## 2-2 Outline of Transport Sector

### 2-2-1 General

After independence in 1957, Ghana had a well developed transport system, however, it suffered from more than a decade of neglect of proper maintenance due to the serious economic depression spanning the entire 1970's and early 1980's. Thus, capacity to transport farm products to the domestic market and principal export commodities such as cocoa and timber to the export port was seriously damaged.

When the first Economic Recovery Programme, (First ERP 1984/86) was launched and the 2nd ERP 1986/88 succeeded thereto, a special emphasis was placed on the physical rehabilitation of the transport infrastructures for principal export commodities, as one of the key instruments to rebuild the national economy as well as institutional improvement of the transport-related organization.

Ghana's transport system, as shown in Fig. 2-3, comprises:

1) a network of about 14,000 km of primary/secondary roads and urban arterial roads, and about an equal length of feeder roads,
2) an overaged road vehicle fleet of about 68,000 vehicles,
3) a 950-km railway system,
4) two major deepwater ports and three small fishing ports,
5) a small inland water transport system over the Volta Lake,
6) a national maritime shipping company, and
7) an international airport at Accra and three main domestic airports as well as a national airline.

As shown in Fig. 2-4, the administration of the transport sector is handled by two ministries: the Ministry of Roads and Highways (MRH), which oversees road investments and maintenance, and the Ministry of Transport and Communications (MTC), which deals with all other transport subsectors and overall transport policy and planning.

The three agencies under the MRH comprises:

1) the Ghana Highway Authority (GHA), an autonomous body which manages maintenance and construction of the primary and secondary roads,

2) the Department of Feeder Roads (DFR) which handles maintenance and construction of feeder roads, and

3) the Department of Urban Roads (DUR) which was set up in 1983 to look after urban roads, but which is not yet fully separated from GHA.

These relationships are shown in Fig. 2-5.

(1) Road and road transport

The total length of roads in Ghana is about 28,300 km, and which is composed of trunk roads of 14,100 km long and feeder roads of 14,200 km long as shown in Table 2-7. The zones of influence of the National Route 1 on which the Project bridge is located shall include the five regions of Western, Central, Ashanti, Eastern (including Greater Accra) and Volta.

The total length of roads in these 5 regions is 17,700 km or about 63% of the total road length in Ghana. The length of paved roads is 5,800 km (trunk road) and the pavement rate is about 20%. The remainder is of gravel or earth. As these roads had not been well maintained in 1974 through 1981, as aforementioned, they generally deteriorated and even the primary trunk roads connecting the principal cities need major rehabilitations or repairs. The secondary and feeder roads are damaged more and this discourages drivers from making long distance trips, resulting in excentrically high vehicle operating costs.

Table 2-8 gives the number of privately owned vehicles with roadworthy certificates. During 1982/85, the number of vehicles were reduced, which means that the import of new vehicles had been restricted for the period.

Table 2-9 shows the fuel consumption. The fuel consumption directly correlates the movements of the vehicles. During 1981/84, the fuel consumption declined by 40% and, in 1985 rose again by 30% over the previous year. The 90% of the passenger transport vehicles used on commercial basis belong to the private sector.

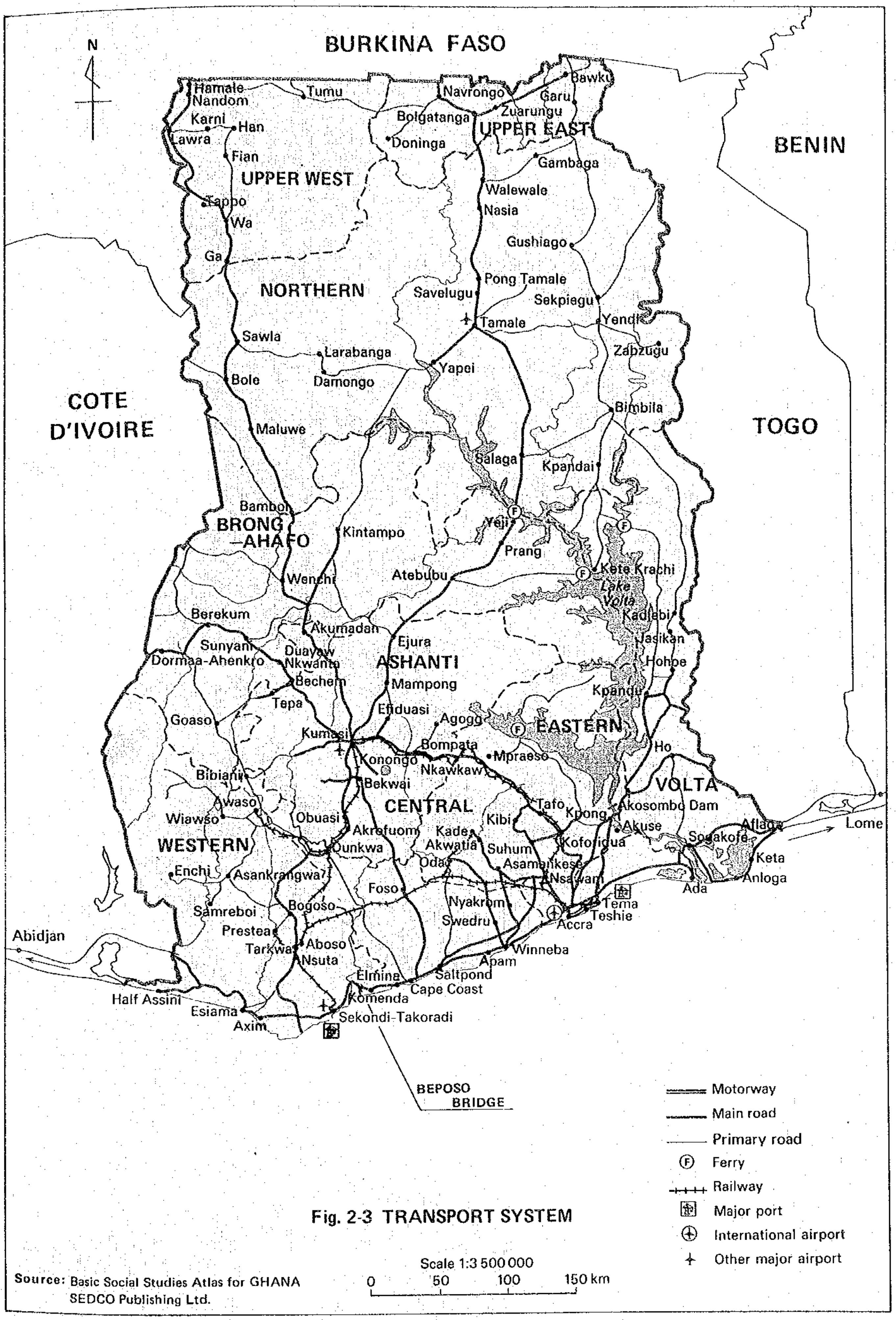



**Fig. 2-3 TRANSPORT SYSTEM**

**Source:** Basic Social Studies Atlas for GHANA
SEDCO Publishing Ltd.

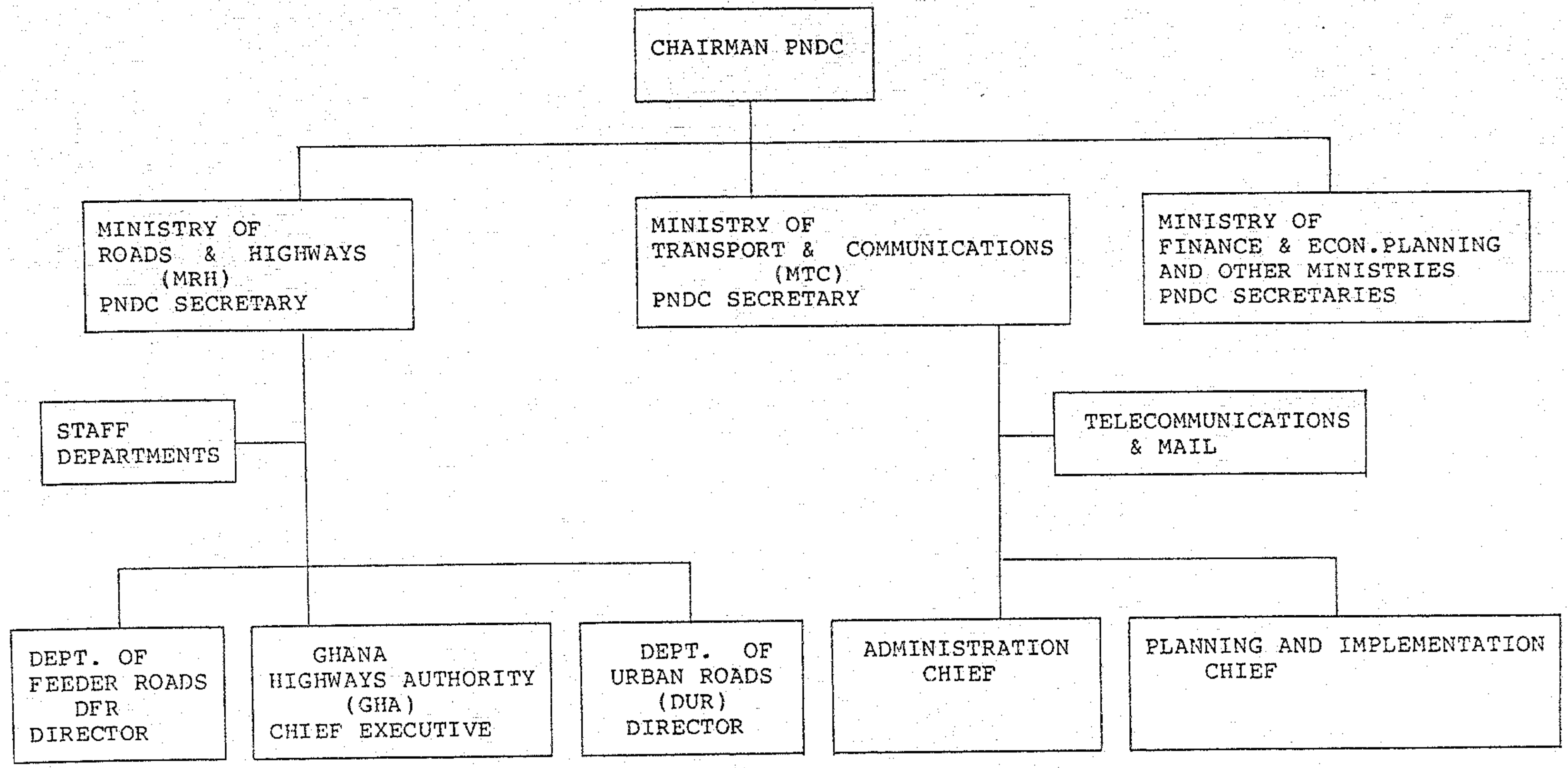



Fig. 2-4 ORGANIZATION CHART OF TRANSPORT AND COMMUNICATION SECTOR (MAY 1987)

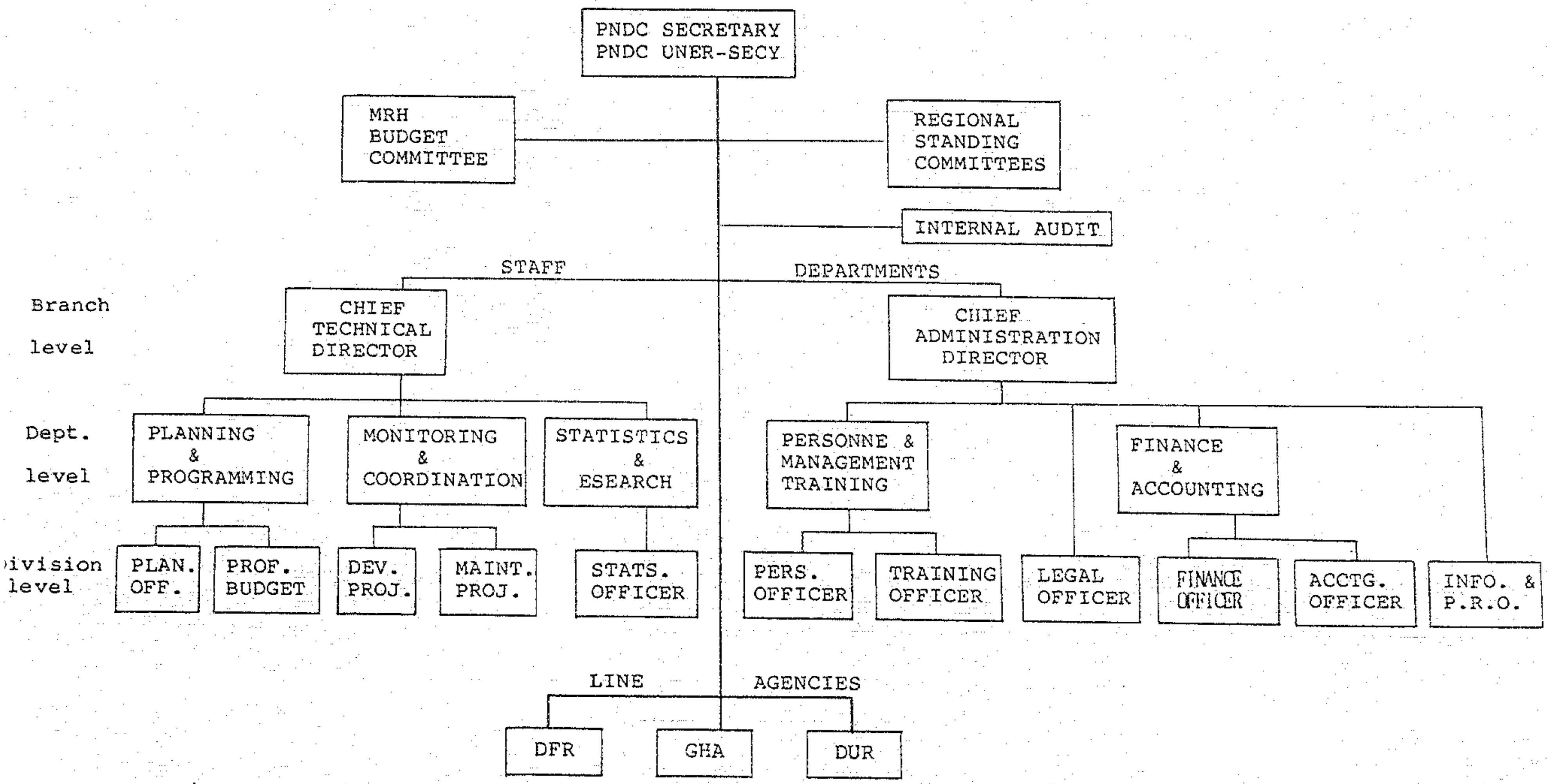



Fig. 2-5 ORGANIZATION CHART OF MINISTRY OF ROADS AND HIGHWAYS (MAY 1987)

Table 2-7 ROAD LENGTH BY REGION (1984)

| Region | Trunk Roads Paved | Trunk Roads Gravel | Trunk Roads Total | Feeder Roads |
|---|---|---|---|---|
| Greater Accra | 486 | - | 486 | 209 |
| Volta | 639 | 899 | 1,538 | 1,656 |
| Eastern | 1,083 | 738 | 1,821 | 2,176 |
| Central | 944 | 307 | 1,251 | 1,317 |
| Western | 302 | 1,226 | 1,528 | 1,615 |
| Ashanti | 883 | 525 | 1,408 | 2,718 |
| Brong Ahago | 656 | 1,191 | 1,847 | 1,942 |
| Northern | 613 | 2,078 | 2,691 | 1,165 |
| Upper | 176 | 1,388 | 1,564 | 1,362 |
| Total | 5,782 | 8,352 | 14,134 | 14,160 |

Source: The world Bank, Staff Appraisal Report, Republic of Ghana, Road Rehabilitation and Maintenance Project.

Table 2-8 VEHICLES REGISTERED 1979/85

| Year | Motor-cycles | Private Cars and Taxis | Buses | Tankers and Trucks | Tractors | Total | Total Excluding Motorcycles |
|---|---|---|---|---|---|---|---|
| 1979 | 6,372 | 50,969 | 12,392 | 7,977 | 1,128 | 78,838 | 72,466 |
| 1980 | 5,751 | 47,872 | 14,649 | 7,411 | 861 | 76,544 | 70,793 |
| 1981 | 3,992 | 44,644 | 14,696 | 6,211 | 688 | 70,231 | 66,239 |
| 1982 | 5,678 | 50,449 | 16,261 | 6,119 | 1,221 | 79,728 | 74,050 |
| 1983 | 5,233 | 47,649 | 13,918 | 6,427 | 940 | 74,167 | 68,934 |
| 1984 | 4,663 | 40,404 | 11,355 | 6,082 | 802 | 63,306 | 58,643 |
| 1985 | 6,577 | 43,174 | 11,168 | 6,490 | 751 | 68,160 | 61,583 |

Notes: Private owned vehicle with Roadworthy Licence only, do not include Govent-owned ones.

