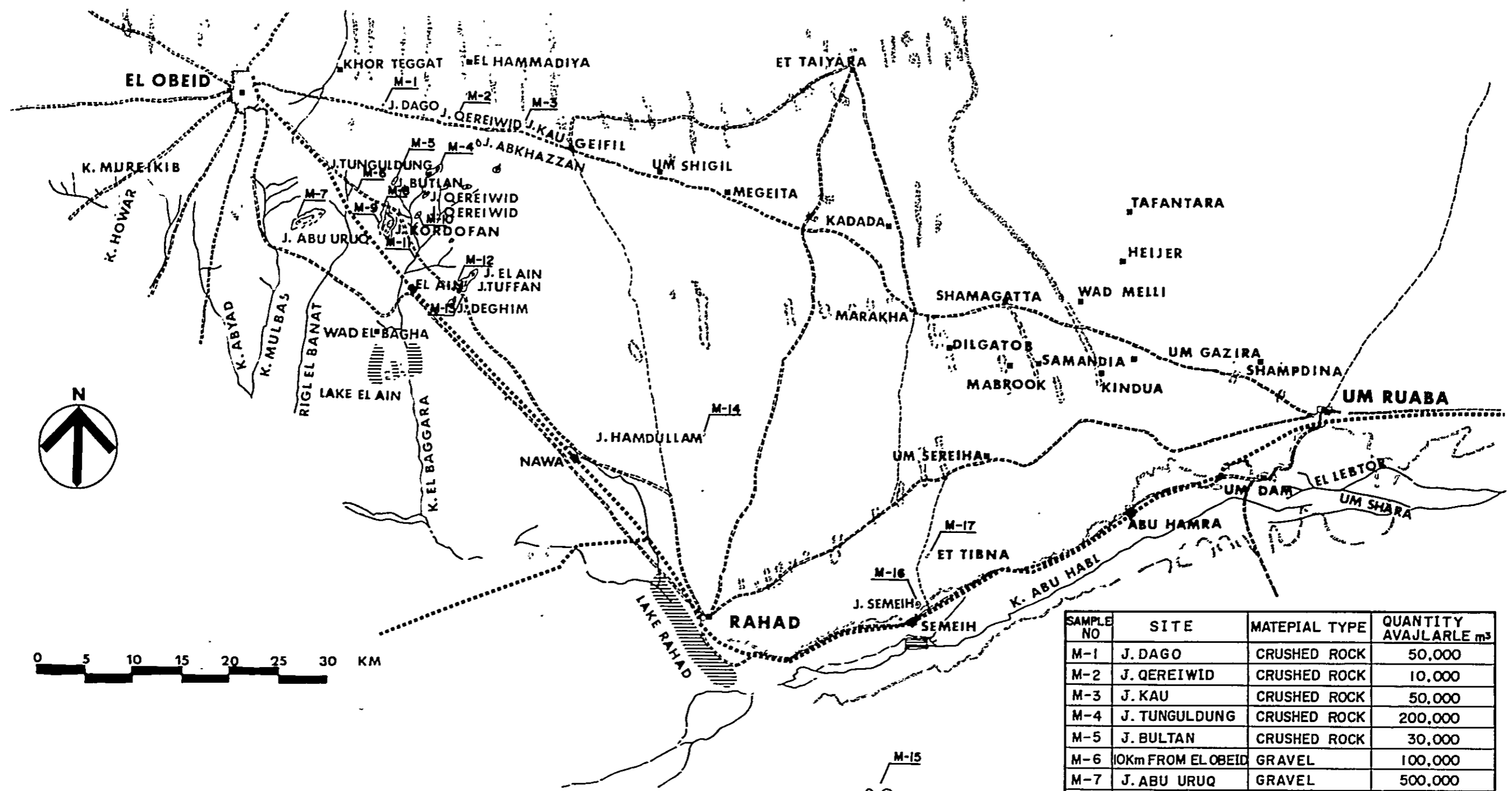


FIG. 5-3 LOCATION MAP OF MATERIALS



SAMPLE NO	SITE	MATEPIAL TYPE	QUANTITY AVAJLARLE m ³
M-1	J. DAGO	CRUSHED ROCK	50,000
M-2	J. QEREIWID	CRUSHED ROCK	10,000
M-3	J. KAU	CRUSHED ROCK	50,000
M-4	J. TUNGULDUNG	CRUSHED ROCK	200,000
M-5	J. BULTAN	CRUSHED ROCK	30,000
M-6	10Km FROM EL OBEID	GRAVEL	100,000
M-7	J. ABU URUQ	GRAVEL	500,000
M-8	J. KORDOFAN	GRAVEL	100,000
M-9	J. KORDOFAN	CRUSHED ROCK	3,000,000
M-10	J. QEREIWID	CRUSHED ROCK	20,000
M-11	K. EL BAGGARA	COARSE SAND	100,000
M-12	J. TUFFAN	CRUSHED ROCK	200,000
M-13	J. TUFFAN	GRAVEL	10,000
M-14	J. HAMDULLAM	CRUSHED ROCK	150,000
M-15	J. DUMBEIR	CRUSHED ROCK	4,000,000
M-16	J. SEMEIH	CRUSHED ROCK	20,000
M-17	J. ET TIBNA	GRAVEL	10,000

TABLE 5-5 SUMMARY OF MATERIAL TEST

CRUSHED ROCK AND SAND

Sample No.	Site	Specific gravity	Absorption %	Los Angeles abrasion %	Surface course	Suitability for Concrete aggregate
M-1	J. DAGO	2.63	0.6	26.2	GOOD	GOOD
M-9	J. KORDOFAN	2.61	0.9	37.9	GOOD	GOOD
M-10	J. QEREIWID	2.62	1.40	44.7	POOR	POOR
M-12	J. TUFFAN	2.56	1.40	50.3	POOR	POOR
M-14	J. HAMDULLAM	2.53	3.00	14.1	GOOD	GOOD
M-16	J. SEMEIH	2.88	0.80	18.3	GOOD	GOOD
M-11	K. EL BAGGARA	2.62	0.60	-	POOR	GOOD

GRAVEL

Sample No.	Site	Specific gravity	Absorption %	Los Angeles abrasion %	C.B.R. modified %	Sub base course	Suitability for Base course
M-7	J. ABU URUQ	-	-	-	* 88	GOOD	GOOD
M-6	10 Km from EL OBEID	2.62	0.75	23.4	28.3	FAIR	POOR
M-8	J. KORDOFAN	2.65	0.38	33.2	14.2	POOR	POOR
M-13	J. TUFFAN	2.55	0.69	35.4	33.3	GOOD	POOR
M-17	J. ETTIBNA	2.61	0.70	31.9	40.8	GOOD	POOR

Note: * Depends on the test result carried out for EL OBEID Airport Construction by R.B.P.C.'s laboratory.

GENERAL RATING AS AGGREGATE

Item	Sub base course		Base course		Surface course		Concrete aggregate	
	GOOD ¹⁾	FAIR ¹⁾	GOOD ¹⁾	POOR ²⁾	GOOD ¹⁾	POOR ²⁾	GOOD ¹⁾	POOR ²⁾
Absorption %	<3	≥3	<3	≥3	<3	≥3	<3	≥3
Los Angeles Abrasion %	<50	≥50	<50	≥50	<40	≥40	<40	≥40
C.B.R. modified %	>30	25-30	<25	≥80	-	-	-	-

Note: 1) The rating as "GOOD" or "FAIR" should meet the three conditions listed in each column.

2) The rating as "POOR" comes when one condition in each column is satisfied.

Table 5-6 Result of Cement Stabilisation Test

Cement Contents %	2	4	6	8	10
Unconfined Compression Strength Kg/cm ²	4.2	4.9	10.8	23.7	25.4

Table 5-7 Result of Lime Stabilisation Test

Lime Contents %		5	10	15
Unconfined Compression Strength Kg/cm ²	Medium curing	-	0.4	0.6
	Rapid curing	-	2.8	2.8

Table 5-8 Result of Asphalt Stabilisation Test (Hubbard-Field Stability)

Asphalt Contents %	6	7	8	9	10
Air Void %	25.3	23.3	21.8	16.4	15.3
Hubbard-Field Stability Kg	220	200	300	30	30

Table 5-9 Result of Asphalt Stabilisation Test (Marshal Stability)

Asphalt Contents %	7	8	9
Air Void %	21.2	18.0	18.1
Marshall Stability Kg	35	40	20

Fig. 5-5 Wetting-And-Drying Test
(Soil Cement Loss)

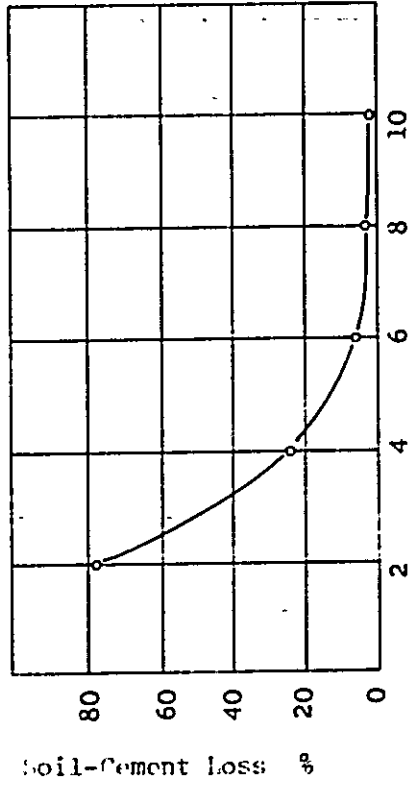


Fig. 5-6 . Wetting-And-Drying Test

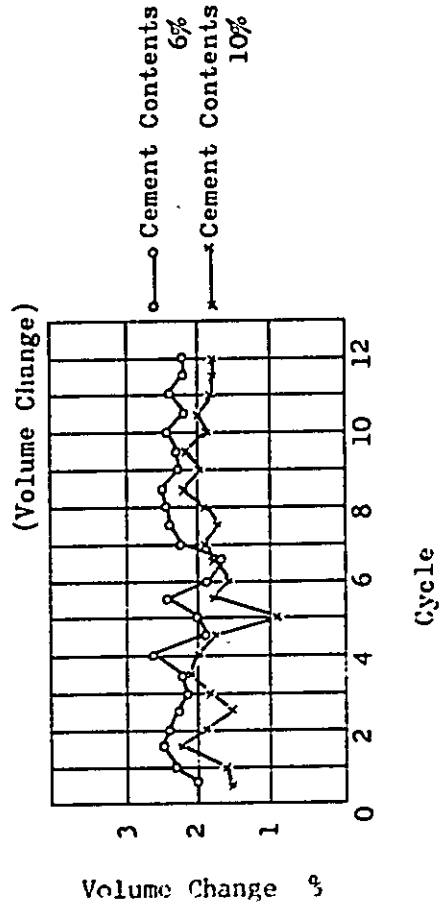


Fig. 5-4 Cement Contents ~
Unconfined Compression Strength

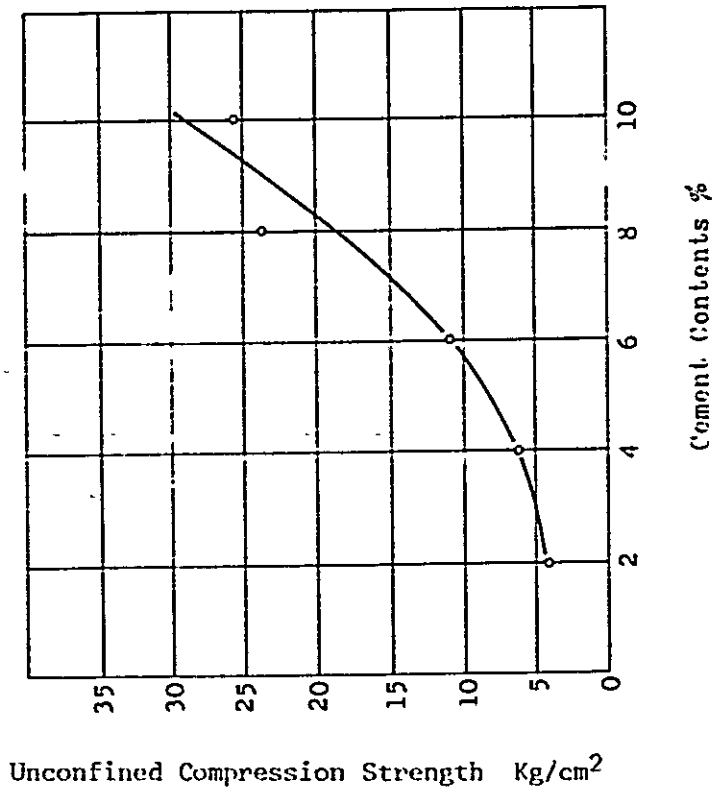


Fig. 5-8 Hubbard-Field Stability Test

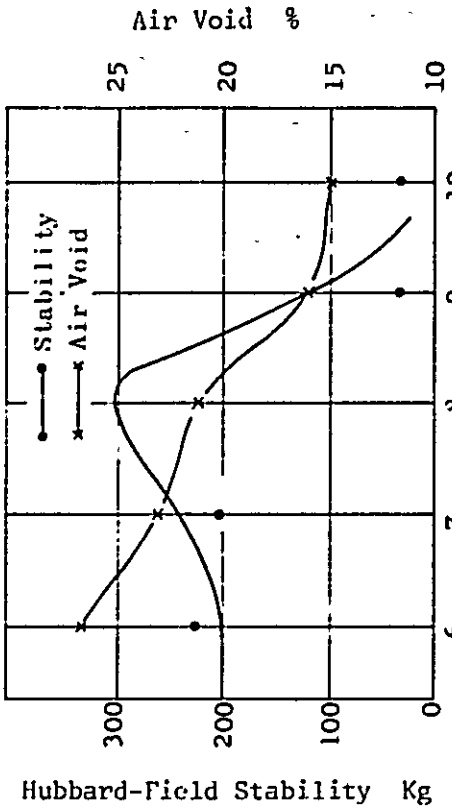


Fig. 5-9 Marshall Stability Test

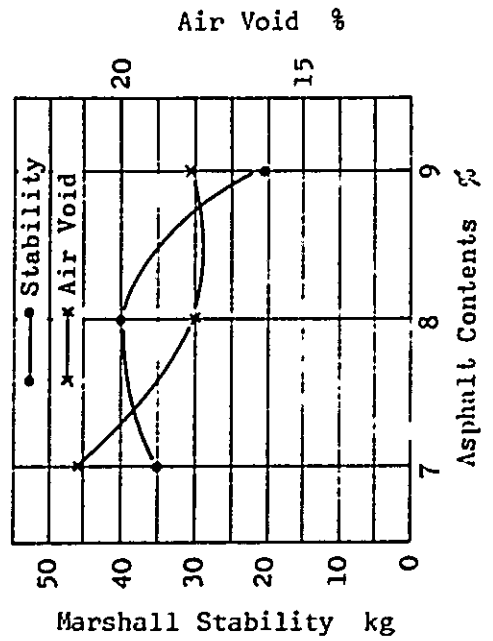


Fig. 5-7 Lime Contents ~ Unconfined Compression Strength

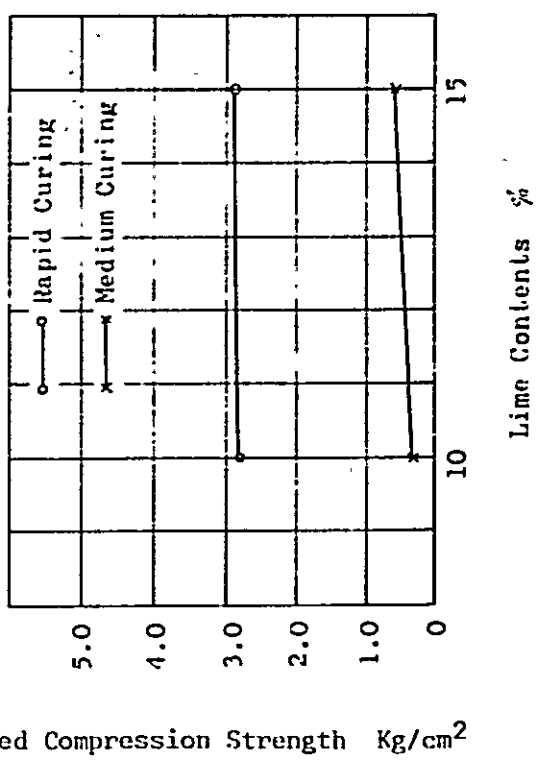
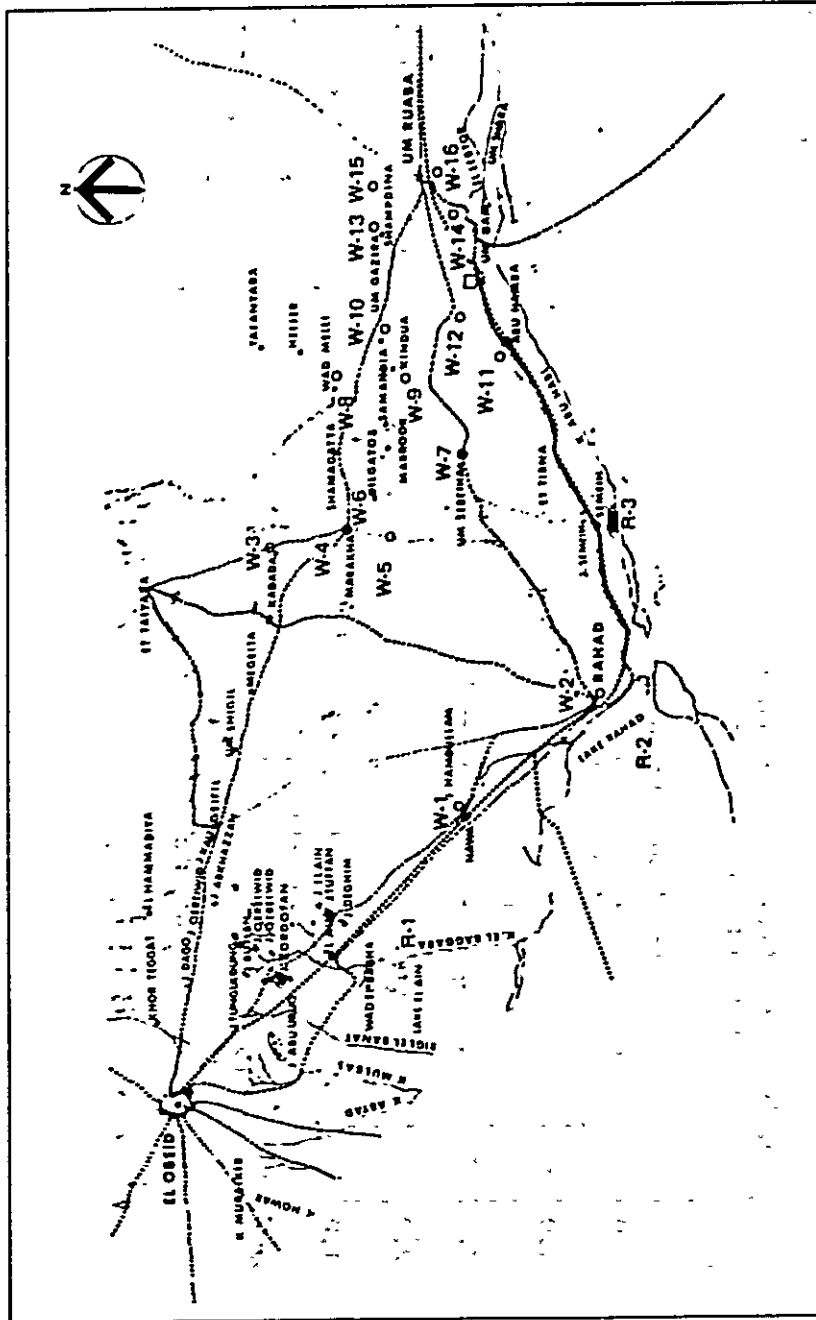


Fig. 5-10 Location Map of Reservoirs and Wells



Wells

No.	LOCATION	NO. OF WELLS	YIELD l/h
W-1	NAVA	2	5150, 4360
W-2	BAHAD	1	5150, 4360, 2270
W-3	KADADA	2	3150, 4090
W-4	MARANIA	2	4170, 4670
W-5	ARU SAID	1	
W-6	DIFIATUNI	2	5180, 1820
W-7	UM SEKIRHA	2	2550, 2950
W-8	UM MAD KELLT	1	9090
W-9	KINIRIA	1	3180
W-10	SAMADIA	2	5460, 5460
W-11	ARU HANHA	3	3180, 4360, 4360
W-12	KOANANUSA	2	1180, 2270
W-13	UM GE'IRA	2	4180, 4180
W-14	GABADIM	1	1180
W-15	UM GENASAS	2	2270, 2270
W-16	UM KUARA	12	4360 - 13640

Reservoirs

NO.	LOCATION	CAPACITY m ³
R-1	AL AIN	5,500,000
R-2	BAHAD	50,000,000
R-3	SEKIRHA	120,000

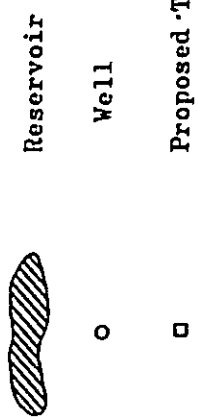


FIG. 5 - 11 AVERAGE ANNUAL RAINFALL 1921 - 1950 YEAR

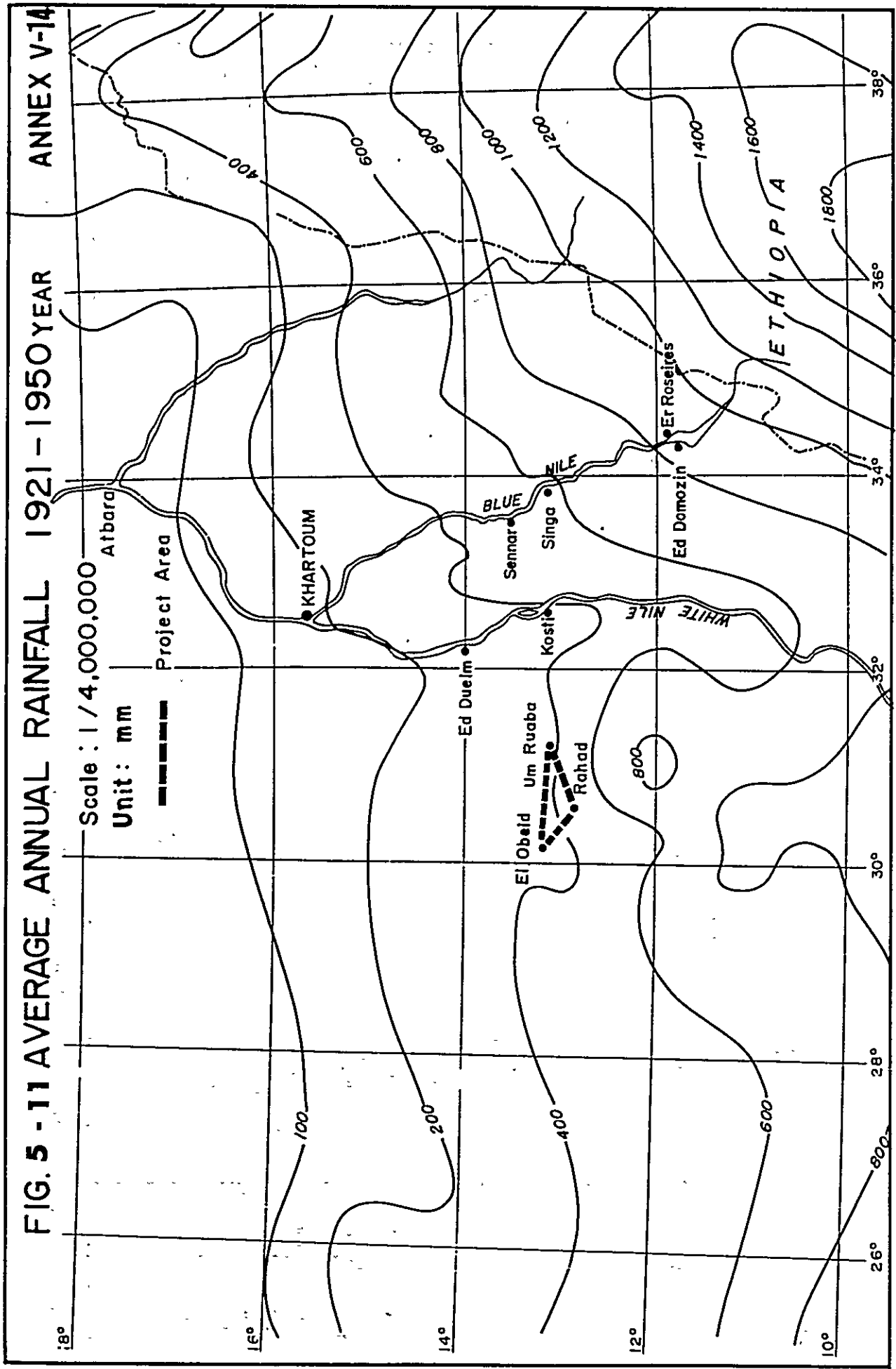


TABLE 5-10 YEARLY MAXIMUM DAILY RAINFALL, EL OBEID, 1943 - 64

Year	Daily Rainfall (mm/Day)	Year	Daily Rainfall (mm/Day)	Year	Daily Rainfall (mm/Day)
1943	44.2	1954	75.0	1965	48.0
44	53.5	55	56.2	66	53.2
45	81.2	56	96.7	67	54.7
46	96.7	57	26.7	68	45.6
47	44.7	58	56.0	69	19.4
48	50.7	59	78.1	70	36.2
49	35.6	60	54.2	71	-
50	40.6	61	50.9	72	-
51	69.1	62	73.6	73	-
52	68.2	63	34.1	74	40.7
53	56.2	64	57.3	75	34.2
				76	67.5

Source: Meteorological Department, Sudan.