Table 2-9 FUEL CONSUMPTION 1970/86

| Year | Gasoline | Diesel Fuel | Total | % Change Over Previous Year |
|---|---|---|---|---|
| 1970 | 172,212 | 194,016 | 366,228 | |
| 1971 | 190,680 | 199,180 | 389,860 | + 8.2 |
| 1975 | 227,002 | 233,331 | 460,333 | + 7.7 |
| 1980 | 245,800 | 282,300 | 528,130 | + 9.5 |
| 1981 | 263,500 | 295,600 | 559,100 | + 6.0 |
| 1982 | 247,600 | 255,600 | 503,200 | -10.0 |
| 1983 | 181,200 | 231,800 | 413,000 | -18.0 |
| 1984 | 178,000 | 223,100 | 401,100 | - 3.0 |
| 1985 | 213,000 | 281,000 | 494,000 | + 2 |
| 1986 | 227,000 | 285,000 | 512,000 | + 3 |

Source: Ghana Bridge Development Programme, First Stage, Feasibility Study, Tahal Consulting Engineers, Accra, May 1983.

(2) Railways

The railway system is operated by the Government owned Ghana Railway Corporation (GRC). The railway network serves only southern Ghana, covering the so called "golden triangle" with Accra, Kumasi and Takoradi at its vertices, with a connection from Accra to Tema port.

While the length of the system is only about 950 km, it serves the richest, most productive, and most populated regions in Ghana.

Until the early 1970's, it carried a significant share of export traffic to the ports: bauxite, manganese and timber to Takoradi, and cocoa to both Takoradi and Tema. Since then, the neglect and consequent deterioration of the railway virtually crippled Ghana's export capabilities. As a result, railway traffic, which was about 1.6 million tons and 8 million passengers in the early seventies, declined to 360,000 tons and 3.4 million passengers in 1983, as shown in Table 2-10.

Within the framework of ERP 1985/88, the railway rehabilitation project has been implemented, thus leading to the restoration of the transport capacity of 590,000 tons.

Table 2-10 PASSENGERS AND COMMODITIES TRANSPORTED BY RAIL 1980/87

| Year | Passenger Traffic | | Freight Traffic | |
|---|---|---|---|---|
| | Passenger Journeys (1,000) | Passenger Kilometres (million) | Total Tonnage of Goods Carried (1,000) | Estimated Tonne Kilometres of Goods (million) |
| 1980 | 5,543 | 459.5 | 643.5 | 106.4 |
| 1981 | 3,693 | 313.5 | 566.4 | 91.9 |
| 1982 | 3,114 | 290.0 | 476.0 | 74.0 |
| 1983 | 3,394 | 380.0 | 358.0 | 61.0 |
| 1984 | 1,379 | 157.4 | 370.0 | 43.5 |
| 1985 | 2,115 | 190.3 | 509.6 | 77.2 |
| 1986 | 2,608 | 255.1 | 599.2 | 100.0 |
| 1987 | 3,485.5 | 566.8 | 593.4 | 106.2 |

### 2-2-2 Development in Road and Bridge Subsector

(1) Development Project in Economic Recovery Programme

The Economic Recovery Programme (ERP) is a national medium or long term socio-economic development programme in Ghana. The 1st ERP 1984/86 was launched in 1983, the 2nd ERP 1985/88 is in progress and practical 3rd ERP (Policy Framework 1988/90) is starting.

(2) Public Investment Programme

A 3-year Public Investment Programme (PIP) has been established to aim at the efficient use of public resources, which is the weakest point in the management of present economic system, within the framework of the above mentioned Economic Recovery Programme. The First PIP was introduced in 1986 and 2nd PIP is being implemented at present, where the priority is given on the rehabilitation of production capacity and new development of the agriculture, manufacturing industry, mining industry and forestry, as well as on the infrastructures following the first PIP.

(3) Transport Sector Investment Programme

Within the PIP the investment programme to the transport sector has been established as follows:

The UNDP and IDA have been helping to strengthen the planning and implementation capabilities of MRH and MOTC. The on going Ports Rehabilitation project and three new projects to be initiated during the 1988/90 plan period, namely, the Transport Rehabilitation Project, the Second Telecommunications Project and the Public Enterprise Project, all of which are being financed by IDA and other donors, are also expected to provide the necessary institutional strengthening to a number of MOTC organizations.

The sector's investment programme for the 1988/90 planning horizon is primarily geared towards the continued maintenance, rehabilitation and refurbishment of essential transport and communications infrastructure, equipment and rolling stock to enable the sector contribute effectively to the country's Economic Recovery Programme (ERP).

To this end, a total incremental investment of ¢128,559 m of which ¢91,339 m represents the foreign and ¢37,220 m the local cost component will be made in 87 top priority projects programmed for execution during the plan period. A brief resume for some of the key projects in the sector is given below.

(4) Roads and Bridge Subsector

Roads and Highways continue to constitute a major focus of the PIP and the total investment of ¢66,092 m accounts for about 51 per cent of the planned total incremental investment of ¢128,559 m for the Transport and Communications sector. Major priority projects implemented within the plan are shown in Table 2-11.

Table 2-12 gives the latest annual estimate of GHA for the rehabilitation and reconstruction projects of roads and bridges, which being based on the rolling plan for 1989/93.

Table 2-11 HIGHWAY AND BRIDGE PROJECT/PUBLIC INVESTMENT PROGRAMME 1988/90

| PROJECT TITLE | CODE | FOREIGN COST (US$ million) | LOCAL COST (Cedi million) | TOTAL (Cedi million) | FINANCING PLAN |
|---|---|---|---|---|---|
| MINISTRY OF ROADS AND HIGHWAYS | | | | | |
| Logistics Support/Technical Assistance Project | MRH 001 | 0.31 | 23 | 81 | IDA: ¢48m/FC, ¢18m/LC(TRP) |
| DEPARTMENT OF FEEDER ROADS | | | | | |
| Periodic Maintenance of Feeder Roads | DFR 001 | 6.0 | 3,855 ( 750) | 4,995 ( 750) | CIDA: ¢918m/FC(DFR&GHA), IDA: ¢2,700m/LC(TRP) |
| Development of Feeder Roads | DFR 002 | | 1,200 ( 400) | 1,200 ( 400) | |
| Development & Maintenance of Cocoa Roads | DFR 003 | | 3,960 (2,900) | 3,960 ( 2,900) | |
| Logistics Support & Building Project | DFR 004 | 0.81 | 209 | 363 | IDA: ¢135m/FC, ¢43m/LC(TRP) |
| GHANA HIGHWAY AUTHORITY | | | | | |
| Fourth Highway Project | HWY 001 | 48.0 (42.3 ) | 1,500 (4,482) | 8,628 (12,521) | IDA, JPN GOV, UNDP&ADB:ALL F/C+¢3,482m L/C |
| Reconstruction of Naswam-Anyinam Road | HWY 002 | 25.6 | 936 | 5,805 | IDA & ADF;ALL F/C & ¢524m L/C, FTBN |
| Yapei-Mormo-Kintampo Road Reconstruction | HWY 003 | 10.45 (11.96) | 321 ( 435) | 2,307 ( 2,707) | GOG:JPN GOV FTBN |
| Road Maintenance Backlog Clearance Project | HWY 004 | 52.79 | 4,394 | 14,424 | IDA: ¢8,618m(¢8,195mFC & ¢423mLC, TRP) |
| Rehabilitation of Kumasi-Sunyani Road Phase I | HWY 005 | 1.50 (18.30) | 1,072 | 502 ( 4,548) | GOG |
| Rehabilitation of Kumasi-Sunyani Road Phase II | HWY 006 | 1.92 ( 1.21) | 664 ( 161) | 1,028 ( 390) | GOG |
| Reconstruction of Yamoransa-Anwiankwanta Road | HWY 007 | 59.4 | 1,152 | 12,437 | OECF/JPN:ALL F/C, GOG:ALL L/C |
| Rehabilitation of Bogoso-Anyanfuri Road | HWY 008 | 7.84 | 648 | 2,137 | GOG:ALL L/C, FTBN for ALL F/C |
| Rehabilitation of Sogakope-Aflao Road | HWY 009 | 20.09 | 936 | 4,908 | ditto |
| Maintenance Study of Axim-Elubo Road | HWY 010 | 0.09 | 4 | 21 | EEC:Entire costs |
| Rehabilitation of Axim-Axim Junction | HWY 011 | 1.61 ( 0.5 ) | 18 | 113 | ditto |
| Rehabilitation of Accra City Roads | HWY 012 | 7.24 ( 7.84) | 582 ( 180) | 1,957 ( 1,669) | IDA:ALL F/C & ¢302m L/C |
| Rehabilitation of Kaneshie Mallam Road | HWY 013 | 2.98 (16.87) | 301 ( 308) | 867 ( 3,514) | GOG |
| Rehabilitation of Kumasi City Roads | HWY 014 | 10.45 (16.39) | 900 ( 756) | 2,886 ( 3,870) | GDR:ALL F/C |
| Bailey Bridge Programme | HWY 015 | 0.98 ( 0.5 ) | 90 ( 91) | 276 ( 186) | GOG |
| Five-Bridge Rehabilitation Programme | HWY 016 | 0.7 (17 ) | ( 363) | 133 ( 3,602) | ECGD:ALL F/C |
| Const. of Asukawkaw Bridge & Road Approaches | HWY 017 | – | 160 ( 195) | 160 ( 195) | GOG |
| Assembly Bridge Programme | HWY 018 | 1.41 ( 6.23) | 9 ( 36) | 276 ( 1,220) | KFW:ALL F/C |
| Reconstruction of Lower Volta Bridge | HWY 019 | 14.27 | 1,062 | 3,773 | ECOWAS:ALL F/C |
| Project Studies & Preparation | HWY 020 | 1.49 ( 0.45) | 46 ( 14) | 330 ( 99) | EEC:ALL F/C & ¢40m L/C |
| Reconstruction & Rehab. of Kumasi-Mampong Road | HWY 021 | 10.04 | 774 | 2,682 | Dutch Consortium:ALL F/C FTBN |
| Rehabilitation of Kumasi-Kintampo Road | HWY 022 | 8.54 | 1,008 | 2,630 | IDA & JPN GROV:ALL F/C & ¢705m L/C |
| Reconstruction of Tamale Page Road | HWY 023 | 11.86 | 1,422 | 3,676 | ditto :ALL F/C & ¢996m L/C |
| Rehabilitation of Ejura District Road | HWY 024 | 5.33 | 648 | 1,661 | IDA:ALL F/C, FDBN |
| Bridge Development Programme-Western Region | HWY 025 | 2.50 | 440 | 922 | EEC:ALL F/C |
| Bridge Reconstruction-Fumbisi Valley | HWY 026 | 9.55 | 407 | 2,221 | WHO:Entire costs FTBN |
| Elubo-Assemkrom Road Construction | HWY 027 | 5.2 | 556 | 1,546 | EEC:Entire costs |
| Awaso-Brbiani-Nobekaw Road Rehabilitation | HWY 028 | 13.99 | 1,099 | 3,758 | EEC:ALL F/C & ¢1,074m L/C |
| Nobekaw-Min-Bediakokrom Road Rehabilitation | HWY 029 | 6.0 | 714 | 1,855 | EEC:Entire costs, FTBN |
| Agona Junction-Tarkwa Road Rehabilitation | HWY 030 | 4.2 | 322 | 1,120 | ditto |
| Accra-Yamoransa Road Rehabilitation | HWY 031 | 18.7 | 1,422 | 4,973 | Donor, FTBN |
| Logistic Support Project | HWY 032 | 3.52 | 602 | 1,271 | GOG |
| Ghana Highway Authority Building Project | HWY 033 | – | 124 | 124 | GOG |
| Dabala-Srogboe-Keta Road Rehabilitation | HWY 034 | 3.76 | 486 | 1,201 | GOG |
| White Volta River Bridge Rehabilitation | HWY 035 | 0.04 ( 1.09) | 8 ( 136) | 15 ( 343) | GOG |
| Completion of Daboase Junction | HWY 036 | 1.93 (25.87) | 90 (1,028) | 456 ( 5,944) | GOG |
| Accra City Centre Improvement | HWY 037 | 2.54 ( 0.5 ) | 513 ( 16) | 995 ( 111) | |

IDA :International Development Association(World Bank)
GOG :Government of Ghana
CIDA:Canadian International Development Agency
OECF:Overseas Economic Cooperation Fund of Japan
ECGD:Export Credits Guarantee Department of G.Britain
WHO:World Health Organization

TRP:Transport Rehabilitation Programme
Figureim( ):Pre/1988 expenditure
DFR:Dept of Feeder Roads
EEC:European Economic Community
KFW:Central Bank of West Germany

GHA:Ghana Highway Authority
JPN GOV:Japanese Government
FTBN:Funding to be negotiated
GDR:Germant Democratic Republic
ECOWAS:
Source:Ministry of Finance and Economic Planning

Table 2-12 GHANA HIGHWAY AUTHORITY 1989 ANNUAL ESTIMATES/ FIVE YEAR DEVELOPMENT PROGRAMME/GHA ROADS AND BRIDGES PROJECT 1989/93

(Mill US$, 1$=190 Cedi)

| | Project Name | Length | Start | Total Est. Cost | | | Exp. to Dec. '88 | | | 1989 Estimate | | | 1990 Estimate | | | 1991 Estimate | | | 1992 Estimate | | | 1993 Estimate | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (km) | Year | TOT | FEC | FAA | TOT | FEC | FAA | TOT | FEC | FAA | TOT | FEC | FAA | TOT | FEC | FAA | TOT | FEC | FAA | TOT | FEC | FAA | |
| 001 | Aiyinam-Kumasi Road Overlay | 136.00 | 09:86 | 22.8 | 18.8 | 21.4 | 19.9 | 16.5 | 18.7 | 2.9 | 2.3 | 2.7 | | | | | | | | | | | | | FAA by A.D.B. under 4HP |
| 002 | Axim-Mpataba-Elubo Road M'tce | 82.00 | 09:87 | 0.2 | 0.2 | 0.2 | | | | 0.2 | 0.2 | 0.2 | | | | | | | | | | | | | FAA through E.E.C. |
| 003 | Kintampo-Morno-Yapei Rd. & Bridges | 148.00 | 08:84 | 40.8 | 28.3 | 28.3 | 25.1 | 20.2 | 20.2 | 8.1 | 4.0 | 4.0 | 7.6 | 4.1 | 4.1 | | | | | | | | | | FAA through E.C.G.D |
| 004 | Kumasi-Tepa Jct. Rehab. & Overlay | 75.00 | 11:84 | 28.2 | 17.8 | 0.0 | 22.0 | 15.1 | | 6.2 | 2.7 | 0.0 | | | | | | | | | | | | | Total financing by G.O.G. |
| 005 | Tepa Jct.-Sunyani-D/Ahenkro Recons. | 139.00 | 09:87 | 41.7 | 16.7 | 0.0 | 5.3 | 2.7 | 0.0 | 4.3 | 1.9 | 0.0 | 12.8 | 4.8 | 0.0 | 11.2 | 4.2 | 0.0 | 8.1 | 3.1 | 0.0 | | | | Total financing by G.O.G. |
| 006 | Accra City Roads Rehabilitation | 25.00 | 11:85 | 11.3 | 9.0 | 10.8 | 10.8 | 8.6 | 10.4 | 0.5 | 0.4 | 0.5 | | | | | | | | | | | | | FAA through I.D.A. |
| 007 | Guggish's Ave-Kaneshie-Mallam Recons | 50.00 | 08:84 | 37.1 | 29.6 | 0.0 | 18.9 | 18.9 | 0.0 | 9.9 | 9.2 | 0.0 | 8.3 | 1.5 | 0.0 | | | | | | | | | | Total financing by G.O.G. |
| 008 | Kumasi City Roads Rehabilitation | 100.00 | 11:85 | 47.3 | 36.4 | 36.4 | 25.3 | 18.9 | 18.9 | 7.6 | 5.0 | 5.0 | 14.4 | 12.5 | 12.5 | | | | | | | | | | Financing by G.O.G. |
| 009 | Axim Jct.-Tarkwa Rd. Rehab | 62.00 | 06:89 | 5.9 | 4.2 | 5.9 | | | | 1.3 | 0.8 | 1.3 | 4.6 | 3.4 | 4.6 | | | | | | | | | | FAA through E.E.C. |
| 010 | Bridge Development Prog. Ph. 1 | 0.30 | 09:86 | 6.8 | 6.4 | 6.6 | 6.4 | 6.1 | 6.3 | 0.4 | 0.3 | 0.3 | | | | | | | | | | | | | FAA through I.D.A./4HP |
| 011 | Yamoransa-Anwiankwant a Road Recons. | 186.00 | 03:80 | 65.5 | 59.4 | 59.4 | | | | 20.3 | 19.0 | 19.0 | 14.2 | 12.7 | 12.7 | 23.3 | 21.4 | 21.4 | 7.7 | 6.3 | 6.3 | | | | FAA through O.E.C.F. |
| 012 | Axim-Axim Junction Road Rehab. | 28.00 | 10:87 | 1.1 | 1.0 | 1.1 | 0.9 | 0.8 | 0.9 | 0.2 | 0.2 | 0.2 | | | | | | | | | | | | | FAA through E.E.C. |
| 013 | Nsawam-Anyinam Road Recons. | 76.00 | 06:88 | 40.0 | 34.0 | 37.8 | 0.0 | 0.0 | 0.0 | 8.0 | 6.8 | 7.6 | 12.8 | 10.9 | 12.1 | 11.2 | 9.5 | 10.6 | 8.0 | 6.8 | 7.5 | | | | FAA by A.D.B. |
| 014 | Kumasi-Ejura Road Recons Ph. 1 | 81.00 | 03:88 | 17.3 | 15.0 | 15.0 | | | | 1.3 | 0.8 | 0.8 | 9.8 | 9.0 | 9.0 | 6.2 | 5.2 | 5.2 | | | | | | | F.T.B.N. with Dutch Govt. |
| 015 | Project Studies and Preparation | | 03:87 | 3.8 | 3.4 | 3.4 | 0.4 | 0.3 | 0.3 | 2.4 | 2.1 | 2.1 | 1.0 | 1.0 | 1.0 | | | | | | | | | | FAA thro' E.E.C./I.D.A. |
| 016 | Kumasi-Kintampo Road recons. | 180.00 | 08:88 | 16.8 | 11.8 | 11.8 | | | | 5.0 | 3.5 | 3.5 | 8.1 | 6.6 | 6.6 | 3.7 | 1.7 | 1.7 | | | | | | | F.T.B.N. |
| 017 | Tepai-Tamale-Paga Road Recons. | 214.00 | 08:88 | 21.8 | 15.3 | 15.3 | | | | 6.6 | 4.6 | 4.6 | 9.4 | 7.3 | 7.3 | 5.8 | 3.4 | 3.4 | | | | | | | FAA through I.D.A. |
| 018 | Dabala-Srogboe-Keta Rd. Rehab. | 64.00 | 08:89 | 6.3 | 3.8 | 0.0 | | | | 2.9 | 1.7 | 0.0 | 2.2 | 1.4 | 0.0 | 1.2 | 0.7 | 0.0 | | | | | | | Financing by G.O.G. |
| 019 | Bailey Bridge Programme | 0.30 | 07:85 | 4.9 | 3.5 | 0.0 | 3.5 | 2.5 | 0.0 | 1.4 | 1.0 | 0.0 | | | | | | | | | | | | | Total financing by G.O.G. |
| 020 | Sogakope-Aloefe(Afl 30) Road Recons. | 61.00 | 08:88 | 25.8 | 20.9 | 0.0 | | | | 3.4 | 2.6 | 0.0 | 9.0 | 7.3 | 0.0 | 7.8 | 6.4 | 0.0 | 5.6 | 4.6 | 0.0 | | | | F.T.B.N. with ECOWAS |
| 021 | Lower Volta Bridge Recons. | 0.66 | 05:88 | 19.9 | 14.3 | 0.0 | | | | 2.7 | 1.6 | 0.0 | 11.2 | 8.3 | 0.0 | 6.0 | 4.4 | 0.0 | | | | | | | F.T.B.N. |
| 022 | Bridge Dev. Programme Ph. 2 | 0.45 | 05:88 | 8.3 | 5.8 | 7.6 | | | | 3.3 | 2.3 | 3.1 | 5.0 | 3.5 | 4.5 | | | | | | | | | | FAA through I.D.A. |
| 023 | Bridge Dev. Prog. in Western Region | 0.40 | 02:88 | 4.9 | 2.5 | 4.9 | | | | 2.5 | 1.2 | 2.5 | 2.4 | 1.3 | 2.4 | | | | | | | | | | FAA through E.E.C. |
| 024 | Bridge in Fumhisi Valley | 0.50 | 08:89 | 11.6 | 9.6 | 0.0 | | | | 3.0 | 2.5 | 0.0 | 4.0 | 3.3 | 0.0 | 4.6 | 3.8 | 0.0 | | | | | | | F.T.B.N. |
| 025 | Bogoso-Ayanfuri Road Rehabilitation | 60.00 | 08:88 | 11.2 | 7.9 | 0.0 | | | | 0.9 | 0.5 | 0.0 | 6.7 | 4.8 | 0.0 | 3.6 | 2.6 | 0.0 | | | | | | | F.T.B.N. |
| 026 | Sogakope-Tema Road Recons. Ph. 2 | 75.00 | 06:92 | 27.1 | 21.7 | 0.0 | | | | | | | | | | | | | 4.1 | 3.2 | 0.0 | 9.3 | 7.2 | 0.0 | F.T.B.N. |
| 027 | Asukawkaw Bridge & Road Approaches | 0.06 | 02:86 | 2.3 | 0.0 | 0.0 | 0.9 | 0.0 | 0.0 | 1.4 | 0.0 | 0.0 | | | | | | | | | | | | | Financing by G.O.G. |
| 028 | Accra-Yamoransa Road Rehab | 115.00 | 10:90 | 26.5 | 25.6 | 0.0 | | | | | | | 6.6 | 5.3 | 0.0 | 9.3 | 7.4 | 0.0 | 5.6 | 4.5 | 0.0 | 5.0 | 8.4 | 0.0 | F.T.B.N. |
| 029 | Elubo-Asemkrom Road Construction | 17.00 | 09:89 | 8.1 | 5.2 | 8.1 | | | | 3.7 | 2.6 | 3.7 | 2.4 | 1.9 | 2.4 | 2.0 | 0.7 | 2.0 | | | | | | | FAA through E.E.C. |
| 030 | Elubo-Asemkrom Road Bridge Recons. | 0.20 | 06:89 | 4.5 | 3.6 | 3.6 | | | | 0.7 | 0.6 | 0.6 | 2.4 | 1.9 | 1.9 | 1.4 | 1.1 | 1.1 | | | | | | | FAA through E.E.C. |
| 031 | Awaso-Bibiani-Nobekaw Rd. Rehab. | 61.00 | 09:89 | 19.8 | 14.0 | 19.8 | | | | 2.7 | 1.6 | 2.7 | 6.8 | 5.0 | 6.8 | 6.0 | 4.3 | 6.0 | 4.3 | 3.1 | 4.3 | | | | FAA through E.E.C. |
| 032 | Cape Coast-Twifo Praso Rd. Recons. | 32.00 | 08:89 | 9.6 | 3.8 | 0.0 | | | | 2.9 | 1.2 | 0.0 | 4.4 | 1.7 | 0.0 | 2.3 | 0.9 | 0.0 | | | | | | | Financing by G.O.G. |
| 033 | Nobekaw-Mim-Bediakokrom Road Rehab. | 63.00 | 11:89 | 9.8 | 6.0 | 9.8 | | | | 1.3 | 0.8 | 1.3 | 3.5 | 2.8 | 3.5 | 3.0 | 2.4 | 3.0 | 2.0 | 0.0 | 2.0 | | | | FAA through E.E.C. |
| 034 | Accra City Centre Improvement | | 08:89 | 5.8 | 3.0 | | | | | 3.8 | 2.0 | | 2.0 | 1.0 | | | | | | | | | | | |
| 035 | Tema-Akuse Jct. Rd. Rehabilitation | 30.00 | 10:89 | 6.8 | 5.4 | 0.0 | | | | 2.8 | 2.2 | 0.0 | 4.0 | 3.2 | 0.0 | | | | | | | | | | F.T.B.N. with K.F.W. |
| 036 | Akuse Jct.-Ho Rd. Rehabilitation | 92.00 | 02:91 | 19.2 | 15.4 | 0.0 | | | | | | | | | | 1.9 | 1.5 | 0.0 | 4.8 | 3.9 | 0.0 | 4.8 | 3.9 | 0.0 | |
| 037 | Bamboi-Wa Road Rehabilitation | 50.00 | 02:92 | 11.6 | 9.3 | 0.0 | | | | | | | | | | | | | 4.6 | 3.7 | 0.0 | 7.0 | 5.6 | 0.0 | |
| 038 | Neoplan Jct.-K/Nkrumah Cir. Recons. | 5.00 | 08:89 | 6.0 | 5.1 | 0.0 | | | | 1.8 | 1.5 | 0.0 | 4.2 | 3.6 | 0.0 | | | | | | | | | | F.T.B.N. with I.D.A. |
| 039 | Tepa Junction-Goaso Road Rehab. | 40.00 | 01:92 | 7.5 | 6.0 | | | | | | | | | | | | | | 3.0 | 2.4 | | 4.5 | 3.6 | | |
| 040 | Hohoe-Bimbila-Yendi Road Recons. | 297.00 | 06:91 | 99.3 | 79.6 | | | | | | | | | | | 9.9 | 8.0 | | 24.8 | 19.9 | | 24.8 | 19.9 | | |
| 041 | Dabose Junction-Dunkwa Road Const. | 104.00 | 03:92 | 30.7 | 24.7 | | | | | | | | | | | | | | 6.2 | 5.0 | | 9.3 | 7.5 | | |
| 042 | Ejura-Amankwakrow Road Construction | 160.00 | 09:91 | 48.2 | 38.3 | | | | | | | | | | | 4.8 | 3.8 | | 12.0 | 9.5 | | 12.0 | 9.5 | | |
| 043 | Elubo-Sunyani Road Construction | 190.00 | 06:92 | 56.9 | 45.6 | | | | | | | | | | | | | | 5.7 | 4.6 | | 14.3 | 11.5 | | |
| 044 | Achimata-Nsawam Road Overlay | 27.00 | 03:89 | 5.5 | 2.6 | | | | | 5.5 | 2.6 | | | | | | | | | | | | | | Financing by G.O.G. |
| 045 | ROAD SAFETY AND MARKING | | 01:89 | 4.5 | 3.2 | 2.8 | 0.9 | 0.6 | 0.5 | 0.9 | 0.6 | 0.5 | 0.9 | 0.6 | 0.5 | 0.9 | 0.6 | 0.5 | 0.9 | 0.6 | 0.5 | 0.9 | 0.6 | 0.5 | FAA Through I.D.A. |
| 046 | Liberation Road Widening to 4 lanes | 5.6 | 03:90 | 11.9 | 8.3 | | | | | | | | 11.9 | 8.3 | | | | | | | | | | | F.T.B.N. with Japan |
| | | 3133.5 | | 922.9 | 702.0 | 310.0 | 140.3 | 111.2 | 76.2 | 132.8 | 92.9 | 66.2 | 192.6 | 139.0 | 91.9 | 126.1 | 94.0 | 54.9 | 107.4 | 81.2 | 20.6 | 91.8 | 77.7 | 0.5 | |

FEC = Foreign Exchange Component
GOG = Government of Ghana
FAA = Foreign Assistance Available
IDA = International Development Association (World Bank)
E.C.G.D. = Export Credit Guarantee Dept. of G. Britain
O.E.C.F. = Overseas Economic Co-operation Fund of Janpan
K.F.W. = Central Bank of West Germany
A.D.B. = African Development Bank

### 2-2-3 Administration of Roads and Bridges

Ghana Highway Authority (GHA) was established in 1974 as an autonomous body with its own Board of Directors appointed by the Government. Fig. 2-6 gives organization chart of GHA. It has a staff and work force of about 10,000, spread over one central office in Accra, 10 regional offices and 32 main district offices.

It carries out the majority of routine maintenance and part of periodic maintenance of trunk roads through its own work force, all other periodic maintenance and construction/reconstruction works are done through contractors, administered by GHA. During 1984, approximately 5% of routine maintenance, 75% of periodic maintenance and 100% of construction/reconstruction works.

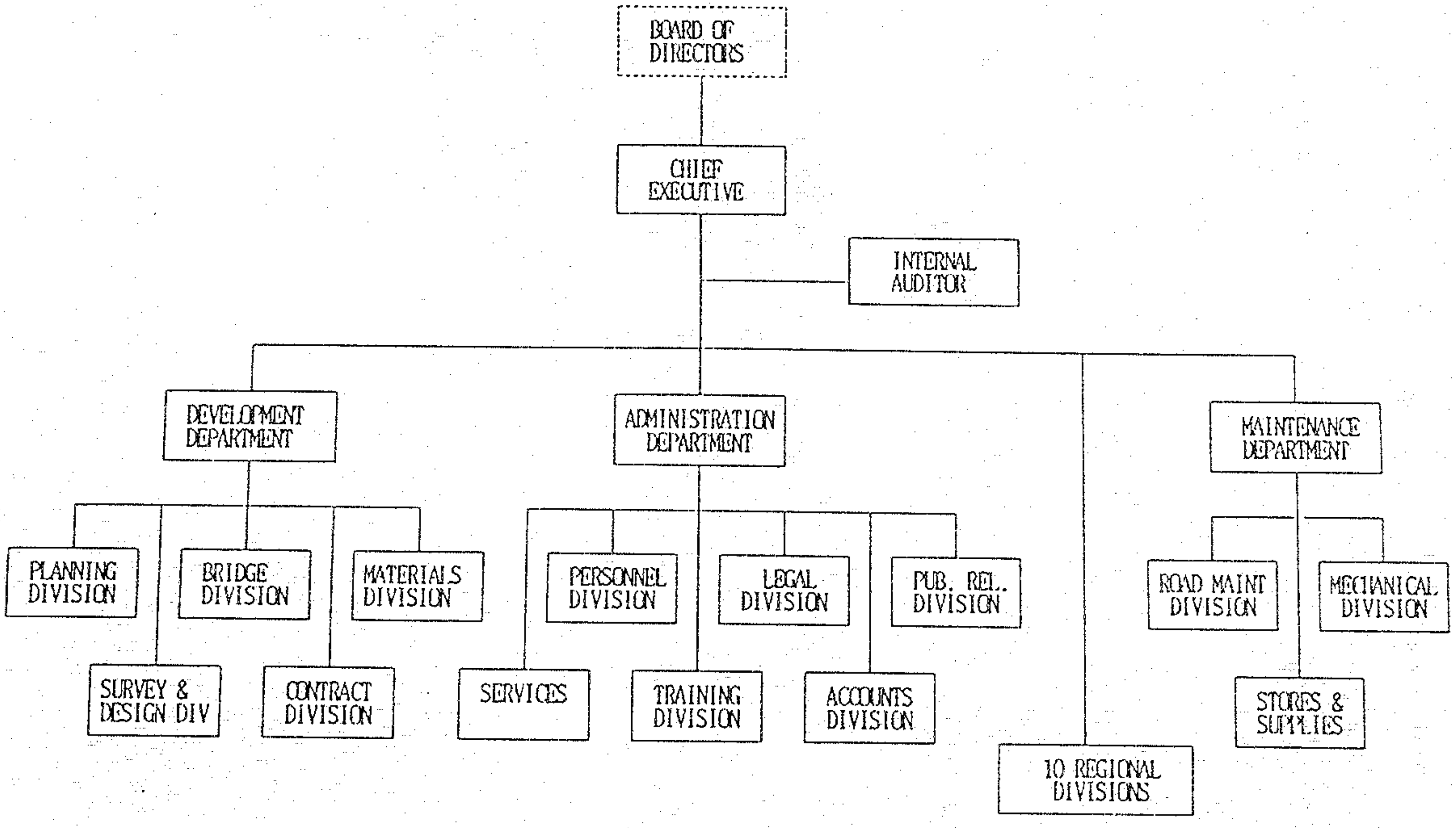



Fig. 2-6 ORGANIZATION CHART OF GHANA HIGHWAY AUTHORITY

## 2-3 Process and Content of the Request

The existing Beposo Bridge is "the one and only" transport means crossing Pra River on National Route 1. However, due to its old age (54 years after its completion in 1934), it has been in general superannuated and, furthermore, there have been observable physical damages or failures on the principal structural members due to the accelerated growth of traffic and increase of heavier vehicles using the bridge.

The Ghana Highway Authority (GHA) commissioned the feasibility studies to an expatriate consultant in 1984 for the improvement of the traffic and physical bottlenecks on the existing Beposo Bridge.

Consequently, the GHA arrived at conclusion that a new bridge of two lanes be reconstructed as urgently as possible at immediate downstream of the existing Beposo Bridge and the Government of Ghana has requested the Government of Japan to implement the Project under the grant aid programme of Japan.