FIG. 5-12 PROBABILITY OF DAILY RAINFALL (GUMBEL METHOD)

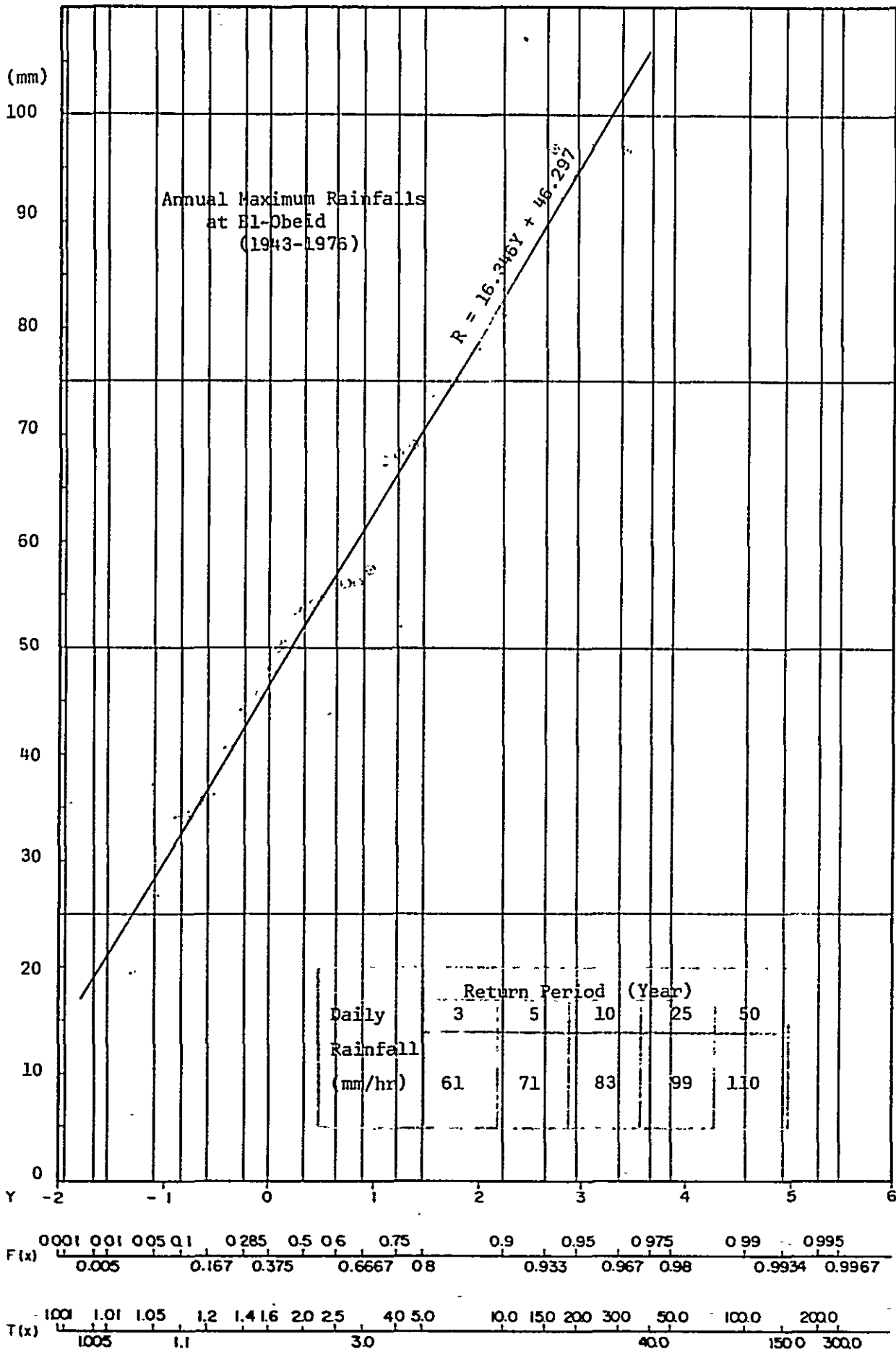
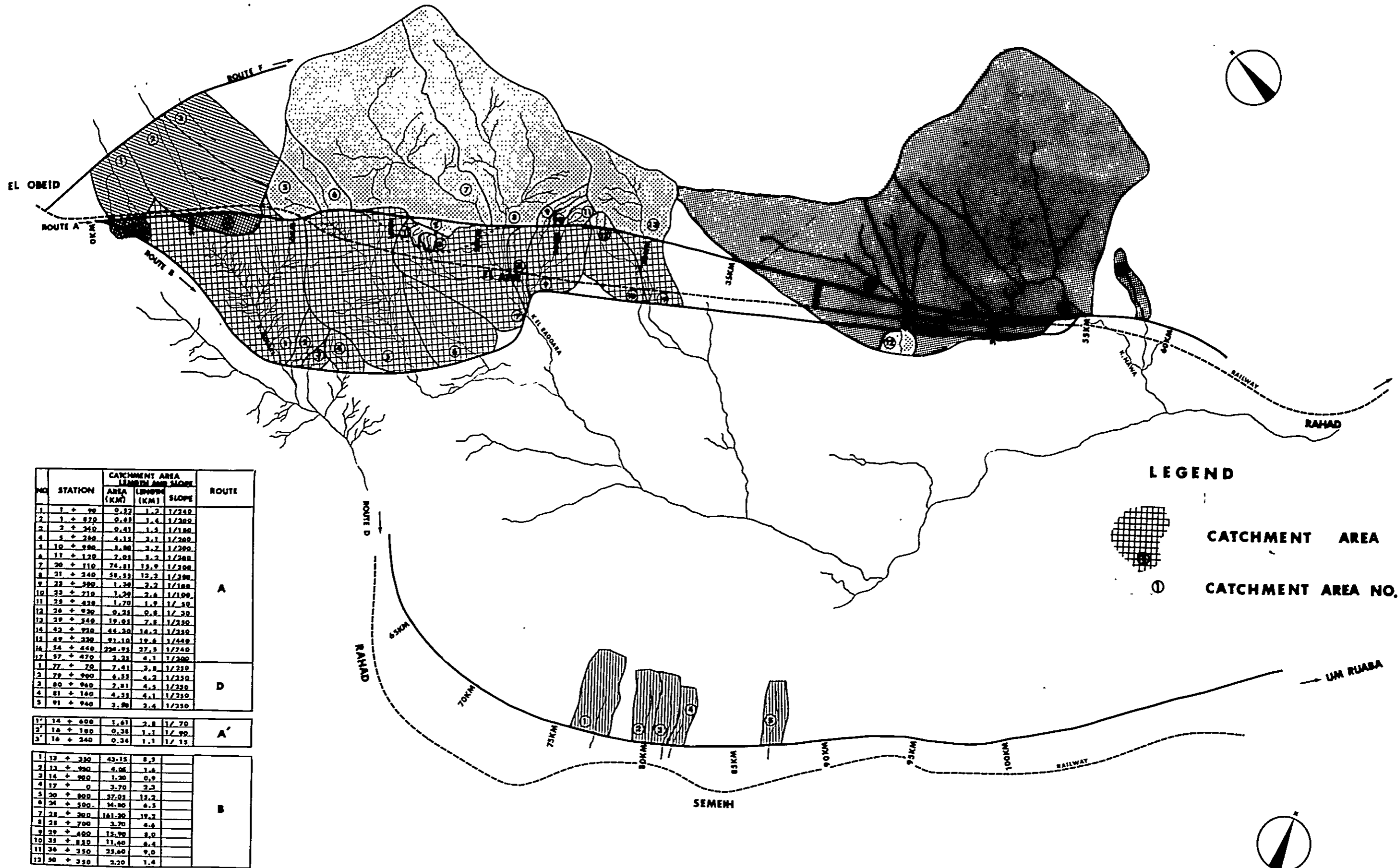


FIG. 5-13 CATCHMENT AREA



NO	STATION	CATCHMENT AREA		ROUTE
		AREA (KM ²)	SLOPE (1/1000)	
1	1 + 90	0.37	1.2	A
2	1 + 870	0.63	1.4	
3	2 + 210	0.41	1.3	
4	5 + 280	4.13	3.2	
5	10 + 380	1.86	3.2	
6	11 + 120	2.03	3.2	
7	20 + 110	74.81	13.9	
8	21 + 240	58.33	12.2	
9	22 + 380	1.39	2.2	
10	23 + 210	1.29	2.6	
11	25 + 420	1.70	1.9	
12	26 + 920	0.23	0.6	
13	29 + 340	19.03	7.6	
14	42 + 920	44.20	14.2	
15	49 + 320	91.10	12.6	
16	54 + 440	224.93	27.5	
17	57 + 470	2.33	4.1	
1	77 + 70	7.41	3.8	D
2	79 + 990	6.33	4.2	
3	80 + 940	7.01	4.3	
4	81 + 140	4.33	4.1	
5	91 + 940	3.96	3.4	
1*	14 + 800	1.61	2.8	A'
2*	16 + 180	0.38	1.1	
3*	16 + 240	0.34	1.1	
1	12 + 230	43.15	8.3	B
2	12 + 990	4.06	1.6	
3	14 + 980	1.20	0.9	
4	17 + 0	3.70	2.3	
5	20 + 800	37.02	12.2	
6	24 + 300	34.80	6.3	
7	28 + 300	181.30	19.2	
8	28 + 700	3.70	4.6	
9	29 + 400	13.99	3.0	
10	33 + 810	11.40	6.4	
11	34 + 250	23.60	9.0	
12	30 + 350	2.20	1.4	
1	4 + 800	12.03	7.0	F
2	7 + 180	28.30	8.3	
3	9 + 600	13.70	3.2	

FIG. 5-14-1 SPECIFIC RUN-OFF CURVES

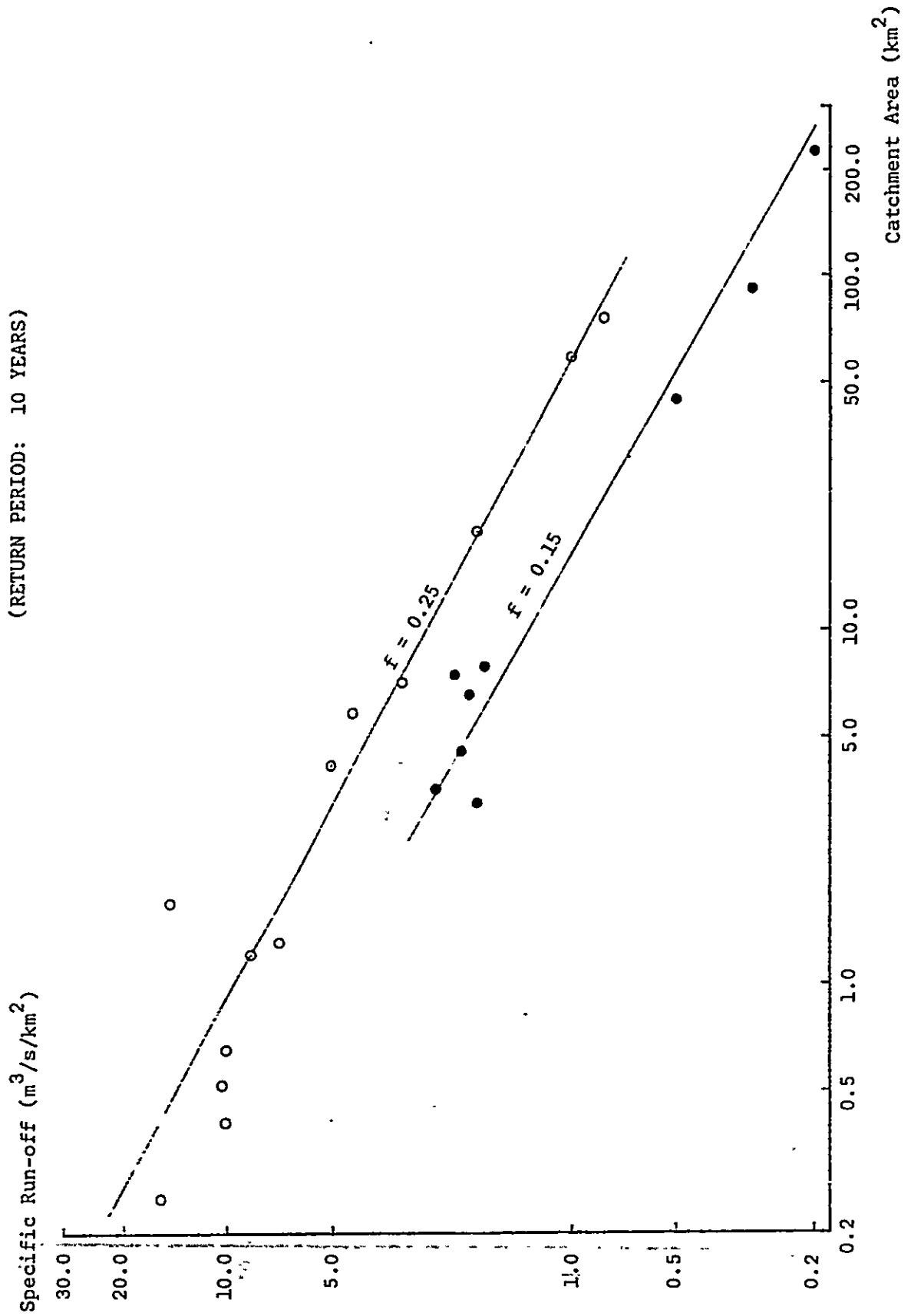


FIG. 5-14-2 SPECIFIC RUN-OFF CURVES

(RETURN PERIOD: 50 YEARS)

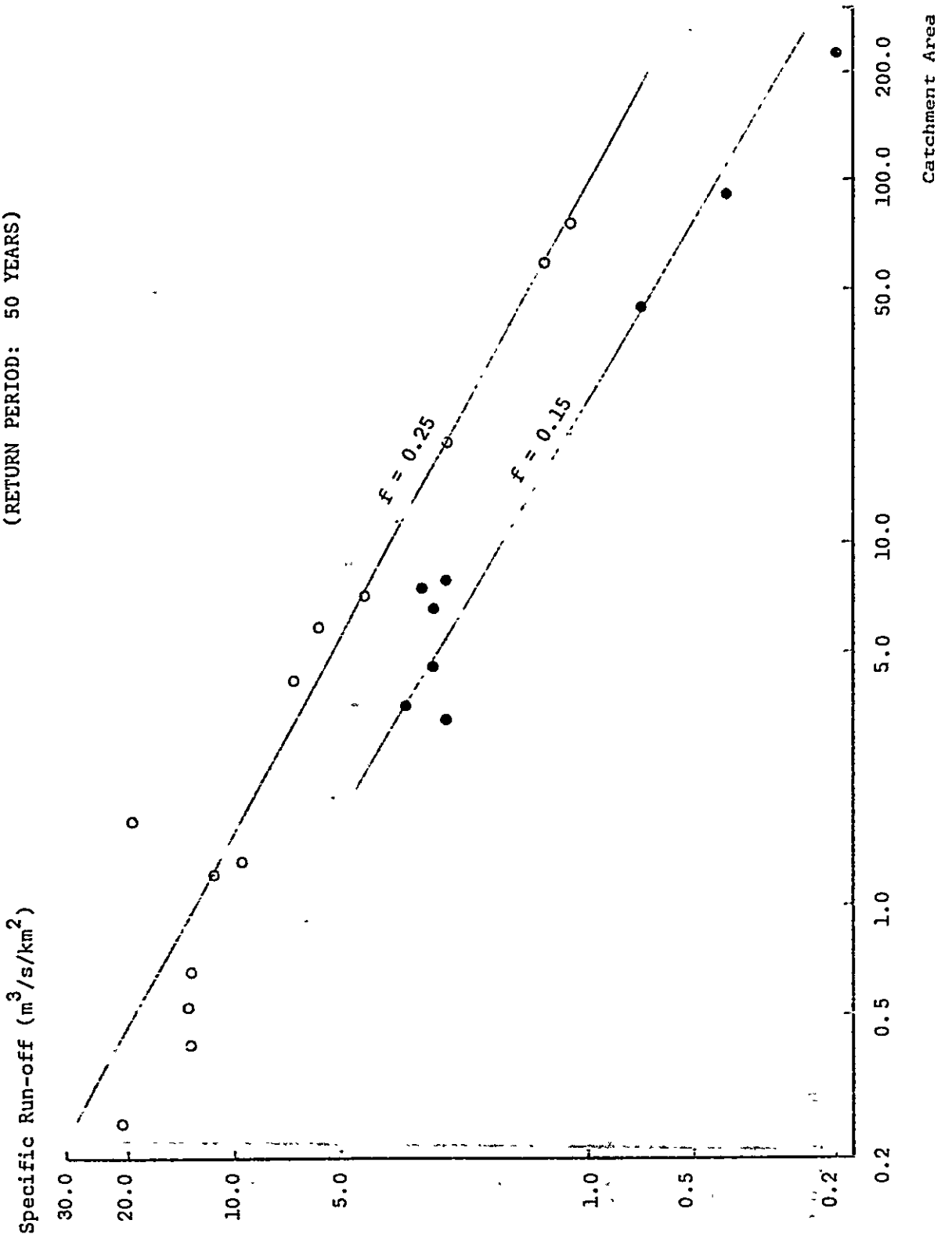


TABLE 5-11-1 ESTIMATED DISCHARGE OF 10 YEAR'S RETURN PERIOD
AT THE LOCATION OF STRUCTURES BY RATIONAL FORMULA

$$r \text{ 1/10} = \frac{5006}{t + 7.0} \quad (W = 1/10)$$

1.1 Route A and D

No.	Station	Catchment area		Time of conc. and Rainfall intensity (min)	Rainfall intensity (mm/hr)	Run-off coefficient	Discharge (m ³ /s)	Specific run-off (m ³ /s/km ²)
		Length (Km)	Slope					
1	1k + 90m	0.52	1/240	27	147.2	0.25	5.3	10.2
2	1k + 870m	0.65	1/200	28	143.0	"	6.5	10.0
3	2k + 240m	0.41	1/180	28	143.0	"	4.1	10.0
4	5k + 250m	4.15	1/200	62	72.6	"	20.9	5.0
5	10k + 900m	5.80	1/200	74	61.8	"	24.9	4.3
6	11k + 120m	7.05	1/200	104	45.1	"	22.1	3.1
7	20k + 110m	74.81	1/300	406	12.1	"	62.9	0.8
8	21k + 240m	58.55	1/300	337	14.6	"	59.4	1.0
9	23k + 500m	1.30	1/100	42	102.2	"	9.2	7.1
10	23k + 710m	1.20	1/100	34	122.1	"	10.2	8.5
11	25k + 420m	1.70	1/50	17	208.6	"	24.6	14.5
12	26k + 920m	0.25	1/30	15	227.5	"	3.9	15.6
13	29k + 540m	19.05	1/250	179	26.9	"	35.6	1.9
14	43k + 920m	44.30	1/350	398	12.4	0.15	22.9	0.5
15	49k + 320m	91.10	1/440	630	7.9	"	30.0	0.3
16	54k + 440m	224.95	1/740	1207	4.1	"	38.4	0.2
17	57k + 470m	3.25	1/300	105	44.7	"	6.1	1.9
1	77k + 70m	7.41	1/250	87	53.2	"	16.4	2.2
2	79k + 900m	6.55	1/250	96	48.6	"	13.3	2.0
3	80k + 960m	7.81	1/250	103	45.5	"	14.8	1.9
4	81k + 160m	4.55	1/250	94	49.6	"	9.4	2.1
5	91k + 940m	3.58	1/250	78	58.9	"	8.8	2.5

TABLE 5-11-2 ESTIMATED DISCHARGE OF 50 YEAR'S RETURN PERIOD
AT THE LOCATION OF STRUCTURES BY RATIONAL FORMULA

$$r \text{ 1/50} = \frac{6635}{t + 7.0} \quad (W = 1/50)$$

1.2 Route A and D

Route	No.	Station	Catchment area Length and Slope		Time of concentration and Rainfall intensity		Run-off coefficient, Discharge and Specific run-off			
			Area (Km ²)	Length (Km)	Slope	Time of conc. (min)	Rainfall inten- sity (mm/hr)	Run-off coefficient	Discharge (m ³ /s)	Specific run-off (m ³ /s/km ²)
	1	1k + 90m	0.52	1.2	1/240	27	195.1	0.25	7.0	13.5
	2	1k + 870m	0.65	1.4	1/200	28	189.6	"	8.6	13.2
	3	2k + 240m	0.41	1.5	1/180	28	189.6	"	5.4	13.2
	4	5k + 260m	4.15	3.1	1/200	62	96.2	"	27.7	6.7
	5	10k + 900m	5.80	3.7	1/200	74	81.9	"	33.0	5.7
	6	11k + 120m	7.05	5.2	1/200	104	59.8	"	29.3	4.2
	7	20k + 110m	74.81	15.9	1/300	406	16.1	"	83.6	1.1
	8	21k + 240m	58.55	13.2	1/300	337	19.3	"	78.5	1.3
	9	23k + 500m	1.30	3.2	1/100	42	135.4	"	12.2	9.4
	10	23k + 710m	1.20	2.6	1/100	34	161.8	"	13.5	11.3
	11	25k + 420m	1.70	1.9	1/50	17	276.5	"	32.6	19.2
	12	26k + 920m	0.25	0.8	1/30	15	301.6	"	5.2	20.8
	13	29k + 540m	19.05	7.8	1/250	179	35.7	"	47.2	2.5
	14	43k + 920m	44.30	14.2	1/350	398	16.4	0.15	30.3	0.7
	15	49k + 320m	91.10	19.6	1/440	630	10.4	"	39.5	0.4
	16	54k + 440m	224.95	27.5	1/740	1207	5.5	"	51.6	0.2
	17	57k + 470m	3.25	4.1	1/300	105	59.2	"	8.0	2.5
	1	77k + 70m	7.41	3.8	1/250	87	70.6	"	21.8	2.9
	2	79k + 900m	6.55	4.2	1/250	96	64.4	"	17.6	2.7
	3	80k + 960m	7.81	4.5	1/250	103	60.3	"	19.6	2.5
	4	81k + 160m	4.55	4.1	1/250	94	65.7	"	12.5	2.7
	5	91k + 940m	3.58	3.4	1/250	78	78.1	"	11.6	3.2

TABLE 5-11-3 ESTIMATED DISCHARGE OF 10 YEAR'S RETURN PERIOD
AT THE LOCATION OF STRUCTURES BY SPECIFIC RUN-OFF METHOD

2.1 Route B $r \ 1/10 = \frac{5006}{t + 7.0}$ (W = 1/10)

No.	Station	Catchment area Length and Slope		Time of concentration and Rainfall intensity		Run-off coefficient, Discharge and Specific run-off		
		Area (Km ²)	Length (Km)	Slope	Time of conc. (min)	Rainfall intensity (mm/hr)	Run-off coefficient	Discharge (m ³ /s)
1	13k + 350m	43.15	8.5				50.1	1.16
2	13k + 950m	4.05	1.6				17.8	4.40
3	14k + 900m	1.20	0.9				10.2	8.50
4	17k + 0m	3.70	2.3				17.0	4.60
5	20k + 800m	57.05	15.2				58.8	1.03
6	24k + 500m	14.80	6.5				31.7	2.14
7	28k + 300m	161.30	19.2				90.3	0.56
8	28k + 700m	3.70	4.6				17.0	4.60
9	29k + 400m	15.90	8.0				32.6	2.05
10	35k + 850m	11.40	6.4				27.9	2.45
11	36k + 250m	25.60	9.0				40.4	1.58
12	50k + 350m	2.20	1.4				13.4	6.10

3.1 Route F

1	4k + 800m	12.05	7.0				28.9	2.40
2	7k + 800m	28.30	8.5				42.5	1.50
3	9k + 600m	13.70	3.2				30.1	2.20

Remarks; Discharges are obtained from Fig. V-14-1 SPECIFIC RUN-OFF DIAGRAM.

TABLE 5-11-4 ESTIMATED DISCHARGE OF 50 YEAR'S RETURN PERIOD
AT THE LOCATION OF STRUCTURE BY SPECIFIC RUN-OFF METHOD

2.2 Route B $r = \frac{1}{50} + \frac{6635}{t + 7.0}$ (W = 1/50)

No.	Station	Area (Km ²)	Length (Km)	Slope	Time of conc. (min)	Time of concentration and Rainfall intensity	Rainfall intensity (mm/hr)	Run-off coefficient	Discharge (m ³ /s)	Specific run-off (m ³ /s/Km ²)
1	13k + 350m	43.15	8.5						67.7	1.57
2	13k + 950m	4.05	1.6						23.9	5.90
3	14k + 900m	1.20	0.9						13.8	11.50
4	17k + 0m	3.70	2.3						22.9	6.20
5	20k + 800m	57.05	15.2						76.4	1.34
6	24k + 500m	14.80	6.5						42.2	2.85
7	28k + 300m	161.30	19.2						119.4	0.74
8	28k + 700m	3.70	4.6						22.9	6.20
9	29k + 400m	15.90	8.0						43.2	2.72
10	35k + 850m	11.40	6.4						37.1	3.25
11	36k + 250m	25.60	9.0						53.8	2.10
12	50k + 350m	2.20	1.4						18.0	8.20

3.2 Route F

1	4k + 800m	12.05	7.0						38.6	3.20
2	7k + 800m	28.30	8.5						56.6	2.00
3	9k + 600m	13.70	3.2						41.1	3.00

Remarks; Discharges are obtained from Fig. V-14-2 SPECIFIC RUN-OFF DIAGRAM.

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TABLE 6-1 ROAD-SIDE INTERVIEW QUESTIONNAIRE

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Station No.		Name of interviewer		Sheet No.		1 Time of Interview						2 Type of vehicle											
Date of Interview	Weather	Name of Surveyor		Direction		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
3 Model/Make	4 Age	5 Origin	6 Destination	7 Trip purpose					8 Passenger cars					9 Trucks			15 Average annual mileage of the car (kilometer per year)						
				1 Work	2 To home	3 Shopping	4 Social intercourse recreation	5 Others	8 Capacity (No. of persons)	9 No of passengers	10 No. of wheels	11 Loading capacity (tons)	12 Type of commodities carried	13 Weight of commodity (tons)	14 Fuel used								
1 Time	2 Type of vehicle	3 Model/make of the vehicle	4 Age	5 Origin	6 Destination	7 Capacity	8 No. of pass.	9 No. of wheels	10 Loading capacity	11 Types of commodities carried	12 Types of commodity carried	13 weight	14 Fuel used	15									

Note; 1) Travel Time
2) Fuel Consumption

TABLE 6-2 TRAFFIC COUNT SURVEY SHEET

ANNEX VI-2

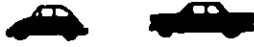






Station No.	Date of count		Weather											Sheet No.
Direction			Name of Surveyor						Name of Supervisor			/		
→														
Type of vehicle	7 8	8 9	9 10	10 11	11 12	12 13	13 14	14 15	15 16	16 17	17 18	18 19	Total	
1. Car, taxi 														
2. Jeep 														
3. Van, pick-up 														
4. Medium truck 														
5. Heavy truck 														
6. Truck-trailer 														
7. Bus 														
8. Motor cycle														
9. Animal drawn vehicle														
10. Others														
Total														

TABLE 6-3-1 DAILY TRAFFIC AT SURVEY POINT 11, EL OBEID

Vehicle Type	May							Average
	9 (MON)	10 (TUE)	11 (WED)	12 (THU)	13 (FRI)	14 (SAT)	15 (SUN)	
Van, Pick-up	1.2	-	3.6	-	-	-	1.2	0.9
Medium Truck	56.4	43.2	49.2	42.0	34.8	82.8	20.4	47.0
Heavy Truck	1.2	2.4	4.8	1.2	1.2	2.4	-	1.9
Bus	1.2	-	-	-	-	-	-	0.2
Total	60.0	45.6	57.6	43.2	36.0	85.2	21.6	50.0

TABLE 6-3-2 DAILY TRAFFIC AT SURVEY POINT 12, EL OBEID

Vehicle Type	May							Average
	9 (MON)	10 (TUE)	11 (WED)	12 (THU)	13 (FRI)	14 (SAT)	15 (SUN)	
Van, Pick-up	3.6	4.8	2.4	1.2	15.6	-	1.2	4.1
Medium Truck	20.4	48.0	34.8	48.0	34.8	45.6	21.6	36.2
Heavy Truck	-	-	-	1.2	1.2	-	-	0.3
Bus	-	1.2	1.2	1.2	2.4	-	1.2	1.0
Total	24.0	54.0	38.4	51.6	54.0	45.6	24.0	41.6

TABLE 6-3-3 DAILY TRAFFIC AT SURVEY POINT 13, EL OBEID

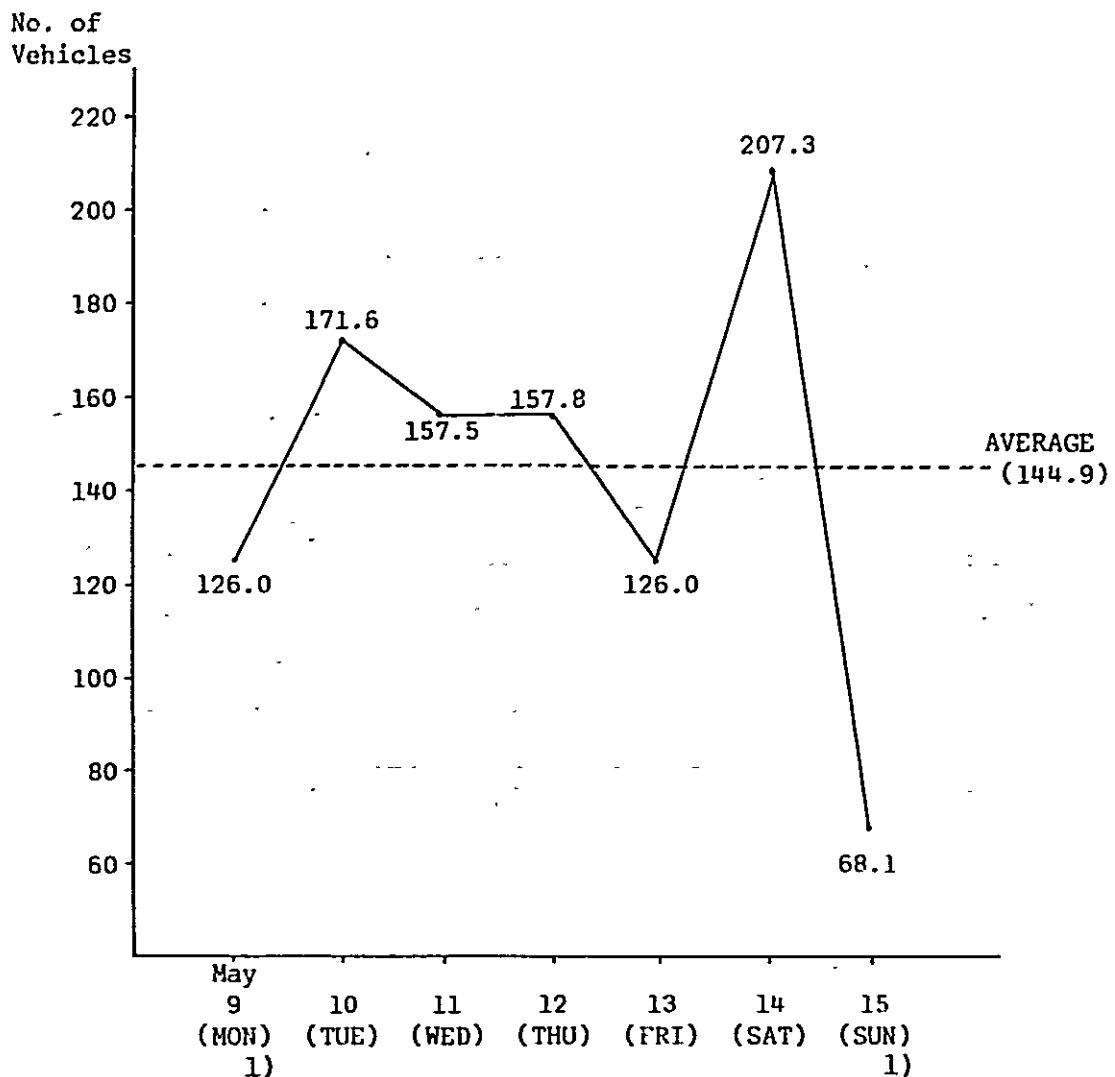
Vehicle Type	May							Average
	9 (MON)	10 (TUE)	11 (WED)	12 (THU)	13 (FRI)	14 (SAT)	15 (SUN)	
Van, Pick-up	-	-	1.5	1.5	-	1.5	3.0	1.1
Medium Truck	25.5	22.5	30.0	30.0	19.5	48.0	18.0	27.6
Heavy Truck	-	3.0	1.5	3.0	3.0	1.5	1.5	1.9
Bus	-	-	-	-	-	-	-	-
Total	25.5	25.5	33.0	34.5	22.5	51.0	22.5	30.6

TABLE 6-3-4 DAILY TRAFFIC AT SURVEY POINT 14, EL OBEID

Vehicle Type	May							Average
	9 (MON)	10 (TUE)	11 (WED)	12 (THU)	13 (FRI)	14 (SAT)	15 (SUN)	
Van, Pick-up	4.5	16.5	7.5	6.0	6.0	9.0	-	7.1
Medium Truck	7.5	22.5	12.0	16.5	3.0	13.5	-	10.7
Heavy Truck	-	-	3.0	-	1.5	-	-	0.6
Bus	4.5	7.5	6.0	6.0	3.0	3.0	-	4.3
Total	16.5	46.5	28.5	28.5	13.5	25.5	-	22.7

FIG. 6-1 DAILY VARIATION OF ROAD TRAFFIC, EL OBEID, 1977
(ALL TYPES OF VEHICLES)

ANNEX VI-4



1) Survey was not conducted for full day.