# CHAPTER 3

# OUTLINE OF THE PROJECT AREA

## CHAPTER 3

## OUTLINE OF THE PROJECT AREA

### 3-1 Outline of the Project Area

### 3-1-1 Influence Area of the Project

The existing Beposo Bridge is located in the southeastern part of the Western Region bordering the Central Region, and crosses Pra River on the National Route 1.

There are (located on National Route 1) several principal cities such as Sekondi at 15 km and Takoradi at 20 km to the west of Beposo Bridge, and Cape Coast at 40 km, Accra at 150 km and Tema at 185 km to the east of the Beposo Bridge.

Fig. 3-1 gives the traffic flow diagram, made on the basis of traffic survey data by GHA. It is easily seen that most of the flow of goods and passengers are concentrated on the National Route 4 and the National Route 1.

As shown in Table 3-1, Tema Port deals with most of imported commodities, and Takoradi Port functions as an export.

Table 3-1 CARGO UNLOADED AND LOADED AT TAKORADI AND TEMA PORT

('000 tonnes)

| | Cargo unloaded | | Cargo unloaded | |
|---|---|---|---|---|
| | Takoradi | Tema | Takoradi | Tema |
| 1973 | 437 | 2,307 | 1,565 | 694 |
| 1974 | 671 | 2,640 | 1,326 | 794 |
| 1975 | 679 | 2,631 | 1,456 | 929 |
| 1976 | 559 | 2,698 | 1,262 | 708 |
| 1977 | 38 | 2,683 | 1,072 | 645 |
| 1978 | - | 2,000 | 1,060 | 544 |
| 1979 | - | 1,947 | 796 | 301 |
| 1980 | - | 2,469 | 542 | 361 |
| 1981 | - | 2,968 | 541 | 710 |
| 1982 | 10 | 1,888 | 387 | 584 |
| 1983 | 245 | 1,054 | 349 | 1,334 |
| 1984 | 184 | 1,735 | 320 | 494 |
| 1985 | 231 | 2,152 | 828 | 534 |

Consequently, the imported material at Tema Port flows to Kumasi on the National Route 4 and to Sekondi/Takoradi on the National Route 1, while most of the commodities exported through Takoradi Port flows from Kumasi on National Route 4 and from Accra/Tema to Takoradi Port on Route 1. The National Route 1 thus plays an important role of export corridor together with National Route 4.

The existing Beposo Bridge is "the one and only" means of crossing over Pra on the National Route 1. Consequently, the significance of the Project is defined subject to the important role of the National Route 1, the influenced area of the Project will be widely the Regions of Western, Central, Eastern, Ashanti and Greater Accra.

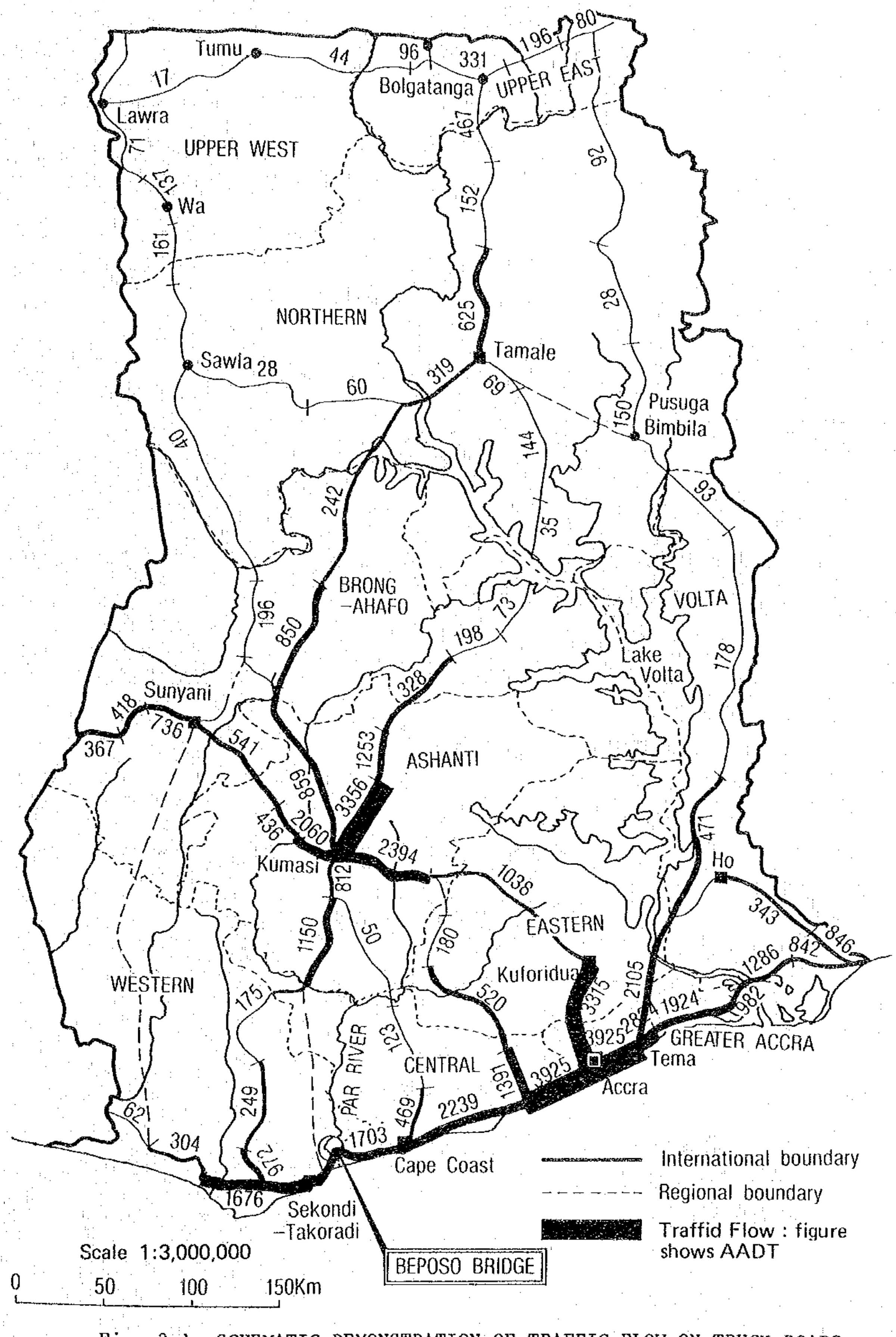



Fig. 3-1 SCHEMATIC DEMONSTRATION OF TRAFFIC FLOW ON TRUCK ROADS (AADT in 1987)

Source : Traffic Report(1983-1987) by Ghana Highway Authority

### 3-1-2 Population of the Project Area

As shown in Table 3-2, the population of the 6 regions that will be beneficiaries of the Project will be about 8.7 million.

If the influence of the Project is limited to the local authorities within 20 km radius of the Project site, the direct beneficiaries will be about 230,000.

Table 3-2 POPULATION BY REGION

| Region | Area (sp. km) | 1970 | | 1984 | |
|---|---|---|---|---|---|
| | | Population (1,000) | Density* | Population (1,000) | Density* |
| Western | 23,921 | 770.1 | 32 | 1,157.8 | 48 |
| Central | 9,826 | 890.1 | 88 | 1,142.3 | 116 |
| Greater Accra | 3,245 | 903.4 | 278 | 1,431.1 | 441 |
| Eastern | 19,323 | 1,209.8 | 63 | 1,680.9 | 87 |
| Volta | 20,570 | 947.3 | 46 | 1,211.9 | 59 |
| Ashanti | 24,389 | 1,481.7 | 61 | 2,090.1 | 86 |
| Sub-total | 101,274 | 6,202.4 | 61 | 8,714.1 | 86 |
| % for All region | (42.5%) | | | (70.9%) | |
| Brong-Ahafo | 39,557 | 766.5 | 19 | 1,206.6 | 31 |
| Northern | 70,384 | 727.6 | 10 | 1,164.6 | 17 |
| Upper West | 18,476 | 319.9 | 17 | 438.0 | 24 |
| Upper East | 8,842 | 542.9 | 61 | 772.7 | 87 |

Source: Population Census of Ghana, 1984.

Table 3-3 DENSITY OF POPULATION BY LOCAL AUTHORITY

| Local Authority (Code No.) | Population (1,000) 1984 | 1989 |
|---|---|---|
| 012 | 48.9 | 57.0 |
| 100 | 76.9 | 80.2 |
| 101 | 86.6 | 92.4 |
| Total | 212.4 | 229.6 |

## 3-1-3 Transport and Flow of Goods

Table 3-4 gives the principal commodities produced within the influence area of the Project, and Table 3-4 shows the amount of those commodities transported by the two modes of transport namely roads and railways. According to the tables, 170,000 tons or 84% of the total of cocoa is produced in a wider part of the influenced area (Sunyani/Kumasi/Koforidua), and almost all the cocoa products thereof are transported to Takoradi (and Tema) by rail (60,000 ton) and road (110,000 ton).

Most of the cocoa for export is transported from Kumasi to Takoradi through National Routes 4 and 1 with a considerable proportion (110,000 ton) of cocoa crossing over the existing Beposo Bridge for export.

Timber is one of the principal export commodities and 80% of the total product from the influenced area of the Project are produced around Kumasi and transported to Takoradi on the National Route 1.

The manganese and bauxite are mainly transported by railway. However, 26,000 tons of manganese and 8,000 tons of bauxite (10% of the total of each) are hauled by heavy trucks to Takoradi on the National Route 1.

Table 3-4 ESTIMATE OF PRODUCTION OF PRINCIPAL COMMODITIES BY REGION

| | Western | Central | Eastern (including Gt. Accra) | Ashanti | Volta | Sub-total (% for Total) | Br.Ahafo | Northern | Upper | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture (1,000 tonnes) | | | | | | | | | | |
| Cocoa | 58 | 25 | 33 | 50 | 2 | 168 ( 84%) | 32 | - | - | 200 |
| Rubber | 10 | - | - | - | - | 10 (100%) | - | - | - | 10 |
| Meat (marketed) | 1 | 4 | 7 | 3 | 5 | 20 ( 44%) | 4 | 8 | 13 | 45 |
| Fish (marketed) | 55 | 122 | 75 | - | 58 | 310 (100%) | - | - | - | 310 |
| Pulses & nuts 1/ | 500 | 63 | 188 | 471 | 128 | 1,350 ( 88%) | 185 | - | - | 1,535 |
| Fruits 2/ | 55 | 7 | 11 | 16 | 5 | 94 ( 94%) | 6 | - | - | 100 |
| Starchy staples 3/ | 530 | 300 | 535 | 1,115 | 290 | 2,770 ( 57%) | 1,840 | 240 | 50 | 4,900 |
| Cereals 4/ | 50 | 52 | 86 | 112 | 56 | 356 ( 35%) | 250 | 194 | 220 | 1,020 |
| Vegetables 5/ | 34 | 9 | 41 | 40 | 56 | 180 ( 64%) | 75 | 12 | 13 | 280 |
| Industrial crops 6/ | 30 | 70 | 100 | 15 | 20 | 235 ( 94%) | 3 | 6 | 6 | 250 |
| Forestry (1,000 $m^3$) | | | | | | | | | | |
| Logs | 282 | 93 | 114 | 47 | - | 536 ( 80%) | 134 | - | - | 670 |
| Sawn timber | 88 | 29 | 36 | 15 | - | 168 ( 80%) | 42 | - | - | 210 |
| Mining (1,000 tonnes) | | | | | | | | | | |
| Manganese one | 145 | - | - | 145 | - | 290 (100%) | - | - | - | 290 |
| Bauxite | 50 | - | - | 50 | - | 100 (100%) | - | - | - | 100 |

1/ Groundnuts, coconut, oil palm, beans and peas.
2/ Banana, pineapples, oranges
3/ Cassava, cocoyam, yam, plantain.
4/ Maize, rice, millet, sorghum, guinea corn.
5/ Tomatoes, pepper, okra, garden eggs.
6/ Cotton, tobacco, sugar cane.

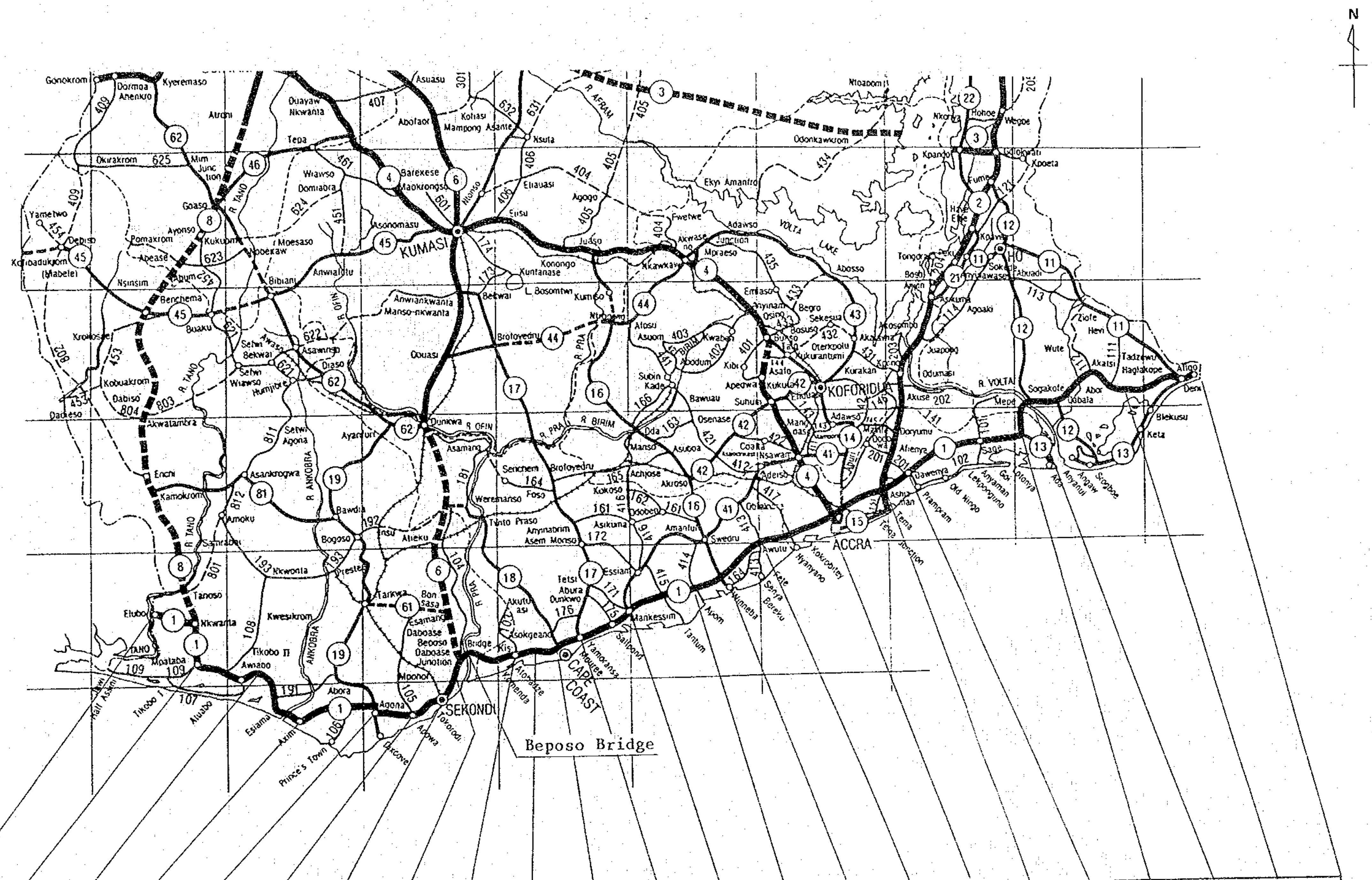
Source: Ghana Highway Authority, Ghana Bridge Development Programme, Feasibility Study, Second Stage, Tahal Consulting Engineers Ltd. Accra Dec. 1986

## Table 3-5 TRANSPORT OF PRINCIPAL COMMODITIES 1989 (ESTIMATED)

| Region | | Cocoa ('000 ton) | Rubber | Meat (marketed) | Fish (marketed) | Pulses & Nuts | Fruits | Starchy Staples | Cereals | Vegetables | Industrial Crops | Logs & Sawn Timber* ('000 m³) | Managanese Ore ('000 ton) | Bauxite | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Western | Total production | 58 | 10 | 1 | 55 | 500 | 55 | 530 | 50 | 34 | 30 | 529 | 145 | 50 | 2,047 |
| | Own consumption | - | - | - | - | 123 | 6 | 394 | 50 | 34 | - | - | - | - | 607 |
| | Railway transport | 21 | - | - | - | 4 | - | 1 | - | - | - | 42 | 132 | 46 | 245 |
| | Road transport | 37 | 10 | 1 | 55 | 373 | 49 | 135 | - | - | 30 | 487 | 13 | 4 | 1,194 |
| Central | Total production | 25 | - | 4 | 122 | 63 | 7 | 300 | 52 | 9 | 70 | 175 | - | - | 827 |
| | Own consumption | - | - | - | - | 63 | 6 | 300 | 52 | 9 | - | - | - | - | 430 |
| | Railway transport | 7 | - | - | - | - | - | - | - | - | - | 11 | - | - | 18 |
| | Road transport | 18 | - | 4 | 122 | - | 1 | - | - | - | 70 | 164 | - | - | 379 |
| Eastern (incl.Gt.Accra) | Total production | 33 | - | 7 | 75 | 188 | 11 | 535 | 86 | 41 | 100 | 214 | - | - | 1,290 |
| | Own consumption | - | - | - | - | 188 | 11 | 535 | 86 | 41 | - | - | - | - | 861 |
| | Railway transport | 11 | - | - | - | - | - | - | - | - | - | 13 | - | - | 24 |
| | Road transport | 22 | - | 7 | 75 | - | - | - | - | - | 100 | 201 | - | - | 405 |
| Ashanti | Total production | 50 | - | 3 | - | 471 | 16 | 1,115 | 112 | 40 | 15 | 89 | 145 | 50 | 2,106 |
| | Own consumption | - | - | - | - | 236 | 12 | 756 | 112 | 40 | - | - | - | - | 1,156 |
| | Railway transport | 21 | - | - | - | 2 | - | 2 | - | - | - | 5 | 132 | 46 | 208 |
| | Road transport | 29 | - | 3 | - | 233 | 4 | 357 | - | - | 15 | 84 | 13 | 4 | 742 |
| Volta | Total production | 2 | - | 5 | 58 | 128 | 5 | 290 | 56 | 56 | 20 | - | - | - | 620 |
| | Own consumption | - | - | - | - | 128 | 5 | 290 | 56 | 39 | - | - | - | - | 518 |
| | Railway transport | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | Road transport | 2 | - | 5 | 58 | - | - | - | - | 17 | 20 | - | - | - | 102 |
| Sub-total | Total production % for Total | 168 (84%) | 10 (100%) | 20 (44%) | 310 (100%) | 1,350 (88%) | 94 (94%) | 2,770 (57%) | 356 (35%) | 180 (64%) | 235 (94%) | 1,007 (80%) | 290 (100%) | 100 (100%) | 6,890 (67%) |
| | Own consumption % for Total | - | - | - | - | 738 (85%) | 40 (87%) | 2,275 (76%) | 356 (58%) | 163 (71%) | - | - | - | - | 3,572 (75%) |
| | Railway transport % for Total | 60 (100%) | - | - | - | 6 (100%) | - | 3 (100%) | - | - | - | 71 (100%) | 264 (100%) | 92 (100%) | 496 (100%) |
| | Road transport % for Total | 108 (77%) | 10 (100%) | 20 (100%) | 310 (100%) | 606 (92%) | 54 (100%) | 492 (26%) | - ( 0%) | 17 (33%) | 235 (94%) | 936 (79%) | 26 (100%) | 8 (100%) | 2,822 (56%) |
| Brong-Ahafo | Total production | 32 | - | 4 | - | 185 | 6 | 1,840 | 250 | 75 | 3 | 251 | - | - | 2,646 |
| | Own consumption | - | - | - | - | 132 | 6 | 422 | 86 | 40 | - | - | - | - | 686 |
| | Railway transport | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | Road transport | 32 | - | 4 | - | 53 | - | 1,418 | 164 | 35 | 3 | 251 | - | - | 1,960 |
| Northern | Total production | - | - | 8 | - | - | - | 240 | 194 | 12 | 6 | - | - | - | 460 |
| | Own consumption | - | - | - | - | - | - | 240 | 87 | 12 | - | - | - | - | 339 |
| | Railway transport | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | Road transport | - | - | 8 | - | - | - | - | 107 | - | 6 | - | - | - | 121 |
| Upper | Total production | - | - | 13 | - | - | - | 50 | 220 | 13 | 6 | - | - | - | 302 |
| | Own consumption | - | - | - | - | - | - | 50 | 85 | 13 | - | - | - | - | 148 |
| | Railway transport | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | Road transport | - | - | 13 | - | - | - | - | 135 | - | 6 | - | - | - | 154 |
| Total | Total production | 200 | 10 | 45 | 310 | 1,535 | 100 | 4,900 | 1,020 | 280 | 250 | 1,258 | 290 | 100 | 10,298 |
| | Own consumption | - | - | - | - | 870 | 46 | 2,987 | 614 | 228 | - | - | - | - | 4,745 |
| | Railway transport | 60 | - | - | - | 6 | - | 3 | - | - | - | 71 | 264 | 92 | 496 |
| | Road transport | 140 | 10 | 45 | 310 | 659 | 54 | 1,910 | 406 | 52 | 250 | 1,187 | 26 | 8 | 5,057 |

* Conversion factor from Table VII-4 is : 1 cu.m = 0.7 tonne hardwood.

Sources: Ghana Highway Authority, Ghana Bridge Development Programme, Feasibility Study, Second Stage, Tahal Consulting Engineers Ltd. Accra Dec. 1986




| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1984 | 59 | 282 | | 404 | 1,488 | 1,406 | | | 491 | 953 | 2,853 | 1,900 | 1,430 | 1,929 | 1,803 | | 3,986 | 3,486 | 1,471 | 821 | 1,179 | 405 |
| 1985 | 58 | 330 | | 370 | 1,582 | 1,510 | 716 | 2,502 | 654 | 1,362 | 3,762 | 2,134 | 1,671 | 2,377 | 1,776 | | 3,887 | 1,075 | 1,299 | 1,211 | 1,246 | 573 |
| 1986 | 60 | 369 | 332 | 308 | 1,464 | 1,512 | 1,419 | 1,512 | 1,242 | 1,441 | 3,892 | 1,988 | 1,819 | 2,757 | 2,010 | | 3,624 | 1,680 | 1,614 | 386 | 1,156 | 686 |
| 1987 | 62 | 330 | 342 | 242 | 1,704 | 1,649 | 1,640 | 1,741 | 1,566 | 1,868 | 2,809 | 2,468 | 1,691 | 2,077 | 2,151 | | 3,925 | 2,874 | 1,924 | 982 | 1,286 | 842 |

Fig. 3-2 TRAFFIC ON NATIONAL ROUTE 1 (AADT)

### 3-1-4 Traffic on the Route 1

Fig. 3-2 shows the annual variation of ADT (Average Daily Traffic) between Sekondi/Takoradi and Accra/Tema extracted from the traffic survey data by GHA. In 1987, the traffic show maximum value 3,925 between Accra and Tema, and decreased gradually westwards to Cape Coast. Around Cape Coast, it showed again a peak value because the traffic within the Cape Coast area and traffic from and to the northern part of the National Route 1 merged here. To the west beyond Beposo, it showed a peak value in Sekondi/Takoradi industrial circle and become smaller after Axim. Routes 62 and 842 carry international traffic to and from Ivory Coast and Togo respectively.

### 3-1-5 Traffic on the Beposo Bridge

An additional analysis has been made in depth on the traffic for the Project bridge, using the 3 days-continuous 24 hours-traffic survey conducted on existing Beposo Bridge within the Basic Design Study.

(1) Traffic Volume

Table 3-7 shows the result of 3 days continuous 24 hours traffic survey, and Table 3-6 the average daily traffic by vehicle types. Using these data, the ADT on the existing Beposo Bridge is estimated as about 1,755, and this value is very close to the figure of 1,741 surveyed by GHA in 1987.

Table 3-6 AVERAGE DAILY TRAFFIC ON EXISTING BEPOSO BRIDGE

| Vehicle Type | | Traffic | % |
|---|---|---|---|
| Type 1 | Motor cars | 480 | 27 |
| Type 2 | Light goods vehicles | 740 | 42 |
| Type 3 | Passenger commercial vehicles (Bus) | 206 | 12 |
| Type 4 | Medium goods vehicles | 76 | 4 |
| Type 5 | Heavy goods vehicles | 253 | 15 |
| | | 1,755 | 100 |

Table 3-7 24 HOURS TRAFFIC SURVEY ON EXISTING BEPOSO BRIDGE

| Vehicle Classification | | Type | 17/10/88 (Mon) | *18/10/88 (Tue) | 19/10/88 (Wed) | 3 DAY Total | % | Average | |
|---|---|---|---|---|---|---|---|---|---|
| Light Vehicle | (1) Cars | Type 1 | 468 | 482 | 489 | 1,439 | 27.3 | 480 | |
| Light Vehicle | (2) Vans Pick-up Land Roavers | Type 2 | 354 | 278 | 241 | 873 | 16.5 | 291 | 70% |
| Light Vehicle | (3) Light Buses | Type 2 | 369 | 533 | 445 | 1,347 | 25.5 | 449 | |
| Medium Vehicle | (4) Heavy Buses | Type 3 | 147 | 169 | 143 | 459 | 10.4 | 153 | |
| Medium Vehicle | (5) Mammy Wagons | Type 3 | 31 | 105 | 23 | 159 | 3.0 | 53 | 16% |
| Medium Vehicle | (6) Light Goods Vehicle | Type 4 | 42 | 89 | 96 | 227 | 4.3 | 76 | |
| Heavy Vehicle | (7) Medium Goods Vehicle | Type 5 | 66 | 79 | 81 | 226 | 4.2 | 75 | |
| Heavy Vehicle | (8) Heavy Goods Vehicle | Type 5 | 170 | 138 | 194 | 502 | 9.5 | 167 | 14% |
| Heavy Vehicle | (9) Others | Type 5 | 11 | 15 | 8 | 34 | 0.6 | 11 | |
| | Total | | 1,658 | 1,888 | 1,720 | 5,266 | | | |

Note: Day marked * is Market day at Beposo

(2) Origin-Destination Survey

O-D survey was carried out by interviewing drivers of 447 vehicles sampled at random from the 5,266 vehicles that crossed the existing Beposo Bridge over the period, (Sampling ratio, 447/5,266=8.5%)

According to the results, nearly 60% of the traffic passing on the existing Beposo Bridge towards Takoradi originated from Accra/Tema area, Kumasi and the northern sector of the country. The remaining 40% constitute local traffic from Cape Coast and its vicinity.

Almost 97% of the traffic that crossed the bridge and originated from westward direction were destined for Secondi/Takoradi industrial zone.

Table 3-10 indicates that 90% or more of the traffic toward Takoradi were passenger vehicles such as passenger cars, mini buses, and buses.

Of the sampled 223 vehicles moving towards Takoradi the number of heavy goods vehicles (HGVs) was 70 or 30%, while for the 241 towards Accra, HGVs shares was 44 or only 19% of the total, which amounts to about one half that of vehicles towards Takoradi.

From Table 3-12 it could be seen that the goods carried by the HGVs towards Takoradi were composed mainly of timber, fuel, cocoa, fruit and vegetable etc. It is very noteworthy that nearly 70% of these HGVs are large trucks or trailers, 20 ton to 30 ton, carrying timber that originated from around Kumasi through National Route 4 down to Accra and then to west on National Route 1, passing on existing Beposo Bridge. Destination was Takoradi Port.

Table 3-8 TRAFFIC BY ORIGIN/DESTINATION (TO TAKORADI DIRECTION)

| | Dest. / Origin | 28 | 27 | 26 | 25 | 30 | 29 | 24 | Total | (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| 18 | Techiman | | | | | 1 | | | 1 | |
| 10 | Kumasi | | | | | 21 | | | 21 | (10) |
| 5 | Knaw Kaw | | | | | 2 | | | 2 | |
| 20 | Anynam | | | | | 1 | | | 1 | |
| 21 | Nsawam | | | | | 1 | | | 1 | |
| 22 | Accra | 1 | | 1 | | 70 | 4 | | 76 | (35) |
| 16 | Winneba | | | | | 2 | 2 | 1 | 5 | |
| 1 | Swedru | | | | | 4 | 2 | | 16 | |
| 17 | Agona | | | | | 1 | | | 1 | |
| 13 | Akm Oda | | | | | 9 | 2 | | 11 | |
| 2 | Mankessim | | 1 | | | 12 | 2 | | 15 | (15) |
| 7 | Cape Coast | | | 1 | | 26 | 6 | | 33 | |
| 8 | Abra Dunkwa | | | | | 1 | | | 1 | |
| 3 | Assin Fosu | | 1 | | | 2 | 1 | | 4 | |
| 19 | Adansi Praso | | | | | 2 | | | 2 | |
| 6 | Elmina | | | | | 7 | 6 | | 13 | ( 6) |
| 14 | Akutuase | | | | | 1 | | | 1 | |
| 9 | Kissi | | | | | 2 | | | 2 | |
| 4 | Komenda | | | | 1 | 7 | 1 | | 9 | |
| | Beposo | | | | | 2 | | | 2 | |
| | | 1 | 2 | 1 | 2 | 184<br>(85) | 26<br>(12) | 1<br>(0.5) | 217 | |

Note: Traffic shown is a sum sampled from the 3 days' continuous survey.

DESTINATION

28 Esiama 27 Axim 26 Tarkwa 25 Agona Junc.
30 Takoradi 29 Secondi 24 Nchaban

Almost all these timber transport vehicles had loads exceeding the regulated weight at the existing Beposo Bridge.

On the contrary, around 90% of traffic towards Accra originated from Secondi/Takoradi industrial area, and almost all the vehicles were destined for Accra/Tema area.

The rest 10% were destined for Cape Coast and its vicinity, and this traffic is regarded as local traffic on the existing Beposo Bridge and 64% of these are passenger transport vehicles as in the case of traffic towards Takoradi.

The principal goods carried by HGVs towards Accra are cement, fuel and fertilizer imported to Takoradi Port and almost all of these vehicles are destined for Accra/Tema area. The weight of cement carrying vehicle is nearly 30 ton and exceeds the regulated weight at the existing Beposo Bridge.

Figures 3-3- and 3-4 show traffic flow diagrams based on sampled numbers in both Takoradi and Accra directions.

The average daily number of persons passing on the existing Beposo Bridge by passenger cars and buses are estimated at around 17,000 in both directions. As the Beposo village with estimated population of around 2,500 forms a local community center containing market, church, police station and fuel station about 300 villages near Beposo are, in routine, using very directly the existing Beposo Bridge to transfer their farm produces and to purchase other goods in Beposo.

Table 3-9 TRAFFIC BY ORIGIN/DESTINATION (TO ACCRA DIRECTION)

| Dest. / Origin | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | Total | (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Abidjan(Int'l) | | | | | | | | | | | 3 | | | | 3 | |
| Tikobo | | | | | | | | 1 | | | | | | | 1 | |
| Samraboi | | | | | | | | | | | 2 | | | | 2 | |
| Elubo | | | | | | | | | | | 5 | | | | 5 | |
| Esiama | | | | | | | | | | | 2 | | | | 2 | |
| Axim | | | 2 | | | | | | | | 6 | | | | 8 | |
| Dvnkwa | | | 1 | | | | | | | | | | | | 1 | |
| Tarkwa | | | | | | | | | | | 3 | | | | 3 | |
| Takoradi | 2 | 4 | 44 | 3 | 1 | 1 | 1 | 7 | 3 | 7 | 113 | 1 | 1 | 13 | 201 | (84) |
| Secondi | 1 | | 1 | | | | | 2 | | 1 | 6 | 2 | | | 13 | ( 5) |
| Iuchaban | | | | | | | | | | | 1 | | | | 1 | |
| Shama | | | | | | | | 1 | | | | | | | 1 | |
| Total | 3 | 4 | 48 | 3 | 1 | 1 | 1 | 11 | 3 | 8 | 141 | 3 | 1 | 13 | 241 | (100) |
| (%) | | | (20) | | | | | (4) | | (3) | (59) | | | (5) | | |

Note: Traffic shown is a sum sampled from the 3 days' continuous survey.