TABLE 6-4-1 DAILY TRAFFIC SURVEY
POINT 21, UM RUABA

ANNEX VI-5

Vehicle Type	May 21 (Sat)	22 (Sun)	23 (Mon)	24 (Tue)	Average
Van Pickup	6.0	1.2	4.8	7.2	4.8
Medium Truck	38.4	38.4	28.8	27.6	33.3
Heavy Truck	-	-	-	-	-
Bus	-	-	-	-	-
Total	44.4	39.6	33.6	34.8	38.1

TABLE 6-4-2 DAILY TRAFFIC SURVEY
POINT 22, UM RUABA

Vehicle Type	May 21 (Sat)	22 (Sun)	23 (Mon)	24 (Tue)	Average
Van Pickup	1.2	-	-	1.2	0.6
Medium Truck	69.6	117.6	104.4	117.6	102.3
Heavy Truck	-	2.4	7.2	2.4	3.0
Bus	1.2	-	-	-	0.3
Total	72.0	120.0	111.6	121.2	106.2

FIG. 6-2 DAILY VARIATION OF ROAD TRAFFIC,
UM RUABA, 1977 (All types of Vehicles)

ANNEX VI-6

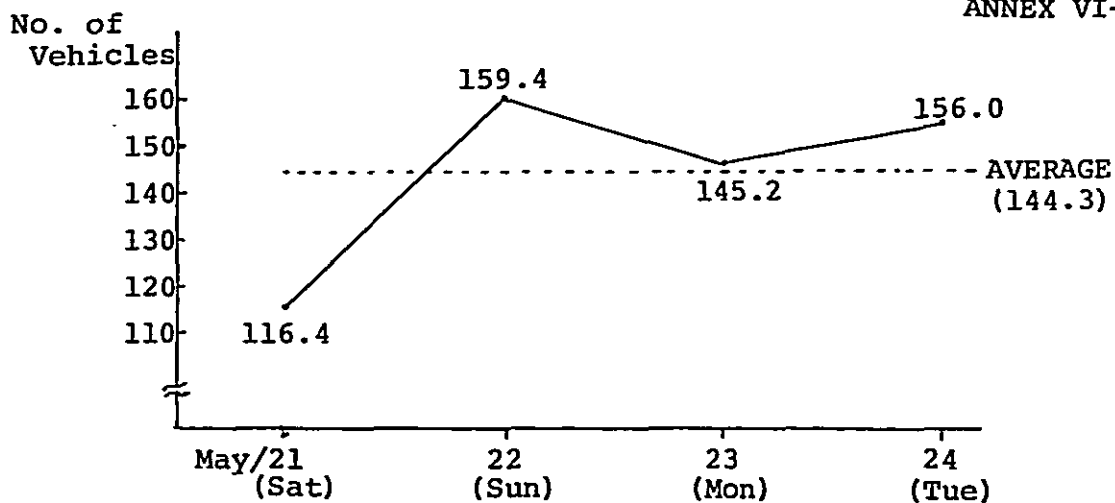


TABLE 6-5-1 HOURLY DISTRIBUTION OF ADT,
EL OBEID AREA, 1977

ANNEX VI-7

	Van/ Pick-up	Medium Truck	Heavy Truck	Bus	Total	
					Vehicles	%
7 - 8	1.5	11.1	0.4	0.2	13.2	8.3
8 - 9	1.7	7.9	0.2	2.0	11.8	7.4
9 - 10	0.5	8.4	0.4	0.8	10.1	6.3
10 - 11	0.2	8.3	0.6	0.2	9.3	5.8
11 - 12	0.9	7.5	0.6	-	9.0	5.6
12 - 13	0.7	6.6	0.6	-	7.9	4.9
13 - 14	0.4	4.6	0.5	-	5.5	3.4
14 - 15	0.6	6.6	-	0.2	7.4	4.6
15 - 16	-	6.2	0.6	3.0	9.8	6.1
16 - 17	1.8	13.2	-	-	15.0	9.4
17 - 18	1.5	14.6	0.4	0.2	16.7	10.5
18 - 19	0.2	5.9	0.2	-	6.3	3.9
19 - 20	1.2	6.3	0.2	-	7.7	4.8
20 - 21	1.0	4.1	-	-	5.1	3.2
21 - 22	0.5	1.9	-	-	2.4	1.5
22 - 23	0.4	1.1	-	-	1.5	0.9
23 - 24	0.4	1.5	-	-	1.9	1.2
0 - 1	1.1	1.9	-	-	3.0	1.9
1 - 2	0.6	1.9	-	-	2.5	1.6
2 - 3	-	2.2	-	-	2.2	1.4
3 - 4	0.2	1.6	-	0.2	2.0	1.3
4 - 5	-	1.4	-	-	1.4	0.9
5 - 6	-	1.6	-	-	1.6	1.0
6 - 7	-	6.3	0.2	-	6.5	4.1
Total	15.4	132.7	4.9	6.8	159.8	100.0

TABLE 6-5-2

HOURLY DISTRIBUTION OF ADT,
UM RUABA AREA, 1977

ANNEX VI-8

Vehicle Hour Type	Van/ Pick-up	Medium Truck	Heavy Truck	Bus	Total	
					Vehicle	%
7 - 8	-	6.9	1.2	-	8.1	5.4
8 - 9	0.3	12.0	-	0.3	12.6	8.3
9 - 10	0.9	9.3	-	-	10.2	6.7
10 - 11	0.3	6.3	-	-	6.6	4.4
11 - 12	0.3	3.3	-	-	3.6	2.4
12 - 13	-	6.9	0.3	-	7.2	4.8
13 - 14	-	2.4	0.3	-	2.7	1.8
14 - 15	1.2	6.6	0.3	-	8.1	5.4
15 - 16	-	9.9	-	-	9.9	6.5
16 - 17	0.3	7.8	-	-	8.1	5.4
17 - 18	1.2	13.8	-	-	15.0	9.9
18 - 19	0.9	7.2	0.6	-	8.7	5.8
19 - 20	-	7.5	-	-	7.5	4.9
20 - 21	-	5.7	-	-	5.7	3.8
21 - 22	-	5.1	-	-	5.1	3.4
22 - 23	-	3.3	0.3	-	3.6	2.4
23 - 24	-	5.7	-	-	5.7	3.8
0 - 1	-	6.9	-	-	6.9	4.6
1 - 2	-	2.7	-	-	2.7	1.8
2 - 3	-	1.8	-	-	1.8	1.2
3 - 4	-	-	-	-	-	-
4 - 5	-	-	-	-	-	-
5 - 6	0.3	0.6	-	-	0.9	0.6
6 - 7	-	10.2	-	-	10.2	6.7
Total	5.7	141.9	3.0	0.3	150.9	100.0

FIG. 6-3-1 HOURLY DISTRIBUTION OF ADT, 1977
(ALL TYPES OF VEHICLES)

ANNEX XI-9

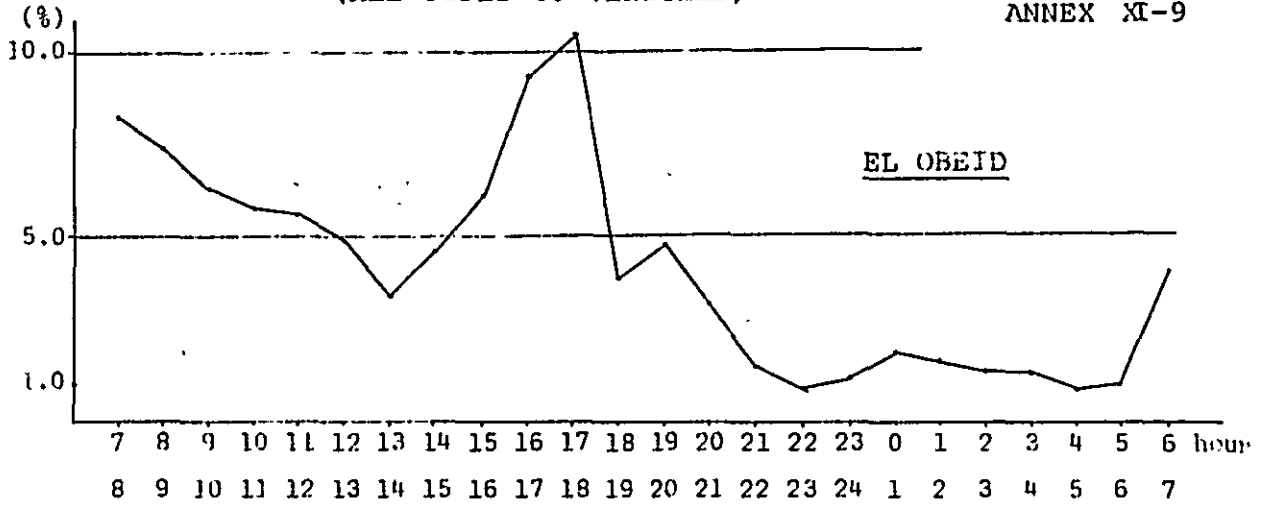


FIG. 6-3-2 HOURLY DISTRIBUTION OF ADT, 1977
(ALL TYPES OF VEHICLES)

UM RUABA

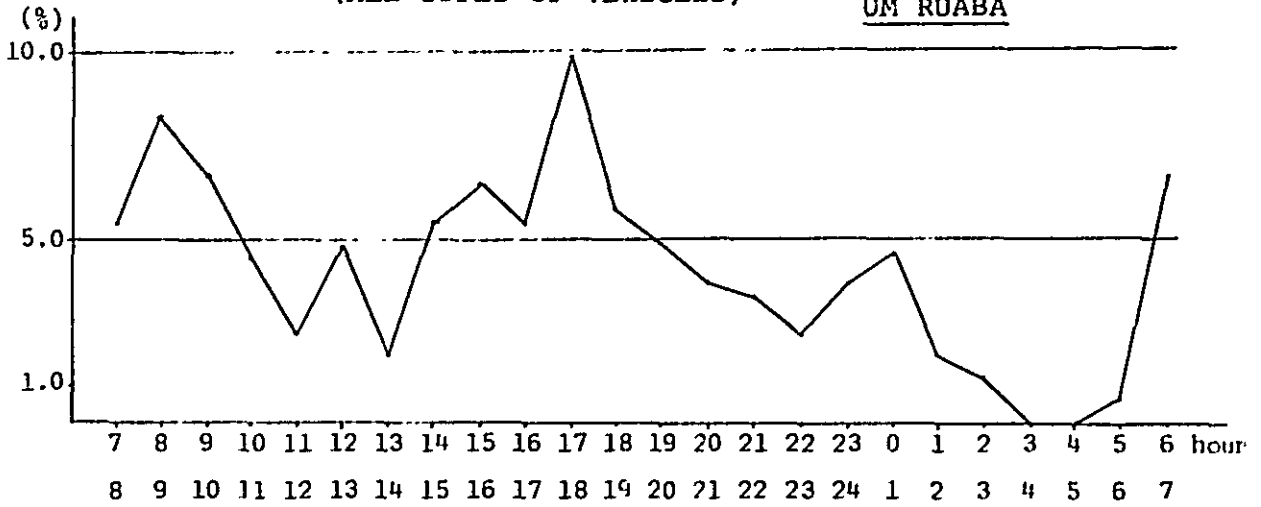


FIG. 6-3-3 HOURLY DISTRIBUTION OF ADT, 1977
(ALL TYPES OF VEHICLES)

PROJECT AREA
(EL OBEID+UM RUABA)

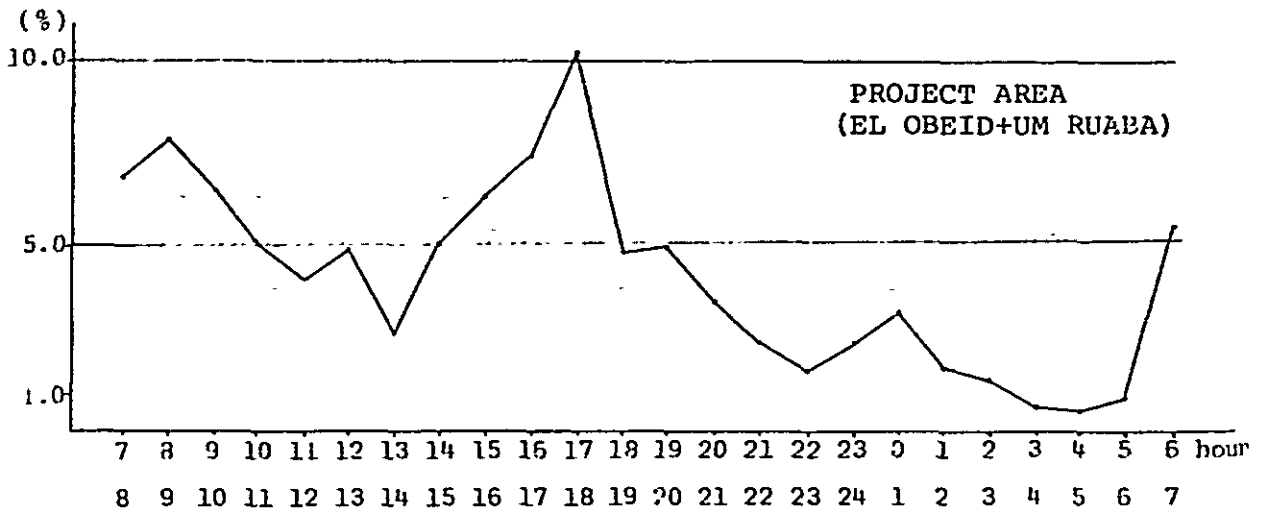


TABLE 6-6-1 SEASONAL VARIATIONS OF RAILWAY
GOODS TRAFFIC AT EL OBEID STATION,
1976

Month	Forwarded	Received	Total
JAN. 1976	11,580	8,417	19,997
FEB.	8,936	7,232	16,168
MAR.	6,952	6,499	13,451
APR.	11,507	7,067	18,574
MAY.	9,672	8,254	17,926
JUN.	9,249	7,349	16,598
JUL.	9,356	8,476	17,832
AUG.	9,401	9,244	18,645
SEP.	7,390	8,466	15,856
OCT.	6,317	7,254	13,571
NOV.	8,425	7,753	16,178
DEC.	8,766	7,249	16,015
1976 Total	107,551	93,260	200,811

Source: Sudan Railways Corporation, 1977

FIG. 6-4-1 SEASONAL VARIATION OF RAILWAY
GOODS TRAFFIC

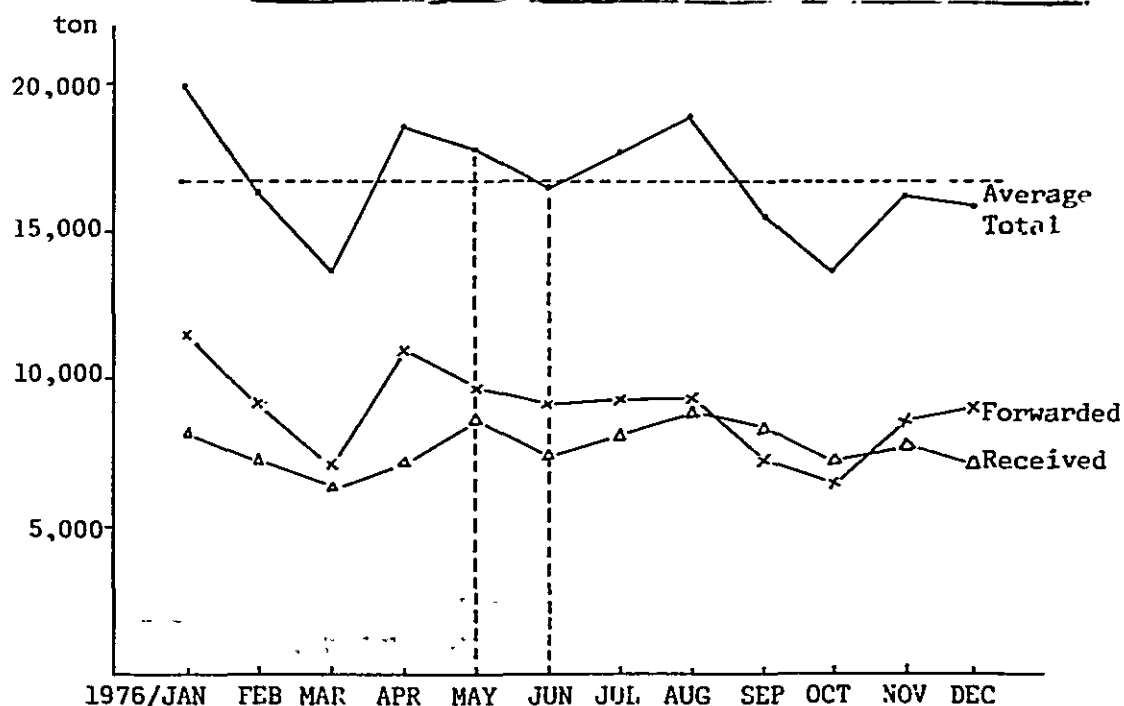


TABLE 6-6-2 TONNAGE OF CROPS HANDLED AT EL OBEID CROP MARKET, 1976

ANNEX VI-11

	Tons
JAN. 1976	104,000
FEB.	95,000
MAR.	87,000
APR.	69,000
MAY	74,000
JUN.	44,000
JUY.	17,000
AUG.	4,000
SEP.	1,000
OCT.	27,000
NOV.	99,000
DEC.	87,000
1976 Total	708,000

Source: El Obeid Crop Market, 1977

FIG 6-4-2 SEASONAL VARIATION OF TONNAGE OF CROPS HANDLED AT EL OBEID CROP MARKET

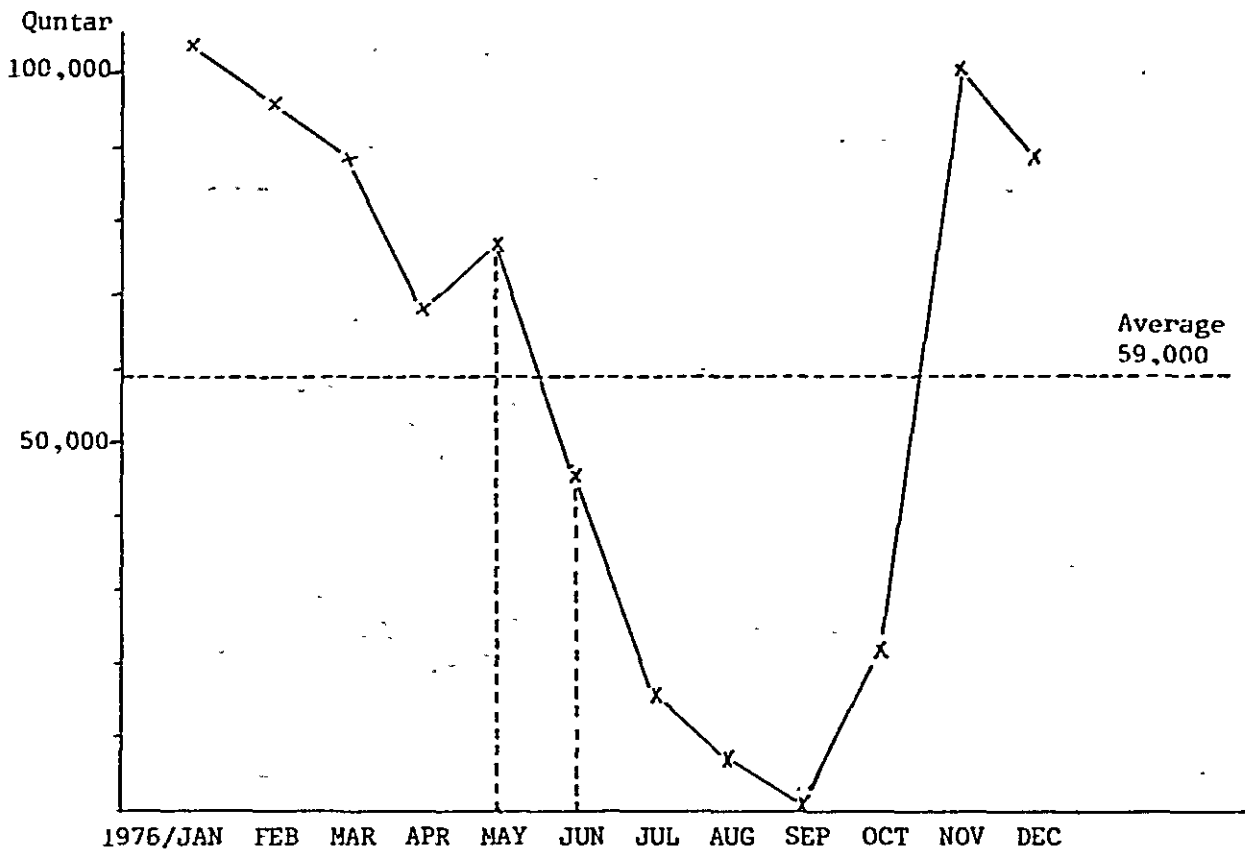


TABLE 6-7 VEHICLE MAKE AND YEARS IN SERVICE

Vehicle Make	Years in Service															Total		
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	No.	%
Volga(1/4)						1.5	1.5										3.0	0.2
Jeep(0.5)	1.2		3.6	1.2	1.2	2.4	1.2	2.4	1.2		1.2	1.2				1.2	18.0	1.1
Land Rover(1.0)	1.2	2.4	3.9	7.5	7.2	4.5											26.7	1.6
Ford Custom(1.5)		7.5	3.6	1.5	1.5	2.4	1.5			1.2							19.2	1.2
Toyota(1.5)	1.2				1.2	1.2				2.7							5.1	0.3
Mercury (3.0)		1.5		1.5	1.2	3.9		1.5	1.5	1.5	3.0				3.0		18.6	1.1
Commer(3.0)			1.2	1.2		3.6	1.5		1.5		1.2						10.2	0.6
Ford(4.0)		1.2	3.9	5.4	4.2	1.5				1.5		1.2					18.9	1.1
Commer(5.0)		1.2	3.6	2.4	2.4	5.1	5.1		4.2	3.0	3.0	1.2	2.4	1.2			34.8	2.1
Austin(5.0)	15.9	51.0	43.5	45.0	32.4	8.4	7.2	2.7	9.0	2.4	3.6		1.2		3.6	225.9	13.7	
Austin(6.0)	16.8	34.2	18.0	18.6	16.5	10.2	6.0	1.2	1.5				1.5		2.4	126.9	7.7	
Bed Ford(6.0)	11.1	43.5	110.1	97.2	87.6	42.3	43.2	10.8	16.8	8.4	14.4	2.4	1.2		1.2	490.2	29.7	
Ford(6.0)		15.9	52.5	30.3	52.5	22.5	16.2	6.6	2.4		2.4		1.2			202.5	12.3	
International(6.0)		1.2			2.4												3.6	0.2
Ford(7.0)		4.5	6.3	52.8	43.0	19.5	19.8	9.3	8.1	3.0	4.2			1.2			202.5	12.3
Nissan(8.0)	6.0	22.5	44.4	42.9	22.5	15.9	3.9	3.0	1.5				1.2				163.8	9.9
Mageros(8.0)		19.2	27.0														46.2	2.8
Fuso(8.0)		1.2							1.2								2.4	0.1
Hino(8.0)		2.4	6.9	5.1													14.4	0.9
Fiat(11.0)	1.5	5.4	15.0	2.7													24.6	1.5
Leyland(12.0)		2.4															2.4	0.1
Super(15.0)		1.2															1.2	0.1
Scania(16.0)			2.4	1.2	1.5												5.1	0.3
Nissan(16.0)		2.4	1.5														3.9	0.2
Bassit(6.0)			1.2	1.2				1.2									3.6	0.2
Liner(16.0)			6.0														6.0	0.4
Total	54.9	220.8	354.6	317.7	275.1	144.9	107.1	38.7	48.9	22.5	34.2	4.8	9.9	2.4	11.4	1647.9	100.0	
	3.4	13.4	21.5	19.3	16.7	8.8	6.5	2.3	3.0	1.4	2.1	0.3	0.6	0.1	0.7	100.0		

Note: 1) Figures in Parentheses indicate loading capacity in tons.

TABLE 6-8 YEARS IN SERVICE OF VEHICLES BY TYPE¹⁾

Vehicle Type	Years in Service													Total (%)	Average Years in Service		
	0	1	2	3	4	5	6	7	8	9	10	11	12			13	14
Van Pick-ups	3.6	9.9	11.1	10.2	9.9	12.0	4.2	2.4	1.2	2.7	2.4	1.2	1.2	1.2	1.2	72.0 (4.5)	4.1
Medium Truck	48.3	180.3	290.4	299.4	258.0	118.2	98.7	32.1	49.0	19.8	27.0	3.6	9.9	2.4	10.2	1,443.3 (90.1)	3.6
Heavy Truck	1.5	11.4	26.1	5.1	1.5		1.2									46.8 (2.9)	2.0
Bus	1.5			3.0	5.7	14.7	4.2	3.0	2.7		4.8					39.6 (2.5)	5.6
Total (%)	54.9 (3.4)	201.6 (12.6)	327.6 (20.5)	317.7 (19.8)	275.1 (17.2)	144.9 (9.0)	107.1 (6.7)	38.7 (2.4)	48.9 (3.1)	22.5 (1.4)	34.2 (2.1)	4.8 (0.3)	9.9 (0.6)	2.4 (0.1)	11.4 (0.7)	1,601.7 (100.0)	3.7

1) Vehicles for military use are excluded.

TABLE 6-9 DISTRIBUTION OF VEHICLES BY LOADING CAPACITY¹⁾

Vehicle Type	Van Pick-ups						Medium Truck						Heavy Truck					
	0.25	0.5	1	1.5	Total	3	4	5	6	7	8	Total	11	12	15	16	Total	
Capacity (ton)	0.25	0.5	1	1.5	Total	3	4	5	6	7	8	Total	11	12	15	16	Total	
Vehicle Number	3.0	18.0	26.7	24.3	72.0	18.6	18.9	260.7	793.5	170.7	170.7	1,443.3	24.6	2.4	1.2	18.6	46.8	1,562.1
Average Capacity (ton)			1.0						6.1						13.1			6.1

Note: 1) Buses and vehicles for military use are excluded.

TABLE 6-10 DISTRIBUTION OF VEHICLES BY LOADED CONTENT¹⁾

Type of Vehicles	Van Pick-up	Medium Truck	Heavy Truck	(Vehicles) Total
Commodities Only		83.7	6.4	90.1
Commodities & Passengers	9.4	1,166.7	31.8	1,207.9
Passengers Only	55.8	173.9	7.3	237.0
Empty	6.8	19.0	1.3	27.1
Total	72.0	1,443.3	46.8	1,562.1

1) Buses and vehicles for military use are excluded.

TABLE 6-11 LOADING CHARACTERISTICS OF VEHICLES¹⁾

Type of Vehicle	Van Pick-up	Medium Truck	Heavy Truck	Total
Average Loaded Tonnage (ton)				
Commodities Only		4.91	8.43	5.15
Commodities & Passengers	0.73	4.78	9.04	4.84
Sub-total	0.73	4.79	8.93	4.87
Total	0.11	4.14	7.19	4.03
Average Loaded Passengers (persons)				
Commodities & Passengers	4.37	9.49	9.03	9.44
Passengers Only	5.35	14.63	4.20	12.08
Total	4.71	9.44	6.54	9.13
Average Loading Rate (%)				
Commodities Only		0.80	0.60	0.77
Commodities & Passengers	0.53	0.78	0.72	0.78
Sub Total	0.53	0.78	0.70	0.77
Total	0.09	0.68	0.54	0.67

Note: 1) Buses and vehicles for military use are excluded.