DESTINATION

| | | | |
|---|---|---|---|
| 1 Beposo | 2 Komenda | 3 Cape Coast | 4 Elmina |
| 5 Yamoransa | 6 Assin Fosu | 7 Twifo-Praso | 8 Mankessim |
| 9 Akm Oda | 10 Swedru | 11 Accra | 12 Tema |

Table 3-10 COMPOSITION OF VEHICLES BY ORIGIN (TO TAKORADI DIRECTION)

| Vehicle / Origin | C | VAN | LB | HB | MW | LGV | MGV | HGV | OTH | Total | (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | | 6 | 2 | | | 1 | 4 | | 15 | ( 6.7) |
| 2 | | | 7 | | | 4 | 4 | | | 15 | ( 6.7) |
| 3 | | | | 2 | | | | 4 | | 6 | |
| 4 | | | 5 | | 1 | 3 | | | | 9 | |
| 5 | | | | | | | 1 | 4 | | 5 | |
| 6 | 1 | | 3 | | 1 | 5 | 1 | 1 | | 12 | (20) |
| 7 | 12 | | 14 | | | 4 | | 1 | 2 | 33 | |
| 8 | 1 | | | | | | | | | 1 | |
| 9 | | | | | | | 1 | 1 | | 2 | |
| 10 | | | | | | | 1 | 18 | 1 | 20 | ( 9) |
| 11 | | | | 1 | | | | | 3 | 4 | |
| 12 | | | | | | | | | | | |
| 13 | 1 | | | | | | 1 | 9 | | 11 | |
| 14 | | | | | | | | 1 | | 1 | |
| 15 | | | | | | | | 1 | | 1 | |
| 16 | 1 | | | | | 4 | | | | 5 | |
| 17 | | | | | | 1 | | | | 1 | |
| 18 | | | | | | | | | 1 | 1 | |
| 19 | | | | | | | | 2 | | 2 | |
| 20 | | | | | | | | 1 | | 1 | |
| 21 | 1 | | | | | | | | | 1 | |
| 22 | 18 | | 19 | 15 | | 2 | 7 | 1 | 12 | 74 | (33) |
| 23 | | | | | | | 1 | | | 1 | |
| Beposo | | | 1 | | | 1 | | | | 2 | |
| Total | 37 | | 55 | 20 | 2 | 24 | 18 | 48 | 19 | 223 | (100) |
| (%) | (16.6) | | (24.7) | (9.0%) | (0.9%) | | | (21.5) | (8.5%) | | |

C : Car
LB : Light Good Vehicle
HB : Heavy Bus
LGV : Light Good Vehicle
HGV : Heavy Good Vehicle
VAN : Van, Pick-up
HB : Heavy Bus
MW : Mummy Wagon
MGV : Medium Good Vehicle
OTH : Others

Table 3-11 COMPOSITION OF VEHICLES BY ORIGIN (TO ACCRA DIRECTION)

| Origin \ Type | C | VAN | LB | HB | MW | LGV | MGV | HGV | OTH | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 23 | | | 1 | | | | | | | 1 |
| 24 | 1 | | | | | | | | | 1 |
| 26 | | 1 | | | | 1 | 1 | | | 3 |
| 27 | 1 | | | 1 | | 2 | 3 | | 1 | 8 |
| 28 | 1 | | | | | 1 | | | | 2 |
| 29 | | | 3 | | | | 1 | | | 4 |
| 30 | | | | | | | 2 | | | 2 |
| 32 | | | | | | | | | | |
| 33 | | | | | | | | | | |
| Takoradi | 32 | | 59 | 34 | | 8 | 15 | | 43 | 191 ( 83%) |
| Secondi | 2 | | 3 | 2 | | 3 | 2 | | | 13 (5.6%) |
| Benso | | | | 1 | | | | | | 1 |
| Abidjan | | | | 2 | | | | | | 2 |
| Tikobe | 1 | | | | | | | | | 1 |
| Ivory Coast | | | 1 | | | | | | | 1 |
| | 38 (17%) | | 68 (30%) | 40 (17%) | | 15 (6%) | 24 (11%) | | 44 (19%) | 230 |

C : Car
LB : Light Good Vehicle
HB : Heavy Bus
LGV : Light Good Vehicle
HGV : Heavy Good Vehicle
VAN : Van, Pick-up
HB : Heavy Bus
MW : Mummy Wagon
MGV : Medium Good Vehicle
OTH : Others

Table 3-12 VEHICLES BY COMMODITY (HGV ONLY) TO ACCRA DIRECTION

| Item | Vehicle | |
|---|---|---|
| Cocoa | 2 | ( 5) |
| Wheat | 4 | ( 10) |
| Timber | 6 | ( 14) |
| Fish | 1 | ( 2) |
| Cement | 15 | ( 38) |
| Fuel | 4 | ( 10) |
| Oil Palm | 1 | ( 2) |
| Tobacco | 3 | ( 7) |
| Electric Appliance | 1 | ( 2) |
| Fertilizer | 2 | ( 5) |
| Total | 39 | (100) |

TO TAKORADI DIRECTION

| Item | Vehicle | |
|---|---|---|
| Timber | 48 | ( 69) |
| Fuel | 9 | ( 13) |
| Bitumen | 2 | ( 3) |
| Cocoa | 4 | ( 6) |
| Vegetable | 3 | ( 4) |
| Fruit | 1 | ( 1) |
| Beer | 1 | ( 1) |
| Fertilizer | 2 | ( 3) |
| Total | 70 | (100) |

(3) Distribution of traffic and passengers by time zone

Table 3-13 shows the distribution of traffic and passengers computed on the basis of the first day sampled number of vehicles. The peak or maximum traffic toward Takoradi direction was observed during the hours 6:00 - 12:00. The Heavy Good Vehicles carrying timber (referred to as ST: Special truck) accounted for 50% of the total vehicles. This means timber from Kumasi is transported on the same day to Takoradi Port for export, thus producing traffic that is concentrated on the existing Beposo Bridge during that time zone.

Since the average daily traffic of such special trucks are estimated at around 220 from the sampling ratio and one truck carries $15m^3$ of timber on average, about 80,000 vehicles transport 1.2 million $m^3$ of timber to Takoradi Port passing over the existing Beposo Bridge. These analyses conform to those generally made in Chapter 2.

The numbers of passenger are distributed almost equally during the hours 6:00 - 24:00. The traffic towards Accra also shows its number of value during the hours 6:00 - 12:00. Especially passengers vehicle is the maximum, about 400 or 40% of all vehicles, during on the time zone.

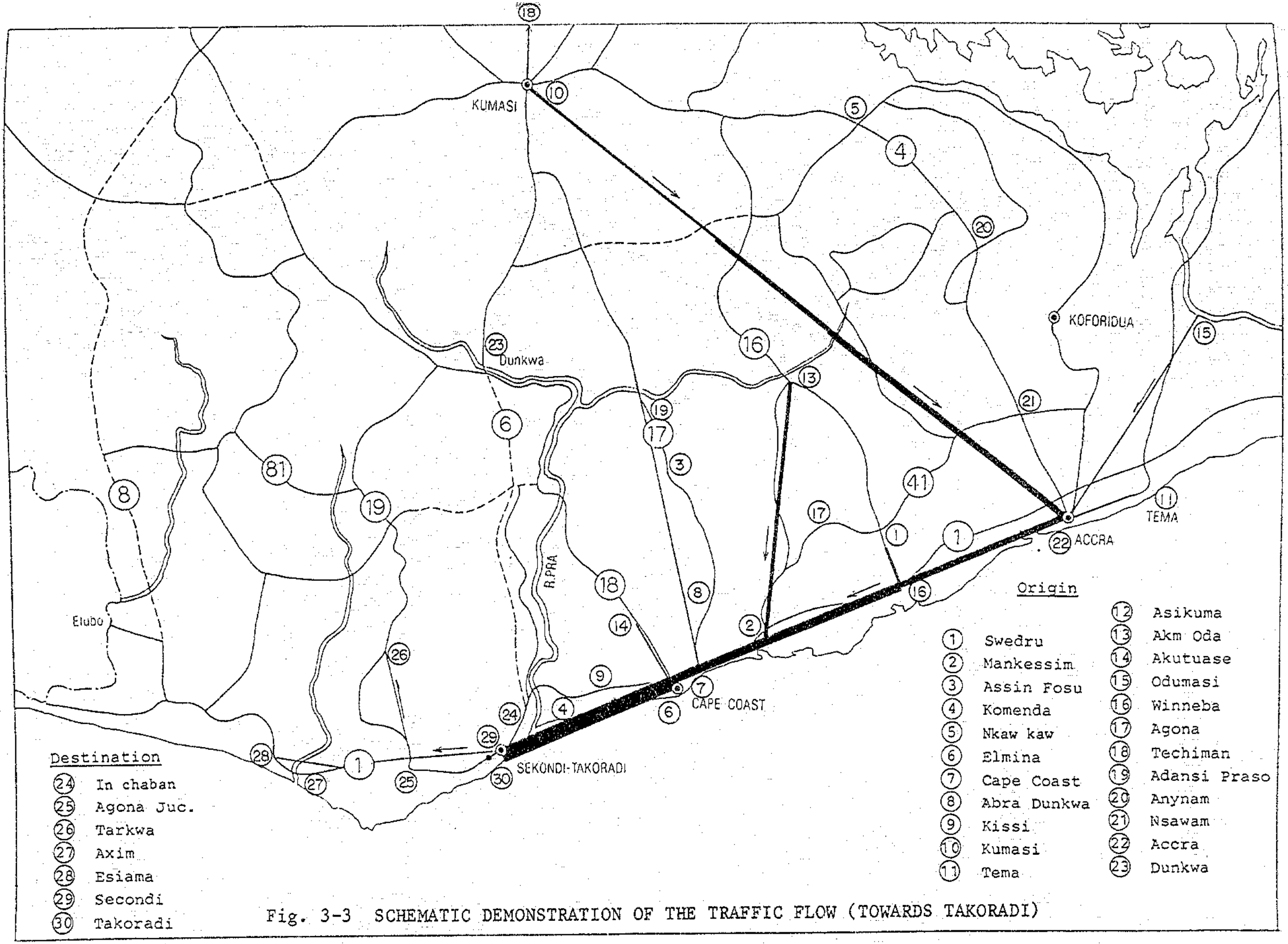



Fig. 3-3 SCHEMATIC DEMONSTRATION OF THE TRAFFIC FLOW (TOWARDS TAKORADI)

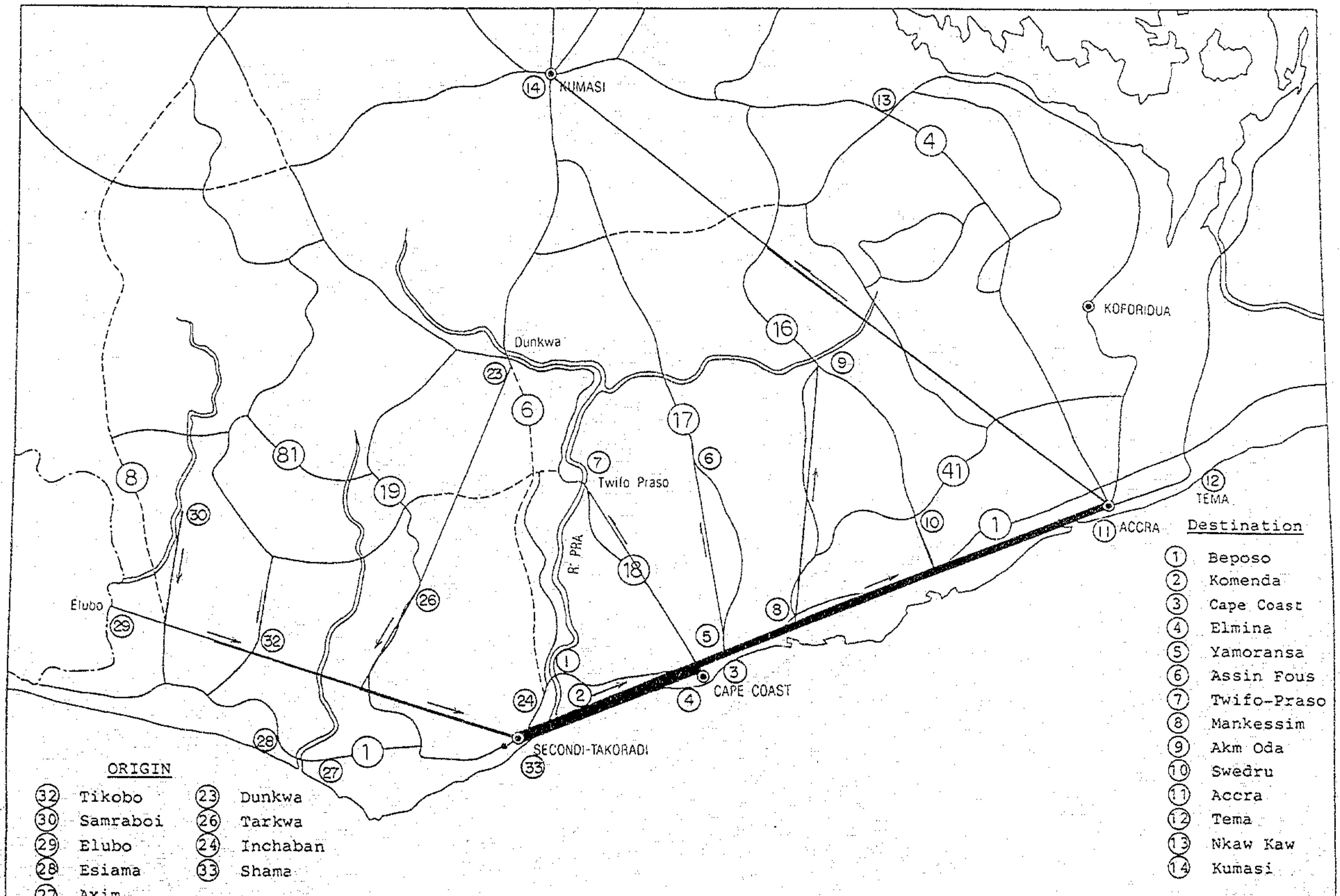



Fig. 3-4 SCHEMATIC DEMONSTRATION OF THE TRAFFIC FLOW (TOWARDS ACCRA DIRECTION)

Table 3-13 DISTRIBUTION OF TRAFFIC AND PASSENGER BY TIME ZONE

| Time / Description | 0:00 6:00 | 6:00 12:00 | 12:00 18:00 | 18:00 24:00 | Total |
|---|---|---|---|---|---|
| Accra/Takoradi | | | | | |
| Passenger | 25 | 345 | 449 | 448 | 1,267 |
| Vehicle | 5 | 32 | 24 | 14 | 75 |
| Passenger car | 4 | 5 | 5 | 3 | 17 |
| Mini bus | 0 | 3 | 6 | 2 | 11 |
| Bus | 0 | 5 | 5 | 7 | 17 |
| Light good vehicle | 0 | 1 | 0 | 0 | 1 |
| Light truck | 1 | 0 | 3 | 2 | 6 |
| Truck | 0 | 2 | 1 | 0 | 3 |
| Special truck | 0 | 16 | 4 | 0 | 20 |
| Takoradi/Accra | | | | | |
| Passenger | 354 | 778 | 491 | 385 | 2,008 |
| Vehicle | 15 | 27 | 17 | 18 | 77 |
| Passenger car | 2 | 4 | 4 | 5 | 15 |
| Mini bus | 4 | 7 | 2 | 2 | 15 |
| Bus | 8 | 9 | 7 | 3 | 27 |
| Light good vehicle | 0 | 0 | 0 | 2 | 2 |
| Light truck | 1 | 0 | 1 | 1 | 3 |
| Truck | 0 | 1 | 1 | 5 | 7 |
| Special truck | 0 | 6 | 2 | 0 | 8 |

## 3-2 Physical Condition

### 3-2-1 Climate

(1) Rainfall

The Beposo area experiences two climatic seasons in a year - the wet and the dry seasons. The wet season usually extends from the middle of March to the end of October. The rainy season has two peaks - a major peak occurring between May and June and a minor peak normally in September/October. Between these two peaks, that is in July and august, there is a relatively dry period when the rainfall temporarily recedes. Annual average rainfall is approximately 1,300 mm.

The period between November and February is normally dry when the area is subjected to the north-east trade locally referred to as the HARMATAAN.

Monthly average rainfall are shown bellow:

Table 3-14 AVERAGE MONTHLY RAINFALL (FOR 30 YEARS)

| Month | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rain-fall | 38.1 | 50.8 | 114.3 | 127.0 | 228.6 | 274.3 | 101.6 | 50.8 | 76.2 | 165.1 | 119.4 | 38.1 | 1,384.3 |

Source: Mean Monthly and Annual rainfall Maps, Ghana Meteorological Service Dept.

(2) Temperature

The Beposo area lies in a moist semi-deciduous forest.

The annual average daily temperature is around 30 degrees Celsius. There are, however, considerable variation in daily temperatures recorded over the year. The highest temperatures are usually recorded just before the start of the rainy season; while the lowest temperatures are normally recorded in July and august.

The site lies in an area of high humidity. The thick vegetation cover retains moisture during the rainy season which, combined with high daytime temperatures, leads to high relative humidities usually above 80% during the day. The relative humidity, however, drops to the lower seventies and sometimes below 70% during the dry season.

### 3-2-2 River Hydrology

(1) General

The Pra is one of the major rivers in Ghana with catchment area of about 22,700 sq. km and length of about 240 km. It flows in an almost north-south direction and enters the Sea at Shama about 10 km south of Beposo. Its main tributaries are the Birim, Ofin and the Anum river as shown in Figure 3-5.

The discharge at Beposo varies by the season. Maximum flows occur after the peak of the rainy season with the minimum flows recorded at the end of the dry season; that is just before the onset of the rains.