TABLE 6-12-1 OD TABLE OF ROAD VEHICULAR TRAFFIC, 1977

(All types of vehicles)

ZONE	(Vehicles per day)																									
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	TOTAL
EL OBEID	4.2				14.9	1.0	22.3	1.0	1.8	1.0	14.1	0.1	0.1	0.1	1.1			2.7	0.5	0.0						11.1
GEFIF					0.6						0.1															7.0
ET TAIYARA					1.1																					4.1
SHAFAGATTA					16.5						0.3	0.0	0.3													17.2
UM RUVABA						3.9	2.1	11.1											6.9	2.1		0.1	0.9			51.2
ABU HAMRA																										7.0
SEMCIH													0.3													1.3
RAHAD										1.5	2.4			3.0								0.7				41.0
NAWA																										1.0
EL AIN																										1.0
TENDELT																			1.3	0.6						4.7
KOSTI-SENAR																			1.3	6.6		0.2	0.1			11.1
WAD MEDANI																				0.9						1.7
KHARTOUM																			1.6	5.4	0.4	1.8	15.6			11.1
KASSALA																										0.1
PORT SUDAN																							0.3			1.0
MALACAL																										2.7
EL ABBASIYA																										6.6
HUSA MOUNTAIN																										11.0
KHAKKI-DILLING																										1.1
WAU-JUBA																										1.1
ER NAHUD																										1.1
JYALA																										1.1
BARA																										1.1
ATBARA																										1.1
TOTAL																										1.1

TABLE 6-12-2 OD TABLE OF ROAD VEHICULAR TRAFFIC, 1977

(Van Pick-ups)

ZONE	(Vehicles per day)																										
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	TOTAL	
EL OBEID	0.2				1.1		0.2	1.2	0.2	1.4		0.3						0.4	0.2	0.6						2.0	
GELIL													1.2														2.0
LT TAIYARA																											2.0
SHAFAGATTA					3.0																						3.0
UM BURABA								0.3														0.3					0.3
ABU HAIRA																											0.2
SEMELI																											1.5
BAHAD																											0.2
NAWA																											1.4
EL AIN																											0.3
TENDELI																											1.2
KOSTI-SHAR																											0.6
WAD MEDANI																											0.2
SHARTOUB																											0.4
KASSALA																											0.2
PORT SUDAN																											0.1
HALACAL																											0.6
EL ABBASIYA																											0.2
SHIFA MOUNTAIN																											0.1
KADUCI-DILLING																											0.5
WAW-JUDA																											0.5
MR NAHID																											0.5
HYALA																											0.5
BAVA																											0.5
ATHAPA																											0.5
TOTAL																											11.5

TABLE 6-12-3 OD TABLE OF ROAD VEHICULAR TRAFFIC, 1977

ZONE	(Vehicles per day)																										
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	TOTAL	
EL OHEID	6.0				13.4		0.4	17.4	0.8	0.4	1.0	3.4	0.8	35.4	0.1	1.6			2.3	0.3	0.2						46.1
CLIFIL					0.1						0.6																7.2
ET TAIYARA					0.3																						0.1
SHAPAGATTA					13.2						6.3			0.6		0.1											20.7
UN RUKADA						3.0	2.1	10.8											2.9	2.1			0.6				34.7
ABU HAMRA																											3.1
SENEIH											0.7																0.7
RAHAD											1.5	2.4		1.0									0.7				7.5
NAWA																											0.8
EL AIN																											0.6
TENDELI																			0.3	0.6		0.3					1.7
KOSTI-SENAR																			0.3	0.3		0.2	0.1				1.0
WAD NEDANI																				2.1							1.7
KHARTOUM																			9.6	4.8	0.4	1.0	10.6				27.7
KASSALA																											0.1
PORT SUDAN																							0.3				0.3
MALACAL																											2.2
EL ARBASIYA																											2.3
HUSA KENTAIN																											1.0
KHARJIL -DILLING																											10.7
WADI-JUBA																											0.4
HI HAHUD																											2.0
UYAMA																											1.1
BARA																											1.1
ATBARA																											1.1
TOTAL																											7.1

TABLE 6-12-4 OD TABLE OF ROAD VEHICULAR TRAFFIC, 1977

(Heavy Truck)

ZONE	(Vehicles per day)																										
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	TOTAL	
EL OHCID					0.3		0.5	0.5																			1.3
GEJIL													2.4														
LT TAIYARA																											
SIKAGATTA																											
UN RUVADA																											0.1
ABU HANRA																											0.0
SEMEH																											0.0
RAHAD																											0.0
HAWA																											
EL AIN																											
TENDHITI																											
KOSTI-SEMAR																				0.1							0.1
WAD MUDARI																											6.3
KHARTOUM																				0.1							0.1
KASSALA																											3.9
PORT SUDAN																											
MALACAL																											
EL ABHASIYA																											
SUDA MEZAIN																											
KHAKEL-DILLIRI																											
WAD-JUDA																											1.1
HH NAHOD																											
AYALA																											1.1
HARA																											
ATBANA																											
TOTAL																											11.0

TABLE 6-12-5 OD TABLE OF ROAD VEHICULAR TRAFFIC, 1977

(BUS)

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	TOTAL	
ZOHU																											
EL OBEID								1.3						0.2												1.5	
GEIFI																											
ET TAIYARA																											
SHAGAGATA																											
UM RUMADA																											
ABU HAMRA																											
SEMBIH																											
RAHAD																											1.3
NAWA																											
EL AIN																											
TENDHITI																											
KOETI-SHAR																											
WAD MIDANI																											
KHARFOUM																											
KASSALA																											
PORT SUDAN																											
MALCAL																											
EL ABBASIYA																											
HABA KHARJAT																											
KARKALI-DILLING																											
WAU-JUBA																											
EL HANID																											
HYALA																											
BARA																											
ATHABA																											
TOTAL																											

Table 6-13 CLASSIFICATION OF COMMODITIES

ANNEX VI-15

CODE NO.	COMMODITY GROUP	NAME OF COMMODITY
10	UNPROCESSED CEREALS	• DURA • MAIZE
20	OTHER UNPROCESSED AGRICULTURAL FOODSTUFFS	• ONIONS • VEGETABLES • DATES • ARADAIB • BEANS • MANGO, FRUITS • MILK • GANZABEEL
31 32 33 34 35 36 37 30	UNPROCESSED AGRICULTURAL CASH CROPS	31. ARABIC GUM 32. GROUND NUTS 33. KARKADIE 34. WATER MELON SEEDS 35. SIMSIM 36. UMBAS (Food-stuffs for Animals) 37. COTTON 30 OTHERS
40	PROCESSED CEREAL PRODUCTS	• FLOUR • RICE
50	MANUFACTURED FOODSTUFFS	• BEER, WINE • TEA • BISCUITS, SWEETS • COFFEE • SALSA • NOODLES • SNUFF, • CIGARETTES • CHEESE • PEANUTS BUTTER
60	PROCESSED AGRICULTURAL CASH CROP	• SUGAR • VEGETABLE OIL • SALT • SIMSIM OIL • SHATTA
70	LIVESTOCK AND PRODUCTS	LIVE ANIMALS / medical goods ANIMAL SKINS / carpets
80	OTHER MANUFACTURED CONSUMER GOODS	WINDOW GLASS TABLEWARE, BEDS BATTERIES, CLOTHING SOAP, SHOES, BOOKS, TYRES, CAR, PAINT, STATIONERY PAPER, MATCHES, SPARE PARTS
90	FORESTRY PRODUCTS	FIREWOOD, CHARCOAL ZAAF
100	MINING PRODUCTS	
110	MINERAL OIL PRODUCTS	BENZINE, FUEL
120	BUILDING AND CONSTRUCTION MATERIALS	CEMENT, SAND, PLASTER, TIMBER, ZINC, AGGREGATE, IRON WATER PIPES
130	MISCELLANEOUS	BARRELS, CARION, TINS IRON BOX, SACKS
140	OTHERS	DIFFERENT GOODS, WATER

TABLE 6-14-1 COMMODITY MOVEMENT BY TRUCK, 1977

10 (Unprocessed Cereals)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHARTOUM	PORT SUDAN	WEST SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		18.4	2.9	1.0	11.7			4.2	38.2
UM RUABA	05	0.7		0.6	8.7					10.0
RAHAD	08		2.7							2.7
Rest of Project Area	02,03,04,06 07,09,10	3.2	2.4							5.6
KHARTOUM	14	1.1								1.1
PORT SUDAN	16									
WEST SUDAN	21,22,23,24			2.5		0.7				3.2
Rest of SUDAN	11,12,13,15,17 18,19,20,25	2.9	33.7			1.5			1.6	39.7
TOTAL		7.9	57.2	6.0	9.7	13.9			5.8	100.5

TABLE 6-14-2 COMMODITY MOVEMENT BY TRUCK, 1977

20 (Other Unprocessed
Agricultural Foodstuffs)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHARTOUM	PORT SUDAN	WEST SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		2.7	1.4		2.8			0.2	7.1
UM RUABA	05	1.7		1.3	2.1			0.3		5.4
RAHAD	08	6.7	1.8						2.1	10.6
Rest of Project Area	02,03,04,06 07,09,10	0.4								0.4
KHARTOUM	14	3.3		0.6	1.2			0.6	3.0	8.7
PORT SUDAN	16									
WEST SUDAN	21,22,23,24					6.7				6.7
Rest of SUDAN	11,12,13,15,17 18,19,20,25	5.5			1.5				12.0	19.0
TOTAL		17.6	4.5	3.3	4.8	9.5		0.9	17.3	57.9

TABLE 6-14-3 COMMODITY MOVEMENT BY TRUCK, 197730 (Unprocessed Agricultural Cash Crops,
Others)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR- TOUM	PORT SUDAN	WEST SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01					1.9				1.9
UM RUABA	05									
RAHAD	08					1.0				1.0
Rest of Project Area	02,03,04,06 07,09,10	0.2								0.2
KHARTOUM	14									
PORT SUDAN	16									
WEST SUDAN	21,22,23,24									
Rest of SUDAN	11,12,13,15,17 18,19,20,25									
TOTAL		0.2				2.9				3.1

TABLE 6-14-4 COMMODITY MOVEMENT BY TRUCK, 1977

31 (Arabic Gum)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR- TOUM	PORT SUDAN	WEST SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		2.2			23.2	1.6		1.5	28.5
UM RUABA	05	0.3								0.3
RAHAD	08	0.8	1.3						1.8	3.9
Rest of Project Area	02,03,04,06 07,09,10		4.7							4.7
KHARTOUM	14	0.9								0.9
PORT SUDAN	16									
WEST SUDAN	21,22,23,24		0.8			2.7				3.5
Rest of SUDAN	11,12,13,15,17 18,19,20,25								0.6	0.6
TOTAL		2.0	9.0			25.9	1.6		3.9	42.4

TABLE 6-14-5 COMMODITY MOVEMENT BY TRUCK, 1977

32 (Ground Nuts)

(tons/day)										
O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR- TOUM	PORT SUDAN	WEST SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		0.4							0.4
UM RUABA	05									
RAHAD	08									
Rest of Project Area	02,03,04,06 07,09,10									
KHARTOUM	14	0.4								0.4
PORT SUDAN	16									
WEST SUDAN	21,22,23,24					1.2			0.4	1.6
Rest of SUDAN	11,12,13,15,17 18,19,20,25	0.2								0.2
TOTAL	X	0.6	0.4			1.2			0.4	2.6

TABLE 6-14-6 COMMODITY MOVEMENT BY TRUCK, 1977

33 (Karkadie)

(tons/day)										
O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR- TOUM	PORT SUDAN	WEST SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01					0.4				0.4
UM RUABA	05									
RAHAD	08									
Rest of Project Area	02,03,04,06 07,09,10									
KHARTOUM	14									
PORT SUDAN	16									
WEST SUDAN	21,22,23,24									
Rest of SUDAN	11,12,13,15,17 18,19,20,25									
TOTAL	X					0.4				0.4

TABLE 6-14-7 COMMODITY MOVEMENT BY TRUCK, 1977

34 (Water Melon Seeds)

		(tons/day)								
O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	WEST SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01					6.1	0.8		2.6	9.5
UM RUABA	05									
RAHAD	08									
Rest of Project Area	02,03,04,06 07,09,10									
KHARTOUM	14									
PORT SUDAN	16									
WEST SUDAN	21,22,23,24					7.9				7.9
Rest of SUDAN	11,12,13,15,17 18,19,20,25									
TOTAL						14.0	0.8		2.6	17.4

TABLE 6-14-8 COMMODITY MOVEMENT BY TRUCK, 1977

35 (Simsim)

		(tons/day)								
O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	WEST SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		7.4			7.0			5.4	19.8
UM RUABA	05	0.6								0.6
RAHAD	08		14.4			1.8			6.7	22.9
Rest of Project Area	02,03,04,06 07,09,10	2.0	5.9							7.9
KHARTOUM	14									
PORT SUDAN	16									
WEST SUDAN	21,22,23,24					0.6				0.6
Rest of SUDAN	11,12,13,15,17 18,19,20,25									
TOTAL		2.6	27.7			9.4			12.1	51.8

TABLE 6-14-9 COMMODITY MOVEMENT BY TRUCK, 1977

36 (Umbas; Feed for Animals)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	WEST SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		0.5	1.2		26.9			2.0	30.6
UM RUABA	05									
RAHAD	08								0.4	0.4
Rest of Project Area	02,03,04,06 07,09,10									
KHARTOUM	14	0.4								0.4
PORT SUDAN	16									
WEST SUDAN	21,22,23,24					1.4				1.4
Rest of SUDAN	11,12,13,15,17 18,19,20,25								2.4	2.4
TOTAL	 	0.4	0.5	1.2		28.3			4.8	35.2

TABLE 6-14-10 COMMODITY MOVEMENT BY TRUCK, 1977

37 (Cotton)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR-TOUM	PORT SUDAN	WEST SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01									
UM RUABA	05									
RAHAD	08									
Rest of Project Area	02,03,04,06 07,09,10									
KHARTOUM	14	0.3								0.3
PORT SUDAN	16									
WEST SUDAN	21,22,23,24									
Rest of SUDAN	11,12,13,15,17 18,19,20,25									
TOTAL	 	0.3								0.3

TABLE 6-14-11 COMMODITY MOVEMENT BY TRUCK, 1977

40 (Processed Cereal Products)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR- TOUM	PORT SUDAN	WEST SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01			1.5						1.5
UM RUABA	05	0.6			1.2				0.4	2.2
RAHAD	08									
Rest of Project Area	02,03,04,06 07,09,10									
KHARTOUM	14	1.0						0.1	0.3	1.4
PORT SUDAN	16									
WEST SUDAN	21,22,23,24									
Rest of SUDAN	11,12,13,15,17 18,19,20,25	1.0								1.0
TOTAL		2.6		1.5	1.2			0.1	0.7	6.1

TABLE 6-14-12 COMMODITY MOVEMENT BY TRUCK, 1977

50 (Manufactured Foodstuffs)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR- TOUM	PORT SUDAN	WEST SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		0.7	1.2	0.2	4.5			3.9	10.5
UM RUABA	05	0.5								0.5
RAHAD	08									
Rest of Project Area	02,03,04,06 07,09,10									
KHARTOUM	14	18.4		1.6				9.6	2.7	32.3
PORT SUDAN	16	1.6								1.6
WEST SUDAN	21,22,23,24		1.3			6.7				8.0
Rest of SUDAN	11,12,13,15,17 18,19,20,25	2.7							0.6	3.3
TOTAL		23.2	2.0	2.8	0.2	11.2		9.6	7.2	56.2

TABLE 6-14-13 COMMODITY MOVEMENT BY TRUCK, 1977

60 (Processed Agricultural Cash Crop)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHARTOUM	PORT SUDAN	WEST SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		3.1	5.6	0.7	2.5			2.9	14.8
UM RUABA	05	4.9		4.8	6.4				2.2	18.3
RAHAD	08	9.2	5.4						2.4	17.0
Rest of Project Area	02,03,04,06 07,09,10									
KHARTOUM	14	21.6		2.4	0.6			27.8		52.4
PORT SUDAN	16							1.9		1.9
WEST SUDAN	21,22,23,24					0.4				0.4
Rest of SUDAN	11,12,13,15,17 18,19,20,25	4.9						1.3	4.5	10.7
TOTAL		40.6	8.5	12.8	7.7	2.9		31.0	12.0	115.5

TABLE 6-14-14 COMMODITY MOVEMENT BY TRUCK, 1977

70 (Livestock and Products)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHARTOUM	PORT SUDAN	WEST SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		0.3			6.6			1.1	8.0
UM RUABA	05	0.4								0.4
RAHAD	08									
Rest of Project Area	02,03,04,06 07,09,10									
KHARTOUM	14									
PORT SUDAN	16									
WEST SUDAN	21,22,23,24					3.2				3.2
Rest of SUDAN	11,12,13,15,17 18,19,20,25								1.2	1.2
TOTAL		0.4	0.3			9.8			2.3	12.8

TABLE 6-14-15 COMMODITY MOVEMENT BY TRUCK, 1977

80 (Other Manufactured Consumer Goods)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHARTOUM	PORT SUDAN	WEST SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		1.0	1.8	0.5	2.6			0.5	6.4
UM RUABA	05	0.7			0.1			0.3	0.6	1.7
RAHAD	08	0.6								0.6
Rest of Project Area	02,03,04,06 07,09,10									
KHARTOUM	14	31.9		2.2	0.7			10.8	3.0	48.6
PORT SUDAN	16	0.3			1.2					1.5
WEST SUDAN	21,22,23,24									
Rest of SUDAN	11,12,13,15,17 18,19,20,25	2.1		1.5		0.9			1.5	6.0
TOTAL	XXXXXXXXXX	35.6	1.0	5.5	2.5	3.5		11.1	5.6	64.8

TABLE 6-14-16 COMMODITY MOVEMENT BY TRUCK, 1977

90 (Forestry Products)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHARTOUM	PORT SUDAN	WEST SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		0.1	0.2		1.2			0.3	1.8
UM RUABA	05				1.2				0.4	1.6
RAHAD	08	3.9								3.9
Rest of Project Area	02,03,04,06 07,09,10	3.8	1.6			1.2				6.6
KHARTOUM	14									
PORT SUDAN	16									
WEST SUDAN	21,22,23,24					1.6				1.6
Rest of SUDAN	11,12,13,15,17 18,19,20,25	1.0	1.2						4.6	6.8
TOTAL	XXXXXXXXXX	8.7	2.9	0.2	1.2	4.0			5.3	22.3

TABLE 6-14-17 COMMODITY MOVEMENT BY TRUCK, 1977

100 (Mining Products)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR- TOUM	PORT SUDAN	WEST SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01									
UM RUABA	05									
RAHAD	08									
Rest of Project Area	02,03,04,06 07,09,10									
KHARTOUM	14									
PORT SUDAN	16									
WEST SUDAN	21,22,23,24									
Rest of SUDAN	11,12,13,15,17 18,19,20,25									
TOTAL										0

TABLE 6-14-18 COMMODITY MOVEMENT BY TRUCK, 1977

110 (Mineral Oil Products)

(tons/day)

O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHAR- TOUM	PORT SUDAN	WEST SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		0.1	1.8						1.9
UM RUABA	05			1.2				0.6		1.8
RAHAD	08		0.9							0.9
Rest of Project Area	02,03,04,06 07,09,10									
KHARTOUM	14	4.2			0.1			4.6		8.9
PORT SUDAN	16	4.1								4.1
WEST SUDAN	21,22,23,24		0.1							0.1
Rest of SUDAN	11,12,13,15,17 18,19,20,25									
TOTAL		8.3	1.1	3.0	0.1			5.2		17.7

TABLE 6-14-19 COMMODITY MOVEMENT BY TRUCK, 1977

120 (Building and Construction Materials)

		(tons/day)								
O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHARTOUM	PORT SUDAN	WEST SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		2.7	0.5		2.8			0.7	6.7
UM RUABA	05	2.9		0.6	4.5					8.0
RAHAD	08	12.5								12.5
Rest of Project Area	02,03,04,06 07,09,10	0.2	6.4			0.9			1.3	8.8
KHARTOUM	14	7.8		0.9				3.5	1.8	14.0
PORT SUDAN	16	1.6								1.6
WEST SUDAN	21,22,23,24					1.9				1.9
Rest of SUDAN	11,12,13,15,17 18,19,20,25	19.3	0.9			4.0			1.9	26.1
TOTAL	XXXXXXXXXX	44.3	10.0	2.0	4.5	9.6		3.5	5.7	79.6

TABLE 6-14-20 COMMODITY MOVEMENT BY TRUCK, 1977

130 (Miscellaneous)

		(tons/day)								
O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHARTOUM	PORT SUDAN	WEST SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		1.0	3.3	0.2	2.9			5.3	12.7
UM RUABA	05	1.3		0.6	1.9					3.8
RAHAD	08	1.5								1.5
Rest of Project Area	02,03,04,06 07,09,10	2.4	1.5							3.9
KHARTOUM	14	5.1						0.2		5.3
PORT SUDAN	16	0.2								0.2
WEST SUDAN	21,22,23,24			1.5		0.3			0.5	2.3
Rest of SUDAN	11,12,13,15,17 18,19,20,25	1.2	1.5			1.0			1.0	4.7
TOTAL	XXXXXXXXXX	11.7	4.0	5.4	2.1	4.2		0.2	6.8	34.4

TABLE 6-14-21 COMMODITY MOVEMENT BY TRUCK, 1977

140 (Others)

		(tons/day)								
O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHARTOUM	PORT SUDAN	WEST SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		0.1	0.3	2.8	2.7			0.5	6.4
UM RUABA	05	0.1			0.4					0.5
RAHAD	08	1.2								1.2
Rest of Project Area	02,03,04,06 07,09,10	1.5								1.5
KHARTOUM	14	6.3						2.3		8.6
PORT SUDAN	16									
WEST SUDAN	21,22,23,24					1.3				1.3
Rest of SUDAN	11,12,13,15,17 18,19,20,25	1.1				1.8			0.3	3.2
TOTAL		10.2	0.1	0.3	3.2	5.8		2.3	0.8	22.7

TABLE 6-14-22 COMMODITY MOVEMENT BY TRUCK, 1977

TOTAL

		(tons/day)								
O \ D	Zone No. in Original O-D Table	EL OBEID	UM RUABA	RAHAD	Rest of Project Area	KHARTOUM	PORT SUDAN	WEST SUDAN	Rest of SUDAN	TOTAL
EL OBEID	01		40.8	21.7	5.6	105.7	2.4		31.0	207.2
UM RUABA	05	15.0		9.1	26.6			1.2	3.7	55.6
RAHAD	08	36.5	26.5			2.8			13.4	79.2
Rest of Project Area	02,03,04,06 07,09,10	13.8	22.8			2.1			1.3	40.0
KHARTOUM	14	102.9		7.8	2.7			59.7	10.8	183.9
PORT SUDAN	16	7.8			1.2			1.9		10.9
WEST SUDAN	21,22,23,24		2.2	4.0		36.9			0.9	44.0
Rest of SUDAN	11,12,13,15,17 18,19,20,25	42.0	37.3	1.5	1.5	9.3		1.3	32.3	125.2
TOTAL		218.0	129.6	44.1	37.6	156.8	2.4	64.1	93.4	746.0

(743.7)

TABLE 6-15 OD TABLE OF PASSENGER MOVEMENT BY ROAD, 1977

(All types of vehicles) 1)

ZONE	(Person per day)																												
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	TOTAL			
EL OBEID	10.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		
GEI'IL		15.0																									15.0		
ET TAIYARA																													
SHAFAGATTA				10.1										12.9	1.2												14.1		
UM RUHABA					170.0											34.5						0.3	5.7				40.5		
ABU HAMRA																													
SEMEII																													
RAHAD											9.9	17.0																26.9	
NAWA																													
EL AIN																													
TENDIITI																													
KOSTI-SINAR																													
WAD MEDANI																													
KHAROUN																													
KASEALA																													
PORT SUDAN																													
FALACAL																													
EL ABHASSIVA																													
HUBA KHARAIN																													
KHAKEL-DIJJIT																													
WAU-JUBA																													
ER HARUD																													
HYALA																													
HARA																													
ATHARA																													
TOTAL																													

Note: 1) Figures in parentheses indicate those of bus and are included in the total figures.

TABLE 6-16 RAILWAY GOODS HANDLED AT MAJOR STATIONS.

Station	Commodity Group Year	Forwarded			Received			Total		
		Goods Tons	Parcels Tons	Live-stock No.	Goods Tons	Parcels Tons	Live-stock No.	Goods Tons	Parcels Tons	Live-stock No.
EL OBEID	1970/71	76,575	564	67,581	139,171	2,031	-	215,746	2,595	67,581
	1971/72	77,207	448	47,795	148,973	2,422	-	226,180	2,870	47,795
	1972/73	94,089	507	43,065	110,056	2,345	9	204,145	2,852	43,074
	1973/74	68,673	413	37,629	135,304	2,224	48	203,777	2,637	37,677
	1974/75	91,308	300	22,860	98,040	3,108	420	189,348	3,408	23,280
	1975/76	66,859	2,535	32,398	147,283	7,388	1,237	214,142	9,923	33,635
EL RAHAD	1970/71	13,132	681	8,539	8,329	678	594	21,461	1,359	9,133
	1971/72	9,576	342	1,310	6,602	475	2,446	16,178	817	3,756
	1972/73	6,701	238	-	6,708	324	87	13,409	562	87
	1973/74	13,534	3,409	415	9,784	654	141	23,318	4,063	556
	1974/75	7,392	348	360	8,568	420	420	15,960	768	780
	1975/76	11,598	370	-	7,906	472	55	19,504	842	55
SEMEIH	1970/71	4,858	17	35	2,285	63	46	7,143	80	81
	1971/72	15,886	15	9	2,491	55	16	18,377	70	25
	1972/73	11,792	13	-	785	47	-	12,577	60	-
	1973/74	13,415	-	-	1,492	-	-	14,907	-	-
	1974/75	3,552	11	-	2,232	24	-	5,784	35	-
	1975/76	5,487	2	-	2,094	7	-	7,581	9	-
UM RUABA	1970/71	31,056	149	4,196	21,276	758	164	52,332	907	4,360
	1971/72	20,099	219	2,497	21,097	850	14	41,196	1,069	2,511
	1972/73	20,613	138	455	14,328	2,686	-	34,941	2,824	455
	1973/74	17,059	104	2,430	14,574	685	-	31,633	789	2,430
	1974/75	16,596	65	1,460	11,480	408	-	28,076	473	1,460
	1975/76	22,621	96	4,159	8,877	317	-	31,498	413	4,159
TOTAL	1970/71	125,621	1,411	80,351	171,061	3,530	804	296,682	4,941	81,155
	1971/72	122,768	1,024	51,611	179,163	3,802	2,476	301,931	4,826	54,087
	1972/73	133,195	896	43,520	131,877	5,402	96	265,072	6,298	43,616
	1973/74	112,681	3,926	40,474	160,954	3,563	189	273,635	7,489	40,663
	1974/75	118,848	724	24,680	120,320	3,860	840	239,168	4,684	25,520
	1975/76	106,565	3,003	36,557	166,160	8,184	1,292	272,725	11,187	37,794

Source: Saudan Railways Corporation, 1977

TABLE 6-17 PASSENGER BOOKINGS AT FOUR STATIONS

Station	Year	Class				Total
		1st	2nd	3rd	4th	
EL OBEID	1970/71	3,894	9,594	37,364	44,107	94,959
	1971/72	3,390	7,960	30,076	53,716	95,142
	1972/73	4,307	9,337	36,030	59,574	109,248
	1973/74	4,255	8,712	33,886	43,492	90,345
	1974/75	5,979	9,660	40,556	28,114	84,309
	1975/76	6,171	9,844	36,854	39,605	92,474
RAHAD	1970/71	353	1,063	5,352	44,530	51,298
	1971/72	390	977	5,565	41,198	48,130
	1972/73	476	966	5,583	37,282	44,807
	1973/74	446	933	5,747	28,577	35,703
	1974/75	324	576	4,145	23,298	28,343
	1975/76	522	1,068	5,922	23,712	31,224
SEMEIH	1970/71	39	122	786	9,252	10,199
	1971/72	31	63	579	7,092	7,765
	1972/73	34	122	662	6,689	7,507
	1973/74	79	126	607	4,600	5,412
	1974/75	34	68	494	3,432	4,028
	1975/76	60	112	362	2,634	3,168
UM RUABA	1970/71	666	1,772	7,243	46,585	56,266
	1971/72	692	1,658	6,291	45,190	53,831
	1972/73	938	1,621	7,526	38,322	48,137
	1973/74	884	1,558	6,533	27,869	36,844
	1974/75	646	1,128	5,630	23,366	30,770
	1975/76	637	883	6,317	25,490	33,327
TOTAL	1970/71	4,952	12,552	50,745	144,474	212,722
	1971/72	4,503	10,658	42,511	147,196	204,868
	1972/73	5,755	12,046	49,531	142,367	209,699
	1973/74	5,664	11,329	46,773	104,538	168,304
	1974/75	6,983	11,432	50,825	78,210	147,450
	1975/76	7,390	11,907	49,455	91,441	160,193

Source: Ibid

ANNEX VI-20 ESTIMATION OF ORIGIN AND DESTINATION OF RAILWAY PASSENGERS

20.1 Trains and Passengers Interviewed

The characteristics of trains and passengers interviewed during the field survey are explained in Chapter VI of the main text, and summarized in the following Table 6-18-1. As shown in the table, all major types of trains operating in the area are included in the survey. The number of interviewed passengers in Table 6-18-1 does not represent all the passengers.

ANNEX VI -20

TABLE 6-18-1 RAILWAY PASSENGERS INTERVIEWED

Date	Direction	Type of Train	Number of Passengers Interviewed	Capacity of Train (seats)	Frequency of service (times/week)
May 17	El Obeid → Khartoum	Express	1,175	961	2
May 20	Khartoum → El Obeid	Express	713	961	2
May 18	Khartoum → El Obeid	Mushtralle	713	758	5
May 19	El Obeid → Khartoum	Mushtralle	834	758	5
May 21	El Obeid → Khartoum	Mushtralle	380	758	5
May 19	Nyala → Khartoum	Mushtralle	1,035	758	4 1)
May 20	Khartoum → Nyala	Express	722	961	3 1)

Note: 1) Same number of trains is served for opposite direction.

20.2 Estimation of OD Pattern of Railway Passengers

Distribution of origin and destination of railway passengers, resulting from the interview survey, differ according to the type of train. In order to estimate the overall OD pattern of railway passengers of all trains in the section between El Obeid and Um Ruaba, OD traffic of each train was weighted according to capacity and frequency of services of each type of train assuming a constant occupancy rate. Capacities and operating frequencies of trains are shown in Table 6-18-1 and capacities of trains were estimated as shown in Table 6-19.

20.3 Estimation of OD Traffic of Railway Passengers

OD traffic of railway passengers, in terms of ADT, was estimated from the OD pattern of railway passengers described in the previous section and the actual number of railway passengers recorded at El Obeid, Rahad and Semeih stations. In the total columns of Table 6-18-2 the actual number of railway passengers of these three stations was entered and the figures in the rest of the columns were obtained by conversion calculation according to the OD pattern.

TABLE 6-18-2 OD TABLE OF RAILWAY PASSENGER

ZONE	(Persons per day)																											
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	TOTAL		
EL OBEID					5.6	0.3	1.2	0.0			7.0	0.0	4.7	0.0	0.2	5.2	0.5									1.1	1.1	
GIFIL																												
ET TAIYARA																												
SHAFAGATTA																												
UN ROMABA							1.0	51.1													1.7	0.3	7.2				15.8	
ABU HAMRA																												4.4
SEMEIH											9.9	2.6		0.3		2.6												18.5
RAHAD											7.5	0.7	15.7	22.0	1.7	0.7												3.5
HAWA												0.1	0.2															0.5
EL AIN											0.0		0.4															1.2
TENDIITI																												51.1
KOSTI-SERAR																												209.8
WAD MEDNHI																												500.6
KHARTOUM																												16.0
KASSALA																												10.1
PORT SUDAN																												12.8
MALACAL																												1.0
EL AUBASIYA																												0.1
JEHA HERRARH																												0.1
KARKEL-DILLI																												0.1
WAD-JUBA																												0.1
EL NABHU																												0.1
HYALDA																												0.1
EAPA																												0.1
ATBAPA																												0.1
TOTAL																												0.1

TABLE 6-19 ESTIMATE OF TRAIN CAPACITY

Train Type Class	Express		Mushttrall		Local	
	No. of Coaches	Capacity (seats)	No. of Coaches	Capacity (seats)	No. of Coaches	Capacity (seats)
Sleeper	2	26	1	13	0	-
1st Class	2	64	1	32	1	16
2nd Class	2	96	1	48	1	24
3rd Class	3	225	3	225	1	75
4th Class	5	550	4	440	1	110
Buffet	1	-	0	-	0	-
Luggage	1	-	1	-	0	-
Brake Wagon	1	-	0	-	0	-
Total	17	961	11	758	4	225

Source: Interview at El Obeid Station.

ANNEX VI-21 ESTIMATION OF VEHICLE OPERATING COST

21.1 Operating Characteristics of Representative Vehicles

Representative vehicles chosen for estimating the operating costs are Toyota Corolla 1200 for cars, Toyota Land Cruiser Pick-ups for vans/pick-ups, Bedford 6-ton truck for medium trucks, Fiat 682 11-ton truck for heavy trucks and remodeled Bedford 6-ton truck for buses.

The operating characteristics of these vehicles are summarized in Table 6-20-1 to Table 6-20-4. Average running speed, annual kilometrage, vehicle life kilometrage and average operating hours per annum are related to each other, and are decided on the basis of analyzing the results of the field survey, interviews and driving survey conducted in the area.

21.2 Depreciation and Interest of Vehicles

i) Prices of vehicles, tyres and locally manufactured bodies

Prices of vehicles were obtained from the analysis of the interview results and various shipping documents provided by dealers in the area. Table 6-20-5 shows the results. Financial cost is the market price of the vehicle and economic cost is cost after taxes, such as import duties, development tax, bank exchange tax, etc., are excluded. The latter is composed of foreign exchange and local components (transportation in the country, handling charges, commissions, etc.).

TABLE 6-20-1 AVERAGE RUNNING SPEED

Road Surface	Vehicle Type					(Km/hr)
	Car	Van Pick-up	Medium Truck	Heavy Truck	Bus	
Paved Road	85	75	60	60	60	
Gravel Road	70	65	52	52	52	
Hard Surface Track	60	55	45	43	45	
Loose Sand Track	-	35	28	25	28	

TABLE 6-20-2 ANNUAL KILOMETRAGE

	(000km)				
Paved Road	20.00	31.25	70.00	75.00	84.00
Gravel Road	16.00	27.50	60.00	63.33	72.00
Hard Surface Track	12.00	22.50	52.00	55.00	62.00
Loose Sand Track	-	18.75	33.33	35.00	40.00

TABLE 6-20-3 VEHICLE LIFE KILOMETRAGE

	(km)				
Paved Road	200,000	250,000	420,000	450,000	420,000
Gravel Road	160,000	220,000	360,000	380,000	360,000
Hard Surface Track	120,000	180,000	310,000	330,000	310,000
Loose Sand Track	-	150,000	200,000	210,000	200,000

TABLE 6-20-4 AVERAGE OPERATING HOURS PER ANNUM (hour/year)

Paved Road	-	-	1,170	1,250	1,400
Gravel Road	-	-	1,150	1,220	1,380
Hard Surface Track	-	-	1,160	1,280	1,380
Loose Sand Track	-	-	1,190	1,400	1,430

Residual value of vehicles was estimated from the interviews in the area.

TABLE 6-20-5 PRICE OF REPRESENTATIVE VEHICLES, 1977

Vehicle Type	Foreign Exchange 1)	Local Component 1)	Taxes & Duties 1)	Price		as of	(LS) Salvage Value (%)
				Economic 1)	Financial 1)		
Car (Toyota Corolla)	1,170	933	2,146	2,103	4,249	June, 1977	15
Van/Pick-up (Toyota Pick-up)	2,487	1,126	1,897	3,613	5,510	June, 1977	15
Medium Truck ²⁾ (Bedford)	3,541	1,326	1,533	4,867	6,400	June, 1977	30
Heavy Truck (Fiat 682)	11,312	1,542	6,374	12,854	19,228	April, 1977	30
Bus ²⁾ (Bedford)	3,541	1,326	1,533	4,867	6,400	June, 1977	30

Notes: 1) Including tyres

2) Excluding the prices of locally manufactured bodies. They are shown by Table 6-20-7.

Source: Interviews with dealers

Table 6-20-6 shows the price of a set of tyres. Most popular tyre type was selected for analysis.

TABLE 6-20-6 PRICE OF A SET OF TYRES, 1977

<u>Vehicle Type</u>	<u>Type of Tyre used</u>	<u>Price (£S)</u>		<u>Number of Tyres</u>
		<u>Financial</u>	<u>Economic</u>	
Car	600-12-4PR	70,000	49,996	4
Van, Pick-up	750-16-8PR	200,000	139,984	4
Medium Truck	Front:900-20-12PR	181,000	126,966	4
	Rear:1200-20-16PR	353,400	227,368	
Heavy Truck	1200-20-16PR	1,060,200	742,062	6
Bus	Front:900-20-12PR	181,400	126,966	4
	Rear:1200-20-16PR	353,400	227,368	

Source: Interviews with dealers.

Bodies of buses and medium trucks are usually manufactured in the Sudan. Although types and structures of bodies vary, prices shown in Table 6-20-7 indicate the average price.

TABLE 6-20-7 PRICE OF LOCALLY MANUFACTURED BODY, 1977

	<u>Financial</u> £S	<u>Economic</u> £S
Medium Truck	1,500	1,095
Bus	2,500	1,825

Source: Interviews with dealers.

ii) Depreciation and interest

Depreciation and interest of vehicles is calculated by the following formula.

$$D = (C - R) \times \frac{i(1+i)^n}{(1+i)^n - 1} \times \frac{n}{LM}$$

where; D = depreciation and interest cost (mm/kms)

C = vehicle price excluding that of tyres (£S)

R = residual value of vehicle (£S)

i = interest rate (10 percent)

n = life years of vehicle (years)

LM = life kilometrage of vehicle (kms)

iii) Insurance fees

Insurance fees vary by type of vehicle. Table 6-20-8 shows the results obtained from interviews with an insurance company in the Sudan.

TABLE 6-20-8 INSURANCE FEES

Type of Vehicle	Basis of Calculation	Financial (£S)	Economic (£S)
Car	On the first £S.1,000 5%, on the balance 3% of the total price of the vehicle	147.5	125.3
Van, Pick-up		185.3	157.5
Medium Truck	3% of the total price of the vehicle	192.0	163.2
Heavy Truck		576.8	490.3
Bus	On the first £S.1,000 6%, on the balance 3% of the total price of the vehicle. Not insurable for passengers.	222.0	188.7

Source: Blue Nile Insurance Company, Sudan.

iv) Wages of drivers and assistants

Trucks are usually operated in the area by a driver and two assistants. Table 6-20-9 shows the average amount of wages obtained from the interview with drivers and trucking companies in the area.

Economic cost of the wages was estimated by deducting income taxes from the wages. Table 6-20-10 shows income tax rate.

TABLE 6-20-9 AVERAGE MONTHLY WAGES OF DRIVERS AND ASSISTANTS ¹⁾

(₹S/month)

	<u>Driver</u>	<u>Assistant I</u>	<u>Assistant II</u>
Medium Truck	65	23	12
Heavy Truck	65	23	12
Bus	70	23	12

Note: 1) Wages include salaries and monetary fringe benefits.

Source: Interviews with drivers and transport companies.

TABLE 6-20-10 TAXATION (INCOME TAX) FOR RESIDENTS

(per year)

<u>Income</u>	<u>On the first</u>	<u>Following</u>	<u>Following</u>	<u>Following</u>	<u>Following</u>	<u>Following</u>	<u>Following</u>	<u>More than</u>	
	<u>LS400</u>	<u>LS200</u>	<u>LS400</u>	<u>LS1,000</u>	<u>LS1,000</u>	<u>LS2,000</u>	<u>LS2,000</u>	<u>LS2,000</u>	<u>LS9,000</u>
Percent	0	5	10	15	20	30	40	50	60

Source: Ministry of National Planning

v) Licensing fees

Table 6-20-11 shows the amount of licensing fees, town development fees and service fees that have to be paid by vehicle owners annually.

TABLE 6-20-11 ANNUAL LICENSE FEES BY VEHICLE TYPE, 1977

<u>Vehicle Type</u>	<u>Licensing Fees</u>	Town Development <u>Fees</u>		<u>Service Fees</u>	(ES)
					<u>Total</u>
Car	8	1		2	11
Van, Pick-up	9	1		2	12
Medium Truck	23	3		2	28
Heavy Truck	23	3		10	36
Bus	23	3		2	28

Source: Kordofan Province Authorities and El Obeid
Municipal Council.

vi) Fuel consumption

Fuel consumption was asked for during the interviews, because it was feared that an estimate of fuel consumption under the road conditions in the area would be quite difficult. In estimating the fuel consumption for road surfaces of loose sand and hard surface clay, the results of the interviews were usually used together with those of the driving survey for Toyota pick-ups. Estimation of fuel consumption on gravel and paved roads is based on the driving survey in the area as well as the various

literature and data such as "Quantification of Road User Savings, IBRD". Table 6-20-12 shows the results of the analysis.

TABLE 6-20-12 FUEL CONSUMPTION

<u>Road Surface</u>	Vehicle Type					(liters per 1,000 km.)
	<u>Car</u>	<u>Van, Pick-ups</u>	<u>Medium Truck</u>	<u>Heavy Truck</u>	<u>Bus</u>	
Paved	80	200	250	300	250	
Gravel	100	250	300	390	300	
Hard Surface	120	300	375	480	375	
Loose Sand	-	450	600	900	600	

Price of fuel was surveyed at both Khartoum and El Obeid and the average price is used for analysis.

TABLE 6-20-13 PRICE OF FUEL IN KHARTOUM AND EL OLEID AREAS

	ES/Gallon (ES/Liter)	
	<u>With Tax</u>	<u>Without Tax</u>
Gasoline (Benzine)	0.460 (0.1012)	0.240 (0.0528)
Diesel (Gas Oil)	0.368 (0.0810)	0.312 (0.0686)

Source: Shell Oil Company, Sudan

vii) Oil consumption

Oil consumption was estimated as shown in Table 6-20-14 from the results of the field survey and "Quantification of Road User Savings, IBRD". Table 6-20-15 shows the price of oil.

TABLE 6-20-14 ENGINE OIL CONSUMPTION

(Liters per 1,000 km.)

Road Surface	Vehicle Type				
	Car	Van, Pick-ups	Medium Truck	Heavy Truck	Bus
Paved	1.1	1.4	2.3	6.8	2.3
Gravel	1.3	1.6	2.6	7.8	2.6
Hard Surface	1.6	1.9	3.1	9.4	3.1
Loose Sand	-	2.5	4.0	12.2	4.0

TABLE 6-20-15 PRICE OF OIL IN KHARTOUM AND EL OBEID AREA

	£ S/Gallon (£ S/Liter)			
	Khartoum		El Obeid	
	<u>With Tax</u>	<u>Without Tax</u>	<u>With Tax</u>	<u>Without Tax</u>
Super	2,330 (0.5125)	2,019 (0.4441)	2,370 (0.5213)	2,059 (0.4529)
Diesel	1,810 (0.3982)	1,571 (0.3456)	1,900 (0.4179)	1,661 (0.3654)

Source: Shell Oil Company, Sudan

viii) Tyre wear

Tyre wear varies depending on the surface conditions of roads. For hard surface clay and loose sand, information was obtained from drivers and garage operators in the area, whilst "Quantification of Road User Savings, IBRD" was referred to for the other road surfaces. Table 6-20-16 shows the life time of a set of tyres on different road surfaces. Prices of tyres are shown in Table 6-20-6.

TABLE 6-20-16 TYRE WEAR

(000 km.)

Road Surface	Vehicle Type				
	<u>Car</u>	<u>Van, Pick-ups</u>	<u>Medium Truck</u>	<u>Heavy Truck</u>	<u>Bus</u>
Paved	30	38	45	45	45
Gravel	15	18	23	23	23
Hard Surface	9	10	12	12	12
Loose Sand	-	12	14	14	14

ix) Maintenance

It is necessary to put high maintenance costs under the particular road conditions in the area. In order to maintain vehicles in good condition, owners have to spend more than £S2,000 per annum after 2 or 3 years' usage of new, medium-size trucks.

Table 6-20-17 and Table 6-20-18 show the maintenance cost of parts and labour, estimated by consultants, based on the analysis of information obtained from extensive interviews with dealers and garage operators in the area as well as from other feasibility reports and literature.

TABLE 6-20-17 MAINTENANCE: PARTS

(% of depreciable value/1,000 km.)

Vehicle Type					
	<u>Car</u>	<u>Van, Pick-ups</u>	<u>Medium Truck</u>	<u>Heavy Truck</u>	<u>Bus</u>
<u>Road Surface</u>					
Paved	0.13	0.14	0.13	0.12	0.13
Gravel	0.16	0.20	0.19	0.18	0.19
Hard Surface	0.45	0.50	0.50	0.47	0.50
Loose Sand	-	0.78	0.78	0.73	0.78

TABLE 6-20-18 MAINTENANCE: HOURS OF LABOUR

(hours/1,000 km.)

Vehicle Type					
	<u>Car</u>	<u>Van, Pick-ups</u>	<u>Medium Truck</u>	<u>Heavy Truck</u>	<u>Bus</u>
<u>Road Surface</u>					
Paved	0.75	0.9	3.0	3.5	3.0
Gravel	1.0	1.3	4.9	5.7	4.9
Hard Surface	2.0	2.6	9.8	11.4	9.8
Loose Sand	-	3.6	13.7	16.0	13.7

- x) Adjustment of vehicle operating cost due to the change of road gradient

The operating cost of a vehicle is affected by the change of road gradient. Although many cost factors are affected, only the effect on fuel consumption, is considered because it affects the other factors much less, and most of the road sections in the area of the study are flat. Table 6-20-19 shows the results of the analysis which is based mainly on "Quantification of Road User Savings, IBRD". Gradient between 0 and 3 percent is regarded as flat.

TABLE 6-20-19 PERCENT INCREASE OF FUEL CONSUMPTION
DUE TO THE CHANGE OF ROAD GRADIENT

<u>Gradient</u>	<u>Car</u>	<u>Van, Pick-ups</u>	<u>Truck, Bus</u>
0 - 3%	100	100	100
3 - 5%	110	124	143

(%)

- xi) Vehicle operating cost during rainy season

Heavy rainfall in the area during the rainy season affects the vehicle operating cost on roads of hard surface clay and loose sand.

Particularly, roads of hard surface clay are affected by rain to such an extent that they become muddy and vehicles

often find it difficult to pass. In the case of loose sand, the surface gets firmer with rainfall and driving conditions become better, but on the other hand, roads are often cut off by washouts in the Qoz area. Therefore, vehicles have to wait at riversides or detour around them.

Although it is very difficult to estimate the influence of rainfall accurately, it has been estimated that, for hard surface clay roads, vehicle operating costs during the rainy season (June to September) are 50 percent higher than during the dry season while operating costs do not change for loose sand roads.

ANNEX VII

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TABLE 7-1 TRAFFIC ON PROPOSED ROAD, 1977¹⁾

(Vehicles per day)

Section Distance (Km) Type of Vehicle	01 - 10	10 - 9	9 - 8	8 - 7 2)	7 - 6	6 - 5	average
		27.3	22.2	25.7	24.7	27.7	26.6
small vehicles	7.2	5.8	5.6	4.1	3.7	3.7	
medium trucks	109.9	109.7	108.9	121.0	130.8	134.7	
large trucks	4.4	4.4	4.4	4.9	4.5	4.5	
buses	1.5	1.5	1.5	0.2	0.2	0.2	
Total	123.0	121.4	120.4	130.2	139.2	143.1	129.6

1) Normal Traffic is quoted by Section 3, Chapter IX.
Neither diverted nor generated traffic is included.

2) This section is between RAHAD and SEMEIH.

TABLE 7-2 NORMAL TRAFFIC ESTIMATE : RAHAD - SEMEIH

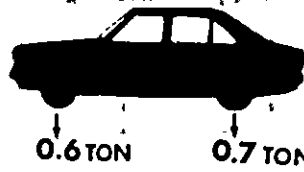
(Vehicle /day)

		Growth Rate per/a		T r a f f i c					
				T r u c k s			Bus	Small Vehicle	Total
				Medium Truck	Large Truck	Total			
	1977		Feasibility	120.9	5.0	125.9	0.2	4.1	130.2
1	78		Detailed	128.0	6.7	134.7	0.2	4.4	139.3
2	79		Design	135.5	8.6	144.1	0.2	4.7	149.0
3	80			141.9	12.3	154.2	0.2	5.0	159.4
4	81		Construction	150.1	14.9	165.0	0.3	5.4	170.7
5	82			158.9	17.7	176.6	0.3	5.8	182.7
6	83		Open 1stY	166.2	22.7	188.9	0.3	6.2	195.4
7	84	7%	2	173.9	28.3	202.2	0.3	6.6	209.1
8	85		3	181.7	34.6	216.3	0.3	7.0	223.6
9	86		4	189.8	41.7	231.5	0.4	7.5	239.4
10	87		5	200.6	47.1	247.7	0.4	8.1	256.2
11	88		6	209.3	55.7	265.0	0.4	8.6	274.0
12	89		7	221.2	62.4	283.6	0.5	9.2	293.3
13	90		8	230.6	72.8	303.4	0.5	9.9	313.8
14	91		9	243.4	81.2	324.6	0.5	10.6	335.7
15	92		10	253.6	93.8	347.4	0.6	11.3	359.3
16	93		11	262.6	102.1	364.7	0.6	11.9	377.2
17	94		12	271.9	111.1	383.0	0.6	12.5	396.1
18	95		13	277.4	124.7	402.1	0.6	13.1	415.8
19	96		14	287.1	135.1	422.2	0.7	13.7	436.6
20	97		15	297.0	146.3	443.3	0.7	14.4	458.4
21	98	5%	16	302.6	162.9	465.5	0.7	15.2	481.4
22	99		17	312.8	176.0	488.8	0.8	15.9	505.5
23	2000		18	323.2	190.0	513.2	0.8	16.7	530.7
24	1		19	328.7	210.1	538.8	0.9	17.5	557.2
25	2		20thY	339.5	226.3	565.8	0.9	18.4	585.1
A	Total			5,073.2	2,124.8	7,198.0	11.5	234.3	7,443.8
B	Accumulated Traffic Volume Per 20 years			1,851,718	775,552	2,627,270	4,198	85,520	2,716,988
C	Equivalent Factors of Standard Axle Numbers			0.3533	2.6906	-	0.0614	0.0036	-
D	Total Equivalent Standard Axle Numbers			654,212	2,086,390	2,740,602	258	308	2,714,168
E	Diverted Traffic and others 10%			65,421	208,639	274,060	26	31	274,117
F	Total Standard Axle Numbers			719,633	2,295,029	3,014,662	284	339	3,015,285
G	Standard Axle Numbers on One Side of Carriage Way			59,817	1,147,514	1,507,331	142	170	1,507,643

FIG. 7-1

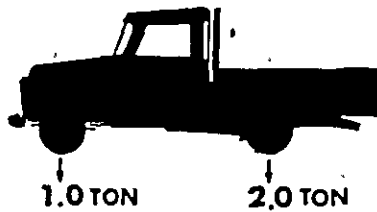
AXLE LOAD OF REPRESENTATIVE VEHICLE

Equivalent Standard Axles
SALOON CAR: TOYOTA COROLLA



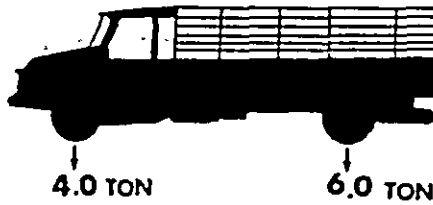
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FOUR WHEEL DRIVE VAN & PICK-UP : TOYOTA LANDCRUISER PICK-UP



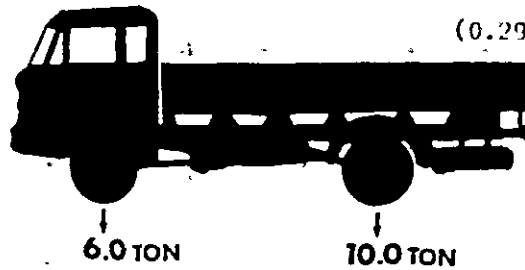
0.0036

TRUCK 6-TON LOADING CAPACITY: BEDFORD



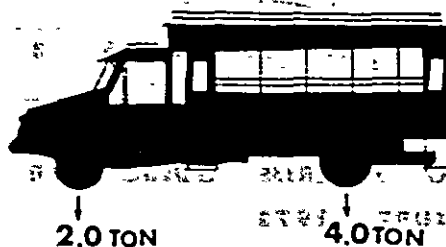
(0.0578 + 0.2955)

HEAVY TRUCK 11-TON LOADING CAPACITY : FIAT 682



(0.2955 + 2.3951)

BUS 44-PASSENGER: BEDFORD

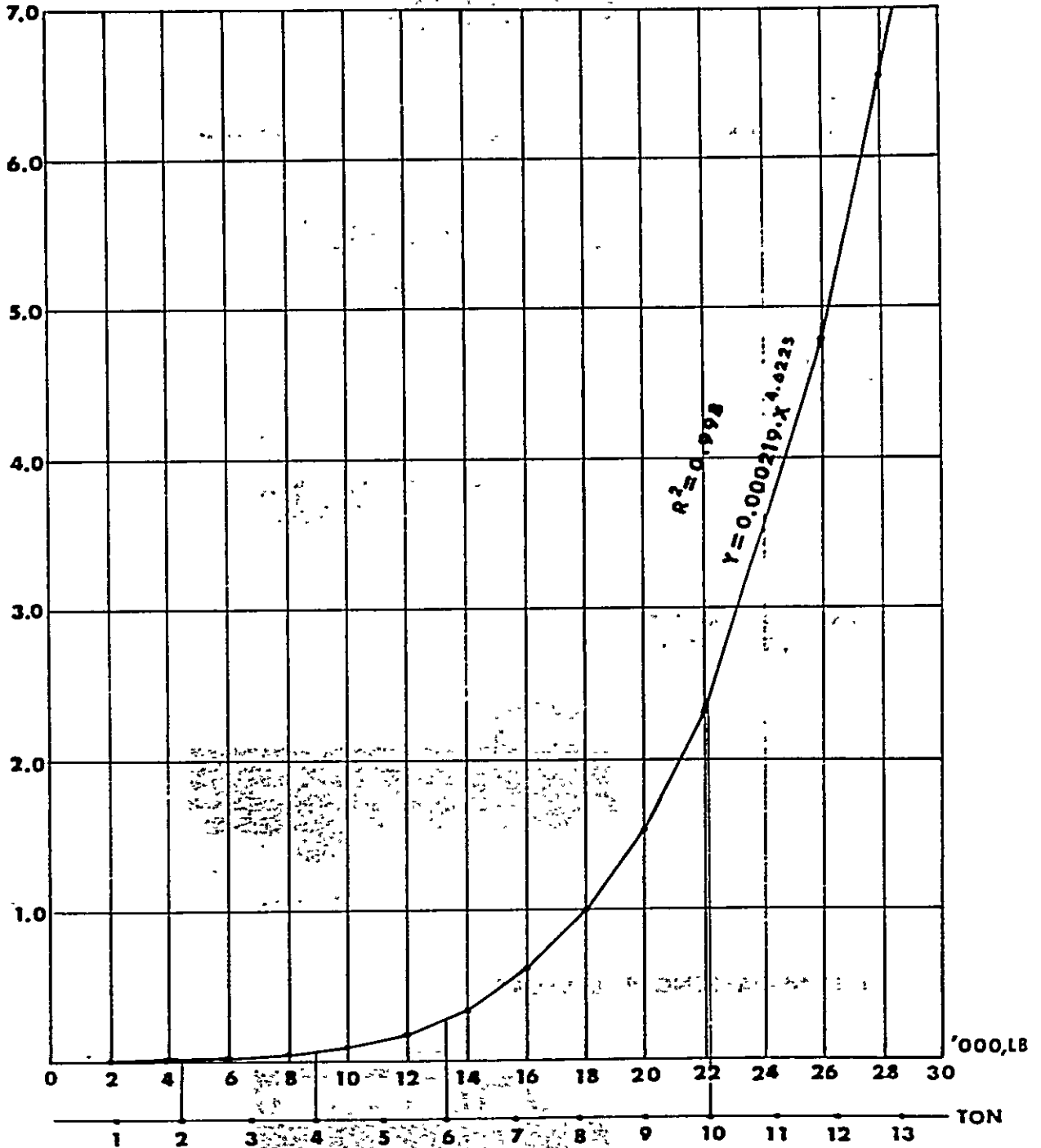


(0.0036 + 0.0578)

FIG. 7-2

EQUIVALENCE FACTORS FOR VARIOUS AXLE LOADING.

FLEXIBLE PAVEMENT ; PT=2.0 SN= 3



SOURCE: AASHTO INTERIM GUIDE FOR DESIGN OF PAVEMENT STRUCTURE 1972

TABLE 7-3 RELATIONSHIP BETWEEN ALLOWABLE
PASSING DISCHARGE AND THE COST
OF STRUCTURE

		Discharge (M ³ /Second)	Net Cost (L.S)
PIPE CULVERT	Ø1000 x 1	1.26	1,198
	Ø1000 x 2	2.52	2,167
	Ø1000 x 3	3.78	3,028
BOX CULVERT H. V. (2.0 x 1.5)	1 Cell	4.8	2,999
	2 Cells	9.6	4,738
	3 Cells	14.4	6,255
	4 Cells	24.0	11,000
BRIDGE (CONCRETE)	L=7.0M (1 span)	24.0	9,100
	L=9.0M (1 span)	32	10,744
	L=7.0Mx2 (2 spans)	49	15,037
	L=9.0Mx2 (2 spans)	65	18,384
	L=9.0Mx3 (3 spans)	98	26,021
BRIDGE (STEEL)	L=7.0 (1 span)	24	9,760
	L=14.0 (2 spans)	49	16,100

FIG. 7-3 RELATIONSHIP BETWEEN DISCHARGE AND THE COST OF STRUCTURES

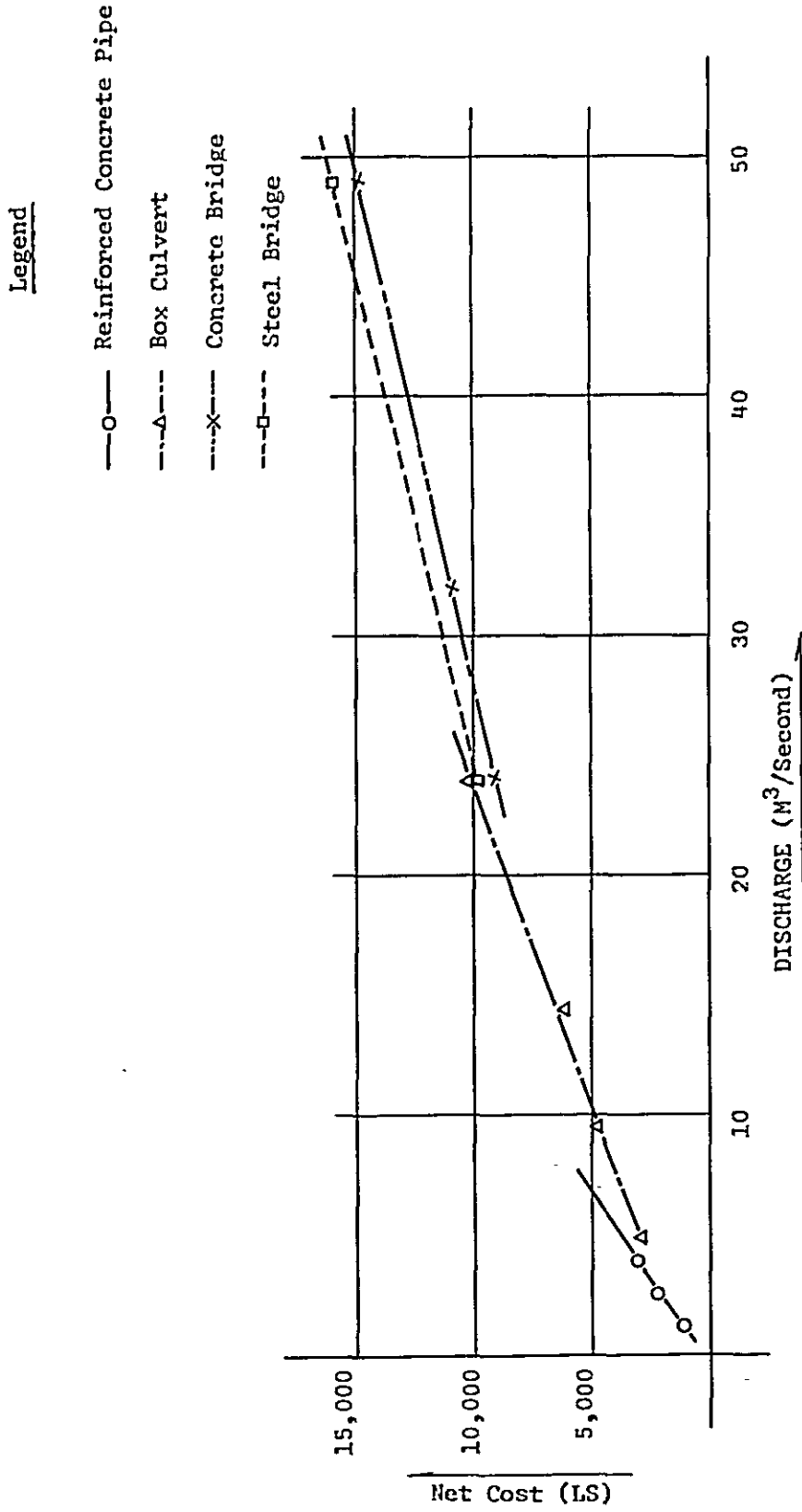
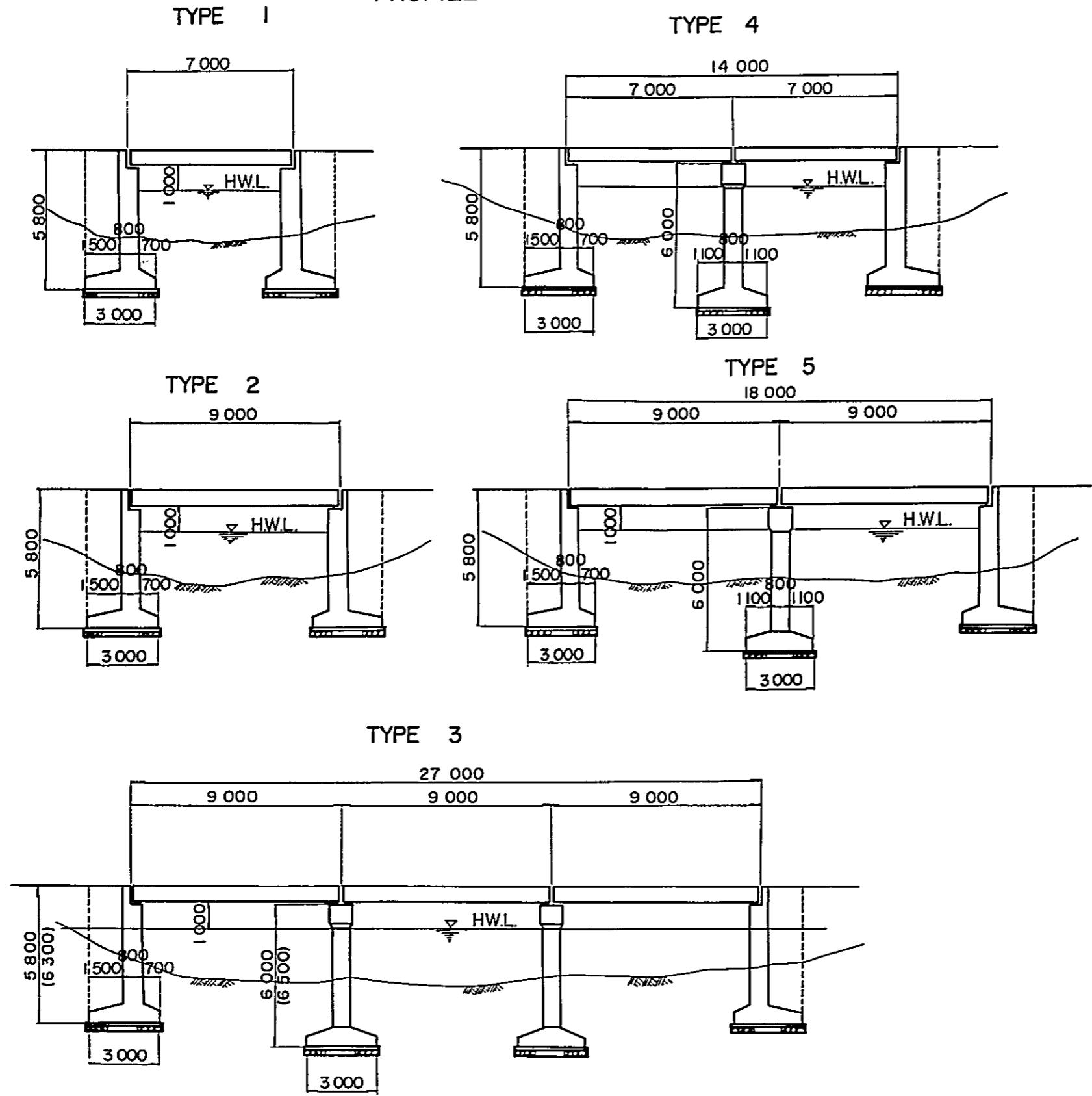