During periods of low flows, it is usual for the tidal waves of the sea to cause backflow of the river up to and beyond the Beposo bridge with resultant sea water contamination of the river water.

As no flood records are available at the proposed site, the gauge and discharge data at Daboasi Gauge Station, 4.5 km upstream of Beposo have been collected for examination.

(2) Maximum Flood Level

1) Flood level assessed from interviews

Interviews with local villagers revealed that the flood level experienced has been about 0.3 m above the road surface in front of GHA traffic regulation office. The Water level was estimated to be MSL + 5.50 m.

At high flood levels, the west approach road becomes inundated sometimes disrupting traffic for days.

2) Flood level analyzed from discharge data

According to flood analysis of the gauge and discharge data at the Daboasi Gauge Station, the maximum recorded flood level was MSL + 7.2 m which occurred in 1968. It reduces to MSL + 5.5 m at proposed site (see Fig. 3-6)

(3) Design Discharge and Flood Level

Peak discharge for 50-year return period flood have been adopted for the basic design. The discharge at Daboasi Gauge Station has been obtained from Gumbel method. Design discharge and corresponding flood level at the proposed site have been obtained from Figure 3-6.

$Q = 1,560\ m^3/sec$
$H = MSL + 5.5\ m$

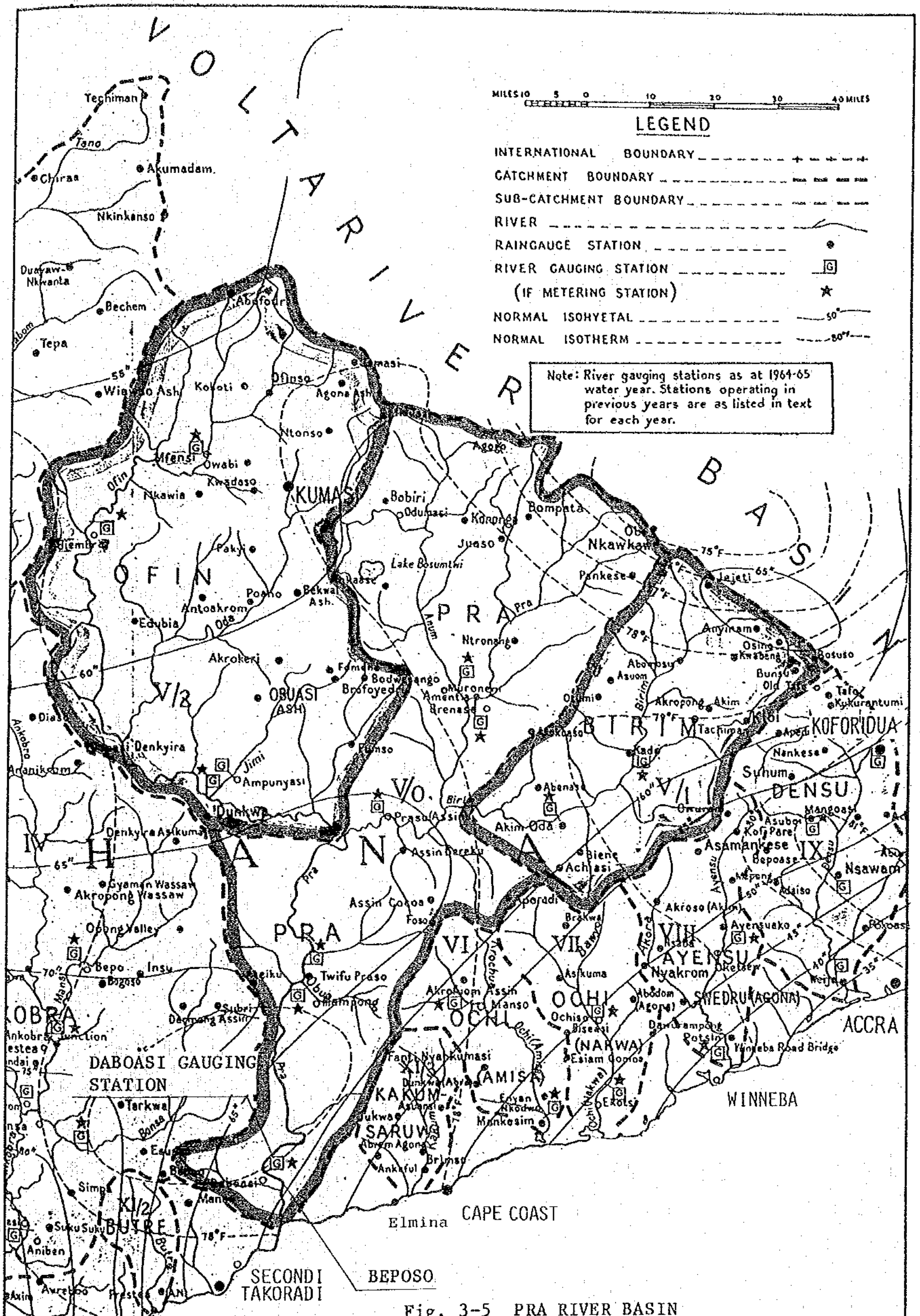



Fig. 3-5 PRA RIVER BASIN

Source: Hydrological Services of Ghana

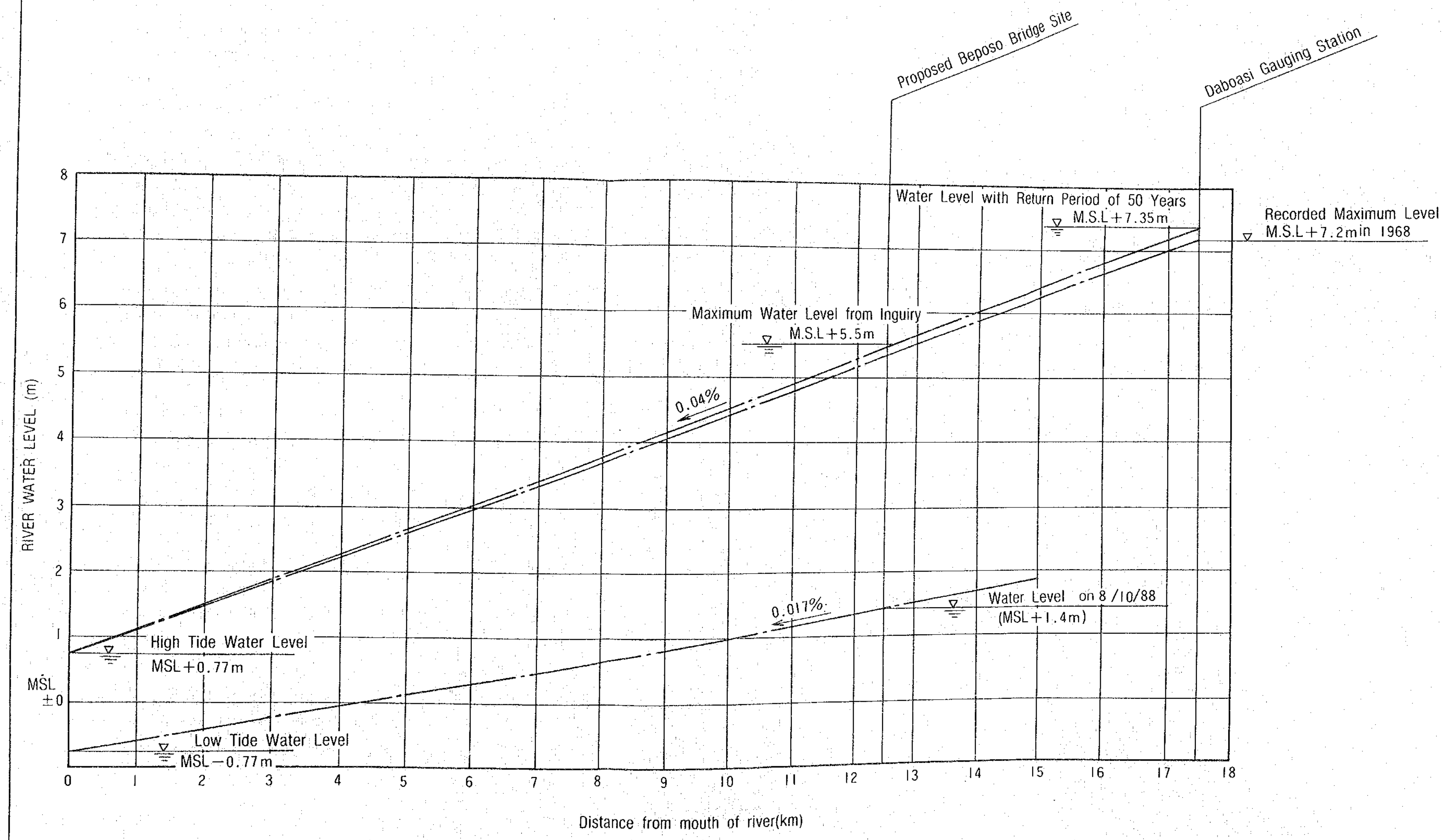



Fig. 3-6 RIVER WATER SURFACE PROFILE

### 3-2-3 Geotechnical Investigation

(1) Field Survey

Field survey comprising four boreholes - one at the east abutment, two at the west abutment and one in the middle of the river - was carried out.

The holes were advanced by shell and auger with steel casings in the overburden when chiselling failed to advance the holes appreciably, rotary drilling with water flush was resorted to. Insitu Standard and Dynamic cone Penetration Tests were carried out in the overburden as drilling progressed. Undisturbed and disturbed samples were recovered for examination and laboratory analysis.

NX core samples of 55 m diameter were obtained from the rotary drilling in the bedrock.

Borehole logs and penetration test results are summarized in the attached Annex 3.3.

(2) Laboratory Investigation

The disturbed and SPT samples recovered from the drilling have been tested for the following:-

Atterberg Limits,
Moisture Content, and
Particle Size Distribution

In addition to these tests, the undisturbed samples have been subjected to the unconsolidated undrained triaxial and the unconfined compression tests. Other tests have included the determination of the wet density and the specific gravity.

Samples of the groundwater and the river water recovered during the investigations have also been tested for the presence of ions known to be deleterious to ordinary portland cement.

The laboratory test results are summarized in the attached Annex. 3.2

(3) Ground Conditions

In March 1984, Cementation International Ltd., carried out an extensive subsoil investigation at the site of a proposed replacement bridge, the centre of which would have been located 8 m from the down stream face of the existing bridge. The information obtained from this study has been summarised in attached Annex 2.1 (2) and has been used to supplement information obtained from the present investigation.

It is inferred from the information available from the present investigations and the earlier one by Cementation International in 1984 that at the location of the proposed bridge the east bank has been cut in residual soil formed over the underlying granitic gneiss bedrock. The west bank, on the other hand, is underlain by alluvium overlying transported sands and gravels which overline the granitic gneiss bedrock.

In the river channel, the bedrock is either bare or is covered by a thin layer of transported sand and gravel. The borehole logs and the penetration test results are summarised in the attached Annex 3.3.

The drilling at the proposed east abutment position revealed the presence of 1.2 m of stiff to very stiff sandy CLAY the top 0.4 m of which had some organic matter. The Standard Penetration Test carried out at a depth 0.6 m recorded at N value of 28. The sandy clay layer is believed to be the direct product of the weathering of the underlying bedrock.

The sandy clay overlies 1.8 m of completely weathered rock which in turn overlies 1.4 m of highly weathered, fractured, GNEISS. The highly weathered gneiss is underlain by weathered to slightly weathered gneiss which grades into fresh granitic gneiss at elevation 1.64 or 6 m below ground level.

The field and laboratory investigations indicate that the west bank is underlain by 0.5 to 0.6 m of organic silt (top soil). This overlies 2-3 m of soft to firm alluvial sandy silt and sandy clay. Four Standard Penetration values recorded in these layers ranged from 5 to 7 with an average of 6. Typical particle size distribution curves for the alluvial silt and clay are given in attached Annex 3.2 (1).

The alluvial silts and clays are underlain by 1 to 3 m of loose medium sand with gravel. The gravel fraction was rounded indicating that the material has been transported. Shells were also present in this layer. Four SPT values of 5,6,7, and 31 were recorded in this layer. A critical examination of the borehole records shows that the value of 31 was obtained when testing was inadvertently carried out in a casing.

Typical particle size distribution curves for the SAND with gravel layer are shown in attached Annex 3.2 (4). The loose sand layer is underlain by about 1 m of moderately to slightly weathered, fractured, gneiss which grades into slightly weathered to fresh bedrock.

Soil profile along proposed bridge are given in the attached Annex 2.1 (3).

### 3-2-4 Topographic Survey

Topographic survey was carried out in parallel to the existing approach roads. It covered about 500 m stretch at the east bank side towards Accra and about 600m at the west bank towards Takoradi over a width of 50 m southwards from the edge of the existing road. These survey results are shown in attached Annex 2.1 (4).

### 3-2-5 Hydrographic survey

Hydrographic survey was performed over an area 150 m upstream and 150 m downstream of the centreline of the existing bridge. The results are also summarized in Annex 2.1 (4). The detailed plan, and profile of the river where the proposed new bridge would be located are shown in maps with scale 1/200, Annex 2.1 (5).

The bench mark used for the levelling is a national bench mark No. GCS/1502, M.S.L + 6.361, located within the compound of the police station on east bank of river Pra.

# CHAPTER 4

# THE PROJECT

## CHAPTER 4

## THE PROJECT

### 4-1 Objectives of the Project

The primary objective of the project is to replace existing Beposo Bridge, which faces serious danger of falling, and thus provide safe means of crossing Pra River. This should consequently raise the efficiency of transportation on National Route 1 which is required for the stable development of economy of Ghana. The traffic and physical problems with the existing bridge are as follows:

1) Development of cracks on the deck slab, which can result in the collapse of bridge deck and thus cause disruption in traffic flow.

2) Overall repair is required due to occurrence of corrosion on the steel structural members and consequential distress of the main support trusses,

3) Difficulty of undertaking thorough repair works due to the fact that the bridge has one lane carriage way only,

4) There are no detours to divert the current traffic in the event of closure of the bridge for thorough repair works,

5) Low efficiency of transportation due to vehicle weight limitation and alternate one-way traffic control, and

6) There will be no spare traffic capacity on the existing bridge to accommodate extra traffic in the near future due to the rapid growth of traffic.

### 4-2 Examination on Content of the Request

Content of the request are described in clause 2.5.

The request, confirmed based on the results of the basic design study, is as follow:

1) Construction of new concrete bridge of 2-lane and 142 m long with clear span of 100 m, close to the existing bridge and

2) Construction of approach roads of 260 m on east bank and 360 m on west bank.

## 4-3 Outline of Existing Beposo Bridge

### 4-3-1 Condition of Existing Beposo Bridge

The existing Beposo Bridge constructed in 1934 is a one spanned, suspension bridge with steel warren truss girder. It is 99.25 m long between the towers and 96.35 m between the abutment faces, and it has only one lane of 5.5 m wide and side walks of 1.25 m on both sides.

At present, the alternate one-way traffic controls are conducted by the GHA staff at the both ends of the bridge. It appears that the bridge has not been well maintained.

The bridge is already 54 years old. As it is located on the National Route 1 which functions as one of the most important trunk roads, and part of the Trans West African Highway running from Abidjan through Accra to Lome, it has long been subjected to increase of traffic of heavy vehicles.

These are causing accumulated fatigues in the main structural members of bridge, such as hanger, truss, the girder, etc. As the initial design documents could not be traced, a general plan of the bridge has been produced as per the attached Annex 2.1 (1).

The outline of the structure is as follows:

(1) Tower

The towers, with a section of 530 mm x 600 mm, are made of 2 I-shaped steel joined by tie plates. On the tops of two towers the howe truss girder is laid, and the pratt truss girder is erected on the middle of towers respectively as formulate the portal at the both side of the bridge. The towers are supported by rocker bearings.

(2) main cable

The main cable is composed of two bundles embracing 7 wire ropes, and these ropes are anchored into the anchor block in a shape of a fan. As socket alloy is used for the anchorage of wires, part of the socket is exposed. The anchored frame can not be seen.

(3) Hanger

Hanger made of 65 mm dia steel bar is clamped by saddle to the main cable.

(4) Main truss girder

The main truss girder is a warren-pony truss type with a span of 98.05 m. The main structural member is made of 2-channel shaped steel joined back to back by tie-plates placed at interval of 150 mm. The width of the structural member is 350 mm, the height of upper member is 310 mm and the lower 300 mm. The upper member is reinforced by combined steel of 200 mm high. The diagonal member is made of channel shaped steel 150 mm x 90 mm x 9 mm, stiffened by L-typed steel 80 m x 80 m x 10 mm.

(5) Floor System

The lateral beam, I-shaped steel 200 mm x 600 mm x 200 mm, is placed just under the panel point of the main truss girder. At both ends of the beam, the hangers are fixed to support the main truss girder.