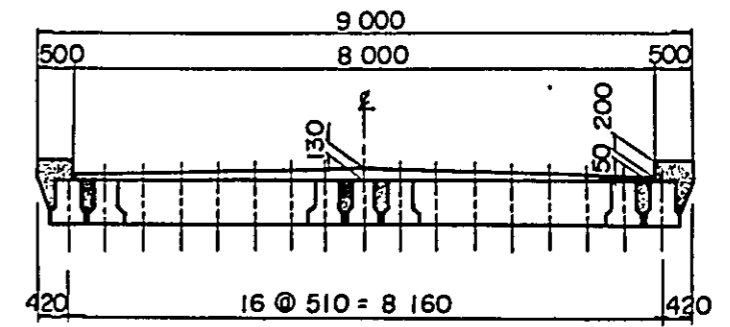
FIG VII-6 TYPE OF BRIDGE

S = 1:100

PROFILE



TYPICAL CROSS SECTION S = 1:50



Note :

1. TYPE 1 ; L = 7.0 M (1 span)
2. TYPE 2 ; L = 9.0 M (1 span)
3. TYPE 3 ; L = 7.0 M x 2 (2 spans)
4. TYPE 4 ; L = 9.0 M x 2 (2 spans)
5. TYPE 5 ; L = 9.0 M x 3 (3 spans)

FIG. 7-5 TYPE OF BOX CULVERT

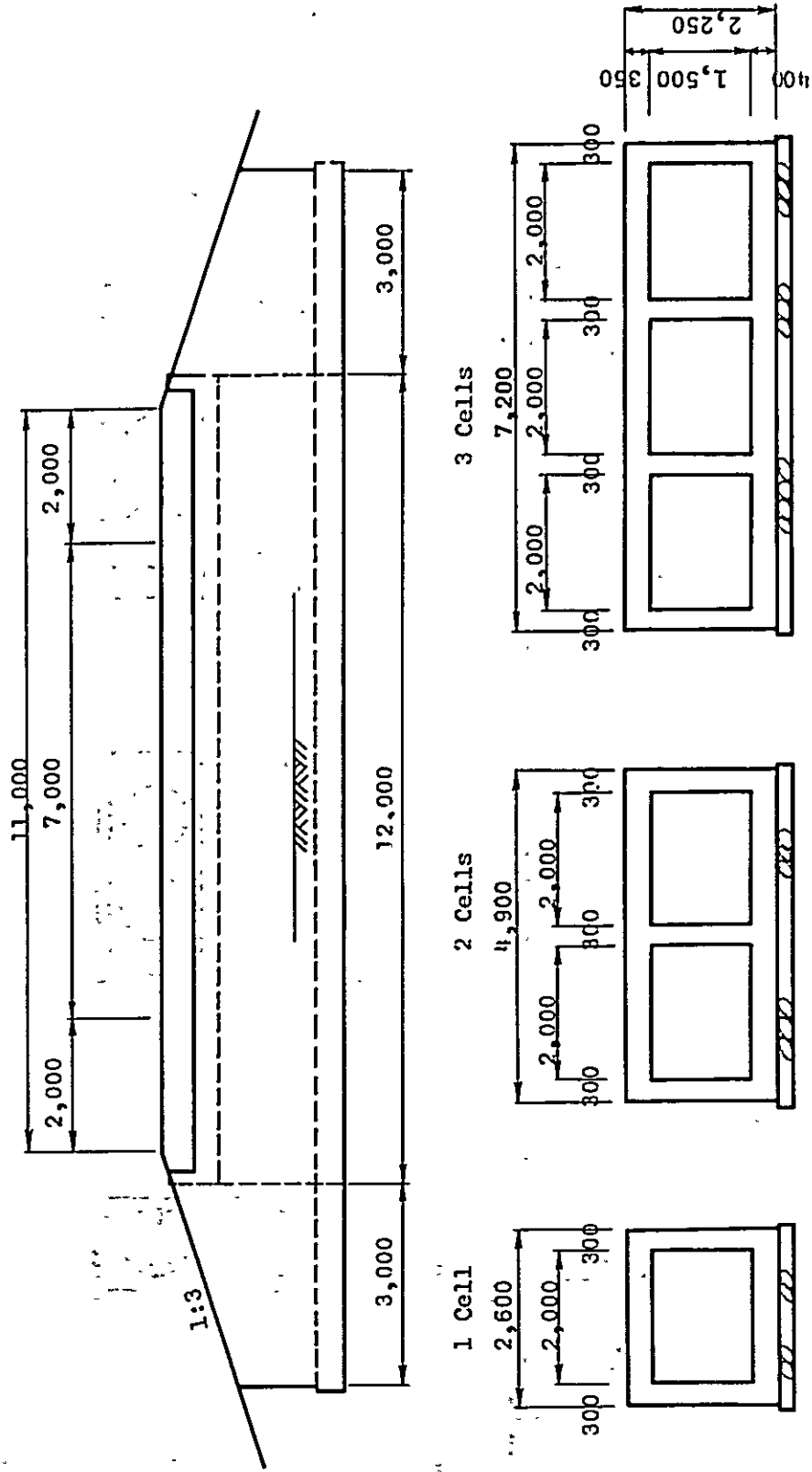


FIG. 7-6 TYPE OF PIPE CULVERT

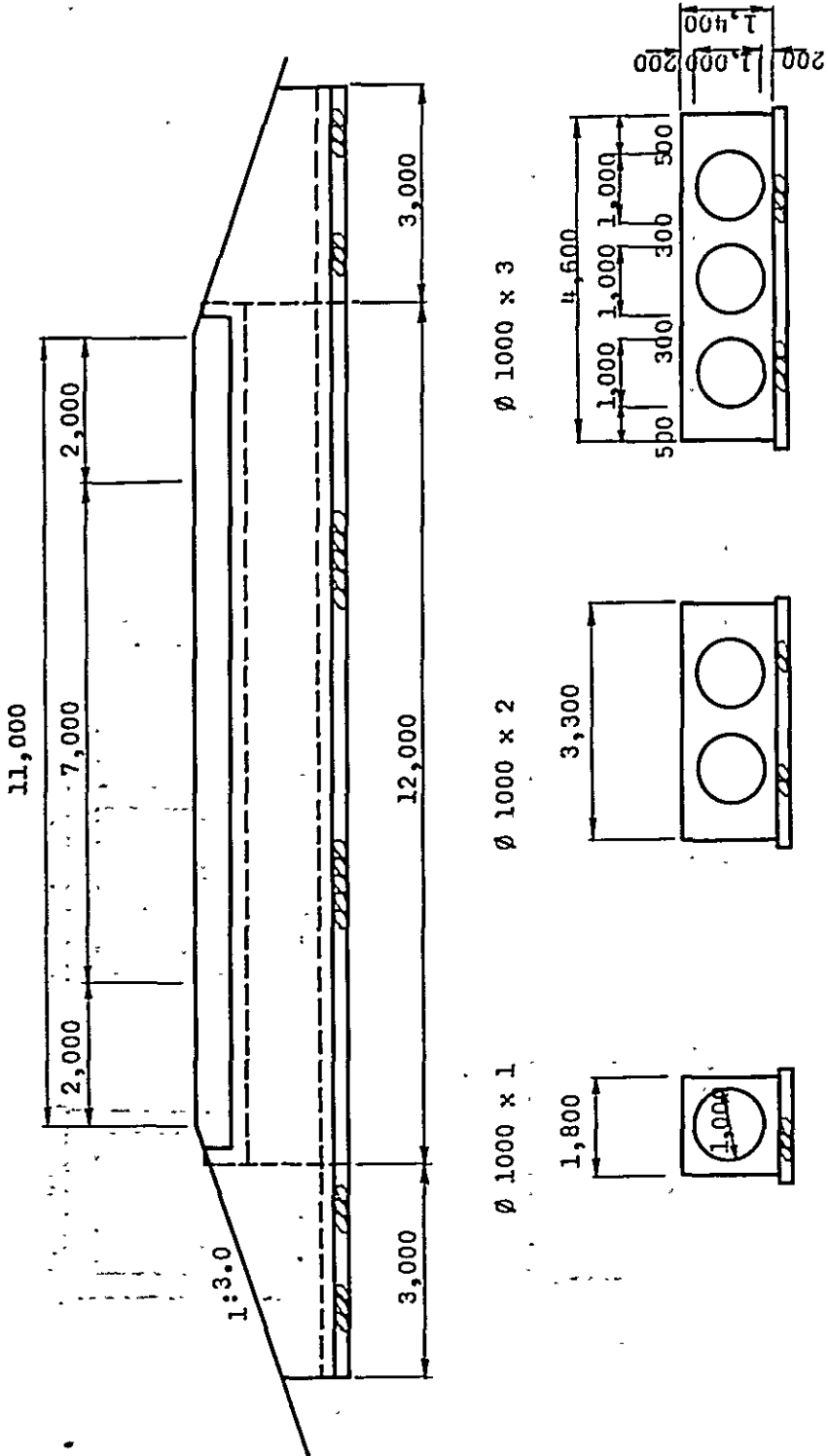


TABLE 7-4 PLANNED BRIDGE LENGTH
BASED ON ESTIMATED DISCHARGE

ANNEX VII-10

No.	Route	Station	Discharge	Bridge Length
1	A	6k + 430km	27.7 t/sec	L=9.0m
2	A	12 + 440	33.0	L=9.0
3	A	12 + 730	29.3	L=9.0
4	A	21 + 550	83.6	L=27.0 (9.0x3span)
5	A	22 + 950	78.5	L=27.0 (9.0x3span)
6	A	27 + 120	32.6	L=9.0
7	A	30 + 600	47.2	L=14.0 (7.0x2span)
8	A	45 + 300	30.3	L=9.0
9	A	51 + 900	39.5	L=14.0 (7.0x2span)
10	A	55 + 900	51.6	L=18.0 (9.0x2span)
11	B	13 + 400	67.7	L=27.0 (9.0x3span)
12	B	14 + 300	23.9	L=7.0
13	B	17 + 200	22.9	L=7.0
14	B	20 + 700	76.4	L=27.0 (9.0x3span)
15	B	23 + 900	42.2	L=14.0 (7.0x2span)
16	B	27 + 800	119.4	L=27.0 (9.0x3span)
17	B	28 + 700	22.9	L=7.0
18	B	29 + 550	43.2	L=14.0 (7.0x2span)
19	B	35 + 750	37.1	L=14.0 (7.0x2span)
20	B	36 + 00	53.8	L=18.0 (9.0x2span)
21	B	50 + 600	18.0	L=7.0
22	F	4 + 640	38.6	L=14.0 (7.0x2span)
23	F	7 + 750	56.6	L=14.0 (7.0x2span)
24	F	10 + 00	41.1	L=14.0 (7.0x2span)
25	C	15 + 500	21.8	L=7.0
26	C	18 + 450	17.6	L=7.0
27	C	18 + 900	19.6	L=7.0
28	D	12 + 900	21.8	L=7.0
29	D	15 + 900	17.6	L=7.0
30	D	17 + 700	19.6	L=7.0

TABLE 7-5 COMPARISON OF CONSTRUCTION COST
BETWEEN CORRUGATED PIPE AND
REINFORCED CONCRETE PIPE

Pipe Item	Per Place	
	Corrugated Pipe ø 1000 x 1 (L=20) Net Cost (L.S)	Reinforced Concrete Pipe ø 1000 x 1 (L=12.0) Net Cost (L.S)
Pipe	687.6	432.3
Excavation	18.4	5.4
Sand Blanket	21.3	-
Placing	183.0	-
Covering	212.3	-
Masonry	84.6	-
Concrete	-	520.3
Form Work	-	67
Reinforcement	-	155.
Gravel	-	17.8
Total	1,207.2	1,198.3

ANNEX VIII

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ANNEX VIII-1 ACQUISITION COST

1.1 Mechanical Equipment

Prices for mechanical equipment are obtained from equipment suppliers. Table 8-1-1 and 1-2 show the cost of acquisition of equipment and daily rate as a percent of cost for future estimation. Table 8-1-3 shows details of D7G of Caterpillar Co., as an example.

1.2 Labour

The following labour costs are estimated on the basis of RBPC of Sudan and El Obeid City standard which was furnished by the city construction authority.

<u>Position</u>	<u>Hourly Rate</u>	<u>Daily Payment (L/S)</u>
Unskilled Labour	0.12	0.96
Skilled Labour	0.20	1.60
Driver	0.25	2.00
Carpenter	0.25	2.00
Mason	0.25	2.00
Mechanic	0.25	2.00
Foreman	0.30	2.40

TABLE 8-1-1 ACQUISITION COST OF EQUIPMENT

(LS)

Equipment	Port Sudan CIF Price	Local Component	Import Duty and Taxes	Total	Daily rate As % of Cost
1. Bulldozer D7G with Blade	41.865	15.153	5.860	62.878	0.17
2. Bulldozer D8K with Blade & Ripper	65.000	23.450	10.660	99.110	0.17
3. 623B Motor Scraper (21 cu.yd.)	68.532	24.886	25.014	118.432	0.18
4. Motor Grader (blade width 12')	21.825	8.339	7.965	38.129	0.18
5. 225 Excavator (0.7 cu.yd.)	39.285	14.650	14.338	68.273	0.22
6. Wheel Loader W90 (1.9 m ³)	23.299	8.655	8.504	40.458	0.17
7. Soil Compactor WF22A	46.697	17.043	17.044	80.784	0.17
8. Tractor Shovel D45S (1.2 m ³)	14.459	5.561	5.278	25.298	0.18
9. Tire Roller (15 tons class)	10.454	3.597	5.385	19.436	0.21
10. Macadam Roller (10 tons class)	8.853	2.997	4.559	16.409	0.18
11. Dump Truck (11 tons)	11.499	3.857	7.072	22.428	0.17
12. Flatbed Truck (10 tons)	8.335	2.828	5.127	16.290	0.34
13. Water Tanker (8,000 L.)	8.730	2.957	5.370	17.057	0.18

TABLE 8-1-2 ACQUISITION COST OF EQUIPMENT

ANNEX VIII-1

(LS)

Equipment	Port Sudan CIF Price	Local Component	Import Duty and Taxes	Total	Daily rate As % of Cost
14. Fuel Tanker (8 tons)	9.127	3.086	5.612	17.825	0.18
15. Asphalt Distributor (4 tons)	12.064	4.040	7.419	23.523	0.18
16. Air Compressor (10.5 m ² /min.)	5.545	1.784	2.023	9.352	0.28
17. Crawler Drill CRF110	8.899	3.315	3.248	15.462	0.33
18. Generator 50HZ EGI50	7.561	2.388	3.893	13.842	0.22
19. Concrete Mixer (0.4 m ³)	2.352	943	859	4.154	0.21
20. Concrete Vibrator ø2" 3/8	238	134	88	460	0.40
21. Crushing Plant (30 T/Hr)	51.587	15.676	18.829	86.092	0.11
22. Vibration Roller (2.5 tons)	3.621	1.296	1.864	6.781	0.21
23. Asphalt Plant (60 T/Hr)	55.556	20.444	20.280	96.280	0.14
24. Asphalt Finisher (2.4 - 4.5 m)	18.487	6.747	6.970	32.204	0.17
25. Plate Compactor WUP38	1.894	692	783	3.369	0.40
26. Truck Crane NK110	15.873	5.755	5.792	27.420	0.15

Source:

TABLE 8-1-3 COST OF ACQUISITION A D7G (CAT.)

A) Foreign Component

CIF Price	<u>US\$</u>	<u>LS</u>
Bare Tractor	94,960	37,683
Angle Blade	10,540	4,182
	<hr/>	<hr/>
Total A	105,500	41,865

B) Custom

4,182	x 25%	1,046
Surcharge	CIF x 5%	2,093
Quey Due	1.5%	628
Development Tax	5%	2,093
		<hr/>
Total B		5,860

C) Local Component

Remittance	CIF x 15%	6,280
Profit	20%	8,373
Transport and Miscellaneous		500
		<hr/>
Total C		15,153
Total A + C		57,018
Total A + B + C		62,878

TABLE 8-1-4 BREAKDOWN OF PRICE OF FUEL

(Unit: LS/gal.)

El Obeid	<u>Total</u>	<u>Tax</u>	<u>FC</u> ¹⁾	<u>LC</u>
Gasoline	0.460	0.220	0.10	0.140
Diesel	0.368	0.056	0.10	0.212

Note 1) 1 Barrel of crude oil: \$10.75

7.37 Barrel = 1 ton of crude oil

Source: Shell Oil Company, Khartoum

BREAKDOWN OF PRICE OF OIL

(Unit: LS/gal.)

El Obeid	<u>Total</u>	<u>Tax</u>	<u>FC</u>	<u>LC</u>
Price in El Obeid				
Super	2.370	0.311	1.553	0.506
Diesel	1.900	0.293	1.209	0.398

Source: Shell Oil Company, Khartoum

1.3 Miscellaneous Materials

i. Fuel and Oil

Cost of fuel and oil are shown in Table 8-1-4.

ii. Cement

In Sudan, there are two cement plants, one at Atbara and one at Kosti, which have maximum daily production of 750 tons and 400 tons, respectively.

Ex-works price is LS 25 per ton. For all cement to be used in this project, the unit price of Sudan product cement is adopted because the Kosti Plant is expected to increase production in the near future.

iii. Other Materials

TABLE 8-1-5 THE COST OF OTHER MATERIALS

<u>Item</u>	<u>Unit</u>	<u>CIF Price Port Sudan</u>	<u>Transport Local Cost</u>	<u>Taxes</u>	<u>Total</u>
Bitumen	T	72.22	11.70	33.58	117.50
Cement	T		40.10	1.65	41.75
Reinforcement Bar	T		243.0	61.0	304.0
Structual Steel	T	156.0	105.0	94.0	355.0
Explosives	Kg	0.98	0.15	0.39	1.52
Timber	m ³		150.0	10.0	160.0
Filler	T		18.10	0.55	18.65
Corrugated Pipe ϕ 1000 m/m	m	32.24	11.28	11.77	55.29

ANNEX VIII-2 UNIT COST

2.1 Unit Cost per Work Item

Unit cost per work item is estimated in compliance with Peurifoy R.L. "Construction of Planning, Equipment and Methods" 1970, and data obtained at the construction sites of El Ain dam and El Obeid airport.

2.2 Income Tax

The income tax component of the Sudan is determined by the Table 6-20-10 in the Annex VI.

2.3 Cost for Equipment

The acquisition cost of equipment is based on the CIF price at Port Sudan, as shown in the Table 8-1-1-2. The unit cost per a work item is calculated by dividing into two categories - (a) equipment depreciation cost and (b) equipment operational cost. Service years of equipment and repair coefficient are shown by the following Table 8-2-1, where a repair coefficient is the maximum percentage figure of all repair costs to the initial acquisition cost, and required number of principal mechanical equipment is shown by the following Table 8-2-2.

2.4 Overhead and Profit

In estimating the unit rate as shown in the Tables 8-3-1 - 7 of Annex VIII-3, about 50% of the cost is added to cover the overhead expense and profit of contractors.

TABLE 8-2-1 DURABILITY AND REPAIR COEFFICIENT OF MECHANICAL EQUIPMENT

Mechanical equipment	Economical durability		Repair Coefficient
	Year	Hours	
Air Compressor	7	6,000	0.75
Asphalt Distributor	8	10,000	0.75
Bull-dozer	8	10,000	0.75
Concrete Mixer	8	8,000	0.75
Concrete Vibrator	4	4,000	0.8
Crawler Drill	5	6,000	0.75
Crushing Plant	12	18,000	0.75
Excavator	8	8,000	0.75
Generator	8	8,000	0.75
Line Painting Unit	4	4,000	0.8
Motor Grader	8	10,000	0.75
Motor Scraper	8	10,000	0.75
Macadam Roller	10	10,000	0.75
Tired Roller	6	8,000	0.75
Soil Compacter	10	10,000	0.6
Tractor Shovel	8	10,000	0.75
Dump Truck	5	10,000	0.75
Flat Body Truck	7	4,000	0.3
Water Tanker	8	10,000	0.75
Fuel Car	8	10,000	0.75
Vibration Roller	5	8,000	0.8
Wheel Loader	8	10,000	0.75
Pump	6	6,000	1
Asphalt Plant	10	12,000	0.75
Asphalt Finisher	8	10,000	0.75

TABLE 8-2-2 REQUIRED NUMBER OF PRINCIPAL MECHANICAL EQUIPMENT

<u>Equipment</u>	<u>PLAN 2</u>		
	<u>1980</u>	<u>1981</u>	<u>1982</u>
Bulldozer D7G	16	17	18
Grader	9	8	8
Motor Scraper	2	2	2
Tire Roller	10	8	8
Macadam Roller	6	6	6
Excavator	2	2	2
Asphalt Distributer	2	2	2
Tractor Shovel	2	2	2
Water Tanker	12	10	10
Wheel Loader	2	2	2
Crawler Drill	2	2	2
Crushing Plant	2	2	2
Dump Truck 11 t.	50	50	50

TABLE 8-3-1 PRICED BILL OF QUANTITY:ROUTE A

Item		Construction Section				Total	
		1	2	3	4		
Earth Work	Clearing	Quantity (M ²)	1,020,370	1,013,790	905,940	2,952,100	
		Rate	0.040	0.040	0.040	0.040	
		Summation	41,300	41,000	36,700	119,000	
	Filling	Quantity (M ³)	140,836	93,840	70,763	305,439	
		Rate	0.637	0.637	0.637	0.637	
		Summation	89,900	59,800	45,000	194,700	
	Cutting (I)	Quantity (M ³)	336,668	351,630	314,223	1,002,521	
		Rate	0.110	0.110	0.110	0.108	
		Summation	37,100	38,800	34,700	110,600	
	Cutting (II)	Quantity (M ³)	49,546	-	-	49,546	
		Rate	0.715	-	-	0.715	
		Summation	35,200	-	-	35,200	
	Slope Protection	Quantity (M ²)	115,252	95,128	85,007	295,387	
		Rate	0.360	0.360	0.360	0.360	
		Summation	41,600	34,300	30,600	106,500	
	Sub Total		245,100	173,900	147,000	566,000	
	Pavement Work	Surface	Quantity (M ²)	164,533	164,533	147,000	476,066
			Rate	0.796	0.796	0.829	
Summation			131,000	131,000	122,000	384,000	
Base		Quantity (M ²)	28,200	28,200	25,200	81,600	
		Rate	2.765	2.765	3.496		
		Summation	78,000	78,000	88,100	244,100	
Subbase		Quantity (M ²)	58,703	58,703	52,457	169,863	
		Rate	2.623	2.623	3.353		
		Summation	154,000	154,000	175,900	483,900	
Shoulder		Quantity (M ³)	12,361	12,361	11,046	35,768	
		Rate	1.905	1.905	1.905	1.905	
		Summation	23,600	23,600	21,100	68,300	
Subgrade		Quantity (M ³)	37,673	41,664	44,330	123,667	
		Rate	1.278	1.278	1.278	1.278	
		Summation	48,200	53,200	56,600	158,000	
Sub Total		434,800	439,800	463,700	1,338,300		
Bridge Work		L = 7.0 ^M (1 span)	Quantity (P)	-	-	-	-
			Rate	-	-	-	-
	Summation		-	-	-	-	
	L = 9.0 ^M (1 span)	Quantity (P)	3	2	-	5	
		Rate	10,433	10,400	-		
		Summation	31,300	20,800	-	52,100	
	L = 7.0 ^M x 2 (2 span)	Quantity (P)	-	1	1	2	
		Rate	-	14,800	14,800	14,800	
		Summation	-	14,800	14,800	29,600	
	L = 9.0 ^M x 2 (2 span)	Quantity (P)	-	-	1	1	
		Rate	-	-	18,200	18,200	
		Summation	-	-	18,200	18,200	
	L = 9.0 ^M x 3 (3 span)	Quantity (P)	2	-	-	2	
		Rate	26,350	-	-	26,350	
		Summation	52,700	-	-	52,700	
Sub Total		84,000	35,600	33,000	152,600		

TABLE 8-3-1 PRICED BILL OF QUANTITY: ROUTE A

Item		Construction Section				Total	
		1	2	3	4		
Box Culvert	2.0 x 1.5 (1 Cell)	Quantity (P)	-	-	1.0	1.0	
		Rate	-	-	2,900	2,900	
		Summation	-	-	2,900	2,900	
	2.0 x 1.5 (2 Cells)	Quantity (P)	4.0	2.0	1.0	7.0	
		Rate	4,725	4,725	4,600		
		Summation	18,900	9,300	4,600	32,800	
	2.0 x 1.5 (3 Cells)	Quantity (P)	-	2.0	-	2.0	
		Rate	-	6,200	-	6,200	
		Summation	-	12,400	-	12,400	
Sub Total		18,900	21,700	7,500	48,100		
Drainage	Pipe Culvert (ϕ 1,000 x 1)	Quantity (P)	2	2	2	6	
		Rate	1,100	1,100	1,100	1,100	
		Summation	2,200	2,200	2,200	6,600	
	Pipe Culvert (ϕ 1,000 x 2)	Quantity (P)	1	-	-	1	
		Rate	1,900	-	-	1,900	
		Summation	1,900	-	-	1,900	
	Pipe Culvert (ϕ 1,000 x 3)	Quantity (P)	-	2	2	4	
		Rate	-	2,700	2,700	2,700	
		Summation	-	5,400	5,400	10,800	
	Side Ditch	Quantity (M ³)	400	-	-	400	
		Rate	22.25	-	-	22.25	
		Summation	8,900	-	-	8,900	
	Side Pipe Culvert	Quantity (M)	117	118	105	340	
		Rate	22.94	22.94	22.94	22.94	
		Summation	2,700	2,700	2,400	7,800	
	Sub Total		15,700	10,300	10,000	36,000	
	Masonry Work	Stone Masonry	Quantity (M ³)	561	-	-	561
			Rate	22.28	-	-	22.28
Summation			12,500	-	-	12,500	
Sub Total		12,500	-	-	12,500		
Total		811,000	681,300	661,200	2,153,500		
Overhead and Profit					1,089,500		
Economic Cost					3,243,000		
Remarks: (P) - Places							

TABLE 8-3-2 PRICED BILL OF QUANTITY:ROUTE B

Item		Construction Section				Total	
		1	2	3	4		
Earth Work	Clearing	Quantity (M ²)	1,121,640	905,940	1,058,640	3,086,220	
		Rate	0.040	0.040	0.040		
		Summation	45,300	36,700	42,800	124,800	
	Filling	Quantity (M ³)	104,008	76,759	120,383	301,150	
		Rate	0.637	0.637	0.637		
		Summation	66,400	48,900	76,700	192,000	
	Cutting (I)	Quantity (M ³)	389,038	314,223	389,038	1,092,299	
		Rate	0.110	0.110	0.110		
		Summation	42,900	34,700	42,900	120,500	
	Cutting (II)	Quantity (M ³)	-	-	-	-	
		Rate	-	-	-	-	
		Summation	-	-	-	-	
	Slope Protection	Quantity (M ²)	105,248	85,008	38,720	228,975	
		Rate	0.360	0.360	0.360		
		Summation	38,000	30,600	13,900	82,500	
	Sub Total		192,600	150,900	176,300	519,800	
	Pavement Work	Surface	Quantity (M ²)	182,000	147,000	182,000	511,000
			Rate	0.795	0.795	0.856	
Summation			144,700	117,000	151,000	412,700	
Base		Quantity (M ³)	31,200	25,000	31,200	87,400	
		Rate	2.772	2.772	3.500		
		Summation	86,500	69,200	109,200	204,900	
Subbase		Quantity (M ³)	64,948	52,458	64,948	182,354	
		Rate	2.623	2.623	3.553		
		Summation	170,600	137,600	217,900	526,100	
Shoulder		Quantity (M ³)	13,676	11,046	13,676	38,398	
		Rate	1.905	1.905	1.905		
		Summation	26,300	21,100	26,300	73,700	
Subgrade		Quantity (M ³)	45,913	44,331	36,192	126,436	
		Rate	1.278	1.278	1.278		
		Summation	58,700	56,600	46,200	161,500	
Sub Total		486,800	401,500	550,600	1,438,900		
Bridge Work		L = 7.0 ^M (1 span)	Quantity (P)	2	1	1	4
			Rate	8,800	8,800	8,800	8,800
	Summation		17,600	8,800	8,800	35,200	
	L = 9.0 ^M (1 span)	Quantity (P)	-	-	-	-	
		Rate	-	-	-	-	
		Summation	-	-	-	-	
	L = 7.0 ^M x 2 (2 span)	Quantity (P)	-	3	-	3	
		Rate	-	15,000	-	15,000	
		Summation	-	45,000	-	45,000	
	L = 9.0 ^M x 2 (2 span)	Quantity (P)	-	1	1	2	
		Rate	-	18,200	18,200		
		Summation	-	18,200	18,200	36,400	
	L = 9.0 ^M x 3 (3 span)	Quantity (P)	2	1	-	3	
		Rate	26,350	26,600	-		
		Summation	52,700	26,600	-	79,300	
Sub Total		70,300	98,600	27,000	195,900		

TABLE 8-3-2 PRICED BILL OF QUANTITY:ROUTE B

Item		Construction Section				Total	
		1	2	3	4		
Box Culvert	2.0 x 1.5 (1 Cell)	Quantity (P)	1	-	1	2	
		Rate	2,900	-	2,900	2,900	
		Summation	2,900	-	2,900	5,800	
	2.0 x 1.5 (2 Cells)	Quantity (P)	5	4	1	10	
		Rate	4,725	4,725	4,600	6,633	
		Summation	23,700	18,900	4,600	47,200	
	2.0 x 1.5 (3 Cells)	Quantity (P)	3	-	1	4	
		Rate	4,740	-	4,740	4,740	
		Summation	18,800	-	4,740	23,540	
	Sub Total		45,400	18,900	12,240	76,540	
	Drainage	Pipe Culvert (ø1,000 x 1)	Quantity (P)	2	2	4	8
			Rate	1,100	1,100	1,100	1,100
Summation			2,200	2,200	4,400	8,800	
Pipe Culvert (ø1,000 x 2)		Quantity (P)	-	-	-	-	
		Rate	-	-	-	-	
		Summation	-	-	-	-	
Pipe Culvert (ø1,000 x 3)		Quantity (P)	-	-	2	2	
		Rate	-	-	2,700	2,700	
		Summation	-	-	5,400	5,400	
Side Ditch		Quantity (M ³)	-	-	-	-	
		Rate	-	-	-	-	
		Summation	-	-	-	-	
Side Pipe Culvert		Quantity (M)	130	105	130	365	
		Rate	22.30	22.30	22.30	22.30	
		Summation	2,900	2,400	2,900	8,200	
Sub Total		5,100	4,600	12,700	22,400		
Masonry Work		Stone Masonry	Quantity (M ³)	1,148	-	-	1,148
			Rate	22.28	-	-	22.28
	Summation		25,700	-	-	25,700	
	Sub Total		25,700	-	-	25,700	
Total		825,900	674,500	778,840	2,279,240		
Overhead and Profit					1,154,300		
Economic Cost					3,433,540		
Remarks: (P) - Places							

TABLE 8-3-3 PRICED BILL OF QUANTITY: ROUTE C

Item	Construction Section				Total		
	1	2	3	4			
Earth Work	Clearing	Quantity (M ²)	1,025,931	1,198,259	983,592	3,207,782	
		Rate	0.040	0.040	0.040	0.040	
		Summation	41,500	48,300	39,800	129,600	
	Filling	Quantity (M ³)	254,570	256,966	24,456	535,992	
		Rate	0.637	0.637	0.637		
		Summation	162,700	164,100	15,400	342,200	
	Cutting (I)	Quantity (M ³)	314,972	389,038	341,156	945,166	
		Rate	0.110	0.110	0.110		
		Summation	34,700	42,900	37,700	115,300	
	Cutting (II)	Quantity (M ³)	70,200	-	-	70,200	
		Rate	0.710	-	-	0.710	
		Summation	50,100	-	-	50,100	
	Slope Protection	Quantity (M ²)	228,459	186,005	92,295	506,759	
		Rate	0.362	0.451	0.451		
		Summation	82,700	84,000	41,600	208,300	
	Sub Total		371,700	339,300	134,500	845,500	
	Pavement Work	Surface	Quantity (M ²)	161,000	182,000	159,633	502,633
			Rate	0.831	0.898	0.898	
Summation			133,800	163,500	143,400	440,700	
Base		Quantity (M ³)	27,600	31,200	27,360	86,160	
		Rate	3.496	4.387	4.959		
		Summation	96,500	136,900	135,700	369,100	
Subbase		Quantity (M ³)	57,454	64,948	56,954	179,356	
		Rate	3.353	4.261	4.814		
		Summation	192,800	276,800	274,200	743,800	
Shoulder		Quantity (M ³)	12,098	13,676	11,993	37,767	
		Rate	1.905	2.339	2.643		
		Summation	23,300	32,000	31,700	87,000	
Subgrade		Quantity (M ³)	80,566	94,627	107,013	282,206	
		Rate	1.278	1.278	1.278		
		Summation	103,200	103,200	137,300	343,700	
Sub Total		549,600	712,400	722,300	1,984,300		
Bridge Work		L = 7.0 ^H (1 span)	Quantity (P)	2	-	-	3
			Rate	8,800	-	-	8,800
	Summation		26,400	-	-	26,400	
	L = 9.0 ^H (1 span)	Quantity (P)	-	-	-	-	
		Rate	-	-	-	-	
		Summation	-	-	-	-	
	L = 7.0 ^H x 2 (2 span)	Quantity (P)	-	-	-	-	
		Rate	-	-	-	-	
		Summation	-	-	-	-	
	L = 9.0 ^H x 2 (2 span)	Quantity (P)	-	-	-	-	
		Rate	-	-	-	-	
		Summation	-	-	-	-	
	L = 9.0 ^H x 3 (3 span)	Quantity (P)	-	-	-	-	
		Rate	-	-	-	-	
		Summation	-	-	-	-	
	Sub Total		26,400	-	-	26,400	

TABLE 8-3-3 PRICED BILL OF QUANTITY:ROUTE C

Item		Construction Section				Total
		1	2	3	4	
Box Culvert	2.0 x 1.5 (1 Cell)	Quantity (P)	2	4	4	10
		Rate	2,900	2,975	2,225	
		Summation	5,800	11,900	8,900	26,600
	2.0 x 1.5 (2 Cells)	Quantity (P)	-	-	-	-
		Rate	-	-	-	-
		Summation	-	-	-	-
	2.0 x 1.5 (3 Cells)	Quantity (P)	-	-	-	-
		Rate	-	-	-	-
		Summation	-	-	-	-
Sub Total		5,800	11,900	8,900	26,600	
Drainage	Pipe Culvert (ø1,000 x 1)	Quantity (P)	6	6	6	18
		Rate	1,133	1,133	1,133	1,133
		Summation	6,800	6,800	6,800	20,400
	Pipe Culvert (ø1,000 x 2)	Quantity (P)	6	13	5	24
		Rate	2,000	2,000	2,000	2,000
		Summation	12,000	26,300	10,000	48,300
	Pipe Culvert (ø1,000 x 3)	Quantity (P)	4	-	5	9
		Rate	2,775	-	2,775	4,240
		Summation	11,100	-	13,900	25,000
	Side Ditch	Quantity (M ³)	780	-	-	780
		Rate	22.25	-	-	22.25
		Summation	17,400	-	-	17,400
	Side Pipe Culvert	Quantity (M)	115	130	114	359
		Rate	22.94	22.30	22.94	
		Summation	2,500	2,900	2,500	7,900
Sub Total		49,800	360,00	33,200	119,000	
Masonry Work	Stone Masonry	Quantity (M ³)	1,972	2,337	-	4,309
		Rate	22.28	22.28	-	58.75
		Summation	44,200	52,500	-	96,700
Sub Total		44,200	52,500	-	96,700	
Total		1,047,500	1,152,100	898,900	3,098,500	
Overhead and Profit					1,570,100	
Economic Cost					4,668,600	
Remarks: (P) - Places						

TABLE 8-3-4 PRICED BILL OF QUANTITY: ROUTE D

Item		Construction Section				Total	
		1	2	3	4		
Earth Work	Clearing	Quantity (M ²)	836,828	1,023,804	919,285	2,779,911	
		Rate	0.040	0.040	0.040		
		Summation	33,800	41,400	37,100	112,300	
	Filling	Quantity (M ³)	104,841	85,827	78,299	268,967	
		Rate	0.637	0.637	0.637		
		Summation	66,900	54,700	49,800	171,400	
	Cutting (I)	Quantity (M ³)	237,913	296,567	305,096	839,576	
		Rate	0.110	0.110	0.110		
		Summation	26,200	32,600	33,700	92,500	
	Cutting (II)	Quantity (M ³)	286,464	301,004	71,466	658,934	
		Rate	0.715	0.715	0.715		
		Summation	204,800	215,300	50,900	471,000	
	Slope Protection	Quantity (M ²)	99,625	107,167	88,830	295,627	
		Rate	0.362	0.451	0.451		
		Summation	36,000	48,300	40,200	124,500	
	Sub Total		367,700	392,300	211,700	971,700	
	Pavement Work	Surface	Quantity (M ²)	140,033	17,500	15,200	466,233
			Rate	0.831	0.898	0.898	
Summation			115,900	157,300	135,900	409,100	
Base		Quantity (M ³)	24,000	30,038	25,920	79,958	
		Rate	3.491	4.957	4.957		
		Summation	83,800	148,900	128,500	361,200	
Subbase		Quantity (M ³)	49,959	62,451	53,956	166,366	
		Rate	3.352	4.816	4.816		
		Summation	167,500	300,800	259,800	728,100	
Shoulder		Quantity (M ³)	10,519	13,150	11,361	35,030	
		Rate	1.929	2.643	2.643		
		Summation	20,300	34,800	30,000	85,100	
Subgrade		Quantity (M ³)	27,840	36,366	40,958	105,164	
		Rate	1.278	1.278	1.278		
		Summation	35,500	46,400	52,300	134,200	
Sub Total		423,000	688,200	606,500	1,717,700		
Bridge Work		L = 7.0 ^M (1 span)	Quantity (P)	3	-	-	3
			Rate	8,800	-	-	
	Summation		26,400	-	-	26,400	
	L = 9.0 ^M (1 span)	Quantity (P)	-	-	-	-	
		Rate	-	-	-		
		Summation	-	-	-	-	
	L = 7.0 ^M x 2 (2 span)	Quantity (P)	-	-	-	-	
		Rate	-	-	-		
		Summation	-	-	-	-	
	L = 9.0 ^M x 2 (2 span)	Quantity (P)	-	-	-	-	
		Rate	-	-	-		
		Summation	-	-	-	-	
	L = 9.0 ^M x 3 (3 span)	Quantity (P)	-	-	-	-	
		Rate	-	-	-		
		Summation	-	-	-	-	
Sub Total		26,400	-	-	26,400		

TABLE 8-3-4 PRICED BILL OF QUANTITY: ROUTE D

Item		Construction Section				Total	
		1	2	3	4		
Box Culvert	2.0 x 1.5 (1 Cell)	Quantity (P)	-	8	2	10	
		Rate	-	3,000	2,900		
		Summation	-	24,000	5,800	5,800	
	2.0 x 1.5 (2 Cells)	Quantity (P)	-	-	-	-	
		Rate	-	-	-	-	
		Summation	-	-	-	-	
	2.0 x 1.5 (3 Cells)	Quantity (P)	-	-	-	-	
		Rate	-	-	-	-	
		Summation	-	-	-	-	
	Sub Total		-	24,000	5,800	29,800	
	Drainage	Pipe Culvert (ø1,000 x 1)	Quantity (P)	4	4	9	17
			Rate	1,100	1,100	1,100	
Summation			4,400	4,400	10,100	18,900	
Pipe Culvert (ø1,000 x 2)		Quantity (P)	3	3	-	6	
		Rate	1,966	1,966	-	3,033	
		Summation	5,900	5,900	-	11,800	
Pipe Culvert (ø1,000 x 3)		Quantity (P)	1	2	-	3	
		Rate	2,600	2,700	-		
		Summation	2,600	5,400	-	8,000	
Side Ditch		Quantity (M ³)	1,640	2,072	484	4,196	
		Rate	22.25	22.25	22.25		
		Summation	36,800	46,500	10,800	94,100	
Side Pipe Culvert		Quantity (M)	100	125	108	333	
		Rate	22.94	22.30	22.30	35.90	
		Summation	2,300	2,800	2,400	7,500	
Sub Total		52,000	65,000	23,300	140,300		
Masonry Work		Stone Masonry	Quantity (M ³)	146	-	-	146
			Rate	21.91	-	-	22.28
			Summation	3,200	-	-	3,200
		Sub Total		3,200	-	-	3,200
Total		872,300	1,169,500	847,300	2,889,100		
Overhead and Profit					1,463,200		
Economic Cost					4,352,300		
Remarks: (P) - Places							

TABLE 8-3-5 PRICED BILL OF QUANTITY:ROUTE E

Item		Construction Section				Total	
		1	2	3	4		
Earth Work	Clearing	Quantity (M ²)	1,283,320	589,454	892,108	2,443,844	
		Rate	0.040	0.040	0.040		
		Summation	52,000	23,700	36,000	111,700	
	Filling	Quantity (M ³)	81,225	31,986	68,237	181,448	
		Rate	0.637	0.637	0.637		
		Summation	51,700	20,200	43,500	115,400	
	Cutting (I)	Quantity (M ³)	343,173	145,142	233,423	721,665	
		Rate	0.110	0.110	0.110		
		Summation	37,900	15,800	25,700	79,400	
	Cutting (II)	Quantity (M ³)	773,130	553,091	395,778	1,722,179	
		Rate	0.751	0.715	0.715		
		Summation	553,500	395,900	283,200	1,232,600	
	Slope Protection	Quantity (M ²)	134,784	61,625	97,989	322,907	
		Rate	0.362	0.362	0.362		
		Summation	48,700	27,700	44,300	120,700	
	Sub Total		743,800	483,300	432,700	1,659,800	
	Pavement Work	Surface	Quantity (M ²)	217,033	98,033	156,133	471,199
			Rate	0.838	0.895	0.895	
Summation			180,300	87,800	140,200	408,300	
Base		Quantity (M ³)	37,200	16,800	26,760	80,760	
		Rate	3.500	4.952	4.952		
		Summation	130,200	83,200	132,700	346,100	
Subbase		Quantity (M ³)	77,676	34,972	55,706	168,354	
		Rate	3.354	4.816	4.816		
		Summation	260,600	168,400	268,300	697,300	
Shoulder		Quantity (M ³)	16,307	7,364	11,730	35,401	
		Rate	1.920	2.643	2.643		
		Summation	31,300	19,500	31,000	81,800	
Subgrade		Quantity (M ³)	65,057	29,934	31,042	126,033	
		Rate	1.278	1.278	1.278		
		Summation	83,300	38,100	39,600	161,000	
Sub Total		685,700	397,000	611,800	1,694,500		
Bridge Work		L = 7.0 ^M (1 span)	Quantity (P)	-	-	-	-
			Rate	-	-	-	-
	Summation		-	-	-	-	
	L = 9.0 ^M (1 span)	Quantity (P)	-	-	-	-	
		Rate	-	-	-	-	
		Summation	-	-	-	-	
	L = 7.0 ^M x 2 (2 span)	Quantity (P)	-	-	-	-	
		Rate	-	-	-	-	
		Summation	-	-	-	-	
	L = 9.0 ^M x 2 (2 span)	Quantity (P)	-	-	-	-	
		Rate	-	-	-	-	
		Summation	-	-	-	-	
	L = 9.0 ^M x 3 (3 span)	Quantity (P)	-	-	-	-	
		Rate	-	-	-	-	
		Summation	-	-	-	-	
Sub Total		-	-	-	-		

TABLE 8-3-5 PRICED BILL OF QUANTITY:ROUTE E

Item		Construction Section				Total	
		1	2	3	4		
Box Culvert	2.0 x 1.5 (1 Cell)	Quantity (P)	8	1	2	11	
		Rate	3,000	2,900	2,900		
		Summation	24,000	2,900	5,800	32,700	
	2.0 x 1.5 (2 Cells)	Quantity (P)	3	4	1	8	
		Rate	4,733	4,725	4,600		
		Summation	14,200	18,900	4,600	37,700	
	2.0 x 1.5 (3 Cells)	Quantity (P)	-	-	-	-	
		Rate	-	-	-	-	
		Summation	-	-	-	-	
	Sub Total		38,200	21,800	10,400	70,400	
	Drainage	Pipe Culvert (ø1,000 x 1)	Quantity (P)	4	1	6	11
			Rate	1,100	1,100	1,132	
Summation			4,400	1,100	6,800	12,300	
Pipe Culvert (ø1,000 x 2)		Quantity (P)	-	-	-	-	
		Rate	-	-	-	-	
		Summation	-	-	-	-	
Pipe Culvert (ø1,000 x 3)		Quantity (P)	-	-	-	-	
		Rate	-	-	-	-	
		Summation	-	-	-	-	
Side Ditch		Quantity (M ³)	3,156	1,720	2,680	7,556	
		Rate	22.50	22.50	22.50		
		Summation	70,900	38,500	60,200	169,600	
Side Pipe Culvert		Quantity (M)	155	70	111	336	
		Rate	22.59	21.42	22.59		
		Summation	3,500	1,500	2,500	7,500	
Sub Total		78,800	41,100	69,500	189,400		
Masonry Work		Stone Masonry	Quantity (M ³)	-	-	-	-
			Rate	-	-	-	-
			Summation	-	-	-	-
		Sub Total		-	-	-	-
Total		1,546,500	943,200	1,124,400	3,614,100		
Overhead and Profit					1,811,200		
Economic Cost					5,425,300		
Remarks: (P) - Places							

TABLE B-3-6 PRICED BILL OF QUANTITY: ROUTE F

Item		Construction Section				Total		
		1	2	3	4			
EARTH WORK	Clearing	Quantity (M ²)	1,601,741	965,596	457,145	1,796,279	4,820,761	
		Rate	0.040	0.040	0.040	0.040		
		Summation	64,900	38,900	18,400	72,700	194,900	
	Filling	Quantity (M ³)	202,799	79,337	24,495	144,812	451,443	
		Rate	0.637	0.637	0.637	0.637	0.637	
		Summation	129,400	50,600	15,500	92,400	287,900	
	Cutting (I)	Quantity (M ³)	493,030	219,957	93,793	450,088	1,246,867	
		Rate	0.110	0.110	0.110	0.110		
		Summation	54,400	24,200	9,000	49,800	137,400	
	Cutting (II)	Quantity (M ³)	213,961	648,808	607,832	1,282,760	2,753,361	
		Rate	0.715	0.715	0.715	0.715		
		Summation	152,900	464,300	434,900	918,300	1,970,400	
	Slope Protection	Quantity (M ²)	296,121	109,686	52,361	198,598	656,766	
		Rate	0.362	0.362	0.451	0.451		
		Summation	107,400	39,600	23,500	89,800	260,300	
	Sub Total		509,000	617,600	501,300	1,223,000	2,850,900	
	PAVEMENT WORK	Surface	Quantity (M ²)	239,066	170,500	79,200	305,200	793,966
			Rate	0.838	0.838	0.925	0.925	
Summation			200,700	142,800	72,500	282,600	698,600	
Base		Quantity (M ³)	40,980	29,220	13,572	52,358	136,130	
		Rate	4.963	4.963	6.882	6.882		
		Summation	203,400	145,000	93,400	360,700	802,500	
Subbase		Quantity (M ³)	85,307	60,828	28,252	10,888	330,764	
		Rate	4.816	4.816	6.272	6.272		
		Summation	411,000	292,900	177,200	68,200	949,300	
Shoulder		Quantity (M ³)	17,963	12,809	5,950	22,927	59,649	
		Rate	1.920	1.920	2.643	2.643		
		Summation	34,500	24,600	15,700	61,000	135,800	
Subgrade		Quantity (M ³)	67,238	39,844	15,743	65,025	187,851	
		Rate	1.278	1.278	1.278	1.278		
		Summation	86,100	50,900	20,000	83,300	240,300	
Sub Total		935,700	656,200	378,800	855,800	2,826,500		
BRIDGE WORK		L = 7.0 ^M (1 span)	Quantity (P)	-	-	-	-	-
			Rate	-	-	-	-	-
	Summation		-	-	-	-	-	
	L = 9.0 ^M (1 span)	Quantity (P)	-	-	-	-	-	
		Rate	-	-	-	-	-	
		Summation	-	-	-	-	-	
	L = 7.0 ^M x 2 (2 span)	Quantity (P)	3	-	-	-	3	
		Rate	14,800	-	-	-	14,800	
		Summation	44,400	-	-	-	44,400	
	L = 9.0 ^M x 2 (2 span)	Quantity (P)	-	-	-	-	-	
		Rate	-	-	-	-	-	
		Summation	-	-	-	-	-	
	L = 9.0 ^M x 3 (3 span)	Quantity (P)	-	-	-	-	-	
		Rate	-	-	-	-	-	
		Summation	-	-	-	-	-	
Sub Total		44,400	-	-	-	44,400		

TABLE 8-3-6 PRICED BILL OF QUANTITY: ROUTE F

Item		Construction Section				Total	
		1	2	3	4		
Box Culvert	2.0 x 1.5 (1 Cell)	Quantity (P)	15	7	4	12	38
		Rate	3,000	3,000	2,975	3,000	
		Summation	45,000	21,000	11,900	36,000	113,900
	2.0 x 1.5 (2 Cells)	Quantity (P)	-	1	-	1	2
		Rate	-	4,600	-	4,600	
		Summation	-	4,600	-	4,600	9,200
	2.0 x 1.5 (3 Cells)	Quantity (P)	-	-	-	-	-
		Rate	-	-	-	-	-
		Summation	-	-	-	-	-
Sub Total		45,000	25,600	11,900	40,600	123,100	
Drainage	Pipe Culvert (Ø1,000 x 1)	Quantity (P)	-	3	1	6	10
		Rate	-	1,100	1,100	1,133	
		Summation	-	3,300	1,100	6,800	11,200
	Pipe Culvert (Ø1,000 x 2)	Quantity (P)	-	-	-	1	1
		Rate	-	-	-	1,900	1,900
		Summation	-	-	-	1,900	1,900
	Pipe Culvert (Ø1,000 x 3)	Quantity (P)	2	-	-	-	2
		Rate	2,700	-	-	-	2,700
		Summation	5,400	-	-	-	5,400
	Side Ditch	Quantity (M ³)	1,000	3,860	2,284	5,404	12,428
		Rate	22.50	22.50	22.50	22.50	
		Summation	22,500	86,600	51,300	121,500	281,900
	Side Pipe Culvert	Quantity (M)	177	122	56	218	573
		Rate	22.59	22.95	21.42	22.95	
		Summation	4,000	2,800	1,200	5,000	13,000
Sub Total		31,900	92,700	53,600	135,200	313,400	
Masonry Work	Stone Masonry	Quantity (M ³)	761	250	-	220	1,231
		Rate	22.59	22.00	-	22.00	
		Summation	17,000	5,500	-	4,800	27,300
Sub Total		17,000	5,500	-	4,800		
Total		1,583,000	1,397,600	945,500	2,259,400	6,185,600	
Overhead and Profit						3,058,000	
Economic Cost							
Remarks: (P) - Places							

TABLE 8-3-7 PRICED BILL OF QUANTITY:ROUTE ACCESS ROAD DBST

Item	Construction Section				Total		
	1	2	3	4			
L E F T L A N E	Clearing	Quantity (M ²)	794,761	801,826		1,596,587	
		Rate	0.040	0.040		0.040	
		Summation	31,790	32,810		64,600	
	Filling	Quantity (M ³)	188,817	166,092		354,909	
		Rate	0.637	0.637		0.637	
		Summation	120,276	106,624		226,900	
	Cutting (I)	Quantity (M ³)	299,260	266,341		565,601	
		Rate	0.110	0.110		0.110	
		Summation	33,068	29,432		62,500	
	Cutting (II)	Quantity (M ³)	-	217,989		217,989	
		Rate	-	0.710		0.710	
		Summation	-	155,800		155,800	
	Slope Protection	Quantity (M ²)	48,000	87,360		135,360	
		Rate	0.451	0.451		0.451	
		Summation	21,666	39,434		61,100	
	Sub Total		206,800	364,100		570,900	
	R I G H T L A N E	Surface	Quantity (M ²)	73,000	64,970		137,970
			Rate	0.898	0.898		0.898
Summation			65,344	58,156		123,500	
Base		Quantity (M ³)	12,080	12,563		24,643	
		Rate	4.957	4.957		4.958	
		Summation	59,902	62,298		122,200	
Subbase		Quantity (M ³)	18,201	18,928		37,129	
		Rate	4.816	4.816		4.816	
		Summation	89,649	91,151		178,800	
Shoulder		Quantity (M ³)	6,320	6,573		12,893	
		Rate	2.652	2.652		2.652	
		Summation	16,764	17,436		34,200	
Subgrade		Quantity (M ³)	11,403	10,400		21,803	
		Rate	1.278	1.278		1.278	
		Summation	14,487	13,213		27,700	
Sub Total		244,146	242,254		486,400		
B I D G E S P A N S		L = 7.0 ^M (1 span)	Quantity (P)	-	-		-
			Rate	-	-		-
	Summation		-	-		-	
	L = 9.0 ^M (1 span)	Quantity (P)	-	-		-	
		Rate	-	-		-	
		Summation	-	-		-	
	L = 7.0 ^M x 2 (2 span)	Quantity (P)	-	-		-	
		Rate	-	-		-	
		Summation	-	-		-	
	L = 9.0 ^M x 2 (2 span)	Quantity (P)	-	-		-	
		Rate	-	-		-	
		Summation	-	-		-	
	L = 9.0 ^M x 3 (3 span)	Quantity (P)	-	-		-	
		Rate	-	-		-	
		Summation	-	-		-	
	Sub Total		-	-		-	

TABLE 8-3-7 PRICED BILL OF QUANTITY:ROUTE ACCESS ROAD DBST

Item		Construction Section				Total	
		1	2	3	4		
Box Culvert	2.0 x 1.5 (1 Cell)	Quantity (P)	2	3		5	
		Rate	2,980	2,980		2,980	
		Summation	5,960	8,940		14,900	
	2.0 x 1.5 (2 Cells)	Quantity (P)	-	-		-	
		Rate	-	-		-	
		Summation	-	-		-	
	2.0 x 1.5 (3 Cells)	Quantity (P)	-	-		-	
		Rate	-	-		-	
		Summation	-	-		-	
Sub Total		5,960	8,940		14,900		
Drainage	Pipe Culvert (Ø1,000 x 1)	Quantity (P)	6	5		11	
		Rate	1,145	1,145		1,145	
		Summation	6,872	5,728		12,600	
	Pipe Culvert (Ø1,000 x 2)	Quantity (P)	-	-		-	
		Rate	-	-		-	
		Summation	-	-		-	
	Pipe Culvert (Ø1,000 x 3)	Quantity (P)	-	-		-	
		Rate	-	-		-	
		Summation	-	-		-	
	Side Ditch	Quantity (M ³)	-	1,128		1,128	
		Rate	-	22.30		22.30	
		Summation	-	25,200		25,200	
	Side Pipe Culvert	Quantity (M)	100	104		204	
		Rate	23.00	23.00		23.00	
		Summation	2,300	2,400		4,700	
	Sub Total		9,172	33,328		42,500	
	Masonry Work	Stone Masonry	Quantity (M ³)	-	-		-
			Rate	-	-		-
Summation			-	-		-	
Sub Total		-	-		-		
Total		466,078	648,632		1,114,700		
Overhead and Profit					551,000		
Economic Cost					1,665,700		
Remarks: (P) - Places							

ANNEX VIII-4 MAINTENANCE AND REPAIR COST

Cost of maintenance and repair is usually calculated under two categories; one is daily maintenance and repair and the other is periodic repair.

4.1 Penetration Pavement

i. Daily Maintenance and Repair

Repair of penetration (DBST) pavement by patching etc., must be done immediately after observation of defects to avoid enlargement of defects and serious damage. Accordingly, it is quite important to arrange for stand-by workers and equipment. A model repair team organization is shown as the following Table 8-4-1. Cost for annual maintenance is shown by Table 8-4-2.

ii. Miscellaneous Works

For maintenance of road edge and removal of soils from side grooves, etc., it is estimated that two labourers per week will be needed. Further, 25% is added for cost of materials, equipment and transportation.

Labour Cost $2/7 \times 260 \text{ days} \times 0.96 = \text{LS } 71.3$

Material, equipment, etc.