(6) Deck

Deck is R.C concrete slab of 230 m thick. The width and height of curb are 100 mm and 150 mm respectively. On the sidewalks, there are no curbs, and the hand rail is supported by 60 mm x 60 mm x 9 mm L-typed steel fixed directly onto the deck. The two pipe hand rails of the carriageway are fixed directly on the side of main truss girder.

### 4-3-2 Problems of the Existing Bridge

The existing Beposo Bridge has been generally superannuated because it has been in existence for more than 5 decades after its completion. In order to extend the serviceable life of the facility, it is evident that extensive and thorough reinforcement or repair works shall be required.

It will, however, be costly and time consuming to carry out the inspections and investigation of the foundation, measurement of the actual stress on the members, sampling of specimen of members for check for fatigues, etc. in order to assess how the bridge should be reinforced and repaired. As a result, the extensive cost of reinforcement and repair works may exceed the reconstruction cost.

In this basic design study, the traffic and physical problems inspected visually are as follows:

(1) Increase in traffic and vehicle weight

The present volume of traffic and the weight of vehicles with commodities using the bridge have increased greatly compared with those when the bridge was constructed. In particular, the volume of special heavy truck or trailer (25 to 35 ton) for the transportation of timber has reached 200 to 300 per day and this puts a lot of strain on the bridge facilities.

Should it be necessary to continue using the bridge, it is indispensable to check as soon as possible, the stability and safety of main structural components such as main cables, hangers and truss girder, as well as floor construction, longitudinal beams and deck slab in accordance with both HA and HB loadings.

(2) Traffic capacity of existing bridge

Since an alternate one-way traffic control and vehicle weight regulation are both applied at present, the running speed of vehicles are necessarily restricted to 20 km/hr on the average, and this gives the traffic capacity on the bridge as

$$N = 1000\ V/S = 1000 \times 20/200$$
$$= 100\ \text{(vehicle/hr)},$$

Where,

$S$ = bridge length (100 m) + distance of passing place (100 m) = 200 (m)

Subsequently, the limit of traffic capacity of existing bridge during 12 hours

100 (vehicle/hr) x 12 (hours) = 1200 (vehicle/day)

On the contrary, the current traffic on the bridge have increased upto more than 1200 (vehicles/12 hours), hence, it is required to expand one carriage lane to two lanes.

(3) Physical failure of the members

1) Corrosion of longitudinal beams (channel shaped steel).

2) Occurrence of cracks in two places on the deck.
Size of cracked areas about 6 m x 6 m

3) Failure on the expansion joints: crashing sounds are heard when the vehicles pass.

(4) Slipping of hanger clamp metal

Due to accumulation of loads exceeding the designed load, the hanger clamps near the tower have slipped downward along on the cable, causing an imbalance in the distribution of load on the main cable.

(5) Repair and coating

Repair and coating of members will be needed to extend their physical lives. As inspected visually, there are no breakages in the steel wires themselves, however, there are failures of cable lapping in some parts making the cables bare at places.

(6) Installation of water main

As it is presently planned to construct a dam to supply water to Cape Coast (and Takoradi), installation of water to persons and industries in mains of dia. 600 mm accross River Pra at Beposo has to be considered.

## 4-4 Implementation of the Project

(1) Implementing Agency

Implementing agency for the Project is Ghana Highway Authority (GHA) which is a Governmental autonomous body under the superintendency of the Ministry of Highways and Roads (MRH). Fig. 2-5 and 2-6 give organization charts of MRH and GHA respectively.

(2) Basic Construction Plan

Basic construction plan of the project is as follows:-

1) Construction of new bridge 23 m downstream from the center of the existing bridge.

2) No bridge piers to be constructed in the river due to difficulty of its submergible execution,

3) Two lane carriage way and side walk on both side to be provided on the bridge,

4) Bridge shall be of type to allow for installation of 600 m water main, and

5) Bridge shall be of type to minimize future maintenance cost.

# CHAPTER 5

# BASIC DESIGN

# CHAPTER 5

# BASIC DESIGN

## 5-1 Basic Design Policy

Basic design policy for reconstructing the Beposo Bridge will be formulated taking into account the characteristics of Project examined and analyzed in the preceding chapters.

### 5-1-1 General Requirement

The following is generally required to be considered in selecting the type of bridge and ancillary facilities:

(1) Foreign Aid Plogramme

As project may be implemented under the Japan's foreign aid programme, it will be required to transfer to the technical persons of the recipient country, technical knowledge related to the project engineering, and to contribute to social stability through the execution of the project engineering, and to contribute to social stability through the execution of the project. The following items will be given particular consideration in selecting bridge type and construction method, taking into account the aid programme's objectives stated above:

1) Ease of construction at site,

2) Maximum use of local construction materials,

3) Creation of employment opportunity in the locality,

4) Technical transfer through the project implementation.

(2) Specific Physical Condition on the Site

Water depth of the channel is more than 10 metres at the time of low tide and this is influenced by the sea, and hard rocks are generally exposed in the channel. Consequently, construction of the piers in the river would not be very preferable considering the difficulty of coffering by sheet piles which should be driven into the hard rocks.

Bridge type requiring smaller space of construction yards would be advantageous due to the narrow working spaces on site. The channel of the existing bridge is forced to be narrow due to the bottleneck on river as shown in attached hydrographical maps. Thus, bridge type which does not obstruct the river flow would be a better choice.

(3) Construction Cost and Period

As the period of project implementation is limited, the bridge type which requires less construction time will be selected. Construction method shall not be vulnerable to weather conditions.

(4) Maintenance Aspect

It is desirable that bridge type should be that which will require the least maintenance.

(5) Appearance

The bridge forms an important link of the Trans West African Route. It is also very important domestically, serving as a link between the centres of production and consumption. It also carries commodities to Takoradi Port for export.

If the Project is implemented under the Japanese grant aid programme, the project bridge would be, monumental work for Ghana and Japan. Hence, the bridge type should be selected to blend harmoniously with the surroundings.

## 5-1-2 Design Requirement

(1) Maximum use of existing road facilities

Abutment of the new bridge should be placed as close as possible to existing abutment, in order to reduce the length and cost of the approach roads.

It is most preferable that the new bridge be located immediately downstream because existing abutments shall protect those of the new one. The following conditions shall be taken into account in determining the location of the bridge:

1) Bedrock on the west bank lies lower than that of existing bridge,

2) There is a low lying marshy area on the west bank,

3) River becomes gradually wider towards downstream after passing the existing bridge.

(2) Number of span

It is interesting to note that the existing bridge was constructed as a suspension type of bridge in 1934 in Africa.

Bailey bridge with some piers could have been adopted at that time instead of suspension bridge, if the condition of the river bed allowed.

This implies that it was very difficult to construct piers in the deep valey-shaped river. Practically, it would be very difficult to secure the construction space for the pier by driving the sheet piles into the hard rocks. This explains why the suspension bridge spanning over the river was adopted at that time.

Taking into account these same difficulties, single span type of bridge will be advantageous.

(3) Type of Bridge

In terms of case of maintenance, concrete structure is superior to steel structure.

## 5-2 Examination of Design and Construction Criteria

### 5-2-1 Subsoil Condition

(1) The river channel at the site is bordered at the west bank by alluvial sediments and at the east bank by residual soil formed over the gneiss bedrock.

The alluvial deposits at the west bank are very soft to firm; and loose for the cohesionless layers. The Standard Penetration Test indicated allowable bearing stresses in the range of 5 - 10 $t/m^2$ for these deposits. The allowable bearing stresses for the deposits at the west bank may therefore be regarded as low. The bottom of the channel is around elevation -12 m. These sediments placed at higher elevations may therefore be expected to be susceptible to scouring at high flood levels.

Thus, not only would placing the substructures in the alluvial sediments or in the sand layer lead to uneconomic design and probably to large settlements, scouring could undermine the foundations leading to failure. It would therefore be expedient to found the substructure at the west bank on or in the slightly weathered gneiss bedrock; or at depths of around 6 m below ground level.

At the east abutment; highly weathered rock was encountered at shallow depths of only around 1.5 m below ground level. Though adequate bearing capacity may be derived from the completely weathered bedrock and is unlikely to be subjected to the effects of scour at high flood levels, it may be advisable to place the foundations below the completely weathered bedrock and into the moderately to slightly weathered rock at approximately elevation, MSL + 0.9 m - that is, around 4.5 m below ground level.

(2) Foundation for Road Embankment

Approach roads will be designed as embankment on both banks. The foundation conditions for the embankment are much different on either side.

Drilling and standard penetration test revealed that the west bank is underlain by soft layer of alluvial deposits of 4 - 6 m thick which overlie the slightly weathered bedrock and groundwater exist near the surface

Countermeasures for filling without failure will be required for the foundation as viewed from the above conditions. The following three factors have therefore been examined:

1) Trafficability for construction equipment

Sandmat will be used to enable construction equipment to pass on the soft ground. This method will simultaneously accelerate the settlement of soft layers.

Lateral reinforcement of bamboo or a geofiberic may also be used under sandmat to strengthen foundation for the passage of construction equipment and, improve the stability of the embankment.

The use of the bamboo is expected to boost to the use of local materials for engineered roads.

2) Settlement Acceleration and Prevention of Sliding

As the embankment height on the west bank shall be from 2.0 m to 8.0 m, it is required to accelerate the consolidation of the soft layer by placement of sandmat.

In order to prevent foundation failure from the rapid fill works, it is recommended that the rate of fill works be lowered to about or less than 0.3 m in height per week.

3) Lateral earth pressure on west bank abutment

Lateral pressure acting on the side face of abutment can be reduced by increasing the strength of the soft ground; it will be attained by the "slow embankment method".

As for remedial measures to overcome the differential settlement behind abutment, surcharge method will be used to minimize the residual settlement. This method is effective in accelerating the consolidation of the soft ground layers.

An approach cushion slab will be employed to minimize the remedial works. The basic materials of the east bank area are products of weathering of gneiss, and are classified as very sound for the foundation of the embankment.

### 5-2-2 Pavement

In case concrete pavement shall be applied, it will be required to restrict the settlements within a range not to cause the requirement of overlay. Surcharge method is recommended for the works.

### 5-2-3 Geometric Design Standard

Road type for the project shall have the standards of a primary road. Terrain is hilly and major geometric design parameters will be as follows:-

1) Road type: Primary Road
2) Design Speed: 80 km/hr
3) Maximum Gradient: 4%
4) Minimum Radius: 420 m (Desirable), 230 m (Absolute)
5) Vertical Curvature on the Bridge: 5,000 m

## 5-3 Basic Design

### 5-3-1 Decision on the Bridge Location

(1) Proposed Construction Site

Existing Beposo Bridge is located on the National Highway 1 across the Pra river. The bridge is located about 12.5 km upstream from the mouth of the sea. The bottleneck condition of the river channel at the site is shown on Fig. 5-1.

Rock outcrop is observed on the east bank, while, the west bank is underlain by soft alluvial deposits.

(2) Location of the bridge

Three possible alternative routes have been examined and compared as shown in Fig. 5-1:

1) About 30 m upstream from existing bridge,
2) Immediate downstream from existing bridge, and
3) 100 m downstream from existing bridge.

In the practical examination of the alternative routes, following conditions were taken into consideration;-

1) Sobsoil condition
2) River width and curvature
3) Approach road length and horizontal alignment

As a result, the alternative plan II is selected. The reasons are summarized in Table 5-1.

(3) Spacing of existing and proposed bridges

It is more desirable that proposed bridge be located close to the existing bridge in order to minimize the cost of approach roads. In this case, an adequate gap between existing and proposed bridges, however, has to be kept to protect existing bridge abutment and anchor block from the construction work.

Consequently, it was decided that the centerline of the proposed bridge should be about 23 m downstream from that of the existing Beposo Bridge.

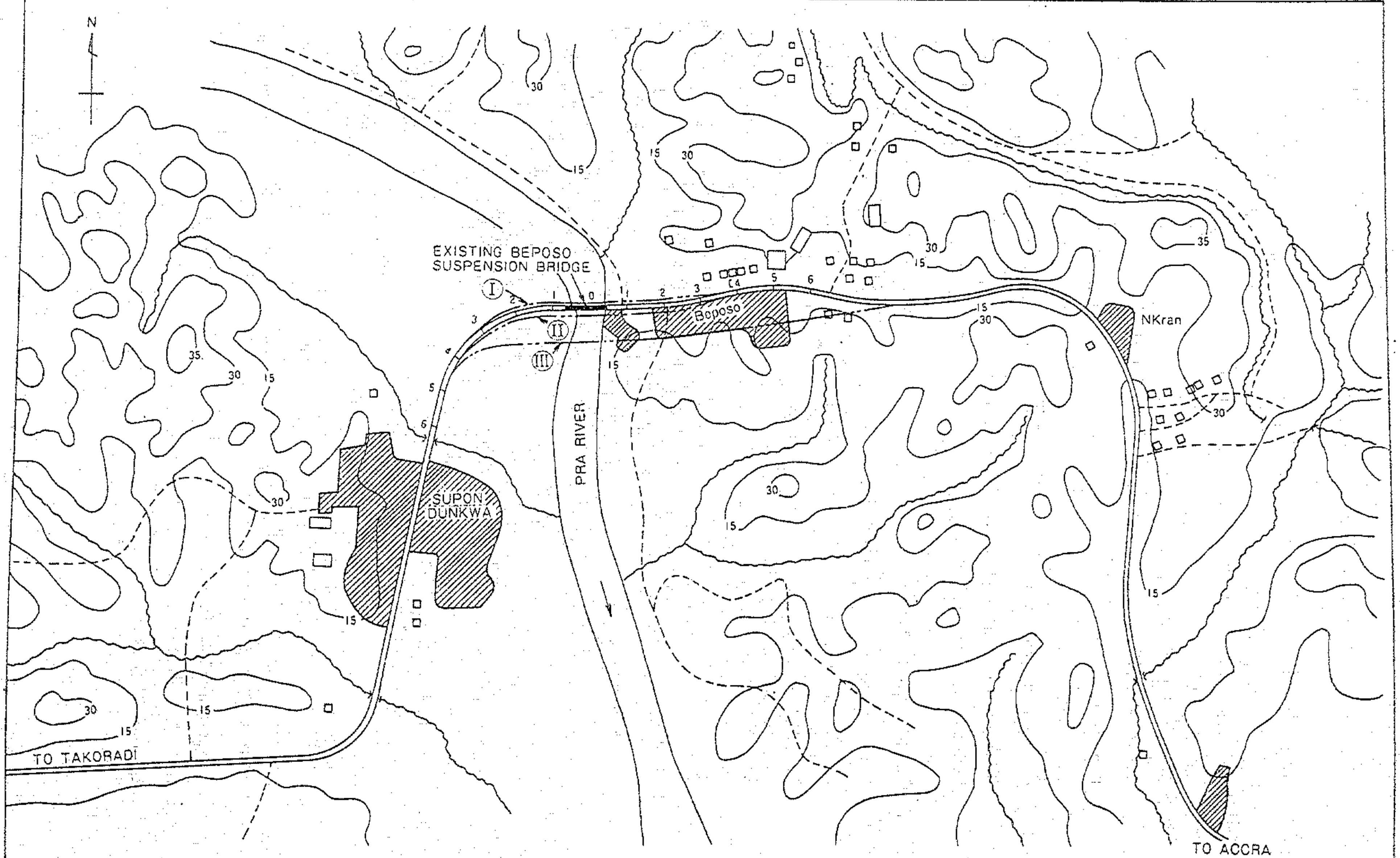



Fig. 5-1 ALTERNATIVE ROUTES

Table 5-1 EXAMINATION OF POSSIBLE LOCATIONS

| | ALTERNATIVE I | ALTERNATIVE II | ALTERNATIVE III |
|---|---|---|---|
| Length of Bridge | 115 m | 100 m | 110 m |
| Length of Approach Road | 920 m | 620 m | 1600 m |
| Horizontal Alignment | △ | ○ | ◎ |
| Construction Cost | △ | ◎ | △ |
| Construction Period | △ | ◎ | △ |
| Ranking | 2 | 1 | 3 |
| Description | Bedrock on the west bank is considerably lower than that on which existing bridge is founded<br><br>There is a low lying marshy on the west bank.<br><br>Bridge becomes longer due to the large width channel.<br><br>Poor horizontal alignment and longer approach road | Rock outcrop is exposed on the east bank. Geological condition on the west bank is almost same as for Alternative I.<br><br>Bridge crosses the narrowest point. | It is expected that both sides of bank are underlain by thick alluvial deposit.<br><br>Good horizontal alignment but the longest approach road. |

Alternative I : 30 m upstream of the existing bridge
Alternative II : Immediately downstream of the existing bridge
Alternative III : About 100 m downstream of the existing bridge