$0.25 \times 71.3 \times 0.70 = 12.5$

LS 83.8

TABLE 8-4-1 A ROAD REPAIR TEAM AND EQUIPMENT

<u>Classification</u>	<u>Quantity</u>	<u>Remarks</u>
<u>Labour</u>		
Foreman	1	General supervision, Technical instruction
Driver for worker transport	1	
Truck driver	1	Material transportation
Roller driver	1	
Bitumen spray worker	1	
Rake man	1	Raking and finishing work
Scavenger	1	Cleaning, removal of surplus soils
Guard and traffic man	2	
<u>Machinery</u>		
Labour transportation car	1	Transportation of labour and equipment
Truck	1	Transportation of aggre- gate, bitumen. 4-ton dump-car
Sprayer	1	For tack coat
Roller	1	
Vibroplate	1	
<u>Equipment</u>		
Picks, shovels	1 lot	
<u>Materials</u>		
Aggregate	2 - 3 M ³	
Bitumen	300 L	

TABLE 8-4-2 UNIT COST OF ROAD MAINTENANCE ON BITUMINOUS SURFACED ROAD

	<u>LS/M²</u>	<u>Economic cost</u>
1. Prime Coat (or Tack Cost) 1.5 Kg/M ² MC 70 1.5 x 0.087 (87 LS/T)	0.131	
2. Aggregate 0.02 x 1.0 x 1.0 x 3.876		
3. Spreading and Compaction	0.078	
4. Bitumen Spreading 1.3 Kg/M ² MC 70 1.3 x 0.087	0.113	
5. 3/8" Aggregate 0.01 x 1.0 x 1.0 x 3.876	0.039	
6. Spreading and Compaction	0.020	
7. Bitumen Spray 1.0 x 0.087	0.087	
8. Sand Spray 0.005 x 2.335	0.012	
9. Sub Total	0.510 x 0.84 = 0.428	
10. Mobilization Cost (5% of 9)	0.25 x 0.95 = 0.024	
11. Supervising and Engineering (14% of 9)	0.070 x 0.91 = 0.064	
12. Total		0.516
13. Cost per Kilometer for 7-meter width pavement = 7.0 x 1,000 x 0.516 = 3,612 LS/KM		
14. Assuming yearly cost is 1% of the above working cost for roads with less than 500 average daily traffic (ADT)		

Yearly cost: 3,612 x 0.01 = 36 LS/KM

To the above total cost, 40% is added as an overhead charge.

Accordingly, yearly maintenance cost of penetration pavement for roads with the traffic less than 500 ADT is shown as follows.

<u>Patching Cost</u>	<u>Miscellaneous</u>	<u>Management</u>	<u>Total LS/km</u>
36	83.8	47.9	168

iii. Periodic Repair

As previously mentioned, working cost for 7-meter width penetration pavement is 3,612 LS/km. If there is less than 500 ADT, it is determined periodic repair is to be carried out every seven to eight years.

4.2 Other Types of Pavement

Yearly maintenance and repair costs for gravel surfaced and asphalt concrete surfaced roads are calculated in similar way as the penetration pavement roads. These costs are summarized as in Table 8-4-3. The estimate of periodic resurfacing costs are also shown in the table terms of economic cost.

TABLE 8-4-3 SUMMARY OF MAINTENANCE AND REPAIR COSTS

	(LS/km.)	
<u>ADT</u> <u>(Average Daily Traffic)</u>	<u>Yearly Maintenance</u> <u>and Repair Costs</u>	<u>Periodic Resur-</u> <u>facing Costs</u>
<u>GRAVEL ROAD</u> W=3.5M		
>50	278	3,651
<u>DBST</u>		
< 500	168	3,612
<u>ASPHALT CONCRETE</u>		
> 500	138	14,658

ANNEX IX

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TABLE 9-1 TRAFFIC COMPOSITION ON KHARTOUM - WAD MEDANI ROAD (24 HOURS)

Station	12Km from Khartoum	9Km from Khartoum	94Km from Khartoum			
Direction	Khartoum	Wad Medani	Khartoum			
Date of Survey	30 May 1977 2)	21-21 Aug. 1976 1)	21-27 Aug. 1976 1)			
Type of Vehicle	ADT	Percent	ADT			
		ADT	Percent			
Car. Taxi	379	14.0	668	26.8	65	14.4
4 Wheel Drive	203	7.5	251	10.1	46	10.2
Box	208	7.7	-	-	-	-
Sum	790	29.2	919	36.9	111	24.6
Bus (Large)	219	8.1	342	13.8	100	22.1
Bus (Medium Small)	222	8.2	107	4.3	6	1.3
Sum	441	16.3	449	18.1	106	23.4
Total	1,231	45.5	1,368	55.0	217	48.0
Van. Pick-up	349	12.9	479	19.2	44	9.7
Medium Truck	815	30.1	588	23.6	173	38.3
Heavy Truck	81	3.0	32	1.3	14	3.1
Truck Trailer	214	7.9	22	0.9	4	0.9
Total	1,459	53.9	1,121	45.0	235	52.0
Other	16	0.6	-	-	-	-
Grand Total	2,706	100.0	2,489	100.0	452	100.0

Source: 1) RBPC, 1977

2) JICA's Project Study Mission, May 30, 1977.

ANNEX IX-2 DIVERSION TRAFFIC AND ITS BENEFITS

When the construction of the project road is completed, passengers and goods carried by railways will be diverted to vehicles on the road. Whether an individual or his goods will divert to road use or not is determined by assessing rates, handling charges, travel time, delays, etc. of road service versus rail service. When the diversion is realized the economic benefit is measured not by the margin of rates between the two modes, but by the margin of transport costs of each. There are other surpluses or losses realized by the diversion, but they are difficult to quantify in terms of economic cost. They are not included in the estimate of economic benefits.

In case of railways, the economic cost is calculated by the working expense on the existing stock which was invested in the past. No investment is assumed but maintenance work is taken into account. While on the road both working expense and capital cost is estimated for the transport of diversion traffic, where the capital cost is measured by vehicle depreciation. It is considered that the long distance traffic on the railways between Nyala and Khartoum will be influenced little by this project.

2.1 Passengers

i. The Cost of Railway Passengers

The working expense of railways is estimated by the following Table 1, where the economic cost of railways between El Obeid and Khartoum is developed as LS 0.005 per passenger - km.

ii. The Cost of Passengers by Vehicles

It is assumed all passengers who divert to vehicle use on roads will be carried by buses. One bus will transport 35 persons out of 44 seats. The depreciation cost of buses is included in the cost of running on the project roads. The cost of the road itself is already included in the primary project cost.

iii. The Value of Time of Passengers

Annual cash income is estimated at LS 155 for a family in a rural area. Although no figures are available for families in urban areas, it is estimated that the average is between LS 200 and 250. Taking the figure of LS 155, the following calculation is made for the time value of one passenger.

$$\begin{aligned} & 155 \div 5 \text{ persons} \div 365 \text{ days} \div 24 \text{ hours} \\ & \quad \quad \quad \text{per family} \\ & = 0.0035 \text{ per person per hour.} \end{aligned}$$

However, it is hardly possible to determine to what extent the saved time is efficiently utilized for other economic activities which contribute to increasing the scale of the Sudanese economy. Savings in travel time are not evaluated in the benefits of the project.

iv. Rail Passengers and Their Diversion

The Table VI-8 shows the movement of rail passengers among the zones.

TABLE 1 WORKING EXPENSE OF RAILWAYS

(£S)					
A	B	C	D	E	F
Revenue per Passenger - Km	Working Expense 1975/76 2)	Working Expense per Passenger - Km 3)	The Project Area Number of Passengers per Train 4)	Working Expense per Train - Km	Average Working Expense Per Person
Sleeping	0.022	386,133	0.024	[26]	0.624
1st class	0.015	675,734	0.015	[64]	0.960
2nd	0.007	772,267	0.007	[96]	0.672
3rd	0.004	1,448,000	0.004	[225]	0.900
4th	0.003	1,544,534	0.003	[550]	1.650
Total	0.004	4,826,669	0.004	[961]	4.806

- Note:
- 1) From Table 10.
 - 2) Working Expense is divided into five classes by the percent of the revenue by class.
 - 3) Calculated by dividing Column B by the figures of passenger - Km in Table 10.
 - 4) From Table 6-18-3, Annex VI-20. Figures are the number of passengers, not in £S.

TABLE 2 BUS OPERATING COST

				(LS)
Working Cost of a Bus per Km 1)	Bus Working Cost per Km per Passenger	Bus Working Cost Between El Obeid and Khartoum per Km per Passenger (700 Km), 2)	Bus Fare Between El Obeid and Khartoum per Passenger on Paved Road 3)	
<u>1. Labour</u>	0.0146	700 x 0.071		
<u>2. Fuel</u>	0.0180	= 49.98		
<u>3. Maintenance</u>	0.0148	49.98 + 10	2.460	
<u>4. Overhead etc.</u>	0.0101	= 59.98		
<u>5. Depreciation</u>	0.0139	59.98 + 35		
<u>Total</u>	0.0714	= 1.714		

Note: 1) From Table VI-15.

2) One nightstay of a driver and an assistance is LS 10.
Their meals, overtime charges, etc. are included in the above.

3) The bus fare is determined by applying the existing
bus fare on the paved road of Khartoum - Wad Medani
of 185 Km.

$$0.65/185 \times 700 = 2.459$$

Generally, the short distant travellers choose vehicles on roads because of frequent services. In the project area, the passengers will make the same choice and divert to buses. The number of passengers who divert to buses are 60 for El Obeid - Um Ruaba, 5 for El Obeid - Rahad, and 53 for Rahad - Um Ruaba. They are shown in Table 5.

The long distant travellers on railways have their origins and destinations distributed over the entire country. They are grouped into two pairs: El Obeid - Khartoum of 147 passengers and Rahad - Khartoum of 39, and are shown in Table 5. The passengers in 3rd and 4th classes must pay higher prices for buses than for rail fares. They will not divert to buses under the assumption established in this study.

v. Diverted Benefits and The Number of Buses

It is likely that passenger value on railways in the project area will remain the same for the coming several years. The reasons are that train seats are occupied nearly 100%, having no allowance for other travellers and the trend in the past several years shows there will be no increase in the number of passengers. The growth rate of the diverted passengers is the same as that for the normal traffic. They are applied for the years after 1983. Table 3 and 4 are the summaries of Table 5.

TABLE 3 NUMBER OF BUSES FOR DIVERTED PASSENGERS PER DAY

Year	El Obeid	Rahad	Um Ruaba	Average
(1977)	(7.5)		(8.5)	(8.0)
1983	7.5		8.5	8.0
1992	13.8		15.6	14.7
2002	22.5		25.4	24.0

TABLE 4 ECONOMIC BENEFITS OF DIVERTED PASSENGERS

Year	(LS)	
	in 1977 Price	Discounted to 1978 at 10%
(1979)	108,138	-
1983	108,138	67,154
1992	198,758	52,333
2002	323,578	32,843

TABLE 5 TRANSPORT COSTS OF PASSENGERS

Section	Class	Train Fares by Class per Passenger (£S)		Bus Fares per Passenger (£S)	Economic Cost per Passenger		Balance (3)=(1)-(2) (£S)	No. of Diverted Passengers by Class	Benefit (3)x365xNo. of Diverted Passengers (£S)	No. of Buses	
		147 Km	135 Km		Train (1) (£S)	Bus (2) (£S)					
El Obeid - Um Ruaba	Sleeper	2.500						4.5			
	1st	2.100						5.0			
	2nd	1.050		0.475	0.7350	0.2835	0.4515	10.6			
	3rd	0.490						28.8			
	4th	0.380						10.7			
								Total	59.6	9,821	1.7
<hr/>											
El Obeid - Rahad	Sleeper	2.500						-			
	1st	1.170						0.1			
	2nd	0.595		0.239	0.345	0.1428	0.2022	-			
	3rd	0.285						2.4			
	4th	0.220						2.4			
								Total	4.9	362	0.1
<hr/>											
Rahad - Um Ruaba	Sleeper	1.875						0.4			
	1st	1.125						-			
	2nd	0.565		0.235	0.390	0.1407	0.2493	4.0			
	3rd	0.265						29.4			
	4th	0.210						19.2			
								Total	53.0	4,823	1.5

TABLE 5 TRANSPORT COSTS OF PASSENGERS
(Cont'd.)

Section	Class	Train Fares by Class per Passenger (LS)	Bus Fares per Passenger (LS)	Economic Cost per Passenger		Balance (3)=(1)-(2) (LS)	No. of Diverted Passengers by Class	Benefit (3)x365xNo. of Diverted Passengers (LS)	No. of Buses
				Train (1) (LS)	Bus (2) (LS)				
		627 Km							
		700 Km							
El Obeid	Sleeper	17.000					29.6		
-	1st	10.200					33.0		
Khartoum	2nd	5.100	2.460	3.135	1.714	1.412	84.3		
	3rd	2.380					-		
	4th	1.840					-		
							<u>Total 146.9</u>	76,192	4.2
		558 Km							
		642 Km							
Rahad -	Sleeper	12.600					9.6		
	1st	8.400					4.7		
Khartoum	2nd	4.200	2.256	2.790	1.600	1.190	24.7		
	3rd	1.960					-		
	4th	1.515					-		
							<u>Total 39.0</u>	16,940	1.1
							No.	LS.	No.
							303.4	108,138	8.6
GRAND TOTAL									

2.2 Goods

i. The Transport Cost by Railways

The economic cost of goods transportation by railways is estimated in Table 6 by applying the Sudan Railways Corporation Statistical data as shown in Tables 11 and 12. The current tariffs for major commodities and the charges on access transport and warehousing are studied as shown in Table 7.

TABLE 6 ECONOMIC COST OF RAILWAYS FOR CARGOES, 1975/1976

(Unit: LS)

	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>	<u>F</u>
	Travel Distance per ton per ton 1)	Revenue per ton- km 1)	Yearly Working Expense ('000) 2)	Working Expense per ton 3)	Working Expense El Obeid- Khartoum (689 km) per ton	Working Expense El Obeid- Khartoum (1476 km) per ton
Goods	(981)	0.010				
Livestock	(807)	0.014				
Total	(981)	0.010	21.988	0.008	5.512	11.808

- Notes: 1) From Table 11
 2) From Table 12
 3) $D = 21,988,000 \div 2,620,723,000 = 0.008$

TABLE 7 RAILWAYS TARIFF

	The No. of Exceptional Rates in the Relevant Table 1)	Application of Scale 80% Loading	Fare per Ton 2)	Loading & Unloading Labour Charge Per-Ton	Transport Cost on Access 4 Km Per-Ton by Horse-Wagon	Additional Storage Charge due to the delay of Trains	Total Tariff on the User
1. Ground Nuts	5	24	13.30	0.55			15.370
2. Sesame	14	40	19.70	0.55			21.770
3. Gum Arabic	15	41	20.20	0.55			22.270
4. Watermelon Seed	-	26	13.90	0.83			16.250
5. Oil, Cakes	-	26	13.90	0.55			15.970
6. Karkadeh	-	26	13.90	1.65		LS 0.20 x 7 days	17.070
7. Sugar	20	37	18.20	0.55	0.12	= LS 1.40/Ton	20.270
8. Salt	-	26	13.90	0.55			15.970
9. Cement	19	50	25.20	0.55			27.270
10. Onions	-	26	7.20	0.55			9.270
11. Flour	3	12	5.10	0.55			7.170
12. Dura	8	18	5.90	0.55			7.970
13. Cotton, American	41	41	18.90	1.10			21.520
14. Cotton Seed	2	23	12.10	0.83			14.450
15. Others 4)	-	26	7.20	0.55			9.270

Note: 1) From The Sudan Railway 'Tariff Table 1975'

2) Rates per ten Kg between El Obeid and Port Sudan of 1,475 Km are calculated by the table in 1).

3) Loading and Unloading charges are determined by the payment to the Labours in El Obeid crop market, where LS 0.025 per sac is paid for loading or unloading.

One sac is in average with the weight of two quinters (200 lb)

1 Kg = 2.2 lb 1 ton = 2,200 lb = 22 quinters = 11 sac

Loading and unloading of 1 ton = 0.025 x 11 x 2 = LS 0.55

4) Others are carried between El Obeid and Khartoum.

5) Between El Obeid and Khartoum of 690 Km.

6) Between Semeih and Port Sudan of 1,385 Km.

TABLE 8 WORKING EXPENSE OF TRUCKS

(ES)

	Working Expense of 11-ton Capacity Truck on Paved Road (LS/Km) 1)	Working Expense per ton-Km 2)	Working Cost on El Obeid-Khartoum Road of 700 Km 3)	Working Cost on El Obeid-Port Sudan Road of 1,550 Km 3)	Working Cost on Semeih-Port Sudan Road of 1,450 Km 3)
Labour	0.01563		78.589	174.019	162.792
Fuel	0.02300	0.11227/8.0	10.000	20.000	20.000
			4.400 4)	4.400 4)	4.400 4)
Maintenance	0.02806	= 0.01403	92.989	198.419	187.192
Overhead, etc.	0.01958		per truck	per truck	per truck
Depreciation	0.0260		11.624	24.802	23.399
			per ton	per ton	per ton
Total	0.11227				

Note: 1) From Table VI-14

2) $0.11227 + 8.0 = 0.01403$. The traffic study in the project area shows that the loading rate in terms of tonnage is approximately 80%. It is applied here to estimate economic cost per ton.

3) When the distance of truck operation is longer, the working cost will increase because an additional expense will be necessary to cover the allowance for items such as overtime charges, meals, and the over-night stops of driver and assistant. It is assumed one night stop for El Obeid-Khartoum trip, and two night stops for El Obeid-Port Sudan trip. The former will cost LS 10 and the latter LS 20. It is assumed the whole road is paved in 1982.

4) Loading and unloading costs are estimated for each trip as LS 0.55/ton and LS 4.4/truck.

TABLE 9 TRUCK FARE ON THE PROJECT ROADS

	Rates per Quarter	Rates per Ton 22 Quarter = 1 Ton LS/Ton	Loading & Unloading Charge per Ton	Rates Loading & Unloading Charge per Ton
1. Ground Nuts	1.20	26.4	0.55	26.95
2. Sesame	1.40	30.8	0.55	31.35
3. Gum Arabic	1.60	35.2	0.55	35.75
4. Watermelon Seed	1.20	26.4	0.83	27.23
5. Oil Cakes	1.20	26.4	0.55	26.95
6. Karkadeh	1.40	30.8	1.65	32.45
7. Sugar	2.00	44.0	0.55	44.55
8. Salt	2.00	44.0	0.55	44.55
9. Cement	2.85	62.7	0.55	63.25
10. Onions	0.70	15.4	0.55	15.95
11. Flour	0.70	15.4	0.55	15.95
12. Dura	0.70	15.4	0.55	15.95
13. Cotton, American	1.20	26.4	0.55	26.95
14. Cotton Seed	1.20	26.4	0.83	27.23
15. Others	0.70	15.4	0.55	15.95

Source: Interviews in the project area

Note : All goods are carried between El Obeid and Port Sudan except 1)
El Obeid-Khartoum and 2) Semcih-Khartoum.

ii. The Transport Cost by Trucks

The vehicle running cost is studied in 4, Chapter 6. The details of the running cost of a heavy truck is again presented in the following Table 8. It is presented in terms of economic cost. Table 9 shows the freight charges by truck operator assuming a paved road between El Obeid and Khartoum.

iii. Diversion of Goods

The shipper of goods selects a mode of transport by comparing the price he pays for alternative methods. Table 7 and Table 9 show the charge per ton for each commodity by railways and trucks, respectively. It is less expensive for railways than for trucks. Table 6 and Table 8 present the economic cost of transport by railways and trucks, respectively. Again, the cost per ton-km is less for railways. By comparing the monetary transport charge, it is quite likely that there will be no diversion to roads.

However, trucks on the existing roads are carrying many items of goods throughout the year as shown in Annex VI-16. The owner of these goods decides to send them by truck because it can meet the timing of loading at Port Sudan, for the changes in market prices, and for less frequent loading and unloading. He chooses the truck service despite paying higher cost because he expects the higher cost of truck service will result in higher benefits, though these benefits are hard to quantify in monetary terms.

When the road is improved to a better paved one, there might be

more goods carried by trucks on the paved road due to diversion from railway service. It is because of a sufficient amount of surpluses, including the shorter travel time, despite the additional expenses of transport cost. These surpluses are to be evaluated in non-quantifiable benefits. They are not included in this economic benefit stream.

TABLE 10 THE SUDAN RAILWAYS CORPORATION, TRAFFIC VOLUMES, 1974/75 AND 1975/76

1. Passengers	Passengers		Passenger - Km ('000)		Revenue	
	1974/75	1975/76	1974/75	1975/76	1974/75	(£S '000) 1975/76
Sleeping Supp.	24,694	(1) 29,999	13,412	(1) 16,226	302	(8) 365
1st Class	79,366	(4) 111,140	38,218	(4) 44,157	563	(14) 662
2nd Class	233,862	(8) 232,062	98,306	(10) 114,131	735	(16) 785
3rd Class	865,955	(32) 970,923	361,521	(36) 417,125	1,255	(30) 1,460
4th Class	1,742,673	(55) 1,725,081	590,409	(49) 575,019	1,574	(32) 1,553
Total	2,946,550	(100) 3,069,205	1,101,866	(100) 1,166,658	4,429	(100) 4,824
2. Goods and Animals	Goods in tons		Goods ton - Km ('000)			
	1974/75	1975/76	1974/75	1975/76	1974/75	1975/76
Export	643,933	815,426				
Import	1,311,742	1,494,409				
Local	433,661	346,282				
Total	2,389,336	2,656,117	2,159,739	2,607,450	18,359	26,175
Livestock (Head) in Equivalent tons	(397,000)	(242,000)	15,640	13,273		
Total	2,400,258	2,672,556	2,175,379	2,620,723	18,559	26,355

Source: Sudan Railways Corporation, Ibid.

Note : () shows a percentage composit.

TABLE 11 THE SUDAN RAILWAYS CORPORATION,
WORKING EXPENSES, 1974/75 AND 1975/76

	(ES)	
	1974/75	1975/76
Locomotives Running	6,455,593	6,561,119
Personnel	1,622,350	1,811,036
Fuel	4,443,197	4,152,862
Stores	157,786	301,036
Water Supply	232,260	296,185
Rolling Stock Maintenance	6,311,930	7,551,324
Superintendence	364,116	439,692
Locomotives	3,436,451	4,004,425
Coaching & Freight	2,511,363	3,107,207
Traffic	4,421,365	4,796,294
Personnel	3,763,947	3,899,152
Others	657,418	897,142
Way and Works	3,873,134	4,489,564
Superintendence	419,569	487,012
Permanent Way, Builds	2,359,431	2,807,408
Signals, Telegraph	253,005	272,063
Bridges, Roads, etc.	542,146	422,731
Others	298,983	500,350
General Charges	3,429,965	3,416,527
Personnel	3,429,965	2,482,982
Others		933,545
Total	24,491,987	26,814,828

Source: Sudan Railways Corporation Annual Report, 1975-76.

Note: Depreciation charges are not included in this table. The statistics show the percentage shares of working expense, including depreciation, are 19% for passenger service and 81% for goods in 1974/75, 18% and 82% respectively in 1975/76. In 1975/76 the working expense is calculated as follows:

Passengers (18%)	4,826,669
Goods (82%)	21,988,159
Total (100%)	26,814,828

TABLE 12 THE SUDAN RAILWAYS CORPORATION,
OPERATIONS, 1974/75 AND 1975/76

	Unit	1974/75	1975/76
1. Passengers			
Train - Km	Km	1,114,000	1,163,000
Vehicle - Km	Km	29,365,000	28,687,000
Average Veh./Tr.	No.	26.4	24.7
Passengers	No.	2,946,550	3,069,205
Passenger - Km	'000 Km	1,101,866	1,166,658
Revenues	£S	4,429,000	4,824,000
2. Goods			
Train - Km	Km	4,860,000	5,341,000
Vehicle - Km	Km	132,291,000	140,961,000
Average Veh./Tr.	No.	27.2	26.3
Goods carried	Ton	2,400,258	2,672,556
Goods - Ton - Km	'000 Km	2,175,379	2,620,723
Revenues	£S	18,559,000	26,355,000

Source: Sudan Railways Corporation, Ibid.

El Obeid - Um Ruaba Road

PLAN 1 Average Number of Vehicles by Type (ADT)

Type of Vehicle		Small Vehicles	Medium size Trucks	Large Trucks	Buses	Total
Traffic by year						
1983	Normal Traffic	7.5	161.4	14.5	1.2	184.6
	Diverted Traffic	-	-	-	8.0	8.0
	Generated Traffic	18.0	-	-	-	18.0
	Total	25.5	161.4	14.5	9.2	210.6
1992	Normal Traffic	13.8	253.5	84.6	2.2	354.1
	Diverted Traffic	-	-	-	14.7	14.7
	Generated Traffic	33.1	-	-	-	33.1
	Total	46.9	253.5	84.6	16.9	401.9
2002	Normal Traffic	22.5	339.7	203.9	3.6	569.7
	Diverted Traffic	-	-	-	24.0	24.0
	Generated Traffic	53.9	-	-	-	53.9
	Total	76.4	339.7	203.9	27.6	647.6

PLAN 2

1983	Normal Traffic	7.5	160.9	14.5	1.4	184.3
	Diverted Traffic	-	-	-	8.0	8.0
	Generated Traffic	18.0	-	-	-	18.0
	Total	25.5	160.7	14.5	9.4	210.3
1992	Normal Traffic	13.8	252.6	84.6	2.5	353.5
	Diverted Traffic	-	-	-	14.7	14.7
	Generated Traffic	33.1	-	-	-	33.1
	Total	46.9	252.6	84.6	17.2	401.3
2002	Normal Traffic	22.5	338.5	203.9	4.0	568.9
	Diverted Traffic	-	-	-	24.0	24.0
	Generated Traffic	53.9	-	-	-	53.9
	Total	76.4	338.5	203.9	28.0	646.8

El Obeid - Um Ruaba Road

PLAN 3

Average Number of Vehicles by Type (ADT)

Type of Vehicle		Small Vehicles	Medium size Trucks	Large Trucks	Buses	Total
Traffic by year						
1983	Normal Traffic	7.7	159.8	14.5	1.4	183.4
	Diverted Traffic	-	-	-	8.5	8.5
	Generated Traffic	18.0	-	-	-	18.0
	Total	25.7	159.8	14.5	9.9	209.9
1992	Normal Traffic	14.1	250.7	84.6	2.5	351.9
	Diverted Traffic	-	-	-	22.5	22.5
	Generated Traffic	33.1	-	-	-	33.1
	Total	47.2	250.7	84.6	25.0	407.6
2002	Normal Traffic	22.9	336.9	203.9	4.0	567.7
	Diverted Traffic	-	-	-	24.0	24.0
	Generated Traffic	53.9	-	-	-	53.9
	Total	76.8	336.9	203.9	28.0	645.6

PLAN 4

1983	Normal Traffic	7.5	160.8	14.5	1.4	184.2
	Diverted Traffic	-	-	-	8.0	8.0
	Generated Traffic	18.0	-	-	-	18.0
	Total	25.5	160.8	14.5	9.4	210.2
1992	Normal Traffic	13.8	252.5	84.6	2.5	353.4
	Diverted Traffic	-	-	-	22.5	22.5
	Generated Traffic	33.1	-	-	-	33.1
	Total	46.9	252.5	84.6	25.0	409.0
2002	Normal Traffic	22.5	338.4	203.9	4.0	568.8
	Diverted Traffic	-	-	-	24.0	24.0
	Generated Traffic	53.9	-	-	-	53.9
	Total	76.4	338.4	203.9	28.0	646.7

El Obeid - Um Ruaba Road

PLAN 5

Average Number of Vehicles by Type (ADT)

Type of Vehicle		Small Vehicles	Medium size Trucks	Large Trucks	Buses	Total
Traffic by year						
1983	Normal Traffic	7.7	160.3	14.5	1.4	183.9
	Diverted Traffic	-	-	-	8.0	8.0
	Generated Traffic	18.0	-	-	-	18.0
	Total	25.7	160.3	14.5	9.4	209.9
1992	Normal Traffic	14.1	251.6	84.6	2.5	352.8
	Diverted Traffic	-	-	-	14.7	14.7
	Generated Traffic	33.1	-	-	-	33.1
	Total	47.2	251.6	84.6	17.2	400.6
2002	Normal Traffic	22.9	337.2	203.9	4.0	568.0
	Diverted Traffic	-	-	-	24.0	24.0
	Generated Traffic	53.9	-	-	-	53.9
	Total	76.8	337.2	203.9	28.0	645.9

PLAN 6

1983	Normal Traffic	7.7	159.3	14.5	1.4	182.9
	Diverted Traffic	-	-	-	8.0	8.0
	Generated Traffic	18.0	-	-	-	18.0
	Total	25.7	159.3	14.5	9.4	208.9
1992	Normal Traffic	14.1	250.6	84.6	2.5	351.8
	Diverted Traffic	-	-	-	22.5	22.5
	Generated Traffic	33.1	-	-	-	33.1
	Total	47.2	250.6	84.6	25.0	407.4
2002	Normal Traffic	22.9	336.1	203.9	4.0	566.9
	Diverted Traffic	-	-	-	24.0	24.0
	Generated Traffic	53.9	-	-	-	53.9
	Total	76.8	336.1	203.9	28.0	644.8

El Obeid - Um Ruaba Road

PLAN 7 Average Number of Vehicles by Type (ADT) 1)

Type of Vehicle		Small Vehicles	Medium size Trucks	Large Trucks	Buses	Total
Traffic by year						
1983	Normal Traffic	8.9	165.4	14.2	1.4	189.9
	Diverted Traffic	-	-	-	8.0	8.0
	Generated Traffic	18.0	-	-	-	18.0
	Total	26.9	165.4	14.2	9.4	215.9
1992	Normal Traffic	16.3	259.5	82.7	2.5	361.0
	Diverted Traffic	-	-	-	14.7	14.7
	Generated Traffic	33.1	-	-	-	33.1
	Total	49.4	259.5	82.7	17.2	408.8
2002	Normal Traffic	26.5	349.7	199.4	4.0	579.6
	Diverted Traffic	-	-	-	24.0	24.0
	Generated Traffic	53.9	-	-	-	53.9
	Total	80.4	349.7	199.4	28.0	657.5

Note : 1) On the main road.

